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**INFORMALITY AND MINIMUM WAGES  
BY COHORT IN COLOMBIA**

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**Mora, J. J., & Muro, J. (2014). Informality and minimum wages by cohort in Colombia. *Cuadernos de Economía*, 33(63), 469-486.**

This article aims to analyze the effect of minimum wage levels on the decision to join the informal job sector. We estimated a pseudo panel model of engagement in the informal sector using an IV-probit. Our results show that an increased wage gap—the relative difference between observed and minimum wage—has not only a disincentive effect on the probability of joining informality, but also leads to a substitution effect between younger and older cohorts.

**Keywords:** Informality, minimum wages, instrumental variable probit, pseudo panel, sample selection bias.

**JEL:** C35, J32.

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**Mora, J. J., & Muro, J. (2014). Informalidad y salarios mínimos por cohorte en Colombia. *Cuadernos de Economía*, 33(63), 469-486.**

Este artículo busca analizar el efecto de los niveles del salario mínimo en la decisión de unirse al sector del empleo informal. Estimamos un modelo pseudo panel de participación en el sector informal usando un probit-IV. Nuestros resultados muestran que la creciente brecha salarial —la diferencia relativa entre el salario observado y el salario mínimo— no solo tiene un efecto de desincentivo en la probabilidad de unirse a la informalidad, sino que además lleva a un efecto de sustitución entre las cohortes más jóvenes y las de mayor edad.

**Palabras clave:** informalidad, salario mínimo, variable probit, modelo pseudo panel, sesgo de selección.

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**Mora, J. J., & Muro, J. (2014). Mora. Informalité et salaires minimums par cohorte en Colombie. *Cuadernos de Economía*, 33(63), 469-486.**

Cet article cherche à analyser l'effet des niveaux du salaire minimum obligatoire sur la décision de rejoindre le secteur de l'emploi informel. Nous considérons un modèle pseudo-panel de participation dans le secteur informel en utilisant un probit-IV. Nos résultats montrent que l'augmentation de l'écart salarial —la différence relative entre le salaire observé et le salaire minimum— n'a pas seulement un aspect démotivant sur la probabilité de rejoindre l'informalité, mais qu'en outre, il porte un effet de substitution chez les cohortes plus jeunes et les plus âgées.

**Mots-clés :** Informalité, salaire minimum, variable probit, modèle pseudo-panel, biais de sélection.

**JEL :** C35, J32.

**Mora, J. J., & Muro, J. (2014). Mora. Informalidade e salários mínimos por coorte na Colômbia. *Cuadernos de Economía*, 33(63), 469-486.**

Este artigo busca analisar o efeito dos níveis do salário mínimo na decisão de se juntar ao setor do emprego informal. Propomos um modelo pseudo-painel de participação no setor informal utilizando um probit-IV. Os nossos resultados mostram que a crescente brecha salarial —a diferença relativa entre o salário observado e o salário mínimo— não só tem um efeito de desestímulo na probabilidade de se juntar à informalidade, mas que, além do mais, leva a um efeito de substituição entre as coortes mais jovens e as mais velhas.

**Palavras-chave:** Informalidade, salário mínimo, variável probit, modelo pseudo-painel, viés de seleção.

**JEL:** C35, J32.

## INTRODUCTION

The minimum wage in Colombia is established through negotiations between representatives of the workers' union and an employers' association in December every year. If they fail to reach an agreement, the government establishes the minimum wage. Only in three of the last eight years, has there been an agreement between both parties.

The minimum wage is a key element of economic and social policy in developing countries. The minimum wage affects not only workers in the formal sector, but also many prices and taxes, which are set based on the minimum wage in Colombia. For this reason, the policy with respect to the minimum wage is significant in Colombia where approximately 56 percent of all workers earn the minimum wage (Hernández & Pinzón, 2006, p. 12) and 73 percent of all workers affiliated to the social security system earn two or less minimum salaries (Arango & Posada, 2007, p. 14).

Furthermore, the minimum wage is the base level for wages in the formal sector. Although there are different explanations as to what is considered informal and formal in the labor market, there seems to be a consensus in terms of considering the absence of entry barriers a key element in the ease to join the informal sector. In the formal sector, in contrast, labor laws, company regulations, and fixed minimum wages, among others, have become entry barriers. In this context, government intervention in the economy via the determination of the minimum wage generates incentives to either join or leave the informal sector; for example, the minimum wage generates incentives to choose one sector. In this article, we assume that those who work in the informal sector have actually chosen to do so.

Compared to other approaches to the problem, this paper differs in several aspects. Firstly, our analysis involves a follow-up of the informal sector from 2001 to 2005, based on the construction of a pseudo panel. Secondly, we discuss the effect of the minimum wage on the probability to join the informal sector. With the available data, we built six cohorts based on information from 13 metropolitan areas, from the June issue of the National Household Survey. This procedure provides a sample of 89,241 individuals for the period under review. As in the standard WGM two-sector model (Gramlich, 1976; Mincer, 1976; Welch, 1976), a higher minimum wage implies low wages in the uncovered or informal sector because of the movements from the formal to the informal sector (Lemos, 2009). In our specification, these movements are the result of worker transitions from one sector to another due to the effect of the minimum wage. This feature is particularly important in developing countries where the informality rate is high, and the total effect of the minimum wage over informality will depend on the labor force composition in the informal sector, i.e., the proportion of younger and older cohorts.

The paper is organized as follows: in the second section we discuss the literature on the effects of the minimum wage on employment in both the formal and informal sectors. In the third section, we present a model of the engagement in the

informal sector and describe the methodology for using pseudo panel data in the analysis. In the fourth section, we offer estimates of the model using an instrumental variable probit in which we take into account a correction for the presence of selection bias in pseudo panel data. We conclude in the last section.

## LITERATURE REVIEW

The theory suggests that the impact of the minimum wage on the labor market depends either on competitive or non-competitive assumptions. In a competitive labor market, the minimum wage established above the market equilibrium wage results in unemployment. In a monopsonistic labor market, if the minimum wage is above the monopsony wage level (but below the competitive level), employment will increase.<sup>1</sup>

A review of the literature on the effect of the minimum wage on unemployment shows no clear conclusion on the direction of the effect. Card and Krueger (1994) found that restaurants in New Jersey, where the minimum wage was raised, expanded the workforce in comparison to restaurants in Pennsylvania. However, using different data, Newmark and Washer (1995) found an increase in unemployment in New Jersey. Castillo-Freeman and Freeman (1992) found that in Puerto Rico a 10% increase in the minimum wage caused an employment reduction of 5%. With respect to the results of Castillo-Freeman and Freeman (1992), Krueger (1995) showed that the results are statistically fragile. Bell (1997) found that in Mexico, the minimum wage has had no effects on wages in the formal employment sector, but found substantial unemployment effects associated with the minimum wage in Colombia. Suryahadi, Widyanti, Perwira and Sumarto (2003) considered the presence of substitution effects: minimum wage decreases employment of unskilled workers and increase employment of white-collar workers. Fields (1994) discussed the effect of minimum wages on multi-sector labor markets (Fields, 1975, 1994) and found that the effect of an increase of the minimum wage in the formal sector on employment is ambiguous.

In developing countries, Lemos (2007) showed that a higher minimum wage in Brazil is associated with a reduction of inequality, but not with lower employment. Lemos (2009) also showed that the employment effects are due to assumptions previously made on the existence of a segmented or integrated labor market.

In Colombia, Magnac (1991) provides the first test of informality in Colombia. In Magnac's (1991) bivariate probit model, the informal sector is identified with self-employment (excluding employers). His results reject a segmented labor market hypothesis. However, Magnac's model shows that when an individual chooses to

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<sup>1</sup> Of course, there are other approaches to informality. In particular, The Economic Commission for Latin America considers the economic structure (Cimoli, Primi & Pugno, 2006). Also Fields (1994) discussed the hypothesis of segmented labor markets.

work in the formal sector, the benefits associated with not working are indistinguishable from the benefits of working in the informal sector.

Núñez (2002) suggests that joining the informal sector in Colombia is a voluntary act of which individuals are aware. Why should one choose one sector or another? Núñez (2002) believes that there are several factors that encourage participation in the informal business sector since there is a lenient environment that facilitates evasion of labor-related taxes. This refers to tax evasion such as tax withholding at the source and other state-imposed taxes based on a formal employment agreement. However, Núñez (2002) failed to discuss the effects of truncated sampling in his results when calculating the informal participation of individuals who earn more than \$1,200,000 Colombian pesos. Ribero (2003) and Correa, Ortiz and Uribe (2006) modeled informal employment as the result of socioeconomic characteristics of an individual, where education has a negative effect on the likelihood to enter into the informal sector. Depending on the purpose of the study, other variables have been included such as age, position in the household, non-labor income, gender, and fertility. Ribero (2003) did not make a selection bias adjustment, and Correa et al. (2006) did not include the selection correction in their calculations.

Hernández and Pinzón (2006) modeled the effect of an increased minimum wage on labor participation using pooled data and find that there are substitution effects between workers. However, Hernández and Pinzón (2006) did not consider the pseudo panel measurement error due to the nature of the Colombian data—the official information by the Colombian Department of Statistics does not include the possibility of panel data.<sup>2</sup> Finally, Rhenals (2009) discussed the relationship between informality and minimum wages in Colombia using pictures and tendencies, but without any formal specification or estimation.

## MODEL SPECIFICATION

In the standard labor force participation model individuals maximize their utility over consumption and leisure, subject to budget constraints and the time available for these activities (Deaton & Muellbauer, 1980; Gronau, 1973; Killingsworth & Heckman, 1986; McConnell, Brue & MacPherson, 2003; Mora, 2013; Pencavel, 1986).

In developing countries, the standard WGM two-sector model (Gramlich, 1976; Mincer, 1976; Welch, 1976) shows that when a group of workers is outside the umbrella of minimum wage legislation, a rise in the minimum wage implies that wages in the uncovered sector fall as a result of the displacement of workers in

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<sup>2</sup> There is no consensus on the effect of the minimum wage levels on employment in Colombia. While Maloney and Núñez (2003) found a negative relationship between minimum wages and employment, Robbins (2003) provides evidence on the fact that minimum wages have not had such a negative effect.

the covered sector into the uncovered sector. As a consequence, the wage effect is expected to be positive in the covered sector and negative in the uncovered sector (Lemos, 2009).

It seems evident that the prediction of the WGM model implies segmentation in the labor market. In Colombia, Arango and Posada (2001) suggested the possibility of segmentation based on a discussion of the unemployment rate. García, Ortiz and Uribe (2007) discussed segmentation comparing Mincer regressions for the formal and informal sectors, and García, Mesa and Roa (2008) also used Mincer regressions, which incorporate differences among cities and sectors. Using Markovian chains Mora and Muro (2013) discussed the possibility of a segmented labor market and found segmentation in professional workers. Finally, Nupia (1997), Jaramillo, Romero and Nupia (2000) and Galvis (2002), using time series, found that there is no cointegration among wages, i.e. there is a segmented labor market.

With respect to the results of the WGM model, we suppose that if there are segmented labor markets in a developing country (such as, for example, Colombia), the impact of an increased minimum wage on labor participation will depend on the proportion of younger and older workers in the economy. Thus, we suppose that the mobility within sectors with a minimum wage is not perfect because of the benefits of the minimum wage. Let us assume that the government imposes a minimum wage for the formal sector in the economy. Then, an individual's decision to enter into the informal sector results from comparing the benefits of working in the formal sector versus the benefits of working in the informal sector. Now, work in the formal sector consists of a standard fixed work time, and the guarantee of social security, pension, and health.

Let us assume that individuals are able to choose whether or not they want to join the formal or informal sector based on a set of variables (Fields, 1994; Maloney, 2004)<sup>3</sup>. Therefore, engagement in the informal sector can be specified as follows:

$$\begin{aligned}
 I_{i(t),t}^* &= \beta_0 + \beta_1' C_{1i(t)} + \beta_2' C_{2i(t)} + \beta_3' C_{3i(t)} + \beta_4' C_{4i(t)} + \beta_5' C_{5i(t)} + \\
 &\beta_6' C_{6i(t)} + \beta_7' W_{i(t),t} + \beta_8' C_{1i(t)} MW_{i(t),t} + \beta_9' C_{2i(t)} MW_{i(t),t} + \\
 &\beta_{10}' C_{3i(t)} MW_{i(t),t} + \beta_{11}' C_{4i(t)} MW_{i(t),t} + \beta_{12}' C_{5i(t)} MW_{i(t),t} + \beta_{13}' C_{6i(t)} MW_{i(t),t} \\
 &+ \beta_1' S_{i(t),t} + \eta_{i(t)} + \mu_{i(t),t}
 \end{aligned} \tag{1}$$

$$t = 1, \dots, T; i = 1, \dots, N; I_{i(t),t} = 1 \text{ if } I_{i(t),t}^* > 0 \tag{2}$$

Where  $I_{i(t),t}^*$  is a latent variable that represents earnings from working in a given sector and  $I_{i(t),t}$  equals one when an individual chooses to work in the informal sec-

<sup>3</sup> This assumption is fundamental because of the characterization of “easy-entry” and “upper-tier” informal employment (Kucera & Roncolato, 2008).

tor or otherwise zero. The “ $i(t)$ ” subscripts indicate that the observations come from representative and independent cross-sections where individuals are only available in one period.

$S_{i(t),t}$  is education level in years. This variable is inversely related with the likelihood to join the informal sector (Correa et al., 2006; López, 2010; Magnac, 1991; Núñez, 2002; Ribero, 2003).

$MW_{i(t),t}$  represents the ratio between real observed and real minimum wage by cities, which decrease the likelihood to enter into the informal sector. In particular, we consider the wage gap, the relative difference between observed and minimum wage. Fiszbain (1992) shows that reductions of the minimum wage increase the employment in the formal sector and reduce the employment in the informal sector. The negative relationship between the wage gap and employment in the informal sector is the result of movements of the labor force across sectors and the size of unemployment and the new employment in the formal sector.

$C_{j,i(t)}$  is the dummy for Cohort <sub>$j$</sub>  ( $J = 1, \dots, 6$ ).  $C_{j,i(t)}MW_{i(t)}$  is the interaction between Cohort <sub>$j$</sub>  ( $J = 1, \dots, 6$ ) and the wage gap. Deaton (1985) suggested using cohorts to obtain consistent estimators of  $\beta$  when numeric variables are used and adjusting the estimator for the presence of measurement errors. Moffitt (1993) proposed an IV-probit approach, which, in the case of independent continuous variables subject to measurement errors, implies using a set of time-invariant variables and a set of time-variant variables.

The  $\eta_{i(t)}$  variable represents the deviation of the effect of the cohort after breaking down fixed individual effects. Therefore, if there are any fixed individual effects, these will be consistent with fixed effects in the cohort. Finally, we include time-variant variables. Since economic growth is a determining factor when setting the minimum salary, the GDP lagged by one period is used as time-invariant variable. It is also worth noting that binary variables will not be subject to correction (Deaton, 1985).

## DATA

The labor market in Colombia experienced an increasing rate of female labor force participation from 1981 to 2000. The female labor force participation rose from 37 percent in 1981 to 51 percent in 1998. Meanwhile, the male labor participation has remained stagnant for the last decades, i.e., 74.28 percent in 1981 and 73.98 percent in 1998 (Bernat, Ribero & Tenjo, 2004). Consequently, the traditional gender gap in labor force participation has decreased over the last century. On the other hand, there has been an important fall in the unemployment rate in the past few years. According to the Colombian Department of Statistics (DANE), unemployment dropped from 16.6 percent in 2000 to 11.4 percent in 2006.

In Colombia, there are no panel survey statistics on household labor supply data. Our sample comes from the National Housing Survey (NHS), which consists of a time series of independent and representative cross-sections collected from 2001

to 2005 by DANE. Since 2000, the DANE has collected information about the labor market through another statistics survey called the Continuous Housing Survey. The DANE measures engagement in the informal sector based on information about workers or employers who have less than 10 workers, independent non-professional, non-technical workers, housekeepers, and family assistants who do not earn monetary compensation. Ribero (2003) proposes four definitions of informality and shows how the informal sector share changes substantially depending on the definition considered. The definitions take into account not only company size, but also other criteria such as membership to the social security system, an employment agreement, or medical insurance coverage.

Based on DANE's definition of informality, Castillo (2006) estimated the size of informality to be 61 percent in 2002 and 59 percent in 2005. However, when the definition does not include the headcount size, but the kind of employment agreement or memberships, the informal sector share is approximately 30 percent, Ribero (2003), whereas Hernández and Pinzón (2006) found that the informal sector share is about 50 percent based on medical insurance coverage.

In this paper, we define "informal" to refer to anyone who does not have social security coverage in health, pensions or formal employment contract. According to this definition and using a sample of individuals who were engaged in the labor market, we have constructed six cohorts of individuals whose ages range from 18 to 56 years in the period 2001-2005. Our sample contains 89,241 individuals for the observed period. Sample means of the selected variables are in the Table 1.

TABLE 1.  
MEANS OF THE VARIABLES

Variable/Year	2001	2002	2003	2004	2005	2001-2005
Years of education	9.85	9.99	10.17	10.32	10.43	10.15
Inflation (13 metropolitan areas)	8.35%	6.32%	7.78%	5.99%	5.03%	6.44%
Minimum wage (thousand Col\$)	286	309	332	358	381.5	333.75
Real minimum wage (thousand Col\$)	262.11	289.46	306.16	336.52	362.3	311.79
Informality	44.51%	44.60%	44.74%	43.65%	43.71%	44.26%
Number of individuals	18.136	17.348	17.415	17.444	18.898	89.241

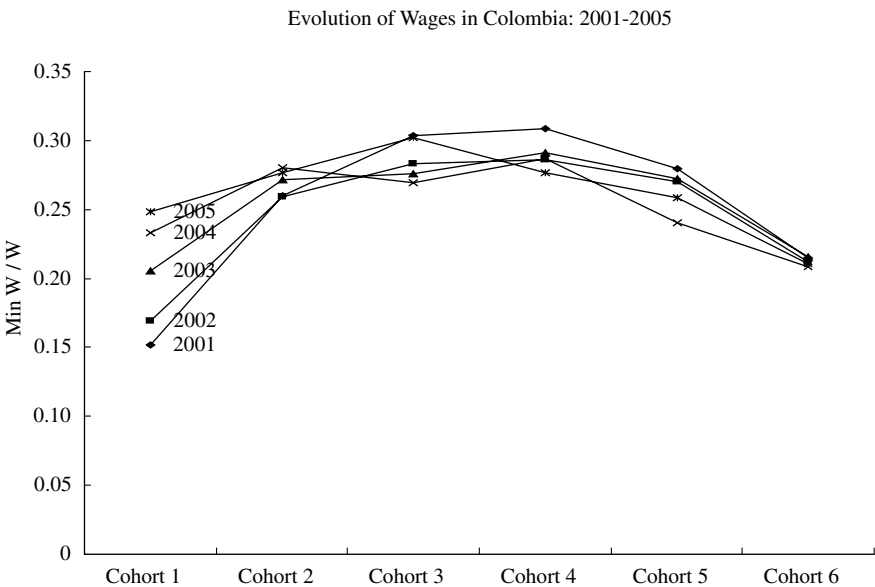
Source: Authors' calculations using The National Housing Survey (DANE-ECH).



As shown in Table 1 above, the average number of years of education is close to 10. This number seems to have been stable for the past 10 years. Mora and Muro (2008) obtained a similar average for the period 1995-2000 using pseudo panel data. Labor income figures were adjusted for inflation in each of the metropolitan areas, showing a slight improvement due to the combined effect of the economic growth and the fall in inflation. It must also be noted that the real minimum wage has been increasing in all metropolitan areas. Finally, there are no substantial differences among the number of individuals in the sample every year. To build our wage gap variable, we calculated by cohorts and cities the ratio between observed wages and real minimum wages by main cities and found an inverted U.

In Figure 1, the ratio increases in cohorts three and four and decreases in five and six. Next, we explored participation in the informal labor market and found that the informal sector has relative homogeneity by cohorts and regions. The results are as follows.

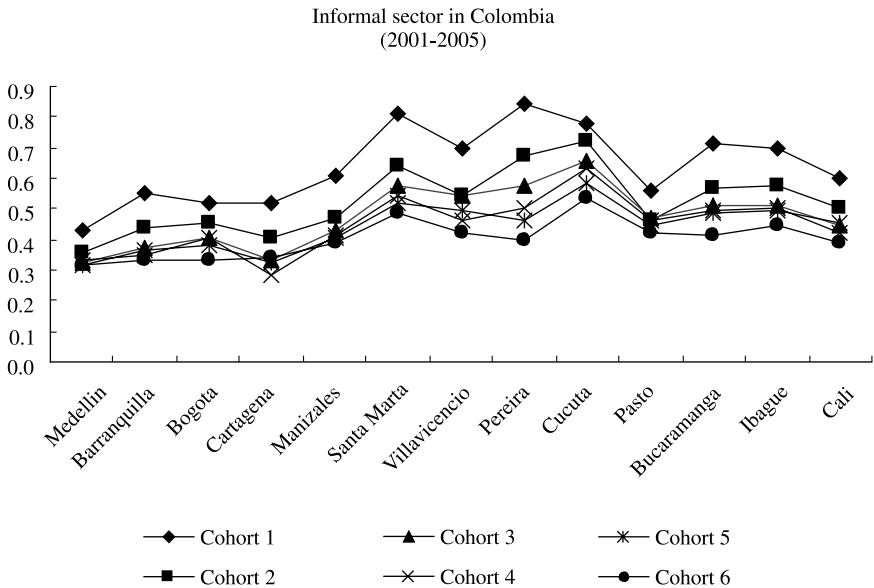
**FIGURE 1.**  
**WAGES BY COHORTS**



Source: Authors' calculations using The National Housing Survey (DANE-ECH).

Figure 2 shows that the youngest cohort has the highest participation in the informal sector. Medellín is the city with the lowest participation in the informal sector rates in each cohort, while Cartagena has the lowest participation in the informal sector in the fourth cohort throughout the entire period under review.

FIGURE 2.  
INFORMAL SECTOR RATE BY COHORTS



Source: Authors' calculations using The National Housing Survey (DANE-ECH).

## RESULTS

The estimates by Núñez (2002); Ribero (2003); Correa et al. (2006) of participation in the informal employment sector were obtained from samples of working individuals. Ribero (2003) justifies this selection because there are other models, such as those by Ribero and Meza (1997), which specifically analyze labor market participation in Colombia. Correa et al. (2006) did not raise any special considerations with regard to this. The results of the estimation of our model of engagement in the informal sector are discussed below.

TABLE 2.  
MARGINAL EFFECTS FOR INFORMAL WORKERS

Variable / Model	Pool-Probit $\beta$ /sd	Marginal Effects	IV-Probit	Marginal Effects
Education	-0.1220063	-0.0483948	-0.0955948	-0.0379173
	(0.0014036) **		(0.0122872) **	
Gap:(W-Wmin)/ Wmin	-0.156334	-0.0620112	-0.1930817	-0.0765851
	(0.0115719)**		(0.0192138)**	
C <sub>1</sub>	-0.7490834	0.5502242	-0.7439434	0.5366604
	(0.0231283)**		(0.0231448) **	
C <sub>2</sub>	-0.3820409	0.3242436	-0.3808606	0.3035093
	(0.0184387) **		(0.0183905)**	
C <sub>3</sub>	0.0203672	0.0326199	0.0318899	0.0092381
	(0.0132721)*		(0.0138739)*	
C <sub>4</sub>	-0.1946036	0.0921534	-0.1921517	0.078173
	(0.0166463)**		(0.0167461)**	
C <sub>5</sub>	-0.1674056	0.0722831	-0.1601081	0.0577017
	(0.0167929)**		(0.0173337)*	
C <sub>6</sub>	-0.1704153	0.0666029	-0.1646574	0.0573355
	(0.0183733)**		(0.0186383)**	
C <sub>1</sub> *Gap	-0.7490834		-0.7439434	
	(0.0231283)**		(0.0231448) **	
C <sub>2</sub> *Gap	-0.3820409		-0.3808606	
	(0.0184387) **		(0.0183905)**	
C <sub>3</sub> *Gap	0.0203672		0.0318899	
	(0.0132721)*		(0.0138739)*	
C <sub>4</sub> *Gap	-0.1946036		-0.1921517	
	(0.0166463)**		(0.0167461)**	
C <sub>5</sub> *Gap	-0.1674056		-0.1601081	
	(0.0167929)**		(0.0173337)*	
C <sub>6</sub> *Gap	-0.1704153		-0.1646574	
	(0.0183733)**		(0.0186383)**	

(Continued)

TABLE 2.  
MARGINAL EFFECTS FOR INFORMAL WORKERS

Variable / Model	Pool-Probit $\beta/sd$	Marginal Effects	IV-Probit	Marginal Effects
InvMills	-11.33548		-11.19631	
	(0.2560378)**		(0.256311)**	
Constant	11.97381		11.78705	
	(0.2485394)**		(0.2633142)**	
$\chi^2$	(15) = 31296.96		(44) = 38151	
% Success	75.75%		76.04%	
% Success (1)	76.91%		77.82%	
% Success (0)	74.67%		74.39%	
<i>N</i>	89.241		89.241	

Note: Dummy variables for cities are included in all regressions and Standard Errors are shown in parenthesis. \*  $p < 0.05$  ; \*\*  $p < 0.01$ .

Source: Authors' calculations using The National Housing Survey (DANE-ECH).

The first column in Table 2 shows estimates from a pooled probit, which are obtained from model (1) specification using the entire sample without considering the existence of a measurement error because of the nature of pseudo panel data. The sign of the education level variable is negative and statistically significant. Each additional year of education raises the probability of working in the informal sector by 4.8 percent. The effect of the wage gap (Gap variable) is negative and statistically significant on the probability of joining informality. Our result shows that a 1% increase in the gap decreases the probability of engagement in the informal sector by 6%. With respect to the cohorts, while the first two cohorts have more than 50% probability to be in the informal sector, in the old cohorts, the probability is around 6%.

The instrumental variable probit estimation column, IV-Probit, shows the estimated probability to join the informal sector using the pseudo panel technique and robust standard errors.<sup>4</sup> In the model, we correct for selection biases. As indicated by Ribero (2003) and Correa et al. (2006), estimates of a model of the engagement in the informal sector for the entire sample of workers lead to the occurrence of selection biases because the unemployment choice is not considered.<sup>5</sup> The presence of selection

<sup>4</sup> The variance-covariance matrix of the IV-probit estimator was corrected using the method proposed by Amemiya (1978). We use all cohorts, one lag for Pib and unemployment rate as instruments (Mora and Muro 2008).

<sup>5</sup> Although Ribero (2003) and Correa et al. (2006) are aware of the problem, Ribero (2003) does not consider it. Correa et al. (2006) try to avoid it by proposing a multinomial model, which not only

bias has been corrected by estimating and incorporating Mills inverse ratio in the model. We have estimated the likelihood of participation based on the number of working individuals in the cohort following the work of Gronau (1974), Lewis (1974), Mora and Muro (2012). In particular, Mora and Muro (2012) showed that it was possible to correct the existence of selection biases based on a semi-parametric test, which involves incorporating Mills inverse ratio. The Mills inverse ratio has been computed from the proportion of the labor participating individuals in each cohort with respect to the total number of individuals in the cohort.<sup>6</sup> Our results show that the Mills inverse ratio is negative and statistically significant, thus, corroborating the presence of selection bias.

Our results indicate that all coefficients are statistically significant, and the percentage of success of the model is above 76 percent. The percentage of the correct classification of ones was 77.82 and the percentage of the correct classification of zeros was 74.39. The education level has negative effects on the probability of entering into the informal sector and one extra year of education reduces the probability of engagement in the informal sector by 3%. Finally, a 1% increase in the wage gap decreases the probability of engagement in the informal sector by around 7%.

In order to consider the relationship between minimum wage and informality, we have introduced in the specification interactions between cohort dummies and the wage gap. Marginal effects of these interactions has been computed using the following equation<sup>7</sup>,

$$\frac{\partial^2 E[Informal \mid C_{1,i(t)}, C_{2,i(t)}, C_{3,i(t)}, C_{4,i(t)}, C_{5,i(t)}, C_{6,i(t)}, MW_{i(t)}, S_{i(t)}, InvMills_{i(t)}]}{\partial W_{i(t)} \partial C_{1,i(t)}} =$$

$$= [\beta_7 + \beta_8] \phi([\beta_7 + \beta_8] * MW_{i(t)} + \beta_1 + S_{i(t)} + InvMills_{i(t)}) -$$

$$\beta_7 \phi(\beta_7 * MW_{i(t)} + \beta_1 + S_{i(t)} + InvMills_{i(t)})$$

The results are in Table 3 below.

Estimates in Table 3 bring to light an interesting issue. A rise of the wage gap reduces the benefits to work in the informal sector, but for individuals in the third cohort it increases the probability to enter into the informal sector. This result has been observed by Hernández and Pinzón (2006) at macro level and a possible

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fails to correct the selection bias, but also raises a discussion about the independence of irrelevant alternatives.

<sup>6</sup> We used 274,162 individuals in all cohorts to estimate the equation of selection.

<sup>7</sup> We acknowledge a referee for suggesting the use of a correct formula for marginal effects of interactions. Ai and Norton (2003) and Karaca-Mandic, Norton and Dowd (2012) show the procedure to be used for one interaction. We use delta method to compute standard errors.

explanation is the presence of substitution effects due to the cost in the formal labor market. When the minimum real wage drops there is an increase of the labor demand in the formal sector and a reduction of the probability of joining informality. If the reduction in unemployment is greater than the growth in formal employment wages in the informal sector drop and the wage gap increases (Fiszbain, 1992).<sup>8</sup> In the period under consideration, the reduction of unemployment was of 7%, employment increased by 0.2% and the minimum wages dropped as a percentage of the GNP (Rhenals, 2009) this is a possible explanation of the result.

TABLE 3.  
MARGINAL EFFECTS FOR INTERACTIONS

Interaction	Pool Probit		IV-Probit	
	$\beta_i$	Std. Err.	$\beta_i$	Std. Err.
C1 * Gap	-0.2084071	0.0098895**	-0.2288879	0.0240004**
C2 * Gap	-0.1255369	0.0072817	-0.1353392	0.0110986**
C3 * Gap	0.0097549	0.0050638**	0.0135323	0.005305**
C4 * Gap	-0.0768808	0.0065253**	-0.0773693	0.0065951**
C5 * Gap	-0.0664945	0.0065668**	-0.0646899	0.0068185**
C6 * Gap	-0.06814	0.0071976**	-0.0666043	0.0073797**

Note: \*  $p < 0.05$  ; \*\*  $p < 0.01$ .

Source: Authors' calculations using The National Housing Survey (DANE-ECH).

## CONCLUSIONS

The engagement of informal workers in the labor market is a topic that has been recently discussed in Colombia. Concerning the determinants of the engagement in the informal sector there is only consensus on a couple of relevant issues. Firstly, the higher the educational level, the higher the incentives to engage in the informal sector, and, secondly, non-labor income has an inverse relationship with the probability to join informality.

On the other hand, the standard results of the WGM model could be moderate in a developing country because the effect of an increased minimum wage on labor

<sup>8</sup> Boeri and Garibaldi (2009) show that the regulations in the labor market produce wage differences between sectors.

participation depends on the proportion of workers by cohorts in both formal and informal sectors. Our estimates corroborate the negative effect of the education level on the decision to enter into the informal sector. Our results also show that the minimum wage levels have an impact on the distribution of wages among formal and informal workers (Arango & Pachón, 2004; Maloney & Núñez, 2003; Lemos, 2007, 2009),<sup>9</sup> and they generate incentives to join informality.

Therefore, we recommend that the political debate about the reduction or elimination of the minimum wage in Colombia should incorporate an analysis of the current encouraging factors that have had an impact on the Colombian labor market. Among them, labor mobility between formal and informal sectors and its relationship with the labor force composition in both sectors is a relevant subject that deserves a more in-depth discussion in the design of advisable policies with respect to the reduction or elimination of the minimum wage in Colombia.

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<sup>9</sup> Arango and Pachón (2004), and Maloney and Núñez (2003) did not estimate the effect of minimum wages on the informal employment share directly.

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