Understanding the long run dynamics of French unemployment and wages

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Michel-Pierre Chélini
Georges Prat

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Michel-Pierre Chelini, University of Artois, France
Email : mpchelini@gmail.com

Georges Prat, EconomiX (CNRS and University of Paris Nanterre), France
Email : georges.prat@parisnanterre.fr

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Abstract - A standard specification of the WS-PS model based on wage bargaining between unions and firms makes it possible to understand the main features of long-term dynamics of unemployment and wages in France at the macroeconomic level. This result is conditional on auxiliary hypotheses made on the representations of the degree of rigidity in the labour market (depicted by a stochastic state variable), of the reservation wage (depending on the legal minimum wage), and on the nature of "other factors" of wages and prices that are not a priori specified in the WS-PS theoretical framework (summarized by the output gap). We find that the observed unemployment adjusts gradually to its equilibrium value, which is composed of three components: a "chronic" component due to the repartition in the added-value (real reservation wage, social contributions, productivity, profit margins of companies), a "cyclical" component depending on the output gap, and a "frictional" component due to the imperfect mobility of labour factor and technical progress. The observed wage also adjusts gradually to its negotiated value, the latter depending on the reservation wage, the social contributions, the price level, the labor productivity, the profit margins of companies, the unionization rate and on the unemployment rate whose influence is time-varying. Our results suggest that, in the average, the power of firms dominates that of unions during the negotiations, while, as predicted by the theory, change in employment intervenes effectively in the adjustment between wage desired by employees and wage offered by employers to achieve equilibrium.

Classification J.E.L.: E24, J2, J30
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1 Introduction

This article aims to portray the macroeconomic evolution in the unemployment rate and wage rate in the long run in France, in accordance both with economic theory and historical and institutional facts.[1] Our study is based on the thought that unemployment and wages must be modelled simultaneously. Indeed, from the point of view of the employee for whom the wage is an income, the requested wages are weakened by unemployment. In contrast, from the point of view of the employer for which the wage constitutes a cost of production, the wage determines the amount of labour input it wishes to use, and thus the extent of underemployment.

Our work does not propose a breakthrough in pure theory, but its objective imposes of course the choice of a general theoretical framework. As will be explained later, our framework refers to a simple specification of the WS-PS model (*Wage Setting - Price Setting*), which seems relevant to describe the behaviour of actors in the French labour

market. In this model, the behaviours of employees and employers are supposed to be rational, but the labor market is characterized by an imperfection of the competitive mechanisms since companies fix their workforces according to wage agreements concluded with the trade unions. This theoretical framework makes it possible to estimate simultaneously at any time the value of the equilibrium unemployment rate and the value of the corresponding wage agreement bargained by the two social partners. To this end, our modelling introduces auxiliary hypotheses, covering the representation of the reservation wage, the other factors likely to influence wages and prices but not directly specified by theory, and the gradual adjustment of unemployment and wages to their equilibrium values. Moreover, we propose an econometric state-space modelling of unemployment and wages using the Kalman filter methodology, which allows a joint representation of the evolutions over time of the degree of labour market rigidity and of the sensibilities to unemployment of wages claimed by unions and those offered by companies. Our results show that the proposed specification of the WS-PS model reproduces the main features of the dynamics of the unemployment rate and the wage rate in France over the period 1955-2008.

The remainder of this article is organized as follows. **Part 2** gives an overview of the literature, especially that devoted to the applications of the WS-PS model in France, and justifies the choice of this model compared to other approaches in the literature. **Part 3** discusses the auxiliary assumptions made to achieve the econometric specification. **Part 4** presents the data, the estimation method and empirical results. The conclusion draws the main lessons from this study.

2 The literature and the choice of the WS-PS model

The economic literature on the relationship between wage rates and unemployment rates has developed along three lines[2]: the Phillips curve with its many extensions, the WS-PS negotiation model, and finally, the matching model pertaining to job supply and demand. Following the seminal article by Phillips [1958], which highlighted a negative relationship between the nominal wage rate of change and the unemployment rate for the United Kingdom, the theoretical and empirical developments since then have led to the concept of "*Non-accelerating inflation rate of unemployment*" (NAIRU) proposed by Tobin, reflecting the theoretical value of the unemployment rate when real wages grow at the same rate as productivity. The debates in the literature highlight that this approach is characterized by theoretical and empirical limitations. At the theoretical level, the NAIRU was considered as representing more a reference value reflecting an economic equilibrium condition in the labour market than an approach describing the actual behaviour of the agents, even if, under certain restrictive conditions, the Phillips curve may join the WS-PS model or can be combined with it (Blanchard and Katz [1999], Heyer et al., [2005, 2007]). On the empirical side, studies have ascertained that, while these approaches explain wage changes rather well (see, for example, Heyer et al. [2000]), the NAIRU often does not adequately represent the trend in the unemployment rate (L'Horty and Thibault, 1997; Richardson et al., 2000), except by admitting *a priori* exogenous hypotheses, including the hysteresis hypothesis suggested by Blanchard and Summers (1986) (Mc Morrow and Roeger [2000]).

The WS-PS model (Layard-Nickel [1985, 1986], Layard-Nickel-Jackman [1991]) explicitly outlines the behaviours of employees and firms in an imperfect competition framework and leads to the definition of an *equilibrium rate of unemployment* (ERU) that characterizes a situation wherein both employees and employers have arrived at a wage agreement; the ERU may be both higher and more fluctuating than the so-called "*natural rate of unemployment*". In fact, the specifications of this model in the literature are as numerous as the number of contributions, not to mention the variety of quantitative methods used to confront this model with observation data. In this regard, it is worth noting that two modes of empirical verification have been followed in the literature. The first is to estimate the structural wage (WS) and price (PS) equations in order to deduce the equilibrium value of the unemployment rate, which requires the introduction of constraints to identify the parameters of the model. The second mode consists of directly estimating a reduced-form of the equilibrium rate of unemployment equation, which is deduced from the equality between the desired and offered values of the real wages given by the two structural equations; this approach assumes that the spread between the observed unemployment and the ERU is a white noise, or that unemployment progressively adjusts to its equilibrium value according to a process to be specified. By adopting this second approach and assuming an adaptive adjustment of observed unemployment to its equilibrium value, Layard et al. [1991, p. 435] show that the WS-PS model fairly describes changes in the unemployment rate in 19 OECD countries including France; the specification used by the authors explains on average 86% of the variance of unemployment rates over the period 1956-88. These results were confirmed for France with the first kind of approach (Bonnet and Mahfouz [1996], L'Horty and Sobczak [1997], Cotis and al. [1998], L'Horty and Thibault [1998], Cahuc and Zylberberg [1996, 1999], l'Horty and Rault [2003], Gérard-Prenveille [2003]).[3] However, empirical analyses have shown that the introduction of numerous institutional variables capable of reflecting the rigidity of the labour market does not lead to very conclusive results (Chagny and al., 2002), Heyer and al [2007]). Interestingly, in order to capture the evolution in the institutional environment of the labour market, Heyer and al. [2007] employed the Kalman filter method to analyse the time variability of the structural parameters of the WS and PS equations over the period 1970-2002 in United States and France. The results show that if parameters stability can be accepted for the United States, some parameters vary significantly for France due to the increasing flexibility of the labour market subsequent to 1982, in particular regarding the deindexation of wages on the price level.

At about the same time as WS-PS, a *matching model* was proposed to capture the frictions between the flows of job supply and job demand (Pissarides [1985, 2000]). This approach then led to many developments that have been rewarded by the 2010 Nobel Prize in economy assigned to Diamond, Mortensen and Pissarides. This "DMP model" is indeed notable because it helps to determine not only an equilibrium level of unemployment and wage (as WS-PS), but also the job creation and job destruction flows at a disaggregated level. However, Diamond [1982] has shown that these frictions can give rise to several possible equilibria, so that agents must be able to coordinate in order to achieve a "good" equilibrium. Moreover, the DMP model ability to describe the dynamics of the labour market was

subsequently challenged by Shimer [2005] who showed that this model generates excessive volatility in real wages (and thus a too-low volatility for employment). Moreover, unlike the WS-PS model in which corporations face a reversed demand curve in the goods market (decreasing as a function of price), the DMP model does not incorporate a Keynesian mechanism involving the level of aggregate demand.

Consistent with the objective of this article, we have chosen to carry out our work within the framework of the WS-PS model. In contrast to the Phillips curve approaches, the agents' behaviours are explicitly outlined and seem rather well adapted to the French context. While the desired values of wages and prices are respectively the results of rational behaviours on the part of employees and firms, the two parties negotiate between themselves to arrive at a wage agreement, ultimately leading the employers to set the level of employment. As for the DMP model, it is inherently more complex than WS-PS because it must describe the frictional forces associated with the inadequacy of job offers with job demand and draw all the consequences concerning the flows of supply and demand of employment. The WS-PS model provides a simple tool well-suited to the limited objective of our study, which deals with the historical dynamics in unemployment and wages in France at the macroeconomic level. Nevertheless, as will be explained below, the choice of this model should not hide the fact that the many specifications encountered in the literature raises difficulties, most of them being related to measurement problems of the variables.

3 The proposed model

3.1 The WS and PS theoretical equations

We consider a static specification of the WS-PS model where agents are representative and the capital exogenous, the aim being to deduce at each date the equilibrium values of the unemployment rate and the corresponding wage rate (one thus determines a time series of short-term equilibria of the labour market). As usual in the literature, the PS and WS equations are presented in a linear form by considering the logarithms of the variables, except for those expressed as a rate.[4] By relaxing the assumption of constant sensibilities of prices and wages to unemployment (i.e. according to the date, unemployment plays *more or less* the role of an adjustment variable between prices and wages), the general equations WS and PS can be expressed as follows[5]:

$$\text{PS}: \quad s_t^{ps} - p_t^c = (p_t - p_t^c) - ce_t + \pi_t + k_t^p u_t - m_t - f_t^p \qquad k_t^p \geq 0 \ \forall t \qquad (1)$$

with $(p_t - p_t^c) = \tau_t \theta_t$; τ_t : trade openness rate ; θ_t : terms of trade

$$\text{WS}: \quad s_t^{ws} - p_t^c = (s_t^R - p_t^c) + cs_t - k_t^s u_t + f_t^s \qquad k_t^s > 0 \ \forall t \qquad (2)$$

s_t^{ps} : Gross hourly wage rate offered by companies

s_t^{ws} : Gross hourly wage rate desired by employees (before tax)

s_t^R : Net reservation hourly wage rate (minimum net remuneration required by employees)

p_t^c : Level of consumer prices considered by employees

p_t : General level of prices set by companies

ce_t : Rate of social levy borne by companies (compared to gross wage)

cs_t : Rate of social levy borne by employees (compared to net wage)

m_t : Rate of gross margin set by companies

π_t : Hourly productivity of labour

u_t : Unemployment rate (ILO definition)

k_t^p : Sensibility to the unemployment rate of the price level set by companies

k_t^s : Sensibility to the unemployment rate of the real wage desired by the employees

f_t^p : Other factors affecting the fixing of prices

f_t^s : Other factors affecting wage requirements

In a monopolistic competition situation where the marginal productivity of labour is decreasing, the PS equation is obtained under the assumption that firms set their prices in a way that maximizes their profits. The variable s_t^{ps} thus corresponds to the wage offered by the representative firm in view of the value of the price level p_t which it considers optimal to set. In this framework of analysis, the "right to manage" principle leads companies to set their workforce according to the wage agreements reached with the unions. It follows that the unemployment rate can act as a variable of adjustment between the aspirations of both parties. The positive influence of the unemployment rate reflects the fact that, in the general case, the marginal productivity of labour increases when the number of workers decreases, thus encouraging the firm to offer a higher real wage, all other things being equal. As a direct result of the model, it can be seen that firms integrate in their selling prices the differential between the general price level and the consumer prices, which captures the influence of the terms of trade (price of exports / import prices). As is usual, Eq.(1) is obtained by considering at the outset that firms integrate in the prices they should set the margin rate m_t [6] and the rate of compulsory social contributions ce_t. Regarding the WS equation, it determines the wage rate desired by employees under the assumption that trade unions aim to maximize the utility function of employees; doing so, trade unions take into account the likelihood that wage earners could be unemployed, receiving in this case an "equivalent income" equal to the monetary values of leisure benefits augmented by the disutility of labour and domestic labour. In Eq.(2), the fact that unemployment weakens the level of wage required by of employees is a very intuitive result. As for the PS equation, it can be seen that the rate of social contributions cs_t paid by employees belongs at the outset to the vector of variables conditioning the gross wage before taxes required by employees. The "other factors" f_t^p and f_t^s in the PS and WS equations represent variables that are a priori unspecified by the theory but that may also influence prices and wages.

3.2 The equilibrium unemployment rate

Equalizing the right-hand sides of equations (1) and (2), that is $s_t^{ps} = s_t^{ws} = s_t^*$ where s_t^* represents the negotiated value of the wage rate, we can express the value of the ERU which makes compatible the aspirations of both agents :

$$u_t^* = \alpha_t [s_t^R + cs_t + ce_t - p_t - \pi_t + m_t + f_t] \qquad (3)$$

$$\text{with} \quad \alpha_t = 1/(k_t^s + k_t^p) \quad \text{and} \quad f_t = f_t^s + f_t^p$$

The relationship (3) shows that the empirical estimate of u_t^* requires auxiliary assumptions to represent the reservation wage s_t^R, the coefficient α_t and the "other factors" f_t of prices and wages. Concerning the representation of the reservation wage s_t^R, the theoretical content of the latter is complex and there is no compelling empirical indicator in the literature. Studies show that using unemployment indemnities as an indicator do not lead to very convincing results (Manning [1993], Cotis et al. [1998]). One explanation could be that the share of the unemployed at the end of entitlement is often both large (up to 50%) and fluctuating. This is the reason why some contributions assume that the real reservation wage follows a linear trend (L'Horty and Sobczak [1996], Cotis et al [1996], L'Horty and Sobczak [1997] 2001), or that it can be represented by the wage of the previous period (Manning [1993], Blanchard and Katz [1999]). Even if these choices are understandable because of the unobservable nature of the reservation wage, they remain arbitrary. Another hypothesis is to index the reservation wage on labour productivity (Blanchard and Katz [1997], Cotis et al., 1998). In fact, if we introduce this hypothesis back into Eq.(3), the equilibrium unemployment no longer depends on the reservation wage and on productivity, which is of course not intuitive.

To circumvent these difficulties, we have followed an alternative direction, that of using the existence in France since 1950 of a legal minimum wage.[7] Indeed, Rioux (2001) analysed the results of four surveys carried out by the French National Statistic Office (INSEE) between 1994 and 1998, by interviewing the unemployed persons on the minimum hourly wage that they required to accept a job, that is to say the value of their reservation wage. It is important to emphasize here that the questions posed did not mention any reference to the SMIC: they are not therefore a priori incited to respond towards the value of the legal minimum. The author finds that two-thirds of the unemployed benefiting from the Minimum Income of (Social) Insertion (RMI, program supported by the French government between 1988 and 2009) and therefore not benefiting from unemployment allowances, ask *at most* the national minimum wage (SMIC) in order to accept an offer of employment. Conversely, two-thirds of the unemployed benefiting from allowances require *at least* this minimum wage (SMIC). Moreover, for this latter group, it appears that the reservation wage increases with the wage level of their last job, while it reduces as the unemployment experience continues. In spite of the heterogeneity of the reservation wage according to individuals[8], these results suggest that the average reservation wage can be linked to the

national minimum wage (SMIC), the latter being seen as a social reference value of the labour price, over which minimum wage requirements will be positioned by default or by excess. This leads us to represent the average hourly reservation wage s_t^R as a function of the trend of the (official) net hourly minimum wage. Consideration of the trend is justified by the fact that we try to represent at each date the average in individual reservation wages, so that we can expect a smoother evolution than that of the SMIC whose revisions are discontinuous. The econometric results obtained support this choice insofar as they have been improved by considering the trend in place of the observed values of the SMIC. We have thus[9]:

$$s_t^R = \sigma_o \log(\overline{SMIC_t} + s_o) \qquad \sigma_o > 0 \qquad \overline{SMIC_t} + s_o > 0 \tag{4}$$

$\overline{SMIC_t}$: trend *HP* (*Hodrick-Prescott*) of the net hourly SMIC

As for the coefficient $\alpha_t = 1/(k_t^s + k_t^p)$, its value is all the smaller because the sum $k_t^s + k_t^p$ of sensibilities to unemployment of the real wages desired and offered is high, which means that α_t is all the smaller because unemployment plays an important role as an adjustment variable between wages (WS equation) and prices (PS equation), that is between s_t^{PS} and s_t^{WS}. In other words, α_t will be all the greater because rigidity in prices (e.g. price control policy), in wages[10] (including social contributions) or in employment (e.g. presence of severance compensation) are strong during the period of negotiation. On the whole, the so-called "rigidity of the labor market" results from these three kinds of rigidities. In this regard, it should be noted that the contributions of the literature show that the introduction of numerous institutional variables capable of translating these rigidities does not lead to very conclusive results. Therefore, the multidimensional, latent and not directly quantifiable character of the degree of rigidity in the labour market has led us to represent the dynamics in the coefficient α_t by a recursive stochastic process estimated using the Kalman filter methodology, which allows the estimation of unobservable variables[11]:

$$\alpha_t = \gamma_0^u + \gamma_1^u \, \alpha_{t-1} + \eta_t^u \qquad 0 \le \gamma_1^u \le 1 \qquad \eta_t^u = N(0, \sigma^2(\eta_t^u)) \tag{5}$$

Finally, it is necessary to formulate a hypothesis to represent the "other factors" f_t involved in Eq.(3) of equilibrium unemployment. As we have already noted, the empirical contributions of the literature often introduce many explanatory variables of unemployment as "proxies" of institutional or cyclical phenomena that can be more or less suggested by theory[12], to the point where it is sometimes difficult to know if it is the theory that is validated or if there occurs simply correlations between unemployment and other macroeconomic variables. Such approaches also involve a multiplication of arbitrary parameters to be estimated. Since we wanted to avoid these drawbacks, and because factors related to the *repartition of added value* are represented by the variables specified by the WS-PS model, we assumed that f_t reflects the influence of the underlying factors of the *level of real added*

value. Accordingly, the factors that determine f_t are summarized by the sum of a cyclical element proportional to the output gap Δq_t and of a constant f_o representing structural factors that may generate some uncompressible unemployment :

$$f_t = b\Delta q_t + f_o \qquad b > 0 \qquad f_o > 0 \qquad \Delta q_t = \overline{q}_t - q_t \qquad (6)$$

Δq_t : output gap, measured by the deviation (%) between the log of potential GDP $\overline{q}_t$ and the log of real observed GDP q_t

$\overline{q}_t$: *HP* trend (q_t^{hp}) of q_t plus a constant of 4.46% ensuring a positive or zero value of the output gap Δq_t over the whole period (this constant corresponds to the minimum negative value of $q_t - q_t^{hp}$ observed in 1973)[13]

At the theoretical level, the output gap Δq_t - which of course depends on variables X_{it} - can be seen as conditioning f_t through the *expected growth rate*. Indeed, because of decreasing returns, the bargaining agents will anticipate in principle a rate of growth of production increasingly smaller as the production nears its maximum (i.e. as Δq_t is close to zero). In these circumstances, an increase in Δq_t will reflect the *expectation* of higher output growth, leading the unions to higher wage demands and better acceptance of these demands by employers, who may compensate by setting higher prices to maintain their profit margins. These behaviours will thus lead to simultaneous increases in f_t^s and f_t^p, hence to their sum f_t, and *in fine* to an increase of equilibrium unemployment (Eq.(3)). Eq.(6) offers the advantage of being very simple[14] and parsimonious about the number of parameters to be estimated. However, it is important to question the identity of the factors X_{it} underlying Δq_t and therefore f_t.[15] On this question, Chélini and Prat [2016, Annex 2] show that a linear combination of variables such as the real interest rate, international competitiveness, corporate profit margins, money supply growth, inflation and unionization rates, provide a fairly good representation of Δq_t.

3.3 The negotiated wage rate

The wage rates s_t^{ps} and s_t^{ws} (equations (1) and (2)) being the solutions of maximization programs of firms and unions before negotiation, these notional rates are interpreted respectively as offered and desired values. Because the negotiated value s_t^* of wage associated to the ERU cannot a priori exceed $\max(s_t^{ps}, s_t^{ws})$ and be less than $\min(s_t^{ps}, s_t^{ws})$, it can be expressed at each date by a weighted average of s_t^{ps} and s_t^{ws}[16]:

$$s_t^* = \kappa s_t^{ws} + (1-\kappa)\, s_t^{ps} \qquad 0 \le \kappa \le 1 \qquad (7)$$

The mechanism leading to the value s_t^* can be described as follows. If, *at the beginning of the negotiation*, the wage desired by employees s_t^{ws} exceeds that offered by firms s_t^{ps} by x%, these latter will be induced to reduce the labour factor in the production process (using the principle of "right to manage"), thus leading to an increase du_t% (in points) of the unemployment rate. According to the WS equation (2), this increase in unemployment leads to a decrease of $k_t^s du_t$% of the wage desired by employees and, according to the PS equation (1), to an increase of $k_t^p du_t$% of the wage offered by the firm. The rise in unemployment towards its equilibrium level thus allows both parties to reach an agreement on an intermediate value s_t^* of wages, thanks to a reduction in the claims of the employees and an acceptance by the firm of an upward revision of wages offered; as a result, unemployment appears as the key mechanism reducing the gap between s_t^{ws} and s_t^{ps} (see in particular Layard and Nickell (1986)). At the *end of the bargaining process*, the wage agreement leads to the equilibrium condition $s_t^{ps} = s_t^{ws} = s_t^*$. As in any situation of bilateral monopoly, the value of s_t^* depends on the power and the cleverness of both parties. These qualities are a priori unknown, but Nash's bargaining theory - a situation in which no player has an interest in deviating individually from his strategy - makes it possible to circumvent this indeterminacy by considering that negotiation maximizes the weighted average of additional utility obtained by the two parties in comparison to a fall-back situation. The overall optimal solution thus corresponds to a negotiated value of the wage s_t^* which necessarily lies between the desired values s_t^{ws} and s_t^{ps} prevailing at the beginning of the negotiation. The parameter κ of Eq. (7) then reflects the balance of the bargaining power between the union and the firm. A value $\kappa = 0$ means that the company is all powerful and can therefore impose employment and wage levels, whereas the value $\kappa = 1$ means on the contrary that the union has complete power in the negotiation. The values of κ ranging from 0 to 1 thus allow to describe the curve of the possible values of the employment contract (d'Autume [2001], p.6). By including equations (1) and (2) in (7), we obtain the theoretical expression of the negotiated wage:

$$s_t^* = \kappa(p_t^c + sr_t^R + cs_t) + (1-\kappa)(p_t + \pi_t - ce_t - m_t) + \omega_t u_t + \kappa f_t^s - (1-\kappa) f_t^p \qquad (8)$$
$$\text{with } \omega_t = [(1-\kappa)k_t^p - \kappa k_t^s]$$

In the relationship (8), the time-varying coefficient $\omega_t = [(1-\kappa)k_t^p - \kappa k_t^s]$ represents the sensibility of the wage rate to unemployment rate. This sensibility is *negative* when the weight attributed to unemployment by the employees during the negotiations is greater than the weight attributed to this variable by the employers (i.e. $(1-\kappa)k_t^p < \kappa k_t^s$), and *positive* in the opposite case. The condition $\omega_t = 0$ expresses a situation where the two weights are

balanced. Eq.(8) shows that the estimation of s_t^* requires auxiliary assumptions about the representation of the real reservation wage sr_t^R, on that of the coefficient ω_t, and finally on the "other factors" of prices and wages that are captured by the pseudo-difference $\kappa f_t^s - (1-\kappa) f_t^p$.

The real reservation wage in Eq.(8) is defined as :

$$sr_t^R = s_t^R - \log \overline{P}_t^c \tag{9}$$

where the nominal reservation wage s_t^R is given by Eq.(4), while, in line with determination of the latter, $\overline{P}_t^c$ is the HP trend of the consumer price index. As with α_t, the coefficient ω_t is determined by a stochastic recursive process estimated using the Kalman filter methodology:

$$\omega_t = \gamma_0^s + \gamma_1^s \ \omega_{t-1} + \eta_t^s \qquad 0 \le \gamma_1^s \le 1 \qquad \eta_t^s = N(0, \sigma^2(\eta_t^s)) \tag{10}$$

Finally, since f_t^s and f_t^p are assumed to depend linearly on variables X_{it}, we can deduce that the influence of the "other factors" results in a linear combination of the X_{it}, where the influence of each variable on wage can a priori be positive, negative or null[17] (in the latter case, the effects of X_{it} compensate each other):

$$\kappa f_t^s - (1-\kappa) f_t^p = \sum_i \upsilon_i X_i + c_o \tag{11}$$

One can notice that equations (9), (10) and (11) associated with the determination of the negotiated wage rate are directly coherent with the auxiliary equations (4), (5) and (6) associated with the equilibrium unemployment rate, so that they do not really add any arbitrariness to the whole model.

3.4 The gradual adjustments toward the equilibrium values

The empirical contributions of the literature suggest that the assumption of a gradual adjustment of observed unemployment to equilibrium unemployment u_t^* may be relevant.[18] Many causes are put forth by the authors to explain such an adjustment occurring after a macroeconomic shock, known as "partial" or "gradual" hysteresis: the costs of collecting information concerning vacancies and mobility costs, the social costs associated with unemployment that include redundancy payments, the duration of unemployment (implying a degradation of human capital), a shortage of physical capital that follows a durable shortfall of demand in the goods market, … This type of adjustment between two successive periods

adds a form of rigidity different from that represented by the alpha coefficient which reflects the degree of rigidity during the negotiation period. This persistence is characterized by an adaptive process[19]:

$$u_t = \lambda_u u_{t-1} + (1-\lambda_u) u_t^* \qquad 0 \le \lambda_u \le 1 \qquad (12)$$

Concerning wages, because of the cost and duration of negotiations (Layard-Nickel-Jackman [1991], p. 425) and the delays due to the establishment employment contracts and to the first payment after negotiations (Avouyi-Dovi et al., 2009), the average wage observed in the statistics only adjusts progressively over its negotiated value, which is also represented by an adaptive process:

$$s_t = \lambda_s s_{t-1} + (1-\lambda_s) s_t^* \qquad 0 \le \lambda_s \le 1 \qquad (13)$$

4 The joint estimate of unemployment and wage rates : data, method and empirical results

4.1 Data

The statistical time series chosen are annual data because wages are governed by collective agreements giving rise to specific agreements (branches or companies) spread over the full year (Avouyi-Dovi et al., [2009]). These latter are negotiated every year or every two years, not every quarter. This choice obviously reduces the number of observations, but the length of the analysis period, which exceeds half a century partially compensates for this limit. The time series cover the period 1950-2008, the sources being INSEE, the Ministry of Labour and the Banque de France.[20] The objective being to identify long-term structural relationships, we preferred to exclude years of turbulence corresponding to the global financial crisis that began in mid-2007. Although there was a second phase of bank failures in the autumn of 2008, it can be assumed that macroeconomic effects only became significant in France in 2009 (we observe a continuous decline in the unemployment rate between 2006 and 2008, with unemployment rising appreciably only in 2009). For similar reasons, the years 1950-54, which are characterized by very high wage changes (reconstruction, inflation of the Korean War, post-inflationary catch-up after 1952), were excluded from the estimation period, which will therefore cover the years 1955 through 2008 included.

4.2 The state-space system to be estimated

By reporting Eq.(6) specifying the influence of "other factors" f_t in the ERU's Eq.(3), and then including the resulting equation in the adjustment process (12), we get the observed unemployment rate equation (Eq. (14) below). Similarly, by reporting Eq.(11) specifying the influence of the "other factors" $\kappa f_t^s - (1-\kappa) f_t^p$ in the negotiated wage Eq. (8), and then including the resulting equation in the adjustment process (13), we arrive at the

observed wage rate equation (Eq. (15) below). The stochastic coefficients α_t and ω_t being described by Eq.(5) and Eq.(10), the set of hypotheses described above leads to the space-state system composed of the four following equations [21]:

The two measurement equations :

$$u_t = \lambda_u u_{t-1} + (1-\lambda_u)\alpha_t (spread_t + m_t + b\Delta q_t + f_o) + \varepsilon_t^u \quad (14)$$

$$0 \leq \lambda_u \leq 1 \qquad spread_t = s_t^R - p_t + cs_t + ce_t - \pi_t$$

$$s_t = \lambda_s s_{t-1} + (1-\lambda_s)\left\{\kappa(p_t^c + sr_t^R + cs_t) + (1-\kappa)(p_t + \pi_t - ce_t - m_t) + \omega_t u_t + \sum_i \upsilon_i X_i + c_o\right\} + \varepsilon_t^s \quad (15)$$

$$0 \leq \lambda_s \leq 1 \qquad \omega_t = [(1-\kappa)k_t^p - \kappa k_t^s] \qquad 0 \leq \kappa \leq 1$$

The two stochastic state equations :

$$\alpha_t = \gamma_0^u + \gamma_1^u \alpha_{t-1} + \eta_t^u \qquad 0 \leq \gamma_1^u \leq 1 \quad (5)$$

$$\omega_t = \gamma_0^s + \gamma_1^s \omega_{t-1} + \eta_t^s \qquad 0 \leq \gamma_1^s \leq 1 \quad (10)$$

Given equations (4) and (9) of the reservation wage s_t^R and its real value sr_t^R, equations (14) and (15) depends on the trend of the national minimum wage SMIC and involves parameters σ_o and s_o which are of course estimated simultaneously with other parameters of the system. The error terms ε_t^u and ε_t^s (called "innovations") of the measurement equations are assumed to be $N(0, \sigma^2(\varepsilon_t^u))$ and $N(0, \sigma^2(\varepsilon_t^s))$, as well as the errors terms (called "noises") η_t^u and η_t^s of the two state variables are assumed to be $N(0, \sigma^2(\eta_t^u))$ and $N(0, \sigma^2(\eta_t^s))$.

4.3 Estimation method and empirical results

The above four-equation system does not pose problems of identification and was estimated over the period 1955-2008 (54 years) using the maximum likelihood method (Harvey [1992], Hamilton [1994]).[22] The initial values of the state variables α_t and ω_t were determined by a grid search to minimize the information criteria (Akaike (AIC), Schwarz (SC) and Hannan-Quinn (HQ)).[23] It should be noted that the Kalman filter method can give rise to difficulties in estimating the variances of the residuals ("innovations") of the measurement equations (also called "signals") and the variances of the residuals ("noises") of the state equations, but it is possible to minimize this risk by initializing these variances with

sufficiently high values (Stock and Watson, 1998; Durbin and Koopman, 2001), as we done. In case of persistent difficulty, it is the practice of econometricians to impose constraints on the variances, in particular by arbitrarily fixing the value of the ratio between the variance of innovations and the variance of noises ("Signal-to-Noise Ratio"). This constraint was not necessary in our estimates, the variances being estimated by imposing a positivity constraint (see note of Table 1).

According to the Kalman filter, the successive values of the state variables α_t and ω_t are revised each year on the basis of new information assumed to reflect a positive, negative or null variation in the degree of the labour market rigidity. This new information takes the form of additive normally distributed white noises, whose variances belong to the vector of the hyperparameters to be estimated. Since the effects of these informational shocks are supposed to spread gradually over the labour market, the dynamics of these two state variables are characterized by AR(1) processes with drift. An AR(2) process or the introduction of observable variables in the state equations have not proved to be empirically relevant. Note that this nonlinear method does not impose stationarity conditions on the observable variables of the system. However, it imposes other conditions which may appear more severe on the error terms ε_t^u and ε_t^s of the measurement equations (14) and (15): absence of autocorrelation, homoscedasticity and normality (see in particular Durbin and Koopman [2001, pp. 33-34]). Therefore, diagnostic tests on standardized residuals were carried out using respectively the tests Q, hH and HK, which were developed by Harvey (1992) specifically for the Kalman filter.

Table 1 gives the estimated values of the parameters[24] as well as the statistics associated with the various diagnostic tests carried out on the standardized values of residuals $\hat{\varepsilon}_t^u$ and $\hat{\varepsilon}_t^s$. For these two residuals, results lead to the conclusion of an absence of autocorrelation (Q statistic) and of heteroscedasticity (hH statistic) at the threshold of 5%, while the normality hypothesis can be accepted at the 1% level of significance (HK statistic), hence indicating that there is no abnormal frequency of extreme points. These properties of residuals thus show that the conditions of application of the Kalman filter are realized and that the specification of the model is statistically globally acceptable.

Table 1 – Estimating of the unemployment rate and the wage rate using the Kalman filter method

	unemployment rate u_t	**gross hourly wage rate** s_t
	state equation (5) $(i=u)$	*state equation* (10) $(i=s)$
γ_1^i	0.88 (16.2)	0.94 (21.0)
γ_o^i	0.07 (1.8)	(*)

c_2^i	-9.58 (-10.8)		-5.80 (-4.8)
	measurement equation (14)		*measurement equation* (15)
λ_i	0.49 (3.0)		0.40 (8.8)
b	7.71 (3.3)		-
s_o		-0.51 (-6.1)	
σ_0		1.15 (20.4)	
f_o	35.97 (2.2)		-
κ	-		0.21 (5.8)
υ_1 (txs_t)	-		0.68 (10.0)
c_o	-		0.45 (22.6)
c_1^i	-4.88 (-4.4)		-9.43 (-30.8)
R^2 (R_D^2)	0.98 (*0.67*)		0.99 (*0.94*)
Q *(**)*	9.1 *(11.1)*		7.1 *(7.8)*
hH *(**)*	10.7 *(28.9)*		18.8 *(28.9)*
HK *(**)*	0.01		0.43
AIC*(AICs)(**)*		-4.82 *(-3.93)*	
SC *(SCs)(**)*		-4.26 *(-3.56)*	
HQ *(HQs)(**)*		-4.61 *(-3.79)*	
LR*(***)*		58.2 *(9.49)*	

Note - The space-state system represented by Eqs. (14), (15), (5) and (10) is estimated over the period 1955-2008 (54 years) using the maximum likelihood method. Numbers in brackets at the right of estimates give the statistic *z*, which is interpreted as a *t-value* ratio. To ensure positivity, the variances of $\hat{\varepsilon}_t^i$ and $\hat{\eta}_t^i$ ($i = u$, s) are estimated as $\exp(c_1^i)$ and $\exp(c_2^i)$. The initial values of α_t and ω_t are those minimizing the information criteria (we obtain 0.053 and -0.795, respectively). R_D^2 is the Harvey [1992] modified coefficient of determination: the positive values obtained indicate that the structural model is more performing than a random walk with drift. (*) The intercept was found to be insignificant and then dropped from the final estimation. *(**)* Q and hH are the statistics of the Ljung-Box autocorrelation test (number of lags: $p = T^{1/2} \approx 7$) and of the heteroscedasticity test that are applied to the standardised values of residuals $\hat{\varepsilon}_t^i$, as proposed by Harvey [1992] for the Kalman filter. At the 5% level of significance, the values obtained for Q being less than the critical tabulated values $\chi^2_{5\%}(5)$ (unemployment) and $\chi^2_{5\%}(3)$ (wage) (indicated in brackets, in *italics* after the statistics), one accepts the null (no autocorrelation) ; values of the statistic hH being less than the tabulated

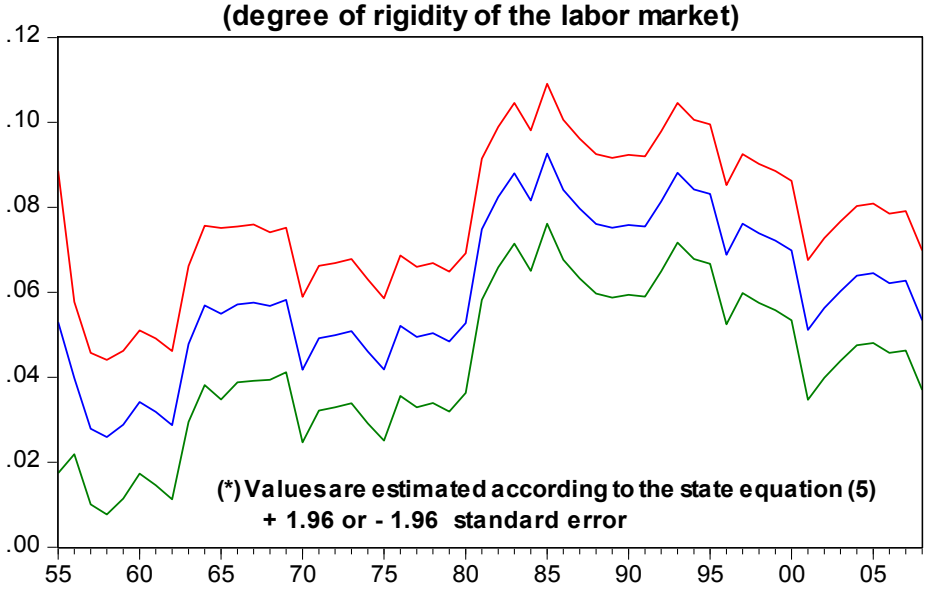
values for these two equations ($\chi^2_{5\%}(18)$, with 18 = T/3), one accept the null (no heteroscedasticity). HK is the *p-values* of the normality test proposed by Harvey-Koopman specified for the Kalman filter: the values obtained allow to accept the normality hypothesis at the 1% level for unemployment and at the 5% level for wages. AIC, SC and HQ stand for Akaike, Schwarz and Hannan-Quinn information criteria for the system; *AICs*, *SCs* et *HQs* give the values of the same statistics under the constancy hypothesis for α_t and ω_t (estimation using the *Seemingly Unrelated Regression method*). (***) LR is the log-likelihood ratio (distributed as a $\chi^2_{\delta\%}(4)$, where δ is the level of significance), allowing to test the null Ho ($\alpha_t = \alpha_o$, $\omega_t = \omega_o$) in the system; for $\delta = 5\%$, the calculated value LR=58.2 being higher than the critical value 9.49, Ho is rejected.

The unemployment rate estimated equation

Examination of the estimated unemployment equation (14) highlights the following points. The values of the parameters $\hat{s}_0 = 1.15$ and $\hat{\sigma}_0 = -0.51$ in the reservation wage equation - which are common to the unemployment and wage measurement equations - are very significant (see Eq. (4)). These outcomes position the reservation wage at around 15% above the national minimum wage SMIC on average over the entire period, with values between the latter and the median wage, approaching the median wage at the end of the period. Given that the national minimum wage SMIC is about 60% of the median wage, our results mean that the reserve wage would be on the order of 70% of the median wage on average, which seems plausible. On the other hand, the constant $\hat{f}_o = 36\%$ in the unemployment equation is significantly positive, which confirms the structural existence of frictional unemployment. Similarly, the value of the coefficient $\hat{b}$ linking the ERU to the output gap is positive, which confirms the expected cyclical effect on unemployment. Finally, the coefficient $\hat{\lambda}_u = 0.49$ indicates an average period of adjustment of unemployment to its equilibrium value close to one year.

As for the state equation (5) that determines the degree of rigidity α_t of the labour market, the estimated slope $\hat{\gamma}_1^u = 0.88$ is within the theoretical range [0,1], thus reflecting an *inertia of the rigidity shocks*, as illustrated in **Figure 1** representing the estimated values of α_t over the entire period. It should be emphasized here that, according to the theoretical expected sign, all the values obtained for α_t are positive and significant (i.e. the lower values are always above the horizontal of the zero point). This means that the observable variables which determine the ERU constitute *at any time* explanatory factors that are globally very significant for unemployment. The 95% confidence interval indicated by the upper and lower bounds shows that the coefficient α_t is significantly time-varying; the estimated values oscillate between a minimum of 0.026 and a maximum of 0.093, indicating substantial changes in the degree of rigidity of the labour market, evolving in a ratio of 1 to 3.5.

Figure 1 - Coefficient alpha in the unemployment rate equation (*)
(degree of rigidity of the labor market)



The general upward trend of α_t until the mid-1980s appears to be in line with the strengthening of institutional constraints during this period : creation of unemployment insurance scheme in 1958 with UNEDIC and ASSEDIC (partnership system employers-unions-public authorities for the management of unemployment insurance), Grenelle' agreements in May 1968 leading to a sharp increase in the national minimum wage (SMIC) and the creation of a union branch inside companies, indexation of the SMIC reinforced in 1970, social provisions on unemployment compensation from 1974 onwards. However, this general trend is marked by significant "rigidity shocks". In particular, in 1963-64, the sharp increase in α_t could be linked with the Giscard d'Estaing stabilization plan aimed at fighting inflation by restricting loans, price freezes and exchange controls. Similarly, the very sharp increase in α_t in 1981-82 corresponds to the election of the socialist François Mitterrand as President of the French Republic in May 1981. Apart from the fact that the political left is in principle less supportive of flexibility than the political right, this historical alternation has been marked by concrete measures which constitute factors of rigidity: blocking wages and prices (from June to November 1982), reduction of the statutory weekly working time (39 hours instead of 40) with the same pay, the addition of a fifth week of paid leave, an increase in the number of civil servants, numerous nationalizations, retirement at 60, etc.

The downturn in α_t from 1983-1985 indicates the beginning of a general movement towards greater flexibility in the French labour market, which again seems to correspond to a historical reality widely recognized in the literature.[25] Indeed, the Auroux laws of 1982 introduced the annual obligation to negotiate wages in companies while reducing the indexation of said wages. The "turning point of rigor" taken by J. Delors between June 1982 and March 1983 also contributed to this movement: a policy of progressive price liberalization and competitive disinflation, progressive deindexation of wages on inflation, a decrease in social benefits. Numerous facts were subsequently linked to maintain this movement of flexibility: lower unemployment benefits and the introduction of a new system

making them dependent on the contribution period, decentralization of collective agreements, abolition of the administrative authorization for economic dismissal, development of individualized differentiation of wages, the increase in fixed-term contracts, the development of part-time and temporary work, the easing of traineeship conditions, the degressivity of allowances and the increased inspection of job searches following the financial crisis of UNEDIC in 1992, and so on.

Within this general movement for flexibility, the creation of the French social minimum income RMI in 1988 under the Rocard government can be seen as reflecting the desire for a minimal state support for the growing number of unemployed people, who had lost their rights. This general downward trend was nevertheless at points counteracted by positive shocks of rigidity. In particular, over the period 1991-94 following the reunification of Germany (October 1989 to October 1990), there was an increase in α_t because this event had given rise to fears of structural economic difficulties for the France's leading trading partner. French firms were thus more cautious about hiring (Germany was down by 2% of GDP in 1993). The increase in α_t during this period was also presumably exacerbated by the adoption of the Maastricht Treaty in September 1992, which arguably gave rise to fears of the emergence of new constraints imposed by Europe (EU). Similarly, it can be seen that the implementation of the 35-hour law in 2000 was followed for the three ensuing years by an increase in the rigidity coefficient before its declining trend re-established itself. This temporary upward in α_t was probably reinforced by the introduction of the single European currency in 2002, because the uncertainty associated with this major institutional change created a period of wait-and-see for companies in the labour market and a downward revision of production plans (a decline in the level of activity was observed during this period). On the whole, this fairly good correspondence between the evolution of the coefficient of rigidity α_t and the historical reality is likely to give credibility to the economic significance of the estimated values of this coefficient.

It may at this point be interesting to distinguish three components in the estimated equilibrium unemployment rate, namely $u_t^* = u_{1,t}^* + u_{2,t}^* + u_{3,t}^*$, which can be compared to the components proposed by Maurice Allais.[26] Accordingly, the rate $u_{1,t}^* = \alpha_t (spread_t + m_t)$ can be considerate as the *chronic component* induced by income requirements (reservation wages, profit margins) or compulsory levies deemed "excessive". In particular, for a given margin rate m_t, the variable $spread_t$ shows that the component $u_{1,t}^*$ will be all the more important as the real reservation wage (including the social contributions) will be higher than the labour productivity. The variable $spread_t$ can be positive, negative or zero, depending on whether the wage requirements increased by the compulsory levies are higher, lower or equal to the productivity.[27] Since the values of α_t are positive, it follows that the chronic component of unemployment $u_{1,t}^*$ can also take positive, negative or zero values, even with a positive profit margin.[28] In other words, the behaviours underlying the distribution of the value added can be

generally net creators or destructors of employment, thus leading to a reduction or increase in the equilibrium unemployment rate in relation to a situation where this component would not exist. Secondly, the $u^*_{2,t} = \alpha_t b \Delta q_t$ rate can be regarded as the *cyclical component* (positive or null) of equilibrium unemployment, resulting from a level of production that is too low to ensure the full use of the production factors. Finally, the values of α_t and f_o being positive, the rate $u^*_{3,t} = \alpha_t f_o$ can be regarded as reflecting a *frictional component* directly related to the degree of rigidity of the labour market. This component may reflect the effects of the necessary duration between the start of the job search and beginning the new job, as well as the effects of technical progress, which may create fewer jobs in the innovative activities than are destroyed in the traditional low-innovation activities, while extending the time required for inter-activity mobility of the workforce, thus accentuating the inadequacy of job supply to job demand.[29]

Figure 2 - The three components in the equilibrium unemployment rate

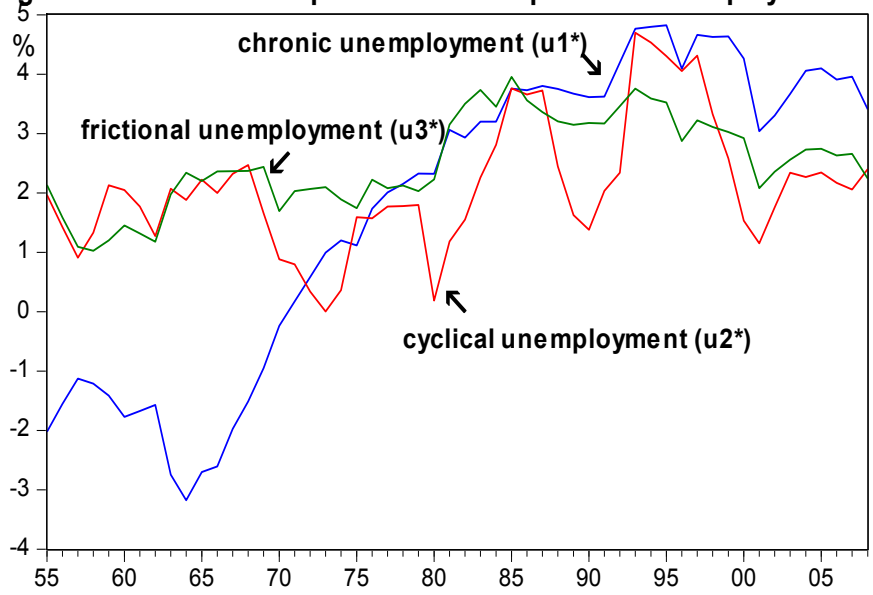


Figure 2 exhibits the estimated values of the $u^*_{1,t}$, $u^*_{2,t}$ and $u^*_{3,t}$ components over the entire period. These values must indeed be looked at with caution, since the estimated values of α_t and structural parameters are of course with a margin or error. Although the specific factors to these three components remain broadly dominant, these three components are linked by a common factor represented by the stochastic coefficient α_t, which means that the degree of labour market rigidity can condition the level of unemployment by these three different ways. Over the period as a whole, the chronic, cyclical and frictional components of the unemployment rate averaged 2.8%, 2.1% and 2.5%, respectively. On the 1975-2008 subperiod, these values are respectively 3.5%, 2.4% and 2.9%.[30] The negative values of the chronic component $u^*_{1,t}$ observed up to 1968 indicate that this latter could have contributed positively to employment by creating a very favourable situation for employers to hire: $u^*_{1,t}$

would have made it possible to lower the unemployment rate between 1% and 2% compared with unemployment which would have prevailed if only the other two components had existed. From the early 1970s onwards, and especially after the oil shock of 1973, the chronic unemployment grew strongly, reaching a first level of 4% in 1985, followed by a ceiling of about 5% in 1993-95, then decreasing to a value close to 3% at the end of the period.[31] This evolution is in line with the observation often made in the economic literature that unemployment attributable to the sharing of value added in favour of employees has developed in France from the 1970s to the end of the 1980s (Laroque and Salanié [2002], Baron et al. [2003], Lannes and Paris [2010]). The cyclical component $u^*_{2,t}$ experienced fluctuations of significant amplitude ranging between 0 and 4.5%.[32] There was also an upward trend in this type of unemployment from the time of the 1973 oil shock through the end of the 1990s. As for the frictional component $u^*_{3,t}$, it oscillates between a minimum of 1% in 1958 and a maximum around 4% during the years 1983-86, this component exhibiting a smoother evolution than the other two. As a whole, these results suggest that neither chronic factors nor cyclical factors, nor indeed frictional factors, can be neglected. In particular, after the oil price shock of 1973, the increases in these three categories of unemployment have accumulated to explain the evolution of the unemployment rate at a two-digit level.

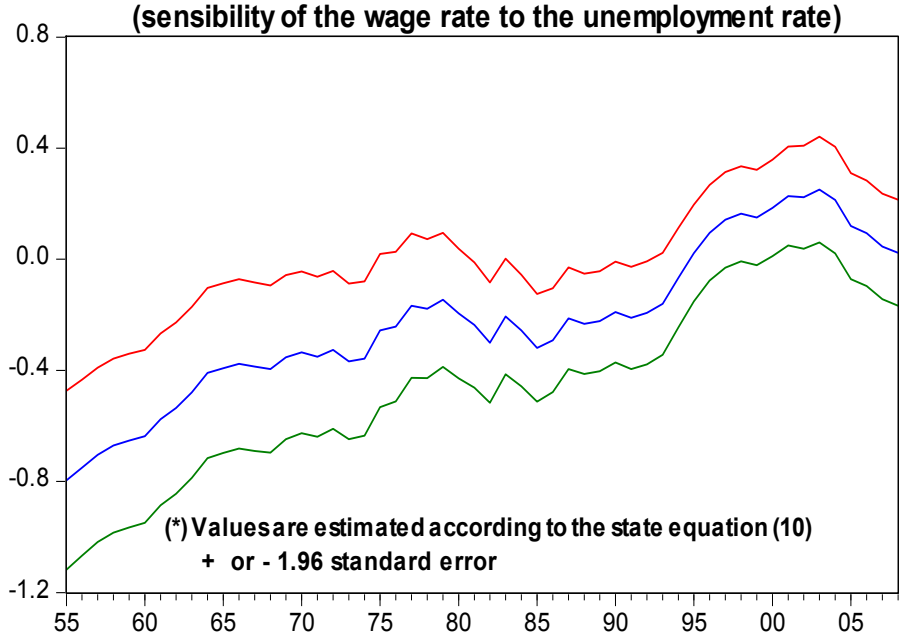
To understand what has happened since 2008, it is interesting to refer to the results issued from the surveys conducted at the micro-level by the Bank of France with a large sample of 1,150 French firms between 2010 and 2013 (Jadeau et al. [2015]), which clearly joins our analytical framework. Despite the slowdown in both economic growth and productivity during this period, wages continued to rise for most firms, showing persistent downward wage rigidities that could lead to a rise in the chronic component of unemployment. The other phenomena mentioned by a majority of companies as constituting a brake on employment are related to future economic growth, changes in labour legislation, changes in social contributions and in dismissal costs, all of which are taken into account in our modelling with the output gap, the rigidity coefficient, the rate of social charges, and the gradual adjustment of the unemployment rate towards its equilibrium value, respectively. Likewise, starting from the fact that unemployment has long been structurally higher in France than in comparable countries, Tirole (2014) draws up a report showing the dysfunction of the French labor market which is in accordance with our results. Indeed, he emphasizes the existence of excessive social charges on the labor factor, the mismatch between labor supply and demand, the rigidity induced by the Smic, the importance of fixed-term contracts which induces tensions between employers and employees, and the cost of dismissal. About this last point, the author finds that companies that do not lay off pay for those who lay off and proposes to tax the dismissal to restore a more equitable functioning of the labor market.

The wage rate estimated equation

Regarding the estimated wage rate (Eq. (15)), only the unionization rate txs_t was found to be significant among the "other factors" X_{it} considered. The positive value of the

estimated coefficient υ_1 means that txs_t is a factor favourable to wages, which seems quite intuitive. The value $\hat{\kappa} = 0.21$ is within the theoretical range [0,1] and indicates a balance of power $\kappa/(1-\kappa)$ on the order of 1 to 4 on average between the employees and the employers, in favour of the latter. A ratio approaching 1 to 2 would nevertheless remain statistically acceptable. The slope $\hat{\gamma}_1^s = 0.94$ of the state equation (10) is significant and within the expected theoretical range [0,1], thus indicating a high inertia in the sensitivity ω_t of wage to unemployment rate. **Figure 3** exhibits the evolution of ω_t over the period; the confidence interval at the 5% threshold shows that this sensibility is significantly time-varying, thus providing an interpretation of the instability of the relation between the wage and (i.e. unemployment has a negative influence on the wage rate), which means that employees have weighed more heavily than employers in the wage-unemployment relationship during this period. However, from 1995 onwards, the values are not significantly different from zero (although negative values remain in the zone that is statistically acceptable), thus reflecting a trend towards balancing the weights of employees and employers. Since $\omega_t = [(1-\kappa)k_t^p - \kappa k_t^s]$, this last result means that even if the employees are much more sensitive to unemployment than the employers ($k_t^s > k_t^p$, see below figure 4), the relative weakness of the former in the negotiations ($\kappa < (1-\kappa)$) has the effect of neutralizing the sensibility effect. Finally, the coefficient of the lagged wage rate ($\hat{\lambda} = 0.40$) indicates an average adjustment period of 7 months of the observed wage on its negotiated value.

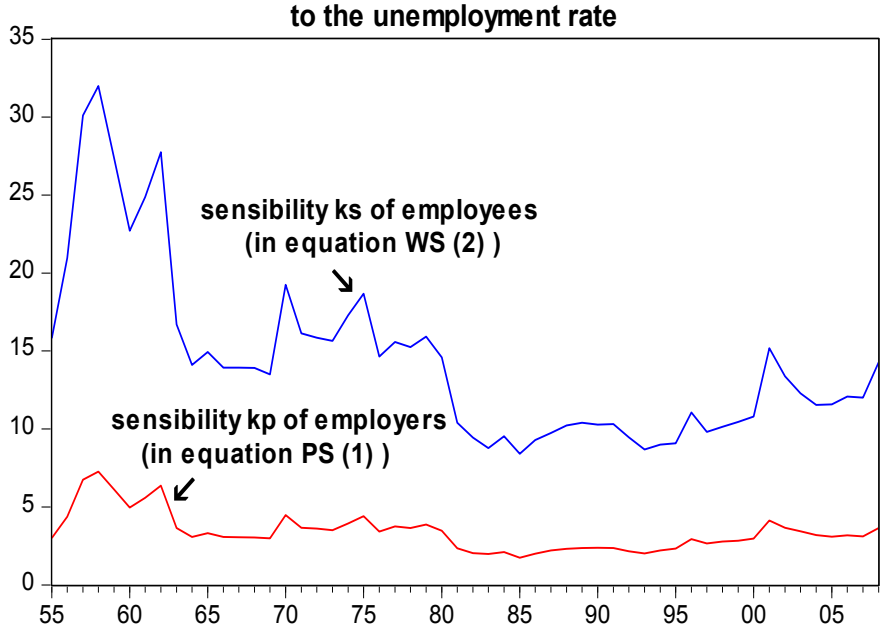
Figure 3 - Coefficient omega in the wage rate equation (*)
(sensibility of the wage rate to the unemployment rate)



The overall properties of the unemployment-wage model

The estimated values of the state variables $\alpha_t = 1/(k_t^s + k_t^p)$ (in unemployment equation) and $\omega_t = [(1-\kappa)\, k_t^p - \kappa\, k_t^s]$ (in wage equation) as well as the estimated value of the parameter κ, make it possible to calculate for each date the implicit values of the sensibilities k_t^s and k_t^p of employees and employers in relation to the unemployment rate. **Figure 4** exhibits the time patterns of the two calculated sensibilities; in accordance with the WS and PS equations, the estimated values of k_t^s and k_t^p are always positive over the period and show a sensibility to unemployment significantly higher for employees than for employers. This finding suggests that economic and institutional constraints faced by firms in the exercise of their "right to manage" have a smaller effect than those represented by the employees' aversion to the risk of being unemployed. The medians for the values of k_t^s and k_t^p are worth respectively 13.7 and 3.1 over the entire period, and 10.2 and 2.4 over the period 1982-2008. We can illustrate how unemployment can play the role of adjustment variable by considering the median values over the second period. For example, if at the beginning of a negotiation, the wage desired by the employees exceeds that offered by firms by 12.6%, a reduction in employment decided by the firms, which would imply a 1% increase (in points) of the unemployment rate, would lead to a 10.2% decrease in the wage desired by the employees (WS equation) and to a 2.4% increase in the wage offered by firms (equation PS); all other things being equal, the rise in unemployment would allow the two parties to reach a wage agreement.

Figure 4 - Sensibilities of employees and employers to the unemployment rate



In addition to the historical analysis of institutional rigidities in the labour market (presented above) in relation with the dynamics of coefficient $\alpha_t = 1/(k_t^s + k_t^p)$, we now conduct a brief econometric analysis that aims to straightforwardly identify some underlying observable factors of k_t^s and k_t^p. Confirming the visual of Figure 4, preliminary tests (non-

reported) show that these two coefficients are characterized by autocorrelation and that their dynamics are non-stationary, which would lead one to subsequently conduct a search for factors. Because this empirical exploration is made without a pre-requisite theoretical, we considered many macroeconomic variables to be potential candidates, such as: unemployment rate, growth rates in the wage rate and in the SMIC, inflation rate, production growth rate, interest rate, growth rate in money supply, margin rate, unionization rate, … Because the comparison of the dynamics of k_t^s and k_t^p suggests that - likely as a result of a common knowledge in institutional rules and in the state of the economy - these sensibilities depend on common factors (see Figure 4), we thus estimate a two-equations system using the *Seemingly Unrelated Regression* method which avoids biases due to contemporary correlation between the two residuals and to heteroscedasticity. For each sensibility, outcomes bring into high relief six significant factors[33] that are the one-period lagged sensibility of the other agent, the unemployment rate u_t (%), the long term interest rate j_t (government bonds, % per annum), the inflation rate for the previous year dp_t (deflator of the added value, % per annum), the one-period lagged margin rate m_t (%), and the growth rate of the net hourly SMIC ($dsmic_t$) :

$$\hat{k}_t^s = \underset{(3.0)}{1.06}\ k_{t-1}^p - \underset{(-6.4)}{0.86}\ u_t - \underset{(-1.2)}{0.22}\ j_t + \underset{(4.1)}{0.84}\ dp_t + \underset{(8.5)}{0.56}\ m_{t-1} - \underset{(-3.5)}{0.31}\ dsmic_t \qquad \bar{R}^2 = 0.785 \qquad DW = 1.29 \qquad (17a)$$

$$\hat{k}_t^p = \underset{(3.1)}{0.06}\ k_{t-1}^s - \underset{(-3.4)}{0.12}\ u_t - \underset{(-3.5)}{0.15}\ j_t + \underset{(4.9)}{0.23}\ dp_t + \underset{(8.2)}{0.13}\ m_{t-1} - \underset{(-2.7)}{0.05}\ dsmic_t \qquad \bar{R}^2 = 0.756 \quad DW = 1.49 \qquad (17b)$$

Although the autocorrelation of residuals suggests missing factors (DW), non-reported ADF tests (using McKinnon's critical values) lead us to conclude at the 5% level that Eqs (17a) and (17b) are cointegrating relations. Overall, the signs of the estimated coefficients are rather intuitive. Considering the one-period lagged sensibilities of the other agent, the estimates suggest a form of inertia in the negotiations, since everything happens as if labour union and firm began the wage bargaining at year *t* by keeping some memory of the sensibility to unemployment of the other partner, as revealed during the negotiation at *t-1*. We also note that higher unemployment is accompanied on average by lower sensibilities of the desired and offered wages. An interpretation could refer to the Beveridge curve, which reflects the negative relationship between the number of unemployed and the number of job vacancies. Indeed, according to this curve, job vacancies are relatively high in times of low unemployment, because the tension in the labour market is accompanied by an unsuitability of job offers to job demand that is greater than in times of significant underemployment. In this context, the competition between firms to attract a workforce adapted to their needs will lead to a wage offered that is all the more (positively) sensitive to unemployment the lower it is, this behaviour being reflected in the PS equation by an increase of k_t^p when unemployment decreases. At the same time, the worsening of the mismatch of job offers with job demands may weaken the sensibility of union claims to unemployment, a behaviour

reflected in the WS equation by a value of k_t^s which increases when unemployment decreases.

It can be seen that the long-term interest rate also has the effect of lowering the two sensitivities. On the firm side, for a given level of unemployment, an increase in the cost of capital may encourage them to offer a lower salary to maintain their profit margins (decline of k_t^p). On the employee side, a decrease in the ratio labour price / capital price could provide unions an argument against firms, which would have the effect of weakening the (negative) influence of the unemployment rate on wage demands (decline of k_t^s); but this last effect appears to be insignificant. The results also show that both sensibilities tend to be larger when inflation is high. For a given level of unemployment, inflation allows firms to offer higher wages without lowering their margin rates (increase of k_t^p). Concerning employees, the increase in the sensibility of the desired wage to unemployment (negative influence) could be understood by the fact that inflation has a negative effect on the "index of consumer sentiment"[34], thus weakening - for a given unemployment rate - wage claims of unions (increase of k_t^s). The two sensibilities are also all the stronger when the one-period lagged margin rate of firms is high. For a given level of employment, it seems intuitive that employers could consider offering a wage today that is even higher than their last rate of margin was large (increase of k_t^p). On the other hand, everything happens as if a higher margin rate in the previous period had the effect of weakening the union wage demands, which results in an increase in the sensitivity k_t^s of desired wages for a given unemployment rate (negative influence). This result could be interpreted by the conjecture that, when underemployment is important (as observed on average over our period), a rise in profit margins may lead unions to encourage companies to hire rather than apply pressure on wages. Finally, for a given level of unemployment, a strong increase in the SMIC (minimum wage) over the previous year tends to moderate both the wage claims of the unions and the level of wages offered by the firms; this result seems intuitive and is manifested by a joint decline of k_t^s and k_t^p when the SMIC increases.

We conclude our analysis of the factors of the two sensibilities by calculating the correlation between the values of the state variable α_t issued from the Kalman filter (Figure 1) and the values recomposed as $\hat{\alpha}_t = 1/(\hat{k}_t^s + \hat{k}_t^p)$, where $\hat{k}_t^s$ and $\hat{k}_t^p$ are from the two-regression system (17a) and (17b); in the same manner, we calculate the correlation between the state variable ω_t (Figure 3) and the recomposed values $\hat{\omega}_t = (1-\hat{\kappa})\hat{k}_t^p - \hat{k}_t^s$. We found $\bar{R}^2(\alpha_t, \hat{\alpha}_t) = 0.801$ and $\bar{R}^2(\omega_t, \hat{\omega}_t) = 0.617$, which suggests that the degree of rigidity in the labor market and the sensibility of the wage rate to unemployment are in part conditioned by some observable factors that themselves likely embed some stickiness (inertia from the preceding bargaining, unemployment, cost of capital, change in price level, desired margins, SMIC,…). Overall, despite their arbitrary character, these *ex-post* results appear to be rather intuitive and thus enhance the credibility of the estimated dynamics of α_t and ω_t using the

state-space modelling. However, a more in-depth theoretical and empirical research about the underlying factors of the two sensibilities would be necessary to consider them *ex-ante* in the structural equations. Indeed, in the measurement equations, when α_t and ω_t are replaced with the values of $\hat{\alpha}_t$ and $\hat{\omega}_t$ issued from equations (17a) and (17b), the fitted values of unemployment and wages deteriorate notably.

Our model also makes it possible to assess at each date the relative difference between wages desired by employees and wages offered by employers, namely $dif_t = (s_t^{ws} - s_t^{ps})$. Indeed, according to the theoretical equations (1) and (2) and the auxiliary hypotheses retained for empirical estimations, this difference can be calculated by the relation

$$\widehat{dif}_t = p_t^c - p_t + \widehat{sr}_t^R + cs_t + ce_t - \pi_t - \left(k_t^s + k_t^p\right) u_t + m_t + \hat{f}_t \qquad (18)$$

where $\widehat{sr}_t^R = \hat{s}_t^R - log\bar{P}_t^c$ (Eq.(9)) with $\hat{s}_t^R = \hat{\sigma}_o \log(\overline{SMIC}_t + \hat{s}_o)$ (Eq.(4)),

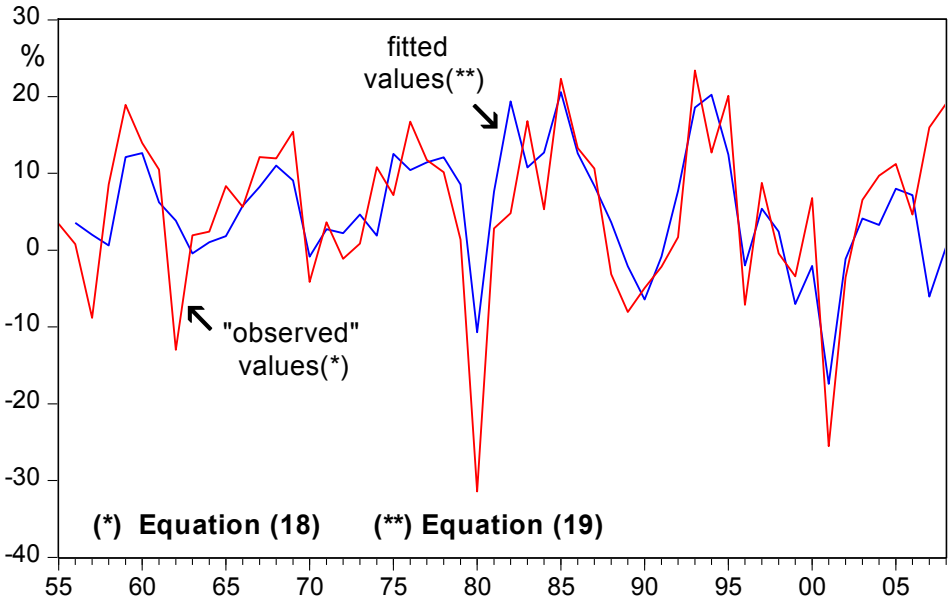
and $\hat{f}_t = \hat{b}\Delta q_t + \hat{f}_o$ (Eq. (6)), while the values of k_t^s and k_t^p issued from the state equations (5) and (10)) are those represented in Figure 4 (for estimates, see Table 1). The average value over the whole period found for $\widehat{dif}_t$ is 5.12%, meaning that employees generally require a wage greater than the one offered by firms, which seems not very surprising. However, as shown by **Figure 5,** $\widehat{dif}_t$ is strongly time-varying (the values being in the range of + 20% to -10%), excluding the extreme negative points in 1980 and 2001. Considering the gap between real notional wages and labour productivity (the latter being viewed as the classical equilibrium value of real wage), these outcomes seem plausible (notwithstanding uncertainty affecting the estimated values of $\widehat{dif}_t$); for example, if unions claim a wage only 5% greater (lower) than productivity while firms offer a wage only 5% lower (greater) than productivity, the difference between the two notional wages would be +10% (-10%).[35] Moreover, it should be noted that the extreme negative values of $\widehat{dif}_t$ that occurred in 1980 coincides with the highest growth rate over the whole period in real GNP (about 7% per year) - this rate being about 4 % for the second extreme negative point in $\widehat{dif}_t$ at 2001. This suggests that when the growth in production is very strong, wages offered by firms tend to exceed wages claimed by unions, which is not very surprising since firms are of course informed earlier than unions regarding production figures. Anyway, the dynamics of $\widehat{dif}_t$ suggests one should examine if this gap is negatively (positively) linked to change in employment (or unemployment), as implied by the WS-PS model according to which the labour factor is an adjustment variable to achieve equilibrium. Using the Newey-West method providing estimators whose variances are robust to autocorrelation and heteroscedasticity, we find that, beyond some inertia between two successive periods, the difference between desired and offered wages are correlated with two (uncorrelated) variables that can be considered as representing employment' adjustment. We found

$$\widehat{dif}_t = 0.22\ \widehat{dif}_{t-1} - 3.36\ dnhw_t + 8.42\ du_{t-1} + 3.55 + \xi_t \quad \bar{R}^2 = 0.470 \qquad (19)$$

(2.45) (–2.27) (4.16) (3.07)

where $dnhw_t$ is the rate of change in the total number of hours worked during year t (% per annum) and du_t the change in employment rate (t-values are in brackets). As shown by Figure 5, the fitted values issued from regression (19) describe roughly the main changes of the "observed" values. This regression represents interdependencies in which the signs of the estimated coefficients are those expected when employment intervenes in the adjustment between s_t^{ws} and s_t^{ps} (see above for the description of the mechanism). However, it is somewhat astonishing that the optimal one period lag found in the change in the unemployment rate; concerning this, we can but conjecture that firms believe that subsequent negotiations will partly validate their strategic plans, thus leading them to make early adjustments in the labor factor. This hypothesis is in accordance with the estimated value of coefficient κ, which suggests that the bargaining power of employers clearly dominates that of employees.

Figure 5 - Differences between the wage desired by employees and the wage offered by employers : "observed" and fitted values values



We finally examine the capacity of our model to represent the historical dynamics of unemployment and wages. Despite sometimes substantial differences, **Figure 6** and **Figure 7** show that the values of the unemployment rate and of the wage rate estimated from equations (14) and (15) describe the fluctuations and the major turning points in observed values.[36] As indicated in **Table 1**, the quality of adjustments is assessed both with the conventional coefficient R^2 and the coefficient R_D^2 proposed by Harvey (1992). The latter is more stringent since it makes it possible to evaluate the relevance of the structural model with respect to a benchmark characterized by a random walk with drift.[37] The values of R_D^2 of the measurement equations being 0.67 and 0.94 respectively for unemployment and wages, we

conclude that the model leads to significantly better quality adjustments than those corresponding to the benchmark. The good statistical properties of the standardised values of residuals $\hat{\varepsilon}_t^u$ and $\hat{\varepsilon}_t^s$ show that the specification of the model is statistically acceptable; this implies especially that the theoretical constraints that are assumed *a priori* in the basic WS and PS equations - resulting in the unit values of the coefficients of price level, productivity, profit margin and contribution ratios - are *a posteriori* admissible. We finally estimated a system composed of equations (14) and (15) by imposing the joint constraint $\alpha_t = \alpha_o$ and $\omega_t = \omega_o \ \forall t$. The results strongly reject this constraint, hence confirming the relevance of our model with time-varying coefficients (see Table 1, the value of the log-likelihood ratio test LR).

Figure 6 - Observed values and estimated values of the unemployment rate

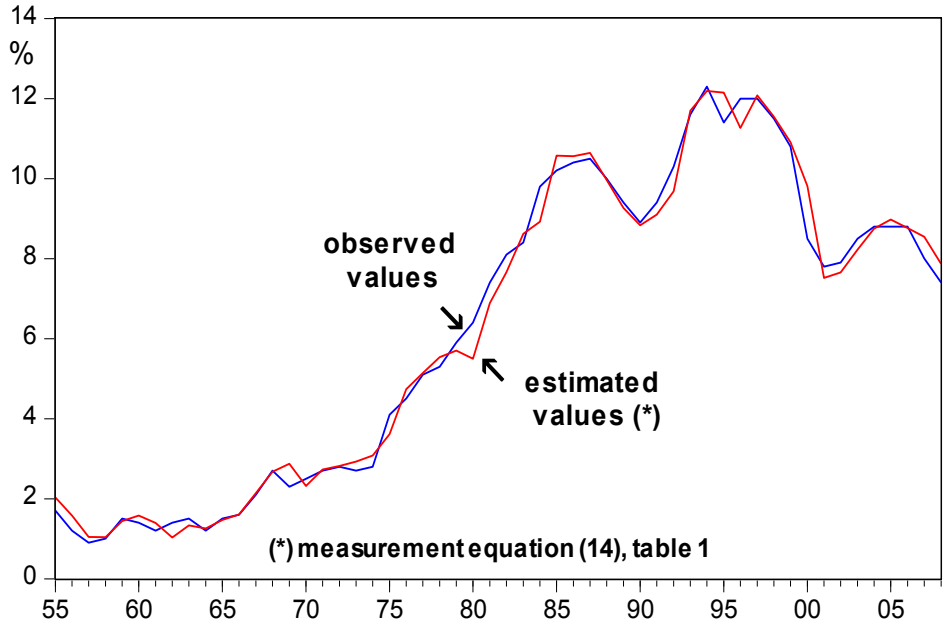
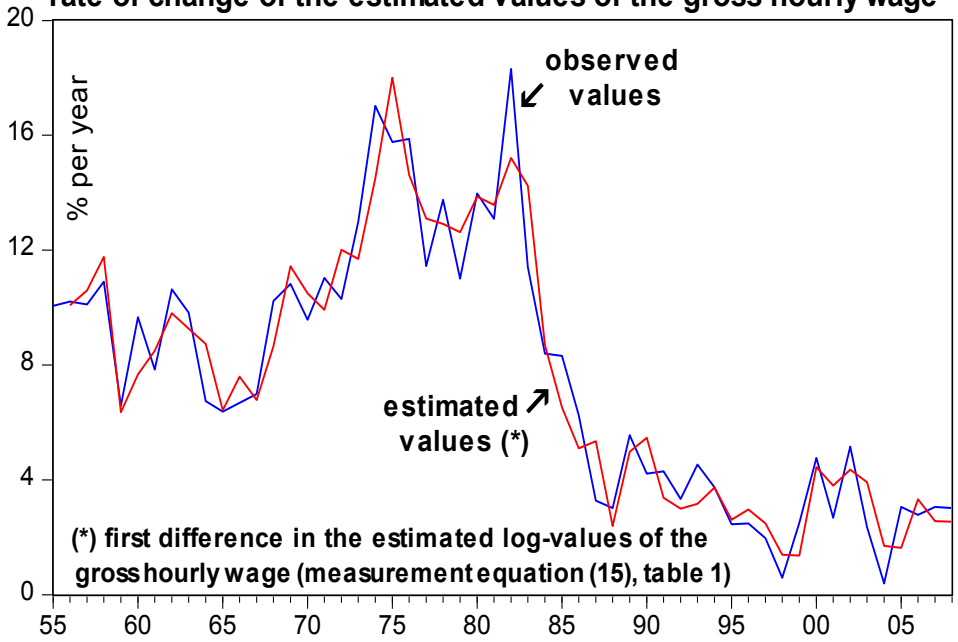


Figure 7 - Observed rate of change of the gross hourly wage and rate of change of the estimated values of the gross hourly wage



5 Conclusions

We conclude this work with the feeling that economic theory allows to shed light on the main features of the historical changes in unemployment and wages in France at the macroeconomic level. The main contribution of this paper is probably to have exhibited over a long period the main economic factors of changes in unemployment and wages with a basic version of the WS-PS bargaining model, provided that the degree of rigidity in the labour market is time-varying. The multidimensional and not directly quantifiable character of this degree of rigidity has led us to represent its dynamics by a stochastic process estimated using the Kalman filter methodology. Concerning this, we note a fairly good concordance between, on the one hand, the evolution of the degree of rigidity estimated and, on the other hand, institutional changes and historical facts. Moreover, we attempted to identify factors of the sensibilities of the desired and offered wages to unemployment by a brief econometric analysis and found that these sensibilities are conditioned by some macroeconomic variables which themselves likely embed some stickiness. However, although these results constitute a rudimentary economic explanation of the degree of rigidity in the labour market, factors are not yet sufficiently specified to consider them directly in our structural equations. Using other auxiliary assumptions concerning the representation of the reservation wage (depending on the legal minimum wage) and "other factors" complementing those specified by the WS and PS equations (these factors being summarized by the output gap), we estimated the equilibrium unemployment rate and the corresponding negotiated wage rate between unions and firms.

Overall, the values of the unemployment rate and of the wage rate estimated from our modelling describe the main fluctuations and the major turning points in observed values. The observed unemployment rate adjusts gradually to its equilibrium value (here we can mention the many social costs associated with unemployment). Three significant components can be

distinguished in the equilibrium unemployment rate, the relative importance of which varies significantly over time: a "chronic" component resulting from the factors underlying the distribution of added value (real reservation wage, profit margin, social contributions, productivity), a "cyclical" component resulting from a level of production below its potential value, and a "frictional" component attributable to an insufficient labour mobility and to technology progress. These results are in line with the idea that the fight against French unemployment must be carried out simultaneously on several fronts : by acting on the factors that determine the sharing of added value (minimum wages, social contributions, taxation, training, and innovations designed to increase productivity, etc.), by pursuing a macroeconomic policy of reviving activity, or by setting up a structural policy aimed at improving labour mobility or increasing the flexibility of the labour force (unemployment insurance rules, dismissal rules and practices, characteristics of employment contracts, etc.). However, our results are of course conditional on the auxiliary hypotheses representing the variables not directly measurable or not identified by the theory (reservation wage, degree of rigidity, "other factors").

Regarding wages, the negotiated value is represented by a weighted average of the wage desired by employees (WS equation) and the wage offered by firms (PS equation), the weighting coefficient reflecting the bargaining power between the two parties. Moreover, due to the duration taken to set up employment contracts, the observed wage adjusts with delay to its negotiated value, which depends on the reservation wage, social contributions, price level, productivity, margin rate, rate of unionization, and finally on the rate of unemployment, the influence of which varies over time. Overall, results about the wage rate highlighted five general teachings. The first is that, on average, employers take the lead on employees during negotiations. The second lesson is that the reservation wage would be on average about 15% above the SMIC, with this gap tending to increase over the period. The third lesson is that the sensibilities of the desired (WS) and offered (PS) wages to unemployment vary over time. This phenomenon may provide an explanation for the instability of the empirical wage-unemployment relationship found in the literature. The fourth lesson is that the difference we assessed between wage desired by employees and wage offered by employers allows us to show that, as predicted by the theory, employment intervenes effectively in the adjustment between the two notional wages to achieve equilibrium. A final lesson is the confirmation of the relevance of the distinction made between five concepts of wage : the *wage desired* by employees whose value depends on the *reservation wage* (WS side), the *wage offered* by the employers (PS side), the *negotiated wage* resulting from the confrontation between the wage claimed by unions and the one offered by firms, and finally the *observed wage* which is the result of the implementation of the negotiated wage contract.

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[1] The present paper is a modified English version of an article written in French (Chélini and Prat [2016]), especially adding novel contributions on two important points. First, it brings up new results about factors of the time-varying sensibilities to unemployment of wages claimed by employees and wages offered by employers, these two sensibilities playing a major role in the WS-PS model on which our approach is based. Second, the present paper assesses the difference between the level of wage claimed by employees and that offered by employers, and show that, as supposed by the theory based on negotiation between the two parties, change in employment intervenes indeed in the adjustment between these two notional wages to achieve equilibrium.

[2] Our analysis focuses on dynamics of unemployment and wages and so leaves aside contributions based on the wage curve, which show a negative correlation between real wages and unemployment rates across regions on average over a given period (Blanchflower and Oswald [1995], [2005]).

[3] It should be noted that, contrary to the approaches issued from the Phillips curve, the WS-PS model is applicable to the analysis of disaggregated data (see in particular Cahuc et al., [2000], Doisy et al., [2001]).

[4] For a description of the passage between the raw solutions of the maximization programs of the two agents and the two log-linear equations, see in particular Chélini and Prat [2016].

[5] Equations (1) and (2) are notably inspired by the presentations made by Blanchard & Katz [1997], Bonnet [1999], Le Bihan & Sterdyniak [1998] and Simonnet [2008]. We note that agents are supposed to be rational and so are not subject to the monetary illusion.

[6] The inclusion of the margin rate as an argument in the price equation is justified by the fact that, if the real wage is equal to or greater than labour productivity (as, for example, supposed by the theory of efficiency wage), this should not imply that the firm accepts a zero or negative profit. Indeed, in the situation of monopolistic competition situation, the firm can set a price higher than the marginal cost in order to obtain a positive margin.

[7] The French Guaranteed Minimum Interprofessional Wage (SMIG) was created in February 1950 and replaced in January 1970 by the Minimum Interprofessional Growth Wage (SMIC) and the Guaranteed Minimum Income used to calculate certain social benefits. While the SMIG was indexed to inflation, the SMIC is revalued by adding to the inflation rate half the increase in the purchasing power of the basic hourly wage of workers (it can also benefit from additional increases from government). Under certain conditions, it could be compared to the US national minimum wage according to the Fair Labor Standards Act (1938).

[8] For the unemployed benefiting from the Minimum Income of Social Insertion (RMI), the coefficient of variation of the responses (standard deviation across respondents / average) is 26%, this value reaching 45% for the unemployed persons who are compensated.

[9] The parameters s_o and σ_o each influence in a different manner both the level and the slope of the reservation wage; the latter may be more or less above or below the trend of the SMIC depending on the dates. In order to capture the possible effects of missing variables, we tried to add a linear trend to the right of equation (4): this trend proved to be insignificant.

[10] The microeconomic theories of the labour market describe the many endogenous sources of wage rigidity, in particular the efficiency wage theory (Shapiro and Stiglitz [1984]), the insider-outsider model (Lindbeck and Snower [1989]) and the implicit contract theory (Azariadis [1975]). The degree of flexibility of wages and employment may therefore vary over time not only because of legal institutional constraints (types of labour contracts, social minima, redundancy payments, collective agreement, wage indexation, etc.), but also because of the behaviour of the actors themselves. Empirically, Bonnet [1999] shows the importance of downward wage rigidities in OECD countries. We can also mention the analysis of Laroque and Salanié [2002] which shows, on the basis of a survey carried out in 1997 among married French women, that there is unemployment called "classic", which is attributable to a wage rigidity induced by the existence of a minimum wage.

[11] It is interesting to note that, by comparing the European countries to the United States, Nickell (1997) shows that all institutional rigidities have not an adverse effect on employment (see also Blanchard and Wolfers, [2000]). This is likely to reinforce an approach with stochastic parameters, which can be seen as capturing the overall effects of institutional changes.

[12] These include the real interest rate, replacement rate, the ratio of minimum wage to average wage, unemployment benefits, the trade balance, duration of unemployment, the price level as a mark-up on wages, terms of trade, unionization rate, job destruction rate, labour force growth rate, share of profits in value added, inflation rate, structure of unemployment,....

[13] Although arbitrary, this approach seems to moderately condition the evaluation of Δq_t . Indeed, the different methods envisaged in the literature to estimate the output gap - including production function based approaches - often lead to similar results (see Bonnet et al., 1995).

[14] When included in the equation of equilibrium unemployment (3), Eq.(6) establishes a link between unemployment and production, thus joining the Okun's empirical law [1962].

[15] This identification will be useful for estimating the wage equation (see Eq. (11)).

[16] Even if trade unions take into account the price level during the negotiations, the employment contracts are fixed in terms of nominal wages. That is why we considered the latter by transferring the consumer price level p_t^c to the right-hand side of equations (1) and (2).

[17] Consider $\Delta q_t = \sum_i c_i X_{it}$ and $a_i = b\, c_i$. Eq. (6) allows: $f_t = f_t^p + f_t^s = \sum_i a_i X_{it} + f_o$ with $f_t^p = \sum_i a_i^p X_{it} + f_o^p$, $f_t^s = \sum_i a_i^s X_{it} + f_o^s$, $a_i = a_i^p + a_i^s$ and $f_o = f_o^p + f_o^s$, which leads to

$\kappa\, f_t^s - (1-\kappa) f_t^p = \sum_i \upsilon_i X_i + c_o$ with $\upsilon_i = \kappa a_i^s - (1-\kappa)\, a_i^p$ and $c_o = \kappa f_o^s - (1-\kappa) f_o^p$, where a_i^s and a_i^p represent the sensitivities of f_t^s and f_t^p to the X_{it} factors. One can see that coefficients υ_i and c_o can eventually cancel each other.

[18] See specifically Layard-Nickell-Jackman [1991], Eq. (16), p. 431.

[19] We have alternatively considered an error correction model: because the results was not improved, the (simpler) adaptive process has been retained as did Layard et al. [1991].

[20] For details about the data, see Chélini and Prat [2016], Annex 3.

[21] The variables in the form of rates are expressed in % in the equation of the unemployment rate and in decimal value in the equation of the wage rate.

[22] In a first step, we have estimated among the hyperparameters the (two) covariances between the residuals of the measurement equations and the auxiliary residuals of the corresponding state equations. As these covariances were not significant, the system was estimated by excluding them.

[23] Estimates were made using the Eviews7 software. The state variables are represented in the "*one-step-ahead predicted states*" mode, which implies that the degree of rigidity at date *t* results from the cumulated effects of the past stochastic shocks reflecting the successive changes in this degree.

[24] In Eq.(14) of the wage rate, the average unemployment rate $\bar{u}_t = 1/2\,(u_t + u_{t-1})$ was considered because this specification allowed an improvement in the results, suggesting that the influence of the level of employment on wages is exerting more slowly than the influence of prices and other variables.

[25] The breakdown of 1982-83 is linked to changes in collective agreements - including the progressive deindexation of wages on the price level - and had the effect of significantly increasing the flexibility of the labour market (Blanchard and Sevestre, 1989; Ralle and Toujas-Bernate [1990], Desplatz et al. [2003]). Heyer et al. [2007] confirm these results with the WS-PS model using the Kalman filter method. The decline in the share of wages in the added value since these years illustrates this change in trend (Meurs [1990], Gérard-Prenveille [2003]).

[26] Indeed, referring to the theoretical exposition presented in Chapter V of his Treatise on Pure Economy [1994, 1943 1st ed.], Allais [1980, 1981] proposed an explanation of the unemployment rate in France over the period 1952-1978 by a linear combination of the "chronic", "cyclical" and "technological" components (see Prat [2016]). Allais (1999) proposed later a partition of unemployment into five categories: chronic unemployment, cyclical unemployment, unemployment due to the free trade of the world, unemployment due to immigration, and finally technological unemployment. Let us concede that the empirical approach proposed by the author to measure these five types of unemployment did not dampen our conviction.

[27] The composite variable $spread_t$ is a priori defined to more or less a constant, since, unlike the net hourly minimum wage expressed in current euros, the series of the price level and labour productivity are in the form of indices. In order to "calibrate" these series together, it was assumed that, at the time of the creation of the minimum wage in 1950, the institutional variables determining the real cost of labour (i.e. minimum wage including contributions) balance with labour productivity (see Chelini and Prat [2016], footnote (54)). The estimated values of the unemployment rate and the wage rate do not depend on this calibration, but the latter determines the relative importance of the estimated chronic and frictional components of unemployment.

[28] Between 1950 and 2008, the profit margin rate oscillates around an average level of 28.4% with a moderate amplitude (the standard deviation equals 2.6%)

[29] Frictional unemployment may be regarded as referring to the "Job Search" (Stigler [1962]) and "matching" models (Pissarides [2000]).

[30] By comparison with our frictional component, the value of the "natural rate of unemployment" as defined by Milton Friedman is generally estimated between 3% and 5% (see for example Weiner [1993], and especially for France, Heyer and Timbeau [2002]).

[31] Note that, after 2008 and until 2014, there have been a widening gap between real wages and productivity accompanied by an increase in the unemployment rate, which suggests that the chronic unemployment has likely increased. After 2014 the gap and unemployment both decreased, suggesting that the chronic component likely lessened.

[32] In particular, one observe in 1990 the coexistence between a low cyclical unemployment (1%) and a consequent chronic unemployment (4%). This result is in line with those of Salanié [2000], which shows that even during good economic times, unemployment can remain high in France, as this phenomenon is attributed to excessive labour costs, notably because of the minimum wage. Note that, after 2008, the sluggish growth in French production suggests an increase in the cyclical component.

[33] Intercepts was removed from the final regressions since not significant.

[34] The "Index of consumer confidence" of French households provided by Insee' surveys appears to be negatively correlated with inflation. It is the same for USA with the well-known « Index of Consumer Sentiment » built by the University of Michigan.

[35] In the same vein and to give an empirical comparison, we note that the gap between observed gross wage and labor productivity fluctuates between +10% and -10% over the period 1950-2008 (supposing a zero gap in 1950).

[36] In order to better illustrate the differences, Figure 6 compares the *rate of change* of the observed wage with the *rate of change* of the values estimated in level according to (14).

[37] We have: $R^2 = 1 - SSR / \sum_{t=1}^{T} (y_t - \bar{y})^2$ and $R_D^2 = 1 - SSR / \sum_{t=2}^{T} (\Delta y_t - \overline{\Delta y})^2$, ($y_t = u_t, s_t$) and $dy_t = y_t - y_{t-1}$, where *SSR* is the sum of the squares of the structural model residuals. A positive (negative) value of R_D^2 means that the structural model gives a better (less good) representation than a simple random walk with drift.