# Labor informality: choice or sign of segmentation?

# A Quantile Regression Approach at the Regional Level for Colombia

**Gustavo A. García**[*]
*Universitat Autònoma de Barcelona*
gustavoadolfo.garcia@uab.cat

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**Abstract**

The labor market in developing countries is remarkably heterogeneous with a small productive formal sector, enjoying high wages and attractive employment conditions and another large informal sector with low productivity and volatile wages. The informal sector is particularly diverse. In this paper we examine the heterogeneity of the informal sector at regional level in Colombia. In general, our findings suggest that, both voluntary and involuntary informal employment co-exist by choice and as a result of labor market segmentation. We also find that there are striking differences in labor market characteristics between cities, in particular in the traditional informal segment. In less developed cities this segment represents roughly 70% of informal total informal employment, while in more developed cities it represents around 40%. Regarding decomposition of the formal/informal wage gap by groups of cities, the results show that at the bottom of the distribution coefficient effects explain most of the wage gap regardless of the group of cities. This evidences the marked labor segmentation at this point of the distribution. Conversely, the positive wage gap at the top of the distribution is mainly explained by characteristics effects in more developed cities, while in less developed cities the wage gap declines to zero since the coefficient effects compensate the differential in characteristics in favor of formal workers. These results indicate that informal workers who are located at the top of the distribution choose working in the informal sector for the wage (and non-wage) benefits that they would not have in such sector.

***Keywords***: Informality, local labor markets, quantile regression, selection bias, formal/informal wage gap decomposition
***JEL Classification*:** O17, J42, J31, C21

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## 1. Introduction

One of the features that stands out in developing countries is the great heterogeneity in their urban labor markets. It is common to observe the coexistence of a small productive formal sector, which offers attractive labor conditions and relatively high wages, with a large informal sector which uses unskilled labor, with low earnings and productivity, and does not fully comply with established legal regulations (Dickens and Lang, 1985; Maloney, 1999 and 2004; Jütting and De Laiglesia, 2009). Nevertheless, within this large informal sector, there is a considerable variety of workers.

But why is there such diversity in the informal sector? Are there different kinds of informal workers; ones who are voluntarily informal and others who end up in this sector because they do not have any other alternative form of employment? Is labor informality a choice or the result of labor market segmentation?

The segmented labor markets theory considers informality as a survival alternative to escape involuntary unemployment for those disadvantaged or rationed out of formal employment opportunities (Dickens and Lang, 1985). The result is a dualism in earnings for individuals with similar characteristics which depend on the sector in which they work. In the formal sector there are internal markets that constrain the labor supply and produce high wages, while in the informal sector there is no institutional or efficiency-wage basis that regulates the wages. In addition the few entry barriers and an abundant supply of unskilled workers lead to low wages. Thus, wages depend on the sector in which workers are employed and not on their skills *per se* (Uribe *et al*., 2007).

On the contrary, the orthodox neoclassical view of the human capital theory postulates that, like in any another market, price flexibility and free labor mobility lead to a full employment equilibrium with equal remuneration for the same kind of work (De Soto, 1987; Saavedra and Chong, 1999; Maloney, 1999). Due to this competitive market framework, being part of the informal sector may be a desirable choice for workers and firms, as it is based on the private cost-benefit calculations of belonging to the sector. Being informal can have desirable non-wage features and therefore individuals maximize their utility rather than their earnings. Alternatively, certain workers have a comparative advantage in the informal sector that they would not have in the formal sector (Gindling, 1991).

These two polarized views can be combined if the informal sector is very heterogeneous and contains elements of each scenario; namely if the informal sector has its own internal duality. Recent literature has recognized the existence of “upper” and

"lower" tiers or "voluntary" and "involuntary" entry of informal employees or firms (Fields, 1990 and 2005; Cunningham and Maloney, 2001; Maloney, 2004). In such a scenario the upper-tier employees are those who are voluntarily informal because, given their specific characteristics, they expect to earn more than they would in the formal sector. On the contrary, the lower-tier employees are those disadvantaged workers that see informality as a last resort.

Nevertheless, from the empirical stance this more recent view on dualism within the informal sector has not been satisfactory treated. For example, Magnac (1991) when testing for competitiveness or segmentation in the labor market of Colombia in the 1980's, found evidence of a competitive labor market structure. Similarly, Gindling (1991) and Pratap and Quintin (2006) found evidence of segmentation in Costa Rica and of a competitive structure in Argentina, respectively. However, in all the above papers the authors assume homogeneity of the informal sector, thus limiting their analysis.

Among the few studies that have tried to model the heterogeneous structure of the informal sector, we can list Cunningham and Maloney (2001), and Günther and Launov (2012). The former model the informal sector as a mixture of "upper-tier" and "lower-tier" enterprises and using econometric techniques of factor and cluster analysis they allow for the segmentation of the market. However, despite finding evidence of segmentation, Cunningham and Maloney (2001) considered only informal firms, so that the alternative of being a formal firm does not exist in their model. Further, they do not take into account the selection bias induced by the type of employment decision of individuals.

The work of Günther and Launov (2012) analyzes the possible heterogeneous structure of the informal sector, estimating a finite mixture model which allows determining the number and size of segments that could compose the informal sector. This model uses minimal *a priori* assumptions to determine the segments and provides a new method to identify the size of voluntary and/or involuntary employment in the informal sector. The empirical analysis uses data from the Ivory Coast at the end of the 1990s. Among their findings, the authors report that the informal sector consists of two segments: a high-paid and a low-paid segment. They also found that 45% of informal employment is not voluntary and is mainly located in the lower-paid informal segment, while the remaining 55% of informal employment is voluntary and is situated in the higher-paid informal segment.

In this paper we analyze the heterogeneity of the informal sector decomposing the wage differential between the formal and informal sector throughout the entire distribution of wages. This methodology is conceptually similar to Günther and Launov's (2012) approach, except it accounts for a wider variety of informal employees as well as formal ones. Our method advances beyond the studies based on the workers' mean-earnings which are incapable of distinguishing if there are different behaviors throughout the entire distribution of wages.

Our research focuses on the regional labor markets of Colombia. Given the geographic, demographic, social conditions and economic dynamics, Colombia provides rich evidence from a large, heterogeneous informal sector. Furthermore, there are marked differences in the structures and dynamics of the local labor markets. In Colombia roughly six out of ten employees work in the informal sector[1] and cities such as Cúcuta or Montería have informality rates of around 75%. Others such as Medellín or Bogotá, have rates of about 50% (García, 2011; Galvis, 2012).

In order to analyze the different motivations to join the informal sector we decompose the formal/informal wage gap. Such decomposition allows us to distinguish what proportion of the wage gap is due to differences in prices related to individual characteristics and what proportion is due to characteristics which differ between the formal and informal sector. If the wage gap is mainly attributable to the first factor it indicates that individuals in the informal sector earn less because they get lower returns for their skills and therefore they are part of the disadvantaged sector of a segmented market. On the other hand, if the wage gap is primarily explained by the second factor, the labor segmentation is not as strong as in the above case and the differences in wages between sectors are due to differences in endowments. In this latter situation, being an informal worker is a choice, because these individuals can get non-wage benefits or earn more than they would not earn in the formal sector.

To carry out the decomposition, we estimate earnings functions for informal and formal workers using quantile regression taking into account the possibility of self-selection into those sectors. We follow the method of Machado and Mata (2005) and the extension proposed by Albrecht, Vuuren and Vroman (2009) to account for selection, which is based on Buchinsky (1998) who uses semi-parametric methods.

[1] According to International Labor Organization (ILO, 2011) estimates, Colombia is the fourth country with the highest informality rate in South America after Paraguay (70.4%), Perú (70.3%) and Bolivia (69.5%).

Following this introduction, Section 2 proceeds with the description of the data. In Section 3 we discuss the estimation procedure. Section 4 describes the empirical findings, and finally conclusions are drawn in Section 5.

## 2. Data and descriptive evidence

The data used in this paper come from the Great Integrated Household Survey (GIHS) for 2009, carried out by the National Administrative Statistics Department (DANE). This cross-section survey has information at micro-data level on labor force, unemployment and informality of thirteen major Colombian cities and their metropolitan areas.[2]

The sample considered in this work is composed of individuals between 12 and 65 years old and we further excluded agriculture workers. Our final sample is composed of 62,278 individuals.[3] The main variable of analysis is the real hourly wage, computed as the monthly wage divided by the effective number of hours worked during that month and adjusted for the price level using the consumer price index (base year 2008) of each city as deflator.[4]

As regards informality, we define informal workers as those workers who are not covered by the social security system. More precisely, informal workers are those workers who are not covered by the health insurance and the pension system. Applying this condition, we have 36,293 (58.3%) formal workers and 25,985 (41.7%) informal workers. In Table 1, we give some descriptive statistics for the key variables for formal and informal workers.

[2] Namely, Barranquilla, Bogotá, Bucaramanga, Cali, Cartagena, Cúcuta, Ibagué, Manizales, Medellín, Montería, Pasto, Pereira, and Villavicencio. These metropolitan areas represent 45% of total population and about 60% of urban population according to 2005 Population Census.

[3] Note that we excluded government employees, employers and self-employed. Given this exclusion the informality rate may differ from that reported by ILO.

[4] Consumer price indices for the biggest cities in Colombia were obtained from DANE. Since each one of these cities is the core of a metropolitan area, we applied the consumer prices index of the city to the whole metropolitan area. To Ibagué the consumer prices index is no calculated by DANE, so we decided to use the consumer prices index of Pereira given the similarities in population and social and cultural characteristics, as well as proximity between theses cities.

**Table 1.** Descriptive statistics

| | **Formal workers** | **Informal workers** | **Total** |
|---|---|---|---|
| Real hourly wage | 3269.2 | 2311.9 | 2927.4 |
| Age (years) | 34.3 | 32.9 | 33.8 |
| Education (years) | 11.0 | 8.6 | 10.2 |
| Tenure at job (years) | 4.7 | 2.8 | 4.0 |
| | | | |
| *Education levels* | | | |
| Less than primary | 0.3 | 1.6 | 0.8 |
| Primary | 24.4 | 49.7 | 33.4 |
| Secondary | 37.6 | 32.7 | 35.9 |
| Tertiary | 37.7 | 16.0 | 29.9 |
| | | | |
| Male | 55.6 | 48.7 | 53.1 |
| Head of household | 43.0 | 35.4 | 40.3 |
| Married | 53.5 | 46.1 | 50.8 |
| | | | |
| *Firm size* | | | |
| 1 – 10 employees | 17.9 | 76.6 | 38.9 |
| 11 – 50 employees | 22.3 | 14.1 | 19.3 |
| More than 51 employees | 59.8 | 9.3 | 41.8 |
| | | | |
| Sample size | 36,293 | 25,985 | 62,278 |

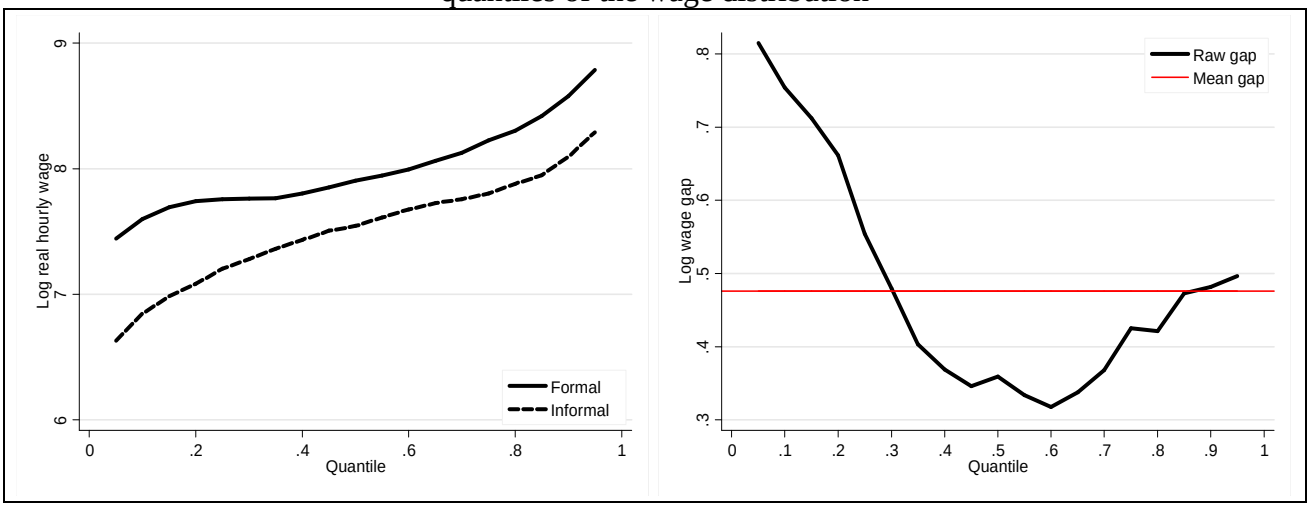
Note: We used person sampling weight available in the database. The wages are in Colombian pesos (in December 2009 the exchange rate was 2935 Colombian pesos per euro).

As can be seen from Table 1, the average wage among formal workers is higher than the corresponding average among informal workers: a formal worker earns on average 30% more than an informal worker. In terms of the variables that we can use to explain variation in wages, there are also some important differences between kinds of employees. Formal workers have on average similar age than informal workers, and years of tenure at job are higher for formal workers than informal workers. Turning to education we can see that formal workers are consistently more educated than informal. The informal sector has a higher percentage of individuals with primary and less than primary education (51%), while the formal sector has a much higher percentage of individuals with secondary and tertiary education (75.3%). As regards other personal characteristics, we can see that the informal workers are less likely being men, head of household and married than formal workers. Finally, informal workers are more likely to work in firms between 1 and 10 employees (77%), while formal workers are employed in firms of more than 51 employees (60%).

Figure 1 depicts the estimated kernel densities of formal's and informal's wages. Wage disparities between sectors are clearly visible, as wage distribution for formal workers is shifted to the right. The distribution of formal and informal sector wage and wage gap between sectors by quantile, i.e., the difference in log wages between formal workers and informal workers at each quantile of their respective distributions, is plotted in Figure 2. We can see that wage differential between sectors is positive along the whole wage distribution with a large wage gap within low-paid occupations. Its size ranges between 54% at the bottom end of the distribution to 30% at the median, then increasing to roughly 39% at the top end of the distribution. There are marked differences between formal and informal workers especially within low-paid and high-paid occupations, which may be due to very different human capital endowments and job opportunities in these points of the earnings distribution.

**Figure 1.** Kernel density of log real hourly wage by formal and informal sector

**Figure 2.** Wage differentials between formal and informal sector over different quantiles of the wage distribution




At the city level we can see that there are also positive wage differences between sectors along the whole distribution and there are different patterns between cities (see Figure A1 in the Appendix). Pasto, Montería and Cartagena present the largest wage gaps, with particularly large wage gap within low-paid occupations. The common characteristic in these cities is that they present the highest levels of informality in Colombia (see Table A1 in the Appendix) and therefore there is an important heterogeneity of employments and workers in the informal sector. In these cities the relative abundance of informal jobs is an important determinant to join the informal sector. Turning to the biggest and most developed cities, such as Bogotá, Medellín, and Cali, we can see that the wages differentials between sectors are smaller than in the first cities.

In order to simplify the presentation of the results of the empirical exercise we define three groups of cities. In the following section we describe these groups and present some descriptive statistics of their labor markets.

### 2.1 Group of cities and their labor markets

We have divided the total sample into three sub-groups of cities corresponding to a group of central and more developed cities, and other two groups of peripheral cities which present a significant informal sector.

In the first group of cities (Group 1) are included Bogotá, Medellín, Cali, Bucaramanga, Manizales, Pereira and Ibagué. This group is composed of the largest industrial and the most dynamic cities in Colombia, and they form the core of the

country's economic activity. These cities represent 0.7% of the national territory and according to the 2005 Population Census they concentrated around 45% of urban population. In terms of economic activity the region formed among Bogotá, Cali, Medellín and Bucaramanga account for 70% of Colombian GDP at the department level.[5][6] Figure 3 shows the spatial distribution of the real GDP per capita at department level in 2009.[7] Overall, it can be seen that excluding the mining departments (Arauca, Casanare and Meta have the largest oil fields in the country and they account for 6% of Colombian GDP in 2009) the highest levels of GDP per capita are in the central region. It is also worth to highlight that the ranking occupied by these cities in terms of their degree of informality has been relatively stable in the time. In this respect, García (2008 and 2011) and Galvis (2012) from a regional perspective have found that these cities show consistently lower informality levels comparing to those cities out of this region (see Figure 4).

As regards the second group of cities (Group 2), it is composed by Barranquilla and Cartagena. Although these cities are among the most urbanized cities and present an important economic dynamic (see Figure 3), their tourist and export vocation make them different from other cities. In these cities are located the main ports of the country and have an important industrial cluster associated with the petrochemical-plastic sector.[8] Nevertheless, their socioeconomic and labor market indicators are unfavorable. These cities show one of the highest poverty, inequality and informality levels among the main cities of Colombia (Bonilla, 2008; Galvis, 2009). As can be seen from Figures 4 and 5, Cartagena and Barranquilla along with Montería and Cúcuta, present the highest levels of Unsatisfied Basic Needs (UBN), as well as of informality. The tourist vocation of the Caribbean region and the relatively low capacity to create jobs in the highly productive sectors (such as chemical, plastic and petrochemical sectors), due to

[5] Colombia is made up of thirty-two departments and Bogotá, the Capital District. Departments are country subdivisions similar to US states, are granted a certain degree of autonomy and each has its own capital city.

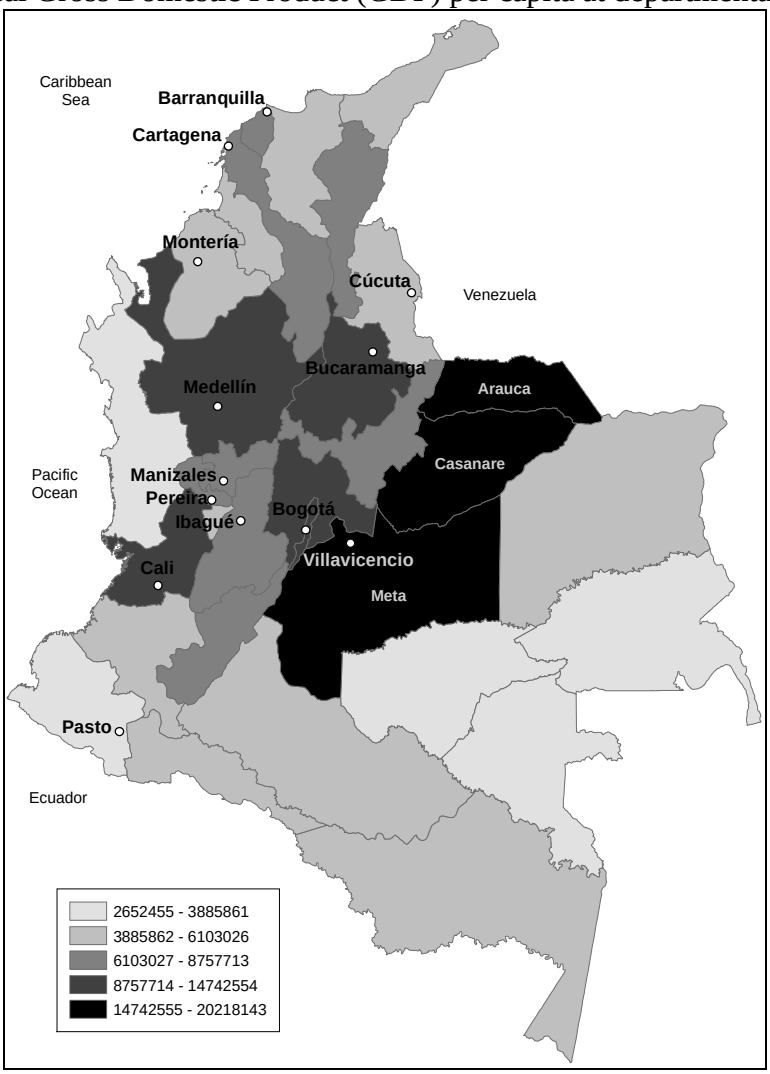
[6] Galvis (2007) undertakes a study identifying the economic regions in Colombia at city level and uses the bank deposits and the local tax collections per capita as measures of economic activity of the cities (according to Bonet and Meisel (1999) there is a correlation between GDP and bank deposits of around 0.8). The author reports that the region formed among these cities account for 80% of total economic activity of the country.

[7] A more relevant variable would be GDP per capita at city level, but in Colombia this data is not available.

[8] In the industrial zone of *Mamonal* in Cartagena is located the second oil refinery of Colombia which is integrated with petrochemical, chemical and plastic industries. Barranquilla is highly specialized in the food and beverages, chemicals, non-metallic mineral products and basic metallurgy sectors. A more detailed economic characterization of Barranquilla and Cartagena can be found in Bonilla (2010) and Acosta (2012), respectively.

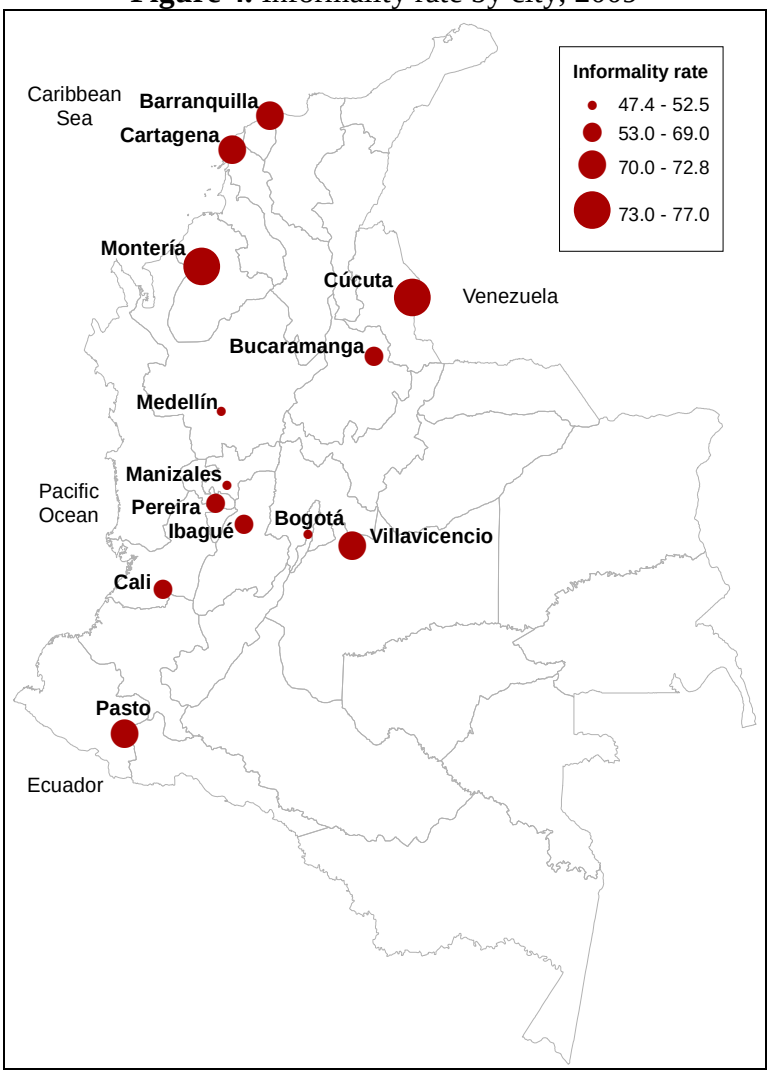
these are mostly composed by big companies with high capital intensity and export activities, have led to a process of tertiarization of the economy. The service sector has little impact on the competitiveness of the other sectors and generates a lot of jobs but of low quality in terms of pay and working conditions (Bonet, 2005 and 2007; Bonilla, 2010; Cepeda, 2011; Acosta, 2012).

**Figure 3.** Real Gross Domestic Product (GDP) per capita at departmental level, 2009




Source: DANE - Colombian currency, constant 2005 prices.

**Figure 4.** Informality rate by city, 2009

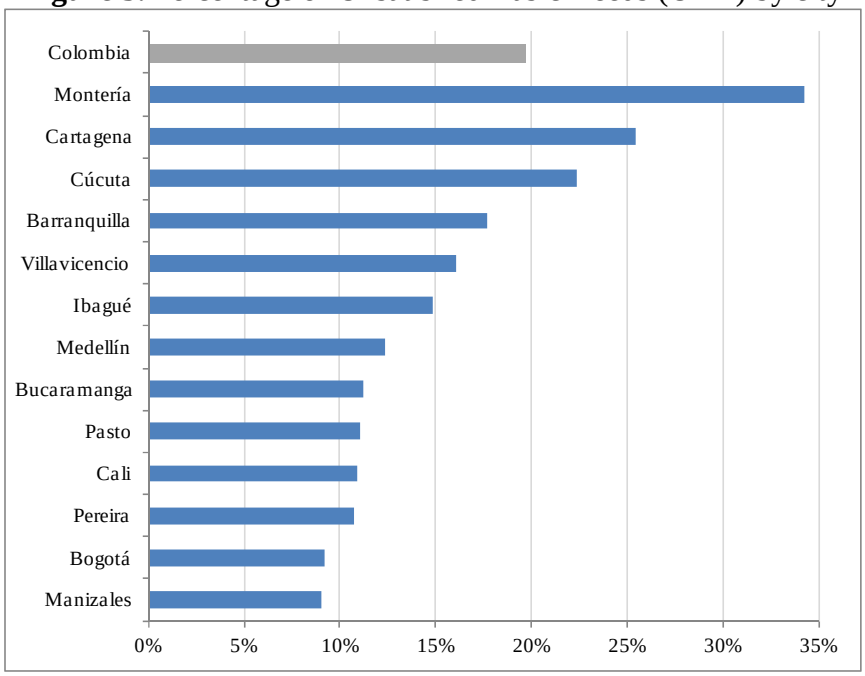



Source: Table A1 in the Appendix.

The third group of cities is composed by Cúcuta, Montería, Pasto and Villavicencio (Group 3) which are the most lagged cities, located in peripheral areas and their activities are very much influenced by agriculture, mining and commerce (see Figure 3). Pasto and Cúcuta are border cities, the first one shares border with Ecuador and the second one with Venezuela, which is a common characteristic that can influence the type of activity and the employment generated, above all those related with the commerce (legal and illegal) and currency exchange (Bonet, 2007; García, 2005 and 2011). Villavicencio is the capital of the department of Meta which currently has the largest oil fields in the country (the department of Meta produce 47% of oil in Colombia (DANE, 2011)) and along with Montería are the capitals of the two main cattle farming regions of the country and therefore their economies are based mainly on these

activities. Furthermore, these two regions are considered conflict zones due to the presence of paramilitaries, guerrillas and drug trafficking activities, which influence not only the activity economic but also the social, political and cultural aspects of the regions (Vilore de la Hoz, 2009; Sánchez *et al*., 2012). Regarding informality, in contrast to first group of cities, this group shows the highest informality levels being Cúcuta the one with the highest rate (77%) (see Figure 4). According to García (2008 and 2011) and Galvis (2012) informality is more prevalent in less prosperous cities, which are usually located on the periphery of the country with less resources and industrial developed than cities of the center of the country.

**Figure 5.** Percentage of Unsatisfied Basic Needs (UBN) by city




Source: 2005 Population Census – DANE

In Table 2 we show some descriptive statistics of the labor markets that form the three groups of cities. As expected, there are a higher percentage of informal wage workers in the group of cities 2 and 3 (47 and 56%, respectively) than in the group 1 (35%). We also can see that the formal workers earn more than the informal workers, and the differences are more severe in the group of cities 2. While the wage differences between sectors in the group of cities 1 is 26%, in the group 2 and 3 the wage differences are 37 and 34%, respectively.

Regarding education we can note that on average the difference between sectors is higher in the group of cities 2 than in the other two groups of cities. By education

levels we can see that the group of cities less developed (Group 3) has a higher percentage of informal workers with primary and less than primary education (56%) than the group of cities more developed (53% in Group 1 and 43% in Group 2), while this two latter group has a higher percentage of informal workers with tertiary education (16 and 21%, respectively) than the former group (10%). There are also striking differences by education level in the formal sector among group of cities. Interestingly, around half of the formal workers in the group of Caribbean coast cities (Group 2) have tertiary education, while in the group of more developed cities (Group 1) this percentage reaches barely 37%. The reason for these results may be associated with higher degree of industrial specialization that there is in Barranquilla and Cartagena. According to Acosta (2012), these cities are among the most specialized cities of Colombia and the industrial sectors of chemicals, petrochemicals, rubber and plastic are leading such specialization. These industries are technically complex and therefore require highly skilled labor. In this regards, Arango (2011), who studies the differences of main variables of the labor markets of the major cities of Colombia in the period from 2001 to 2011, find that indeed Barranquilla and Cartagena (along with Bogotá) are cities characterized by having the highest worker education rates in Colombia.

**Table 2.** Descriptive statistics by groups of cities

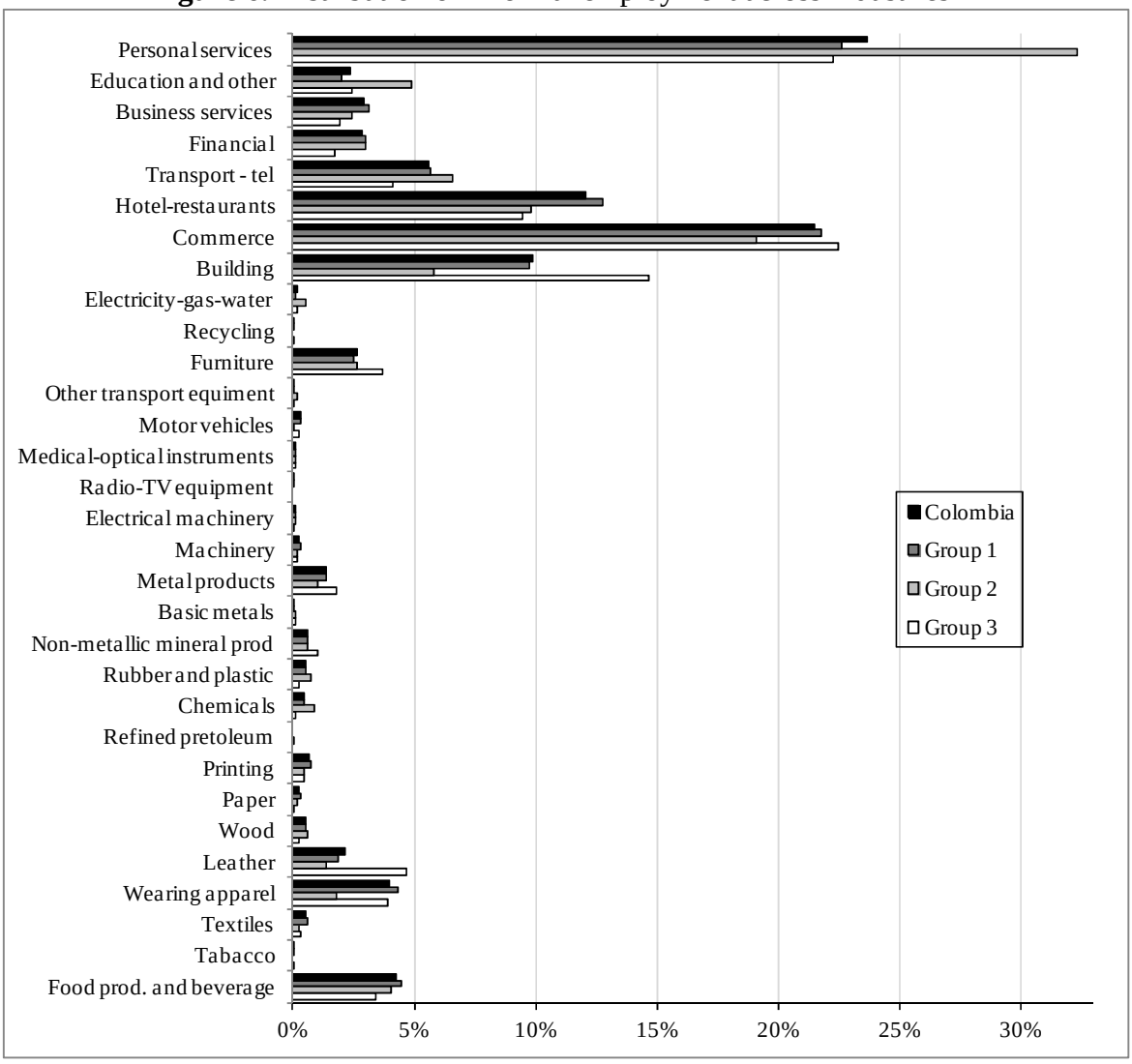
| | **Group 1** | | | **Group 2** | | | **Group 3** | | |
|---|---|---|---|---|---|---|---|---|---|
| | **Formal workers** | **Informal workers** | **Total** | **Formal workers** | **Informal workers** | **Total** | **Formal workers** | **Informal workers** | **Total** |
| Real hourly wage | 3273.1 | 2408.5 | 2989.8 | 3240.8 | 2031.1 | 2688.0 | 2941.5 | 1946.7 | 2492.6 |
| Age (years) | 34.2 | 33.0 | 33.8 | 35.4 | 33.9 | 34.7 | 34.1 | 31.7 | 32.7 |
| Education (years) | 10.9 | 8.6 | 10.2 | 11.9 | 9.2 | 10.7 | 10.1 | 8.1 | 9.4 |
| Tenure at job (years) | 1.9 | 1.4 | 1.8 | 2.2 | 1.7 | 2.0 | 1.9 | 1.4 | 1.6 |
| *Education levels* | | | | | | | | | |
| Less than primary | 0.3 | 1.4 | 0.7 | 0.2 | 1.9 | 1.0 | 0.6 | 2.75 | 1.8 |
| Primary | 25.4 | 50.4 | 33.6 | 14.7 | 42.0 | 27.1 | 19.9 | 53.2 | 39.1 |
| Secondary | 37.1 | 32.1 | 35.4 | 39.5 | 35.3 | 37.6 | 45.4 | 33.8 | 38.7 |
| Tertiary | 37.2 | 16.1 | 30.3 | 45.6 | 20.8 | 34.3 | 34.1 | 10.3 | 20.4 |
| Male | 55.1 | 48.3 | 52.9 | 62.0 | 46.2 | 54.8 | 53.4 | 54.2 | 53.8 |
| Head of household | 43.0 | 35.8 | 40.7 | 43.6 | 31.0 | 37.9 | 42.4 | 36.5 | 39.0 |
| Married | 52.3 | 45.7 | 50.1 | 64.8 | 49.9 | 58.0 | 56.4 | 45.6 | 50.1 |
| *Firm size* | | | | | | | | | |
| 1 – 10 employees | 18.5 | 77.3 | 37.7 | 9.0 | 67.3 | 35.7 | 20.8 | 81.1 | 55.7 |
| 11 – 50 employees | 22.3 | 13.6 | 19.4 | 23.5 | 17.2 | 20.6 | 22.1 | 13.7 | 17.2 |
| More than 51 employees | 59.3 | 9.1 | 42.9 | 67.5 | 15.5 | 43.7 | 57.1 | 5.2 | 27.1 |
| Sample size | 25,368 | 13,723 | 39,091 | 4394 | 3832 | 8226 | 6531 | 8430 | 14,961 |

Note: We used person sampling weight available in the database. The wages are in Colombian pesos (in December 2009 the exchange rate was 2935 Colombian pesos per euro).

Another difference among group of cities can be found in the firm size variable. As can been seen from Table 2, in the group of cities 2 there is substantially a higher proportion of informal workers carry out their activities in medium and large firms (around 33%) than in the group of cities 1 and 3 (23% and 19%, respectively). This difference can reflect the fact that in the former group of cities there is a relative higher share of informal workers in modern activities such as chemicals, petrochemicals and plastic in which are cities have high specialization.

Figure 6 shows the distribution of informal sector employment across 2-digit industries by group of cities. Most informal sector employment is in the service sector (around 80%), being the personal services and commerce sectors where is concentrated the greater share of informal employment. It is noteworthy the case of the group of Caribbean coast cities in which more than a third of informal workers are employed in the personal services sector. This result reflects the marked influence of tourism activities to the economy of this region. Within the industrial sector, overall, it can been seen that the informal employment is in food and beverages and wearing apparel, followed by furniture, leather and metal products. In this sector, the group of cities 3 has a relatively higher proportion of informal employment in leather and wearing apparel sectors, which can show the incidence of border and cattle farming activities on the productive structure of these cities. As noted, the sectoral composition of production of cities is an important aspect to take into consideration in the explanation of informality at regional level.

**Figure 6.** Distribution of informal employment across industries

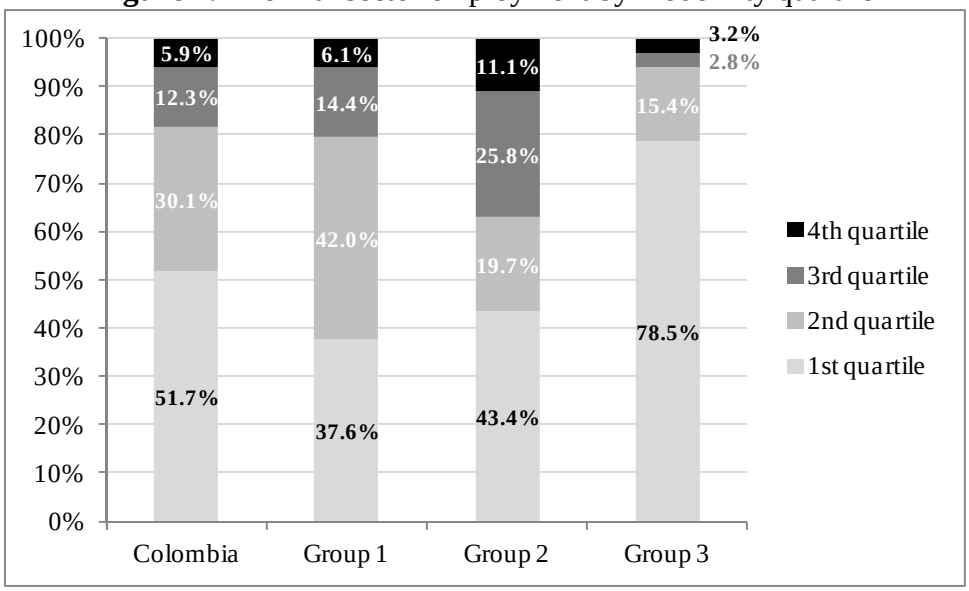



In order to measure the degree of modernity of the informal sector for each industry we calculate an index based on the location and size of firms where the worker performs his activity. This measure is suggested by Ranis and Stewart (1999) and they argue that the modern informal segment is capital-intensive, usually larger in size, dynamic in technology and often organized outside their owners' homes.[9] Hence, we defined our measure of modernity of informal sector as the log ratio between the number of workers perform their activity in enterprises with more than 10 workers and with a local fixed such as offices or plants but outside of the household, and the number of workers perform their activity in enterprises with 10 or fewer workers and located in the household, without local fixed or outside of a office or plant (such as kiosks, vehicles, among others). We calculated this index for each 2-digit industry and city.

[9] See Moreno-Monroy *et al.*, (2012) for an application of this index for the case of India.

Figure 7 displays the distribution of informal employment across modernity quartiles for the total sample and by group of cities. As shown in figure less than 6% of informal employment in Colombia is in sectors in the top quartile of the modernity index distribution, that is, where the majority of workers perform their activity in large firms and with a fixed location. In fact, more than half of informal employment (52%) remains in the most traditional activities. By group of cities the results show that more developed cities (Group 1 and 2) have higher degree of modernity of the informal sector than less developed cities (Group 3). By contrast, as expected, in less developed cities most of informal employment is in less modern and most traditional activities (79%).

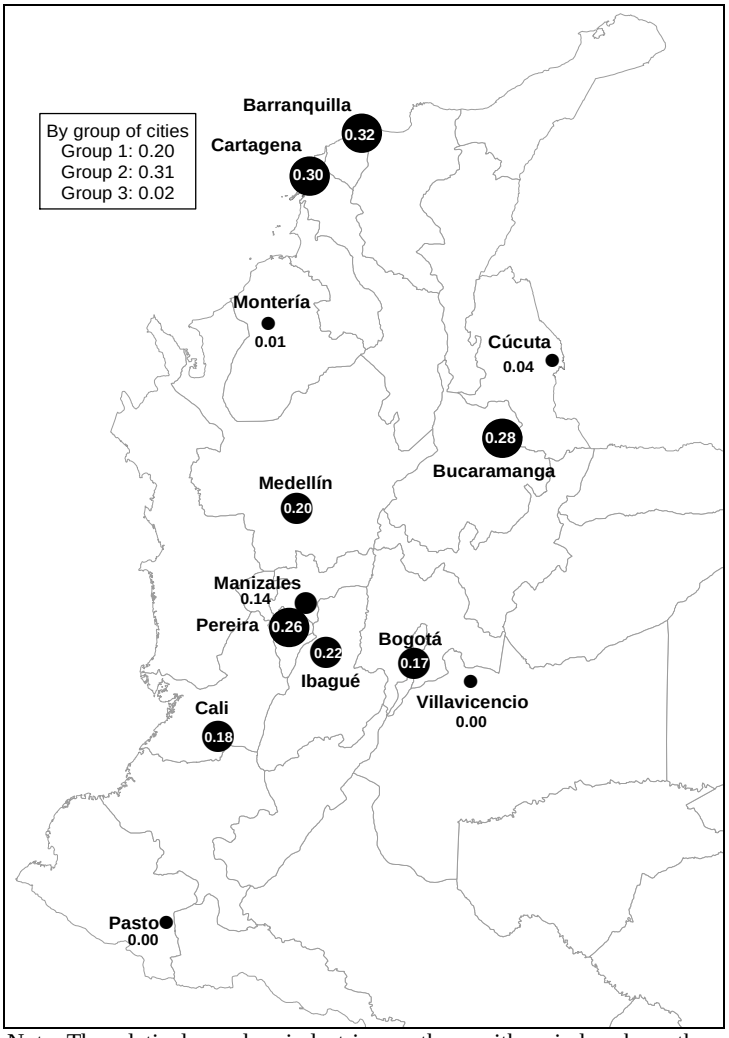
**Figure 7.** Informal sector employment by modernity quartile




Interestingly from Figure 7, we can also note that there is a difference of 5 percentage points in the top quartile of the modernity index distribution between the group of cities 1 and 2. This result can indicate that in the latter group the modern informal segment has a higher size than in the former group. In Figure 8 we show the size of modern informal segment by each city calculated as the share of informal industrial employment in relatively modern industries. As can be seen from data in figure, Barranquilla and Cartagena present the highest share of informal modern employment, around 31%. This higher size of the modern informal segment in these cities may be associated with the cluster of plastic and petrochemical activities which

generate important productive linkage (DNP, 2007; Acosta, 2012).[10] According to Ranis and Stewart (1999) higher intermediate linkages (e.g. through subcontracting) between the formal and informal sector in the most productive and moderns sectors can lead to the expansion of the modern informal segment.[11]

**Figure 8.** Share of informal industrial employment in relatively modern industries



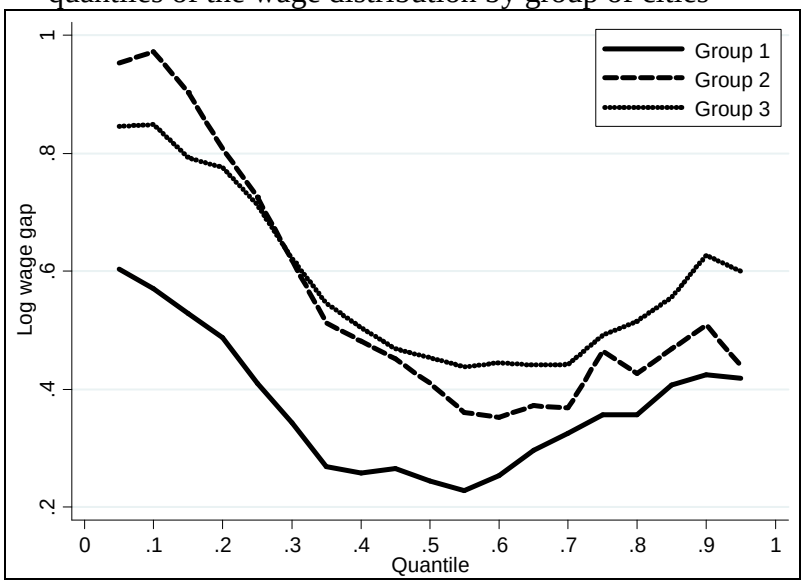

Note: The relatively modern industries are those with an index above the average index of modernity.

Turning now to the wage gap between sectors, in Figure 9 we present this at each quantile of their respective distributions by groups of cities. From the figure we can see that the wage differentials between the formal and informal sector are considerably lower in the group of cites 1, above all at the bottom end of the

[10] According to Bonilla (2010) and Acosta (2012) the sectors of chemicals, petrochemicals and plastics have an important contribution to the value added of these cities.
[11] In fact, in the group of cities 3 the sectors of chemicals and plastics have the highest index of modernity (see Figure A2 in the Appendix)

distribution. Interestingly, it can also note that the wage differential at the bottom of the distribution is higher in the group of cities 2 than group 3. This result can be due to the strong influence of personal services activities associated with the tourism in the Caribbean coast cities, the majority of which are informal activities of very low qualifications and wages.

**Figure 8.** Wage differentials between formal and informal sector over different quantiles of the wage distribution by group of cities




### 3. Estimation procedure

In order to determine what factors influence the wage gap between the formal and informal sector taking into account the heterogeneity of workers along of the distribution, as well as the differences that can exist between groups of cities, we make use of the quantile decomposition methodology. Quantile regression methods are particularly useful to analyze the decomposition of the wages gap at different points of the distribution in situations where disparities are large, as is the case of a country like Colombia (Bonilla, 2008 and 2009). Furthermore, this methodology allows takes into account the wage heterogeneity between group of individuals and the different impact that could have the determinants of wages and their gaps by type of employment at different points of the distribution (Machado and Mata, 2005). Thus, the results are more complete than those obtained by OLS.

The decomposition methods have been extensively used to analyze the gender and union wage gap, and temporal change in wage.[12] In recent years this approach also has been used to study the wage differences by race (Bucheli and Porzecanski, 2011), ethnicity (Atal *et al.*, 2009), native/immigrant (Simón *et* al., 2008; Nicodemo and Ramos, 2012) and type of workers such as private/public (Lucifora and Meurs, 2006; Bargain and Melly, 2008), full/part-time (Hardoy and Schone, 2006; Wahlberg, 2008), permanent/temporary (Bosio, 2009; Comi and Grasseni, 2009) and formal/informal (Bargain and Kwenda, 2010; Arabsheibani and Staneva, 2012).

We now present a brief description of the estimation procedure of the Machado and Mata decomposition with sample selection adjustment. We follow the adaptation of the Machado-Mata procedure introduced by Albrecht *et al*. (2009) based on Buchinsky (1998), which is a non-parametric method to account for selection for quantile regression.

In our analysis, the potential selection bias in the estimation of wage equations may result from a self-selection of individuals into different employment types: formal or informal. There are several observable and unobservable factors which may affect whether a worker is part of the formal or informal sector. In order to correct this selection bias, as a first step we could follow Heckman (1979) and estimate a probit model to calculate the probabilities of workers being in the formal and informal sector. However, the methodology proposed by Buchinsky (1998) does not impose the restriction of normality and instead uses a semi-parametric method developed by Ichimura (1993), which makes no assumptions about the distribution of the residuals.

Following Buchinsky (1998), we thus let $I_i$ be the variable that indicates the sector in which worker *i* is employed and takes the values: 1 for the informal and 0 for the formal. For this binary model we have the following equation for the latent or index variable:

$$I_i^* = z_i'\gamma + v_i, \tag{1}$$

where $z_i$ is a set of observable characteristics that influence the probability that a worker *i* is employed in the informal sector; and $\gamma$ is a vector of coefficients to estimate. The employment sector is determined by:

$$I_i = \begin{cases} 1 \text{ if } I_i^* > 0 \\ 0 \text{ if } I_i^* \leq 0 \end{cases} \tag{2}$$

[12] A more detail literature review of this methodology can be found in Fortin *et al*. (2011)

Now, let $X_{inf}$ and $X_{for}$ be the stochastic vectors of characteristics for informal (*inf*) and formal (*for*) workers which have distribution functions $G_{X_{inf}}$ and $G_{X_{for}}$, respectively. The realizations of these stochastic vectors are given by $x_{inf}$ and $x_{for}$. The endogenous variable that represents the log wage is $Y_{inf}$ for the group of informal workers and $Y_{for}$ for the group of formal workers and have unconditional distribution functions $F_{Y_{inf}}$ and $F_{Y_{for}}$, respectively. The quantile regression can be written for each sector as:

$$Q_\theta(Y_{for} \mid X_{for} = x_{for}) = x'_{for}\beta^{for}(\theta) \tag{3}$$

and

$$Q_\theta(Y_{inf} \mid X_{inf} = x_{inf}) = x'_{inf}\beta^{inf}(\theta), \tag{4}$$

where $Q_\theta(Y \mid X = x)$ is the conditional quantile at $\theta^{th}$ quantile. The Machado-Mata procedure consists in generating a random sample of size *m* from a uniform distribution $U[0,1]: u_1, u_2, ..., u_m$, and calculating the conditional quantile regression for each group which yields *m* estimates of the quantile regression coefficients $\hat{\beta}^{inf}(u_m)$ and $\hat{\beta}^{for}(u_m)$. Then we use the estimated result and a random sample of size *m* of the vectors of covariates *x* to predict simulated values of both $\hat{y}_{for} = \tilde{x}'_{for}\hat{\beta}^{for}(u)$ and the counterfactual wage distribution $\hat{y}_{inf} = \tilde{x}'_{inf}\hat{\beta}^{for}(u)$, that is, the wage distribution of the informal sector resulting from assigning the returns of the formal sector but keeping the observed characteristics of the informal sector unaltered. These steps are repeated *m* times. Finally, the difference between the log wages of formal workers and the log wage given in the counterfactual distribution at the $\theta^{th}$ quantile can be decomposed as:

$$\begin{aligned} Q_\theta(Y_{for} \mid X_{for} = \tilde{x}_{for}) - Q_\theta(Y_{inf} \mid X_{inf} = \tilde{x}_{inf}) = & \underbrace{\left[ Q_\theta(\tilde{x}'_{for}\hat{\beta}^{for}(u)) - Q_\theta(\tilde{x}'_{inf}\hat{\beta}^{for}(u)) \right]}_{characteristics\ effects} \\ & + \underbrace{\left[ Q_\theta(\tilde{x}'_{inf}\hat{\beta}^{for}(u)) - Q_\theta(\tilde{x}'_{inf}\hat{\beta}^{inf}(u)) \right]}_{coefficient\ effects} \end{aligned} \tag{5}$$

The first term of the right hand side of expression (5) refers to the characteristics effects. This term shows the contribution of the differences in the distribution of endowments between formal and informal workers to the wage gap at the $\theta^{th}$ quantile. The second term computes the counterfactual value of the wage gap if the informal

workers retained their observed characteristics but were paid for them like the formal workers. This term represent the coefficient effects. We use a bootstrap procedure to estimate standard errors for the reported components of the decomposition.

Since we only observe the wages of those workers who actually work in the informal or formal sector, these workers are not draw randomly from the distribution of individuals and therefore there can be a selection bias when we estimate the wage equations. Consequently, in order to correct for selection and to get unbiased estimates of $\beta$ in the quantile wage equations, Buchinsky (1998) proposes to introduce an extra term in the quantile regressions, namely,

$$Q_\theta(Y_{for} \mid Z = z) = x_{for}^{'}\beta^{for}(\theta) + h_\theta(z^{'}\gamma) \tag{6}$$

and

$$Q_\theta(Y_{inf} \mid Z = z) = x_{inf}^{'}\beta^{inf}(\theta) + h_\theta(z^{'}\gamma). \tag{7}$$

The vector *Z* includes also the set of observable characteristics that influence wages (i.e., the *X*'s), but for identification *Z* must contain at least one variable that is not included in *X* and should be uncorrelated with the log wage. The term $h_\theta(z^{'}\gamma)$ plays the same role as Mill's ratio in the usual Heckman (1979) procedure, but it is quantile-specific and more general so as not assume normality. Buchinsky (1998) suggests the following power series approximation to the term $h_\theta(z^{'}\gamma)$

$$\hat{h}_\theta(z^{'}\gamma) = \sum_{k=1}^{K}(\lambda(\hat{\mu}' + \hat{\sigma}z^{'}\hat{\gamma}))^{k-1}\hat{\delta}_k(\theta), \tag{8}$$

where $\lambda(\cdot)$ represents the usual inverse Mill's ratios, and $\hat{\mu}$ and $\hat{\sigma}$ are scaling parameters which are estimates of the constant and slope coefficients from the probit regression of $I_i$ on the index $z^{'}\hat{\gamma}$.

In order to estimate the coefficients $\gamma$ in equation (1), Buchinsky (1998) proposes to use the semi-parametric least-squares (SLS) method proposed by Ichimura (1993). Since we estimate a semi-parametric sample selection model, the intercept in the wage equation is not identified. When *k*=1 in equation (8), $\delta_1(\theta)$ is equal to one and therefore it cannot be separately identified from the constant term in $\beta(\theta)$. To identify the constant term in the wage equation, we first remove the *k*=1 term from the power series expansion and estimate the resulting quantile model; and then we estimate the constant term in the wage equation without adjusting for selection by using a subsample of observations such that the probability of informal sector participation is close to one.

In summary, the extension of the Machado-Mata algorithm to adjust for selection proposed by Albrecht *et al*. (2009) is the following:

1. Estimate $\gamma$ using a semi-parametric least-squares (SLS) method (Ichimura, 1993).
2. Sample *u* from a standard uniform distribution.
3. Compute $\hat{\beta}^{inf}(u)$ and $\hat{\beta}^{for}(u)$ using the Buchinsky technique.
4. Sample $x_{inf}$ and $x_{for}$ from the empirical distribution $\hat{G}_{X_{inf}}$ and $\hat{G}_{X_{for}}$, respectively.
5. Compute $\hat{y}_{for} = \tilde{x}'_{for}\hat{\beta}^{for}(u)$ and $\hat{y}_{inf} = \tilde{x}'_{inf}\hat{\beta}^{for}(u)$.
6. Repeat steps 2 – 5 *m* times. [13]
7. Compare the simulated distributions to decompose the estimated wage gap between sectors.

## 4. Results

In this section we present the results of the quantile decomposition formal/informal wage gap. The conditional quantile regression approach proposed by Machado and Mata (2005) allows decomposing the difference between the formal and informal workers log wage distributions and identifying how much of the wage gap estimated at different quantiles of the wage distribution can be attributed to differences in characteristics and how much can be attributed to differences in returns to those characteristics.

### 4.1 SLS estimation and the quantile regression models

As mentioned in Section 3, in the first step we estimate the semi-parametric least squares (SLS) model for the probability of being informal, and in the second step we estimate the quantile regression models for the wage equation including the power series expansion to deal with selection. In both the probability and the quantile regression models we included variables for education levels, gender, and dummies for size of firm, industry and occupation. In order to identify the probability models we included variables for presence of children between 0 and 12 years old at home, presence of other relatives working as formal workers, the average number of years of education of members of the household as a measure of the educational environment of the household, if the individual is head of household and marital status. Table 2 shows

[13] Our estimations are based on *m*=1000.

results for the probit and SLS probability models for the total sample and by group of cities.

In order to test if in effect the probability of being informal relies on the normality assumption for the residuals, we performed a Hausman test. As pointed out by Buchinsky (1998), the SLS estimate is consistent and independent of the distribution of the residuals, while the probit estimate is efficient under normally distributed residuals, and therefore a Hausman type test can be performed. Test statistics for Hausman's test reported at the bottom of Table 2 clearly indicate that for the total sample and by groups of cities the null hypothesis of normal errors is rejected at the 5% significance level. Therefore we use the estimates from the SLS models in the quantile regression models.

**Table 2.** Estimates of the informal employment models
(y = 1 informal; 0 formal)

| | Total sample | | | Group 1 | | Group 2 | | Group 3 | |
|---|---|---|---|---|---|---|---|---|---|
| | Probit | Probit[a] | SLS | Probit | SLS | Probit | SLS | Probit | SLS |
| Constant | 2.658*** | 2.474*** | 2.474 | 2.652*** | 2.652 | 2.707*** | 2.707 | 2.988*** | 2.988 |
| | (66.61) | (51.13) | (·) | (49.12) | (·) | (22.31) | (·) | (35.02) | (·) |
| Age | -0.019*** | -0.018*** | -0.018 | -0.019*** | -0.019 | -0.016*** | -0.016 | -0.023*** | -0.023 |
| | (-26.39) | (-20.52) | (·) | (-19.16) | (·) | (-8.24) | (·) | (-14.73) | (·) |
| *Education levels* | | | | | | | | | |
| Primary | -0.151*** | -0.132*** | -0.142*** | -0.113 | -0.119*** | -0.180*** | -0.018 | -0.253*** | -0.267*** |
| | (-7.02) | (-5.15) | (-4.82) | (-4.07) | (-3.29) | (-2.62) | (-0.23) | (-5.30) | (-4.80) |
| Secondary | -0.498*** | -0.452*** | -0.480*** | -0.458*** | -0.534*** | -0.614*** | -0.753*** | -0.688*** | -0.680*** |
| | (-25.10) | (-19.10) | (-16.56) | (-17.42) | (-12.69) | (-10.02) | (-7.58) | (-16.16) | (-11.74) |
| Tertiary | -0.766*** | -0.700*** | -1.028*** | -0.722*** | -1.074*** | -0.948*** | -1.451*** | -1.046*** | -1.136*** |
| | (-22.29) | (-17.05) | (-16.84) | (-14.73) | (-11.27) | (-10.83) | (-8.27) | (-14.40) | (-10.38) |
| Male | -0.122*** | -0.119*** | -0.179*** | -0.148*** | -0.197*** | -0.144*** | -0.351*** | -0.117*** | -0.167*** |
| | (-7.82) | (-6.42) | (-8.45) | (-7.11) | (-6.45) | (-3.44) | (-6.08) | (-3.43) | (-4.19) |
| Head of household | -0.162*** | -0.057*** | -0.140*** | -0.165*** | -0.244*** | 0.114** | -0.310*** | 0.155** | -0.160*** |
| | (-9.94) | (-2.90) | (-6.54) | (-7.61) | (-6.46) | (-2.54) | (-4.31) | (-4.44) | (-3.48) |
| Married | -0.084*** | -0.094*** | -0.145*** | -0.098*** | -0.105*** | -0.090** | -0.238*** | -0.174** | -0.191*** |
| | (-5.69) | (-5.34) | (-6.60) | (-4.93) | (-3.49) | (-2.27) | (-4.35) | (-5.53) | (-4.64) |
| Presence of children at home | 0.021 | 0.043** | 0.115*** | -0.018 | -0.009 | 0.029 | 0.087** | 0.045 | 0.085** |
| | (1.42) | (2.44) | (6.08) | (-0.91) | (0.34) | (0.73) | (2.04) | (1.46) | (2.41) |
| Other relatives working as formal | -0.361*** | -0.272*** | -0.293*** | -0.215*** | -0.287*** | -0.476*** | -0.734*** | -0.325*** | -0.380*** |
| | (23.84) | (16.80) | (12.77) | (10.70) | (8.42) | (-11.50) | (-7.97) | (-9.43) | (-7.83) |
| Education of household | -0.014*** | -0.022*** | -0.036*** | -0.009** | -0.021*** | -0.018** | -0.001 | 0.007 | -0.014** |
| | (-4.96) | (-6.72) | (-8.68) | (-2.45) | (-3.58) | (-2.27) | (-0.08) | (1.17) | (-2.06) |
| *Size of firm* | | | | | | | | | |
| 11 - 50 employees | -0.982*** | -0.995*** | -1.083*** | -0.967*** | -1.260*** | -1.173*** | -1.580*** | -1.044*** | -1.502*** |
| | (-57.82) | (-49.05) | (-22.16) | (-42.01) | (-14.48) | (-24.28) | (-8.67) | (-29.33) | (-12.72) |
| More than 51 employees | -1.617*** | -1.608*** | -1.934*** | -1.552*** | -2.180*** | -1.778*** | -2.790*** | -1.870*** | -2.501*** |
| | (-98.03) | (-81.80) | (-23.36) | (-69.15) | (-14.44) | (-38.86) | (-8.90) | (-51.30) | (-13.13) |
| Observations | 62,278 | 43,595 | | 39,091 | | 8226 | | 14,961 | |
| Hausman test | | 216.1 | | 198.6 | | 384.7 | | 207.4 | |
| p-value | | [0.000] | | [0.000] | | [0.000] | | [0.000] | |

Note: ***, **, *, denotes significance at 1%, 5% and 10%, respectively. ( ) z-statistics. The constant and the coefficient on variable age in the SLS models were normalized, they are equal to their values in the probit models, so that the probit and SLS models are comparable. All models include industry dummies and occupation dummies. Less than primary school and 1-10 employees are the excluded categories in education and size of firm variables, respectively.

[a] Given computational restrictions on the total sample we take a sample randomly selecting 70% of the observation in each metropolitan area. The resulting sample is 43,595 observations.

Results presented in Table 2 indicate that, overall, younger, less educated, females, non-head of household and non-married individuals are more likely to work in the informal sector. These higher probabilities of individuals in less important positions into family may indicate that the secondary incomes of household are made in informality.

Turning to the household characteristics variables, the findings show that having a child at home has a positive impact on the propensity to work in the informal sector but this variable is not significant in more developed cities. At the same time, the presence at home of other relatives working in the formal sector has a negative impact on the probability of being informal and this effect is greater in the group of Caribbean coast cities. And households with a higher education level imply a negative effect on the likelihood of being an informal worker being of particular importance in the groups of cities 1 and 3. As noted, family environment has a significant effect on the decision to be informal.

Finally, the size of firm variables are significant and show that as the size of firm increases, the probability of being part of the informal sector decreases and this effect is higher in the group of cities 2 and 3 than in the group 1.

As described above, in the second step we use the estimates from the SLS to calculate the power series expansion and introduce this term in the quantile regression models to correct for selectivity. To calculate this correction term we included two terms of orthogonal polynomials in the series expansion.[14] At the same time, to implement the identification of the constant term in the wage equations, we used a subsample of workers with a high probability of being informal, namely, those who are younger or older, less educated (less than primary education), with presence of children at home and other relatives working in the informal sector. In Tables A2 to A5 in the Appendix we present results for corrected quantile regressions for the $5^{th}$, $10^{th}$, $25^{th}$, $50^{th}$, $75^{th}$, $90^{th}$ and $95^{th}$ quantiles.

It can be seen from data in Tables A2 to A5 that in the group of cities 2 and 3, as well as in the total sample most of the selection terms are statistically significant, while in more developed cities (Group 1) not all such terms are significant. These results indicate the presence of sample selection bias for individuals across the whole wage distribution in the groups 2 and 3, but not in the group 1. Given these results we use the

[14] In fact we tested including a third term of polynomials in the series expansion, but the estimations presented severe multicollinearity problems. This problem was also mentioned by Buchinsky (1998).

estimations of wage equation for the group of cities 1 without correcting for selectivity in the decomposition. Table 3 summarizes the results for corrected and uncorrected quantile regressions at three representative quantiles. The results obtained from OLS and other quantiles for the group of cities 1 are shown in Table A6 in the Appendix.

From Table 3 we can see that in the group of cities 2 informal workers receive higher returns to education than formal workers, above all at high quantiles. Similar results, but this time at median and lower quantiles of the distribution, are found in the group of cities 3. With regards to other basic human capital variables, such as experience and job tenure, results show that more experience has a positive and decreasing impact on wages and this effect is particularly higher at low quantiles in the informal sector and similar in magnitude among groups of cities. An extra year of tenure in a job has a positive impact on wages and it is relatively constant across the distribution in the formal sector independently of the group of cities. Meanwhile, in the informal sector an extra year of tenure also has a positive effect but this decreases across the distribution.

Regarding the gender variable, results display that there is a strong discrimination against women in the informal sector. This characteristic is more marked in less developed cities (Group 3) and at low quantiles of the distribution: a woman's expected earnings at the $10^{th}$ percentile is approximately 15% lower than a man's. Meanwhile, in the group of cities 1 and 3 similar results are found but at high quantiles: the difference in wage between a woman and a man informal worker is around 11%.

**Table 3.** Quantile regressions by group of cities

(y = Log real hourly wage)

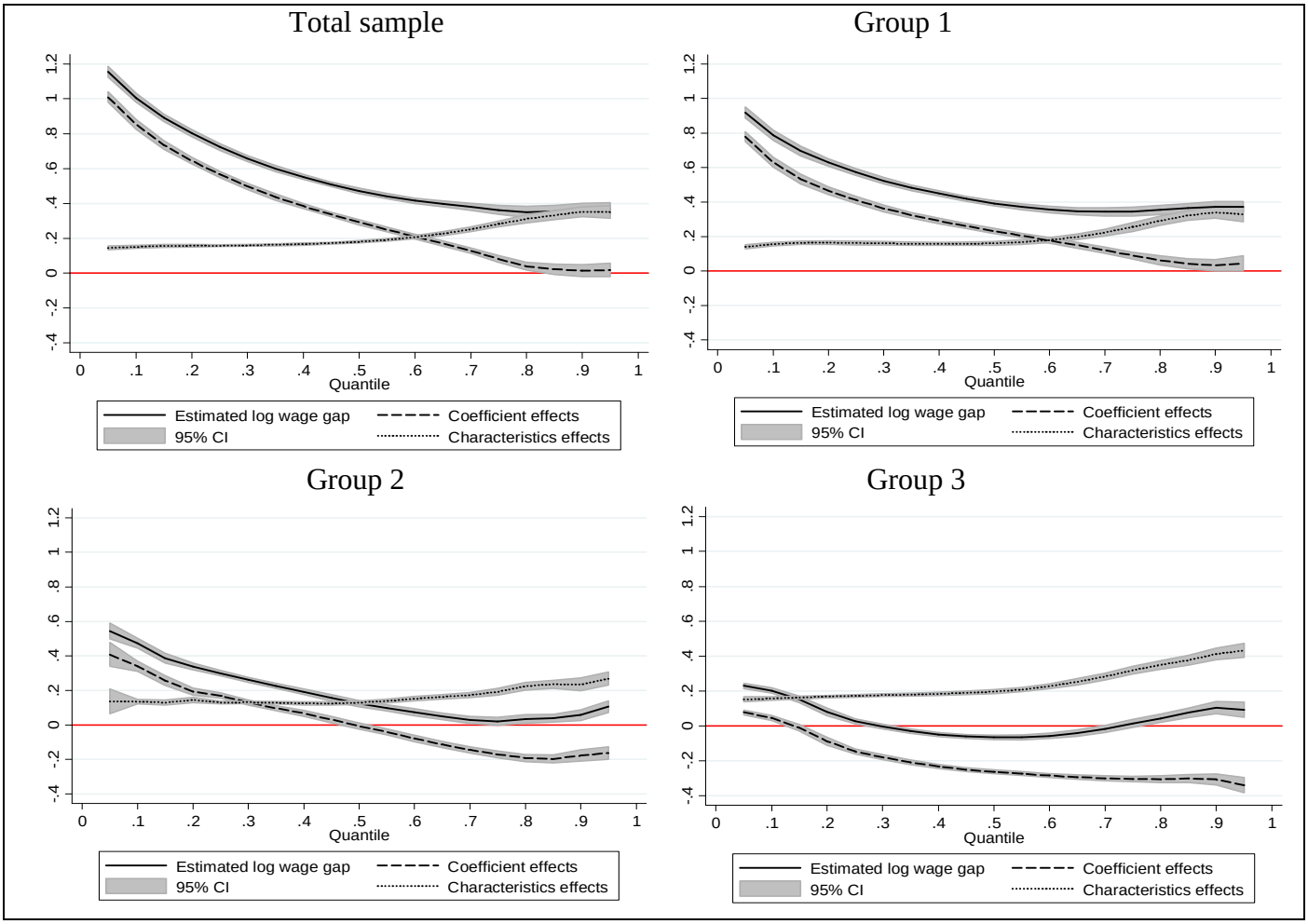
| | Group 1 | | | | | | Group 2 | | | | | | Group 3 | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | Formal | | | Informal | | | Formal | | | Informal | | | Formal | | | Informal | | |
| | 10% | 50% | 90% | 10% | 50% | 90% | 10% | 50% | 90% | 10% | 50% | 90% | 10% | 50% | 90% | 10% | 50% | 90% |
| Constant | 7.245*** | 7.525*** | 7.662*** | 6.702*** | 7.287*** | 7.719*** | 7.475*** | 7.617*** | 7.844*** | 6.437*** | 7.030*** | 7.440*** | 7.429*** | 7.577*** | 7.573*** | 6.429*** | 7.004*** | 7.451*** |
| | (412.1) | (709.99) | (262.73) | (203.86) | (475.94) | (250.72) | (94.29) | (133.63) | (64.44) | (125.83) | (205.84) | (150.60) | (116.43) | (238.93) | (94.60) | (176.96) | (342.06) | (193.48) |
| λ | | | | | | | 0.111** | 0.070** | 0.172** | 0.201*** | 0.073*** | 0.101* | 0.196*** | 0.055*** | -0.031** | -0.231*** | -0.180*** | -0.212*** |
| | | | | | | | (2.54) | (2.36) | (2.55) | (3.18) | (2.86) | (1.65) | (6.64) | (3.63) | (-2.07) | (-6.52) | (-9.02) | (-5.91) |
| *Education levels* | | | | | | | | | | | | | | | | | | |
| Primary | 0.067*** | 0.038*** | 0.091*** | 0.071*** | 0.089*** | 0.091*** | 0.115*** | 0.047** | 0.084* | 0.065* | 0.055** | 0.115*** | 0.067** | 0.069*** | 0.126*** | 0.126*** | 0.105*** | 0.097*** |
| | (5.30) | (4.84) | (4.20) | (3.38) | (8.75) | (4.50) | (3.82) | (2.08) | (1.65) | (1.93) | (2.37) | (3.64) | (2.05) | (4.17) | (3.08) | (5.38) | (7.72) | (3.95) |
| Secondary | 0.164*** | 0.119*** | 0.296*** | 0.179*** | 0.196*** | 0.216*** | 0.162*** | 0.100*** | 0.212*** | 0.155*** | 0.208*** | 0.238*** | 0.166*** | 0.139*** | 0.300*** | 0.243*** | 0.246*** | 0.278*** |
| | (13.21) | (15.72) | (14.20) | (7.82) | (18.35) | (10.27) | (5.44) | (4.34) | (4.12) | (4.09) | (8.00) | (6.78) | (5.03) | (8.80) | (7.57) | (9.01) | (16.69) | (10.56) |
| Tertiary | 0.406*** | 0.536*** | 0.666*** | 0.388*** | 0.547*** | 0.765*** | 0.259*** | 0.430*** | 0.530*** | 0.410*** | 0.528*** | 0.659*** | 0.344*** | 0.503*** | 0.691*** | 0.766*** | 0.691*** | 0.695*** |
| | (22.41) | (51.48) | (22.74) | (7.38) | (21.49) | (15.11) | (6.38) | (14.84) | (8.14) | (5.90) | (10.17) | (9.57) | (7.95) | (24.50) | (13.28) | (12.69) | (19.42) | (10.88) |
| Experience | 0.002*** | 0.004*** | 0.006*** | 0.012*** | 0.010*** | 0.005** | -0.002 | 0.002 | 0.007** | 0.013*** | 0.009*** | 0.004 | -0.003 | 0.004*** | 0.008*** | 0.015*** | 0.014*** | 0.016*** |
| | (2.37) | (7.42) | (3.58) | (6.64) | (10.42) | (2.55) | (-1.24) | (1.45) | (2.22) | (4.43) | (4.12) | (1.38) | (-1.23) | (4.12) | (2.95) | (6.72) | (11.19) | (6.86) |
| Experience$^2$ | -0.0001** | -0.0001*** | -0.0001** | -0.0002*** | -0.0002*** | -0.00005 | 0.00004 | -0.00004 | -0.0001 | -0.0002*** | -0.0001*** | -0.0001 | -0.00006 | -0.0001*** | -0.0001* | -0.0002*** | -0.0002*** | -0.0002*** |
| | (-2.50) | (-6.66) | (-1.96) | (-6.46) | (-8.25) | (-1.29) | (0.99) | (-1.14) | (-1.27) | (-3.36) | (-2.88) | (-0.54) | (-1.20) | (-3.07) | (-1.76) | (-5.19) | (-8.49) | (-5.15) |
| Tenure | 0.011*** | 0.011*** | 0.019*** | 0.045*** | 0.019*** | 0.026*** | 0.007** | 0.015*** | 0.016*** | 0.028*** | 0.025*** | 0.023*** | 0.005 | 0.003** | 0.010** | 0.023*** | 0.018*** | 0.021*** |
| | (7.04) | (11.92) | (7.64) | (10.25) | (8.55) | (5.86) | (2.53) | (7.13) | (3.27) | (5.95) | (7.05) | (5.13) | (1.36) | (1.99) | (2.44) | (4.66) | (5.97) | (4.36) |
| Tenure$^2$ | -0.0002*** | 0.00001 | -0.0002** | -0.002*** | -0.001*** | -0.001*** | -0.0001 | -0.0002*** | -0.0001 | -0.001*** | -0.0006*** | -0.0005*** | -0.00005 | -0.0002*** | 0.0001 | -0.0006*** | -0.0004*** | -0.0005** |
| | (-3.36) | (0.29) | (-1.98) | (-10.61) | (-5.15) | (-4.02) | (-1.33) | (-3.11) | (-0.92) | (-4.70) | (-4.30) | (-2.82) | (-0.34) | (-3.05) | (0.35) | (-2.85) | (-3.15) | (-2.47) |
| Male | 0.016*** | 0.052*** | 0.112*** | 0.083*** | 0.094*** | 0.105*** | -0.023 | 0.020** | 0.051** | 0.040 | 0.104*** | 0.116*** | -0.029* | 0.018** | 0.065*** | 0.150*** | 0.137*** | 0.143*** |
| | (2.24) | (12.16) | (9.96) | (4.72) | (10.79) | (6.21) | (-1.55) | (1.97) | (2.32) | (1.43) | (5.23) | (4.01) | (-1.87) | (2.31) | (3.23) | (6.98) | (11.01) | (6.24) |
| *Size of firm* | | | | | | | | | | | | | | | | | | |
| 11 – 50 employees | 0.100*** | 0.059*** | 0.072*** | 0.205*** | 0.130*** | 0.134*** | 0.111*** | 0.064*** | 0.034 | 0.275*** | 0.185*** | 0.142*** | -0.007 | 0.015 | 0.076* | 0.314*** | 0.196*** | 0.238*** |
| | (10.14) | (9.52) | (4.31) | (9.70) | (12.07) | (6.31) | (3.39) | (2.62) | (0.67) | (6.45) | (6.06) | (3.30) | (-0.22) | (0.98) | (1.94) | (10.61) | (11.68) | (8.25) |
| More than 51 employees | 0.151*** | 0.106*** | 0.151*** | 0.189*** | 0.125*** | 0.221*** | 0.077* | 0.046 | -0.001 | 0.292*** | 0.213*** | 0.235*** | -0.010 | 0.056*** | 0.210*** | 0.529*** | 0.481*** | 0.575*** |
| | (17.45) | (19.75) | (10.46) | (7.17) | (9.47) | (8.69) | (1.78) | (1.44) | (-0.31) | (4.16) | (3.97) | (3.18) | (-0.29) | (3.16) | (4.63) | (8.90) | (16.10) | (11.26) |
| Observations | 18,018 | | | 8304 | | | 4394 | | | 3832 | | | 6531 | | | 8430 | | |

Note: ***, **, *, denotes significance at 1%, 5% and 10%, respectively. ( ) t statistics. Experience is calculated as (age-year of education-6). All models include industry dummies and occupation dummies. Up to primary school and 1-10 employees are the excluded categories in education and size of firm variables, respectively.

### 4.2 Decomposition results

In this section we present the results of the decomposition. Figures 9 plots the wage gap that remains after we take into account the difference in the returns of observed characteristics between sectors and correcting for selection for the total sample and by group of cities.

**Figure 9.** Quantile decomposition of the wage gap between the formal sector and informal sector




Source: Table A7 and A8 in the Appendix

As can be seen from Figure 9, for the total sample a significant positive wage gap across the whole distribution remains with a large gap at the bottom of the distribution. Regarding the contribution of each set of factors (coefficients and characteristics), we can see that at the bottom of the distribution much of the wage gap is due to informal workers being paid less for given remunerated characteristics than those in the formal sector. The coefficient effects fall over all the distribution, while the characteristics effects rise, particularly toward the upper end of the distribution where

largely exceed the coefficient effects. These results indicate that low-pay informal workers earn less because not only are they less skilled, but they also get lower returns to such skills. This suggests that informal workers at the bottom of the distribution cannot have incentive to move toward the formal sector and therefore they represent the disadvantaged segment of a segmented labor market. Meanwhile, high-pay informal workers earn less because formal workers have much better skills. In this case, although the informal workers earn less than their counterpart formal workers, they find informal activities more profitable than formal activities. Informality can be seen as a deliberate choice of entrepreneurs to avoid start up cost. Also a greater independence and work schedule freedom or inefficiencies combined with high administrative costs of the social security system may discourage some workers from getting a job in the formal sector (Maloney 1999; Cunningham, 2001; Jütting *et al.*, 2008). Hence, in this higher-paid segment the specific characteristics of workers can imply a comparative advantage in the informal sector. This comparative advantage can be translated into higher non-wage benefits compared to potential wages in the formal sector, which might be incentives to choose informality.

At the groups of cities level we can see different patterns in the wage gap and their determinants. The pattern in the group of cities 1 is similar to the total sample, in that the wage gap is positive over the whole distribution, the extent of the coefficient effect is higher at the bottom and median of the distribution and at the top the characteristics effect explains most of the wage gap. In the groups of cities 2 and 3 the wage gap between sectors is smaller over the whole distribution; indeed this gap tends to zero over the upper of the distribution in the group of cities 2 and is negative between the $30^{th}$ and $70^{th}$ quantile of the distribution in the group of cities 3. This lower wage gap can suggest that in cities where the informal activities are the main source of income, the informal sector is no longer considered the poor and marginal sector. This result is in line with Marcouiller *et al*. (1997), and Arabsheibani and Staneva (2012) who find a wage premium associated with work in the informal sector in Mexico and Tajikistan, respectively. These authors claim that the low regulations, low intensity of enforcement and permissive behavior toward informal activities can imply higher wage benefits associated with work in the informal sector.

With regard to the contribution of the coefficient and characteristics effects on the wage differential, we can note that in the group of Caribbean coast cities at low quantiles the former effect is positive and have an important contribution on the wage

gap, while at upper half of the distribution the extent of the characteristics effect is higher than the negative coefficient effect. On the one hand, these results suggest that at the lower quantiles levels of human capital and other remunerable characteristics are lower in the informal sector than formal one, but more importantly the rate of returns to those characteristics are lower in the former sector than in the latter. This seems to confirm that at these points of the wages distribution there is no room for these workers in the formal sector and informality is a last resort option to escape unemployment. On the other hand, although the high-pay informal workers are getting higher returns of their characteristics throughout the distribution, they have a higher disadvantage regarding those remunerated characteristics compared to formal workers and therefore the wage gap is positive. In this case, informal workers may accept to earn lower wages in order to avoid having to contribute to social protection which can be perceived to be ineffective. For example, the size of the estimated wage differential in this group of cities is 10% at the $95^{th}$ quantile, which can be easily compensated with the cost saving associated with to be unregistered. Hence, in this segment of the distribution there are incentives to voluntarily choose informality as a form of employment.

Finally, in the group of cities 3 we can see that only at the extremes of distribution there is a positive wage gap and is primarily explained by the characteristic effects. While at the median of distribution the informal employment wage premium is explain by the negative coefficient effect. These results indicate that, as mentioned, the relative abundance of informal jobs undermine the benefits being formal and therefore the informal workers end up earning similar or higher wages than their counterpart formal, despite the fact that their levels of remunerated characteristics are very low. In these conditions of a high rationing of formal jobs, at very bottom of distribution workers do not have alternative other than to be employed in the informal sector, while that at high quantiles the non-wage benefits associated with informality far exceeds the costs of being part of formal sector.

## 5. Conclusions

In this paper we investigate the heterogeneity of the informal sector at the regional level in Colombia by analyzing decomposition of the wage gap between the formal and informal sector. We use the quantile regression decomposition method and correct by selectivity using semi-parametric methods. This econometric model allows us to

analyze individuals across the entire distribution of wages and determine if the informal sector has its own internal duality.

Our results show that there is a marked heterogeneity in the informal sector in Colombia. We find that in general there are two distinct segments of workers in the informal sector who have different motivation to work in this manner. On the one hand, there is a lower-paid informal segment in which informality is seen as the only alternative form of employment. On the other hand, there is a higher-paid informal segment which is composed of individuals who, given their specific characteristics, are voluntarily informal. These results suggest that just as formal and informal activities co-exist, voluntary and involuntary informal employment co-exists. Informality may be a choice as well as being the result of labor market segmentation. Certainly, these are two concurrent scenarios of the same phenomenon.

We also find that there are striking differences in labor market characteristics between groups of cities, in particular with the kind of informal employment that exists. The results show that the largest share of informal employment is in the most traditional activities, that is, those where the majority of workers perform their activity in very small firms and without a fixed location. In less developed cities (Group 3) this segment represents about 78% of total informal employment, while in more developed cities (Group 1) it represents around 40%. With regards to the modern informal segment, the results show that while in the group of Caribbean coast cities (Group 2) this segment represents 11% of total informal employment, in the group of more developed cities is 6%. This relative higher size of the modern informal segment in the group of cities 2 has been associated with high specialization levels in linkage-intensive industries such as petrochemical, chemical and plastic industries, whereby the complementarities between the formal and informal sector can be more intense and therefore lead to the expansion of the modern informal segment.

Turning to the wage differential once it has taken into account the difference in the returns of observed characteristics between formal and informal sector, the results show that the wage gap along the whole distribution is much narrower in the groups of cities 2 and 3 than in the group 1. The relative higher abundance of informal activities can lead to undermine the ability of the state for employee protection and therefore there can be higher benefits associated with work in the informal sector.

With regard to decomposition we have found that the wage gap at very bottom of the distribution is mainly explained by the differential in returns to characteristics of

individuals, in particular in the group of cities 1 and 2. In this segment levels of human capital and other remunerable characteristics are very low and given greater importance of the differential in rates of return to characteristics between sectors on wage gap, there is a marked segmentation effect. This result indicates that at these points of the distribution the informal sector represents the disadvantaged sector where workers end up as a last resort option to get a paid job.

At the upper half of the distribution the characteristics effect dominates on the coefficient effect and the wage gap is positive. These findings suggest that choosing to be an informal worker in these points of the distribution can be in part due to the fact that high-paying informal workers may to some extent accept lower wages in order to avoid start up cost or because they seek a greater independence and work schedule freedom. For example, the results showed that the sizes of the estimated wage differential in the groups of cities 2 and 3 are 10% and 9% at the $95^{th}$ quantile respectively, which can be easily compensated with the non-wage benefits associated with to work in the informal sector.

From a policy point of view, our findings suggest that to combat informal employment is necessary to understand better the different realities within the cities, as well as different groups within the informal sector. It is essential to distinguish between individuals who voluntary choose informality and therefore they are not necessarily worse-off compared to those working in the formal sector, and individuals who do not have any choice at all other than staying informal and are systematically excluded of the formal sector. This latter group of individuals is the segment that contributes significantly on overall wages inequality and poverty in Colombia and policies should be addressed to remedy this bottleneck.

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## Appendix

**Table A1.** Informality rate by metropolitan area

| | |
|---|---|
| Colombia | 58.28 |
| Medellín | 47.38 |
| Bogotá | 52.13 |
| Manizales | 52.50 |
| Pereira | 58.15 |
| Cali | 65.66 |
| Bucaramanga | 66.46 |
| Ibagué | 69.03 |
| Barranquilla | 70.76 |
| Villavicencio | 71.53 |
| Cartagena | 72.64 |
| Pasto | 72.75 |
| Montería | 75.55 |
| Cúcuta | 76.93 |

Note: we included government employees, employers and self-employees to calculate the informality rate.

**Figure A1.** Wage differentials between formal and informal sector over different quantiles of the wage distribution by metropolitan area

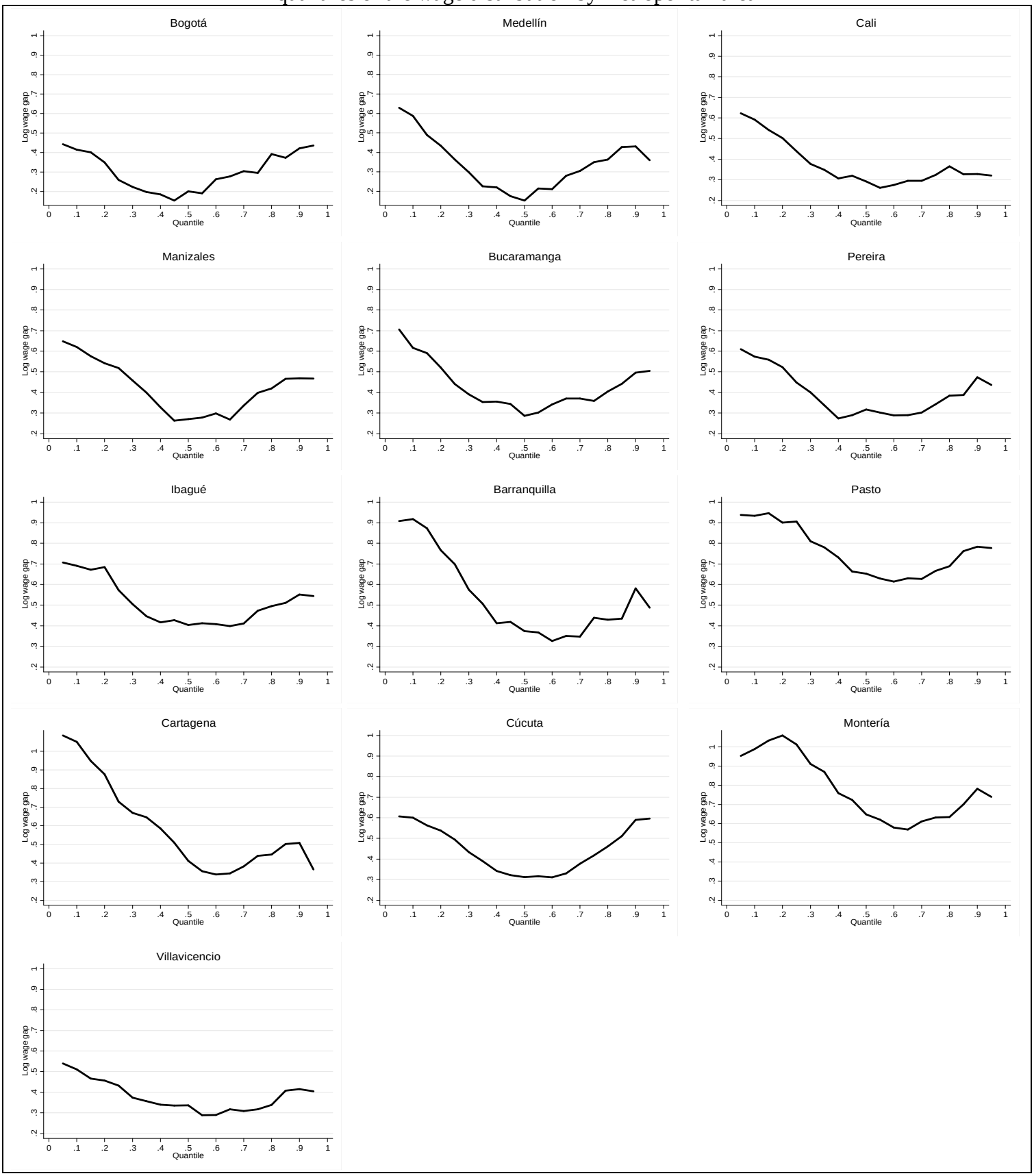

**Figure A2.** Index of modernity by sector

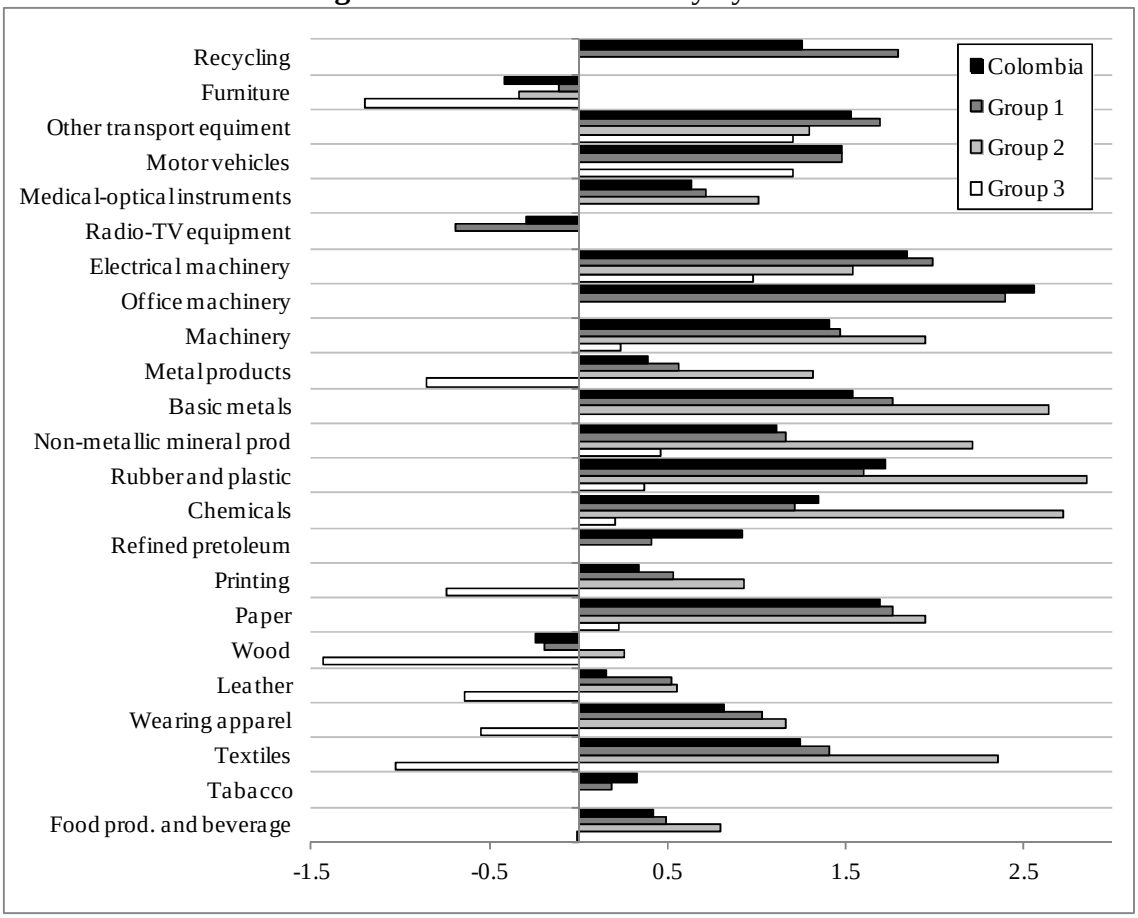

**Table A2.** Quantile regressions for total sample with corrections for selectivity
(y = Log real hourly wage)

| | Formal workers | | | | | | | | Informal workers | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **OLS** | **5%** | **10%** | **25%** | **50%** | **75%** | **90%** | **95%** | **OLS** | **5%** | **10%** | **25%** | **50%** | **75%** | **90%** | **95%** |
| Constant | 7.540*** | 7.271*** | 7.453*** | 7.572*** | 7.556*** | 7.594*** | 7.689*** | 7.829*** | 7.117*** | 6.316*** | 6.525*** | 6.834*** | 7.169*** | 7.429*** | 7.619*** | 7.782*** |
| | (410.75) | (182.36) | (282.55) | (515.1) | (385.98) | (301.87) | (190.59) | (153.84) | (506.18) | (184.07) | (244.24) | (350.91) | (467.5) | (463.19) | (293.46) | (223.75) |
| λ | 0.065*** | 0.164*** | 0.177*** | 0.087*** | 0.024*** | 0.036*** | 0.026 | 0.040 | -0.046*** | -0.014 | -0.049*** | -0.035** | -0.024* | -0.033*** | -0.073*** | -0.101*** |
| | (6.17) | (7.46) | (11.91) | (10.18) | (2.16) | (2.47) | (1.07) | (1.25) | (-3.89) | (-0.51) | (-2.23) | (-2.15) | (-1.87) | (-2.51) | (-3.47) | (-3.67) |
| *Education levels* | | | | | | | | | | | | | | | | |
| Lower secondary education | 0.063*** | 0.073*** | 0.059*** | 0.052*** | 0.041*** | 0.066*** | 0.087*** | 0.085*** | 0.095*** | 0.098*** | 0.083*** | 0.086*** | 0.096*** | 0.106*** | 0.095*** | 0.114*** |
| | (7.20) | (3.90) | (4.81) | (7.36) | (4.46) | (5.52) | (4.56) | (3.59) | (9.98) | (4.27) | (4.67) | (6.56) | (9.29) | (10.03) | (5.67) | (5.15) |
| Higher secondary education | 0.172*** | 0.153*** | 0.141*** | 0.100*** | 0.116*** | 0.195*** | 0.274*** | 0.324*** | 0.228*** | 0.194*** | 0.215*** | 0.227*** | 0.210*** | 0.201*** | 0.239*** | 0.272*** |
| | (19.74) | (7.81) | (11.19) | (14.20) | (12.51) | (16.50) | (14.62) | (14.03) | (22.18) | (7.44) | (10.71) | (15.73) | (18.75) | (17.56) | (13.07) | (11.28) |
| Bachelor/Master | 0.493*** | 0.289*** | 0.320*** | 0.396*** | 0.497*** | 0.589*** | 0.647*** | 0.670*** | 0.582*** | 0.487*** | 0.508*** | 0.530*** | 0.551*** | 0.624*** | 0.630*** | 0.640*** |
| | (42.22) | (10.87) | (18.20) | (41.14) | (39.85) | (36.93) | (25.25) | (21.04) | (24.49) | (8.49) | (11.10) | (15.96) | (21.29) | (23.57) | (14.72) | (11.39) |
| Experience | 0.005*** | 0.003** | 0.002*** | 0.002*** | 0.004*** | 0.005*** | 0.006*** | 0.005*** | 0.010*** | 0.013*** | 0.015*** | 0.013*** | 0.010*** | 0.009*** | 0.009*** | 0.008*** |
| | (7.15) | (2.34) | (2.35) | (3.93) | (5.74) | (5.98) | (4.48) | (3.01) | (11.84) | (6.43) | (8.72) | (11.07) | (10.80) | (8.83) | (5.38) | (3.72) |
| Experience$^2$ | -0.0001*** | -0.0001*** | -0.0001*** | -0.0001*** | -0.0001*** | -0.0001*** | -0.0001*** | -0.0001 | -0.0001*** | -0.0002*** | -0.0002*** | -0.0002*** | -0.0001*** | -0.0001*** | -0.0001*** | -0.0001 |
| | (-6.10) | (-3.77) | (-3.63) | (-5.20) | (-5.29) | (-4.20) | (-2.45) | (-1.06) | (-8.00) | (-4.95) | (-6.61) | (-8.53) | (-7.68) | (-5.83) | (-3.03) | (-1.62) |
| Tenure | 0.013*** | 0.015*** | 0.010*** | 0.008*** | 0.012*** | 0.013*** | 0.016*** | 0.016*** | 0.023*** | 0.035*** | 0.031*** | 0.028*** | 0.020*** | 0.017*** | 0.020*** | 0.015*** |
| | (12.62) | (6.98) | (6.79) | (9.63) | (11.29) | (9.61) | (7.47) | (5.97) | (12.05) | (7.82) | (9.09) | (10.62) | (9.64) | (8.29) | (5.96) | (3.38) |
| Tenure$^2$ | -0.0001*** | -0.0004*** | -0.0002*** | -0.0001** | -0.0001** | 0.00001 | -0.0001 | -0.0001 | -0.001*** | -0.001*** | -0.001*** | -0.001*** | -0.001*** | -0.0004*** | -0.001*** | -0.0003 |
| | (-2.95) | (-4.33) | (-2.77) | (-2.31) | (-2.11) | (-0.42) | (-1.25) | (-1.34) | (-8.24) | (-6.69) | (-7.41) | (-7.49) | (-5.99) | (-5.00) | (-3.65) | (-1.55) |
| Male | 0.044*** | -0.001 | -0.001 | 0.011*** | 0.041*** | 0.077*** | 0.094*** | 0.094*** | 0.103*** | 0.091*** | 0.091*** | 0.092*** | 0.094*** | 0.103*** | 0.130*** | 0.120*** |
| | (9.60) | (-0.14) | (-0.13) | (3.08) | (8.39) | (12.55) | (9.75) | (7.74) | (12.51) | (4.47) | (5.80) | (8.25) | (10.49) | (11.07) | (8.87) | (6.30) |
| *Size of firm* | | | | | | | | | | | | | | | | |
| 11 – 50 employees | 0.055*** | 0.055*** | 0.012 | 0.033*** | 0.049*** | 0.059*** | 0.064*** | 0.058*** | 0.207*** | 0.293*** | 0.272*** | 0.210*** | 0.162*** | 0.142*** | 0.175*** | 0.217*** |
| | (6.37) | (3.10) | (0.99) | (4.82) | (5.31) | (5.08) | (3.43) | (2.44) | (18.43) | (11.05) | (12.84) | (13.49) | (13.18) | (11.15) | (8.7) | (8.30) |
| More than 51 employees | 0.103*** | 0.066*** | 0.020 | 0.049*** | 0.091*** | 0.127*** | 0.150*** | 0.137*** | 0.312*** | 0.386*** | 0.392*** | 0.295*** | 0.248*** | 0.243*** | 0.342*** | 0.433*** |
| | (10.30) | (3.17) | (1.38) | (6.09) | (8.59) | (9.34) | (6.81) | (4.84) | (17.58) | (8.92) | (11.50) | (11.88) | (12.83) | (12.36) | (11.06) | (10.66) |
| Observations | 25,392 | | | | | | | | 18,203 | | | | | | | |

Note: ***, **, *, denotes significance at 1%, 5% and 10%, respectively. ( ) t statistics. Experience is calculated as (age-year of education-6). All models include industry dummies and occupation dummies. Less than primary school and 1-10 employees are the excluded categories in education and size of firm variables, respectively.

**Table A3.** Quantile regressions for the group of cities 1 with corrections for selectivity
(y = Log real hourly wage)

| | Formal workers | | | | | | | | Informal workers | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **OLS** | **5%** | **10%** | **25%** | **50%** | **75%** | **90%** | **95%** | **OLS** | **5%** | **10%** | **25%** | **50%** | **75%** | **90%** | **95%** |
| Constant | 7.497*** | 7.239*** | 7.429*** | 7.575*** | 7.534*** | 7.529*** | 7.628*** | 7.812*** | 7.255*** | 6.532*** | 6.696*** | 6.984*** | 7.287*** | 7.512*** | 7.723*** | 7.886*** |
| | (431.42) | (207.56) | (313.61) | (600.03) | (519.89) | (311.57) | (180.33) | (141.75) | (431.26) | (121.72) | (205.26) | (350.75) | (472.1) | (452.85) | (253.31) | (184.71) |
| λ | 0.035*** | 0.146*** | 0.165*** | 0.083*** | 0.009 | 0.0002 | -0.031 | 0.017 | -0.006 | 0.028 | 0.022 | 0.021 | -0.011 | -0.024 | -0.029 | -0.037 |
| | (3.10) | (6.53) | (10.93) | (10.14) | (0.95) | (0.01) | (-1.09) | (0.45) | (-0.54) | (0.81) | (1.07) | (1.55) | (-1.04) | (-1.13) | (-1.36) | (-1.26) |
| *Education levels* | | | | | | | | | | | | | | | | |
| Lower secondary education | 0.068*** | 0.065*** | 0.059*** | 0.039*** | 0.037*** | 0.073*** | 0.093*** | 0.096*** | 0.076*** | 0.004*** | 0.07*** | 0.083*** | 0.090*** | 0.084*** | 0.093*** | 0.086*** |
| | (7.87) | (3.96) | (5.20) | (6.27) | (5.15) | (6.12) | (4.46) | (3.63) | (6.77) | (0.11) | (3.35) | (6.30) | (8.74) | (7.79) | (4.64) | (3.06) |
| Higher secondary education | 0.184*** | 0.147*** | 0.132*** | 0.087*** | 0.117*** | 0.213*** | 0.303*** | 0.355*** | 0.198*** | 0.116*** | 0.174*** | 0.195*** | 0.200*** | 0.197*** | 0.220*** | 0.254*** |
| | (21.30) | (8.55) | (11.40) | (13.82) | (16.27) | (17.85) | (14.63) | (13.61) | (16.36) | (3.03) | (7.56) | (13.47) | (17.97) | (16.89) | (10.23) | (8.55) |
| Bachelor/Master | 0.534*** | 0.323*** | 0.356*** | 0.435*** | 0.533*** | 0.632*** | 0.676*** | 0.685*** | 0.512*** | 0.349*** | 0.389*** | 0.413*** | 0.550*** | 0.565*** | 0.768*** | 0.810*** |
| | (44.90) | (13.42) | (21.12) | (49.19) | (53.78) | (38.12) | (23.17) | (18.30) | (17.84) | (4.07) | (7.30) | (12.45) | (20.91) | (20.15) | (14.52) | (11.27) |
| Experience | 0.004*** | 0.004*** | 0.002** | 0.002*** | 0.004*** | 0.005*** | 0.006*** | 0.005*** | 0.009*** | 0.012*** | 0.012*** | 0.012*** | 0.010*** | 0.007*** | 0.005*** | 0.004* |
| | (6.69) | (3.05) | (2.18) | (4.18) | (8.10) | (5.90) | (3.65) | (2.23) | (8.85) | (3.89) | (6.30) | (10.22) | (10.42) | (7.47) | (2.93) | (1.68) |
| Experience$^2$ | -0.0001*** | -0.0001*** | -0.0001*** | -0.0001*** | -0.0001*** | -0.0001*** | -0.0001** | -0.00002 | -0.0002*** | -0.0002*** | -0.0002*** | -0.0002*** | -0.0002*** | -0.0001*** | -0.0001 | -0.00003 |
| | (-5.39) | (-4.42) | (-3.39) | (-5.65) | (-7.38) | (-3.73) | (-1.89) | (-0.46) | (-7.23) | (-4.11) | (-6.25) | (-9.17) | (-8.24) | (-5.49) | (-1.55) | (-0.58) |
| Tenure | 0.014*** | 0.014*** | 0.010*** | 0.008*** | 0.011*** | 0.016*** | 0.019*** | 0.017*** | 0.025*** | 0.049*** | 0.045*** | 0.029*** | 0.019*** | 0.021*** | 0.025*** | 0.017*** |
| | (13.69) | (6.74) | (7.36) | (10.34) | (13.15) | (11.08) | (7.92) | (5.34) | (10.15) | (6.78) | (10.31) | (10.38) | (8.33) | (9.16) | (5.63) | (2.64) |
| Tenure$^2$ | -0.0001*** | -0.0002*** | -0.0002*** | -0.0001* | 0.0001 | -0.0001 | -0.0002** | -0.0002 | -0.001*** | -0.002*** | -0.002*** | -0.001*** | -0.0005*** | -0.001*** | -0.001*** | -0.0004 |
| | (-3.38) | (-2.85) | (-3.32) | (-1.77) | (0.33) | (-1.51) | (-2.08) | (-1.52) | (-7.03) | (-7.31) | (-10.62) | (-8.20) | (-4.96) | (-5.65) | (-3.76) | (-1.15) |
| Male | 0.057*** | 0.010 | 0.004 | 0.014*** | 0.052*** | 0.097*** | 0.114*** | 0.098*** | 0.098*** | 0.098*** | 0.083*** | 0.101*** | 0.096*** | 0.102*** | 0.104*** | 0.100*** |
| | (12.01) | (1.15) | (0.62) | (4.21) | (13.17) | (15.04) | (10.34) | (6.89) | (10.19) | (3.29) | (4.71) | (9.16) | (10.87) | (10.97) | (6.22) | (4.26) |
| *Size of firm* | | | | | | | | | | | | | | | | |
| 11 – 50 employees | 0.068*** | 0.057*** | 0.026*** | 0.041*** | 0.055*** | 0.080*** | 0.085*** | 0.059*** | 0.165*** | 0.205*** | 0.197*** | 0.143*** | 0.134*** | 0.125*** | 0.145*** | 0.178*** |
| | (7.99) | (3.38) | (2.21) | (6.54) | (7.67) | (6.76) | (4.18) | (2.19) | (12.54) | (5.45) | (8.48) | (9.53) | (11.05) | (9.66) | (6.09) | (5.40) |
| More than 51 employees | 0.124*** | 0.089*** | 0.048*** | 0.060*** | 0.101*** | 0.156*** | 0.169*** | 0.132*** | 0.169*** | 0.121*** | 0.163*** | 0.112*** | 0.138*** | 0.192*** | 0.259*** | 0.324*** |
| | (13.05) | (4.74) | (3.75) | (8.68) | (12.72) | (11.98) | (7.46) | (4.41) | (8.66) | (2.08) | (4.71) | (5.01) | (7.74) | (10.32) | (7.50) | (6.66) |
| Observations | 25,368 | | | | | | | | 13,723 | | | | | | | |

Note: ***, **, *, denotes significance at 1%, 5% and 10%, respectively. ( ) t statistics. Experience is calculated as (age-year of education-6). All models include industry dummies and occupation dummies. Less than primary school and 1-10 employees are the excluded categories in education and size of firm variables, respectively.

**Table A4.** Quantile regressions for the group of cities 2 with corrections for selectivity
(y = Log real hourly wage)

| | Formal workers | | | | | | | | Informal workers | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **OLS** | **5%** | **10%** | **25%** | **50%** | **75%** | **90%** | **95%** | **OLS** | **5%** | **10%** | **25%** | **50%** | **75%** | **90%** | **95%** |
| Constant | 7.641*** | 7.369*** | 7.475*** | 7.592*** | 7.617*** | 7.819*** | 7.844*** | 7.925*** | 6.969*** | 6.275*** | 6.437*** | 6.724*** | 7.030*** | 7.262*** | 7.440*** | 7.480*** |
| | (128.28) | (58.68) | (94.29) | (556.54) | (133.63) | (92.39) | (64.44) | (53.88) | (248.69) | (114.92) | (125.83) | (180.51) | (205.84) | (255.79) | (150.60) | (96.46) |
| λ | 0.121*** | 0.081 | 0.111** | 0.028*** | 0.070** | 0.168*** | 0.172** | 0.196** | 0.125*** | 0.327*** | 0.201*** | 0.188*** | 0.073*** | 0.053 | 0.101* | 0.075 |
| | (3.88) | (1.19) | (2.54) | (3.93) | (2.36) | (3.76) | (2.55) | (2.44) | (3.29) | (4.60) | (3.18) | (3.86) | (2.86) | (1.44) | (1.65) | (0.83) |
| *Education levels* | | | | | | | | | | | | | | | | |
| Primary | 0.072*** | 0.126*** | 0.115*** | 0.074*** | 0.047** | 0.070** | 0.084* | 0.059 | 0.076*** | 0.077** | 0.065* | 0.036 | 0.055** | 0.099*** | 0.115*** | 0.102** |
| | (3.04) | (2.71) | (3.82) | (13.58) | (2.08) | (2.04) | (1.65) | (1.05) | (3.95) | (2.12) | (1.93) | (1.40) | (2.37) | (5.22) | (3.64) | (2.19) |
| Secondary | 0.142*** | 0.125*** | 0.162*** | 0.086*** | 0.100*** | 0.156*** | 0.212*** | 0.217*** | 0.210*** | 0.125*** | 0.155*** | 0.143*** | 0.208*** | 0.221*** | 0.238*** | 0.280*** |
| | (5.90) | (2.70) | (5.44) | (15.71) | (4.34) | (4.47) | (4.12) | (3.65) | (9.81) | (2.98) | (4.09) | (4.95) | (8.00) | (10.55) | (6.78) | (5.35) |
| Tertiary | 0.420*** | 0.212*** | 0.259*** | 0.345*** | 0.430*** | 0.510*** | 0.530*** | 0.544*** | 0.524*** | 0.408*** | 0.410*** | 0.407*** | 0.528*** | 0.603*** | 0.659*** | 0.632*** |
| | (13.85) | (3.43) | (6.38) | (49.01) | (14.84) | (11.65) | (8.14) | (7.23) | (12.28) | (5.62) | (5.90) | (7.30) | (10.17) | (14.66) | (9.57) | (6.03) |
| Experience | 0.004** | 0.006* | -0.002 | 0.0004 | 0.002 | 0.004** | 0.007** | 0.012*** | 0.008*** | 0.008*** | 0.013*** | 0.010*** | 0.009*** | 0.005*** | 0.004 | 0.008* |
| | (2.44) | (1.79) | (-1.24) | (1.21) | (1.45) | (1.97) | (2.22) | (3.49) | (4.74) | (2.49) | (4.43) | (4.52) | (4.12) | (3.08) | (1.38) | (1.73) |
| Experience$^2$ | -0.0001** | 0.00003 | 0.00004 | -0.00001 | -0.00004 | -0.0001 | -0.0001 | -0.0002** | -0.0001*** | -0.0001* | -0.0002*** | -0.0002*** | -0.0001*** | -0.0001* | -0.0001 | -0.0001 |
| | (-2.06) | (0.47) | (0.99) | (-1.35) | (-1.14) | (-1.43) | (-1.27) | (-1.99) | (-3.10) | (-1.85) | (-3.36) | (-4.02) | (-2.88) | (-1.65) | (-0.54) | (-1.05) |
| Tenure | 0.013*** | 0.011*** | 0.007** | 0.001*** | 0.015*** | 0.018*** | 0.016*** | 0.012** | 0.027*** | 0.033*** | 0.028*** | 0.030*** | 0.025*** | 0.026*** | 0.023*** | 0.023*** |
| | (5.62) | (2.80) | (2.53) | (2.67) | (7.13) | (5.44) | (3.27) | (2.20) | (9.37) | (7.18) | (5.95) | (8.03) | (7.05) | (9.66) | (5.13) | (3.60) |
| Tenure$^2$ | -0.0002** | -0.0001 | -0.0001 | -0.0001*** | -0.0002*** | -0.0003** | -0.0001 | -0.0001 | -0.0007*** | -0.001*** | -0.001*** | -0.001*** | -0.0006*** | -0.0007*** | -0.0005*** | -0.0005** |
| | (-1.96) | (-0.93) | (-1.33) | (-4.18) | (-3.11) | (-2.24) | (-0.92) | (-0.41) | (-5.97) | (-6.32) | (-4.70) | (-5.31) | (-4.30) | (-6.74) | (-2.82) | (-2.29) |
| Male | 0.018* | -0.023 | -0.023 | 0.001 | 0.020** | 0.016 | 0.051** | 0.047* | 0.096*** | 0.001 | 0.040 | 0.082*** | 0.104*** | 0.117*** | 0.116*** | 0.167*** |
| | (1.64) | (-1.03) | (-1.55) | (0.58) | (1.97) | (1.05) | (2.32) | (1.85) | (5.87) | (0.05) | (1.43) | (3.92) | (5.23) | (7.06) | (4.01) | (3.74) |
| *Size of firm* | | | | | | | | | | | | | | | | |
| 11 – 50 employees | 0.062** | 0.166*** | 0.111*** | 0.080*** | 0.064*** | -0.009 | 0.034 | 0.052 | 0.190*** | 0.196*** | 0.275*** | 0.232*** | 0.185*** | 0.134*** | 0.142*** | 0.169** |
| | (2.41) | (3.23) | (3.39) | (13.76) | (2.62) | (-0.25) | (0.67) | (0.86) | (7.55) | (4.29) | (6.45) | (7.11) | (6.06) | (5.34) | (3.30) | (2.55) |
| More than 51 employees | 0.039 | 0.139** | 0.077* | 0.076** | 0.046 | -0.039 | -0.001 | 0.007 | 0.215*** | 0.157** | 0.292*** | 0.187*** | 0.213*** | 0.231*** | 0.235*** | 0.249** |
| | (1.16) | (2.00) | (1.78) | (10.12) | (1.44) | (-0.85) | (-0.31) | (0.09) | (4.89) | (1.97) | (4.16) | (3.47) | (3.97) | (5.22) | (3.18) | (2.27) |
| Observations | 4394 | | | | | | | | 3832 | | | | | | | |

Note: ***, **, *, denotes significance at 1%, 5% and 10%, respectively. ( ) t statistics. Experience is calculated as (age-year of education-6). All models include industry dummies and occupation dummies. Less than primary school and 1-10 employees are the excluded categories in education and size of firm variables, respectively.

**Table A5.** Quantile regressions for the group of cities 3 with corrections for selectivity
(y = Log real hourly wage)

| | Formal workers | | | | | | | | Informal workers | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **OLS** | **5%** | **10%** | **25%** | **50%** | **75%** | **90%** | **95%** | **OLS** | **5%** | **10%** | **25%** | **50%** | **75%** | **90%** | **95%** |
| Constant | 7.507*** | 7.264*** | 7.429*** | 7.564*** | 7.577*** | 7.508*** | 7.573*** | 7.808*** | 6.965*** | 6.230*** | 6.429*** | 6.728*** | 7.004*** | 7.232*** | 7.451*** | 7.560*** |
| | (203.25) | (100.59) | (116.43) | (203.96) | (238.93) | (123.73) | (94.60) | (81.75) | (341.80) | (144.39) | (176.96) | (237.28) | (342.06) | (270.28) | (193.48) | (167.78) |
| λ | 0.058*** | 0.173*** | 0.196*** | 0.113*** | 0.055*** | -0.020 | -0.031** | 0.006 | -0.197*** | -0.209*** | -0.231*** | -0.213*** | -0.180*** | -0.186*** | -0.212*** | -0.227*** |
| | (3.28) | (5.22) | (6.64) | (6.24) | (3.63) | (-0.70) | (-2.07) | (0.13) | (-9.96) | (-5.02) | (-6.52) | (-7.68) | (-9.02) | (-7.27) | (-5.91) | (-5.52) |
| *Education levels* | | | | | | | | | | | | | | | | |
| Primary | 0.087*** | 0.046 | 0.067** | 0.057*** | 0.069*** | 0.091*** | 0.126*** | 0.082* | 0.112*** | 0.146*** | 0.126*** | 0.110*** | 0.105*** | 0.111*** | 0.097*** | 0.132** |
| | (4.63) | (1.24) | (2.05) | (2.99) | (4.17) | (2.97) | (3.08) | (1.68) | (8.29) | (5.16) | (5.38) | (5.90) | (7.72) | (6.30) | (3.95) | (4.60) |
| Secondary | 0.190*** | 0.128*** | 0.166*** | 0.121*** | 0.139*** | 0.223*** | 0.300*** | 0.262*** | 0.264*** | 0.257*** | 0.243*** | 0.246*** | 0.246*** | 0.268*** | 0.278*** | 0.314*** |
| | (10.32) | (3.35) | (5.03) | (6.43) | (8.80) | (7.35) | (7.57) | (5.52) | (18.03) | (8.09) | (9.01) | (11.79) | (16.69) | (14.32) | (10.56) | (10.48) |
| Tertiary | 0.501*** | 0.309*** | 0.344*** | 0.345*** | 0.503*** | 0.594*** | 0.691*** | 0.674*** | 0.720*** | 0.736*** | 0.766*** | 0.688*** | 0.691*** | 0.760*** | 0.695*** | 0.623*** |
| | (20.99) | (6.16) | (7.95) | (14.00) | (24.50) | (15.19) | (13.28) | (10.87) | (20.30) | (10.06) | (12.69) | (13.89) | (19.42) | (16.85) | (10.88) | (8.02) |
| Experience | 0.006*** | 0.004 | -0.003 | 0.002* | 0.004*** | 0.006*** | 0.008*** | 0.009*** | 0.014*** | 0.014*** | 0.015*** | 0.015*** | 0.014*** | 0.014*** | 0.016*** | 0.016*** |
| | (4.43) | (1.61) | (-1.23) | (1.71) | (4.12) | (2.75) | (2.95) | (2.61) | (11.25) | (5.15) | (6.72) | (8.44) | (11.19) | (8.51) | (6.86) | (6.15) |
| Experience$^2$ | -0.0001*** | -0.0001** | -0.00006 | -0.00004 | -0.0001*** | -0.0001 | -0.0001* | -0.0001 | -0.0002*** | -0.0002*** | -0.0002*** | -0.0002*** | -0.0002*** | -0.0002*** | -0.0002*** | -0.0002*** |
| | (-3.24) | (-2.18) | (-1.20) | (-1.53) | (-3.07) | (-1.45) | (-1.76) | (-1.51) | (-8.37) | (-3.67) | (-5.19) | (-6.54) | (-8.49) | (-6.39) | (-5.15) | (-4.17) |
| Tenure | 0.007*** | 0.012*** | 0.005 | 0.006*** | 0.003** | 0.007** | 0.010** | 0.010** | 0.022*** | 0.027*** | 0.023*** | 0.023*** | 0.018*** | 0.020*** | 0.021*** | 0.025*** |
| | (3.56) | (2.91) | (1.36) | (2.95) | (1.99) | (2.07) | (2.44) | (2.09) | (7.39) | (4.54) | (4.66) | (6.00) | (5.97) | (5.47) | (4.36) | (4.65) |
| Tenure$^2$ | -0.00001 | -0.0005*** | -0.00005 | -0.00005 | -0.0002*** | 0.0001 | 0.0001 | 0.0001 | -0.0006*** | -0.0006*** | -0.0006*** | -0.0006*** | -0.0004*** | -0.0005*** | -0.0005** | -0.0006*** |
| | (0.22) | (-3.05) | (-0.34) | (-0.61) | (-3.05) | (0.95) | (0.35) | (0.33) | (-4.39) | (-3.34) | (-2.85) | (-4.21) | (-3.15) | (-3.12) | (-2.47) | (-3.06) |
| Male | 0.018** | -0.013 | -0.029* | -0.010 | 0.018** | 0.047*** | 0.065*** | 0.079*** | 0.149*** | 0.142*** | 0.150*** | 0.140*** | 0.137*** | 0.163*** | 0.143*** | 0.135*** |
| | (2.01) | (-0.75) | (-1.87) | (-1.11) | (2.31) | (3.11) | (3.23) | (3.34) | (12.04) | (5.66) | (6.98) | (8.20) | (11.01) | (9.98) | (6.24) | (4.92) |
| *Size of firm* | | | | | | | | | | | | | | | | |
| 11 – 50 employees | 0.038** | 0.055 | -0.007 | -0.006 | 0.015 | 0.068** | 0.076* | 0.033 | 0.245*** | 0.368*** | 0.314*** | 0.245*** | 0.196*** | 0.203*** | 0.238*** | 0.246*** |
| | (2.12) | (1.62) | (-0.22) | (-0.31) | (0.98) | (2.35) | (1.94) | (0.73) | (14.64) | (10.50) | (10.61) | (10.46) | (11.68) | (9.59) | (8.25) | (7.01) |
| More than 51 employees | 0.104*** | 0.069* | -0.010 | 0.014 | 0.056*** | 0.177*** | 0.210*** | 0.169*** | 0.523*** | 0.523*** | 0.529*** | 0.491*** | 0.481*** | 0.502*** | 0.575*** | 0.650*** |
| | (5.02) | (1.73) | (-0.29) | (0.65) | (3.16) | (5.25) | (4.63) | (3.20) | (17.62) | (7.60) | (8.90) | (11.04) | (16.10) | (13.75) | (11.26) | (10.85) |
| Observations | 6531 | | | | | | | | 8430 | | | | | | | |

Note: ***, **, *, denotes significance at 1%, 5% and 10%, respectively. ( ) t statistics. Experience is calculated as (age-year of education-6). All models include industry dummies and occupation dummies. Less than primary school and 1-10 employees are the excluded categories in education and size of firm variables, respectively.

**Table A6.** Quantile regressions for the group of cities 1 without corrections for selectivity
(y = Log real hourly wage)

| | Formal workers | | | | | | | | Informal workers | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **OLS** | **5%** | **10%** | **25%** | **50%** | **75%** | **90%** | **95%** | **OLS** | **5%** | **10%** | **25%** | **50%** | **75%** | **90%** | **95%** |
| Constant | 7.457*** | 7.075*** | 7.245*** | 7.479*** | 7.525*** | 7.528*** | 7.662*** | 7.791*** | 7.255*** | 6.547*** | 6.702*** | 6.981*** | 7.287*** | 7.507*** | 7.719*** | 7.883*** |
| | (645.22) | (317.65) | (412.1) | (799.3) | (709.99) | (461.05) | (262.73) | (220.65) | (432.07) | (115.50) | (203.86) | (332.00) | (475.94) | (460.77) | (250.72) | (179.44) |
| *Education levels* | | | | | | | | | | | | | | | | |
| Lower secondary education | 0.071*** | 0.077*** | 0.067*** | 0.052*** | 0.038*** | 0.073*** | 0.091*** | 0.097*** | 0.076*** | 0.003 | 0.071*** | 0.087*** | 0.089*** | 0.084*** | 0.091*** | 0.085*** |
| | (8.25) | (4.77) | (5.30) | (7.51) | (4.84) | (6.17) | (4.20) | (3.66) | (6.75) | (0.09) | (3.38) | (6.24) | (8.75) | (7.94) | (4.50) | (2.98) |
| Higher secondary education | 0.191*** | 0.177*** | 0.164*** | 0.109*** | 0.119*** | 0.213*** | 0.296*** | 0.359*** | 0.196*** | 0.118*** | 0.179*** | 0.200*** | 0.196*** | 0.193*** | 0.216*** | 0.245*** |
| | (23.18) | (10.93) | (13.21) | (16.39) | (15.72) | (18.57) | (14.20) | (14.32) | (16.77) | (2.97) | (7.82) | (13.46) | (18.35) | (17.40) | (10.27) | (8.21) |
| Bachelor/Master | 0.545*** | 0.378*** | 0.406*** | 0.466*** | 0.536*** | 0.632*** | 0.666*** | 0.690*** | 0.509*** | 0.368*** | 0.388*** | 0.416*** | 0.547*** | 0.548*** | 0.765*** | 0.794*** |
| | (47.94) | (16.49) | (22.41) | (49.54) | (51.48) | (39.83) | (22.74) | (19.14) | (18.19) | (4.15) | (7.38) | (12.11) | (21.49) | (20.51) | (15.11) | (11.19) |
| Experience | 0.005*** | 0.004*** | 0.002*** | 0.002*** | 0.004*** | 0.005*** | 0.006*** | 0.005** | 0.009*** | 0.012*** | 0.012*** | 0.013*** | 0.010*** | 0.007*** | 0.005** | 0.003 |
| | (6.94) | (3.48) | (2.37) | (4.31) | (7.42) | (5.94) | (3.58) | (2.26) | (8.87) | (3.73) | (6.64) | (10.04) | (10.42) | (7.42) | (2.55) | (1.28) |
| Experience$^2$ | -0.0001*** | -0.0001*** | -0.0001** | -0.0001*** | -0.0001*** | -0.0001*** | -0.0001** | -0.0001 | -0.0002*** | -0.0003*** | -0.0002*** | -0.0002*** | -0.0002*** | -0.0001*** | -0.00005 | -0.00001 |
| | (-5.32) | (-4.31) | (-2.50) | (-4.89) | (-6.66) | (-3.76) | (-1.96) | (-0.40) | (-7.22) | (-3.98) | (-6.46) | (-8.85) | (-8.25) | (-5.50) | (-1.29) | (-0.16) |
| Tenure | 0.014*** | 0.014*** | 0.011*** | 0.008*** | 0.011*** | 0.016*** | 0.019*** | 0.017*** | 0.025*** | 0.050*** | 0.045*** | 0.029*** | 0.019*** | 0.022*** | 0.026*** | 0.016** |
| | (13.75) | (7.45) | (7.04) | (9.56) | (11.92) | (11.10) | (7.64) | (5.41) | (10.15) | (6.52) | (10.25) | (10.07) | (8.55) | (9.42) | (5.86) | (2.47) |
| Tenure$^2$ | -0.0001*** | -0.0003*** | -0.0002*** | -0.0001* | 0.00001 | -0.0001 | -0.0002** | -0.0002 | -0.001*** | -0.002*** | -0.002*** | -0.001*** | -0.001*** | -0.001*** | -0.001*** | -0.0003 |
| | (-3.48) | (-3.64) | (-3.36) | (-1.82) | (0.29) | (-1.51) | (-1.98) | (-1.58) | (-7.03) | (-7.02) | (-10.61) | (-8.03) | (-5.15) | (-5.65) | (-4.02) | (-1.05) |
| Male | 0.059*** | 0.021** | 0.016*** | 0.019*** | 0.052*** | 0.097*** | 0.112*** | 0.100*** | 0.097*** | 0.094*** | 0.083*** | 0.103*** | 0.094*** | 0.099*** | 0.105*** | 0.097*** |
| | (12.61) | (2.45) | (2.24) | (5.17) | (12.16) | (15.28) | (9.96) | (7.10) | (10.18) | (3.01) | (4.72) | (8.85) | (10.79) | (10.91) | (6.21) | (4.01) |
| *Size of firm* | | | | | | | | | | | | | | | | |
| 11 – 50 employees | 0.085*** | 0.127*** | 0.100*** | 0.078*** | 0.059*** | 0.080*** | 0.072*** | 0.068*** | 0.162*** | 0.216*** | 0.205*** | 0.153*** | 0.130*** | 0.115*** | 0.134*** | 0.155*** |
| | (12.63) | (10.30) | (10.14) | (14.51) | (9.52) | (8.52) | (4.31) | (3.25) | (13.76) | (5.87) | (9.70) | (10.64) | (12.07) | (10.26) | (6.31) | (5.21) |
| More than 51 employees | 0.147*** | 0.189*** | 0.151*** | 0.113*** | 0.106*** | 0.156*** | 0.151*** | 0.145*** | 0.162*** | 0.157*** | 0.189*** | 0.131*** | 0.125*** | 0.170*** | 0.221*** | 0.277*** |
| | (25.03) | (17.39) | (17.45) | (24.11) | (19.75) | (19.33) | (10.46) | (8.10) | (11.14) | (3.39) | (7.17) | (7.38) | (9.47) | (12.53) | (8.69) | (7.73) |
| Observations | 25,368 | | | | | | | | 13,723 | | | | | | | |

Note: ***, **, *, denotes significance at 1%, 5% and 10%, respectively. ( ) t statistics. Experience is calculated as (age-year of education-6). All models include industry dummies and occupation dummies. Less than primary school and 1-10 employees are the excluded categories in education and size of firm variables, respectively.

**Table A7.** Decomposition results for the total sample

| Q | Raw log wage gap | Estimated log wage gap | Characteristics | Coefficient |
|---|---|---|---|---|
| 0.05 | 0.812 | 1.155 | 0.145 | 1.010 |
| | | (0.016) | (0.006) | (0.015) |
| 0.10 | 0.756 | 1.005 | 0.151 | 0.854 |
| | | (0.013) | (0.005) | (0.014) |
| 0.15 | 0.716 | 0.892 | 0.157 | 0.735 |
| | | (0.011) | (0.004) | (0.013) |
| 0.20 | 0.67 | 0.803 | 0.158 | 0.645 |
| | | (0.01) | (0.004) | (0.010) |
| 0.25 | 0.555 | 0.725 | 0.158 | 0.567 |
| | | (0.010) | (0.003) | (0.010) |
| 0.30 | 0.479 | 0.657 | 0.160 | 0.498 |
| | | (0.009) | (0.003) | (0.009) |
| 0.35 | 0.404 | 0.600 | 0.163 | 0.437 |
| | | (0.009) | (0.003) | (0.009) |
| 0.40 | 0.37 | 0.552 | 0.167 | 0.385 |
| | | (0.008) | (0.003) | (0.007) |
| 0.45 | 0.346 | 0.509 | 0.172 | 0.337 |
| | | (0.007) | (0.003) | (0.007) |
| 0.50 | 0.359 | 0.472 | 0.180 | 0.292 |
| | | (0.008) | (0.004) | (0.008) |
| 0.55 | 0.335 | 0.441 | 0.192 | 0.250 |
| | | (0.008) | (0.004) | (0.007) |
| 0.60 | 0.317 | 0.416 | 0.207 | 0.209 |
| | | (0.008) | (0.005) | (0.007) |
| 0.65 | 0.338 | 0.397 | 0.227 | 0.171 |
| | | (0.008) | (0.006) | (0.008) |
| 0.70 | 0.368 | 0.381 | 0.252 | 0.129 |
| | | (0.010) | (0.007) | (0.008) |
| 0.75 | 0.427 | 0.364 | 0.282 | 0.081 |
| | | (0.013) | (0.009) | (0.010) |
| 0.80 | 0.421 | 0.351 | 0.311 | 0.040 |
| | | (0.016) | (0.012) | (0.011) |
| 0.85 | 0.472 | 0.354 | 0.332 | 0.022 |
| | | (0.018) | (0.013) | (0.015) |
| 0.90 | 0.492 | 0.367 | 0.353 | 0.014 |
| | | (0.017) | (0.015) | (0.017) |
| 0.95 | 0.506 | 0.369 | 0.351 | 0.018 |
| | | (0.017) | (0.018) | (0.020) |

Note: ( ) Bootstrap standard errors based on 1000 repetitions.

**Table A8.** Decomposition results by group of cities

| | Group 1 | | | | Group 2 | | | | Group 3 | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Q | Raw log wage gap | Estimated log wage gap | Characteristics | Coefficient | Raw log wage gap | Estimated log wage gap | Characteristics | Coefficient | Raw log wage gap | Estimated log wage gap | Characteristics | Coefficient |
| 0.05 | 0.604 | 0.919 | 0.140 | 0.779 | 0.953 | 0.545 | 0.137 | 0.408 | 0.846 | 0.230 | 0.152 | 0.078 |
| | | (0.017) | (0.006) | (0.015) | | (0.023) | (0.036) | (0.035) | | (0.007) | (0.007) | (0.007) |
| 0.10 | 0.570 | 0.786 | 0.157 | 0.63 | 0.973 | 0.474 | 0.135 | 0.339 | 0.849 | 0.202 | 0.157 | 0.045 |
| | | (0.015) | (0.005) | (0.014) | | (0.015) | (0.007) | (0.015) | | (0.008) | (0.005) | (0.008) |
| 0.15 | 0.528 | 0.696 | 0.164 | 0.533 | 0.903 | 0.387 | 0.130 | 0.257 | 0.792 | 0.153 | 0.163 | -0.010 |
| | | (0.015) | (0.005) | (0.015) | | (0.015) | (0.008) | (0.015) | | (0.010) | (0.004) | (0.010) |
| 0.20 | 0.487 | 0.630 | 0.165 | 0.465 | 0.807 | 0.338 | 0.145 | 0.193 | 0.776 | 0.081 | 0.169 | -0.088 |
| | | (0.011) | (0.005) | (0.012) | | (0.010) | (0.008) | (0.011) | | (0.012) | (0.004) | (0.012) |
| 0.25 | 0.409 | 0.574 | 0.162 | 0.411 | 0.725 | 0.299 | 0.129 | 0.170 | 0.713 | 0.027 | 0.173 | -0.146 |
| | | (0.010) | (0.006) | (0.011) | | (0.008) | (0.004) | (0.008) | | (0.008) | (0.004) | (0.007) |
| 0.30 | 0.343 | 0.524 | 0.161 | 0.363 | 0.618 | 0.262 | 0.131 | 0.130 | 0.622 | -0.003 | 0.177 | -0.180 |
| | | (0.010) | (0.005) | (0.01) | | (0.007) | (0.003) | (0.007) | | (0.007) | (0.004) | (0.007) |
| 0.35 | 0.269 | 0.482 | 0.158 | 0.324 | 0.512 | 0.226 | 0.129 | 0.097 | 0.546 | -0.030 | 0.179 | -0.209 |
| | | (0.008) | (0.005) | (0.008) | | (0.007) | (0.004) | (0.007) | | (0.007) | (0.004) | (0.007) |
| 0.40 | 0.258 | 0.449 | 0.158 | 0.291 | 0.481 | 0.192 | 0.125 | 0.067 | 0.505 | -0.049 | 0.184 | -0.233 |
| | | (0.008) | (0.005) | (0.008) | | (0.008) | (0.005) | (0.009) | | (0.006) | (0.004) | (0.006) |
| 0.45 | 0.265 | 0.418 | 0.159 | 0.26 | 0.451 | 0.156 | 0.124 | 0.032 | 0.469 | -0.061 | 0.190 | -0.250 |
| | | (0.008) | (0.005) | (0.008) | | (0.009) | (0.005) | (0.009) | | (0.006) | (0.005) | (0.006) |
| 0.50 | 0.244 | 0.392 | 0.160 | 0.232 | 0.410 | 0.124 | 0.13 | -0.006 | 0.453 | -0.066 | 0.197 | -0.263 |
| | | (0.008) | (0.006) | (0.008) | | (0.009) | (0.005) | (0.009) | | (0.007) | (0.006) | (0.006) |
| 0.55 | 0.228 | 0.372 | 0.168 | 0.204 | 0.360 | 0.099 | 0.139 | -0.041 | 0.438 | -0.066 | 0.208 | -0.273 |
| | | (0.009) | (0.007) | (0.007) | | (0.010) | (0.006) | (0.009) | | (0.007) | (0.006) | (0.006) |
| 0.60 | 0.253 | 0.357 | 0.180 | 0.177 | 0.352 | 0.074 | 0.152 | -0.078 | 0.445 | -0.057 | 0.228 | -0.285 |
| | | (0.010) | (0.007) | (0.008) | | (0.010) | (0.006) | (0.010) | | (0.008) | (0.007) | (0.006) |
| 0.65 | 0.296 | 0.347 | 0.197 | 0.15 | 0.372 | 0.050 | 0.163 | -0.114 | 0.441 | -0.040 | 0.253 | -0.294 |
| | | (0.011) | (0.008) | (0.009) | | (0.010) | (0.006) | (0.009) | | (0.010) | (0.009) | (0.007) |
| 0.70 | 0.325 | 0.343 | 0.223 | 0.12 | 0.368 | 0.029 | 0.173 | -0.145 | 0.442 | -0.017 | 0.283 | -0.300 |
| | | (0.012) | (0.010) | (0.009) | | (0.010) | (0.007) | (0.009) | | (0.010) | (0.010) | (0.007) |
| 0.75 | 0.357 | 0.345 | 0.255 | 0.09 | 0.465 | 0.022 | 0.192 | -0.170 | 0.491 | 0.015 | 0.319 | -0.304 |
| | | (0.013) | (0.013) | (0.01) | | (0.012) | (0.01) | (0.01) | | (0.011) | (0.011) | (0.008) |
| 0.80 | 0.356 | 0.354 | 0.292 | 0.062 | 0.427 | 0.034 | 0.225 | -0.191 | 0.515 | 0.044 | 0.350 | -0.306 |
| | | (0.014) | (0.014) | (0.013) | | (0.013) | (0.011) | (0.011) | | (0.012) | (0.013) | (0.010) |
| 0.85 | 0.407 | 0.364 | 0.322 | 0.042 | 0.468 | 0.039 | 0.236 | -0.197 | 0.556 | 0.076 | 0.377 | -0.301 |
| | | (0.014) | (0.014) | (0.015) | | (0.012) | (0.012) | (0.012) | | (0.014) | (0.015) | (0.012) |
| 0.90 | 0.425 | 0.373 | 0.340 | 0.033 | 0.509 | 0.057 | 0.234 | -0.177 | 0.627 | 0.105 | 0.412 | -0.308 |
| | | (0.016) | (0.017) | (0.017) | | (0.016) | (0.019) | (0.016) | | (0.018) | (0.017) | (0.016) |
| 0.95 | 0.418 | 0.373 | 0.329 | 0.044 | 0.440 | 0.107 | 0.269 | -0.162 | 0.600 | 0.093 | 0.433 | -0.340 |
| | | (0.016) | (0.022) | (0.023) | | (0.018) | (0.02) | (0.019) | | (0.022) | (0.021) | (0.022) |

Note: ( ) Bootstrap standard errors based on 1000 repetitions.