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Sticky Wages. Evidence from Quarterly Microeconomic Data[1]

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Abstract This paper documents nominal wage stickiness using an original quarterly firm-level dataset. We use the ACEMO survey, which reports the base wage for up to 12 employee categories in French firms over the period 1998 to 2005, and obtain the following main results. First, the quarterly frequency of wage change is around 35 percent. Second, there is some downward rigidity in the base wage. Third, wage changes are mainly synchronized within firms but to a large extent staggered across firms. Fourth, standard Calvo or Taylor schemes fail to match micro wage adjustment patterns, but fixed duration 'Taylor-like' wage contracts are observed for a minority of firms. Based on a two-thresholds sample selection model, we perform an econometric analysis of wage changes. Our results suggest that the timing of wage adjustments is not state-dependent, and are consistent with existence of predetermined of wage changes. They also suggest that both backward- and forward-looking behavior is relevant in wage setting.
JEL codes: E24, J3

Keywords: Wage stickiness, wage predetermination.

Résumé Cet article étudie la rigidité des salaires nominaux en France à partir des observations individuelles de l'enquête ACEMO entre 1998 et 2005. L'enquête ACEMO recueille le salaire de base pour au maximum 12 catégories représentatives des salariés. Les résultats suggèrent premièrement que la fréquence de changement de salaires est de l'ordre de 35% par trimestre. Deuxièmement, nos résultats confirment qu'il existe une rigidité à la baisse du salaire de base. Troisièmement, les changements des salaires sont essentiellement synchronisés au sein des entreprises mais échelonnées entre elles. Quatrièmement, la version standard des modèles de Calvo ou Taylor ne permet pas de caractériser globalement le mode de révision des salaires mais des contrats à la Taylor avec des changements de salaire à intervalle régulier sont observés pour une minorité d'entreprises. De plus, l'estimation d'un modèle de sélection pour les changements de salaires indique un rejet de l'hypothèse de « dépendance à l'état ». Nous montrons aussi qu'il existe une prédétermination des salaires ainsi qu'une indexation des salaires à l'inflation et au chômage à la fois passé et futur.
Classification JEL : E24, J3

Mots-clés : Rigidité des salaires, prédétermination des salaires.

Non-technical summary

This paper analyzes nominal wage stickiness using an original quarterly dataset. Nominal wage stickiness is quite widely acknowledged to be a crucial issue for macroeconomics and in particular for monetary policy. The New Keynesian literature has recently reemphasized the role of wage stickiness and suggested that reliance on microeconomic evidence is relevant. While there is a relatively abundant research assessing wage rigidity with microeconomic data, that research mainly focuses on the issue of downward nominal rigidity, i.e. the fact that nominal wages are not usually observed to decrease. We focus on another concept of wage stickiness which is arguably at least as relevant from a macroeconomic perspective: wage stickiness as defined by the fact that nominal wages adjust infrequently and usually with some delay with respect to shocks. Measures of wage stickiness like the frequency of wage change or the duration of wage contracts are often embodied in 'deep' parameters of macroeconomic models for monetary policy, and their value is typically found to have a strong influence on the degree of inflation persistence or the optimal monetary policy rule.

Our work complements the relatively scarce microeconomic evidence, surveyed e.g. in Taylor (1999), on these characteristics of wage adjustment. One reason is that microeconomic data on wage are typically available at annual frequency. For instance, existing evidence on the frequency of wage adjustment is mainly based on annual frequency data. Few studies have provided evidence at infra-annual frequencies, arguably particularly relevant frequencies for monetary policy.

The data used are the quarterly individual observations from the survey on Labor Activity and Employment Status (ACEMO) over the period 1998 to 2005. The ACEMO survey collects the level of the monthly base wage excluding bonuses, allowances, and other forms of compensations for 12 representative categories of employees.

We obtain the following main findings. The frequency of base wage changes is around 35% per quarter. There is some evidence of downward rigidity in base wages. Wages changes are mainly synchronized within firms and are to a large extent staggered across firms, although some across firm synchronization is induced by minimum wage changes and by seasonality (wage changes are more frequent in the first quarter). Strict Taylor or Calvo models fail to account for the

dynamics of wage changes, but a significant share of firms has a Taylor contract-like behavior.

As a further contribution, we carry out an econometric analysis based on an empirical model for wage changes. The econometric set-up is a sample selection model, which allows to address the fact that, in most quarters, the observed change in wage is zero. Wages changes are triggered by decision variables including elapsed duration. Size of changes in wage is related to unemployment and inflation. We also test for expectations of these variables. Our estimation results point to three features of wage setting. First, wage setting is mostly time dependent. Second, there are both elements of forward and backward-lookingness in wage changes. Third, predetermination seems a relevant feature of wage changes. In particular, while wage changes are implemented on average every two quarters, wage decisions are actually significantly less frequent. Wages changes implemented at some time are then based on 'old' information.

Though several issues are involved when using micro data to assess and calibrate macroeconomic models, our findings may be helpful for informing macroeconomic models used for monetary policy. For instance, a relevant issue is to compare the extent of wage stickiness to that of price stickiness. From available evidence on French data, the average duration of price spells is quite similar to that we obtain for wage spells: two to three quarters. However, we find wage changes to be predetermined, which suggest that the actual degree of rigidity in wage adjustments is larger than that of price adjustments. In addition, the degree of downward rigidity is much more pronounced for wages than prices: around 15% of wage changes are wage decreases, around 40% for prices. Furthermore, the absolute size of wage changes we obtain is much smaller than that of price changes. Relatedly we reject state-dependency in wage-setting, while the assumption of state-dependence is found to have some relevance for modelling price setting.

Résumé non technique

Cet article étudie la rigidité des salaires nominaux en France à partir d'un jeu de données individuelles. La rigidité des salaires nominaux est un élément crucial pour les modèles macroéconomiques et notamment pour l'élude de la politique monétaire. La littérature néo-keynésienne a récemment réaffirmé le rôle de la rigidité des salaires et la pertinence du recours aux données individuelles. Bien qu'il existe de nombreux travaux visant évaluer la rigidité des salaires à partir de données microéconomiques, ces travaux se concentrent principalement sur la question de la rigidité nominale à la baisse. Dans cette étude, la rigidité des salaires est définie par le fait que les salaires nominaux s'ajustent rarement et réagissent avec un certain retard suite à un choc. Les mesures de la rigidité des salaires comme la fréquence de changement ou de la durée des contrats de salaire sont des paramètres structurels des modèles macroéconomiques. Ces paramètres ont généralement une forte influence sur le degré de persistance de l'inflation ou pour la définition de la règle de politique monétaire optimale. Notre travail complète les rares travaux empiriques sur les rigidités salariales à partir de données infra-annuelles (cf. Taylor (1999)). Une des raisons de cette relative rareté est que les données microéconomiques de salaires sont généralement disponibles en fréquence annuelle seulement. Ainsi, la fréquence de changement des salaires est traditionnellement calculée à partir de données annuelles.

Les données utilisées sont les observations individuelles de l'enquête ACEMO entre 1998 et 2005. L'enquête ACEMO recueille le niveau du salaire mensuel de base brut hors primes pour 12 catégories représentatives des salariés. Les résultats suggèrent premièrement que la fréquence de changement de salaires est de l'ordre de 35% par trimestre. Deuxièmement, il existe une rigidité à la baisse du salaire de base. Troisièmement, les changements des salaires sont essentiellement synchronisés au sein des entreprises mais échelonnés entre entreprises. Une certaine synchronisation est néanmoins induite par des changements au salaire minimum et par la saisonnalité des variations de salaires (plus fréquents au premier trimestre). De plus, nous procédons à une analyse économétrique fondée sur un modèle de sélection en deux étapes. Ce modèle permet de prendre en compte le fait que pour la plupart des trimestre, à un poste de travail donné, on n'observe pas de changements de salaire. Nous modélisons séparément l'incidence d'un changement de salaires, déclenchés par des variables de décision comme la

durée écoulée depuis le précédent changement, et l'ampleur du changement de salaire, que nous relions au chômage et à l'inflation. Nous testons également l'effet des anticipations portant sur ces variables. Nos résultats indiquent trois caractéristiques de la fixation des salaires. Tout d'abord, la probabilité d'une révision de salaires dépend principalement de la durée écoulée depuis le précédent changement de salaire. De plus, la version stricte des modèles de Calvo ou Taylor ne permet pas de caractériser globalement le mode de fixation des salaires mais les contrats à la Taylor avec des changements de salaire à intervalle régulier sont observés pour une minorité d'entreprises. On rejette ainsi l'hypothèse de « dépendance à l'état ». Nous montrons aussi qu'il existe une indexation des salaires à l'inflation et au chômage passés et futurs. Enfin, la prédétermination est un élément important de l'évolution des salaires. Alors que les variations de salaires ont lieu en moyenne tous les deux trimestres, les décisions liées à ces changements sont en réalité nettement moins fréquentes.

Il est instructif de comparer l'ampleur de la rigidité des salaires à celle des prix. A partir de données disponibles pour la France, la durée moyenne des trajectoires de prix est similaire à celle que nous obtenons pour les trajectoires de salaire : de deux à trois trimestres. Toutefois, nous montrons que les changements des salaires peuvent être prédéterminés, ce qui suggère que le degré effectif de rigidité dans les ajustements salariaux est plus grand que celui des ajustements de prix. En outre, le degré de rigidité à baisse est nettement plus prononcé pour les salaires que les prix : environ 15% des changements correspondent à des baisses contre environ 40% pour les prix. De plus, l'ampleur des variations de salaires est beaucoup plus faible que celle obtenue pour les prix. De même, nous rejetons l'hypothèse de « dépendance à l'état » dans le comportement de fixation des salaires, tandis que cette hypothèse est pertinente pour la modélisation du comportement de fixation des prix.

1 Introduction

Nominal wage stickiness is quite widely acknowledged to be a crucial issue for macroeconomics and in particular for monetary policy. The New Keynesian literature has recently reemphasized the role of wage stickiness (e.g. Levin et al. 2006, Taylor, 2007, Woodford, 2003). Reliance on microeconomic evidence has in addition been argued to be relevant by this literature. While there is a relatively abundant research assessing wage rigidity with microeconomic data, that research mainly focuses on the issue of downward nominal rigidity, i.e. the fact that nominal wages are not usually observed to decrease (e.g. McLaughlin, 1994, Akerlof et al., 1996, Card and Hyslop, 1997, and more recently Dickens et al., 2005). From a macroeconomic perspective, another concept of wage stickiness is arguably at least as relevant: wage stickiness as defined by the fact that nominal wages adjust infrequently and usually with some delay with respect to shocks. Measures of wage stickiness like the frequency of wage change or the duration of wage contracts are often embodied in 'deep' parameters of macroeconomic models for monetary policy, and their value is typically found to have a strong influence on the degree of inflation persistence or the optimal monetary policy rule.

The microeconomic evidence on these characteristics of wage adjustment, surveyed e.g. in Taylor (1999) is relatively scarce. One reason is that microeconomic data on wage are typically available at annual frequency. For instance, evidence on the frequency of wage adjustment is provided in Khan (1997) and Fehr and Goette (2005) using annual frequency data. Few studies have provided evidence at infra-annual frequencies, arguably particularly relevant frequencies for monetary policy.[5] The present paper contributes to filling this gap by resorting to an original quarterly longitudinal dataset to investigate nominal wage stickiness. We use a large, representative, quarterly survey of French firms (the ACEMO survey), which reports the base wage for up to 12 employee categories in each surveyed firm, over the period 1998 to 2005.[6] Using these data, we assess the frequency of wage change, and investigate patterns of wage

[5] Gottshalk (2005) is an exception. The use of collective agreement data as e.g. in Taylor (1983), Christofides and Wilton (1983), Cecchetti (1987), Blanchard and Sevestre (1989) also provide some information at non-annual frequencies.

[6] Base wage denotes compensation excluding bonuses, allowances, and overtime

adjustment such as the degree of synchronization or staggering, and test for the presence of forward-lookingness and predetermination in wage setting.

The paper is organized as follows. Section 2 reviews the main models of wage rigidity and some monetary policy issues. Section 3 provides a presentation of the wage setting context in France. Section 4 describes the dataset. Section 5 presents the main empirical patterns of wage changes. Section 6 presents econometric evidence on wage adjustments. Section 7 concludes.

2 Wage stickiness: macroeconomic issues

This section briefly reviews the main models of wage nominal stickiness as well as some monetary policy issues that provide the background for our empirical investigation.[7]

2.1 Models of nominal wage rigidity

Several models of nominal wage rigidity have been considered in the macroeconomic literature. One widespread model has been proposed by Taylor (1980). It assumes that wages are set for a constant period of e.g. one year. This model is motivated by institutional arrangements like those prevailing in the unionized manufacturing sector in the US (Cecchetti, 1987, Taylor, 1983). Taylor's (1980) model assumes in addition that wage contracts are staggered, i.e. that a constant fraction of wage contracts is renewed at each date within the year.

Another widespread model is the random duration model proposed by Calvo (1983). This model assumes that the probability of a wage change is constant through time. It is usually introduced to represent price changes in New Keynesian General Equilibrium models. It has been recently introduced into these models to also model wage changes (Erceg et al., 2000, and Smets and Wouters, 2003). The Calvo assumption has no deep microeconomic or institutional foundations. It is nevertheless used in many such macroeconomic models because of its convenient aggregation properties. It has in addition been shown to be a relevant empirical approximation of price changes for some categories of goods (e.g. Fougère et al., 2007). A common feature of

[7] The reader is referred to Blanchard and Fisher (1989, chapter 8), Taylor (1999), or Woodford (2003) for detailed surveys.

Taylor and Calvo models is that they are time-dependent models, as opposed to state-dependent models.

State-dependent approaches attribute nominal wage rigidity to fixed costs such as the costs of opening a negotiation or implementing a wage cut. Such an assumption is put forward by Khan (1997) and Fehr and Goette (2005) to motivate their empirical models. The presence of a fixed cost typically results in state-dependent models in an 'inaction band' for the dependent variable.[8] As a corollary, a large fixed cost should translate into a low frequency of wage changes, and at the same time into a large typical size of a wage change. With fixed costs, the probability of observing a wage change varies across time: it is larger whenever the deviation from the optimal wage is important, leading to state-dependency.

2.2 Monetary policy issues

Assessing the degree and the nature of nominal rigidity is an important issue for monetary policy. Indeed, sticky prices and sticky wages are shown to be crucial elements in macroeconomic models to account for the observed persistence in aggregate output and inflation and to obtain real effects of monetary shocks. In particular, considering sticky wages in addition to sticky prices has been argued to be a fundamental ingredient for generating persistence (e.g. Christiano et al. 2005). Furthermore, in a normative analysis, Erceg et al. (2000) have shown that optimal monetary policy involves a trade-off between output and inflation variances only when both prices and wages are sticky. Were only the prices sticky, assuming the absence of any exogenous cost-push shock, the central bank could fully stabilize inflation by stabilizing the output gap (Woodford, 2003, Blanchard and Gali, 2007). Erceg et al. (2000) study *inter alia* how the level of consumer welfare depends on the wage contract duration. Furthermore, Levin et al (2005) show that, in a micro-founded macroeconomic model, replacing random duration wage stickiness by Taylor wage contracts substantially modifies the optimal monetary policy rule as well as the welfare loss resulting from wage rigidity.

Another important issue is whether a path for wage changes is predetermined within a

[8] We are however not aware of a formal microeconomic model of wage bargaining with fixed cost of wage change or negotiation.

contract. Predetermined wage contracts, incorporating wage changes set in advance, have been motivated by empirical observation of US union wage contracts (Taylor, 1983). Long-term union wage contracts typically include escalator clauses, which decide at period t two or more future increases. Fisher (1977) proposed the first theoretical model of predetermined wage setting. When wages are predetermined over more than one period, the Fisher model predicts that monetary policy is non-neutral in the short run, contrasting with the irrelevance of the monetary policy rule that obtains with non-predetermined price setting.[9] Under predetermination non-neutrality obtains even if wages do change at each date, so that the observed frequency of wage change is unity. The frequency of wage changes is thus not a sufficient indicator to assess the degree and nature of nominal rigidity. As already noted by Cecchetti (1987), in presence of predetermined wage change, wage rigidity can be underestimated when measured by simple indicators, like wage spells duration.

Other relevant issues include indexation to the inflation rate and the degree of staggering as opposed to synchronization of wage changes. While the Calvo model involves staggered wage changes by construction, the fixed length contract model may be compatible with either synchronization or staggering of wage changes. Staggered and synchronized wage changes result in different macroeconomic outcomes in the short-run. In general, it is found that staggered wage setting produces a larger degree of persistence, since staggering gives rise to a contract 'multiplier' (see e.g. discussion in Woodford, 2003, chapter 3). With synchronized wage setting, the effect of a shock cannot last longer than the contract length. Finally, indexation of wages or prices to the past inflation rate typically leads to more persistence in the inflation rate, in monetary policy models like those of Christiano et al. (2005) and Smets and Wouters (2003). This mechanism is found to help fit macroeconomic output and inflation dynamics (see Woodford, 2003, chapter 5).

Providing estimates on the nature and degree of microeconomic wage stickiness is therefore relevant for monetary policy analysis, and is the objective of the remaining of this paper. The use of micro data to deal with macroeconomic questions raises some issues, which are discussed

[9] In a similar spirit, Taylor (1983) concludes that one consequence escalator clauses in wage contracts was to slow down the disinflation process in the United-States during the early 80's.

in the conclusion.

3 Wage setting: the French context

To allow for a better interpretation of the data and results we review some basic facts about wage negotiations and the French labour market context.

Institutional context

The wage setting process in France involves various levels of decision. The government defines the legal framework of wage changes, as well as the evolution of the gross minimum wage (the 'SMIC'). According to the Labour Law, the base wage has to appear in the labour contract. As a consequence, if the employer wants to obtain a decrease of the base wage, it requires a formal revision of the contract, in agreement with the employee. The hourly minimum wage is updated on the 1st of July each year with the following explicit indexation rule:

$$g_{\mathrm{SMIC},t}= g_{CPI,t} + 0.5(g_{W,t} - g_{CPI,t}) + d_t$$

where $g_{\mathrm{SMIC},t}$ denotes the percentage increase in the minimum wage$_t$ $g_{\mathrm{CPI},t}$ is the annual variation of the Consumer Price Index, and $g_{W,t}$ is the percentage increase of workers hourly wage (the 'salaire horaire de base ouvrier') and d_t is a discretionary increase that may be decided by the government. In addition, the SMIC is also immediately indexed to inflation whenever the CPI has increased by more than 2% since the last change in the minimum wage. In the non farm business sector, the share of employees paid at the minimum wage was around 9.7% in 1998 and around 15% at the end of the sample period.

Collective wage negotiations involve employers and employees representatives, as well as the government, and take place both at the industry and the firm- level.[10] At the industry level, collective agreements define a salary scale, which associates a minimum wage to every category of worker. In practice, these agreements are not necessarily binding, since actual wages are often much higher than those minimums and at the bottom of the wage scale, the national minimum wage is even higher than the branches minimums in some cases. Agreements are negotiated at

[10] See Avouyi-Dovi et al. (2007) for a more detailed description of wage negotiations in France.

the industry level between the 'social partners' but the government can extend the agreement to all the companies belonging to the sector (on request of employers or unions). In 2004, 97.7 % of the employees are covered by collective agreements (Dares, 2006a).[11]

At the firm-level, annual collective bargaining between employers and employees representatives is compulsory (Auroux Act of 1982). In practice this obligation is actually enforced only in firms with union representatives, that are mainly firms with 50 employees or more. In addition, while the opening of negotiation itself is compulsory, it is not required that an agreement should necessarily be reached. According to a survey on negotiation for year 2005 reported in Dares (2007), only 13.9% of firms (accounting for 58.6% of employees) engaged a collective negotiation at the firm-level, and around 20% of firms that negotiate report they do not reach an agreement on wages each year. Avouyi-Dovi et al. (2007) find that other things equal, firm-level agreements have a significant positive effect on wage dynamics. Note that no legal national or sectoral indexation mechanism to price inflation exists, apart from that associated to the minimum wage.

Collective wage changes can only explain a fraction of wage changes. According to a survey by the Ministry of Labor, the share of individual increases in base wage changes was 42.7 % in 2004 (Dares, 2006b). Wage change individualization varies across socio-occupational groups. Noteworthy, for managers, individualized wage changes represent 70 % of total wage increases in 2004. On the other hand, individualized wage increases correspond to respectively 29.2 % and 35.4 % for manual workers and employees. Individualization of wage changes should not be opposed to collective bargaining since the amount of individualized wage increases within a firm is determined by a collective negotiation.

'Dualism' has been pointed as one main feature of the French labour market (see e.g. Cahuc and Kramarz, 2004). Permanent contracts, characterized by a high degree of employment protection, cover 86% of the employed labour force. The percentage of fixed-term contracts in the labour force is around 8 % (other contracts being trainees, contracts through temporary employment agency, etc.). However, the majority of new contracts signed are temporary (more than 70% according to Dares, 2006c), with maximum duration 6 months. The dataset used in the present study does not allow assessing the impact of contract type on wage patterns, since

[11] Collective agreements include agreements at both industry and firm level

whether a given wage corresponds to a permanent or temporary employee is not known.

The macroeconomic context

During our sample period, i.e. 1998 to 2005, inflation in France remained at a low level around 2%. Inflation variability was also low in spite of an oil shock, and uncertainties in the geopolitical environment. In contrast, GDP growth varied from 4.0% in 2000 to 1.1% in 2003. Over the cycle, labor productivity gains per head tended to flatten between 0.5% and 2.0% per year. The unemployment rate fluctuated over the cycle but remained high and persistent between 8% and 11%.

One major event in the sample we consider was the reduction in legal working time. The legal duration is the limit after which further working time is considered overtime. The 35 hours working week was adopted in 2000, first for firms with more than 20 employees and then in 2002 for firms with less than 20 employees. The previous legal duration of the workweek was 39 hours. Reduction in working time was implemented either as reduction in hours worked per day or through additional days out of work. As a rule, the working time reduction was implemented without cut in the monthly wage, thus the ex-ante labour cost increased sharply (about 11%). However, firms benefited from payroll tax cuts on lower wages resulting in a partial offsetting of the labour cost increase. For wage levels in the range of the minimum wage, employer social security contributions were reduced from 12% to 4.2% of the wage (OFCE, 2003). In addition in the context of the collective negotiations on working time reduction, the maintaining of monthly wage was traded-off against future wages moderation from the part of wage earners in many large companies.

4 The data

The ACEMO survey

The data used in the following are the individual observations from the survey on Labor Activity and Employment Status (ACEMO) carried out by the French ministry of Labour and Social affairs. The ACEMO survey covers establishments with at least ten employees in the non-farm market sector i.e., the private sector plus public-sector companies. Data are collected by a postal survey at the end of every quarter from about 38,000 establishments. The available files span the period from the fourth quarter of 1998 to the fourth quarter of 2005.

The ACEMO survey collects the level of the monthly base wage, inclusive of employee social security contributions. The data excludes bonuses, allowances, and other forms of compensations. The survey is used to produce a 'constant structure' index that monitors monthly wage for a specific position and rank. Changes in monthly base wage are observed for four socio-occupational categories within the firm: manual workers, clerical workers, intermediate occupations, managers. Each firm has to report the wages level of up to 12 employees, representative of the four above mentioned occupations (1 to 3 occupations in each category).

The base wage is a relevant indicator of wage since in France base wage represents 77.9% of gross earnings. Furthermore, most bonuses (like '13th month' payments or holidays bonuses) constitute a fixed part of the earnings (5.2%) and are linked to the base wage[12]. Performance-related bonuses, which are disconnected from base wage, represent 3.2% of earnings. Observing only the base wage, we miss a source of wage flexibility. Nonetheless, considering overall compensation rather than base wage may have led to distorted indicators of rigidity like the frequency of wage change. This is in particular the case if temporary components like bonuses introduce volatility in wage changes without representing substantial fluctuations in the amount of earnings. Various studies have focused on the base wage in their analyses of wage rigidity (Altonji and Devereux 1999, Gottshalk, 2005, and Dickens et al. 2005).

In addition to the monthly wage, the dataset includes a limited set of other occupation- or firm-specific variables: hours worked, the sector and the number of employees.

Methodological issues and data treatment

Measurement error is a crucial concern when analyzing wage data. Dickens et al. (2005) attempt to identify the frequency of errors estimating a statistical model of the distribution of wage changes. Gottschalk (2005) uses time series tests for breaks to discriminate between true and spurious wage changes in a survey among individuals. As with other surveys indeed, measurement errors may distort the ACEMO dataset: reporting errors and rounding effects

[12] Figures here are taken from Pouget (2005) who analyzes the 'Structure of Earning' Survey carried by the INSEE in 2002.

during the data collection. The ACEMO survey is however answered by firms, which should limit measurement errors, as argued by Altonji and Devereux (1999) and Gottschalk (2005). In addition, note that ACEMO survey is designed to provide precise information about hours worked and hourly wages. The base wage does not include overtime pay, and we compute hourly wage using the normal working time that is reported in the survey.

Normal working time is the working time on the labor contract and may be different from legal working time (i.e. the number of hours above which work is considered as overtime). The empirical distribution of working times reported by firms is concentrated around legal working time. Our analysis relies on hourly wages and there is a measurement issue insofar as actual working time may differ from normal working time (i. e. unpaid extra hours). It is however not clear that we should want to interpret temporary changes in hourly wage resulting from such unobservable fluctuations in working time as reflecting wage flexibility.

The design of the ACEMO survey may also give rise to a specific measurement error issue: wages trajectories do not necessarily correspond to the same employee through time. However, some checks are performed in the process of collecting the data. Whenever changes between two quarters are larger than 2%, firms are re-interviewed by the statistical agency -Dares- in order to check whether observations were actually comparable. Furthermore, at each survey vintage dated t, firms are requested to report, along with current wage of an employee, the employee's wage level in the previous quarter. We use this figure to compute the frequency of wage changes, so the frequency of wage changes is not affected by employee substitutions. Also, we compare the employee's wage level in the previous quarter to the wage that was declared as 'current wage' by the firm in the vintage of survey of previous quarter $t-1$. When the figures do no match, we disregard the observations in the computation of wage spell durations, so that changes in wages due to changes in individual followed are filtered out. It could be the case that an employee is replaced by another employee with exactly the same wage. However given the extent of synchronization of wage changes within firms (documented below), we do not expect that the computation of durations is biased even under such an undetected substitution.

Yet another concern is that the firms may not report the base wage. We performed some checks by focusing on very short durations. The amplitude of wage changes associated to these durations was of a small amount and not synchronized within firms, suggesting they do not mainly correspond to bonus payments. Note that to the extend that a misreporting bias may be present, it would lead to overestimate the flexibility of the base wage.

In order to produce aggregate measures of the frequency of wage changes and wage durations, the statistics reported in the following are weighted, with ACEMO survey weights. Results with unweighted data were similar. Our analysis focuses on hourly wages. The ACEMO survey measures the number of hours worked per week, and the hourly wage was computed as the ratio of monthly wage over hours worked. Our results were however unchanged when considering monthly wage.

We removed outliers in our analysis. An observation was classified as an outlier if the distance to median of the wage growth rate was in excess of 5 times the interquartile range (difference between third and first quartile of wage growth rates). The final dataset contains around 3.7 million wage records and around 1.8 million wage spells.

5 Main features of base wage stickiness

5.1 The frequency of wage adjustment

We report two indicators of wage stickiness: the frequency of hourly wage change (i.e. the proportion of observations with a wage change) and the duration of wage spell.[13] The indicators are related, the average duration is expected to be close to the inverse of the average frequency of wage change (though the exact relation holds only with unweighted data and absent censoring). As mentioned above in the ACEMO observations corresponding to the same firm and to the same occupation at different times do not necessarily correspond to the same employee, but we are able to overcome this feature using information provided in each vintage of the survey related to the base wage in the current quarter, and to that in the previous quarter.

As expected, we obtain that changes in hourly base wage are infrequent. The frequency of hourly base wage changes is 38% per quarter. The degree of heterogeneity in the frequency of wage change according to control variables is limited: the average frequency does not vary much

[13] Results computed with the monthly base wage are similar.

across industries, socio- occupational groups or firm sizes (see Table 1). Frequency is higher for large firms, which may be due to the larger share of employees involved in negotiations in those firms (88% in firms between 250 and 2000 employees against 68 % in firms between 50 and 250 employees, Dares, 2006a). In order to compare with other studies, the data can also be used to compute the annual (rather than quarterly) frequency of wage changes. The frequency of annual wage changes is 88%. It is not too far from the estimation one would get assuming a constant probability of quarterly wage change of 38% (85% $\approx$1-$(1-38\%)^4$). It is also consistent with the figure of 89% obtained by Birscourp et al. (2005) with the same data set but for the year 1997.

[TABLE 1: Frequencies of Wage Changes]

The base wage is usually fixed for several quarters. A period of constant wage is called a wage spell in the following. The mean of wage spell durations is 2.0 quarters.[14] It is not too far from the estimate one would get with the inverse of the average frequency. Note that around 60% of wage spells are (left or right) censored, meaning that the full spell is not observed. For example a spell may be right censored because of the end of the observation period, or because the statistical agency stopped recording an individual's wage before the end of the spell. Discarding censored spells in the computation of average duration however only slightly increases the mean duration, from 2.0 to 2.1 quarters. The distribution of wage spell durations for completed spells is plotted in Figure 1.

[FIGURE 1: Distribution of Wage Spell Durations]

[TABLE 2: Wage Spell Durations]

An informative tool to represent the distribution of wage duration is the hazard function, i.e. the probability of a wage change conditional on the elapsed duration of a wage spell (see e.g. Lancaster, 1990, for details). Figure 2 plots the baseline hazard function of changes in

[14] The figures on wage spells durations are computed by sampling randomly one wage spell from each wage trajectory, in order to remove over-representation of short spells that may emerge with the pooled set of spells.

nominal wage.[15]. The highest conditional probability of a wage change occurs here after four quarters. Among the employees who did not change wages during the first three quarters, the probability of change is approximately 0.8 in the fourth quarter. The hazard function present other noticeable spikes at durations 8, 12 and 16 quarters. Gottschalk (2005) obtained a similar shape of the hazard function for the United States, once measurement errors in the SIPP data set were corrected. Such pattern is consistent with prevalence of Taylor-like one year contracts.

[FIGURE 2: Hazard function of wage changes], Note: The sample includes all non-left-censored spells of constant wage.

To get a sense of how our results might be influenced by misreporting of base wage by firms, we identify in the database wage spells of duration one quarter that were either started with a wage increase and ended with a wage decrease, or started with a wage decrease and ended with a wage increase. Our assumption is that those patterns may reflect cases when the reported wage includes some temporary non-base wage components, like bonuses (for cuts, it might reflect misreporting of hours, for instance in the case of sick leave). Excluding such temporary changes we obtain an estimated frequency of wage change of around 34%. Difference with the baseline computation is thus moderate.

Overall, the observed average duration is short in regard of the conventional assumption that wages are typically changed once per year. To rationalize this result, we note that, in collective bargaining, annual agreements on wages are often implemented in the form of two successive predetermined wage changes.[16] Our econometric analysis in section 6 investigates predetermination.

[15] The hazard function is estimated with the life-table method. The estimator for the hazard rate at duration T is $h_T = d_T/(n_T - c_T/2)$ where d_T is the number of wage changes at duration T, n_T the number of spells 'at risk' at a given duration T ; c_T the number of censored spells between T and $T+1$.

[16] Avouyi-Dovi et al. (2007) provide evidence that the frequency of implementation of collective agreements is larger than that of achieving collective agreements.

5.2 The distribution of wage changes and downward nominal rigidity

The overall probability of a wage change breaks down into a 32% frequency of wage increases and a 6% frequency of wage decreases. Base wages are therefore not strictly subject to downward nominal rigidity. This point is further illustrated by the distribution of wage changes plotted in Figure 3 (the zeros, i.e. observations with no change in wage, have been removed from the histograms since otherwise they dominate the distribution). One may have expected a stricter degree of downward rigidity given that the base wage is an element of the labor contract which may not be decreased without opening a formal negotiation. Since the ACEMO data relate to occupations rather than employees, one possibility could be that many observations of wage decreases in the data result from mismeasured turn-over, rather than changes in the base wage for a given individual. However, wage decreases larger than 2% are specifically checked by the data-collecting agency against measurement error, and such changes represent more than half of the wage decreases in the dataset. Most wage decreases are thus presumably 'true' wage changes, though there might be a concern that the firm reports total pay rather than base wage. Following Birscourp et al. (2005) base wage decreases may be compensated by working conditions that improve following for instance a switch from night-work to day-work.

[FIGURE 3: Distribution of Wage Changes excluding 0s]

The sample average hourly wage change is 2.2% and the average wage increase is 3.2%. Other relevant characteristics of the distribution in Figure 3 are its asymmetry (while the mean is 2.2%, the median wage change is 1.3%) and fat tails (kurtosis is 4.6). These patterns of the distribution of wage change are similar to those found by Dickens et al. (2005) using annual data for various countries. The specific peak in the distribution of wage changes, in the 10% to 11% and the 11% to 12% intervals of the histogram, essentially reflects the one-shot reduction in weekly working time many firms implemented at some point in the sample period. Assuming the monthly wage to be kept unchanged, as programmed in standard workweek reduction agreements, the mechanic impact of a reduction in workweek from 39 to 35 hours should be either +11.3% or +10.6% (i.e. -ln(152/169) or -ln(151/169)) where 151, 152 and 169 are the working time in number of hours per month reported by firms. This outlier obviously influences the sample mean of hourly wage growth and the median-mean spread. In our econometric analysis we control for the reduction in working time by using firm-specific dummy variables for the shift to 39 to 35 hours.

5.3 Staggering and synchronization

Time variation in the frequency of wage change provides some indications on the synchronization of wage changes. Figure 4 plots this frequency over time for all wages as well as for wages close to the minimum wage. There is evidence of a large degree of staggering since the frequency of wage changes is in no quarter lower than 20%. Nevertheless, there is some synchronization at work since wages tend to be changed more often in the first and in the third quarter. The spike and synchronization in the third quarter is related to the national minimum wage update in July, as confirmed by the time series of the frequency of changes for wages at the bottom of the wage scale.

[FIGURE 4: Frequencies of Wage Changes Over Time]

While wage changes are largely staggered across firms, there is a large degree of synchronization of wage changes within firms. To illustrate this, we first consider firms for which 12 categories of workers are observed at a particular date. For those firms the event that all employees included in the survey change wage (i.e. exactly 12 simultaneous wage changes are reported) is observed in 21% of the quarters. If wage changes were staggered within firms, i.e. independent across workers, one would expect almost no case where the 12 reported wages change together. The expected proportion for such an event is indeed virtually zero, based on a quarterly frequency of wage change of 38% ($38\%^{12} \approx 0\%$). A similar type of computation can be done for each possible number of workers categories (N^{cat}) observed. This information is reported in the 12 histograms of Figure 5. Firms are grouped according to the number N^{cat} of workers categories that are present. For each group of firms, the histogram reports the distribution of the number of wage changes, which we denote n, occurring in a given quarter for a given firm. Obviously, $0 \leq n \leq N^{cat}$. If wage changes were independent across categories of workers within the firm, then the histogram should have a bell-shape resulting from a binomial distribution (at least for most values of the probability of a wage change p). However, the distribution is all cases U-shaped. A first mode at zero (no wage change in the firm) is observed for each histogram. Furthermore, there is in each case a second mode at the maximum value ($n = N^{cat}$), i.e. for the case when all reported employee categories in the firm experience a wage change.

[FIGURE 5: Distribution of the Number of Wage Changes within Firms]

Indicators of synchronization at the firm-level can be defined from the histograms. As a baseline case, we consider that a set of wage changes occurring at a given date is synchronized if *all* observed wages in the firm do change. The (few) cases with only one employee category are removed since they are obviously uninformative about synchronization. We then consider as an indicator of synchronization the share of such synchronized wage changes events among all quarters with at least one wage change. It is as large as 44% (see Table 3). This definition of synchronization is very restrictive. In the Appendix we consider less restrictive definitions of synchronization (not requiring that all employees change wage) and obtain that with two alternative definitions the share of synchronized wage changes are 74% and 65%. Note our indicators of synchronization within firms may be affected by synchronization due to seasonality, rather than to firm-specific synchronization. However, considering these indicators for a specific quarter does not change much the results. Considering the year 2002 for instance the first indicator of synchronization has a maximum of 49% on the first quarter and a minimum of 36% on the second quarter.

[TABLE 3: Share of Wage Changes Synchronized Within Firms]

5.4 Evidence on Taylor-like contracts

Infrequent wage changes may be consistent with two popular 'time-dependent' models of wage setting: the Taylor and the Calvo models. That Calvo's constant probability of wage change model cannot account for wage dynamics is apparent from the variations in the frequency in Figure 4 (further evidence is provided in section 6). In this section, we investigate the relevance of Taylor contracts. In Taylor's (1980) model, wage rigidity comes from fixed length wage contracts. To assess the weight of these contracts in the economy we proceed as follows. Four quarters Taylor contracts are defined as observations corresponding to the same firm and to the same occupation for which the hourly base wage changes (at most) every four quarters. Each wage trajectory, i.e. the collection of wage records corresponding to the same firm and to the same occupation is classified either as one of four types of 'four quarters Taylor contract' (the ones where the base wage changes in the first quarter, the ones where the base wage changes in the second quarter, the ones where the base wage changes in the third quarter and the ones where the base wage changes in the fourth quarter) or as a not consistent with a (four quarters) Taylor contract.[17] Results are presented in Table 4. The weight of 'four quarters Taylor contracts' measured this way is quite small: they represent 13% of wage trajectories, suggesting that such contracts do not describe properly base wage dynamics.

In order to test the robustness of this conclusion, we introduced two variants of that test. In the first variant, we also allow two quarters Taylor contracts: the share then rises from 13% to 21%. The second one consists in allowing for small deviations from strict Taylor contracts. We consider as "Taylor contracts" wage trajectories for which Taylor contracts account for a large share of the variance of wage changes. We set this fraction of variance to 90%. We then select trajectories for which the variance of the wage change explained by either one of the quarterly seasonal dummies (interacted with year dummies) in an OLS regression is larger than 90%. By contrast, in the first experiment, we required that 100% of the variance was explained. We then obtain that 39% of the trajectories (among those observed in the first quarter of 2005) are characterized 'four quarters Taylor contracts'.

[TABLE 4: Share of Taylor Contracts in 2005]

There are four types of "four quarters Taylor contracts" each corresponding to a quarter of wage renewal. The one representing the largest share of observations is the one where the wage changes in the first quarter but the shares of Taylor contracts with changes in the second and third quarter are of the same order of magnitude.

[17] This computation is carried restricting to trajectories that were observed in the course of the first quarter of 2005.

6 Econometric evidence

We now provide econometric evidence on the process of nominal wage changes. Our specification is a flexible empirical reduced form designed to account for lumpiness in wage adjustments. Namely, we distinguish the wage change decision and the size of wage change. This specification is guided by theoretical models. Infrequent wage changes may be rationalized either by state-dependent models or by time-dependent models, and the model we estimate allows to investigate whether the probability of a wage change varies according to the state of the economy, as in state-dependent models, or depend on elapsed duration as in time dependent models[18]. As regards the size of wage changes we focus here on the effect of aggregate prices and unemployment. Our analysis thus falls in the tradition of empirical 'Phillips curves', though the use of micro data is a distinctive feature. We specifically look at two issues which are rarely considered in the micro data empirics of wages. A first issue is whether wages are forward-looking, as postulated in the New Keynesian literature, or backward looking, reflecting e.g. indexation clauses or adaptive expectations. A second important issue is predetermination of wages. As discussed in section 2, predetermination occurs when a path of wage increases is set in advance.

Before presenting specification and results, we discuss a few empirical issues. A first issue is the modelling of wages in level versus first difference, a controversial issue in the econometrics of wages (see e.g. Blanchard and Katz, 1999). The traditional Phillips curve focuses on the relation between the wage in difference and unemployment, whereas the 'wage curve' literature stresses the relation between the level of real wage and unemployment. We here consider a first difference model. This allows to control for constant unmeasured worker of firm characteristics (productivity, effort, education, etc.). Theoretical models from various branches of the literature indeed point to a wide range of potential individual or firm-specific determinants for the target base wage, and due to data limitations, we lack of firm-level control variables. In addition some of these omitted relevant variables may be time-varying. Our maintained assumption is then that omitted firm-level variables are orthogonal to variables related to macroeconomic developments

[18] Note that state-dependent models typically do not yield closed form solutions for the process followed by the decision variable.

(inflation and regional unemployment) which we focus on.

6.1 An empirical model of wage changes

We now describe our empirical model of the size of wage change, adopting the following notations: Δw_{it} denotes a wage that changes at time t in a firm i, p_t the logarithm of the price level (measured by CPI) and $\mathbf{u}_t$ the (regional) unemployment rate. All other variables are collected in a row vector $\widetilde{x}_{it}$. We note x_{it} the complete set of regressors. As detailed below, we sample one individual per firm to perform estimation, so we do not distinguish between firms and individual indices in this section. We consider a linear specification for observed wage changes:

$$\Delta w_{it} = x_{it}\beta + \eta_{it} \tag{1}$$

Wages are here modelled in first-difference, following the traditional Phillips curve approach. Given that we are using a panel dataset, one advantage of using such a specification is to eliminate individual effects (see e.g. Bils, 1985, for a similar motivation of a first-difference specification on wage data). Note only individual effects in the *level* of wage are eliminated.[19] An important issue is that most observations of Δw_{it} are zeros, so that estimating equation (1) by least-square, restricting to non-zero wage changes, is likely to be biased due to sample selection. Our econometric model is mainly devoted to address this issue. To handle sample selection, we introduce an "inaction" band for wage changes.

The econometric framework is related to "type II" Tobit models (see e.g. Wooldridge, 2002, p.566), and in particular to Fehr and Goette's (2005) model of wage change. Related models have been applied to price rigidity (see, inter alia, Dhyne et al., 2007, Fisher and Konieczny, 2006). Let Δw^*_{it} be the latent wage change that would be observed absent wage rigidity. We consider a latent variable y^*_{it} that triggers wage changes. Both latent variables depend on explanatory variables as follows:

[19] Though estimating a second-difference equation would allow to deal with potential firm-specific effects in wage growth, such a specification is not appealing in economic terms. Furthermore, it would entail loosing a considerable number of observations since the relevant lag of Δw_{it} is the last wage change observed, typically several quarter before the current wage change.

$$y_{it}^{*} = z_{it}\mu + \varepsilon_{it} \tag{2}$$

$$\Delta w_{it}^{*} = x_{it}\beta + u_{it} \tag{3}$$

We consider an inaction band so that no wage change will be observed when $v_{it}\gamma_1 < y_{it}^{*} < v_{it}\gamma_2$ where v_{it} includes a constant and potentially some covariates. By allowing the inaction band to depend on covariates, this model extends that of Fehr and Goette (2005). The relationship between latent variables and observed variable is the following:

$$\Delta w_{it} = 0 \text{ if } v_{it}\gamma_1 < y_{it}^{*} < v_{it}\gamma_2 \tag{4}$$

$$\Delta w_{it} = x_{it}\beta + u_{it} \text{ otherwise} \tag{5}$$

Introducing the latent variable y_{it}^{*} as distinct from Δw_{it}^{*} allows us to account for small wage changes. Consistent with the notion of time-dependence, we include in the v_{it}'s indicators variables for the elapsed duration, i.e. the time elapsed since the last price change. This specification accounts for Taylor contracts through allowing the trigger point for wage change to be lower after four quarters. Furthermore, unlike a standard ordered probit model, this specification allows that both the probability of a wage increase and that of a wage decrease are higher, say, after an elapsed duration of four quarters. In addition, the specification allows for asymmetric effect of the covariate on the probability of a wage increase and decrease. To implement maximum likelihood estimation (ML), we assume gaussian serially uncorrelated error terms: $\varepsilon_{it} \sim N(0, \sigma_{\varepsilon}^2)$, $u_{it} \sim N(0, \sigma_u^2)$, and $Eu_{it}\varepsilon_{it} = \rho\sigma_u\sigma_{\varepsilon}$. We interpret ρ as the degree of state-dependence at the micro level. For instance, an unobserved firm-level productivity shock may rise at the same time the probability of a wage increase and the size of observed wage increase. The probability of a wage increases $\Phi((z_{it}\mu - v_{it}\gamma_2)$ is one object of interest from the estimation procedure.

The likelihood for ML estimation method is detailed in appendix 2. Estimations were performed by maximum likelihood as well as, for comparison purposes, by OLS restricting to non-zero observations. A discussion of identification in our model is in order. For identification z_{it} and v_{it} variables have to be distinct. The v_{it} variables include dummy variable capturing time-dependence: elapsed duration and seasonal dummies. The z_{it} variables include sectoral, category and firm size dummies. Right-hand size variables for the size of wage change equation (x_{it}) include the alternative relevant transformations of $\mathbf{u}_t$ and p_t, as well as the variables in v_{it} and z_{it} with the exception of elapsed duration. Excluding one variable insures identification of parameters of equation (3), otherwise identification would rely on distributional assumptions only. Excluding elapsed duration is sensible, since wage setting models do not predict that, other things equal, elapsed duration should matter for the size of wage changes.

We now discuss the alternative specifications considered for the model for wage changes. The baseline specification is backward-looking:

$$\Delta w_{it} = \alpha(p_{t-1} - p_{t-\tau_{-1}}) \; + \kappa(\mathbf{u}_{t-1} - \mathbf{u}_{t-\tau_{-1}}) + \widetilde{x}_{it}\beta + u_{it} \tag{6}$$

where we denote τ_{-1} the duration of the spell that ended at date $t-1$, and for convenience we drop dependence of τ_{-1} on firm index i and date index t. We also drop dependence of the unemployment rate on a region index. An important remark is that we compute inflation and unemployment by the cumulative change of these variables along the ongoing wage spell. Economically, cumulated variables are relevant proxies for the deviation from optimal wage, that determine the triggering of a wage change. Statistically, these variables are a source of identification, as the duration of spells does differ across individuals, so that cumulated macro variables vary across observations.

We extend this specification to test for forward-lookingness and predetermination. To test for forward lookingness, we construct several expectation variables. In the empirical analysis, those forecasts are generated using ARIMA models. For each date t in the sample we generate forecast for the inflation (or unemployment) rate k period ahead which we denote ${}_t\widehat{\pi}_{t+k}$ (note ${}_t\widehat{\pi}_{t+k} =_t \widehat{p}_{t+k} - {}_t\widehat{p}_{t+k-1}$) and ${}_t\widehat{\mathbf{u}}_{t+k}$. Similarly to above, we in the following note τ_1 the duration of the wage spell started at date t, and τ_2 the duration of the subsequent spell (started at date $t+\tau_1$). We note τ_{-2} the duration of previous spell started at date $t-\tau_{-1}-1$. Our forecasting model allows us to compute forecast cumulated inflation (and unemployment) over the life of the starting wage spell: ${}_t\widehat{p}_{t+\tau_1} - p_{t-1}$. An important assumption that we are making here is that at date t when wage is decided, the length of the wage spell τ_1 is known. This assumption is consistent with Taylor like time dependent models (although not with Calvo or state dependent models). Also, in computing cumulated unemployment and inflation, we make the assumption that wages are set at the beginning of each quarter.

To test for forward-lookingness, the equation we consider is as follows:

$$\Delta w_{it} = \alpha^f ({}_t\widehat{p}_{t+\tau_1} - p_{t-1}) + \alpha^b (p_{t-1} - p_{t-\tau_{-1}}) + \kappa^f ({}_t\widehat{\mathbf{u}}_{t+\tau_1} - \mathbf{u}_{t-1}) + \kappa^b (\mathbf{u}_{t-1} - \mathbf{u}_{t-\tau_{-1}}) + x_{it}\beta + u_{it} \tag{7}$$

The parameters α^f and α^b (respectively κ^f and κ^b) provide evidence on forward versus backward looking behavior.

Predetermination is another issue we investigate. As noted above, preset wage increases may account for the short durations (lower than one year) we observe, in a context where wage negotiations are casually observed to be implemented on an annual basis. The simplest, as well as the most plausible according to casual observations, case of predetermination is that one wage contract determines the path of wage over exactly two spells. For instance if a wage change is decided at date t, the firm sets simultaneously the wage change Δw_{it}, the duration τ_1, and the size of next wage change $\Delta w_{it+\tau_1}$ and presumably the duration τ_2. In such a case, and assuming a forward looking model, the newly set wage will depend on the overall price increase expected to prevail over the whole trajectory of the contract i.e. ${}_t\widehat{p}_{t+\tau_1+\tau_2} - p_{t-1}$. Now, consider the same set-up but suppose the wage change observed at date t is a preset wage change: then the wage change has been decided upon at date $t - \tau_{-1}$ based on information (or expectations) available at that date, and incorporating an inflation forecast for the two subsequent spells, that is $({}_{t-\tau_{-1}}\widehat{p}_{t+\tau_1} - p_{t-\tau_{-1}-1})$. For the backward-looking case, we also can compute current and lagged cumulated inflation over 2 spells: $(p_{t-1} - p_{t-\tau_{-1}-\tau_{-2}})$ and $(p_{t-\tau_1-1} - p_{t-\tau_{-1}-\tau_{-2}-\tau_{-3}})$. Similar computations were made with respect to the unemployment rate $\mathbf{u}_t$.

To test for predetermination of wage changes, we incorporate the aforementioned variables in a wage change regression. In a backward looking model:

$$
\begin{aligned}
\Delta w_{it} &= \alpha_1^b(p_{t-1} - p_{t-\tau_{-1}}) + \alpha_2^b(p_{t-1} - p_{t-\tau_{-1}-\tau_{-2}}) + \widetilde{\alpha}_2^b(p_{t-\tau_1-1} - p_{t-\tau_{-1}-\tau_{-2}-\tau_{-3}}) \qquad (8)\\
&+\kappa_1^b(\mathbf{u}_{t-1} - \mathbf{u}_{t-\tau_{-1}}) + \kappa_2^b(\mathbf{u}_{t-1} - u_{t-\tau_{-1}-\tau_{-2}}) + \widetilde{\kappa}_2^b(\mathbf{u}_{t-\tau_1-1} - \mathbf{u}_{t-\tau_{-1}-\tau_{-2}-\tau_{-3}})\\
&+ x_{it}\beta + u_{it}
\end{aligned}
$$

Significant parameters α_2^b and $\widetilde{\alpha}_2^b$ (respectively κ_2^b, $\widetilde{\kappa}_2^b$) can be interpreted as rejection of non-predetermination of wages. In the case of a forward-looking model:

$$
\begin{aligned}
\Delta w_{it} &= \alpha_1^f({}_t\widehat{p}_{t+\tau_1} - p_{t-1}) + \alpha_2^f({}_t\widehat{p}_{t+\tau_1+\tau_2} - p_{t-1}) + \widetilde{\alpha}_2^f({}_{t-\tau_1}\widehat{p}_{t+\tau_1} - p_{t-\tau_1-1}) \qquad (9)\\
&+\kappa_1^f({}_t\widehat{\mathbf{u}}_{t+\tau_1} - u_{t-1}) + \kappa_2^f({}_t\widehat{\mathbf{u}}_{t+\tau_1+\tau_2} - u_{t-1}) + \widetilde{\kappa}_2^f({}_{t-\tau_1}\widehat{\mathbf{u}}_{t+\tau_1} - \mathbf{u}_{t-\tau_1-1})\\
&+ x_{it}\beta + u_{it}
\end{aligned}
$$

This regression incorporates different vintages of forecasts. This test has important similarities with tests of 'Sticky Information' theories as carried out by Klenow and Willis (2007).

We emphasize that, using reduced forms specifications as (7) to (9), we can only provide an indirect test of predetermination and forward-lookingness, lacking additional information. First, as regards testing for predetermination, even if the data were generated by a two-period contract models, at a given date we do not know whether a given observed wage change results from a fresh decision or from the implementation of a wage change that was previously pre-set. Second, we note that completing such a forward-looking specification with a model for the probability of wage change, as we do when estimating the sample selection model by ML, can only be an approximation. Indeed, the way we compute expected inflation relies on a deterministic horizon for the spell (here denoted τ_1, τ_2) which is not strictly consistent with random wage durations that are generated by model (4)-(5).

To implement estimation, given the high degree of synchronization of wages within firms (see Section 5.3), we sample randomly one employee (or occupation) per firm to carry our econometric analysis. This removes a source of correlation between observations, namely unobserved firm-specific fixed effects (firm productivity growth, financial position, etc.) without loss of information for our purpose. After this sampling, we obtain a baseline estimation dataset of around 240 000 observations. We complement the dataset by using quarterly series for the CPI, and regional unemployment rates obtained from the Ministry of Labour website. Using regional unemployment rates provides cross-section variability. To compute expectations we estimated a set of ARIMA models over the sample 1990:1-2005:4.[20] Based on BIC selection criteria we selected an AR(3) specification for regional unemployment rates and an AR(4) model for CPI inflation. We then recursively generated forecasts from each date of the sample and match these forecasts with micro data.

6.2 Results: the probability of a wage change

[TABLE 5: Estimation of the probability of a wage change]

We first focus on the probability of a wage change and on testing for state-dependence. Table 5 reports estimates for the parameters γ_1, γ_2, μ from two sets of estimates, under specification (6) i.e. using the baseline (backward-looking) set of regressors. Other parameters produced by the ML procedure are not reported. State-dependent behavior supposes that the timing of decisions reacts to macroeconomic shocks. Here we test this assumption by investigating whether the probability of a wage change depends on $(p_{t-1} - p_{t-\tau_{-1}})$ and $(\mathbf{u}_{t-1} - \mathbf{u}_{t-\tau_{-1}})$, thus through including these variables in the set of regressors z_{it}. Panel A reports the results without elapsed duration dummies in the regressors z_{it} while panel B presents results with those regressors included. Marginal effects are reported in the last columns of each Panel. Marginal effects, i.e. the effects of a one unit increase in right hand side variables on the probability of a wage decrease or increase, are computed at the reference category: a manual worker in firm with over 500 employees, in the manufacturing of consumer goods sector, with a duration over 4 quarters.

Without elapsed duration dummies (Panel A) cumulated inflation has a strongly significant parameter though unemployment is only marginally significant. However, when time-dependent dummies are introduced in the regression (Panel B), cumulated inflation is no more statistically

[20] This is obviously a limited information approach. One advantage is that the model generating the forecasts is consistent across forecasts horizons, unlike what would emerge if we used a GMM-type approach to handle expectations.

significant while the parameters on cumulated unemployment change has then a positive sign which does not conform to intuition. The marginal effect associated to this parameter is weak as indicated in the last column (a one percentage point change in unemployment rate is predicted to increase by 0.61 percentage point the probability of a wage increase), suggesting absence of state-dependence as long as time-dependence is allowed for. The "Calvo"-type behavior of wage setting can be assessed with this specification, since the probability of wage change should be constant over time under the Calvo model. The joint nullity of coefficients on time dummies is largely rejected, consistent with the fluctuations in the frequency of wage change observed in Figure 3. Overall, we interpret these results as providing evidence against state-dependence and "Calvo"-type behavior in wage setting. They may be consistent with the presence of some Taylor contracts, as suggested by the strong significance of elapsed duration dummies. Noticeably, the probability of a wage increase is higher by 24.6 percentage points when elapsed duration is four-quarters than for the reference duration. This result is consistent with results in earlier sections, e.g. the hazard function in Figure 2. The clear seasonal pattern in wage setting, wage increases being more likely to occur in the first quarter than in others, can also be interpreted in terms of Taylor contracts. Finally, there is some heterogeneity in the probability of a wage change. Wage increases are in particular more frequent in larger firms, while wage decreases are more frequent in small firms. The extent of cross-sectoral and cross-occupation heterogeneity is however less pronounced.

The determinants of wage decreases are less clear cut, since marginal effects are low. The probability of wage decrease is larger in small firms however. Note the dummy variable for duration "one-quarter" has a strong positive effect on the probability of wage decrease (4.8 percentage point). This likely reflects temporary wage increases followed by wage declines, it may to some extent capture misreporting of base wage.

We have checked the robustness of the results using a more flexible specification: an unordered multinomial logit model for the probability of wage increases and wage decreases. Results were largely unchanged.

6.3 Results : the size of wage changes

Table 6 presents estimation results, focusing now on the size of wage change, and considering alternative sets of regressors. To save space, we do not present parameters pertaining to the wage decision $(\mu, \gamma_1, \gamma_2)$. In each case, these parameters were close to those reported in Table 5. Our maintained assumption here, based on the results from Table 5, is that wage setting is time dependent with respect to macroeconomic variables so that state dependent variables are not included in the z_{it}.

[TABLE 6: Results for the size of wage change]

Panel A of Table 6 reports results for the baseline backward-looking specification. The estimated standard deviation of the error term in wage growth is 3.9%. This high value partly reflects the truncation associated with sample selection, and partly the overall rather poor fit of the model. Indeed idiosyncratic shocks, e.g. firm-level factors, not available in our data, are important sources of variability in wage changes. Our estimates however give rise to a Phillips curve interpretation: cumulated inflation has a positive and significant effect on wage changes, while unemployment change has a negative and significant effect. Sample selection has a very noticeable impact on parameter point estimates. Indeed the parameter on inflation is estimated to be $\widehat{\alpha}$ =0.549 with OLS, but to $\widehat{\alpha}$ =0.235 with the sample selection model. The semi-elasticity of wages to unemployment changes is $\widehat{\kappa} = -0.266$. The estimated correlation between the error of the selection equation and that of the wage change equation is $\widehat{\rho}$ =0.606. This large correlation may reflect a high degree of state-dependence with respect to idiosyncratic factors at the company or local level. An idiosyncratic demand or productivity shock at the firm-level for instance raises both the probability and the size of a wage change. As regards the effect of control variables, it appears that heterogeneity across sectors is rather limited, but that wage changes in the first quarter are larger. Wages change by smaller amount in large firms. This balances the fact obtained from the selection equation that employees in large firms experience a larger number of wage changes per year. The same patterns regarding the effect of control variables are obtained for all specifications, so in the remaining we focus on commenting the parameters pertaining to inflation and unemployment.

Panel B reports the results of specification (7) which nests backward and forward looking behavior. The number of observations (n=160754) is considerably reduced due to the extent of right censored wage spells, for which forward inflation cannot be computed since the end of the spell is not known. The first noticeable result is that both expected (forward) and elapsed (backward) inflation seem to influence wage changes. The two parameters are very significant, with backward looking inflation having a more important role ($\widehat{\alpha}^b$ =0.197) than forward-looking inflation ($\widehat{\alpha}^f$ =0.110). As regards the unemployment rate, both the backward and forward cumulated rate have a significant and negative impact. They have the same order of magnitude. Overall, results from estimates of equation (7) suggest wage changes are influenced both by past and expected changes in inflation and unemployment.

In Panel (C) and (D) we report estimation results for equations (9) and (8). Estimation of these equations raises an important multicollinearity issue since the various forecast terms are largely overlapping. Coefficients are therefore imprecisely estimated. We did not obtain insightful results from an encompassing specification nesting equations (9) and (8). Panel C reports the result of the backward-looking specification with various cumulative inflation and unemployment terms, over one or two spells, included. As regards the inflation terms, both the cumulated inflation rate over the last two elapsed spells and its lag are significant, with respective coefficients 0.152 and 0.053. As regards the unemployment terms, only the lag of the unemployment change over two spells is significant. It is as expected negative (-0.164). Thus, we reject non-predetermination, and this specification suggests predetermination is a relevant ingredient of wage setting.

From the results for the forward looking specification (9) reported in Panel D, we observe that both the current and lagged inflation forecast over 2 spells have positive and significant parameters, while the current forecast over one spell is insignificant. As regards the unemployment term, only the lagged forecast over two spells is significant, and has a negative value ($\widehat{\gamma}_2^f$ =-0.357). Overall, while our specifications do not allow to estimate a proportion of predetermined and non-predetermined wage contracts, these results indicate rejection of the assumption of no predetermination. Our results are consistent with the hypothesis that a significant part of wage changes is decided in advance, hence based on past information (or past expectations) at the time wage changes are implemented.

We have performed some robustness experiments not presented for brevity. As a robustness check for the ML estimates, we estimated the model with a Heckman two-step procedure detailed in the appendix, with Autocorrelation-Heteroskedasticity consistent standard errors implemented in the second stage (OLS) regression.[21] Results were hardly affected, and the standard errors in the wage change equations were somewhat smaller.

7 Conclusion

This paper has analyzed nominal wage stickiness using an original quarterly dataset. Our main findings are the following. The frequency of base wage changes is around 35% per quarter. There is some evidence of downward rigidity in base wages. Wages changes are mainly synchronized within firms and are to a large extent staggered across firms, although some across firm synchronization is induced by minimum wage changes and by seasonality (wage changes are more frequent in the first quarter). Strict Taylor or Calvo models fail to account for the dynamics of wage changes, but a significant share of firms has a Taylor contract-like behavior. In addition, our econometric results suggest two features of wage setting of interest for monetary policy. First, there are both elements of forward and backward-lookingness in wage changes. Second, predetermination seems a relevant feature of wage changes. In particular, while wage changes are implemented on average every two quarters, wage decisions are presumably significantly less frequent.

From a macroeconomic perspective, it might be informative to compare the extent of wage stickiness to that of price stickiness. From available evidence on French data, the average duration of price spells is quite similar to that we obtain for wage spells: two to three quarters.[22] However, our results are consistent with a significant share of wage changes being predetermined, which

[21] We however neglect the fact that inflation and unemployment forecasts are generated regressors in our estimation. Performing the bootstrap, a possible remedy, is prohibitive in terms of computation time.

[22] See Baudry et al.(2006), for consumer prices and Gautier (2007) for producer prices. Price rigidity patterns for France are similar to those identified by Bils and Klenow (2004) for the US, but price durations are found to be longer.

suggests that the actual degree of rigidity in wage adjustments is larger than that of price adjustments.[23] In addition, the degree of downward rigidity is much more pronounced for wages than prices: around 15% of wage changes are wage decreases, around 40% for prices. Furthermore, the absolute size of wage changes we obtain is much smaller than that of price changes. Relatedly we reject state-dependency in wage-setting, while the assumption of state-dependence is found to have some relevance for modelling price setting.[24]

Our findings may be helpful for discriminating among alternative wage schemes in macroeconomic models used for monetary policy. It may be worthwhile to qualify these results by reminding some characteristics of the dataset and some issues involved when using micro data to assess and calibrate macroeconomic models. First, macroeconomic models usually assume that firms and workers are identical, while heterogeneity is an obvious pattern of micro data. For instance, it is not clear whether the most relevant mapping with macroeconomic models featuring identical agents or a representative agent, is obtained by considering the average characteristics over observed individual, e.g. here the average frequency of wage changes.[25] Second, the results were obtained for France in a decade of low and stable inflation. The patterns we have obtained may not be invariant e.g. to the policy regime. Also, the dataset used reports the base wage of employees that stay in the same firm, thus does not incorporate an element of wage flexibility resulting from variable payments such as bonuses, or from inflows and outflows of workers across firms. A relevant area for further research is then to extend the analysis to other countries, and to other, more detailed, datasets. In particular, constructing datasets with firm-level and employee information at an infra-annual frequency would allow to get closer to performing structural estimation of sticky wage models on microeconomic data.

[23] Price changes are typically not set in advance. Note however that Klenow and Wills (2007) find evidence that price changes in the US are consistent with a sticky information model. Under such a model, the degree of rigidity may also be underestimated by looking at the frequency of price change.

[24] See Fougère et al. (2007) and Gautier (2007) for evidence on French data.

[25] See Carvalho (2006) for an illustration of this point in the case of price stickiness, and Hansen and Heckman (1996) for a general and authoritative discussion of calibrating general equilibrium model from micro data.

8 References

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9 Appendices

9.1 Appendix 1 Alternative indicators of synchronization

We here complement section 5.3 by investigating the following less restrictive definition of synchronization. Consider as a benchmark the hypothesis of wage changes being independent across individuals and each occurring with a probability p. For a given quarter, the number of wage changes n in a firm for which the number of workers (categories) is N^{cat}, then follows a binomial distribution with parameters (p, N^{cat}). We then consider that the independence hypothesis can be rejected, and thus wage changes considered as synchronized within the firm, if the observed n is larger than the 95th percentile of the binomial distribution. The threshold n^* above which the wage changes are considered as synchronized depends on p and . For instance with p =35%, and a number of employee categories $N^{cat} = 12$ we select $n^* = 7$. Thresholds are $n^* = 2$ for $N^{cat} = 2, 3$, $n^* = 3$ for $N^{cat} = 4, 5, n^* = 4$ for $N^{cat} = 6, 7$, $n^* = 5$ for $N^{cat} = 7, 8$, $n^* = 6$ for $N^{cat} = 9, 10$, $n^* = 7$ for $N^{cat} = 11, 12$. With this criteria the share of synchronized wage changes within firms is then much larger than with the strict criteria used in section 5.3. $(n^* = N^{cat})$: 73%. We construct another alternative indicator by considering that wage changes are synchronized if all employees within the same occupational category experience a change in wage. Only occupational categories with at least two (and at most 3) employees are considered. The share of synchronized wage changes is then also quite large: 74%. Note that when restricting synchronization to the case of exactly 3 wages change when 3 socio-occupational categories, the indicator is equal to 65%. For comparison, under a binomial distribution with parameter 35% it should be equal to only $35\%^3/(1 - (65\%^3)) \approx 6\%$ (the probability of observing 3 simultaneous wage changes conditional on observing one wage change).

9.2 Appendix 2 likelihood for the two-threshold Tobit model

This appendix derives the estimation methods for system (2)-(3). Two approaches have been considered: maximum likelihood and a two-step approach related to the Heckman procedure.

We first derive the likelihood function. The probability that wage is unchanged is:

$P(\Delta w_{it} = 0) = P(v_{it}\gamma_1 < \Delta w_{it}^* < v_{it}\gamma_2) = P((v_{it}\gamma_1 - z_{it}\mu) < \varepsilon_{it} < (v_{it}\gamma_2 - z_{it}\mu)) =$

$\Phi((v_{it}\gamma_2 - z_{it}\mu)/\sigma_\varepsilon) - \Phi((v_{it}\gamma_1 - z_{it}\mu)/\sigma_\varepsilon)$

where Φ denote the cumulative distribution function of the Gaussian distribution. In our model, as is typically the case in Tobit models, the variance σ_ε^2 and the parameters of the selection equation (2) cannot be separately identified. Hereafter, we impose the identifying restriction $\sigma_\varepsilon^2 = 1$. Then the contribution to the likelihood of an observation with no wage change is $l_{it}^0 = \Phi(v_{it}\gamma_2 - z_{it}\mu) - \Phi(v_{it}\gamma_1 - z_{it}\mu)$

For observations with positive wage changes, $\Delta w_{it}^*(= \Delta w_{it})$ is observed. The likelihood can be expressed as the product of the likelihood of the observed wage change, and of the probability that the wage change was observed conditional on the value of the wage change. Conditional on the observed wage change $\Delta w_{it}^* = x_{it}\beta + u_{it}$, the term $z_{it}\mu - v_{it}\gamma_2 + \varepsilon_{it}$ is normally distributed with expectation $z_{it}\mu - v_{it}\gamma_2 + \frac{\rho}{\sigma_u}(\Delta w_{it} - x_{it}\beta)$. The contribution to the likelihood of an observation with a positive wage change is then:

$$l_{it}^+ = L(\Delta w_{it}, \Delta w_{it} > 0 | x_{it}, v_{it}, z_{it}) = \frac{1}{\sigma_u}\varphi(\frac{\Delta w_{it} - x_{it}\beta}{\sigma_u})\Phi((z_{it}\mu - v_{it}\gamma_2 + \frac{\rho}{\sigma_u}(\Delta w_{it} - x_{it}\beta))\frac{1}{\sqrt{1-\rho^2}})$$

where φ denotes the density of the Gaussian distribution $\varphi(x) = \frac{1}{\sqrt{2\pi}}e^{-\frac{x^2}{2}}$ and the above formula uses the property $V(\varepsilon_{it}|u_{it}) = \sigma_\varepsilon^2(1-\rho^2)$ and acknowledges the restriction $\sigma_\varepsilon = 1$.

Similarly for observations for which wage changes are observed to be negative it is known that $z_{it}\mu + \varepsilon_{it} < v_{it}\gamma_1$. The contribution to the likelihood is

$$l_{it}^- = L(\Delta w_{it}, \Delta w_{it} < 0 | x_{it}, z_{it}) = \frac{1}{\sigma_u}\varphi(\frac{\Delta w_{it} - x_{it}\beta}{\sigma_u})\Phi(-z_{it}\mu + v_{it}\gamma_1 - \frac{\rho}{\sigma_u}(\Delta w_{it} - x_{it}\beta)\frac{1}{\sqrt{1-\rho^2}})$$

The sample log-likelihood is:

$$L = \sum_{(i,t)|\Delta w_{it}=0} \ln l_{it}^0 + \sum_{(i,t)|\Delta w_{it}>0} \ln l_{it}^+ + \sum_{(i,t)|\Delta w_{it}<0} \ln l_{it}^-$$

The log-likelihood is maximized using a Newton-Raphson algorithm as implemented in the SAS-IML software. The vector of first derivatives of the likelihood function with respect to parameters and the Hessian matrix were computed numerically.

An alternative to the maximum likelihood approach, we implemented a Heckman two-step approach. This approach is arguably more robust since allows for a more general distribution of the error term in equation (3). The expectation of wage change conditional on wage change being observed to be positive in the above model can be written as:

$$E(\Delta w_{it}^{*}|y_{it}^{*} > v_{it}\gamma_2) = x_{it}\beta + \rho\sigma_u \frac{\varphi(z_{it}\mu - v_{it}\gamma_2)}{\Phi(z_{it}\mu - v_{it}\gamma_2)}$$

For wage decreases, the corresponding formula is:

$$E(\Delta w_{it}^{*}|y_{it}^{*} < v_{it}\gamma_1) = x_{it}\beta + \rho\sigma_u \frac{\varphi(-z_{it}\mu + v_{it}\gamma_1)}{\Phi(-z_{it}\mu + v_{it}\gamma_1)}$$

In the first stage, we estimate parameters μ, γ_1, γ_2 using a ordered probit approach with $I(\Delta w_{it} > 0)$, $I(\Delta w_{it} < 0)$ and $I(\Delta w_{it} = 0)$ as possible outcomes. We use the equalities $P(\Delta w_{it} = 0) = \Phi(v_{it}\gamma_2 - z_{it}\mu) - \Phi(v_{it}\gamma_1 - z_{it}\mu)$, $P(\Delta w_{it} < 0) = \Phi(v_{it}\gamma_1 - z_{it}\mu)$, and $P(\Delta w_{it} > 0) = 1 - \Phi(v_{it}\gamma_2 - z_{it}\mu)$ to construct the likelihood, and obtain estimates of parameters γ_1, γ_2, μ by maximum likelihood. We recover estimates of the inverse Mills ratios: $\widehat{\lambda}_{it} = \varphi(z_{it}\widehat{\mu} - v_{it}\widehat{\gamma}_2)/\Phi(z_{it}\widehat{\mu} - v_{it}\widehat{\gamma}_2)$ when $\Delta w_{it} > 0$ and $\widehat{\lambda}_{it} = \varphi(-z_{it}\widehat{\mu} + v_{it}\widehat{\gamma}_2)/\Phi(-z_{it}\widehat{\mu} + v_{it}\widehat{\gamma}_2)$ when $\Delta w_{it} < 0$. Parameter β is then estimated using an OLS regression on observations with wage changes $\Delta w_{it} \neq 0$:

$$\Delta w_{it} = x_{it}\beta + \gamma\widehat{\lambda}_{it} + e_{it}$$

Note that $\gamma = \rho\sigma_u$ but ρ and σ_u are not separately identifiable in this approach.

Table 1: Frequency of Wage Change

	Mean frequency	Number of observations
Total	0.38	3 738 251
Manufacturing	0.41	1 566 466
Construction	0.38	291 544
Services	0.36	1 880 241
Manual workers	0.40	917 588
Clerical workers	0.37	1 000 164
Intermediate occupations	0.39	895 318
Managers	0.37	925 181
0 to 19 employees	0.37	488 333
20 to 49 employees	0.35	583 915
50 to 149 employees	0.35	1 274 658
150 to 499 employees	0.37	1 065 966
more than 500 employees	0.42	325 379

Table 2: Frequency and size of hourly base wage changes

		Number of observations	all	increase	decrease
Frequency	all	3 738 251	38%	32%	6%
	0 to 19 employees	488 333	37%	28%	9%
	20 to 49 employees	583 915	35%	28%	7%
	50 to 149 employees	1 274 658	35%	29%	5%
	150 to 499 employees	1 065 966	37%	32%	5%
	more than 500 employees	325 379	42%	37%	5%
Size	all	1 297 667	2.2%	3.2%	-3.5%
	0 to 19 employees	171 354	2.4%	4.5%	-4.7%
	20 to 49 employees	195 565	2.5%	4.3%	-4.6%
	50 to 149 employees	423 547	2.5%	3.6%	-4.0%
	150 to 499 employees	378 022	2.2%	3.0%	-3.4%
	more than 500 employees	129 179	1.9%	2.4%	-2.0%

Table 3: Share of Wage Changes Synchronised within Firms

Wage Changes are synchronised within firms if …	Share of Synchronised Wage Changes	Total number of Wage Changes
… all Wages Change Together	44%	1 290 466
… the null Assumption of a binomial distribution is rejected	75%	1 290 466
… all Wages Within An Occupational group Change Togethe	76%	1 064 004

Note: Firms which report data for only one category of employees are removed. Results are weighted.

Table 4 : Estimated Share of Taylor contracts in 2005 (in %)

	Considering occupations and hourly wages	Considering occupations and monthly wages	Considering employees and hourly wages	Considering two quarters Taylor contracts	With more than 90% of wage changes explained by a Taylor contract
With changes in Q1	6%	6%	5%	16%	17%
With changes in Q2	3%	3%	3%	5%	7%
With changes in Q3	4%	5%	5%	-	10%
With changes in Q4	1%	1%	1%	-	3%
Total	13%	15%	14%	21%	38%

Table 5 : Conditional probability of wage increases and decreases :

		Panel A						Panel B					
		Parameter estimates		Standard errors		Impact on probability of wage increase	Impact on probability of wage decrease	Parameter estimates		Standard errors		Impact on probability of wage increase	Impact on probability of wage decrease
Variable category	Variable	γ_1	γ_2	γ_1	γ_2			γ_1	γ_2	γ_1	γ_2		
	Intercept	-1.670	0.650	*0.013*	*0.012*			-2.201	0.687	*0.028*	*0.020*		
"Time dependent" variables	First quarter	1.017	0.025	*0.011*	*0.008*	0.210	0.003	-0.505	0.067	*0.012*	*0.008*	0.182	0.003
Seasonal dummies	Second quarter	0.378	-0.031	*0.011*	*0.008*	0.072	-0.003	-0.195	-0.121	*0.011*	*0.008*	0.065	-0.004
	Third quarter	0.310	-0.013	*0.011*	*0.008*	0.087	-0.001	-0.256	-0.057	*0.011*	*0.008*	0.087	-0.002
	1 quarter							-0.081	0.666	*0.025*	*0.017*	0.026	0.048
Duration	2 quarter							-0.152	0.281	*0.025*	*0.015*	0.050	0.014
	3 quarter							-0.053	0.124	*0.026*	*0.015*	0.017	0.005
	4 quarter							-0.666	0.062	*0.029*	*0.015*	0.246	0.002
		μ		$se(\mu)$				μ		$se(\mu)$			
"State dependent" variables	Cumulated inflation	0.080		*0.003*		0.007	-0.047	-0.004		*0.005*		-0.001	0.000
	Cumulated unemployment variation	-0.009		*0.005*		-0.003	0.001	0.019		*0.005*		0.006	-0.001
	Clerical workers	-0.024		*0.006*		-0.008	0.002	-0.026		*0.006*		-0.007	0.001
Socio-occupational group	Intermediate occupations	-0.069		*0.007*		-0.022	0.007	-0.072		*0.007*		-0.022	0.003
	Managers	-0.145		*0.007*		-0.044	0.016	-0.151		*0.007*		-0.044	0.006
Industry dummies (NES)	Manufacture of cars	0.115		*0.017*		0.038	-0.010	0.116		*0.017*		0.038	-0.004
	Manufacture of capital goods	-0.016		*0.010*		-0.005	0.002	-0.018		*0.010*		-0.005	0.001
	Manufacture of intermediate goods	0.001		*0.008*		0.000	0.000	0.000		*0.008*		0.000	0.000
	Construction	-0.068		*0.010*		-0.021	0.007	-0.068		*0.010*		-0.020	0.003
	Trade	-0.080		*0.008*		-0.025	0.008	-0.082		*0.008*		-0.025	0.003
	Transports	-0.026		*0.011*		-0.008	0.003	-0.025		*0.011*		-0.007	0.001
	Financial activities	-0.033		*0.014*		-0.011	0.003	-0.028		*0.014*		-0.008	0.001
	Real estate activities	0.019		*0.018*		0.006	-0.002	0.018		*0.019*		0.006	-0.001
	Services to businesses	-0.082		*0.009*		-0.026	0.009	-0.087		*0.009*		-0.026	0.003
	Personal and domestic services	-0.022		*0.012*		-0.007	0.002	-0.016		*0.012*		-0.005	0.001
	Education, health and social work												
Size of the firm dummies	10 to 19 employees	-0.206		*0.010*		-0.062	0.024	-0.210		*0.010*		-0.061	0.009
	20 to 49 employees	-0.189		*0.010*		-0.057	0.021	-0.198		*0.010*		-0.050	0.009
	50 to 149 employees	-0.138		*0.009*		-0.042	0.015	-0.149		*0.009*		-0.044	0.006
	150 to 499 employees	-0.074		*0.010*		-0.023	0.008	-0.083		*0.010*		-0.025	0.003
	Working Time Reduction	2.049		*0.033*		0.662	-0.046	2.060		*0.033*		0.669	-0.014
	Number of observations	262 827						262 827					
	Log Likelihood :	-548 009						-593599					
	Wald test of joint nullity of seasonal dummies	6 542						4 549					
	(Khi 2)	<0.001						<0.001					

Note: The model is estimated by maximum likelihood. Parameters for the size of wage change are not reported. The reference category is : Manual Worker, Manufacturing goods, Firm with more than 500 employees, Fourth quarter, Duration > 4 quarters. The impact on the probabilities of wage increase and decrease are the impact of the change of one unit evaluated for the reference category, and for cumulated changes in inflation and unemployment equal to zero. For the reference case the estimated probability of wage increase is 0.299 and the probability of wage decrease is 0.04.

Table 6: Sample selection model estimates: size of wage changes

Variable category	Variable	Parameter estimates	se	Parameter estimates	se	Parameter estimates	se	Parameter estimates	se	Parameter estimates	se
		Panel A Backward-looking				Panel B Backward and forward looking		Panel C Backward-looking with predetermination		Panel D Forward-looking with predetermination	
	Estimation method	OLS (excluding zeros)		ML (sample selection)		ML (sample selection)		ML (sample selection)		ML (sample selection)	
	Intercept	0.412	0.068	-0.915	0.058	-0.902	0.066	-1.032	0.077	-0.889	0.077
TV Covariates	Inflation (backward, elapsed spell)	0.549	0.019	0.235	0.016	0.197	0.021	0.100	0.035		
	Inflation (backward, elapsed 2 spells)							0.153	0.029		
	Inflation (backward, lagged, elapsed 2 spells)							0.055	0.021		
	Inflation (forward current spell)					0.110	0.020			0.029	4.938
	Inflation (forward, 2 spell)									0.063	2.251
	Inflation (forward, lagged forecast, 2 spell)									0.051	3.161
	Unemployment (backward, elapsed spell)	-0.266	0.030	-0.280	0.023	-0.234	0.036	-0.106	0.076		
	Unemployment (backward, elapsed 2 spells)							-0.002	0.058		
	Unemployment (backward, lagged, elapsed spell)							-0.164	0.032		
	Unemployment (current spell forward)					-0.187	0.063			0.133	0.167
	Unemployment (forward, 2 spells)									-0.092	0.110
	Unemployment (forward, lagged forecast, 2 spell)									-0.447	0.043
Socio-occupational group	Clerical workers	0.216	0.038	0.134	0.031	0.121	0.037	0.110	0.042	0.112	0.044
	Intermediate occupations	0.111	0.041	0.008	0.034	0.033	0.040	-0.047	0.044	0.047	0.047
	Managers	0.332	0.042	0.204	0.035	0.210	0.042	0.069	0.047	0.151	0.050
Time dummies	First quarter	0.670	0.042	1.020	0.035	1.017	0.041	1.063	0.046	1.066	0.048
	Second quarter	0.302	0.044	0.378	0.036	0.375	0.041	0.466	0.047	0.468	0.050
	Third quarter	0.155	0.044	0.307	0.036	0.283	0.043	0.461	0.048	0.372	0.050
Industry dummies (NES)	Manufacturing of cars (D)	0.204	0.101	0.342	0.085	0.417	0.094	0.400	0.100	0.386	0.105
	Manufacturing of capital goods (E)	0.194	0.058	0.242	0.048	0.242	0.056	0.268	0.061	0.235	0.065
	Manufacturing of intermediate goods (F)	0.035	0.045	0.057	0.037	0.096	0.043	0.043	0.048	0.075	0.050
	Construction (H)	0.440	0.061	0.512	0.050	0.588	0.063	0.559	0.074	0.522	0.078
	Trade (J)	0.172	0.047	0.316	0.039	0.280	0.048	0.231	0.054	0.238	0.057
	Transports (K)	0.265	0.066	0.252	0.054	0.125	0.065	0.157	0.073	0.047	0.077
	Financial activities (L)	0.022	0.080	0.255	0.066	0.256	0.077	0.403	0.084	0.350	0.089
	Real estate activities (M)	-0.155	0.111	-0.241	0.091	-0.295	0.105	-0.315	0.112	-0.337	0.120
	Services to businesses (N)	0.280	0.053	0.350	0.044	0.339	0.055	0.347	0.064	0.267	0.068
	Personal and domestic services (P)	0.081	0.068	0.342	0.056	0.295	0.071	0.401	0.083	0.254	0.089
Firm size dummies	10 to 19 employees	0.357	0.060	0.656	0.050	0.621	0.059	0.681	0.067	0.738	0.071
	20 to 49 employees	0.391	0.061	0.489	0.051	0.402	0.060	0.393	0.068	0.482	0.072
	50 to 149 employees	0.322	0.054	0.251	0.046	0.149	0.051	0.162	0.054	0.248	0.058
	150 to 499 employees	0.144	0.054	0.037	0.046	-0.004	0.051	0.006	0.053	0.054	0.056
	Working Time Reduction	8.433	0.068	9.759	0.062	7.764	0.066	7.707	0.092	7.832	0.077
σ_u^2				3.928	0.008	3.715	0.010	3.354	0.011	3.587	0.012
ρ *(ML)*				0.606	0.002	0.609	0.003	0.630	0.004	0.652	0.004
Number of wage observations		95675		262827		160754		98909		88222	
Number of observations (wage changes)		95675		95675		59841		39224		39224	
Number of wage increases		80360		80360		50121		34140		32982	
Log Likelihood :				-544519.8		-338665.1		-212507.0		-211884.3	

Note: The sample selection model is estimated by maximum likelihood. Parameters for the selection equation are very close to those reported in table 5 and are not reported. The dependent variable is wage change computed as $100.\ln(w_{it}/w_{it-1})$. The reference category is : Manual Worker, Manufacturing goods, Firm with more than 500 employees, Fourth quarter, Duration > 4 quarters.

Figure 1: Distribution of wage spells durations

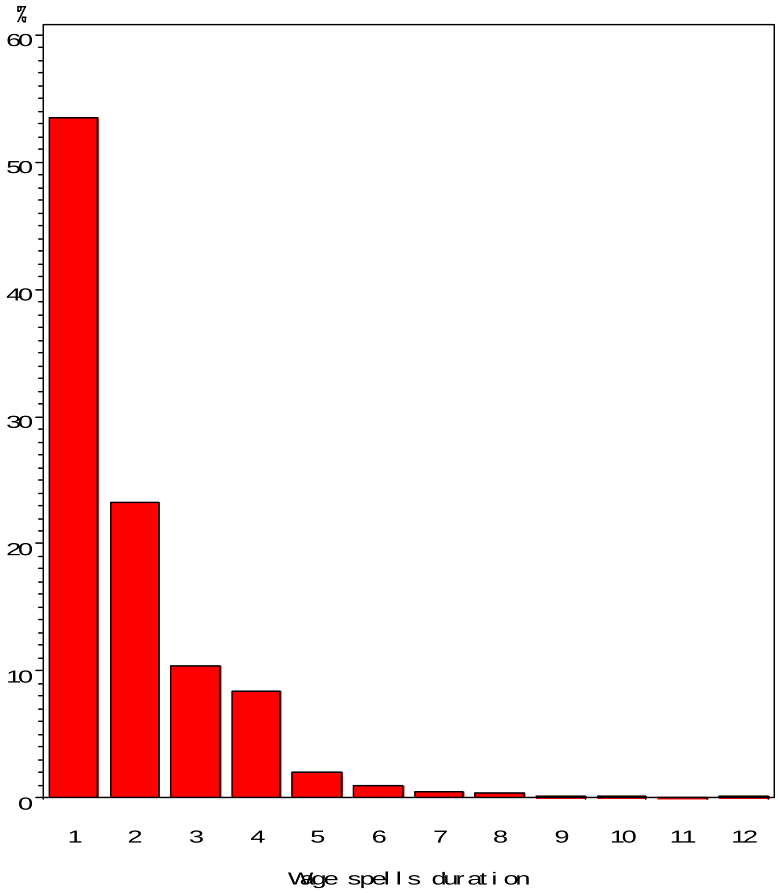


Figure 2 : Hazard function of wage changes

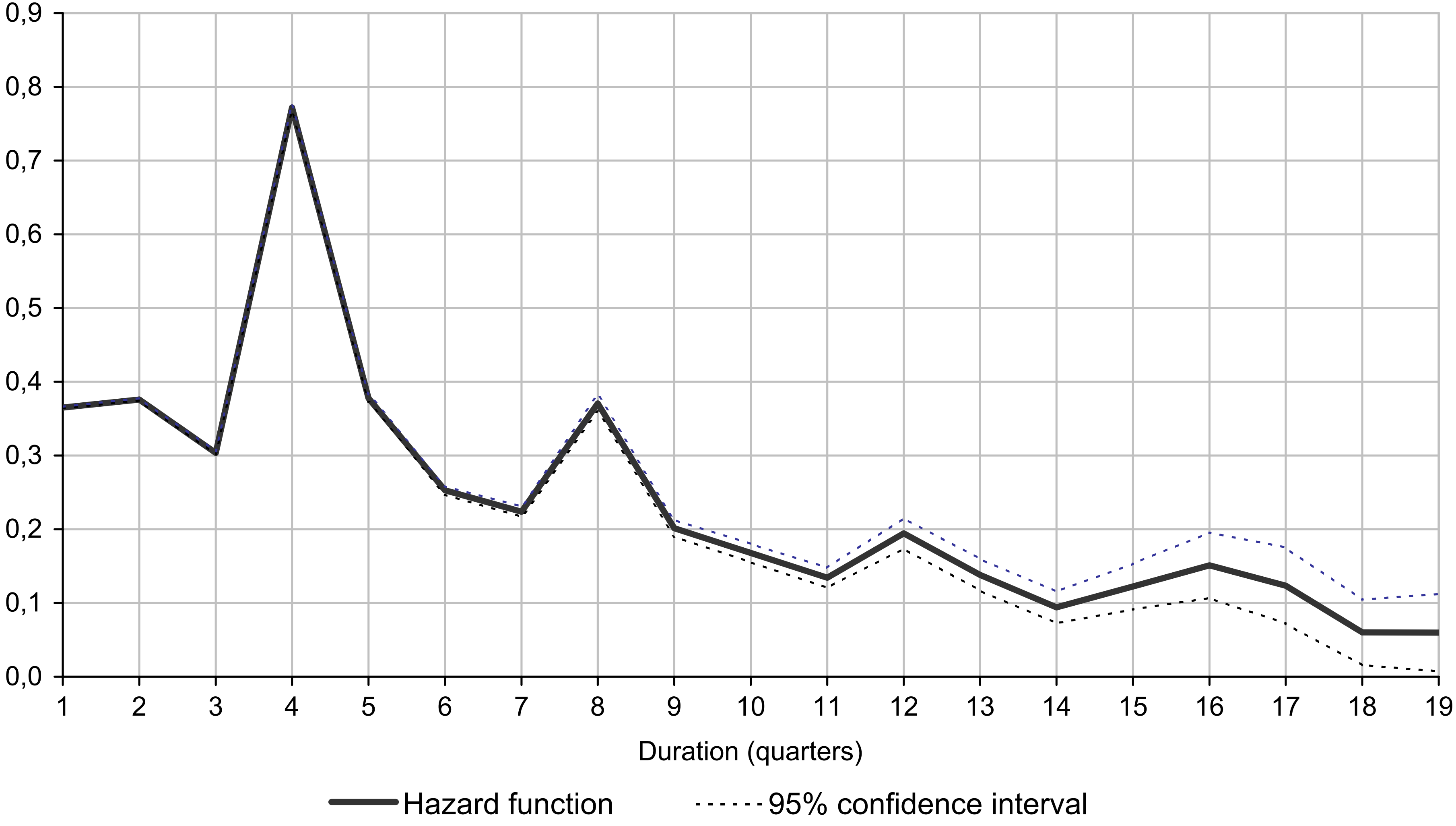


Figure 3 : Distribution of (non – zero) wage changes

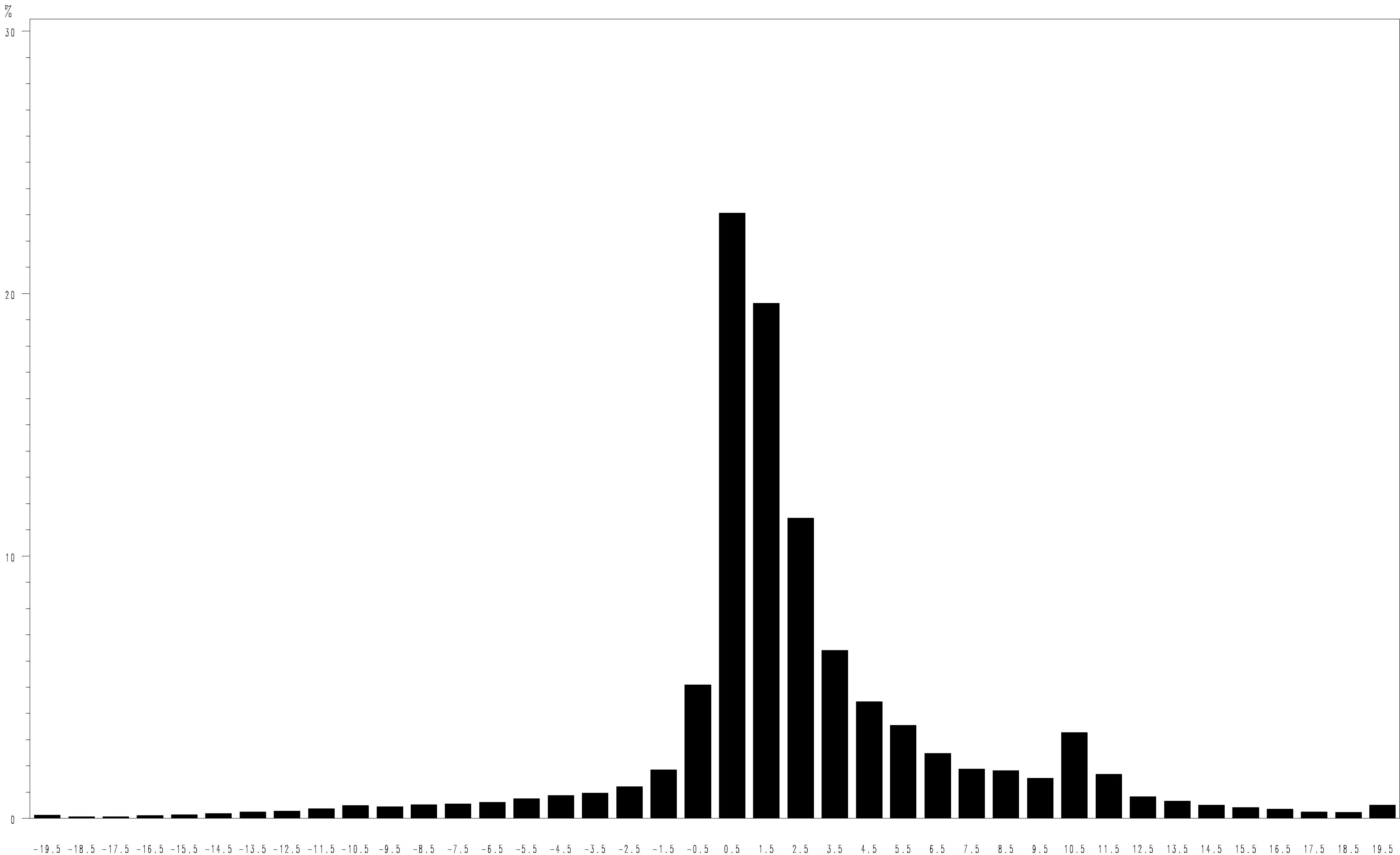


Figure 4 : Frequency of wage changes

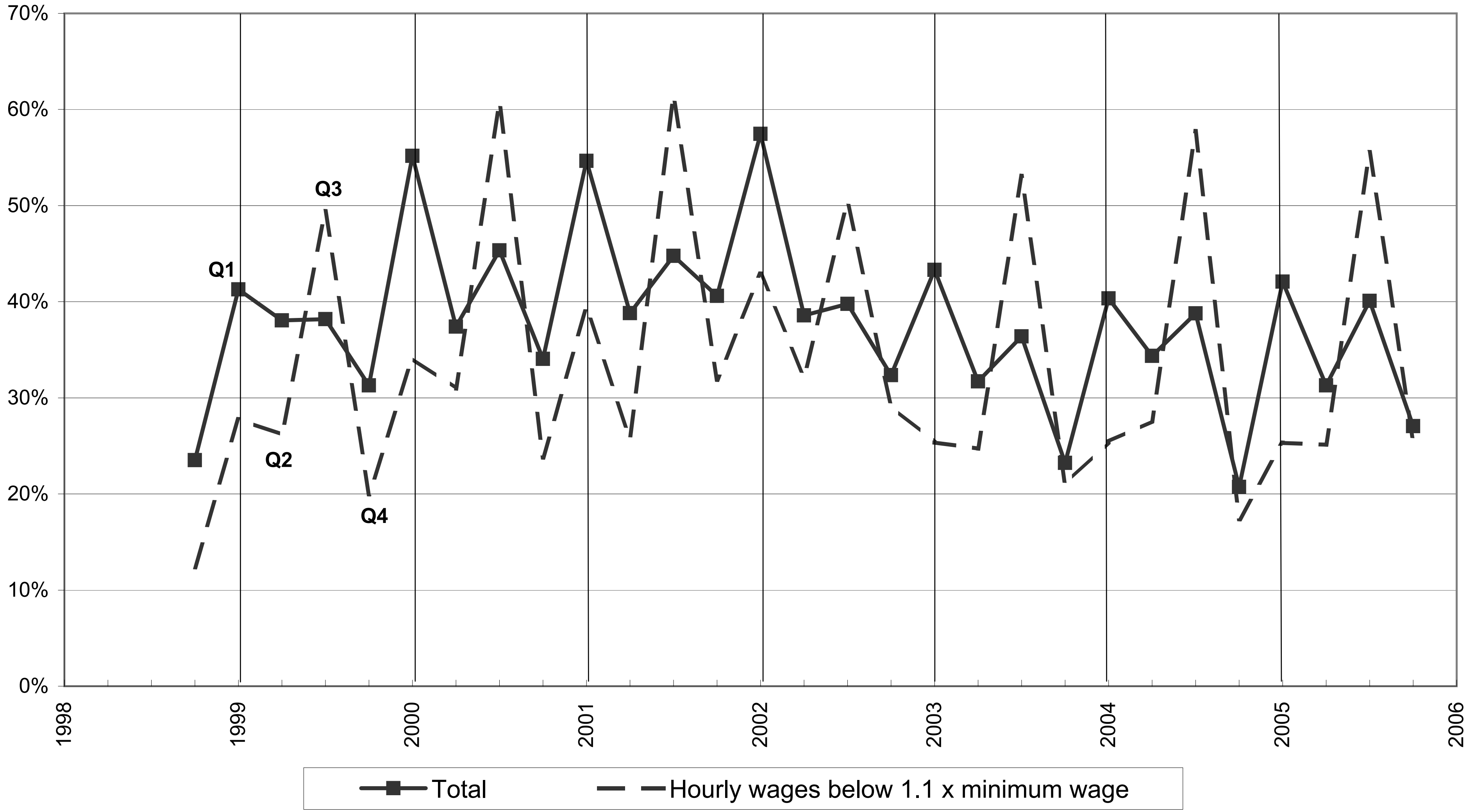
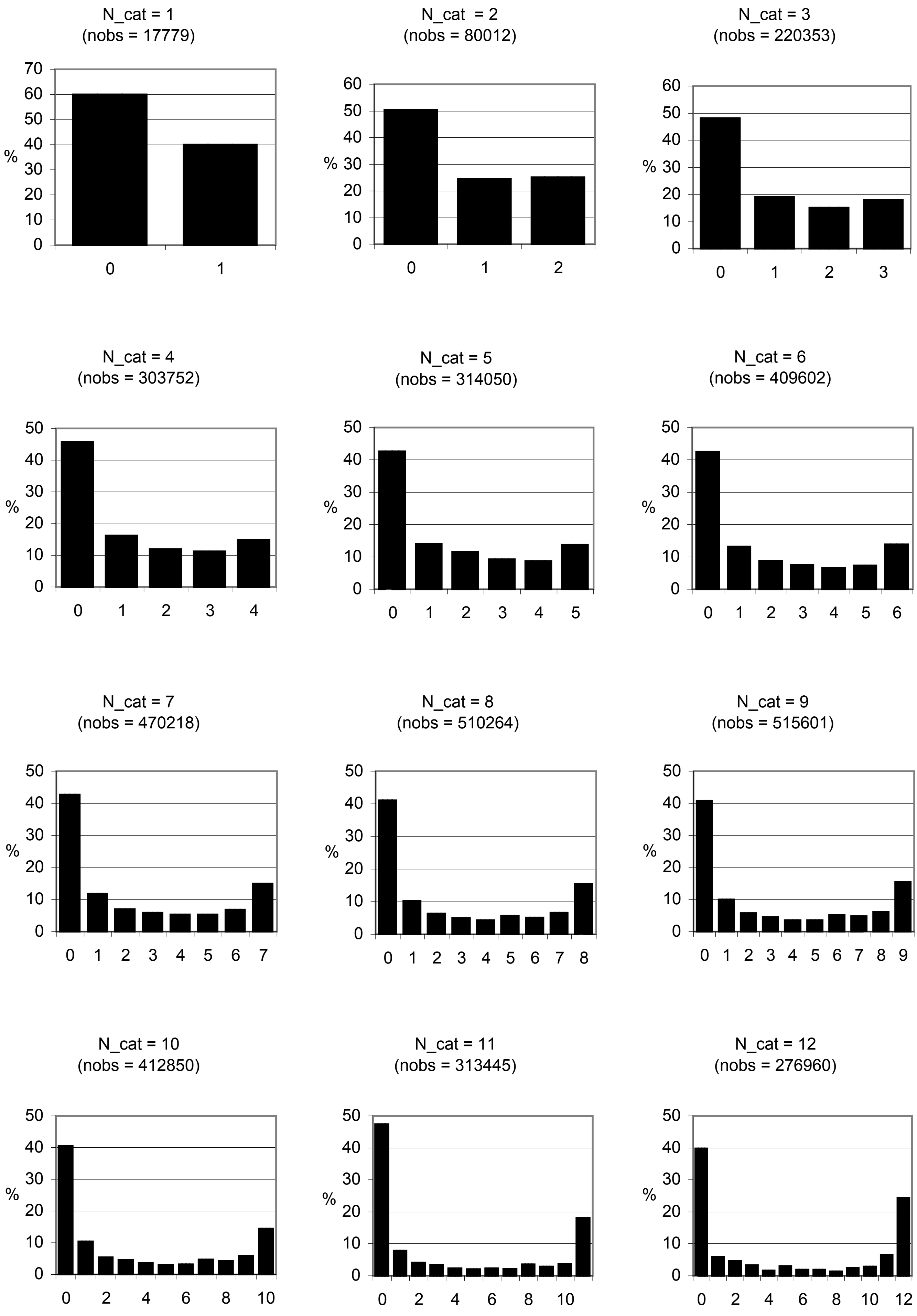


Figure 5 : Distribution of the number of employee categories with wage changes



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