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Are wages rigid in Colombia?: Empirical evidence based on a sample of wages at the firm level[♣]

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Abstract

This paper uses Colombian data at the firm level for the period 1999 to 2006 to provide microeconomic evidence on the existence and extent of downward nominal wage rigidity. To conduct the analysis, we use a rich panel of firms for white and blue collar workers, consisting of 1517 firms for the former and 781 firms for the latter. The presence of wage rigidity is determined by means of three statistic techniques used in recent literature, such as the analysis of the histograms of the distribution of wage changes, the LSW statistic and the Kahn test. The results suggest the existence of downward nominal wage rigidities; it is worth mentioning that rigidity is higher for blue collar workers than white collar workers, since the increase in the wages of the blue workers is generally done by taking into account the change in the minimum wage, which is why a higher rigidity would be expected.

Key words: Wage rigidity, Kahn test, *LSW* Statistic, Colombia.

JEL Classification: J31, E24, C23

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I. Introduction

During the past two decades, the reduction of inflation and the adoption of an inflation targeting regime have revived the interest in the study of wage rigidities, due to the impact they may have on employment. However, this subject continues to create controversy in the economics literature. On the one hand, the traditional literature (Tobin, 1972, Akerlof, et al 1996; Fortin, 1996) states that when nominal wages are downwardly rigid, a certain level of inflation allows for a greater flexibility of real wages, since these may be reduced through increases in nominal wages that are lower than inflation, thus facilitating adjustments in the labor market. On the other hand, Elsby (2009) maintains that the macro-economic effects of the nominal rigidities of wages are probably small, suggesting that nominal rigidity is not a strong argument against the adoption of a low inflation target.

A recent contribution to this debate, which makes use of the greater availability of information on a micro-economic level, has been the considerable increase in empirical studies of wage rigidities. These studies have employed information based on surveys and dataset at both the firm and worker levels. Blinder and Choi (1990), Campbell and Kamlani (1997), Bewley (1999) and Agell and Lundborg (1995, 2003) are some of the authors that use survey data. They find that the reason why firms do not reduce wages is that they do not want to affect the motivation, effort and morale of workers, which thus leads to downward nominal wage rigidity.

Among the studies that utilize datasets on both firms and workers, it is worth singling out the *International Wage Flexibility Project*, which analyzes changes in individual labor incomes by using 31 data bases from 16 European countries over the past three decades. This research project finds evidence of downward rigidities both in nominal and real wages, although the degrees and the causes of rigidity

vary across different countries that were analyzed.[1] Others examples can be found in the November, 2007 issue of the *Economic Journal* (vol 117, no. 524), whose main subject of interest was that of wages rigidity. The articles in this special issue journal use a common methodology to estimate the occurrence and scope of both real and nominal wage rigidities at the individual level in Germany, Italy and the United Kingdom. The studies find that real rigidities are important in these three countries, although they have declined over time. They also suggest that rigidities are associated with unfavorable results in the labor market, particularly on employment.[2]

Other studies that have used micro-economic information at the level of individuals and/or firms in Europe and the United States are those by McLaughlin (1994), Kahn (1997), Stiglbauer (2002), Lebow et al (2003), Schweitzer (2007), Brzoza-Brzezina and Socha (2007), Messina et al (2008) and Knoppik and Beissinger (2009), among others. These studies offer mixed evidence regarding wage rigidity, as they vary in accordance with their respective methodology and source of information. In the Latin American context, the study of wage rigidities does not appear to have received a great deal of attention. Two exceptions are Castellanos et al (2004) and Cobb and Opazo (2008). The former study analyzes wage rigidity in Mexico, utilizing workers data from the Mexican Institute of Social Security for the period 1985-2001. These authors find evidence of nominal rigidity, though there also appears to be evidence that it has lessened over time. The latter study presents micro-economic evidence about the degree of downward wage rigidity in Chile, on the basis of the information provided by the wage history of 440,000 workers during the period from 2001 to 2007.

Recently, the European Central Bank (ECB) and the central banks of the European Union formed a research group known as the *Eurosystem Wage Dynamic Network*

[1] A summary of the main results of the Project is found in Dickens et al (2007).

[2] See Goette et al (2007), Bauer et al (2007), Devicienti et al (2007) and Barwell and Schweitzer (2007).

whose aim is to study the dynamics of the wages of the region and their policy implications.[3] The research team is divided into three areas: a macro group which is exploring the dynamics of wages at an aggregate level, a micro group which uses information on the level of the individual and/or firm, and a group which is conducting an *ad hoc* survey of the setting of prices and wages at the firm level.[4]

Given the scarcity of studies of wage rigidities for developing countries, and following the lines of the recent research by the European central banks on the formation of prices and wages, this paper aims to determine whether nominal wages in Colombia are downwardly rigid. To the best of our knowledge, this is the first study that provides micro-economic evidence about the existence and the degree of nominal wage rigidity in Colombia. To conduct the analysis, we used a dataset at the firm level for white and blue collar workers, taken from the companies which submitted their financial statements to the *Superintendencia de Sociedades* (Superintendency of Corporations) during the period from 1999 to 2006.

In particular, the degree of nominal rigidity is determined through the use of some statistical techniques employed in the recent literature, such as the analysis of the histogram of the distribution of wage changes, the *LSW* statistic and the Kahn test. The results of these alternative approaches suggest the existence of downward nominal wage rigidities in Colombia.

This article is divided into three parts, besides this introduction. In the second one the data base is described and the main statistics for the variables used in the

[3] The preliminary results of the research of these groups which make up this network were presented at the "Wage Dynamics in Europe: Findings from the Wage Dynamics Network" conference, held in Frankfurt, Germany, on June 24th and 25th, 2008. The presentations and the papers are available on: http://www.ecb.europa.eu/events/conferences/html/wage_dynamics_network.en.html.

[4] The surveys were carried out by 17 central banks (Austria, Belgium, Czech Republic, Estonia, France, Germany, Greece, Hungary, Italy, Ireland, Lithuania, Luxembourg, Holland, Poland, Portugal, Slovenia and Spain) between the end of 2007 and the first semester of 2008 and included interviews with more than 17,000 firms of different sizes and economic sectors.

empirical analysis are presented. The third section explains the tests for wage rigidities and discusses the results that were obtained. The final section presents the main conclusions.

II. Dataset and descriptive statistics

This paper analyzes data at the firm level which come from the firms that submitted financial statements to the Superintendencia de Sociedades (Supersociedades) during the period from 1999 to 2006. The Supersociedades does provide complete information about the number of workers and their wages in an important number of companies from different sectors of the economy. The study excludes public servants and government employees, the self-employed and those who work for small-scale companies.

Particularly, this study used the information on number of employees and the average wage by gender and type of occupation (white collar and blue collar workers). Given that the methodology used to determine wage rigidities requires a balanced panel, it was decided to include only those firms that reported the payment of wages to workers with permanent contracts throughout the period under consideration. The empirical analysis was undertaken with two independent samples, one for white collar workers and the other one for blue collar workers, which do not necessarily include the same companies.

The sample for white collar workers includes 1,517 firms that reported complete information for all the years of the period under analysis. The firms were grouped into 7 sectors: agriculture, commerce, construction, electricity, gas and water, manufacturing, financial and other services. As can be seen in Table 1, the number of white collar workers is concentrated in the sectors of manufacturing (35.8%) and commerce (33.8%). With regard to firm size, 76.8% of the companies are classified

as large while the remaining 23.2% are not large.[5] In addition, 81.7% of the firms are located in the main four cities of the country; namely 51.4% in Bogotá, 15.8% in Medellín, 9.6% in Cali and 4.9% in Barranquilla. The remaining 18.3% is located in other cities of the country. Regarding blue collar workers, there are 781 firms, of which 81.6% are classified as large. These firms are concentrated in the sectors of manufacturing (60.2%), agriculture (15.4%) and commerce (14.7%). Also, about 44% of the firms are located in Bogotá.

In the 1,517 companies included in the sample of white collar workers, males accounted for approximately 54.3% of the work force. This share is higher in the sector of electricity, gas and water (80.6%) and lower in that of financial services (37.1%). In the case of blue collar workers, the share of males reaches 66.8%, surpassing 50% in all of the sectors.

Table 2 shows the average real salaries for the period 1999-2006 by sector, size, location and gender, for both white and blue collar workers. The average monthly wage of the white collar workers included the sample was US$637. With the exception of the salaries observed in financial services, men´s wages were significantly higher than those of women. In the case of blue collar workers, the average real wage is approximately US$328. In general, it is seen that, on average, the wage of men is higher than that of women by about 16%. These differences are larger in the sectors of commerce, construction and manufacturing and smaller in agriculture and services. These gender differences in wages confirm findings widely documented in the literature on the subject, and although they have been reduced on an international level since the 1980´s, they are still present; see, e.g., Croson and Gneezy (2009), and the references therein.

[5] The classification of the firms by size was made by using the criteria established in the Law 590 of 2000. Small (not large) firms are those whose total assets are less than 15,000 current legal minimum monthly wages (SMMLV, in Spanish initials) while the large firms are those which have total assets higher than 15,000 SMMLV.

It can also be seen that, on average, the wage of white collar workers is twice that of blue collar workers. In addition, the electricity, gas and water sector pays, on average, the highest wages, followed by the manufacturing sector, while the lowest ones are, on average, paid in the agricultural and financial services sectors. In terms of company size, the large firms pay, on average, higher wages, than those paid by firms that are not large. For white collar workers this amounts to a difference of 41% on average, while it is 23% for blue collar workers. It is worth noting that, in both cases, on average, men receive higher wages than women. With regard to the geographical location of the companies in the sample of white collar workers, it is seen that the firms located in Bogotá pay, on average, higher wages than those in the rest of the country. According to the results of the statistical significance tests, the wage difference is significant in the case of firms located in Cali and Medellin, but not for those in Barranquilla. Furthermore, in all of the cities the wages of men significantly surpass those of women. In the case of blue collar workers, no statistically significant differences between the average wages in the different cities are observed, suggesting that such wages are homogeneous on a national level. This might be explained by the fact that these wages closely follow the level of the national minimum wage. By contrast, gender differences are statistically significant in most of the cities in the sample.[6]

Finally, it is worth noting to the wide dispersion seen in real wages in the sample of white and blue collar workers. In fact, the standard deviation in the wages of white collar workers reaches US$426 while that for blue collar workers is US$130, for the period being analyzed.[7] In addition, the distribution of the wages by deciles, shown in Table 3, indicates that 50% of white collar workers received, on average, a wage lower than US$511, and 50% of the blue collar workers, one lower than US$297.

[6] The annual information on wages and the statistical significance tests of the annual difference in wages by gender, sector and size, both for white and blue collar workers, were not included for reasons of space, but they are available from the authors upon request.

[7] The annual standard deviations of wages by sector, size and location, both for white and blue collar workers, are available from the authors upon request.

By contrast, in the highest decile, the wages of white and blue collar workers reached, on average, a figure of US$4,056 and US$1,527 respectively.

III. Wage rigidities

This section presents an empirical analysis of downward wage rigidities for a sample of Colombian firms. This subject is important, given its possible impact on the persistence and volatility of inflation, since wages are one of the main components of the marginal cost.

To evaluate wage rigidities, both nominal and real, the recent literature has used several statistical tools, including the analysis of the histograms of the distribution of wage changes in a given period of time.[8] In the presence of rigidities, the distribution is asymmetrical and the data cluster around a reference point. In the case of nominal rigidity, the observations are clustered at zero and show asymmetry around this point, which is why negative observations near zero are less frequent than positive ones. In turn, real rigidity shows increases located to the right of the inflation reference. In general, the studies for Europe and the United States have found that nominal rigidities are more common when inflation is low, whereas real rigidities are more frequent with high inflations.[9]

In the case of Colombia, Graphs 1 and 2 show the distribution of the annual changes in nominal wages for white and blue collar workers, respectively, during the period 1999-2006.[10] In the histograms the bars were given a width of one percentage point. The first vertical line on the left shows the point where the

[8] See Kahn (1997), Dickens et al (2007), Goette et al (2007), Bauer et al (2007), Devicienti et al (2007), Barwell and Schweitzer (2007), Schweitzer (2007), Brzoza-Brzezina and Socha (2007), Knoppik and Beissinger (2009), Stiglbauer (2002), Lebow et al (2003), Castellanos et al (2004) and Messina et al (2008).

[9] For example, Schweitzer (2007), Brzoza-Brzezina and Socha (2007), Holden and Wulfsberg (2007 and 2008) and Lebow et al (2003).

[10] Extreme salary changes (less than -15% and more than 35%) were excluded from the construction of the histograms, since these changes probably reflect mistakes in reporting or measurement errors.

change of the nominal wage is zero and the second line shows the observed rate of inflation lagged one year. It is worth noting that the histograms show the percentage of firms whose average change in wages was negative. This does not necessarily imply that the workers have wage cuts, since the information used in this study corresponds to the average wage of the firm and not to the wages of individuals. Thus, the average wage of a firm may be affected by changes in the composition of the work force, job rotation and the flexibility of labor contracts, which may lead to modifications in the company´s wage structure. Additionally, as Akerlof et al (1996) point out, some of the negative changes may be due to mistakes in the way wages are reported, which may increase the frequency of such changes.[11]

In general, what stands out in the case both of white and blue collar workers is the high variation in the magnitude of wage changes in the same year. It is worth noting that most of the wage changes lie in the vicinity of zero and that there is a relative small amount of negative wage changes compared to positive increases around this point, which would suggest the presence of downward nominal wage rigidities. Viewed from another angle, the high cluster of data found around the observed level of inflation might be evidence of real rigidity, which may be explained by the Colombian practice of adjusting wages, either in line with the inflation of the previous year or with the increase in the minimum wage.[12]

Notwithstanding the above, visual inspection of the histograms does not amount in itself to a conclusive proof of the existence of downward wage rigidities. For example, Stiglbauer (2002) points out that the analysis of the histograms may be

[11] Akerlof et al (1996) point out that some studies present data corrected for measurement errors which affect the true distribution of the wage changes, For example, they mention that McLaughlin (1994) shows corrected measurements of the standard deviation of the wage changes, which may be inappropriate if the true distribution is asymmetrical.

[12] During the period under analysis the increase in the minimum wage in Colombia has been higher than the observed inflation in the previous year. Sentence C-815 of the Constitutional Court (1999) rules that the setting of the minimum wage must take into account the observed level of inflation.

sensitive to the choice of the intervals and/or the width of the bars. This author also states that it is difficult to determine if a high cluster of observations around zero is due to a high proportion of constant nominal wages or small changes in them. For these reasons, it is necessary to statistically test the significance of the results derived from a visual inspection of the histograms. Towards this end, we employ two tests that are frequently applied in the literature.[13] The first is the *LSW statistic* due to Lebow, Stockton and Wascher (1995), and the second one is the Kahn (1997) test, also known as the *Histogram-Location Approach*.

The *LSW statistic* measures the asymmetry generated by the rigidity of wages by comparing the size of the two tails of the distribution: it takes, as a reference, points equidistant from the median. Thus, a symmetrical distribution will tend to have an equal number of observations both to the right and the left of the median and the *LSW statistic* will be zero, indicating that there are no rigidities. On the other hand, the statistic will be positive if there is a scarcity of negative increments, which suggests the presence of nominal wage rigidities. Also, since it is a measure of order, the statistic will not be affected by extreme observations.[14]

In line with Lebow et al (2003), this statistic is defined as the accumulated frequency of the distribution of the change in wages which is higher than twice the median minus the accumulated frequency of the distribution that is less than zero. That is, *LSW ≡ [1-F(2*median)]-F(0)*.[15]

The results of the *LSW* test of asymmetry for white and blue collar workers, along with the probability that the null hypothesis would be rejected, are shown in Tables

[13] For a presentation of other tests used in the literature, see Lebow et al (2003), Kuroda and Yamamoto (2003) and McLaughlin (1994 and 2000).

[14] For more details about the *LSW statistic*, see Lebow et al (2003) and Castellanos et al (2004).

[15] To calculate the statistical significance of the *LSW* statistic, we use the normal approximation to the binomial distribution suggested by Kuroda and Yamamoto (2003). The statistic follows a normal distribution, and under the null hypothesis of symmetry $F(y_i) = 1 - F(2y^m - y_i), \forall i$, where F is the cumulative distribution function, y_i is the change in the nominal wage, y^m is the median of y_i, and *n* is the number of observations.

4 and 5, respectively. As can be seen, when the calculation of the statistic includes information from the whole period, the distribution in the change of the average wages is positive and significantly asymmetrical, with 7.5% and 7.8% more observations on the right tail of the distribution than on the left for white and blue collar workers, respectively, which would suggest the presence of downward nominal wage rigidities.[16] These results are robust when the statistic is calculated for both white and blue collar workers using information for the different years.

The above results fit within the framework of those reported in the international literature. For example, in the case of Australia, Dwyer and Leong (2000) the estimated *LSW* is 15.8% for the distribution of the wages from a sample of jobs between March 1987 and December 1999. Beissinger and Knoppick (2001) find an *LSW statistic* of 4.8% on the basis of the distribution of changes in labor incomes from a sample of employees in West Germany for the period 1975-1995. Kuroda and Yamamoto find an *LSW* statistic of 11% for the distribution of the monthly wages of full-time employees in Japan between 1993 and 1998. Lebow et al (2003) estimate an *LSW* of 13.2% for the United States, using information about changes in salaries and wages by position in the industry during the period from 1981 to 1999.

Furthermore, Table 4 shows that 79.1% of companies, on average, carry out positive changes in nominal wages of white collar workers, while 5.4% of firms do not make any changes and 15.5% effect negative changes. In the case of blue collar workers these percentages are 81.8%, 7.9% and 10.3%, respectively (Table 5). These results support the presence of downward nominal wage rigidities.

[16] Lebow et al (2003) point out that a more robust test about the existence of nominal rigidities should take into account the existing relationship between the distribution of wages and inflation. To do this, these authors econometrically estimate the relationship between the LSW statistic and inflation, obtaining a negative and significant coefficient. In our case, since the analyzed period is short, we calculate the correlation coefficient between these two variables, instead of estimating a regression, as Lebow et al (2003) do. In the case of the samples of white collar workers, the correlation coefficient is -0.51 and -0.15 for the blue collar workers, which supports the evidence for the presence of downward nominal wage rigidities.

Nevertheless, it is important to point out that the *LSW statistic* could not be robust to the underlying asymmetry in the distribution of wage changes. In fact, according to Lebow et al (2003), if, independently of the downward wage rigidity, the distribution is skewed to the right, then as inflation falls and the distribution moves to the left, the statistic may change, even if the shape of the distribution does not.

For the above reason, the Kahn (1997) test was used, which in addition to being robust to the presence of extreme observations, has the advantage of not assuming that the underlying distribution is symmetrical. This test also assumes that the shape of the distribution does not change with inflation in the absence of downward nominal wage rigidities.[17]

This test is based on the histograms of the distribution of the annual changes of nominal wages and compares, for each year, the height of the histogram bars which are below zero with those which include changes that are equal to and higher than zero, up to the median of the annual change of wages. To carry out the test a histogram is constructed for each year, with the width of the bars set at one percentage point.[18] On the basis of this information, a system of equations is econometrically estimated in accordance with the proportional model suggested by Kahn (1997), which is given by:

$$Prop_{rt} = \alpha_r(1 + \beta_1 DNEG_{rt} + \beta_2 D1_{rt} + \beta_3 D2_{rt} + \beta_4 DN1_{rt}) + \left(\gamma - \left[\beta_1 \sum_{j>r} \alpha_j + \beta_2 \alpha_{r-1} + \beta_3 \alpha_{r-2} + \beta_4 \alpha_{r+1}\right]\right) D0_{rt} + \mu_{rt} \qquad (1)$$

$$\forall r = 1, \dots 12$$

[17] See Lebow et al (2003) and Castellanos et al (2004) for recent applications of this test.

[18] Behr (2006) gives a detailed analysis of the properties of the Kahn (1997) methodology through Monte Carlo simulations and finds that this methodology gives an adequate estimate of the parameter of rigidity. However, the estimator may possibly be underestimated, if we take into account that the standard errors depend on the width of the bars under consideration.

where:

r indicates a bar of the histogram;

$Prop_{rt}$ denotes the proportion of the companies whose average annual wage changes in the year *t* fall within the range given by: (i) the median of the changes minus *r* percentage points and (ii) the median of the changes minus *r+1* percentage points;

$DNEG_{rt}$ is a dummy variable which takes the value of 1 when the change in the average nominal wages is less than 0;

$D0_{rt}$ is a dummy variable which takes the value of 1 in the bar which has the 0;

$D1_{rt}$ is a dummy variable which takes the value of 1 in the bar immediately above that which has the 0;

$D2_{rt}$ is a dummy variable which takes the value of 1 two bars above that which has the 0; and

$DN1_{rt}$ is a dummy variable which takes the value of 1 in the bar immediately below the one which has the 0.

The parameters to be estimated are α_r, β_s, γ. The model imposes the restriction that β_s are equal across equations. Specifically, β_1, is the parameter which measures the rigidity and detects when the histogram bar varies only when it contains negative observations. If β_1=0, the bar will have the same height in every year and there will be no nominal rigidity. If, by contrast, β_1 is negative there will be evidence of nominal rigidity. The model also imposes the restriction that γ is the

same in all the equations. The parameter γ detects the concentration of observations at zero and β_2, β_3 and β_4 measure the existence of menu costs, ensuring that β_1 and γ detect the nominal rigidity independently of those costs.

In this exercise twelve equations were estimated, which correspond to the same number of histogram bars, since, as in Kahn (1997) the average changes in the wages 12% below the median are always negative. This system is estimated by using iterative weighted least squares, since the number of years included in the sample (7 years) prevents the SUR estimation done by Kahn (1997).[19] In addition, in line with Lebow et al (2003) and Brzoza-Brzezina and Socha (2007), a logistic transformation is used in each equation, since the estimated dependent variable (the height of the histogram bar) cannot be negative.[20].

The results of the Kahn test are shown in Tables 6 and 7 for the sample of white and blue collar workers, respectively. The coefficient of the *DNEG* variable, which, as was said, indicates the presence of downward nominal wage rigidities is negative and significant in both cases. Specifically, in the sample of white collar workers, this coefficient (β_1) would imply that the negative changes in the wages are close to 17.5% less than what would be expected in the absence of wage rigidities.[21] In the case of the workers this coefficient is higher than that of the white collar workers (β_1=29%), which is consistent with the fact that the wage of the workers is closely linked to the performance of the minimum wage, which is why one would expect a greater nominal downward wage rigidity.

It is worth noting that the magnitude of these results might be affected by reporting errors in the wages and by the fact that in this exercise the unit of analysis is the

[19] Beissinger and Knoppik (2001) and Knoppik and Beissinger (2009) also use iteratively reweighted least squares to avoid unstable results resulting from the relatively short period of their sample.

[20] This is: $ln[Prop_{rt}/(100 - Prop_{rt})] = ln\big[f(.)/\big(100 - f(.)\big)\big]$.

[21] That is, the height of the histogram bars which contain negative changes would fall by 17.5% with respect to a scenario without wage rigidities.

average wage of the firms and not the individual wage. A similar result was found by Brzoza-Brzezina and Socha (2007) who estimate downward nominal wage rigidities at the firm level in Poland. These authors argue that such rigidity is less than the one calculated on the basis of individual worker data, since in the first case information about the average wage is used. As a consequence, it is not clear whether the indicator for rigidity obtained at the firm level is the result of a greater flexibility of wages or changes in the composition of the work force within each firm. Thus, as in the Polish case, the coefficient of rigidity that is obtained must be regarded as a lower limit of the true downward nominal rigidity.

The estimated coefficient on the variable *D0* indicates that the bars of the histograms which include changes in wages equal to zero are larger than they would be in the absence of long-term contracts or reasons other than the rigidity of wages or menu costs. The estimated coefficients of the dummy variables that were included to detect the presence of menu costs, namely *D1*, *D2* and *DN1*, are positive but only *D1* and *D2* are statistically significant. This suggests that the menu costs are not important in the case of the sample under analysis and for that reason the average increases of the wages of the firms, although positive, may be less than 1 and 2%, respectively. These results are different from those estimated by Kahn (1997) and Lebow et al (2003), who find that the coefficients of these variables are negative. The difference may be due to the fact that, in this case, changes in the average nominal wage of the companies are analyzed instead of that of individuals, which might increase the number of changes in wages close to zero.

It should be mentioned that the coefficient of rigidity (β_1) estimated in this study lies in the lower range of those reported by the international studies (Table 8). However, these comparisons must be interpreted with caution, since the unit of analysis (that is individual, job or firm), the measurement of remuneration, the

period under consideration and the labor legislation widely differ from one country to another.

IV. Conclusions

This study provides micro-economic evidence about the existence and degree of downward nominal wage rigidity for a sample of Colombian firms during the period 1999- 2006. In particular, from the analysis of the histograms of the distribution of the annual changes in nominal wages it is found that there is a high variation in its magnitude, both for white and blue collar workers.

It is worth emphasizing the cluster of wage variations around zero as well as the existence of more positive than negative wage changes, suggesting the presence of downward nominal wage rigidities. Furthermore, the higher cluster of data found around the observed inflation, could be the consequence of the common Colombian practice of adjusting wages on the basis of inflation or the increase of the minimum wage.

To statistically test the significance of the results derived from the visual inspection of the histograms, two tests frequently applied in the literature on wage rigidities were used: the *LSW* statistic and the Kahn test. The results of these tests confirm the existence of downward nominal wage rigidities in the analyzed samples.

It is worth noting, in addition, that on the basis of the results of the Kahn tests, we find that the coefficient of rigidity is higher for blue collar workers than white collar workers, since the increase in the wages of the blue collar workers is generally done by taking into account the change in the minimum wage, which is why a higher rigidity would be expected.

The coefficients of rigidity estimated in this paper lie in the lower range of those reported by international studies, which may be due to the fact that the analysis was made on the level of the firm and not the individual. As a consequence, the indicator for rigidity may be affected by changes in the composition of the workforce within each firm.

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Table 1
Sample statistics: 1999-2006

Firms by sector				
Sector	**White collar workers**		**Blue collar workers**	
	Firms	Share of the total (%)	Firms	Share of the total (%)
Agriculture	148	9.8	120	15.4
Commerce	513	33.8	115	14.7
Construction	99	6.5	37	4.7
Electricity, gas and water	29	1.9	7	0.9
Manufactures	543	35.8	470	60.2
Financial services	53	3.5	10	1.3
Other services	132	8.7	22	2.8
Firms by size				
Size	**White collar workers**		**Blue collar workers**	
	Firms	Share of the total (%)	Firms	Share of the total (%)
Large	1,165	76.8	637	81.6
Not large	352	23.2	144	18.4
Firms by location				
City	**White collar workers**		**Blue collar workers**	
	Firms	Share of the total (%)	Firms	Share of the total (%)
Bogotá	780	51.4	344	44.0
Cali	145	9.6	59	7.6
Medellín	239	15.8	84	10.8
Barranquilla	75	4.9	34	4.4
Other cities	278	18.3	260	33.3
Total sample	**1,517**	**100**	**781**	**100**

Source: Supersociedades and authors' calculations.

Table 2
Average real wage 1999-2006 (US$)

Real wage by sector: average 1999-2006						
	White collar workers			Blue collar workers		
	Male	Female	Weighted	Male	Female	Weighted
Agriculture	559.4	475.8	522.6	257.6	245.8	256.6
Commerce	628.6	519.2	582.7	320.6	269.1	315.5
Construction	627.3	477.1	558.2	310.2	265.1	308.6
Electricity, gas and water	1578.1	977.8	1418.1	700.6	642.6	700.5
Manufactures	769.7	603.5	696.6	359.8	305.9	348.6
Financial services	470.5	470.6	466.6	292.5	246.0	282.4
Other services	749.9	605.9	688.7	300.6	271.6	296.8
Real wages by size: average 1999-2006						
	White collar workers			Blue collar workers		
	Male	Female	Weighted	Male	Female	Weighted
Large	748.1	594.4	682.7	348	298.6	339.7
Not large	521.2	432.9	486.5	283.1	238.0	276.6
Real wages by location: average 1999-2006						
	White collar workers			Blue collar workers		
	Male	Female	Weighted	Male	Female	Weighted
Bogotá	761.9	604.6	695.0	334.1	278.6	325.1
Cali	659.3	544.4	600.8	317.1	295.8	310.1
Medellín	685.1	551.1	625.4	342.2	306.0	333.3
Barranquilla	734.4	523.0	666.6	343.1	276.9	334.6
Other cities	526.9	445.0	496.0	339.9	298.3	333.6
Total sample	**695.8**	**557.2**	**637.2**	**336.0**	**288.8**	**328.1**

Source: Supersociedades and authors' calculations.
Note: Annual wages were converted into American dollars using the average exchange rate of each year.

Table 3
Distribution of real wages by deciles:
Average 1999-2006 (US$)

Decile	White collar workers	Blue collar workers
1	292	209
2	348	231
3	401	253
4	453	275
5	511	297
6	585	324
7	682	354
8	834	395
9	1,115	475
10	4,056	1,527

Source: Supersociedades and authors' calculations
Note: Annual wages were converted into American dollars using the average exchange rate of each year.

Table 4
Asymmetry test *LSW* for white collar workers

Year	*LSW* Statistic (%)	*p*-value	Percentage changes in nominal wages		
			Positive	Equal to zero	Negative
2000	6.841	0.0000	81.3	6.1	12.6
2001	3.686	0.0137	79.4	4.5	16.1
2002	6.390	0.0001	78.6	5.8	17.5
2003	7.454	0.0000	79.6	5.0	15.4
2004	9.453	0.0000	79.8	5.6	14.6
2005	6.357	0.0002	77.6	4.5	17.9
2006	7.926	0.0000	77.4	6.5	16.1
All years	7.448	0.0000	79.1	5.4	15.5

Source: Authors' calculations.

Table 5
Asymmetry test *LSW* for blue collar workers

Year	*LSW* Statistic (%)	*p*-value	Percentage changes in nominal wages		
			Positive	Equal to zero	Negative
2000	8.242	0.0000	82.8	8.3	8.9
2001	5.467	0.0021	83.2	7.5	9.3
2002	5.505	0.0020	82.6	7.1	10.3
2003	5.172	0.0056	80.0	8.5	11.5
2004	7.806	0.0000	82.9	7.3	9.8
2005	9.274	0.0000	80.6	8.2	11.2
2006	5.937	0.0020	80.1	9.0	10.9
All years	7.807	0.0000	81.8	7.9	10.3

Source: Authors' calculations.

Table 6
Kahn test for nominal wage rigidities:
White collar workers 1999-2006

Dependent variable: $Prop_{rt}$

Variables	**Coefficients**	***p*-value**
$DNEG_{rt}$	-0.1746 (0.0791)	0.0307
$D0_{rt}$	1.6645 (0.9070)	0.0700
$D1_{rt}$	0.0856 (0.1108)	0.4426
$D2_{rt}$	0.2418 (0.1042)	0.0234
$DN1_{rt}$	0.0323 (0.0588)	0.5841
Number of observations: 84 (r=12, t=7)		

Note: Standard errors in parenthesis.

Table 7
Kahn test for nominal wage rigidities:
Blue collar workers 1999-2006

Dependent variable: $Prop_{rt}$

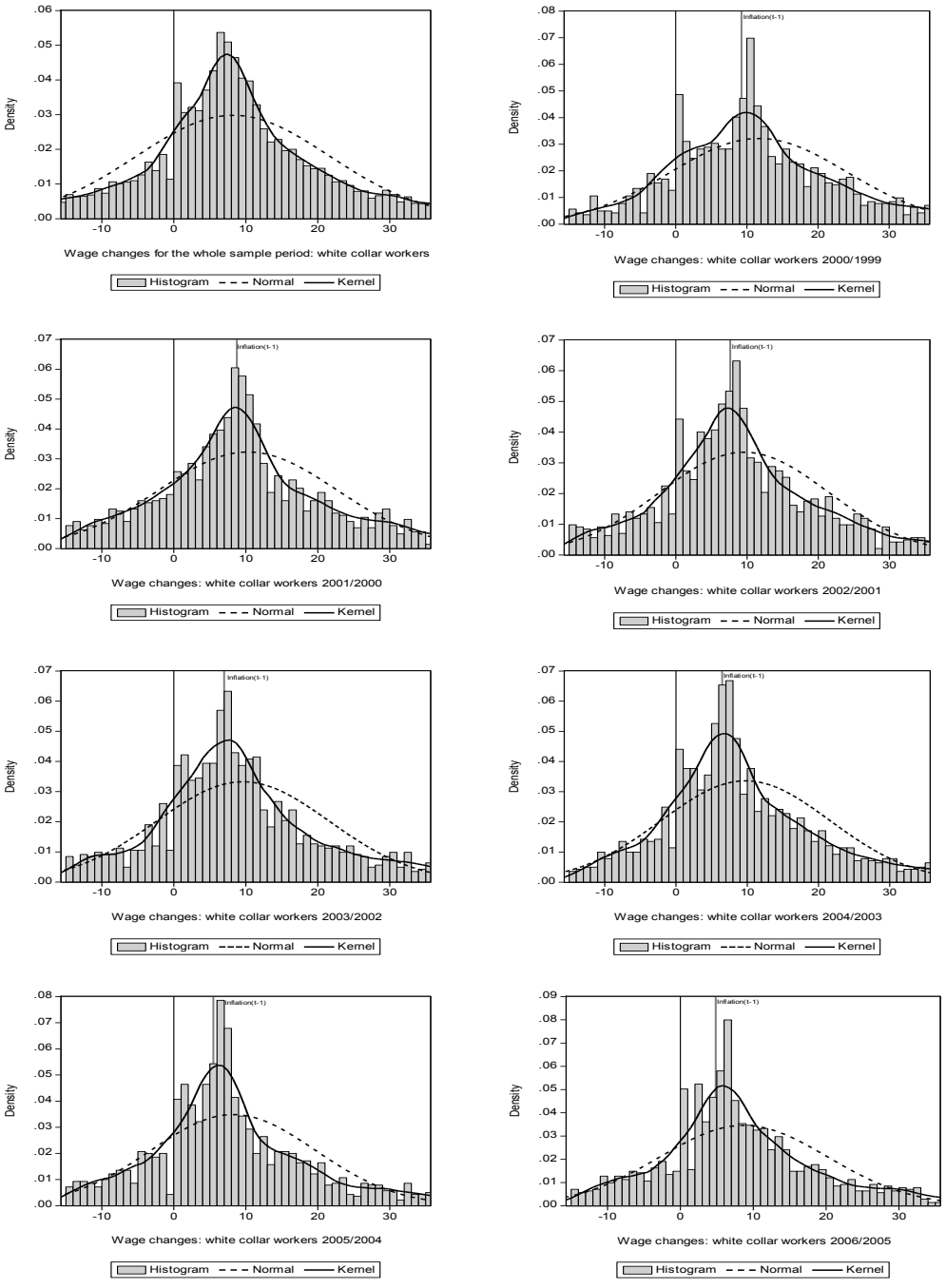
Variables	**Coefficients**	***p*-value**
$DNEG_{rt}$	-0.2861 (0.0932)	0.0031
$D0_{rt}$	2.6600 (1.0089)	0.0104
$D1_{rt}$	0.3381 (0.0978)	0.0009
$D2_{rt}$	0.1395 (0.0812)	0.0903
$DN1_{rt}$	0.0260 (0.0989)	0.7932
Number of observations: 84 (r=12, t=7)		

Note: Standard errors in parenthesis.

Table 8
Kahn (1997) test: International evidence

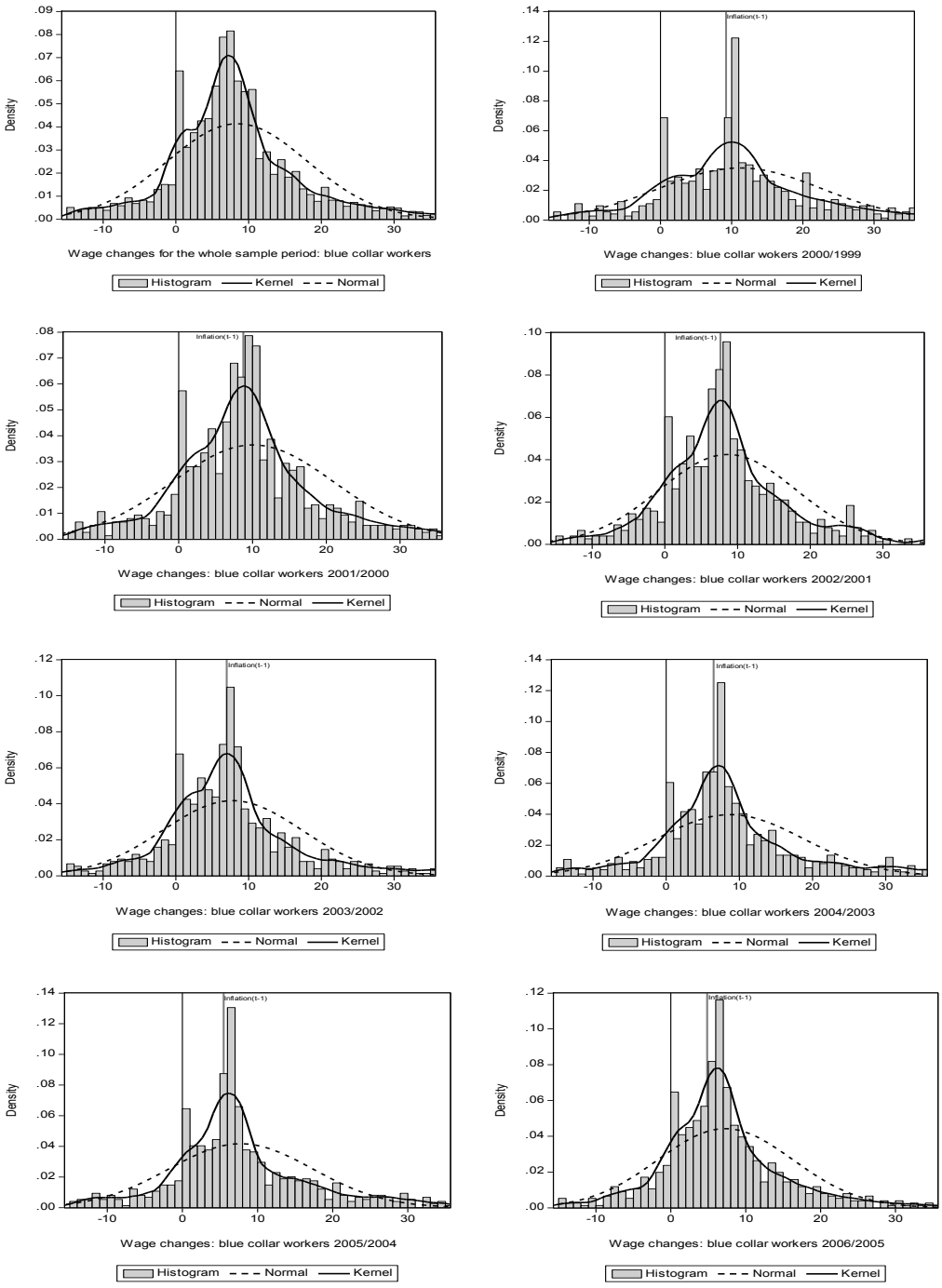
Paper	Sources of information	Country/period	β_1	γ
Kahn (1997)	Wage earners *Panel Study of Income Dynamics (PSID)*	United States 1970-1988	-0.47	4.43
Dwyer and Leong (2000)	Prevailing market rates of pay for specific job descriptions *Mercer Cullen Egan Dell Survey*	Australia 1987-1999	-0.92	
Beissinger and Knoppik (2001)	Blue collar workers *IAB-Beschäftigtenstichprobe* (Social security information)	Germany 1975-1995	-0.09	
	White collar workers *IAB-Beschäftigtenstichprobe* (Social security information)	Germany 1975-1995	-0.17	
Lebow et al (2003)	Specific job categories in the private nonfarm sector *Employment Cost Index* (*ECI*)	United States 1981-199	-0.52	5.49
Castellanos et al (2004)	Wage earners Instituto Mexicano de Seguridad Social	Mexico 1985-2001	-0.62	0.12
Brzoza-Brzezina and Socha (2007)	Wages at the firm level *Central Statistical Office Forms-Corporate Financial Reports*	Poland 1996-2005	-0.02	
Schweitzer (2007)	Wage earners *British New Earnings Surveys*	United Kingdom 1976-2001	-0.49	1.26
Knoppik and Beissinger (2009)	Wage earners *European Community Household Panel (ECHP)*	12 countries of the European Union 1994-2001: Austria Belgium Denmark Finland France Germany Greece Ireland Italy Portugal Spain United Kingdom	-0.36 -0.45 -0.47 -0.35 -0.46 -0.23 -0.28 -0.43 -0.18 -0.66 -0.41 -0.07 -0.14	

Graph 1
Histograms of the distribution of annual changes in average nominal wages of the firms: White collar workers 1999-2006



Source: Authors' calculations.

Graph 2
Histograms of the distribution of annual changes in average nominal wages of the firms: blue collar workers 1999-2006



Source: Authors' calculations.