Microeconomic Evidence of Nominal Wage Rigidities in Chile

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1. INTRODUCTION

The labor market, and its wage dynamics in particular, is a central element of macroeconomic analysis. In this context, the main objective of this paper is to provide evidence on the frequency of nominal wage adjustments in Chile and, in particular, the frequency of wage reductions as a measure of labor market rigidity. For such purpose, we constructed a panel with 588,000 wage histories between December 2001 and December 2007 from the Asociación Chilena de Seguridad (Chilean Social Security Association, AChS).[1] This database contains worker information including gender, age, income, company, and sector.

It is worth mentioning that despite a growing international interest in this type of study, and the importance of its subject to monetary policy, to our knowledge, this is the first study of its type in Chile.[2] Additionally, the

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[1] The Asociación Chilena de Seguridad is a private, non-profit organization which develops risk prevention programs and provides health coverage to its members in case of accident. About 35% of salaried employees are affiliated to this association.

[2] Jadresic (1992) uses information added to identify rigidity in Chile.

sample period under study is of special interest as it is characterized by near 10% unemployment rates until the end of 2005, which then declined to an average of 7% in 2007. It is an especially attractive scenario for studying the frequency of wage adjustments in this context, as it provides information which allows for a more integrated look at the level of the Chilean labor market flexibility during that period, an aspect that has been under discussion in numerous Chilean case studies (Cowan et al., 2005; Sapelli, 2007).

This paper focuses on downward nominal wage rigidity as a first step toward an integrated understanding of wage dynamics. It is worth noting that the study of the frequency of nominal wage reduction is considered by literature as one of the measures used for analyzing labor market rigidity. Nevertheless, it is important to point out that other countries' studies are not limited to nominal rigidities but also include real rigidities (Messina et al., 2008; Hall, 2005; among others). From the monetary authority's perspective, each of these phenomena represents different problems. While higher inflation can neutralize the impact of nominal rigidity, this does not occur in the case of real rigidity. On the other hand, the effects of nominal rigidity are particularly evident at the macroeconomic level when inflation is very low (Fehr and Goette, 2005).

In reference to the methodology used in this study, the econometric technique of structural breaks developed by Bai and Perron (2003) is used to reduce possible data measurement errors. This has been employed previously for the United States (USA) by Gottschalk (2005) and is based on the assumption that wages remain fixed for a certain number of periods and only experience discrete adjustments. The methodology not only reduces measurement errors, but also decreases temporary fluctuations that are not necessarily related to a change in the individual's wage profile such as, for example, a prearranged bonus. The disadvantage of this methodology is that this type of modification can mask wage movements of more flexible wage arrangements (or the movements of a variable component, such as would be the case for salesmen) because it reflects real changes as measurement errors. Nonetheless, the fact that the results of Gottschalk (2005) allow for the reconciliation of the estimates from a national survey with administrative macroeconomic information suggests that the benefits of the methodology outweigh its potential disadvantages.

The most important finding resulting from an examination of the compiled wage histories is that the average number of periods it would take for wages to adjust is higher than nine quarters, with some sector

specific differences. In reference to the determinants of these adjustments, the degree of downward wage flexibility correlates positively to young employees (less than 30 years of age) share, positively to the size of the firm and negatively to the proportion of high income employees. Sector specific effects are statistically and economically significant.

The rest of the study is divided into four sections. Section 2 provides a review of the international evidence. Section 3 describes the database. Section 4 shows estimates for adjustment frequency as well as an analysis of the factors determining them. Section 5 sums up the main findings.

2. INTERNATIONAL EVIDENCE

The most recent studies in the area of downward nominal wage adjustments have been carried out using estimates based on microdata.[3] The results, however, vary from country to country (Table 1). For example, the frequency of wage reduction in Mexico is 21% for the period 1983-1986, while it was between 0.3% and 0.4% in Canada. Estimates also differ significantly in studies carried out for the same country. For example, Blinder and Choi (1990) found that wages in the USA were relatively flexible while Altonji and Devereux (1999) concluded that they were quite rigid. Different authors came to contradictory conclusions even in cases where the same source of information was used. For instance, McLaughlin (1994, 1999) argues for the absence of wage rigidities based on the Panel Study of Income Dynamics (PSID) while Card and Hyslop (1997) find evidence to the contrary using the same database.

It is necessary to point out that, for various reasons, the numbers found in Table 1 are not directly comparable with each other and are only shown to give an idea of the diversity of studies and estimates, as well as the inherent complexity of calculating the frequency of downward wage adjustments. As such, for example, the degree of comparability can be affected by the fact that various countries and time periods used in the studies imply, with a high degree of probability, different macroeconomic scenarios –a simple example being that a certain figure will have different readings depending on whether it was calculated in a period of high or low inflation. Moreover, if a country and a time period analyzed in two

[3] Another area of study corresponds to Fortin and Dumont (2000) and to Farès and Lemieux (2001), who use the Phillips curve and distinct wage increase measurements to make inferences on wage rigidity.

TABLE 1. SELECTED WAGE RIGIDITY STUDIES, 1970-2001

Study	*Period*	*Annual frequency of wage reductions (percentage)*
Mexico		
Castellanos et al. (2004)	1986-2001	24.2
United States[a]		
McLaughlin (1994)	1976-1986	17.3
Card and Hyslop (1996)	1976-1993	15.0-20.0
Kahn (1997)	1970-1988	10.6-24.3
Akerlof et al. (1996)	1994-1995	1.6-5.8
Altonj and Devereux (1999)	1971-1992	0.5-2.5
Gottschalk (2005)	1986-1993	1.5-2.0
Australia		
Dwyer and Leong (2000)	1987-1999	3.5-8.0
Canada		
Faruqui (2000)	1983-1986	0.3-0.4
	1996-1999	0.2-1.3
Switzerland		
Fehr and Goette (2005)	1991-1997	6.8-15.5

[a] Information from Gottschalk (2005).

studies are the same, the differences in methodologies and sources of information directly prevent the comparability of the studies. For example, the use of a national survey requires a different approach than a study based on administrative information from private companies and could also respond to a different set of questions.

The abovementioned makes it very clear that direct comparison of studies should be avoided without first clearly and precisely establishing the differences between them. Regarding this point, it is important to mention two current initiatives. First, the International Wage Flexibility Project (IWFP), from a network which studies wage rigidities in 17 OECD countries; preliminary results suggest that real rigidities predominate over nominal ones in European countries but not in the USA or the United Kingdom (UK) (Dickens et al., 2007). Second, the European Central Bank's Wage Dynamics Network (WDN) has recently concluded various surveys referring to such topics as marginal adjustments and price and wage synchronization, among others.[4] Some of these studies conclude that wage reductions are very infrequent.[5]

[4] The WDN organized a conference in Frankfurt in June 2008 to present progress.

[5] Babecky et al. (2009) shows that only 398 of 14,122 (2.82%) of those surveyed declared a reduction in wages during the last five years.

3. THE DATA

3.1 General Information

The database was constructed from the information reported monthly to the AChS by its affiliated companies during 2001m12-2007m12. The data was taken from the payrolls provided by each company which contains employee taxable income information, i.e., it includes both the variable and fixed wage components and worker gender and age. It also contains the reporting company's economic sector information, classified by a digit, namely: agriculture; mining; industry; construction; electricity; gas and water; commerce; transport; and services.

It is important to emphasize that the other source of national wage information, the income survey from the Instituto Nacional de Estadísticas (National Statistics Institute, INE), does not allow for studies like the one presented in this paper. In fact, the INE's survey only reports information at the company level, basically just costs by wages and number of employees, which does not permit a direct examination of the phenomenon of labor flexibility at the microeconomic level. In addition, it should be emphasized that AChS information comprises almost 35% of all salaried employees from around 25% of companies in the country, which translates into good sample coverage for the study.[6] Finally, according to previous studies, the information reported to the AChS does not present any major reporting problems.[7]

As for the limitations of the database, the most significant of these is a lack of information for the number of hours of work, which means that wage modifications derived from a change in the number of hours of work cannot be isolated. Unfortunately, the wages reported are truncated to the maximum taxable wage. This limit was USD 2,300/month in December 2007 and, according to income distribution surveys, affected around 5% of Chile's salaried workers.

The information is also limited to the affiliated companies, and a study of employment flows is therefore not so viable. Finally, the use of the AChS as a source of information restricts the study of wage dynamics to formal employees; consequently, the present database cannot be used for a study of informal workers' wages.

[6] Based on information from the Servicio de Impuestos Internos.

[7] Aravena (2006) finds problems such as a repetition of the worker identifier and missing information are not significant for general use for the 2002- 2005 period.

3.2 Panel Construction

The original base sample consisted of the average monthly wage information for 1.5 million workers during the period examined. This data was used to construct an unbalanced panel of worker wage histories. For example, if a worker stops working at AChS affiliated companies, the worker's wage history is suspended. This point, which is in line with previous studies on the topic (see below), is dealt with by establishing a minimum presence criteria in each individual's observations database.[8] In light of the aforementioned, it was necessary to filter the base sample due to the presence of certain inconsistencies probably produced by the manual entry of information, incomplete information, truncated histories or the sporadic appearance of workers.[9] To be specific, reported workers who fulfilled one of the following criteria were removed from the database:

i) The same identification number as another worker during the same period.

ii) Wage higher than the taxable maximum or lower than the current legal minimum.

iii) Wage equal to the taxable maximum for more than two consecutive periods.

It should be mentioned that criteria *(i)* and *(ii)* control data inconsistencies, while criteria *(iii)* attempts to eliminate truncated wage histories starting from a certain period and which, therefore, could lead to an underestimation of the actual degree of wage flexibility. In relation to criteria *(i)*, we found that, on average, 4% of the identifiers are not unique within the same month. With respect to criteria *(ii)* and *(iii)*, the sample contains, on average, 2% of workers who report wages below the legal

[8] It should be mentioned that as it cannot be determined if workers who stop reporting in AChS firms become unemployed or go to work at another non-AChS company, this represents a strong limitation for the study of employment flows and transitions.

[9] In cases where there is no wage information for up to three consecutive periods, and as long as the worker returns to work for the same employer, it is assumed that the worker remained employed by the company and that the company stopped reporting the worker's wage. When the wage does not change within the aforementioned period, it is assumed that it remained constant during the periods without data; if the wage did change, the wage adjustment is attributed assuming a uniform probability of wage adjustment in those periods for which data was missing.

minimum, while 3% of the observations imply a truncated wage, which means, equal to or over the maximum for more than two consecutive periods.

Once the base was filtered, in line with Fehr and Goette's (2005) approach, a sample is built using those workers with a wage history of at least 24 consecutive months. This procedure attempts to construct a panel of wage histories with sufficient length to allow for the best inference of wage adjustment dynamics.

The final sample, which contains an average of 429 thousand workers per month, represents 11% of Chilean workers at the national level on the panel (table 2). Regarding economic sectors, Services and Industry has the largest representation with 14%; the rest of the sectors fluctuate between 3% and 11%, which allows for a reasonable margin of reliability for our calculations.

TABLE 2. NUMBER OF WORKERS IN THE SAMPLE BY ECONOMIC SECTOR

	Number of workers[a]	*Percentage of salaried workers*[b]
Agriculture	36,455	8.4
Mining	2,302	3.1
Industry	89,417	14.0
Construction	14,574	4.1
Electricity, gas and water	3,131	11.3
Commerce	68,414	10.8
Transport	18,785	5.7
Services	195,067	13.7
Total	*428,528*	*10.9*

SOURCE: Own elaboration based on information from the AChS.
[a] Monthly average. [b] Estimate based on information published by the Instituto Nacional de Estadísticas.

As for the number of companies, the database includes information on workers from over 50,000 companies (Table 3), which according to information from the Servicio de Impuestos Internos de Chile (Chilean Internal Tax Service) represents around 23% of the total number of firms registered in Chile.[10] With respect to the distribution of firms, small, medium and large companies account for 51%, 46% and 3% of the sample, with coverage by size of 17%, 40% and 35% respectively. In this way, the sample used tends to over-represent medium and large companies, a

[10] This estimate takes into account all companies with at least one employee.

TABLE 3. NUMBER OF COMPANIES IN THE SAMPLE BY SECTOR AND NUMBER OF WORKERS

	Number of companies	*Less than 10 workers*	*11 to 199 workers*	*200 or more workers*
Agriculture	7,928	4,351	3,419	158
Mining	367	138	199	30
Industy	11,598	6,090	5,166	342
Construction	4,603	2,345	2,188	70
Electricity, gas and water	490	316	157	17
Commerce	7,330	3,749	3,324	257
Transport	4.329	2,853	1,427	49
Services	13,843	5,998	7,101	744
Companies in the base sample	*50,488*	*25,840*	*22,981*	*1,667*
Base sample/total of companies in Chile (%)	*23.3*	*16.6*	*40.1*	*35.1*

SOURCE: Own elaboration based on information from Servicio de Impuestos Internos and Asociación Chilena de Seguridad.

situation suggesting that subsequent analysis should consider an analysis of wage adjustments by size of firm so as to not influence added statistics.

As for the sample's representativeness of worker characteristics, the distribution of the sample does not differ significantly from INE figures for the population as a whole with respect to gender, although younger workers are under-represented as compared with national total (Table 4).

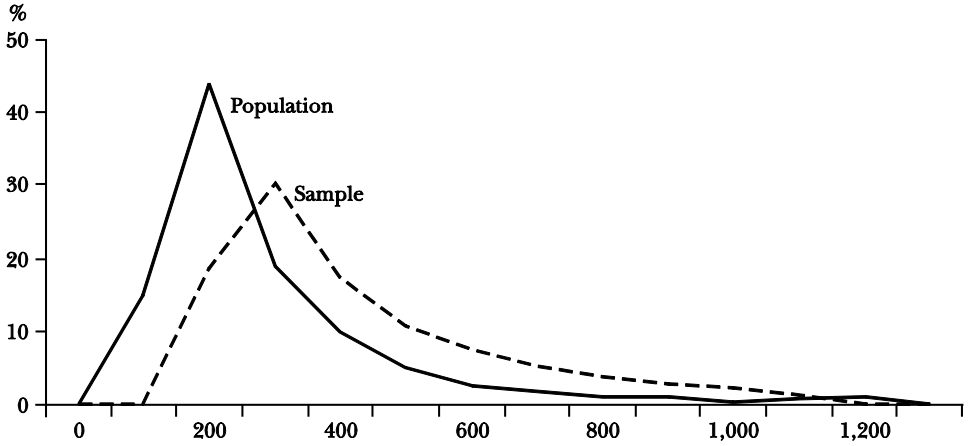
Regarding the representativeness of the sample with respect to wage distribution, an upward bias is observed with respect to the distribution derived from the Social Protection Survey (Figure 1). This is not surprising given the characteristics of the database used. Companies affiliated to the AChS belong to the formal sector, meaning they cannot pay wages that are below the legal minimum, which explains the absence of workers earning less than the minimum wage in the sample. Thus, the estimates obtained refer to companies and salaried workers in the formal sector.

TABLE 4. SAMPLE REPRESENTATIVENESS: AGE AND GENDER

	Sample (percentaje)	*Population (percentaje)*
Gender		
Female	37.7	35.2
Male	62.3	64.8
Age		
Under 30	17.4	27.5
30-49	60.0	55.2
50 or over	20.6	17.3

SOURCE: Own elaboration using data from AChS and Instituto Nacional de Estadísticas.

FIGURE 1. SAMPLE REPRESENTATIVENESS OF WAGE DISTRIBUTION, 2004



SOURCE: Population distribution from the Social Protection Survey, Universidad de Chile.

One final point, concerning the sample used, is that the estimation of wage flexibility determinants carried out in section 4.2 employs two other criteria to purge the database and, thereby, control for worker characteristics. Thus, the database used to calculate adjustment frequencies excludes wage histories for workers who fulfill one of the following conditions:

i) Non-specified age or gender;

ii) Over 90 or under 15 years of age.

Around 25% of cases in the original base sample fall under one of these categories. In fact, 9% of the sample does not contain information about gender and 23% of the sample does not comply with age criteria. Thus, as a result of these adjustments, the base sample used to estimate the determinants of wage adjustment frequency contains close to an average of 336 thousand wage histories per month. Note that the number of wage histories in the panel which do not take the filter of not reporting gender or age over 90 or under 15 into account differs less significantly than the panel obtained by not applying these criteria –i.e., 23% vs. 21.5%–, which reflects a small overlap with the population which does not simultaneously fulfill the two aforementioned criteria.

3.3 Wage Adjustments

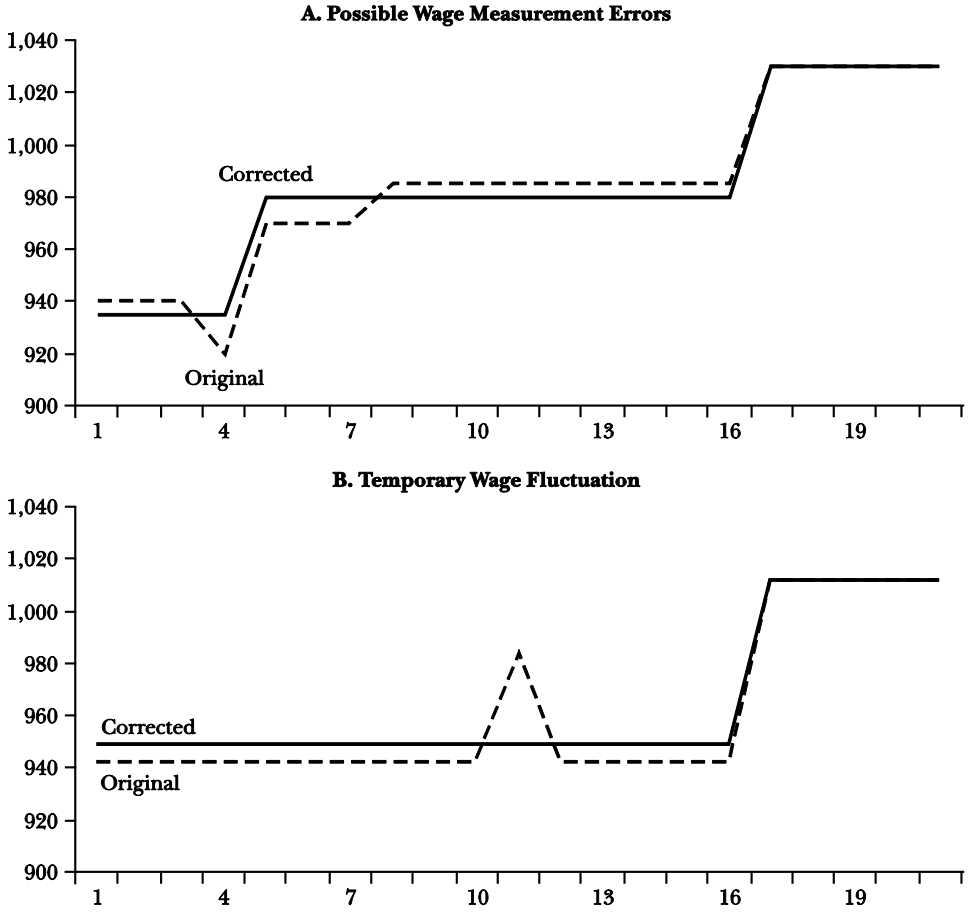
As mentioned above, the wages reported in the base sample could be subject to measurement errors, and eventually include temporary fluctuations that do not necessarily represent actual changes in workers' wages. One example is the case of a fixed year-end bonus on contract basis or benefits such as an education bonus which some companies give to employees with children at the start of the school year.

In light of this phenomenon, the wages are corrected using the approach employed by Gottschalk (2005). The methodology rests on the assumption that nominal wages remained fixed for a number of periods and move in a discrete manner when they are adjusted. This assumption is implemented by employing the structural break detection method developed by Bai and Perron (2003).

Taking the above into account, it is immediately apparent that the assumed fundamentals of this methodology have the potential disadvantage of ignoring short term wage changes due to the fact that the identification of the change requires that the adjustment have a significant impact on the average wage. This could lead to an underestimation of the actual level of wage flexibility. However, the results produced by using this methodology for the US suggest that this disadvantage does not play an important role. In fact, a direct reading of the PSID survey indicates that around 17% of the workers surveyed experienced a wage reduction once a year, but after this base sample is corrected with the method proposed by Gottschalk (2005), it can be concluded that this percentage overestimates the real number by approximately a factor of three, finding that the corrected estimate is in line with other estimates calculated with administrative information provided by private companies.

Figure 2 illustrates the application of the adjustment methodology. The left panel shows a wage history from the base sample and its respective corrected history. Fluctuations are observed in the actual series of wages around the date on which a discrete wage change can be observed – the dotted line–, while the solid line corresponds to the wage sequence once Gottschalk's (2005) method has been applied. As can be seen on the Figure, the simulated history follows the original wage sequence very closely; nonetheless, this ignores small deviations in months three and six. On the right panel, in contrast, the effect of a bonus on the wage history can be observed. As might be expected, the structural change methodology considers the bonus as a transitory event and not as a significant wage

FIGURE 2. ORIGINAL AND CORRECTED WAGE[a]

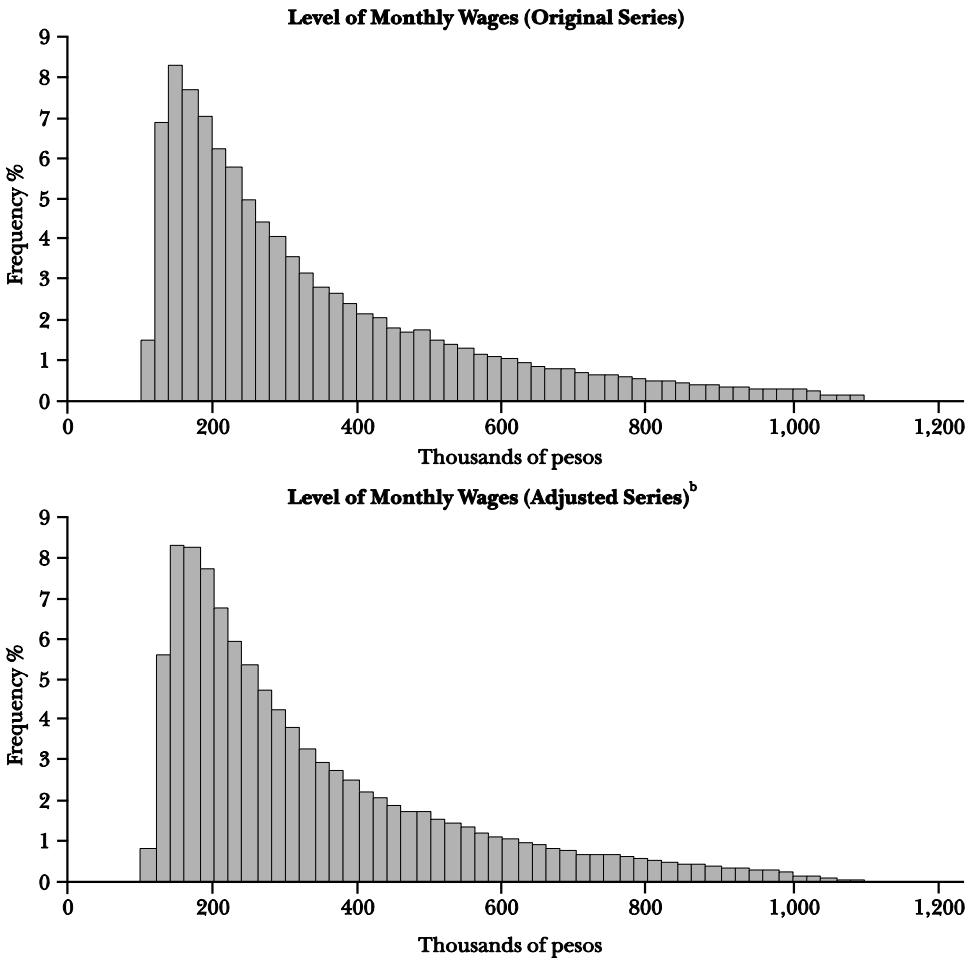


SOURCE: Own elaboration based on information from AChS.
[a] Using Gottschalk's (2005) methodology.

change.[11] However, it is important to point out that the methodology identifies wage changes in those cases where the magnitudes of the eventual bonuses change significantly. For example, if a wage history considers a bonus equivalent to one month's wage in December of each year, then the method assumes a constant wage equal to 1+1/12 wages per month; on the other hand, if the December bonus is increased to 2 months wages, then the methodology will indicate a wage of 1+1/12 wages per month for

[11] Appendix 1 contains a description of the methodology.

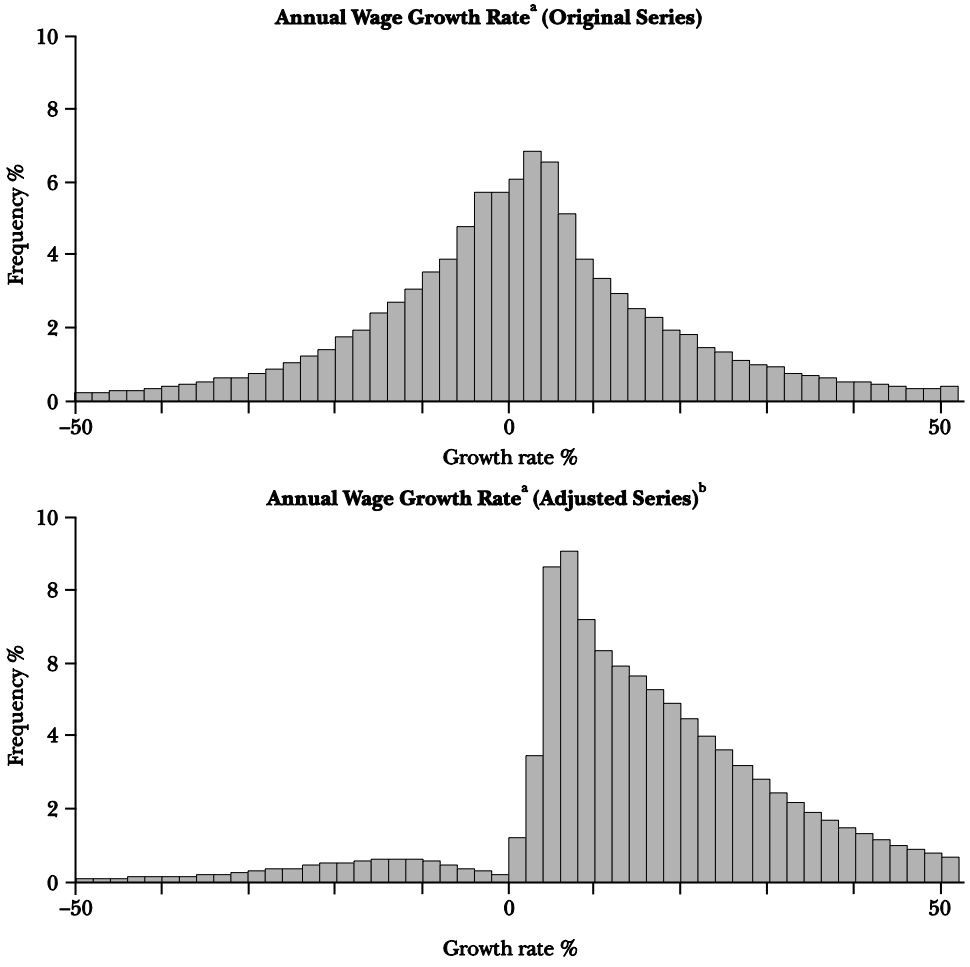
FIGURE 3. HISTOGRAMS OF ANNUAL WAGE LEVEL AND GROWTH



SOURCE: Own elaboration based on AChS information.
[a] Only effective wage changes taken into consideratión. [b] Using Gottschalk's (2005) methodology.

the period previous to the increase and, for the period after the increase, the average monthly wage will be 1+2/12 wages per month.

It should be pointed out that in aggregate terms the application of structural change methodology does not modify significantly the level of wage distribution; however, the impact on the frequency of changes is considerable (Figure 3). In fact, the unadjusted frequency change is more or less symmetric centered on a number slightly higher than zero, while



that of the adjusted base sample demonstrates a clearly asymmetric distribution with a bias toward wage increases. These results imply that, if the methodology is not applied, the sample frequency of adjustments reflects flexibility that is significantly higher than could be obtained by adjusting the base sample. Considering Gottschalk's (2005) results, the unadjusted series has a high probability of overestimating the real frequency of adjustment.

4. WAGE ADJUSTMENTS IN CHILE

4.1 Description of Frequency of Adjustments in Chile

Wage adjustment estimates are divided into wage changes not associated with a change of workplace by the worker and those which coincide with workers who change their workplace. Regarding the former, the average adjustment frequency is 3.7% per month, with increases and decreases being 3.4% and 0.3% respectively. These figures suggest that the time it would take for all the wages in the economy to adjust would be, on average, something over nine quarters (Table 5). This last result is consistent with the estimates obtained by the DSGE model for Chile, where the average adjustment is 12.5 quarters with a lower boundary of 5.6 and a 66% confidence level.[12] Furthermore, the frequency of nominal wage reductions is very low, which, to a certain extent, suggests that the labor market could exhibit a low degree of wage flexibility as suggested by studies such as Cowan et al. (2005). It is necessary to point out that if Gottschalk's (2005) adjustment methodology is not applied, the frequency of wage reductions increases to 30.97%, a very high number in comparison to estimates for other countries and beyond that expected for this type of statistic.

TABLE 5. FREQUENCY OF WAGE ADJUSTMENTS IN CHILE

Item	*Wage changes (monthly, percentage)*	*Average time for a complete adjustment (quarters)*	*Wage increases (monthly, percentage)*	*Wage reductions (monthly, percentage)*
Without changing workplace	3.68	9.05	3.36	0.32
With changing workplace[a]	58.90	–	35.40	23.50

SOURCE: Own elaboration based on information from the EChS.
[a] Frequency calculated using last wage reported at previous company.

Among those workers who change their workplace, 34% receive higher wages, 24% receive lower wages and around 42% do not experience any significant change in wages. The fact that a change in workplace is not linked exclusively to an increase in wages may be associated with one of the two following factors. First, the partial flexibility of wages has temporary unemployment as its counterpart, a situation which definitely translates

[12] This estimate is obtained using Bayesian methodology applied to a DSGE model for Chile. See Caputo et al. (2006).

into the involuntary character of some of the labor changes reported and, as a consequence, not necessarily associated with wage increases. Second, these results are also consistent with the existence of complementary wage factors used to determine the benefits associated with working in a particular place and, as a consequence, a worker might be willing to change their workplace and accept a lower wage in exchange for other compensatory elements to the lower wage; for example, better employment prospects and more flexible hours, among others. However, it is not possible to establish the specific role of each of these factors with the information available and it is beyond the objective of this present paper.

Analysis by company size indicates that small companies have slightly higher frequency than the other two groups (Table 6), although the size of such differences does not appear to be significant. Considering the frequency of wage reductions as a more direct indicator of labor flexibility, the bigger companies are the most rigid. Nevertheless, these numbers should be considered with caution, as these frequencies can be affected not only by company size but also by worker characteristics. A formal analysis of the incidence of these characteristics in the adjustment frequency is carried out in the next section.

TABLE 6. FREQUENCY OF WAGE ADJUSTMENT BY SIZE OF COMPANY (monthly, percentage)

Size	*Wage changes*	*Wage increases*	*Wage reductions*
Less than 10 workers	3.79	3.42	0.38
From 10 to 199 workers	3.67	3.30	0.36
200 or more workers	3.67	3.40	0.27

SOURCE: Own elaboration based on information from the AChS.

Wage adjustment frequency by economic sector indicates a high degree of heterogeneity (Table 7). For example, the adjustment frequency of the Services and Construction sectors are the highest (4.28% and 3.95% per month, respectively), while the Industry sector shows the lowest (3.11%). By focusing on reductions, it is interesting to note that the frequencies observed are very similar in all sectors, with the sole exception of Construction which is almost double that of the other sectors, a situation consistent with the fact that hiring in this sector is determined to a large extent by the execution of projects for limited time periods.

TABLE 7. FREQUENCY OF WAGE ADJUSTMENTS BY ECONOMIC SECTOR

Sector	*Wage changes (monthly, percentage)*	*Average time for a complete adjustment (quarters)*	*Wage increases (monthly, percentage)*	*Wage reductions (monthly, percentage)*
Agriculture	3.29	10.14	2.97	0.31
Mining	3.33	10.00	3.04	0.29
Industry	3.20	10.40	2.90	0.30
Construction	4.01	8.30	3.50	0.52
Electricity, gas and water	3.29	10.13	3.02	0.27
Commerce	3.44	9.69	3.12	0.32
Transport	3.40	9.81	3.06	0.34
Services	4.24	7.85	3.94	0.30
Total	*3.68*	*9.05*	*3.36*	*0.32*

SOURCE: Own elaboration based on information from the AChS.

4.2 Determinants of Wage Flexibility: Econometric Focus

Literature uses worker and company characteristics to explain the degree of wage rigidity present in the economy. In reference to worker characteristics, Campbell and Kamlani (1997) emphasize that variables related to worker skills are crucial for understanding labor rigidities. In contrast, Messina et al. (2008), and Franz and Pfeiffer (2006) consider information on company size and the economic sector to which it belongs to be relevant.

Similar variables will be used in the following to explain econometrically the percentage of workers in each company whose wages are adjusted downwards on a quarterly basis. It is worth noting that a quarterly frequency, not a monthly one as used in the previous analysis, is used here due to the fact that a monthly frequency would introduce too much noise to the estimates without generating any significant effect on the results. The variable to be explained was measured as the percentage of workers at each company whose nominal wage decreased during the quarter, without this decrease being associated with a change in work place by the worker. In relation to the statistics associated with this variable, the average unconditional value is 1.3% per quarter, a number which compares with the close to 0.3% average monthly frequency of wage reduction.

Regarding worker characteristics, we have information on worker gender and age. The former characteristic is introduced to the model as the ratio of female workers in each company over time, while for the latter, a dummy variable was employed in order to differentiate between

three groups of companies: companies with an average worker age fewer than 30, those between 30 and 50 and those over 50 years of age. In addition, as an approximation of the skill level of the company's workers, a percentage of the company's workers who receive wages higher than the sectorial average was calculated, white vs. blue collar workers. In terms of the characteristics of the company, the size of the firm was used (small, medium, or large) and the economic sector to which they belong.[13] The level of sectorial unionization was also controlled for.

Employing these variables –and those mentioned previously– regressions were estimated whose dependent variable was the percentage of workers in each company who experienced a wage decrease each quarter, with the explanatory variables being those mentioned in the last paragraph.[14] It should be noted that the dependent variable is restricted to interval $[0,1]$, and therefore the ordinary least squares procedure is not appropriate in this case. For this reason, following Papke and Wooldrige (1996) and Messina et al. (2008), the fractional logit of the following logistic function was estimated:

$$E(y_{it} \mid w_{it}, f_{it}) = \frac{\exp(w_{it}\alpha_0, f_{it}\alpha_1)}{1+\exp(w_{it}\alpha_0, f_{it}\alpha_1)}, \tag{1}$$

where y_{it} is the percentage of workers who experience a wage reduction at company i in quarter t, w_{it} the collection of worker characteristics of company i, and f_{it} represents characteristics of company i in quarter t. The estimate covers 2001-2007 and the frequency of data is quarterly.

Table 8 shows the marginal effects on the dependent variable, whose unconditional average value is 1.3% per quarter. As observed, with respect to the worker characteristics, the percentage of women at each firm was not statistically significant, a result which is consistent with those reported in European countries by Messina et al. (2008). Age variables show that a larger percentage of workers under 30 years of age (the regression reference group) is associated with a higher frequency of downward wage adjustments, i.e., that older workers experience a lower frequency of nominal wage decreases. Thus, for example, companies with a majority of workers in the age range of 30 to 50 will have a wage reduction frequency

[13] There is no further information to allow for a higher heterogeneity between companies.

[14] The reported numbers only include those for workers who remain with their companies, but the results are consistent with the complete sample.

0.3 percentage points lower than those firms with a higher percentage of workers less than 30 years of age. This result conceptually validates the role of the outsider assigned to young workers.[15] This, however, contrasts with what is reported by Messina et al. (2008) for Europe, which shows the opposite.

As for company characteristics, those with less than 10 workers exhibit a lower downward wage adjustment than larger companies (over 200 workers), this being a statistically significant effect when the percentage of

TABLE 8. DETERMINANTS OF DOWNWARD NOMINAL RIGIDITY. DEPENDENT VARIABLE: PERCENTAGE OF WAGE REDUCTIONS AT THE COMPANY LEVEL (marginal effects, percentage points)

Variable	*(1)*	*(2)*	*(3)*	*(4)*
Ratio of women	−0.05	−0.07	−0.05	−0.07
Dichotomous variable for age of worker in the company:				
Average age of worker between 30 and 49 years of age	−0.34[a]	−0.26[b]	−0.34[b]	−0.26[c]
Average age of worker equal to or over 50 Years of Age	−0.25[b]	−0.20[c]	−0.25[b]	−0.20[c]
Dichotomous variable for number of workers in the company:				
9 workers or less	−0.07	−0.15[a]	−0.07	−0.15[a]
Between 10 and 199 workers	−0.01	−0.05	−0.01	−0.05
Ratio of workers with income over the sectorial average		−0.54[a]		−0.54[a]
Sectorial level of unionization			−0.03	−0.02
Sectorial fixed effects				
Mining	0.32	0.47[c]	0.53	0.70
Industry	0.36[a]	0.42[a]	0.38[a]	0.44[a]
Construction	0.81[a]	0.87[a]	1.05[a]	1.11[b]
Electricity, gas and water	−0.02	0.04	−0.01	0.05
Commerce	0.31[a]	0.39[a]	0.30[a]	0.39[a]
Transport	0.42[a]	0.49[a]	0.50[a]	0.57[a]
Services	0.38[a]	0.50[a]	0.38[a]	0.49[a]
Temporary effect	Yes	Yes	Yes	Yes

SOURCE: Own elaboration based on information from the ACHS.
[a] 1% significance. [b] 5% significance. [c] 10% significance.

[15] The *insider-outsider* theory states that companies do not fire formal employees (insiders) to hire unemployed workers (outsiders) at a lower wage due to the cost of firing workers and hiring and training new ones.

workers with high wages is controlled for (columns 2 and 4); the marginal effect associated with these companies as compared to larger ones is 0.15 percentage points less downward wage adjustments. An explanation for this could be related to larger companies' more favorable position to apply more complex remuneration schemes that allow them a greater degree of flexibility. Furthermore, particularly in the case of small firms, companies avoid wage reductions because the impact of the loss of a small number of employees arising from such reductions is relatively more important to the company the smaller it is. Regarding workers' skill levels (measured as the percentage of workers in each company with higher wages than the sectorial average), a negative relation between the proportion of workers with higher wages and wage flexibility was found, possibly indicating that these workers' higher skill levels give them a higher degree of labor mobility, which, following the nomenclature set out for age variables, would let them play the role of the outsiders in the labor markets and/or, additionally, this is consistent with the conceptual framework of efficiency wages, as workers with more highly skilled positions are more difficult to monitor. The degree of unionization does not appear to be statistically significant.

As for fixed sectorial effects, the marginal effects are measured with respect to the Agriculture sector, and the most important results indicate that sectors exist for which the marginal effect is both very statistically and economically significant. For instance, the marginal effect for the Construction sector indicates that companies in this sector have a frequency of quarterly wage reductions on average 1 percentage point higher than the frequency for companies in the Agriculture sector. This number is very significant if the sample average of quarterly downward adjustments of 1.3% is taken into consideration. Significant statistical effects, although to a less extent, are also observed in the Commerce, Transport and Services sectors.[16]

5. MAIN FINDINGS

This paper shows the dynamics of wage adjustments in Chile based on a microeconomic information panel composed of an average of 429 thousand wage histories for the period 2001m12-2007m12. The main finding is

[16] The non-linearness of the model implies that the marginal effects of the dummy sector variable cannot be isolated completely.

that the frequency of wage adjustments for this period is approximately 3.7% per month, where 0.3% corresponds to nominal wage reductions.

The frequency of wage adjustments shows some differences among economic sectors. In particular, the Construction, Commerce, Transport and Services sectors exhibit a higher relative adjustment frequency. These differences are economically significant, especially for the Construction sector. This may be a reflection of the fact that there are a significant percentage of short term wage contracts in Construction.

Econometric analysis of the determinants of the downward nominal rigidity indicates that both the characteristics of the worker and the company are relevant. With reference to worker characteristics, the ratio of female workers is not statistically significant, but that of young workers is, given that a positive relationship is observed between young workers and the frequency of nominal wage reductions. Likewise, the frequency of downward adjustments is less in companies with a higher percentage of workers with high wages (compared to the sectorial average). Regarding the company, small and medium sized companies show a lower frequency of reductions than larger companies (over 200 employees).

Although this paper shows evidence for the labor market, some interesting questions remain unanswered. In particular, the main shortcoming of the base sample, which limits its use for exploring other topics, is the lack of information on worker characteristics such as education level and contractual conditions. The spectrum of studies should be increased significantly as more complete base samples become available.

Appendix A

Bai-Perron (2003) Methodology

This appendix gives a description of the contrast of structural breaks used to determine wage changes. Bai and Perron (2003) formally present the contrast.

T is defined as the number of periods for which a particular worker's wage was observed, with m being the number of breaks observed in periods T_1, T_2, ..., T_m. The wage in any period is equal to constant plus a measurement error in the following manner:

$$
\begin{aligned}
&w_t = \beta_1 + \mu_t; \qquad t = [1, T_1] \\
&w_t = \beta_2 + \mu_t; \qquad t = [T_1 + 1, T_2] \\
&\vdots \\
&w_t = \beta_{m+1} + \mu_t; \qquad t = [T_m + 1, T]
\end{aligned}
\tag{A. 1}
$$

Bai and Perron (2003) proposed an estimator MCO for β and T. For this purpose, it is assumed that the number of breaks is known and is equal to m. In this case, the idea is to estimate βs and Ts that minimizes the residual quadratic sum (SSR) of system A.1. However, this calculation can be very demanding in computer terms due to the fact that the duration between breaks is unknown and as such there is a very large number of T combinations. Bai and Perron (2003) show that the problem can be reduced through dynamic programming in the following way:

$$
S\tilde{S}R(\hat{T}_1, \ldots, \hat{T}_m) = S\tilde{S}R(\hat{T}_1, \ldots, \hat{T}_{m-1}) + \min_{T_m} SSR(\hat{T}_m) \tag{A. 2}
$$

The algorithm is resolved recursively according to the following procedure. Calculations are made for the SSR for T–2h potential breaks that divide the T observations in two segments of a minimum length of h. The break point of the minimum SSR is selected from among T–2h potential break points. The two segments derived from the last step are taken and the procedure is repeated until m segments are obtained. From there the SSR minimum of all the possible combinations of m breaks is obtained with a minimum segment length of h.

To determine the optimal m, a sequential procedure is used. First, by dividing the sample in two, the null structural break existence hypothesis is contrasted using SSR with and without structural break with an F contrast. In the event that the null hypothesis is rejected, the contrast from the segments obtained of the last stage is carried out. The process is repeated until the null hypothesis cannot be rejected.

References

Akerlof, G. A., W. Dickens and G. Perry (1996), "The Macroeconomics of Low Inflation", *Brookings Papers on Economic Activity*, No. 1, pp. 1-59.

Altonji, J., and P. Devereux (1999), *The Extent and Consequences of Downward Nominal Wage Rigidity*, NBER (Working Paper, No. 7236).

Aravena, C. (2006), *Base de datos AChS, descripción y análisis*, unpublished paper, Banco Central de Chile.

Babecký, J., P. Du Caju, T. Kosma, M. Lawless, J. Messina and T. Rõõm (2009), *Downward Nominal and Real Wage Rigidity: Survey Evidence from European Firms,* European Central Bank (Working Paper Series, No. 1105).

Bai, J., and P. Perron (2003), "Computation and Analysis of Multiple Structural Change Models", *Journal of Applied Econometrics,* Vol. 18, No. 1, pp. 1-22.

Blinder, A., and D. Choi (1990), "A Shred of Evidence on Theories of Wage Stickiness", *Quarterly Journal of Economics,* Vol. 105, No. 4, pp. 1003-1015.

Campbell, C., and K. Kamlani (1997), "The Reasons for Wage Rigidity: Evidence from a Survey of Firms", *Quarterly Journal of Economics,* Vol. 112, No. 3, pp.759-789.

Caputo, R., J. P. Medina and C. Soto (2006), *Nominal Rigidities, Indexation and Inflation Persistence in Chile: A Structural Investigation,* unpublished paper, Banco Central de Chile.

Card, D., and D. Hyslop (1997), "Does Inflation Grease the Wheels of the Labor Market?", in Christina D. Romer and David H. Romer (eds.), *Reducing Inflation: Motivation and Strategy,* University of Chicago Press.

Castellanos, S., R. García-Verdú and D. Kaplan (2004), *Nominal Wage Rigidities in Mexico: Evidence from Social Security Records,* NBER (Working Paper, No. 10383).

Cowan, K., A. Micco, A. Mizala, C. Pagés and P. Romaguera (2005), *A Diagnosics of Unemployment in Chile,* Universidad de Chile.

Dickens, W. T., L. Goette, E. L Groshen, S. Holden, J. Messina, M. E. Schweitzer, J. Turunen and M. Ward (2007), "How Wages Change: Micro Evidence from the International Wage Flexibility Project", *Journal of Economic Perspectives,* Vol. 21, No. 2, pp. 195-214.

Dwyer, J., and K. Leong (2000), *Nominal Wage Rigidity in Australia,* Reserve Bank of Australia, Research (Discussion Papers, No. 2000-08).

Farès, J., and T. Lemieux (2001), "Downward Nominal Wage-rigidity: A Critical Assessment and Some New Evidence for Canada", in A. Crawford (ed.), *Proceedings of the Bank of Canada Conference on Price Stability and the Long Run Target for Monetary Policy,* Bank of Canada.

Faruqui, U. (2000), *Employment Effects of Rated-wage Rigidity: An Examination Using Wage-settlements Data,* Bank of Canada (Working Paper, No. 2000-14).

Fehr, E., and L. Goette (2005), "Robustness and Real Consequences of Nominal Wage Rigidity", *Journal of Monetary Economics*, Vol. 52, No. 4, pp. 779-804.

Fortin, P., and K. Dumont (2000), *The Shape of the Long-run Phillips Curve: Evidence from Canadian Macro, 1956-97*, Département des Sciences Économiques, Université du Quebec à Montréal (Working Paper).

Franz, W., and F. Pfeiffer (2006), *Reasons for Wage Rigidity in Germany*, IZA Institute for the Study of Labor (Discussion Papers, No. 2017).

Gottschalk, P. (2005), "Downward Nominal Wage-flexibility: Real or Measurement Error?", *The Review of Economic and Statistics*, Vol. 87, No. 3, pp. 556-568.

Hall, R. (2005), "Employment Fluctuations with Equilibrium Wage Stickiness", *American Economic Review*, Vol. 95, No. 1, pp. 50-65.

Jadresic, E. (1992), "Dynamics of Wages and Contracts in Chile", *Colección Estudios Cieplan*, No. 34, pp. 5-30.

Kahn, S. (1997), "Evidence of Nominal Wage Stickiness from Microdata", *The American Economic Review*, Vol. 87, No. 5, pp. 993-1008.

McLaughlin, K. J. (1994), "Rigid Wages?", *Journal of Monetary Economics* Vol. 34, No. 3, pp. 383-414.

McLaughlin, K. J. (1999), "Are Nominal Wage Changes Skewed Away from Wage Cuts?", *Federal Reserve Bank of St. Louis Review*, Vol. 81, No. 3, pp. 117-132.

Messina J., P. Du Caju, C. Duarte, M. Izquierdo y N. Hansen (2008), *The Causes and Consequences of Nominal and Real Wage Rigidity: A Sectoral Approach*, presented in Wage Dynamic Network Conference, Frankfurt, June.

Papke, L., y M. Wooldridge (1996), "Econometric Methods for Fractional Response Variables with an Application to 401(k) Plan Participation Rates", *Journal of Applied Econometrics*, Vol. 11, No. 6, pp. 619-632.

Sapelli, C. (2007), "Algunas reflexiones sobre los problemas que presenta el funcionamiento del mercado laboral", *Puntos de Referencia* (Centro de Estudios Públicos, Chile), No. 289, November.