Inflation persistence and bargained firing costs

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Abstract

This paper develops a New-Keynesian model with a search and matching labor market with firing costs. I study the implications for inflation persistence of the introduction of severance payment and bargained firing costs. Previous literature tried to explain inflation persistence thanks to a labor market à la Mortensen and Pissarides (1994). Trigari (2006) and Christoffel et al. (2009) have shown that wage channel and labor market institution are both necessary to reproduce the inflation persistence. Following this literature, I consider the following modeling setups: first I assume that firing costs are composed by severance payment (a transfer from firms to workers) and by a tax component (imposed by the government). Then, I introduce a bargaining between firms and workers on the firing costs’ transfer component. As in Gari-baldi and Violante (2002, 2005) I show that, despite the Lazear bonding critique the transfer component of firing acts differently than the firing costs’ tax component. Indeed, while with only the firing costs’ tax component, firms pay the entire job protection, I show that with severance payment, workers pay a contribution to their own job protection. Finally, I show that in a Right-to-Manage wage’s bargaining framework, the workers’ contribution to their job protection introduce a new dynamic in wages. This new dynamic rises substantially the inflation persistence and it make us able to explain the inflation dynamic as it is observed in the empirical data.

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1 Introduction

Even if inflation seems to be a controlled variable that well by all the Central Banks around the world, its dynamic and its origins are not understood as well. In particular, Fuhrer (2010) puts forward two interesting facts: first, the degree of inflation persistence decreased during the last decade; second, inflation persistence is still present in empirical data. The first phenomenon can be explained by the fact that Central Bankers now have some forward-looking expectations when they run the monetary policy. By doing this, Central Bankers reduce what Fuhrer (2010) calls the intrinsic persistence of inflation. On the second hand, inherited persistence is still present and continues to affect the monetary policy without economists can perfectly understand it.

Because of the New Phillips Curve (NPC) which bridges directly the inflation level and the firms marginal costs, the labor market plays then a fundamental role in inflation persistence. By taking into account a price rigidity à la Rotemberg (1982) or à la Calvo (1983), a large part of the existing literature tried to reproduce the degree of inflation persistence. For instance, Christiano et al. (2005) study the importance of the nominal rigidity of wage in a monopolistic competitive economy. These authors demonstrated that rather than real rigidities, nominal rigidity are necessary to match the empirical data. Nevertheless, Blanchard and Gali (2007) demonstrate that although real rigidities can not reproduce the degree of inflation persistence, it can allow the standard new-Keynesian model for matching the dynamic of inflation in a qualitative way. Finally, Tsoukis et al. (2011) show that even in presence of rigidity à la Rotemberg or à la Calvo, the NPC can not explain by itself inflation persistence.

Nevertheless, New Keynesian models offer new perspectives to understand inflation persistence. In these models, firms produce only with labor as input. Because there is no capital in the short run of the new Keynesian models, economists focus on the dynamic of wage. Especially, they focus on the labor market institutions which are mainly the wage bargaining process, the worker protection and the employment protection. Following Mortensen and Pissarides (1994) model of the labor market, Trigari (2006), Christoffel et al. (2009a)1 and Christoffel and Linzert (2010)2 show that taking into account the wage bargaining in new keynesian models leads to a hourly wage which depends directly on the labor market tightness and on unemployment benefits. Secondly, according to the type of bargaining used - efficient bargaining or right-to-manage bargaining - two transmission canals from the wage dynamic to inflation persistence exist: the extensive margin channel and the wage channel, as expressed by Trigari (2006). Finally, while the extensive margin channel links indirectly through the marginal rate of substitution between leisure and consumption the wage dynamic to inflation persistence, the wage channel links both of them directly.

These authors show the importance of the labor market institutions in inflation persistence, without achieving to reproduce inflation persistence.

In this paper, I propose to introduce severance payments into a DSGE model with search and matching frictions. Since the work of Lazear (1990), severance payment of firing costs have been rejected of theoretical models. Indeed, severance payments represent a transfer from firms

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1. This article makes a survey of different hypotheses which are made in order to explain inflation persistence. For example, Ravenna et al. (2008) propose to introduce into the Trigari’s model a contemporaneous hiring rather than previously a lag before a new worker takes on a job. Krause and Lubik (2006) and Van Zandweghe (2010) introduce on-the-job search. Christoffel et al. (2009a) compare all of these hypotheses and conclude that the dynamic of wage has the most significant impact on inflation persistence.

2. In this paper, the authors introduce wage rigidity into a DSGE model with wage bargaining via a social norm upon the wage level. The authors compare the impact of the social norm on the labor market flows to the impact of job protection. However, the author admit that this way to model the employment protection does not take into account the impact of employment on wage dynamic.
to workers which undone by modifications in wages in case of perfect flexible wage bargaining framework. This theoretical point is known as the bonding critique. However, recently Garibaldi and Violante (2002, 2005) show that severance payments must be reintroduced into theoretical models for two main reasons. First, they are at least as important quantitatively as taxes in global firing costs. For Italy, they represent approximately 80% of global firing costs. Secondly, severance payments and tax component of firing costs have the same impact on employment only in case of full wage rigidity.

The aim of this paper is to investigate the impact of severance payment on inflation persistence. To do so, I model firing costs as Garibaldi and Violante (2005) and I assume they are composed by two elements: a tax component and a transfer component.

Then, I study three cases. In the first case, severance payments are supposed to be fixed exogenously. Wages are bargained accordingly to the efficient bargaining framework. This first case allow to study the impact of the transfer from firms to workers in case of redundancy on the wage dynamic. In the second case, while wages are still efficiently bargained I assume that, at every period, firms and worked determine together the level of severance payments. I study here the impact of dynamic severance payments on wage in an efficient bargaining framework. Finally, in the third case, severance payments are negotiated and wages are bargained following the right-to-manage framework. The impact of dynamic severance payments on the wage canal is studied here. These three cases are finally compared in the simulation to a fourth one which represent the basic New-Keynesian model with no firing costs. Table 1 sums up the different cases.

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My findings are as follows. When firing costs are fixed, the tax and transfer component act similarly on wages: they both increase the insiders' wage and the decrease the outsiders' wage. The introduction of fixed severance payments leads to a strengthening of the tax component impact on wage but without an improvement on inflation persistence. This impact on wage is different when severance payments are bargained. The introduction of the new bargaining in a new-Keynesian model leads to create a new source of wage rigidity which has a tangible impact on inflation persistence. The introduction of dynamic firing costs allows me to increase persistence of inflation in a New-Keynesian framework, only with forward-looking behavior and respecting the Lazear's bounding critic. Nevertheless, this increase is not enough to reproduce inflation persistence. That's why I explore deeply the wage canal underlined by Trigari (2006), Christoffel and Kuester (2008) and Christoffel et al. (2009a) and which appears in the Right-to-Manage bargaining (RTM) framework. This canal bridges directly the bargained wage and the firms marginal costs. Since this last is present directly in the New-Keynesian Phillips Curve the first's dynamic influences directly inflation persistence and allows me to obtain a substantial increase in inflation persistence.

The rest of the paper is structured as follows. In the section 2, I present the New Keynesian framework. In section 3, I present the wage and the worked hours bargaining. I focus on the influence of the firing costs on the wage dynamic, keeping in mind the Lazear's bonding critique. Moreover, I will compare in this section the dynamic of wage when severance payments are fixed.
and when they are bargained in the framework of the efficient bargaining. Section 4 present the wage canal under the RTM bargaining. In section 5, I present the calibration choice. In section 6, I present my results and section 7 concludes.

2 The New-Keynesian framework

In this section, I give details about the new-Keynesian framework. I follow Trigari’s (2006) model, which is used e.g. by Christoffel et al. (2009a) and Macit (2010).

The economy is composed by a representative household, by a Central Bank and three industrial sectors: an intermediate goods sector, a retail goods sector and a final goods sector. For sake of simplicity, firms producing in the intermediate goods sector are simply called firms; the ones producing in the retail goods sector are called retailers; and finally the firm producing in the final good sector is called the firm of the final goods.

The separation between the three sectors allows to study separately the labor market à la Mortensen and Pissarides (1994), the monopolistic competition and the price setting. Retailers evolve in a sector of monopolistic competition where each good is only imperfectly substituable to another good. Nevertheless, firms and retailers meets each other in a perfect competitive market as the representative household and the final goods firm. One can notice that this artificial separation is neutral regarding inflation persistence. Figure 1 presents this economy and the interactions between each single agent.

2.1 The representative household

I assume that there is a representative household composed by a continuum of homogeneous workers indexed in \([0, 1]\). As in Merz (1995), each worker insures each other member 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. This late is given for each member of the representative household by:

\[
U(c_t, c_{t-1}) - g(h_t),
\]

with

\[
g(h_t) = \kappa_h \frac{h_t^{1+\phi}}{1 + \phi},
\]

and

\[
U(c_t, c_{t-1}) = \log(c_t - ec_{t-1}),
\]

where \((c_t, c_{t-1})\) and \(g(h_t)\) represent in period \(t\) the utility derived from consumption \(c_t\) and the desutility derived from the labor supply \(h_t\), respectively. Finally, \(e > 0\) represents the consumption habits persistence. \(1/\phi\) is the labor supply elasticity and \(\kappa_h > 0\). I assume 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 one.

3. Macit (2010) adds into the Trigari’s model a new kind of labor market institutions : the employment protection through to firing costs. In an efficient bargaining framework, firing costs have a positive impact on inflation persistence, but this impact is not strong enough to match the empirical data.

4. This assumption have been showed by Sveen and Weinke (2007), Christoffel et al. (2009a), Kuester (2010) and Thomas (2011).
The representative household’s program of maximization is

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

subject to

$$c_t + \frac{B_t}{p_t r^n_t} = d_t + \frac{B_{t-1}}{p_t}.$$ (2.2)

The inter-temporal utility of the representative household depends on its level of consumption per capita just as the sum of effort linked to the labor supply of the entire household $G_{t+s}$. This function does not need to be explicit here since the level of labor supply is fixed by the household in the labor market with respect to the efficient bargaining. Moreover, I assume here that there is no inactive worker in the economy. A member of the representative household can only be employed or unemployed.

$\beta \in (0, 1)$ represent the discount factor. The representative household holds an one-period bonds $B_t$ with price $1/r^n_t$, where $r^n_t$ is the nominal interest rate and the Central Bank’s monetary policy tool. $p_t$ is the consumer price index and $d_t$ the real income per capita in $t$.

The resolution of the previous problem leads to the household’s optimal consumption and saving decision,

$$\lambda_t = \frac{1}{c_t - e c_{t-1}} - E_t \beta \frac{e}{c_{t+1} - e c_t} \lambda_t = r_t \frac{E_t}{\lambda_{t+1}},$$ (2.3)

where $\lambda_t$ is the marginal utility of consumption in $t$ and where

$$r_t = \frac{p_t}{p_{t+1}} r^n_t \Leftrightarrow r_t = \frac{r^n_t}{E_t[\pi_{t+1}]}.$$ (2.4)

2.2 The labor market

In the model, the labor market is the place where workers and the intermediate goods firms meet each other. Workers can be either in a job or unemployed. When they are unemployed, workers search a job without paying any costs in terms of utility whereas the supply of labor is painful, as I mention it above. As well, 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.\footnote{Authors as Gertler and Trigari (2006) have made the assumption of variable vacancy costs but this hypothesis is unable to make the model reproduce inflation persistence. Indeed, in this paper, the hiring costs are assumed to be a convex function of the firms’ hiring rate. Gertler and Trigari (2006) assume that the more the hiring rate will be, the more the effort a firm will have to make to find a worker will be too.}

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

$$m_t = \sigma_m u_t^\sigma v_t^{1-\sigma},$$ (2.5)

where $m_t$ is for the number of matches in the labor market, $\sigma_m > 0$ measure the efficiency of the matching process, $u_t$ is the number of workers looking for a job and $v_t$ is the number of job vacancies. I assume that there is no on-the-job search : the workers in job are looking for a new job only when they are fired with a probability $\rho$.\footnotemark
According to the matching function, I define respectively the probability $q_t$ for a firm to fill its job and the probability $s_t$ for a worker to find a job as:

$$q_t = \frac{m_t}{u_t}$$

(2.6)

and

$$s_t = \frac{m_t}{v_t}.$$  

(2.7)

Moreover, the employment dynamic is given by:

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

(2.8)

where $n_t$ is the level of employment in $t$. Equation (2.8) tells that employment is function of the number of job which are not destroyed during the previous period plus the number of new match at the previous period. I assume here that new matches are made at the end of the period, which implies that a new match can only be productive at the beginning of the following period.

Moreover, the number of workers looking for a job is equal to the $(1-n_t)$ workers unemployed at the beginning of the period plus the $\rho n_t$ workers who lost their job at the beginning of the period. Thus, I can define the number of worker looking for a job as

$$u_t = 1 - (1 - \rho)n_t.$$  

(2.9)

### 2.3 The different firms

This section presents the relationship between the different kind of firms. Following, the firms on the intermediate goods sector and the 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. With this only production factor, they produce the intermediates goods in a perfect competitive market. They sell these goods to the retailers. Retailers turn these goods into differentiated goods thanks to a one-to-one technology. Retailers sell the differentiated goods to the final goods firm. The final goods firm aggregates the differentiated goods and sells the final goods to the representative household.

Because retailers produce differentiated goods, they get some market power. This market power allows them to maximize their profit by setting their own price.

#### 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 only hire a unique worker. When it is the case, they produce only with labor and accordingly to the production function

$$f(h_t) = z h_t^\alpha,$$

(2.10)

where $z$ is the technological factor for all the firms and with $\alpha \in (0, 1)$. When firms do not find a worker, they produce nothing.
2.3.2 Retailers, the final goods firm and the price setting

I assume that there is a continuum $i$ of retailers indexed on the unite interval. These retailers produce their goods according to a technology that changes an intermediate good bought $x_t$ in a perfect competitive market into a differentiate good $y_t$. This differentiation leads to an imperfect substitutability of the goods and gives to the retailers a certain market power. Thus, retailers can fixe themselves their price.

The differentiate goods are next sold to the final firm which aggregates them into the final goods $y_t$.

The firm of the final goods produces thanks to the following Constant Elasticity of Substitution production function:

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

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

The firm of the final goods maximizes its profits by choosing the level for each differentiate good that it will include in its production process. The profit maximization leads to the following demand function for each good $y_t$:

$$y_t = \left( \frac{p_t}{p_t} \right)^{-\varepsilon} y_t,$$

where

$$p_t = \left[ \int_0^1 p_t^{1-\varepsilon} \, di \right]^{\frac{1}{1-\varepsilon}}.$$

The retailers’ market power obtained via the imperfect elasticity of substitution allows them to maximize their profit by fixing their own price. I assume here that the economy is subject to some rigidity à la Calvo (1983). Retailers can re-optimize their price each period given the probability $1 - \phi$. A fraction $\phi$ of the retailers are stuck with their previous price. Maximizing of the profits of the retailer $i$ leads to define the optimal level of $p_{it}^*$ such as

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

where $x_t$ is the retailers’ marginal costs - which in the model correspond to the firms’ price - and where $\mu = \frac{\varepsilon}{\varepsilon-1}$ is the optimal mark-up.

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

$$p_t = \left( (1 - \phi)p_t^{1-\varepsilon} + \phi p_{t-1}^{1-\varepsilon} \right)^{\frac{1}{1-\varepsilon}},$$

after log-linearize the equations (2.11) and (2.12) and after some rearrangements, one can obtain the New-Keynesian Phillips Curve

$$\hat{\pi}_t = \frac{(1 - \phi)(1 - \beta \phi)}{\phi} \hat{c}_t + \beta E_t \hat{\pi}_{t+1}.$$

To close the production side of the model by imposing a resource constraint for the whole economy

$$y_t = c_t,$$

as well as a clearing condition for the retailers market

$$y_t = n_t (1 - \rho) f(h_t),$$

where the aggregate demand $y_t$ is equal to the production $f(h_t)$ of each $n_t (1 - \rho)$ firm which actually produce.
2.4 The monetary authority

I assume that the monetary authority has as unique instrument for its policy the short run nominal interest rate $r_t^n$. This authority follows a Taylor rule such as
\[ r_t^n = \beta^{-1} \left( 1 - \rho_m \right) \left( r_{t-1}^n \right) \rho_m E_t \left[ \pi_{t+1}^\infty \right] \pi_t + \gamma_y \left( 1 - \rho_m \right) \gamma_y \left( 1 - \rho_m \right) e^{\epsilon_t^m}, \] where $\rho_m$ is the interest rate smoothing, $\gamma_\pi$ and $\gamma_y$ represent respectively the response coefficients of the nominal interest rate to a shock of the inflation and of the output gap $y_t^*$. $\epsilon_t^m$ is the monetary policy shock which is iid.

Following Clarida et al. (2000), the monetary authority uses as policy tool the short-term nominal interest rate. Following Smets and Wouters (2003), this monetary authority has two principal objectives: the control of the inflation and the stabilization of the output gap.

3 The impact of severance payments on wages in the Efficient Bargaining framework

This section presents the cases 1 and 2. Indeed, I first introduce severance payment as a fixed cost imposed by an external authority such as a court. This first case allows to study the impact of the transfer from firms to workers on wages when the match is broken. Case 2 introduces a dynamic on severance payment by taking into account severance payment setting through period-by-period bargaining. Firms and workers are allowed to bargain between them before passing in front of a court.

Moreover, this section presents how wages and hours worked are determined through the Efficient Bargaining.

3.1 Fixed firing costs

This section present the case 1 where severance payment are imposed by an external authority.

Firing costs are composed by a fixed tax component which is typically a notice period and a fixed transfer component which can be seen as a legal severance payments or a conventional ones that is to say severance payments which are bargained in a higher level than the individual one (by sector or imposed by the law). As a reminder, the notice period represents only a cost for firms without affecting workers. By contrast, the conventional severance payments are both a cost for firms and a new temporary income for workers.

3.1.1 The Bellman’s equations

As in Macit (2010), the introduction of firing costs leads to differentiate a worker who was in job a long time enough to enjoy the Employment Protection Legislation (EPL) to a worker who just gets in job. Indeed, I assume here that firms will have to pay firing costs when the relationship is broken only when the worker was in job during the previous period. Otherwise, firms could break the relationship freely.

**Firms**: When a firm finds a worker to fill their vacancy, its expected profits are equal to $J_t$ whereas when its job is vacant its expected profits are equal to $V_t$. As well, when a firm has just filled its job with a new match, its expected profits are equal to $J_t^n$. 

\[ J_t = x_t f(h_t) - w_t h_t + E_t \beta_{t,t+1} [(1 - \rho)J_{t+1} + \rho(V_{t+1} - F)] \] (3.1)

where \( w_t \) is the hourly wage for an old job, \( x_t \) the relative price for the intermediate goods and \( F \) the firing costs. Firing costs are assumed to be equal to \( F = S + T \), where \( S \) corresponds to severance payments and \( T \) to the notice periods. \( \beta_{t,t+s} \) is the stochastic discount factor such as \( \beta_{t,t+s} = \beta^s \frac{\lambda_{t+s}}{\lambda_t} \). One can see that the expected profits from an old job is equal to firms to the sum of the instantaneous profits \( x_t f(h_t) - w_t h_t \) plus the expected gains which depend on the condition of the job at the next period. If the job is destroyed with a probability \( \rho \), firms will get the value from a vacancy minus the firing costs in their whole. If the job is maintained with a probability \( (1 - \rho) \), firms will get the value of a filled job in \( t + 1 \).

In the case of a new job, firms will face the same kind of situation with the exception of wages which will be different

\[ J^n_t = x_t f(h_t) - w^n_t h_t + E_t \beta_{t,t+1} [(1 - \rho)J^n_{t+1} + \rho(V_{t+1} - F)]. \] (3.2)

One can notice that firing costs are still present in the equation (3.2). Indeed, if at the end of the period \( t \), firms decide to stop the match with the new worker, this worker would have lost his outsider status and would be protected by the EPL. As I will see later, firing costs play a different role between an old worker and a new worker, mainly during the wage bargaining.

Finally, a vacant job is also a promise for future gains (or costs). These gains will first depend on the hiring costs - which are assumed to be constant - expressed in terms of goods of consumption. This worker will also get the value of the income next period if

\[ V_t = \frac{-\kappa}{\lambda_t} + E_t \beta_{t,t+1} [q_t (1 - \rho)J_{t+1} + (1 - q_t) V_{t+1}] \] (3.3)

Under free entry condition hypothesis, the job creation equation is

\[ \frac{\kappa}{\lambda_t q_t} = E_t \beta_{t,t+1} [(1 - \rho)J_{t+1}] \] (3.4)

This condition tells that, for \( \lambda_t \) and \( \kappa \) constant, the expected profits of a filled job increases, a new firm will enter the market and will create a new job. Therefore, the number of vacancy 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 ones to match a worker increase.

**Workers**: The expected utility for a worker with a job is \( W_t \) for an old job and \( W^n_t \) for a new job. As well, the expected utility for a worker unemployed is equal to \( U_t \).

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

\[ \Leftrightarrow W_t = w_t h_t - \frac{g(h_t)}{\lambda_t} + E_t \beta_{t,t+1} [(1 - \rho)(W_{t+1} - U_{t+1}) + U_{t+1} + \rho S] \] (3.5)

When a worker has a job, he receive \( w_t h_t \) minus the desutility linked to the labor supply in terms of goods of consumption. This worker will also get the value of the income next period if
he is not fired - with a probability \((1 - \rho)\) - and the value of unemployment at the next period plus the severance payment if he is fired - with a probability \(\rho\). The same pattern holds for a worker newly in a job with a difference in terms of wage:

\[
W^n_t = w^n_t h_t - \frac{g(h_t)}{\lambda_t} + E_t \beta_{t,t+1} [(1 - \rho)(W_{t+1} - U_{t+1}) + U_{t+1} + \rho S]
\]  

(3.6)

Finally, the situation for a worker unemployed is the following:

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

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

(3.7)

When a worker is unemployed, he receives unemployment benefits \(b\). Moreover, he receives as expected gains the utility of a worker with a job at the next period weighted by the probability \(s_t\) that he find a job and by the probability \((1 - \rho)\) that the new match is successful. In the case where the new match is not successful - with a probability \(\rho\) - or that the worker does not find a job - with a probability \((1 - s_t)\), this worker will stay unemployed the next period.

### 3.1.2 Efficient bargaining and fixed firing costs

I present in this section the wage and the worked hours bargaining when firing costs are fixed. I assume that firms and workers follow a Nash Efficient Bargaining. The two parties will focus on the Nash product which, in the case of an old job, can be defined as

\[
[W_t - (U_t + S)]^\eta [J_t - (V_t - F)]^{1-\eta},
\]  

(3.8)

where \(U_t + S\) and \(V_t - F\) are respectively the breaking point for workers and firms and where \(\eta\) and \(1 - \eta\) are respectively the workers and the firms bargaining power. In the case of a new job, the Nash product is defined as

\[
[W^n_t - U^n_t]^{\eta} [J^n_t - V^n_t]^{1-\eta}
\]  

(3.9)

One can see here the difference between an insider worker and an outsider worker accordingly to the EPL. When an insider worker and a firm do not agreed on a wage level and when the bargaining stop, the firm has to pay \(S\) to the worker plus \(T\). When an outsider worker and a firm do agreed on a wage level, since the worker is not protected by the EPL, the separation goes freely.

### 3.1.3 Wages bargaining with fixed firing costs

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

\[
(1 - \eta) [W_t - U_t - S] = \eta [J_t + F]
\]  

(3.10)

Substituting the expression for \(J_t\), \(W_t\) and \(U_t\) by the equation (3.1), (3.5) and (3.7) leads to

\[
w_t h_t = \eta x_t f(h_t) + (1 - \eta) \left[ \frac{g(h_t)}{\lambda_t} + b \right] + (1 - \eta)(1 - \rho \beta)S + \eta(1 - \rho)F
\]

\[
+ \eta E_t \beta_{t,t+1} [(1 - \rho)J_{t+1}] - (1 - s_t)(1 - \eta)E_t \beta_{t,t+1}[(1 - \rho)(W_{t+1} - U_{t+1})]
\]

\[
(1 - s_t)E_t \beta_{t,t+1}[(1 - \rho)(W_{t+1} - U_{t+1})]
\]

\[
+ \eta E_t \beta_{t,t+1} [(1 - \rho)J_{t+1}] - (1 - s_t)(1 - \eta)E_t \beta_{t,t+1}[(1 - \rho)(W_{t+1} - U_{t+1})]
\]  

(3.11)
According to the equation (3.10),
\[
W_{t+1} - U_{t+1} = \frac{\eta}{1 - \eta} (J_{t+1} + F) + S,
\]
\[
\iff E_t \beta_{t,t+1} [(1 - \rho)(W_{t+1} - U_{t+1})] = E_t \beta_{t,t+1} \left[ (1 - \rho) \frac{\eta}{1 - \eta} (J_{t+1} + F) + S \right].
\]
Substituting the previous equation in the wage equation leads to
\[
w_t h_t = \eta x_t f(h_t) + (1 - \eta) \left[ \frac{g(h_t)}{\lambda_t} + b \right] + (1 - \eta)(1 - \rho)S + \eta(1 - \rho)F \\
+ \eta s_t E_t \beta_{t,t+1} [(1 - \rho)J_{t+1}] - \eta (1 - s_t)(1 - \rho)F - (1 - \eta)(1 - s_t)(1 - \rho)S
\]
By noting that \( \theta_t = s_t/q_t \),
\[
w_t = \eta \left[ \frac{x_t mpl_t}{\alpha} + \frac{\kappa \theta_t}{\lambda_t h_t} \right] + (1 - \eta) \left[ \frac{mr s_t}{1 + \phi} + \frac{b}{h_t} \right] \\
+ \eta s_t (1 - \rho) \frac{F}{h_t} + (1 - \eta) \frac{s_t (1 - \rho)}{h_t} S,
\]
where \( mpl_t = f'(h_t) \) is the marginal productivity of labor and \( mr s_t = \frac{g'(h_t)}{\lambda_t} \) is for the marginal rate of substitution.

As in Trigari (2006), the wage’s equation sums up the demands of the two parties. While workers want to promote their productivity and a certain kind of measure of the rarity of the rate of substitution.

For the new job case:

When a new match arises, the bargaining takes place in a special context. Indeed, the firm and the worker who just meet each other know that if there is no agreement made about the wage level, the firm will not have to pay the firing costs. Therefore the Nash product is defined by \( W^n_t - U_t \eta J^{-\eta}_t \). The maximization of this product with respect to wage gives
\[
(1 - \eta)(W^n_t - U_t) = \eta J_t
\]
\[
\iff w^n_t h_t = \eta x_t f(h_t) + (1 - \eta) \left[ \frac{g(h_t)}{\lambda_t} + b \right] - \eta F - (1 - \eta) \rho S \\
+ \eta E_t \beta_{t,t+1} [(1 - \rho)J_{t+1}] - (1 - \eta)(1 - s_t) E_t \beta_{t,t+1} [(1 - \rho)(W_{t+1} - U_{t+1})]
\]
Knowing that
\[
W_t - U_t = \frac{\eta}{1 - \eta} J_t,
\]
\[
 \beta_{t,t+1} [(1 - \rho)(W_{t+1} - U_{t+1})] = E_t \beta_{t,t+1} (1 - \rho) \left[ \frac{\eta}{1 - \eta} J_{t+1} \right],
\]
which leads to
\[
w^n_t = \eta \left[ \frac{x_t mpl_t}{\alpha} + \frac{\kappa \theta_t}{\lambda_t h_t} \right] + (1 - \eta) \left[ \frac{mr s_t}{1 + \phi} + \frac{b}{h_t} \right] - \frac{\eta \rho}{h_t} F - \frac{(1 - \eta) \rho}{h_t} S
\]
(3.12)
The hourly wage for a new job pays the same item than the hourly wage for an old job. The difference holds in the negative impact of the EPL on the wage. I can trace back the logical of the insider-outsider system when the new arrival pay the protection of the older as in Macit (2010).

3.2 The dynamic of firing costs

This section present the case 2 where firms and workers are allowed to bargain the amount of severance payment before passing in front of a court. This new bargaining will introduce a new dynamic on wage and finally on inflation through the New-Keynesian Phillips Curve.

3.2.1 The severance payment bargaining

I assume now that firing costs are not fixed any longer but that severance payments are renegotiated at each period as in Garibaldi and Violante (2005).

To do so, let us define *ex post* and *ex ante* firing costs with regards to a court decision. The firsts refer to firing costs which are imposed by a judge after a firing is judge unfair while the lasts are referring to firing which are bargained with the fired worker.

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

\[
\hat{F}_t = \hat{S}_t + T, \tag{3.13}
\]

with

\[
\hat{S}_t = w_t^\gamma. \tag{3.14}
\]

\( \hat{S}_t \) represents legal severance payments and \( \gamma \) the wage elasticity of legal severance payments.

These costs are however valuable only if a judge declare the firing unfair. I assume that it is the case only with a probability \( \rho_u \). As emphasized by Garibaldi and Violante (2005), many of firing are not contested. In that case, severance payments can be bargained between the two parties. Assuming that the *ex ante* severance payment bargaining follows a Nash process, the maximization program is

\[
\max_{S_t} \left( S_t - \rho_u \hat{S}_t \right) \left[ -S_t + \rho_u \left( \hat{S}_t + T \right) \right]^{1-\gamma}, \tag{3.15}
\]

where \( S_t \) is the level of bargained severance payments. The bargaining will answer to two contradictory objectives: for the worker, what matters is to maximize the distance between what he could receive if a court judge the firing unfair - \( \rho_u \hat{S}_t \) - and what he could receive from this bargaining; for the firm, the objective is to minimize the distance between what it would have to pay if a court judge unfair the firing - \( \rho_u \left( \hat{S}_t + T \right) \) - and the bargained severance payment. Each objective is balanced by the respective bargaining power of each party.

The maximization of the previous program gives

\[
S_t = \rho_u \left( \hat{S}_t + \eta T \right). \tag{3.16}
\]

(3.16) define the *ex ante* severance payment and shows that it is profitable for the two parties to bargain rather to stand in front of a court.

\[
\rho_u \hat{S}_t < \rho_u \left( \hat{S}_t + \eta T \right) < \rho_u \left( \hat{S}_t + T \right),
\]
which means that both the firm and the worker respectively pay less and obtain more from the bargaining that from the court’s judgment.

Finally, in order to define fully the ex ante firing cost, I need to define $\rho_a$, the probability that an agreement is found between the firm and the worker without resorting to a court. Moreover, I assume that if the court judges the firing fair, neither the firm or the worker will pay something to the other parties. I finally obtain

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

(3.17)

### 3.2.2 The wages bargaining

Introducing the firing costs à la Garibaldi and Violante (2005) into the traditional Bellman’s equation and assuming that the free entry condition holds

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

(3.18)

$$\frac{\kappa}{\lambda q_t} = E_t \beta_{t,t+1} [(1 - \rho) J_{t+1}],$$

(3.19)

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

(3.20)

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

(3.21)

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

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

(3.22)

The maximization of this product leads to the following condition

$$(1 - \eta)(W_t - U_t - S_t) = \eta (J_t + F_t)$$

$$(1 - \eta) (W_t - U_t - S_t) = \eta (J_t + F_t)$$

(3.23)

$$(1 - \eta) (W_t - U_t - S_t) = \eta (J_t + F_t)$$

(3.24)

$$(1 - \eta) (W_t - U_t - S_t) = \eta (J_t + F_t)$$

(3.25)

Replacing $J_t, W_t$ and $U_t$ in the equation (3.25) by the equations (3.18), (3.21) and (3.22) gives

$$w_t = \eta \left[ \frac{x_m p h_t}{\alpha} + \frac{\kappa \theta_t}{\lambda_t h_t} + (1 - \eta) \left[ \frac{m r s_t}{1 + \phi} + \frac{b}{h_t} \right] \right] + \frac{1 - \eta}{h_t} S_t + \frac{\eta}{h_t} F_t$$

$$- \frac{1 - (1 - \rho) s_t}{h_t} \left[ (1 - \eta) E_t \beta_{t,t+1} [S_{t+1}] + \eta E_t \beta_{t,t+1} [F_{t+1}] \right].$$

Equation (3.26) tells that the hourly wage remunerates the traditional items. I focus now on the impact of the EPL on this wage equation. I have to distinguish the impact of the EPL in $t$ and its impact in $t + 1$. During the current period, the EPL has expected impact on wage that is to say that both firing costs and severance payment increase the insider hourly wage.

However, the introduction of a dynamic in firing costs through the introduction of ex ante and ex post firing costs and through the severance payment bargaining leads to a wage dynamic
which reconciles the Lazear (1990)’s bonding critique with the Garibaldi and Violante (2002, 2005) claiming regarding the transfer component of firing costs. One can notice that the introduction of dynamical firing costs leads to the apparition of a new component into the wage equation. This component tells that workers will pay today their job protection of tomorrow. In this point of view, the bonding critique still holds : the optimal contract between firms and workers leads to avoid a part of the firing costs. Moreover, firing costs and severance payments seem to evolve in a same qualitative way even if the first one is still promote by workers while the second one is promoted by firms. Workers pay in fact contribution to their own protection in the future.

Nevertheless, the study of severance payments must not be given up, as Garibaldi and Violante (2002, 2005) claim since the wage equation has now a forward-looking component -based in deed on rational expectations - which will help to match inflation persistence. This point is important in itself since economists failed in reproducing inflation persistence without using some backward-looking behavior.

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

\[
(W^n_t - U^n_t)\eta^\star (J^n_t)^{1-\eta},
\]

where

\[
J^n_t = x_tf(h_t) - w^n_th_t + E_t\beta_{t,t+1}[(1-\rho)J_{t+1} - \rho F_{t+1}]
\]

\[
W^n_t = w^n_th_t - \frac{g(h_t)}{\lambda_t} + E_t\beta_{t,t+1}[(1-\rho)(W_{t+1} - U_{t+1}) + U_{t+1} + \rho S_{t+1}]
\]

The maximization of the Nash product with respect to the outsiders wage, and after some rearrangement, gives

\[
w^n_t = \eta \left[ \frac{x_t \beta_{mpl} t}{\alpha} + \frac{\kappa \theta_t}{\lambda_t h_t} \right] + (1-\eta) \left[ \frac{mr_s_t}{1+\phi} + \frac{b}{h_t} \right] - \frac{(1-\eta)\rho}{h_t} E_t\beta_{t,t+1}[S_{t+1}] - \frac{\eta \rho}{h_t} E_t\beta_{t,t+1}[F_{t+1}].
\]

The equation (3.30) shows that the EPL affects negatively the 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.

3.3 The worked hours bargaining and the extensive margin

This sub-section presents the determination of worked hours in the framework of the efficient bargaining. In this framework, firms and workers maximize conjointly their surplus accordingly to the worked hours. As I will show, the EPL has no impact on how firms and workers determine the worked hours. For sake of simplicity, I present only the worked hours bargaining in the case of fixed firing costs.

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

\[
\eta \left[ w_t - \frac{g'(h_t)}{\lambda} \right] (J_t + F) = (1-\eta) \left[ w_t - x_t f'(h_t) \right] [W_t - U_t - S]
\]
According to the equation (3.10), I obtain \textit{in fine} the canal of the extensive margin

\[ x_{mpl_t} = mrs_t \]  \hspace{1cm} (3.31)

The equation (3.31) emphasizes the canal of the extensive margin, according to Trigari (2006), where the extensive margin is the number of employees, by opposition of the intensive margin which is the number of worked hours. In this economy where \( x_t \) is both the intermediate goods price and the retailers marginal cost, the existence of the canal of the extensive margin will push firms to adjust their production \textit{via} the employment rather than the worked hours. I can write the extensive margin canal as \( x_t = \frac{mrs_t}{mpl_t} \). Beside, an increase of employment is without additional costs for firms whereas an increase of the worked hours will lead to an increase of the retailer marginal cost.

Moreover, one can notice that the determination of worked hours for a new worker or for an old and a new worker in the case of dynamic firing costs leads to the same optimal condition. The EPL has thus not impact on the determination of worked hours in the case of EB process.

4 The dynamic firing costs under the Right-To-Manage Bargaining

In this section, severance payment are still bargained between firms and workers. However, differences appear in the wage bargaining.

Indeed, following Trigari (2006), Christoffel and Kuester (2008) and Christoffel et al. (2009a), I explore deeper the wage canal, which, as I motioned before, rely directly the marginal cost of firms to the hourly wage. In the RTM process, the hourly wage is used as a proxy of the marginal rate of substitution by firms and workers. I discuss here of the impact of dynamic firing costs à la Garibaldi and Violante (2002) into the RTM bargaining framework.

4.1 The wage canal

Under the RTM bargaining, firms and workers bargain only about the wage level. However, unlike the EB, firms set the worked hours level unilaterally accordingly to the wage level and 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 notes thanks to worked hours.

\[ \frac{\partial J_t}{\partial h_t} = 0 \iff x_t f(h_t) - w_t = 0 \]

\[ \iff w_t = x_t mpl_t \]  \hspace{1cm} (4.1)

The equation (4.1) presents the wage canal which links directly the wage level to the firms marginal costs. Because the real bargained wage is taken as given by firms, it becomes a proxy of the marginal rate of substitution as labor costs and play a role in the determination of worked hours. One can then defined \( h_t \) as \( h_t = h(w_t) \). RTM bargaining has as consequence to fix firmly the wage dynamic into the marginal costs’ one and consequently into inflation persistence.

4.2 The wages bargaining in the RTM bargaining framework with dynamic firing costs

I present here the maximization of the two Nash products given by the equations (3.23) and (3.27) knowing that \( h_t = h(w_t) \).
4.2.1 The old job wage

I use here the function values described by the equations (3.18) to (3.22). The maximization of the Nash product leads to the following optimal condition

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

where

\[ \delta_t^W = h_t + w_t h_w(w_t) - \frac{g_t h_w(w_t)}{\lambda_t} \]

\[ \Leftrightarrow \delta_t^W = \frac{h_t}{1 - \alpha} \left( \frac{mr s_t}{w_t} - \alpha \right) \]

and

\[ \delta_t^F = -[x_t \text{mpl}_t h_w(w_t) - h_t - w_t h_w(w_t)] = h_t. \]

\[ \delta_t^W \] and \( \delta_t^F \) are respectively the expected gains for workers and firms after an increase of the real wage. Substituting \( J_t, W_t \) and \( U_t \) by their value leads to

\[ w_t h_t = \chi_t [x_t f(h_t) + F_t] + (1 - \chi_t) \left[ \frac{g(h_t)}{\lambda_t} + b + S_t \right] \]

\[ -\chi_t E_t \beta_{t,t+1} [(1 - \rho) F_{t+1}] - (1 - \chi_t) E_t \beta_{t,t+1} [(1 - s_t)(1 - \rho)(W_{t+1} - U_{t+1})] \]

\[ + \chi_t E_t \beta_{t,t+1} [(1 - \rho) J_{t+1}] - (1 - \chi_t) E_t \beta_{t,t+1} [(1 - s_t)(1 - \rho)(W_{t+1} - U_{t+1})], \]

with \( \chi_t = \frac{\eta \delta_t^W}{\eta \delta_t^W + (1 - \eta) \delta_t^F} \).

Moreover, knowing that \( W_{t+1} - U_{t+1} = \frac{\eta \delta_{t+1}^W}{(1 - \eta) \delta_{t+1}^F} (J_{t+1} + F_{t+1}) + S_t, \)

\[ \chi_t E_t \beta_{t,t+1} [(1 - \rho) J_{t+1}] - (1 - \chi_t) E_t \beta_{t,t+1} [(1 - s_t)(1 - \rho)(W_{t+1} - U_{t+1})] \]

\[ = \chi_t \frac{k \theta_t}{\lambda_t} + (1 - s_t) \frac{\kappa}{\lambda_t q_t} [\chi_t - (1 - \chi_t) \xi_{t+1}] \]

\[ -(1 - s_t)(1 - \rho)(1 - \chi_t) \xi_{t+1} E_t \beta_{t,t+1} [F_{t+1}] - (1 - \chi_t)(1 - s_t)(1 - \rho) E_t \beta_{t,t+1} [S_{t+1}], \]

noting \( \xi_{t+1} = \frac{\eta \delta_{t+1}^W}{(1 - \eta) \delta_{t+1}^F} \).

Regrouping (4.5) and (4.6) leads to

\[ w_t = \chi_t \left[ \frac{x_t m p l_t}{\alpha} + \frac{\kappa \theta_t}{\lambda_t h_t} + \frac{F_t}{h_t} \right] + (1 - \chi_t) \left[ \frac{mr s_t}{1 + \phi} + b + \frac{S_t}{h_t} \right] \]

\[ + (1 - s_t) \frac{\kappa}{\lambda_t q_t h_t} [\chi_t - (1 - \chi_t) \xi_{t+1}] - \mathcal{A}_t E_t \beta_{t,t+1} [F_{t+1}] - \mathcal{B}_t E_t \beta_{t,t+1} [S_{t+1}], \]

with

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

and

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

15
The wage described by the equation (4.7) presents the same communies items as the wage obtained in the EB framework. Beside, the impact of the EPL on the wage level is quasi the same according both the two kind of bargaining. As in the EB framework, the forward-looking components of the EPL have a negative impact on the wage level for an insider worker while the current components have a positive impact on wage. Thus, I find back the contribution system that was present in the EB framework.

4.2.2 The new job wage

I maximize here the Nash product describe by the equation (3.27). I obtain the following optimal condition

\[ \eta \delta_t W^J = (1 - \eta) \delta_t^F (W_t^n - U_t), \]  

(4.10)

which, when \( J_t^n, W_t^n \) and \( U_t \) are replace by the function values describe by the equation (3.28), (3.29) and (3.22) gives

\[ w_t^n h_t = \chi_t [x_t f(h_t)] + (1 - \chi_t) \left[ \frac{g(h_t)}{\lambda_t} + b \right] - \chi_t E_t \beta_{t+1} [\rho F_{t+1}] - (1 - \chi_t) E_t \beta_{t+1} [\rho S_{t+1}] \\
+ \chi_t E_t \beta_{t+1} [(1 - \rho) J_{t+1}] - (1 - \chi_t) E_t \beta_{t+1} [(1 - s_i)(1 - \rho)(W_{t+1} - U_{t+1})] \]  

(4.11)

Moreover, I

\[ \chi_t E_t \beta_{t+1} [(1 - \rho) J_{t+1}] - (1 - \chi_t) E_t \beta_{t+1} [(1 - s_i)(1 - \rho)(W_{t+1} - U_{t+1})] = \]

\[ = \chi_t \frac{\kappa \theta_t}{\lambda_t} + (1 - s_i) \frac{\kappa}{\lambda_t q_t} [\chi_t - (1 - \chi_t) \xi_{t+1}] . \]  

(4.12)

Replacing (4.12) in (4.11) gives

\[ \Leftrightarrow w_t^n = \chi_t \left[ \frac{x_t m^{pl_t}}{\alpha} + \frac{\kappa \theta_t}{\lambda_t h_t} \right] + (1 - \chi_t) \left[ \frac{m r s_t}{1 + \phi} + \frac{b}{h_t} \right] + (1 - s_i) \frac{\kappa}{\lambda_t q_t h_t} [\chi_t - (1 - \chi_t) \xi_{t+1}] \\
- \chi_t \frac{E_t \beta_{t+1} [\rho F_{t+1}]}{h_t} - \frac{(1 - \chi_t)}{h_t} E_t \beta_{t+1} [\rho S_{t+1}] . \]  

(4.13)

Thus, as in the EB framework, the EPL has a negative global impact on the outsider wage level. However, this negative impact is still explain by the contribution of the outsider worker to his own protection he will receive next period and not by a contribution to the insider protection.

To sum up, the RTM bargaining does not change the fundamentals results: these ones show a contribution system where employees pay for their own protection as it is claimed by the bonding critique. However, in this economy, the tax component has the same behavior than the transfer component and the inverse. Moreover, it is the transfer component which give to firing costs its dynamic. These two arguments move toward the Garibaldi and Violante (2002, 2005)'s demand regarding severance payments.

Finally, the RTM bargaining allows to put down the wage dynamic into inflation persistence. This is necessary to obtain a significant improvement in inflation persistence.
Table 2 – Calibration Choices

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5 The calibration choices

In this section, I present the calibration choice I have made to simulate the model.

Table ?? presents the different choice relative to the calibration. Regarding the preference of the representative household, I fix the habit persistence in consumption to 0.7 in accordance to the Smets and Wouters (2003, 2007) empirical study on European and US data. Beside, following Card (1991), who estimates that the elasticity of substitution - namely $1/\phi$ - must be between 0.1 and 0.5. Following Trigari (2006) and Christoffel et al. (2009b), I fix $\phi$ equal to 10. Moreover, I fix traditionally $\beta = 0.99$ in order to have a quarterly real rate of interest of almost 1%.

With regards to the labor market, I fix the employment destruction rate $\rho$ equal to 0.08, as Trigari (2006). This value is an intermediate value to the one chosen by Christoffel et al. (2009b) and Krause and Lubik (2010) and Macit (2010) who fix respectively $\rho$ equal to 0.06 and to 0.1. This choice allows to take into account the exit from employment to unemployment as the exit of the labor market. Accordingly to Krause and Lubik (2010) and Macit (2010), we set the hiring costs equal to 0.16 in order to take account of the costs of recruitment and of training. Regarding the bargaining power, we follow Hagedorn and Manovskii (2008) and we set $\eta = 0.1$. Following Petrongolo and Pissarides (2001), Trigari (2006) and Christoffel and Kuester...
According to OECD (2013), I fix $\Upsilon = 0.35$ in order to obtain the average level of 4.2 month of wage by worked year.

Regarding the coefficient of Calvo, I fix the average duration between each optimal price adjustment to 4 quarterly and set $\varphi = 0.75$. 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 fixed according Clarida et al. (2000) and Trigari (2006) : the elasticity $\rho_m$ of the gross nominal interest rate with regards to its own late to 0.9. Besides, the elasticities of the nominal interest rate with regards to inflation and the output gap are respectively set to 1.5 and 0.5.

Finally, I fix $\tau$ equal to 0.18 in order to have legal cost equal to 20% of the average wage, following Thomas and Zanetti (2009). Following Garibaldi and Violante (2005), I then set $\hat{F}$ equal to 0.6 and I compute the other steady state accordingly.

6 Results: the importance of bargained firing costs and the wage canal for the reproduction of inflation persistence

In this section, I submit the economy to a monetary policy shock of 100 basis points. In order to compare the different cases to the New-Keynesian model with a labor market à la Mortensen and Pissarides, I assume a fourth case where there is no firing costs. I compare both the impulse reaction function and the level of inflation persistence of the four cases. I find that the case 3, where severance payments are bargained and where wages are bargained in the RTM bargaining framework, is the more able to reproduce the inflation persistence level observed in the data.

To measure inflation persistence, I follow Fuhrer (2010) and I take as a definition of inflation persistence the auto-correlation function which can be define as the vector of correlations of current period $t$ with each of its own lags $x_{t-i}$. While Pivetta and Reis (2007) retained only the first order autocorrelation coefficient as a measure of inflation persistence, I choose to adopt the first five coefficients as measure.

I will first present the auto-correlation function for five lags of inflation and for the four different cases. I will then present the impulse-response function to the monetary policy shock in order to identify the mechanism of transmission of the shock.

6.1 The autocorrelation functions

<table>
<thead>
<tr>
<th>Case</th>
<th>i=1</th>
<th>i=2</th>
<th>i=3</th>
<th>i=4</th>
<th>i=5</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1 : Fixed firing costs</td>
<td>0.2649</td>
<td>0.1700</td>
<td>0.0840</td>
<td>0.0254</td>
<td>0.0401</td>
</tr>
<tr>
<td>Case 2 : Dynamic firing costs and EB</td>
<td>0.2871</td>
<td>0.1733</td>
<td>0.0766</td>
<td>0.0155</td>
<td>0.0313</td>
</tr>
<tr>
<td>Case 3 : Dynamic firing costs and RTM</td>
<td>0.5991</td>
<td>0.3692</td>
<td>0.1917</td>
<td>0.0846</td>
<td>0.0590</td>
</tr>
<tr>
<td>Case 4 : No firing costs</td>
<td>0.2692</td>
<td>0.1724</td>
<td>0.0852</td>
<td>0.0259</td>
<td>0.0400</td>
</tr>
</tbody>
</table>

Table 3 shows the different auto-correlation function according to the different cases. The index $i$ refers to the time lag of the inflation’s auto-correlation function.
The first result provided by the table 3 is given by the comparison of case 1 and case 4. One can see that the only introduction of severance payment in a New-Keynesian model do not improve inflation persistence. All of the coefficient of auto-correlation are quite the same than the model without firing costs. One can even notice a few decrease of the fourth firsts coefficient.

The comparison of case 1 and case 2 shows that the introduction of dynamic firing costs has as consequences to increase inflation. This result shows that it is the contributing system to the worker protection that affects the most the inflation persistence and not the transfer from the firms to the worker in case of dismissal. However, this increase is quite weak and holds only for the first auto-correlation coefficient. This can be explain by the fact that in the EB framework and because of the extensive margin canal wages have no direct impact on marginal costs. Accordingly, any changes in the wage dynamic will have no significant impact on the inflation dynamic.

Finally, the introduction the wage canal with bargained firing costs leads to double inflation for the whole auto-correlation function. The impact of dynamic firing costs are thus well exploited by the wage canal. Figure 1 helps to visualize the improvement in terms of inflation persistence\(^6\). Figure 2 gives more details.

\textbf{FIGURE 1} – The auto-correlation functions

\includegraphics[width=\textwidth]{figure1}

\textbf{FIGURE 2} – The auto-correlation functions more detailed

\includegraphics[width=\textwidth]{figure2}

\footnote{NCF is for "No Firing Cost, FFC is for "Fixed Firing Costs", EB is for "Efficient Bargaining" and RTMB is for "Right To Manage Bargaining"}
6.2 The Impulse Response Functions

I present in this section the Impulse Response Functions of the economy after the monetary policy shock of 100 basis points. I present first 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 with dynamic both with dynamic firing costs (RTBM). This first presentation allows to compare the three cases to the stilized facts. I will then discuss different degrees of the Calvo nominal rigidity. I will finish this section by discussing more precisely regarding the dynamic of the EPL.

6.2.1 The stylized facts and the whole economy reaction

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

1. after a positive monetary policy shock, output increases significantly with a peak response around 0.3 and 0.8 percentage point;
2. inflation rises - with a peak response around 0.2 percentage point - but less than output just as wages;
3. employment rises while unemployment falls. However, unemployment’s variation is stronger than employment’s one - with a peak response around 3-4.5 percentage points;
4. finally, the intensive margin increase but largely less than the extensive margin.

The different figures I present in appendix are the impulse responses function to an unanticipated 100 basis point reduction of the nominal interest rate in time 0. All functions are in percentage deviations from steady state.

First of all, as the IRF show, the economy reacts qualitatively in the same for the three cases (FFC, EB and RTMB), expect for the wage dynamic and concerning only the FFC and the EB cases in a same amplitude. After the monetary policy shock output increases instantaneously in the three cases. Regarding the FFC and the EB cases, the response peak is reached at the second period for a deviation from the steady state around 0.6%. In the RTMB framework, the response peak is reached at the third period for a deviation from the steady state around 0.5% which is below the stylized facts. The inflation reaction is the same the FFC and the EB cases and as previously the reaction in the RTMB framework is below the stylized facts.

Relatively to the wage reaction, I can in the figure 8 that the EB framework’s wage reaction is quite different from the two other cases. As figure 9 shows, the EB wage is driven by the global firing costs (see the GFEB curve). In the EB framework the global firing costs react instantaneously strongly and positively to the monetary policy shock. During the second periods and the other periods after, the wage bargaining on the firing costs lead to correct this over reaction. In the RTMB framework, the global firing costs reaction is more balanced during the first period and it does not needed to be corrected during the other period. This meanly explain the difference in the wage reaction between the two different frameworks.

Finally, one can be questioned by the pro-cyclical reaction of the global firing costs. The first objective of firing costs is to insure workers from loosing their job. Thus, it should be natural to conceive firing costs as a counter-cyclical variable since it is under recession that unemployment protection is needed. Pro-cyclical firing costs can theoretically be assumed since during the high period of the economic cycle, it is more costly for a worker to lost its job than during the lower period of the cycle.
6.2.2 About the pro-cyclical behavior of firing costs

As the figure 9 tells, in the RTMB framework and in average in the EB framework, global firing costs are pro-cyclical in the model. Obviously, this behavior can be explained by the relationship described by the equation (3.26)\(^7\).

It could be counter intuitive to obtain such a result and several arguments can be found in the literature to defend the opposite. First, it could seem natural that firing costs protect more workers when an economy is in recession and less when this economy is in a growth period. Moreover, Marinescu (2008) argue that firing costs are present in an economy to internalize externalities linked to firing. These externalities are much more present in times of recession than in times of growth.

However, firing costs have other functions and these functions argue in favor of a pro-cyclical behavior. Indeed, firing costs are generally considered as a tool to protect workers from loosing their job and so from loosing a part of their income. This could explain why in times of economic growth the protection of job must be stronger than in times of recession, since wage has a pro-cyclical behavior. Moreover, for Saint-Paul (1995) and Fella (2000), firing costs are a signal emanating from firms to make workers felling reassured about the longevity of their work. This security allows workers to invest into specific capital and makes the match more productive. Following this new approach, in time of economic recession firms are reducing this signal because of the balanced budget constraints and because of the threat of bankruptcy. Firing costs, which are still present in the economy, are then negatively deviating from their steady state. In contrary, in times of economic growth, firms are much more able to reassure workers and the firing costs signal is stronger.

6.2.3 Releasing the nominal rigidities

As I explain above, the right-to-manage bargaining with bargained firing costs framework is the most able to reproduce inflation persistence. Nevertheless, this framework provides responses too weak to the monetary policy shock.

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

Table 4 – Alternative Calibration for the Calvo coefficient

<table>
<thead>
<tr>
<th></th>
<th>$\varphi = 0.85$</th>
<th>$\varphi = 0.7$</th>
</tr>
</thead>
<tbody>
<tr>
<td>Inflation first</td>
<td>0.5991</td>
<td>0.5870</td>
</tr>
<tr>
<td>Autocorrelation Coefficient</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Inflation peak Response</td>
<td>0.0373</td>
<td>0.1753</td>
</tr>
</tbody>
</table>

Table 4 shows that the Calvo coefficient has not an important impact on inflation persistence. Moreover, this table shows that with a calibration for the Calvo coefficient between the one chased by Christoffel et al. (2009b) and Macit (2010), the inflation peak response is closer to the stylized facts than the inflation response with the Trigari (2006)’s one. However, if I relief more the nominal rigidity, inflation respond to strongly to the monetary shock.

The Annex B present the impulse response functions under in the RTMB framework with both the standard calibration and the alternative calibration with $\varphi = 0.7$.

\(^7\) This assumption can found justification with Garibaldi and Violante (2005) but also with Goerke (2006) and with OECD (2004).
7 Conclusions

In this paper, I reintroduce a conception of firing costs - the severance payment - which have been abandoned by the economic literature since the bonding critic. I consider three cases: in the first one, I just introduce the severance payment into a DSGE model within a frictional labor market; in the second and the third cases, following Garibaldi and Violante (2005), I introduce a bargaining on the severance payment. The second and the third cases are distinguished in the wage bargaining process since the second case correspond to the Efficient Bargaining while the third case is for the Right-To-Manage Bargaining.

My results are the following. In a first time, the only introduction of severance into the New-Keynesian framework do not allow to increase inflation persistence. In the second time, the introduction of bargaining on severance payments gives to firing costs a dynamic aspect. I find here that even if the Lazear (1990) critic still hold, the introduction of the transfer component of firing cost leads to introduce a new dynamic into wages. However, this dynamic is not strong enough in the efficient bargaining framework but it allows an improvement of inflation persistence in the Right-to-Manage bargaining framework where the wage canal is active. Thus, I provide here a DSGE model with rational expectations and bargained firing costs which allows to improve inflation persistence.
Bibliographie


A The dynamic of the model

I note $\tilde{x}_t$ the log-deviation of the variable $x_t$ according to its steady-state $x$.

The Euler equation:

$$\tilde{\lambda}_t = -\frac{c}{\lambda(c - ec)^2} \tilde{c}_t + \frac{ec}{\lambda(c - ec)^2} \tilde{c}_{t-1} - \beta \frac{e}{(e - 1)^2} E_t[\tilde{c}_{t+1}] + \beta \frac{e^2c}{\lambda(c - ec)^2} \tilde{c}_t$$

The marginal utility of consumption:

$$\tilde{\lambda}_t = \tilde{r}_t + E_t \tilde{\lambda}_{t+1}$$

The matching function:

$$\tilde{m}_t = \sigma \tilde{u}_t + (1 - \sigma) \tilde{v}_t$$

The transition probabilities:

$$\tilde{q}_t = \tilde{m}_t - \tilde{v}_t$$

$$\tilde{s}_t = \tilde{m}_t - \tilde{u}_t$$

Employment:

$$\tilde{n}_t = (1 - \rho) \tilde{n}_{t-1} + \rho \tilde{m}_{t-1},$$

knowing that at the steady state $n = (1 - \rho) n + m \iff \rho n = m \iff m/n = \rho$.

Unemployment:

$$\equiv \tilde{u}_t = -\frac{n}{u} (1 - \rho) \tilde{n}_t$$

The job creation equation:

$$\tilde{q}_t = -\tilde{\lambda}_t - \beta(1 - \rho)^{-1} \left\{ \frac{\kappa}{\lambda q} \left[ (ahx)^{-1}(\tilde{x}_{t+1} + \alpha \tilde{h}_{t+1}) + (wh)^{-1}(\tilde{w}_{t+1} + \tilde{h}_{t+1}) \right] - \left[ \tilde{\lambda}_{t+1} + \tilde{q}_{t+1} \right] \right\}.$$  

The job tightness:

$$\tilde{\theta}_t = \tilde{s}_t - \tilde{q}_t.$$  

The New-Keynesian Phillips Curve:

$$\tilde{\pi}_t = (1 - \varphi)(1 - \varphi \beta) \frac{\varphi}{\varphi} \tilde{m}_t \tilde{c}_t + \beta E_t \tilde{\pi}_{t+1}.$$  

The Aggregate Demand:

$$\tilde{y}_t = \tilde{c}_t.$$  

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The clearing market condition:
\[ \ddot{y}_t = \ddot{n}_t + \alpha \dot{h}_t \]

The Taylor rule:
\[ \dddot{r}_t^n = \rho_m \dddot{r}^n_{t-1} + \gamma_s (1 - \rho_m) E_t \dddot{\pi}_{t+1} + \gamma_y (1 - \rho_m) \dddot{y}_t + \varepsilon_t^n \]

The real short term interest rate:
\[ \dddot{r}_t = \dddot{r}_t^n - E_t \dddot{\pi}_{t+1} \]

The canal of the extensive margin:
\[ \dddot{x}_t + \dddot{mpl}_t = \dddot{mrs}_t \]

The marginal productivity of labor:
\[ mpl_t = z \alpha h^{\alpha - 1}_t \iff \dddot{mpl}_t = (\alpha - 1) \dddot{h}_t \]

The marginal rate of substitution:
\[ \dddot{mrs}_t = -\dddot{\lambda}_t + \phi \dddot{h}_t. \]

A.0.4 Wages with fixed firing costs

The wage of an old job:
\[ \Leftrightarrow \dddot{w}_t = \frac{\eta mpl x}{\alpha w} [\dddot{x}_t + \dddot{mpl}_t] + \frac{\eta \kappa \theta}{\lambda w h} [\dddot{\theta}_t - \dddot{\lambda}_t - \dddot{h}_t] + \frac{(1 - \eta)}{w} \left[ \frac{mrs}{1 + \phi} \dddot{mrs}_t - \frac{b}{h} \dddot{h}_t \right] + \frac{\eta (1 - \rho) s F}{wh} [\dddot{s}_t - \dddot{h}_t] + \frac{(1 - \eta) (1 - \rho) s S}{wh} [\dddot{s}_t - \dddot{h}_t]. \]

The wage for a new job:
\[ \dddot{w}_n = \frac{\eta mpl x}{\alpha w^n} [\dddot{x}_t + \dddot{mpl}_t] + \frac{\kappa \theta}{\lambda w^n h} [\dddot{\theta}_t - \dddot{\lambda}_t - \dddot{h}_t] + \frac{(1 - \eta)}{w^n} \left[ mrs \left[ \frac{b}{h} \dddot{h}_t \right] - \frac{\rho}{w^n h} \left[ \eta F \dddot{h}_t + (1 - \eta) S \dddot{h}_t \right] \right]. \]

A.0.5 Wages with dynamic firing costs and efficient bargaining

Ex-post firing costs
\[ \dddot{F}_t = \frac{\dddot{S}}{\dddot{F}}. \]

Legal severance payments:
\[ \dddot{S}_t = \dddot{w}_t \]
Bargained severance payments:

\[ \Leftrightarrow \hat{S}_t = \rho_u \hat{S} \]

*Ex-ante* firing costs:

\[ \hat{F}_t = \rho_u \rho_a \frac{\hat{S}}{F} \hat{S}_t + (1 - \rho_a) \rho_u \frac{\hat{F}}{F} \hat{F}_{t+1} \]

The old job wage with dynamic firing costs:

\[ \hat{w}_t = \eta \frac{mplx}{\alpha w} (\hat{x}_t + \hat{mpl}_t) + \frac{\kappa \theta}{\chi wh} (\hat{\theta}_t - \hat{\lambda}_t - \hat{h}_t) + (1 - \eta) \frac{mrs}{1 + \phi} m\hat{r}s_t - \frac{b}{wh} \hat{h}_t \]

\[ + \frac{1 - \eta}{wh} [\hat{S}_t - \hat{h}_t] + \frac{\eta F}{wh} [\hat{F}_t - \hat{h}_t] + \frac{1 - \eta}{wh} \beta \{(1 - \rho) s\hat{s}_t + [1 - (1 - \rho) s] \hat{h}_t \}
\]

\[ - \frac{1 - \eta}{wh} \beta [(1 - \eta) \hat{S}_{t+1} + \eta F \hat{F}_{t+1}] \]

The new job wage with dynamic firing costs:

\[ \hat{w}_t^n = \frac{\eta}{w^n} \left[ \frac{mplx}{\alpha} (\hat{x}_t + \hat{mpl}_t) + \frac{\kappa \theta}{\chi wh} (\hat{\theta}_t - \hat{\lambda}_t - \hat{h}_t) \right] + \frac{1 - \eta}{w^n} \left[ \frac{mrs}{1 + \phi} m\hat{r}s_t - \frac{b}{h} \hat{h}_t \right] \]

\[ - \frac{1 - \eta}{h} \frac{\rho S}{\beta} [\hat{S}_{t+1} - \hat{h}_t] - \frac{\eta p F}{h} \beta [\hat{F}_{t+1} - \hat{h}_t] \]

A.0.6 Right to Manage bargaining and dynamic firing costs:

The wage canal:

\[ \hat{w}_t = \hat{x}_t + \hat{mpl}_t \]

The old job wage:

\[ \hat{w}_t = \left[ a^{-1} + \frac{\kappa \theta}{\chi wh} + \frac{F}{wh} \right] \chi \hat{x}_t + \frac{\chi}{\alpha} \left[ \hat{x}_t + \hat{mpl}_t \right] + \frac{\chi \kappa \theta}{\chi wh} [\hat{\theta}_t - \hat{\lambda}_t - \hat{h}_t] + \frac{\chi F}{wh} [\hat{F}_t - \hat{h}_t] \]

\[ - \left[ \frac{mrs}{1 + \phi} + \frac{b + S}{h} \right] \chi \hat{x}_t + \frac{1 - \chi}{h} \left[ \hat{S}_t - \hat{h}_t \right] + \frac{(1 - s) S}{h} \chi \hat{x}_t \]

\[ - \frac{A F}{w} [\hat{F}_{t+1} + \hat{A}_t] - \frac{B S}{w} \beta [\hat{S}_{t+1} + \hat{B}_t] \]

\[ \hat{A}_t = -\hat{h}_t + \frac{\chi}{\hat{A} h} \left[ \rho \hat{x}_t - (1 - \rho) s\hat{s}_t - (1 - s)(1 - \rho) \xi \hat{x}_t + (1 - s)(1 - \rho) \xi_{t+1} \right] \]

\[ \hat{B}_t = -\hat{h}_t - \frac{\rho + (1 - s)(1 - \rho)}{h} \frac{\chi}{\hat{B} h} \hat{x}_t - \frac{(1 - \chi)(1 - \rho)}{h} \frac{s}{\hat{B} \hat{s}_t} \]
The new job wage:

$$\hat{w}_n = \chi \left[ \alpha^{-1} + \frac{\kappa \theta}{\lambda w_n h} \right] \hat{x}_t - \chi \frac{m_{rs}}{w} \left[ 1 + \phi + \frac{b}{h} \right] \hat{x}_t + \frac{\chi}{\alpha} \left[ \hat{x}_t + \hat{m}_{pl} \right]$$

$$+ \frac{\chi \kappa \theta}{\lambda w_n h} \left[ \hat{\theta}_t - \hat{x}_t - \hat{h}_t \right] + \frac{(1 - s) \kappa}{\lambda q u_n h} \left[ \chi (1 + \xi) \hat{x}_t - (1 - \chi) \xi \hat{\xi}_{t+1} \right]$$

$$- \frac{\chi \beta \rho F}{w^m h} \left[ \hat{x}_t - \hat{h}_t + \hat{F}_{t+1} \right] - \frac{\beta \rho S}{w^m h} \left[ (1 - \chi)(\hat{S}_{t+1} - \hat{h}_t) - \chi \hat{x}_t \right]$$

$$\delta_t^W$$’s dynamic:

$$\tilde{\delta}_t^W = \tilde{h}_t + \frac{h m_{rs}}{(1 - \alpha) w \delta W} \left[ \tilde{m}_{rs} s_t - \tilde{w}_t \right]$$

$$\delta_t^F$$’s dynamic:

$$\tilde{\delta}_t^F = \tilde{h}_t$$

$$\chi_t$$’s dynamic:

$$\tilde{\chi}_t = \chi^{-1} \frac{\eta (1 - \eta) \delta^W \delta^F}{[\eta \delta^W + (1 - \eta) \delta^F]^2} [\tilde{\delta}_t^W - \tilde{\delta}_t^F]$$

$$\xi_{t+1}$$’s dynamic:

$$\tilde{\xi}_{t+1} = \tilde{\delta}_{t+1}^W - \tilde{\delta}_{t+1}^F$$

B 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.

**Figure 3 – The Output reaction to the monetary shock**
C The IRF under the Standard Calibration (SC) and the Alternative Calibration (AC)

I present here the IR functions (figure 10 to figure 15) in two different cases: the first case correspond to the RTMB case where the Calvo coefficient is fixed to 0.85. The second case
Figure 7 – The Worked Hours reaction to the monetary shock

Figure 8 – The Wage reaction to the monetary shock

Figure 9 – The Global Firing Costs reactions according to the EB and the RTMB frameworks

correspond to the RTMB framework where the Calvo coefficient is fixed to .07.
Figure 10 – Output reaction with alternative calibration

Figure 11 – Inflation reaction with alternative calibration

Figure 12 – Employment reaction with alternative calibration
Figure 13 – Searching Workers reaction with alternative calibration

Figure 14 – Hours reaction with alternative calibration

Figure 15 – Wage reaction with alternative calibration
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