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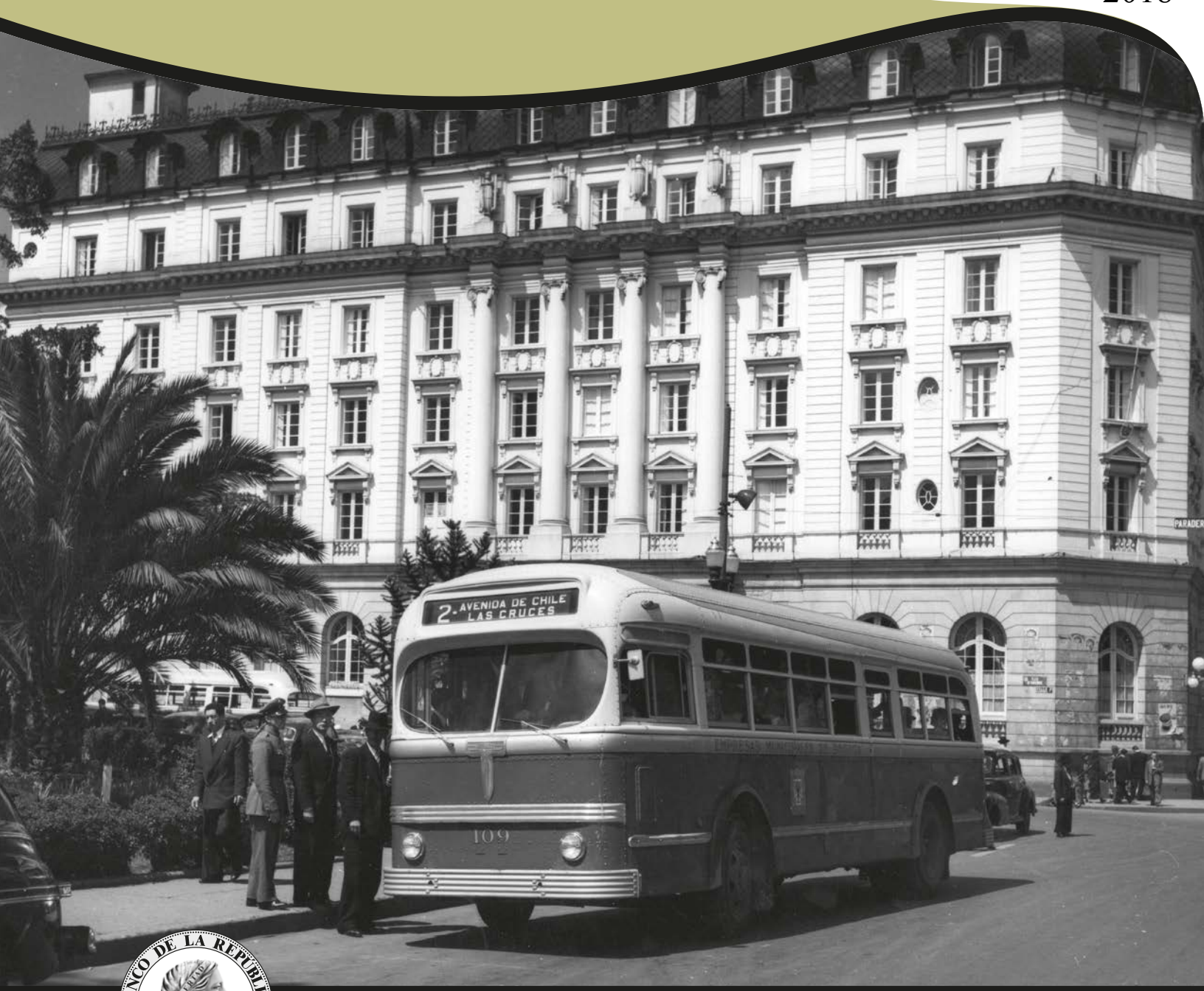

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The Returns from Training in Colombia: Evidence from a Longitudinal Survey

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Abstract

In this paper we explore the wage returns from training in Colombia, using data from the "The Social Longitudinal Survey" between 2009 and 2010. Using the longitudinal component of the data, we control for time invariant individuals' unobserved heterogeneity and, following Wooldridge (1995), we correct for sample selection in panel data. Our results suggest that there is a positive return from training. The magnitude of the estimates suggests an increase in wages between 7% and 9%. We find that OLS overestimate the effects of receiving training. This suggests that individuals who receive training are the ones with high unobserved skills. We also find that trainees increase their probability of being continuously employed, suggesting an improvement in individuals' working conditions.

JEL classification: C23, I26, J31, P36.

Keywords: Education, returns from training, unobserved heterogeneity, sample selection bias and panel data.

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Retornos de la capacitación para el trabajo en Colombia: evidencia basada en la Encuesta Longitudinal

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Resumen

Este documento explora los retornos de la capacitación para el trabajo en Colombia usando los datos de la Encuesta Longitudinal de Fedesarrollo entre 2009 y 2010. Los datos panel nos permite controlar por la heterogeneidad no observada de los individuos, que no cambia en el tiempo. Para controlar por el sesgo de selección, utilizamos la metodología de corrección propuesta en Wooldridge (1995). Los resultados sugieren que los retornos a la capacitación para el trabajo son positivos y significativos, entre el 7% y 9%. Adicionalmente, los resultados indican que la mayor capacitación incrementa la probabilidad de continuar empleado, sugiriendo una mejora en las condiciones laborales de los individuos.

JEL: C23, I26, J31, P36.

Palabras claves: Educación, retornos de la capacitación, heterogeneidad no observada, sesgo de selección, datos panel.

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Introduction

There has been a lot of research regarding the relevance of training in general and of on the job training in particular. Previous evidence suggests that training does not only help workers to adapt to the specific needs of the economy and firms but keeps the economy competitive and promotes growth and prosperity (Jenkins et al., 2003; Yamauchi, Poapongsakorn, and Srianant, 2009). Training has also shown to have a positive effect on income distribution by benefiting low skilled workers. It reduces the risk of unemployment, improves job prospects of stability and it may yield higher wages (Albert, García-serrano, and Hernanz, 2010). Moreover, from the firms' point of view, training may reduce job turnover.

Most of the evidence regarding the returns from training came from developed countries (Albert et al., 2010; Bassanini and Brunello, 2008; Brunello, Lorena, and Sonedda, 2012; Fersterer and Winter-ebmer, 2008; Fouarge, Schils, and Grip, 2013; Jenkins et al., 2003; Riphahn, Zibrowius, and Riphahn, 2015; Schøne, 2004, among others) ; and little is known about the effects of training in the developing world (see Attanasio, Guarín, Medina, and Meghir, 2015; Attanasio, Kugler, and Meghir, 2011, for some evidence regarding the returns from vocational training in Colombia).

The main contribution of this paper is to provide additional evidence on the returns from training in Colombia. To do so we use data from the survey conducted by *Fedesarrollo* between 2009 and 2010. We estimate a panel data model that controls for individuals' unobserved heterogeneity. We also follow Wooldridge (1995) to control for sample selection in panel data models. Our results suggest that there are positive returns from training in the Colombian case. The wage returns are between 7% and 9%. The magnitude of this effect is similar to what was found by Attanasio et al. (2015), when evaluating the long-term effects of the training program *Jóvenes en Acción*. We also find that trainees increase their probability of being continuously employed, suggesting an improvement in individuals' working conditions.

In Colombia, there is a concern among policy makers about the ability of workers to move between economic sectors, especially after the country opened the economy to the world market in 1991, and after the growth of the services sector. In the last decades, the number of institutions (public and private) offering training to individuals working in specific sectors

has increased. According to the National Department of Statistics (DANE), between 2011 and 2012, 46% of firms in the Manufacture and Trade sectors gave training to their workers, and 74% did the same in the service sector. In both cases, it represents a significant investment in human capital by firms.

The rest of this paper is organized as follows. Section 1 reviews the previous evidence on returns from training in developed and developing economies. In particular, we focused on how different authors have dealt with individuals' unobserved heterogeneity and sample selection. Sections 2 and 3 describe the methodologies and the data used in this study, respectively. Section 4 reports our estimates for the returns from training after controlling for individuals' unobserved heterogeneity and sample selection. Finally, Section 5 summarizes the main findings and concludes.

1. Literature review

In the last decades, there has been much interest among policy-makers to understand the returns to human capital investment and more specific to understand the returns from vocational training. Training has been seen as an important way to keep the competitiveness of the economy and to promote the economic growth and prosperity (Jenkins et al., 2003; Percival, Cozzarin, and Formaneck, 2013). To be able to meet the challenges of a competitive market, a faster technological change needs to move together with a highly qualified labour force (Arulampalam and Booth, 1998); Therefore, individuals' skills formation in the labour market is important. This allows workers to satisfy employers' needs for new skills and to maximize the efficiency of new technologies (Yamauchi et al., 2009).

The theoretical framework to study the human capital accumulation is built on the Becker's (1964) model. The model defines education and training as an investment that yields higher wages through increase in productivity. Individuals choose the optimal level of schooling by balancing the benefits and the costs of investing in more years of education. The training investment will depend on whether or not the skills to be acquired are general or specific. Becker (1964) argues that, even though in a competitive labour market firms will never pay for general training, workers would be willing to do so. A different set of outcomes would be observed in the presence of non-competitive markets for example, a number of authors

have shown how in the presence of non-competitive markets, firms may pay for general training (Acemoglu and Pischke, 1998; Acemoglu and Pischke, 1999; and Acemoglu et al., 1999). The main reason for this result is the monopsony power that allows firms to pay workers below their productivity level, with a compressed wage structure[1].

While most of the previous studies estimate the wage returns from training using Mincer' equations (Mincer, 1975), others have focused on its effects on working conditions. They estimate the probability of whether or not an individual continues employed or whether or not an individual moved to a better job (Arulampalam and Booth, 1998; Booth, 1991).

The main difficulty when estimating the returns from training is that trainees may not be a random sample of the population. They may have some particular characteristics (some of them unobserved) that make them more likely to receive training. This could be the case if high skilled workers choose to invest more in training in contrast to low skilled workers. The most common way to deal with the self-selection problem is to follow the Heckman (1979) correction. After using this methodology and controlling for sample selection bias, Salas-velasco (2009) finds a positive and significant return from training among young graduates in Europe.

Previous studies dealing with the problem of permanent unobserved heterogeneity in panel data, have found, on average, positive returns[2]. Fouarge et al. (2013) using panel data for Netherlands between 1994 and 2006 found that economic returns from training were positive and significant only for low educated workers. They also found that these types of workers were less likely to participate in training due to their individual preferences. Jenkins et al. (2003) using data for the UK found positive employment effects from lifelong learning, and limited evidence was found for its effects on wages. Similarly, Arulampalam and Booth

[1] Compressed wage structure is known as the gap between productivity and wage, which is higher at greater levels of skills. This wage structure might be the source of transaction costs, asymmetric information, moral hazard, minimum wages and unions, see Acemoglu and Pischke (1998).

[2] Another group of researchers studies returns to training using instrumental variables to control unobserved heterogeneity. These authors found evidence for a positive and significant effect of training (see Fersterer et al. (2008), Brunello et al (2012), and Shone (2004), among others). Moreover, authors as Franzis et al (2005) focus on the nonlinear functional form of training.

(2001) identified a positive effect on wage growth in UK. Using data for Germany between 1986 and 1989, Pischke (2001) compared returns from "on the job training" with the ones received when "out of the job". The author found a lower return from "on the job training", especially for women. Moreover, other studies have reported a positive effect of vocational training and apprenticeship among the youth (Riphahn et al., 2015). Additional evidence for the positive effects from training has been documented by Bassanini and Brunello (2008). These authors concluded that firms have incentives to pay for general training due to the compressed wage structure. Thus, the increase in productivity after training is greater than the increase in wages.

Following the above/ whether or not gains in productivity translate into higher wages depends on labour market characteristics and on whether or not there is a competitive market. Thus, to evaluate the returns from training, some authors have used alternative measures of productivity from employee-employer data (see, Dostie, 2013; Percival et al., 2013; Yamauchi et al., 2009). Percival et al., (2013) used data for Canada between 1999 and 2005, to explore the impact of investing on training on industries' productivity. They found that in 12 out of 14 industries, training had a positive effect on productivity[3].

The evidence for the returns from training in Colombia is limited. Some of the previous studies have focused on the returns of secondary and technical education. Bettinger, Kremer, and Saavedra (2010) compare the income of PACES[4] beneficiaries with the one of non-beneficiaries, fifteen years after the program. They found that those studying in private institutions received higher salaries than those who did not (between 11% and 13% more). Other authors (see, Barrera and Corchuelo, 2003; Gaviria and Nuñez, 2003; Santa Maria et al., 2009; Sarmiento et al., 2007), using information from the cross-section survey "*Encuesta de Calidad de Vida*", (ECV), explored returns from professional and technological education on earnings. While correcting for sample selection, the studies focused on the effectiveness

[3] The authors emphasize that the high employee turnover does not allow the efficacy of training, given that the trained workers leave the firm and untrained workers enter the firm concluding that the returns of training in productivity are just enough to maintain the current labour productivity.

[4] PACES, known by his name in Spanish as "Programa para la Ampliación de Cobertura en Educación Secundaria". It was implemented in 1991 and gave scholarships to 125.000 students from low income. The scholarship was assign randomly and those who win have the chance to study in a private school.

of the technical and technological programs from the National Training Service, SENA (*Servicio Nacional de Aprendizaje*).

More recently, Attanasio et al. (2011), examined returns from a training program introduced in Colombia in 2005 (*Jóvenes en Acción*[5]). The program was randomly assigned and offered training to young individuals between 18 and 25 years old belonging to low-income families. The authors found an increase in earnings and an improvement in participants' employment conditions especially among women. These results show that women's wages increased by 19.6% and that the probability of having a paid employment was 6.8pp higher among trainees[6]. Medina and Nuñez (2005) explored returns from vocational training or from attending short courses offered by SENA. Using matching estimators, the study does not find evidence of any significant effect of short courses on wages. The authors suggested that courses offered by private institutions provide higher returns for the participants than the ones offered by public institutions.

In a more recent study, Attanasio et al., (2015) evaluated the long-term impacts of the program "*Jóvenes en Acción*". The study found that ten years after the program, individuals earned formal wages that were 11.8% higher than the ones received by non-beneficiaries. Moreover, the effect was higher for females (17.5%) in contrast to males (10.7%). The study also reported that beneficiaries had a higher probability of working in the formal sector and in large firms.

The aim of this study is to contribute to the understanding of the returns from vocational training in Colombia, using the "The Social Longitudinal Survey" administered by *Fedesarrollo* between 2009 and 2010. By using the panel component of the data, we can produce more accurate estimates of the wage returns from vocational training and its effects on individuals' working conditions (e.g., the probability of being continuously employed or

[5] *Jóvenes en Acción* program provided subsidized training to poor young people (18-25 years old) living in urban areas. Training consisted of three months of classroom training and three months of on-the-job training, where classroom training was provided by private training institutions. The private training institutions received a substantial fraction of the overall payment when the students completed the apprenticeship and an additional payment if the beneficiaries where hired by the firms that trained them, then there was an incentive to identify the skills for which a demand was present in the labour market.

[6] The authors also find positive effects for men, however given that the attrition turn out to be high in men, this compromise the hypothesis of baseline quality between treatment and control characteristics in this group.

moving to better jobs). To the best of the authors' knowledge, this is the first attempt to estimate vocational training using longitudinal data from Colombia.

2. Methodology: a selection correction for panel data (Wooldridge 1995)

To estimate returns from training, we need to deal with different sources of bias. The first one comes from the correlation between individuals' unobserved heterogeneity (e.g., ability) and the probability of receiving training (see, Frazis, Loewenstein, and Tract, 2005). If high skilled workers invest more in training than low skilled workers, the estimates of the returns from training might be upward biased. The traditional way to deal with that source of bias or endogeneity is using fixed effects (FE).

Following Mincer (1974), the wage equation of each individual is represented by the following equation:

$$lnw_{it} = X_{it}\beta + \gamma T_{it} + \alpha_i + \varepsilon_{it} \quad (1)$$

Where lnw_{it} represents the wage of individual *i* in period *t* expressed in logarithms. X_{it} is the set of workers' and firms' characteristics (e.g., labour market experience, current tenure, level of education, firm's size, among others). T_{it} denotes whether or not the worker has received any training before period *t.* α_i is an individual effect which is unobserved and time invariant, and ε_{it} is the standard stochastic error term. To be able to eliminate the time-invariant person-specific unobserved heterogeneity, we estimate a FE model using the traditional within transformation as follows:

$$lnw_{it} - \ln \bar{w}_i = (X_{it} - \bar{X}_i)\beta + \vartheta(T_{it} - \bar{T}_i) + (\varepsilon_{it} - \bar{\varepsilon}_i) \quad (2)$$

Assuming a time invariant unobserved individual heterogeneity, the standard fixed effect regression will eliminate any correlated effects with wages. To be able to estimate this model we need at least two observations for each individual[7].

[7] Pischke (2001) suggests that if the wage growth rate of those receiving training is different from the one experienced by untrained individuals, our estimation may be biased. On the contrary, if the wage growth does not change for each individual, a fixed effect regression of the first difference will solve the problem. For the latter case, to be able to capture the effect, individuals need to be followed for at least three years, and have enough variation in the training variable. Due to data limitations we cannot follow this approach.

Another source of bias may arise when unobserved individuals' heterogeneity (e.g., ability) is correlated with observable characteristics such as wages. In that case we may face a sample selection problem and inconsistent estimates. Wages are only observed for labour market participants or for those whose reservation wage is lower than the wage offered in the labour market, leading to a sample selection bias. To get rid of this bias, we follow Wooldridge (1995) who proposes a panel data correction based on the ideas of Chamberlain (1984), Heckman (1979) and Mundlak (1978). The correction comprises a three-step procedure as follows

Step1. Estimate a probit for the *sample selection equation* for each year:

$$s_{it} = 1(s_{it}^* > 0) = 1(\eta_0 + X_{it}^*\delta + \zeta_{it} > 0) \quad (3)$$

Where s_{it} is an indicator function equal to 1 when the worker decides to participate in the labour market (e.g., when w_{it} is observed), 0 otherwise. X_{it}^* is the vector of observed individuals' characteristics and variables explaining the selection equation. In this equation we use as exclusion restrictions the number of children younger than five years old in the household and the family income without individual earnings[8]. These variables may affect the decision to participate in the labour market without having a direct effect on wages. ζ_{it} represents the factors' combined effect on participation, which can be expressed as the sum of two components: $\zeta_{it} = c_i + \mu_{it}$, a time-invariant person-specific unobserved heterogeneity component, c_i, and a standard stochastic error term, μ_{it}. Following Chamberlain (1984), Mundlak (1978) and Wooldridge (1995), we assume that time-invariant effects are linked to X_{it}^* through a linear function of the time averages of X_{it}^*, it means $c_i = \overline{X_i^*}\eta$, then we can write the selection equation following Mundlak- Chamberlain:

$$s_{it} = 1(s_{it}^* > 0) = 1\left(\eta_0 + \overline{X_i^*}\eta + X_{it}^*\delta + \mu_{it} > 0\right) \quad (4)$$

Step 2. Calculate the inverse Mills ratio for each probit in *t*.

[8] For this variable we use a dummy variable taking the value of 1 when family income without individual earnings is higher than the median of the family income distribution.

Once we have estimated the selection equation for each year using the set of variables contained in vector $h_{it} = [1 \ \overline{X_i^*} \ X_{it}^*]$, we can calculate the inverse Mills ratio suggested by Heckman (1976) as follows:

$$\hat{\lambda}_{it} = \frac{\phi(h_{it} \cdot \hat{\varphi})}{\Phi(h_{it} \cdot \hat{\varphi})} \tag{5}$$

where $\phi(h_{it} \cdot \hat{\varphi})$ is the normal density and $\Phi(h_{it} \cdot \hat{\varphi})$ the accumulative normal density.

Step 3. Estimate the equation of interest using OLS pooled regressions, including the inverse Mills ratio for each year as suggested by Heckman (1976):

$$lnw_{it} = \alpha + \overline{X}_i\psi + X_{it}\,\beta + \hat{\lambda}_{i1}\gamma_1 + \hat{\lambda}_{i2}\gamma_2 \ldots \hat{\lambda}_{iT}\gamma_T + e_{it} \tag{6}$$

Making explicit the training variable, we estimate the following equation:

$$lnw_{it} = \alpha + \overline{X}_i\psi + X_{it}\,\beta + \vartheta_1 T_{it} + \hat{\lambda}_{i1}\gamma_1 + \hat{\lambda}_{i2}\gamma_2 \ldots \hat{\lambda}_{iT}\gamma_T + e_{it} \tag{7}$$

From equation (7), and following Wooldridge (chapter, 17, p. 583), we can get consistent estimates of the parameters of interest. However, the asymptotic variance of the estimated parameters needs to be fixed from general heteroscedasticity, serial correlation, and the first-stage estimation. Appendix A explains step-by-step the error correction suggested by Wooldridge (1995) and how it was implemented in this study[9].

3. Data description

The information used in this study comes from the panel component of the Social Longitudinal Survey (*Encuesta Social Longitudinal, ESLF*) developed and administered by the Foundation for Higher Education and Development, *Fedesarrollo*. The survey collects information about demographic characteristics, health, living conditions and labour market indicators of urban households. The panel component of the survey started in 2004[10] and it ended in 2010. It has a rotating panel design, with 25% of the households interviewed replaced each year. From its beginnings, the longitudinal dimension covered three of the

[9] We use Stata program to implement the Wooldridge (1995) correction. The code is available upon request.
[10] Even though, *Fedesarrollo* conducted the first social survey in 1999, it was only since 2004 when the panel component was included.

main cities during seven years until 2010 (Bogotá, Cali and Bucaramanga). In 2008, the survey included 10 more metropolitan areas, ending up with a sample for the main thirteen cities of the country, for which the survey is representative.

Tables B.1 to **B.3** in Appendix B offer a better description of the households interviewed each year. We focus on the years 2009-2010, for which the training module is available. **Table B.1** shows that between 2009 and 2010 the survey covered almost 3500 households, 67% of them interviewed in Bogotá, Cali and Bucaramanga. Most of the interviews were conducted in low and middle-income households, as suggested by their socioeconomic strata (see **Table B.2**). Finally, the proportion of households continuously living in the same house and who were followed in the survey was close to 71% in 2010 (**Table B.3**).

Our sample is representative for the urban labour market of the country. Moreover, it is the only data with two consecutive years of information, allowing us to conduct a dynamic analysis of the labour market in Colombia[11]. It is possible to identify different labour market transitions experienced by individuals after training. In addition to the standard characteristics asked to the individual such as education, age, marital status, employment conditions, etc., between 2009 and 2010, the survey added a training module with the following questions: ¿Have you received training in the last 12 months?; ¿For how long?; ¿Who paid for the training?; and finally ¿Which institution offered the training?

Table 1 reports the summary statistics of the data used in the analysis. While column (1) reports the statistics for the whole sample; columns (2) and (3) do the same separating by training status. According to column (1), 15.076 individuals were surveyed during 2009-10, and 10% of them either received training in the last year or were receiving it at the moment of the interview. Even though trainees and non-trainees were of similar age, most of trainees were males, living in couples, and more educated than those individuals who did not received any training. Similarly, an important proportion of those who received training had completed secondary education (46% vs 33%). In terms of labour market conditions we find that those who received training were salaried workers (76%), with indefinite contracts

[11] There is a most recent panel data developed by the University of Andes, called ELCA, which follow individuals every three years. However, given the long gap between the two waves, we cannot get information about the transition of the individual immediately after the period he has received the training or if during these lapse of time he has received more training.

(59%), larger tenure (more than 5 years) and higher salaries than those who didn't receive training. Trainees were also more likely to contribute to pensions and health (more than 60%) and to be working in the service sector and in large firms.

Table 2 describes some of the training courses taken by individuals in the last 12 months or at the moment of the survey. The average duration of a training course was 1.22 months, and the main source of funding was the employer. In 36% of the cases, the training was offered at the work place and in 42% of the cases in institutions different from SENA. In addition to the question of whether they had received training in the last 12 months, workers were asked retrospective information for whether or not they received training before that period. 409 individuals reported to have received training before last year. Regarding the length and the funding source of the training course, the answers were similar to the ones reported by those who received training in the last 12 months.

4. Empirical evidence

4.1 Panel estimation

4.1.1 Probability of receiving training

Table 3 reports the estimates for the probability an individual receives training using different samples. While in column (1) we include all individuals participating in the labour market, in column (2) we restrict the analysis to individuals who were actually employed. Besides the time and city indicators included in column (1), column (2) includes workers and firms' characteristics. The results from column (1) suggest that among labour market participants, the ones with the highest probability of receiving training are those who were actually employed. Moreover, among employees (column (2)), the probability of receiving training increases monotonically with firm's size. Individuals working in firms with more than 100 employees had a higher probability of receiving training in contrast to those individuals working in firms with less than 100 employees.

According to the previous results, employed individuals are more likely to receive training.] In the following section we explore whether or not there are wage gains from it.

4.1.2 Returns from training

In this section we explore the wage returns from any training courses received by individuals in our sample between 2009 and 2010. While column (1) of **Table 4** reports the fixed effects estimates, columns (2) and (3) report the OLS and selection-corrected estimates, respectively[12]. As expected, wages are positively related with more years of education and experience. Having an additional year of education increased worker's wage by 7% according to the selection-correction model. Similarly, higher wages are observed for individuals working in larger firms. Workers in firms with more than 20 employees earn higher salaries than those working in firms with less than 5 employees.

Regarding the wage effect of receiving training, the estimates suggest a positive and a significant return from training. According to our preferred specification, i.e., the one that uses the selection correction for sample selection in panel data, receiving training is related to an increase in salary of 9% (see column (3) **Table 4**)). Notice that the estimated coefficients associated with lambda variables are significant, suggesting the existence of selection bias.

The previous estimates included both type of workers, employees and self-employed. **Table 5** restricts the analysis to employees due to their higher probability of receiving training. To deal with the self-selection problem we use as exclusion restriction an indicator variable for whether or not an individual makes contributions to pensions and health. The first column of **Table 5** presents the FE estimates. As before, columns (2) and (3) report the OLS and the Wooldridge correction estimates, respectively. Without controlling for sample selection, the FE estimates (column (1)) suggest that the returns from training are 11%. Once we control for sample selection, the estimated returns from training falls to 7% (column (3), which is smaller than the one reported by OLS (column (2)). This suggests that high skilled salaried workers (i.e., those with unobserved higher ability) are the ones receiving training. Our results are similar to those found by Fouarge et al. (2013) for the Netherlands. The authors show that low educated workers are significantly less willing to participate in training due to their economic preferences and personality traits.

[12] In the Wooldridge (1995) correction we were not able to include the average of all the observed characteristics, but we include all those that showed a higher variability.

4.1.3 Robustness check

One of the advantages of the information used in this study is the possibility to follow up individuals over time. In the previous exercise we use information for two years only: 2009 and 2010. To increase the sample size, we include retrospective information regarding any training received before the last 12 months when the survey was conducted. This allows us to include information regarding any training received during 2008 or before. **Table 6** reports the wage returns from training between 2008 and 2010. While the first three columns present results for all types of workers, the last three columns restrict the analysis to those working as employees. The results of the selection-correction approach/methodology are very similar to previous findings. We found a wage return from training close to 9% among all workers and 7% for those who were actually working as employees. When we compare the FE and the selection-correction estimates with the coefficients coming from OLS, we find that the latter ones are upward biased. Once again, this suggests that individuals with higher unobserved ability are the ones receiving training.

In Table 7 we explore whether or not the returns from training differ by gender. For this exercise we use the sample of all workers observed between 2008 and 2010. The results suggest a positive and a significant return from training among women, without finding evidence for a significant effect among men. A similar finding was reported by Attanasio et al., (2015; 2011) when studying the effects of the program *Jóvenes en Acción*.

A different strategy to control for individuals' unobserved ability is to find a proxy for this variable. As a robustness check, we include the score obtained in the National Examination Test, ICFES[13] (for its name in Spanish) as a proxy for individual's initial level of ability; the ICFES is the secondary level exit test and is frequently used as screening mechanism for tertiary education access. **Tables 8 and 9** report the summary statistics for the sample of individuals for whom we were able to find the score. Among individuals observed between 2009 and 2010, 895 were found in the National Examination Test Records. This is, 1790 observations for the 2009-2010 period. In contrast to the whole sample, the subsample

[13] In this case we use the ICFES test score information from 1990-2007. To verify that the sample data we are using is representative to the population sample for those who take the test, we compared the score distribution of all individuals that present the test and those we observed in Fedesarrollo's survey for every year. We cannot reject the null that both distributions are identical. Results are available upon request.

merged with the National Examination database, comprises younger individuals (26 years old on average vs. 36 years old observed in the whole sample). This should not surprise us since 50% of the individuals in the whole sample did not complete the secondary level of education and, as a consequence did not take the National Examination Test (see **Table 8**). Thus, individuals in the small sample have on average 3 years more of education than the ones in the whole sample. Moreover, when comparing trainees with non-trainees in the small sample, we find that the first ones are older, more educated, and more likely to be in salaried jobs (see **Table 9**).

Table 10 presents the results for all workers for the 2009-2010 period. Due to the small sample size[14], we do not differentiate between employees and self-employed individuals. After using the Wooldridge correction, the returns from training are close to 18.7%. Moreover, neither the lambda coefficient associated to the year 2009 nor the FE estimates are statistically significant, suggesting that there is no a significant correction on the sample selection. Nevertheless, those results need to be read with caution due to the smaller sample size used in this analysis.

4.1.4 Probability of continuing in employment

Previous literature has stated that among the benefits from training there are also the better employability conditions a trainee can acquire in his current job. In this section we explore the effect of receiving training in period $t-1$ on the probability of working as an employee or having a long-term contract in t. **Table 11** reports these results. According to our estimates in column (1), those who received training have a higher probability (6.6%) to be working as an employee in the period after the training was received. This result is maintained even after controlling for individual' and firm' characteristics. Moreover, we do not find any evidence of a training effect on the duration of the contract. As before, it is important to point out that the sample size used in this analysis is small and may affect the consistence of the estimates.

[14] We estimate the regression including the same of 2008, but the results do not change.

5. Final remarks

This study provides evidence of a positive return from training during the 2009-2010 period in Colombia. The estimated return was found to be between 7% and 9%, with the higher effect among working individuals. To control for unobserved individual heterogeneity we use the longitudinal component of the data. Similarly, to correct for sample selection in panel data, we follow the Wooldridge (1995) correction. We find that the OLS estimates of the returns from training are upward biased. This suggests that individuals with higher unobserved ability are the ones who received training, a result that agrees with findings by other authors (Fouarge et al., 2013).

As a first robustness check we used retrospective information for any training course received 12 months before the survey was conducted. This allowed us to have additional information for 2008 and before. Using the information for 2008-2010 we confirmed the previous findings, the existence of a positive return from training between 6.5% and 8.9%. Moreover, comparing the OLS estimates of the returns from training with the ones from FE and the Wooldridge correction, we confirmed the existence of a positive bias.

As an additional robustness check we used the score obtained by the individuals in the National Examination Test, ICFES (for its name in Spanish) as a proxy for individuals' unobserved heterogeneity (e.g. ability). We found a positive return from training of about 18%, however, those results need to be read with cautious due to the small sample size used in those regressions and additional sample selection problems.

Our results are similar to the ones found by Attanasio et al. (2015) when evaluating the long-term impacts of the program "*Jóvenes en Acción*". The authors found that ten years after the program was introduced, individuals who received training earned 11.8% more than those who did not. We also found that even though those who received training had a higher probability of being employed in the next period, little evidence was found for the probability of having a long-term contract. Moreover, our data is limited, and to explore the effects of training on employment conditions we need to be able to follow individuals for a longer period of time.

Despite the limitations of our data, it is important to emphasize that, to the best of our knowledge, this is the first exercise exploring the returns from training using longitudinal information (different to the randomized experiments previously studied by Attanasio et al., 2015). The results are interesting since they support the strong effort of governments and firms to improve the ability of workers, especially of low skilled workers through training. This process of skills formation is getting relevance in the new phase of technology and robotic where the demand for high skill workers would be increase.

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Tables

Table 1: Sample means, standard deviations and t-test 2009-2010

	Means				
	Total	No-Training	Training	Diff. in means(2&3)	St. error of the Difference
	(1)	(2)	(3)	(4)	(5)
Individual attributes					
Age	35.57	35.57	35.64	-0.07	0.40
	(15.33)	(15.69)	(12.00)		
Male	0.45	0.44	0.50	-0.05**	0.01
Partnered	0.43	0.42	0.50	-0.09**	0.01
Single	0.47	0.48	0.40	0.08**	0.01
Widow or divorce	0.10	0.10	0.09	0.01	0.01
Years of education	9.60	9.31	11.87	-2.56**	0.10
Education level					
Primary incomplete	0.20	0.22	0.07	0.14**	0.01
Secondary incomplete	0.29	0.31	0.14	0.17**	0.01
Secondary complete	0.34	0.33	0.46	-0.13**	0.01
Technical	0.08	0.07	0.15	-0.08**	0.01
University	0.09	0.07	0.18	-0.10**	0.01
Student	0.19	0.20	0.10	0.10**	0.01
Housekeeper	0.24	0.25	0.10	0.15**	0.01
Disabled	0.02	0.02	0.00	0.02**	0.00
Potential working experience	20.32	20.56	18.46	2.10**	0.43
	(16.39)	(16.79)	(12.78)		
Unemployed	0.14	0.15	0.08	0.06**	0.01
Working	0.52	0.49	0.80	-0.31**	0.01
Working as salaried worker	0.61	0.58	0.76	-0.18**	0.01
Tenure in the salaried work (mths)	58.70	57.01	64.91	-7.90**	2.98
	(84.97)	(84.58)	(86.16)		
Working as independent	0.37	0.40	0.23	0.18**	0.01
Tenure in the independent work (mths)	112.83	114.66	96.44	18.23*	10.20
	(118.99)	(120.36)	(104.88)		
Working without remuneration	0.01	0.01	0.01	0.01*	0.00
Working without contract	0.21	0.24	0.09	0.16**	0.01
Working with indefinite contract	0.50	0.47	0.59	-0.12**	0.02
Working with a fixed term contract	0.29	0.28	0.33	-0.04**	0.02
Contributes to the pensions system	0.40	0.35	0.63	-0.28**	0.01
Contributes to the health system	0.47	0.42	0.70	-0.27**	0.01
Wage from work in real terms (prices of 2008)	713229	664865	944531	-279666**	32853
	(1097935)	(863377)	(1828410)		
Non-labour income in real terms (prices 2008)	59401	58789	64272	-5482	8330
	(321723)	(298167)	(468852)		
Number of hours working per week	48.35	48.33	48.44	-0.11	0.53
	(17.61)	(17.77)	(16.81)		
City of residence					
Bogota	0.30	0.30	0.35	-0.05**	0.01
Cali	0.03	0.03	0.03	0.00	0.00
Bucaramanga	0.33	0.33	0.32	0.01	0.01
Medellin	0.09	0.09	0.08	0.00	0.01
Barranquilla	0.07	0.07	0.06	0.01*	0.01
Rest of cities	0.18	0.18	0.15	0.03**	0.01
Employer characteristics					
Firm size					
Employees: 1	0.30	0.33	0.17	0.16**	0.01
Less than 5 employees: 1-5	0.25	0.27	0.16	0.11**	0.01
From 6 to 19 employees	0.15	0.15	0.14	0.01	0.01
From 20 to 50 employees	0.10	0.10	0.14	-0.05**	0.01

From 51 to 100 employees	0.06	0.05	0.09	-0.04**	0.01
More than 100 workers	0.14	0.11	0.30	-0.19**	0.01
Economic sector					
Agriculture	0.02	0.02	0.01	0.00	0.00
Manufacturing	0.14	0.14	0.13	0.01	0.01
Construction	0.06	0.07	0.02	0.04**	0.01
Trade	0.20	0.21	0.14	0.07**	0.01
Private services	0.55	0.54	0.61	-0.07**	0.02
Public services	0.04	0.03	0.08	-0.06**	0.01
Observations	15076	13391	1685		

Source: Authors calculations using information from the Social Longitudinal Survey of Fedesarrollo (2009-2010). Standard deviations in parentheses. Significance levels for t-tests of mean differences: * = .1, and ** = .05

Table 2: Summary statistics of training in last year and previous years 2009-2010

	Training last 12 months		Training before the previous last year	
	Mean	St. dev.	Mean	St. dev.
Training characteristics				
Duration of training (months)	1.22	3.83	1.38	4.08
Source of funding				
Government	0.24	0.43	0.27	0.45
Employer	0.46	0.50	0.36	0.48
Others	0.30	0.46	0.36	0.48
Institution offering the course				
SENA (public)	0.22	0.41	0.25	0.44
Employer	0.36	0.48	0.29	0.46
Other institution	0.42	0.49	0.45	0.50
Observations	1685		409	

Source: Authors' calculations using information from the Social Longitudinal Survey of Fedesarrollo (2009-2010)

Table 3: Probability of taking training

	Participants	*Occupied*
Individuals' attributes		
Partnered	-0.002	-0.004
	(-0.06)	(-0.07)
Years of education	0.016	0.018
	(1.41)	(1.23)
Level of Education		
Primary and secondary (ref.)		
Technical & University	-0.010	-0.037
	(-0.33)	(-0.86)
Potential experience	0.006	0.003
	(0.47)	(0.20)
Potential experience^2	-0.000	-0.000
	(-0.56)	(-0.16)
Employee	0.031*	-0.010
	(1.78)	(-0.38)
Job characteristics		
Economic sector		
Private services (ref.)		
Agriculture		0.063
		(0.89)
Industry		-0.025
		(-0.83)
Construction		-0.007
		(-0.14)
Trade & Transport		0.005
		(0.20)
Public services		-0.031
		(-0.64)
Firms size		
Less than 5 employees (ref.)		
From 6 to 19 employees		0.029
		(1.03)
From 20 to 50 employees		0.061*
		(1.87)
From 51 to 100 employees		0.072*
		(1.77)
More than 100 workers		0.153**
		(4.27)
Constant	-0.114	-0.148
	(-0.35)	(-0.35)
N (observations)	*12478*	*9616*

Source: Authors' calculations using the Social Longitudinal Survey (ESLF 2009-2010). Include control of years and cities. Significance levels: * = .10, ** = .05, t-statistics in parentheses.

Table 4: Wage returns from training for all workers between 2009 and 2010

	FE	*OLS*	*Wooldridge95*
Individual attributes			
Gender		0.212**	0.221**
		(11.49)	(11.20)
Partnered	-0.093	0.108**	-0.065
	(-0.89)	(5.59)	(-0.55)
Years of education	0.067**	0.058**	0.074**
	(2.36)	(16.25)	(14.72)
Training	0.069	0.107**	0.087**
	(1.47)	(3.72)	(2.03)
Training finance			
Employer (ref.)			
Government	-0.001	-0.262**	-0.252**
	(-0.02)	(-4.82)	(-4.33)
Others	-0.203**	-0.051	-0.047
	(-2.47)	(-1.01)	(-0.93)
Level of Education			
Primary and secondary (ref.)			
Technical & University	0.124*	0.220**	0.231**
	(1.66)	(7.86)	(7.94)
Potential experience	0.094**	0.021**	0.031**
	(2.84)	(8.34)	(6.93)
Potential experience^2	-0.001**	-0.000**	-0.000**
	(-2.37)	(-6.59)	(-6.02)
Tenure	0.001	0.015**	0.010**
	(0.39)	(11.46)	(3.38)
Job characteristics			
Economic sector			
Private services (ref.)			
Agriculture	-0.116	0.017	0.012
	(-0.97)	(0.24)	(0.15)
Industry	0.010	-0.056**	-0.057**
	(0.18)	(-2.11)	(-2.16)
Construction	0.180*	0.097**	0.101**
	(1.78)	(2.38)	(2.67)
Trade & Transport	0.021	-0.027	-0.024
	(0.40)	(-1.10)	(-0.94)
Public services	-0.022	0.122**	0.113**
	(-0.28)	(2.87)	(2.66)
Firms size			
Less than 5 employees (ref.)			
From 6-19 employees	0.078	0.331**	0.131**
	(1.58)	(12.98)	(2.80)
From 20-50 employees	0.265**	0.406**	0.294**
	(4.82)	(14.29)	(5.41)
From 51-100 employees	0.245**	0.474**	0.317**
	(3.68)	(13.11)	(5.22)
More 100 workers	0.182**	0.541**	0.280**
	(3.03)	(19.78)	(4.86)
Constant	11.934**	11.816**	11.782**
	(15.53)	(227.31)	(195.14)
$\hat{\lambda}_{it}$			
2009			-0.084**
			(-3.80)
2010			-0.128**
			(-5.50)
$\overline{X_i}$			✓
N (observations)	*7283*	*7283*	*7283*

Source: Authors calculations using the Social Longitudinal Survey (ESLF 2009-2010). The dependent variable is the logarithm of real wages. Controls include year and city indicators. Significance levels: * = .10, ** = .05, t-statistics in parentheses.

Table 5: Wage returns from training for the sample of employees between 2009 and 2010

	FE	*OLS*	*Wooldridge95*
Individual attributes			
Gender		0.109**	0.108**
		(5.66)	(5.27)
Partnered	0.008	0.103**	-0.059
	(0.06)	(5.03)	(-0.51)
Years of education	0.070*	0.046**	0.048**
	(1.90)	(11.10)	(10.51)
Training	0.109**	0.075**	0.068**
	(2.23)	(2.97)	(2.51)
Training finance			
Employer (ref.)			
Government	-0.077	-0.123**	-0.102*
	(-0.74)	(-2.29)	(-1.66)
Others	-0.127	0.009	0.014
	(-1.41)	(0.17)	(0.27)
Level of Education			
Primary and secondary (ref.)			
Technical & University	0.249**	0.215**	0.220**
	(2.88)	(7.57)	(7.60)
Potential experience	0.111**	0.011**	0.019**
	(2.86)	(3.87)	(3.91)
Potential experience^2	-0.002**	-0.000	-0.000**
	(-1.97)	(-1.37)	(-1.97)
Tenure	0.003	0.009**	0.009**
	(0.65)	(5.78)	(4.63)
Job characteristics			
No contract (ref)			
Indefinite contract	0.480**	0.390**	0.273**
	(5.22)	(13.82)	(4.82)
Fixed-term contract	0.337**	0.283**	0.148**
	(3.75)	(9.38)	(2.65)
Economic sector			
Private services (ref.)			
Agriculture	-0.244	-0.043	-0.030
	(-1.56)	(-0.59)	(-0.29)
Industry	0.046	-0.042	-0.045*
	(0.65)	(-1.60)	(-1.67)
Construction	-0.166	0.182**	0.187**
	(-0.78)	(3.53)	(4.39)
Trade & Transport	0.102	-0.015	-0.017
	(1.53)	(-0.57)	(-0.66)
Public services	0.018	0.155**	0.159**
	(0.22)	(4.14)	(3.83)
Firms size			
Less than 5 employees (ref.)			
From 6 to 19 employees	-0.039	0.072**	0.059
	(-0.47)	(2.50)	(1.08)
From 20 to 50 employees	0.124	0.100**	0.142**
	(1.55)	(3.29)	(2.73)
From 51 to 100 employees	0.085	0.137**	0.183**
	(0.92)	(3.82)	(3.35)
More than 100 workers	0.061	0.233**	0.207**
	(0.73)	(7.93)	(7.29)
Constant	10.754**	12.169**	12.051**
	(11.48)	(193.93)	(161.23)
$\hat{\lambda}_{it}$			
2009			0.012**
			(6.26)
2010			0.010**
			(4.00)
$\overline{X_i}$			✓
N (observations)	*4525*	*4525*	*4525*

Source: Authors calculations using the Social Longitudinal Survey (ESLF 2009-2010). The dependent variable is the logarithm of real wages. Controls include year and city indicators. Significance levels: * = .10, ** = .05, t-statistics in parentheses. As exclusion restrictions we use indicators for whether or not an individual makes contributions to the health and pensions system.

Table 6: Wage returns from training between 2008 and 2010

	All workers			*Employees*		
	FE	*OLS*	*Wooldridge95*	*FE*	*OLS*	*Wooldridge95*
Individual attributes						
Gender		0.204**	0.210**		0.118**	0.118**
		(13.02)	(12.14)		(7.39)	(6.73)
Partnered	0.033	0.107**	-0.028	0.083	0.104**	-0.072
	(0.47)	(6.48)	(-0.34)	(0.96)	(6.09)	(-0.84)
Years of education	0.037*	0.057**	0.068**	0.011	0.044**	0.046**
	(1.82)	(18.61)	(16.03)	(0.41)	(13.17)	(11.99)
Training	0.077*	0.118**	0.089**	0.083**	0.074**	0.065**
	(1.92)	(4.47)	(2.52)	(1.97)	(3.15)	(2.53)
Training finance						
Employer (ref.)						
Government	-0.038	-0.259**	-0.242**	-0.112	-0.122**	-0.096*
	(-0.51)	(-5.21)	(-4.50)	(-1.29)	(-2.48)	(-1.74)
Others	-0.119*	-0.043	-0.034	-0.077	0.016	0.026
	(-1.69)	(-0.93)	(-0.72)	(-0.96)	(0.35)	(0.57)
Level of Education						
Primary and secondary (ref.)						
Technical & University	0.072	0.232**	0.239**	0.136**	0.234**	0.240**
	(1.32)	(9.63)	(9.26)	(2.26)	(9.84)	(9.49)
Potential experience	0.048**	0.022**	0.031**	0.042	0.015**	0.023**
	(2.16)	(10.18)	(7.50)	(1.55)	(6.51)	(5.35)
Potential experience^2	-0.001*	-0.000**	-0.000**	-0.001	-0.000**	-0.000**
	(-1.83)	(-7.91)	(-7.01)	(-1.52)	(-3.37)	(-3.93)
Tenure	0.004*	0.014**	0.010**	0.006*	0.010**	0.005**
	(1.69)	(12.86)	(4.90)	(1.87)	(7.36)	(2.14)
Job characteristics						
No contract (ref)						
Indefinite contract				0.209**	0.371**	0.210**
				(4.99)	(16.62)	(6.55)
Fixed-term contract				0.156**	0.281**	0.157**
				(3.54)	(11.76)	(4.64)
Economic sector						
Private services (ref.)						
Agriculture	-0.027	0.084	0.083	-0.106	0.054	0.056
	(-0.32)	(1.39)	(1.14)	(-1.06)	(0.86)	(0.58)
Industry	-0.026	-0.050**	-0.054**	-0.039	-0.048**	-0.049**
	(-0.70)	(-2.26)	(-2.44)	(-0.93)	(-2.27)	(-2.21)
Construction	0.116*	0.099**	0.104**	0.012	0.151**	0.162**
	(1.74)	(2.89)	(3.07)	(0.13)	(3.85)	(4.00)
Trade & Transport	-0.058*	-0.013	-0.011	-0.055	-0.006	-0.007
	(-1.71)	(-0.60)	(-0.48)	(-1.35)	(-0.27)	(-0.33)
Public services	0.057	0.106**	0.095**	0.044	0.123**	0.123**
	(1.05)	(2.94)	(2.52)	(0.79)	(3.87)	(3.30)
Firms size						
Less than 5 employees (ref.)						
From 6 to 19 employees	0.107**	0.322**	0.150**	0.046	0.105**	0.100**
	(3.31)	(14.97)	(4.77)	(1.09)	(4.53)	(3.10)
From 20 to 50 employees	0.224**	0.388**	0.239**	0.120**	0.125**	0.132**
	(6.20)	(16.27)	(6.39)	(2.71)	(5.04)	(3.62)
From 51 to 100 employees	0.216**	0.445**	0.291**	0.085*	0.155**	0.179**
	(4.95)	(14.58)	(6.94)	(1.67)	(5.20)	(4.64)
More than 100 workers	0.235**	0.527**	0.294**	0.143**	0.256**	0.224**
	(6.07)	(22.91)	(7.83)	(3.09)	(10.64)	(9.51)
Constant	12.086**	11.948**	11.815**	12.467**	12.132**	12.001**
	(21.85)	(268.56)	(228.76)	(16.55)	(236.96)	(197.48)
$\hat{\lambda}_{it}$						
2008			-0.068**			0.010**
			(-3.38)			(3.93)
2009			-0.068**			0.013**
			(-3.53)			(8.03)
2010			-0.112**			0.011**
			(-5.44)			(4.66)
$\overline{X_i}$			✓			✓
N (observations)	*9285*	*9285*	*9285*	*6342*	*6342*	*6342*

Source: Authors calculations using the Social Longitudinal Survey (ESLF 2009-2010). Controls include year and city indicators. Significance levels: * =.10, ** = .05, t-statistics in parentheses. As exclusion restrictions we use whether or not an individual makes contributions to the health and pensions system.

Table 7: Wage returns from training by gender. (Years between 2008 and 2010)

	Male			*Female*		
	FE	*OLS*	*Wooldridge95*	*FE*	*OLS*	*Wooldridge95*
Individual attributes						
Partnered	0.028	0.194**	-0.068	0.026	-0.013	-0.075
	(0.27)	(8.38)	(-0.54)	(0.27)	(-0.52)	(-0.69)
Years of education	0.055**	0.052**	0.060**	0.010	0.061**	0.074**
	(2.10)	(13.27)	(12.22)	(0.29)	(12.49)	(10.46)
Training	0.080	0.118**	0.060	0.091	0.113**	0.102*
	(1.51)	(3.47)	(1.37)	(1.45)	(2.73)	(1.75)
Training finance						
Employer (ref.)						
Government	-0.017	-0.209**	-0.202**	-0.071	-0.267**	-0.253**
	(-0.15)	(-3.02)	(-2.57)	(-0.68)	(-3.71)	(-3.34)
Others	-0.061	-0.006	-0.001	-0.236*	-0.067	-0.053
	(-0.71)	(-0.09)	(-0.02)	(-1.91)	(-0.94)	(-0.71)
Level of Education						
Primary and secondary (ref.)						
Technical & University	-0.003	0.238**	0.242**	0.096	0.219**	0.235**
	(-0.03)	(7.32)	(6.77)	(1.28)	(6.14)	(6.26)
Potential experience	0.081**	0.027**	0.032**	-0.004	0.018**	0.031**
	(2.71)	(9.41)	(5.58)	(-0.11)	(5.65)	(5.07)
Potential experience^2	-0.000	-0.000**	-0.000**	-0.001*	-0.000**	-0.000**
	(-1.03)	(-7.44)	(-6.13)	(-1.65)	(-4.87)	(-4.65)
Tenure	0.004	0.012**	0.006**	0.003	0.015**	0.012**
	(1.63)	(8.77)	(2.72)	(0.68)	(8.23)	(3.13)
Economic sector						
Private services (ref.)						
Agriculture	-0.050	0.046	0.045	0.051	0.140	0.132
	(-0.49)	(0.66)	(0.52)	(0.34)	(1.24)	(0.93)
Industry	-0.052	-0.049*	-0.048*	0.029	-0.050	-0.046
	(-1.15)	(-1.78)	(-1.65)	(0.44)	(-1.36)	(-1.36)
Construction	0.113	0.054	0.059	0.009	0.099	0.094
	(1.58)	(1.53)	(1.64)	(0.04)	(0.82)	(0.80)
Trade & Transport	-0.102**	-0.031	-0.034	-0.016	-0.003	-0.005
	(-2.25)	(-1.07)	(-1.15)	(-0.31)	(-0.09)	(-0.16)
Public services	0.092	0.120**	0.109**	0.017	0.098*	0.098*
	(1.16)	(2.50)	(2.13)	(0.23)	(1.84)	(1.72)
Firms size						
Less than 5 employees (ref.)						
From 6 to 19 employees	0.070	0.242**	0.191**	0.145**	0.384**	0.241**
	(1.63)	(8.52)	(4.54)	(2.95)	(11.77)	(5.33)
From 20 to 50 employees	0.174**	0.267**	0.275**	0.289**	0.509**	0.405**
	(3.72)	(8.60)	(5.94)	(5.05)	(13.81)	(7.63)
From 51 to 100 employees	0.206**	0.359**	0.390**	0.222**	0.510**	0.391**
	(3.65)	(9.06)	(7.84)	(3.24)	(10.81)	(6.36)
More than 100 workers	0.186**	0.441**	0.447**	0.295**	0.605**	0.594**
	(3.73)	(14.93)	(14.95)	(4.76)	(16.66)	(16.73)
Constant	11.288**	12.148**	12.021**	13.330**	11.991**	11.890**
	(15.69)	(211.90)	(173.37)	(15.50)	(175.87)	(153.83)
$\hat{\lambda}_{it}$						
2008			-0.018**			-0.099**
			(-2.49)			(-2.25)
2009			-0.018**			-0.103**
			(-2.74)			(-2.15)
2010			-0.025**			-0.187**
			(-3.42)			(-3.88)
$\overline{X_i}$			✓			✓
N (observations)	*5107*	*5107*	*5107*	*4178*	*4178*	*4178*

Source: Authors calculations using the Social Longitudinal Survey (ESLF 2009-2010). The dependent variable is the logarithm of real wages. Controls include year and city indicators. Significance levels: * = .10, ** = .05, t-statistics in parentheses.

Table 8: Sample means, standard deviations, t-test: whole sample vs. the test scores' subsample. 2009-2010

	Total	Means		Diff.(2&3)	St. error of Diff
		No-Match	Match		
	(1)	(2)	(3)	(4)	(5)
Individual attributes					
Age	35.57	36.84	26.17	10.67**	0.38
	(15.33)	(15.72)	(6.70)		
Male	0.45	0.44	0.50	-0.06**	0.01
Partnered	0.43	0.45	0.24	0.21**	0.01
Single	0.47	0.44	0.72	-0.28**	0.01
Widow or divorce	0.10	0.11	0.04	0.06**	0.01
Years of education	9.63	9.19	12.72	-3.52**	0.10
Level of education					
Primary incomplete	0.20	0.23	0.00	0.23**	0.01
Secondary incomplete	0.29	0.32	0.05	0.27**	0.01
Secondary complete	0.35	0.31	0.66	-0.35**	0.01
Technical	0.08	0.07	0.15	-0.08**	0.01
University	0.09	0.08	0.14	-0.06**	0.01
Student	0.19	0.19	0.23	-0.04**	0.01
Housekeeper	0.24	0.25	0.12	0.13**	0.01
Disable	0.02	0.02	0.01	0.02**	0.00
Potential working experience	20.32	21.98	8.53	13.45**	0.40
	(16.39)	(16.67)	(6.67)		
Unemployed	0.14	0.13	0.14	-0.01	0.01
Working	0.52	0.51	0.62	-0.11**	0.01
Working as salaried worker	0.61	0.58	0.79	-0.20**	0.02
Tenure as salaried worker (mths)	58.70	64.84	30.96	33.88**	3.13
	(84.97)	(90.82)	(40.50)		
Working as independent	0.37	0.40	0.19	0.21**	0.02
Tenure as independent worker (mths)	112.83	117.21	57.42	59.80**	11.69
	(118.99)	(121.10)	(67.02)		
Working without remuneration	0.01	0.01	0.02	-0.01*	0.00
Working without contract	0.21	0.23	0.13	0.10**	0.02
Working with indefinite contract	0.50	0.49	0.55	-0.06**	0.02
Working with fixed-term contract	0.29	0.29	0.32	-0.03*	0.02
Contributes to the pension system	0.40	0.37	0.58	-0.21**	0.02
Contributes to the health system	0.47	0.44	0.65	-0.21**	0.02
Wage in real terms (prices of 2008)	713229	707872	745858	-37985	35864
	(1097935)	(1149660)	(704689)		
Non-labour income in real terms (prices 2008)	59401	65918	11029	54889**	8097
	(321723)	(340900)	(80933)		
Number of hours working per week	48.35	48.66	46.43	2.23**	0.57
	(17.61)	(18.09)	(14.21)		
City of residence					
Bogota	0.30	0.29	0.38	-0.08**	0.01
Cali	0.03	0.03	0.03	0.00	0.00
Bucaramanga	0.33	0.34	0.21	0.13**	0.01
Medellin	0.09	0.09	0.08	0.00	0.01
Barranquilla	0.07	0.07	0.09	-0.02**	0.01
Rest of cities	0.18	0.17	0.21	-0.04**	0.01
Employer characteristics					
Firm size					
Employees: 1 employee	0.30	0.32	0.15	0.17**	0.02
From 1 to 5 employees	0.25	0.26	0.22	0.03**	0.01
From 6 to 19 employees	0.15	0.14	0.17	-0.03**	0.01
From 20 to 50 employees	0.10	0.10	0.15	-0.05**	0.01
From 51 to 100 employees	0.06	0.05	0.09	-0.03**	0.01
More than 100 employees	0.14	0.12	0.22	-0.09**	0.01
Economic sector					
Agriculture	0.02	0.01	0.02	-0.01**	0.00

Manufacturing	0.14	0.14	0.13	0.00	0.01
Construction	0.06	0.06	0.03	0.04**	0.01
Trade	0.20	0.20	0.17	0.03**	0.01
Private services	0.55	0.55	0.60	-0.05**	0.02
Public services	0.04	0.04	0.05	-0.02**	0.01
Observations	15076	13286	1790		

Source: Authors calculations using the Social Longitudinal Survey (ESLF 2009-2010). Standard deviations in parenthesis. Significance levels: * = .10, ** = .05.

Table 9: Sample means, standard deviations and t-test: Training vs. No Training for matching sample 2009-2010

	Total	No-Training	Means Training	Diff.(2&3)	St. error of Diff
	(1)	(2)	(3)	(4)	(5)
Individual attributes					
Age	26.17	25.89	27.45	-1.55**	0.41
	(6.70)	(6.71)	(6.47)		
Male	0.50	0.49	0.53	-0.04	0.03
Partnered	0.24	0.22	0.30	-0.08**	0.03
Single	0.72	0.73	0.66	0.07**	0.03
Widow or divorce	0.04	0.05	0.04	0.00	0.01
Years of education	12.72	12.38	13.26	-0.88**	0.15
Level of education					
Primary incomplete	0.00	0.01	0.00	0.01	0.01
Secondary incomplete	0.05	0.12	0.02	0.10**	0.02
Secondary complete	0.66	0.60	0.58	0.02	0.03
Technical	0.15	0.14	0.21	-0.08**	0.02
University	0.14	0.13	0.19	-0.06**	0.02
Student	0.23	0.25	0.11	0.14**	0.03
Housekeeper	0.12	0.13	0.06	0.07**	0.02
Disable	0.01	0.01	0.00	0.00	0.00
Potential working experience	8.53	8.40	9.15	-0.75*	0.41
	(6.67)	(6.71)	(6.44)		
Unemployed	0.14	0.16	0.09	0.08**	0.02
Working	0.62	0.57	0.84	-0.27**	0.03
Working as employed salaried	0.79	0.77	0.85	-0.08**	0.03
Tenure of employed salaried (mths)	30.96	28.95	36.75	-7.81**	3.11
	(40.50)	(37.13)	(48.51)		
Working as independent	0.19	0.21	0.14	0.07**	0.03
Tenure of independent worker (mths)	57.42	57.18	58.40	-1.22	16.33
	(67.02)	(59.51)	(94.31)		
Working without remuneration	0.02	0.02	0.01	0.01	0.01
Working without contract	0.13	0.15	0.07	0.09**	0.03
Working with an indefinite contract	0.55	0.54	0.57	-0.03	0.04
Working with a fixed-term contract	0.32	0.31	0.36	-0.05	0.04
Contributes to the pensions system	0.58	0.54	0.72	-0.18**	0.03
Contributes to the health system	0.65	0.61	0.77	-0.17**	0.03
Wage in real terms (prices of 2008)	745858	709292	860406	-151114**	49626
	(704689)	(728399)	(611866)		
Non-labour income in real terms (prices 2008)	11029	9021	20373	-11352.72**	5012.60
	(80933)	(78991)	(88954)		
Number of hours working per week	46.43	46.25	46.99	-0.74	1.00
	(14.21)	(14.23)	(14.19)		
City of residence					
Bogota	0.38	0.37	0.39	-0.02	0.03
Cali	0.03	0.04	0.01	0.03**	0.01
Bucaramanga	0.21	0.21	0.18	0.03	0.03
Medellin	0.08	0.08	0.11	-0.03*	0.02
Barranquilla	0.09	0.09	0.09	-0.00	0.02
Rest of cities	0.21	0.21	0.22	-0.01	0.03
Employer characteristics					

Firm size					
Employees: 1 employee	0.15	0.17	0.10	0.06**	0.03
From 1 to 5 employees	0.22	0.26	0.11	0.15**	0.03
From 6-19 employees	0.17	0.18	0.15	0.02	0.03
From 20-50 employees	0.15	0.13	0.18	-0.04*	0.03
From 51-100 employees	0.09	0.08	0.11	-0.03	0.02
More than 100 employees	0.22	0.18	0.33	-0.15**	0.03
Economic sector					
Agriculture	0.02	0.02	0.02	0.00	0.01
Manufacturing	0.13	0.14	0.13	0.00	0.02
Construction	0.03	0.02	0.03	-0.01	0.01
Trade	0.17	0.19	0.10	0.09**	0.03
Private services	0.60	0.59	0.62	-0.04	0.04
Public services	0.05	0.04	0.09	-0.05**	0.02
Observations	1790	1472	318		

Source: Authors calculations using the Social Longitudinal Survey (ESLF 2009-2010). Standard deviations in parenthesis. Significance levels: * = .10, ** = .05.

Table 10: Wage returns from training controlling for individuals' initial level of ability. 2009-2010

	FE	*OLS_TS*	*OLS*	*Wooldridge95*
Individual attributes				
Gender		0.042	0.048	0.039
		(0.98)	(1.12)	(0.87)
Partnered	-0.370	0.084	0.074	-0.001
	(-1.42)	(1.60)	(1.40)	(-0.01)
Years of education	0.145	0.098**	0.105**	0.112**
	(1.19)	(6.49)	(7.20)	(6.33)
Test score		0.068**		0.068**
		(2.51)		(2.42)
Test score square		-0.025		-0.027*
		(-1.52)		(-1.68)
Training	-0.022	0.194**	0.202**	0.187**
	(-0.18)	(3.25)	(3.39)	(3.80)
Training finance				
Employer (ref.)				
Government	0.080	-0.121	-0.124	-0.116
	(0.38)	(-1.08)	(-1.10)	(-1.01)
Others	-0.211	-0.262**	-0.267**	-0.250**
	(-1.04)	(-2.40)	(-2.44)	(-2.13)
Education				
Primary and secondary (ref.)				
Technical & University	0.156	0.105*	0.099	0.114*
	(1.00)	(1.72)	(1.62)	(1.88)
Potential experience	0.155	0.052**	0.051**	0.081**
	(1.26)	(4.84)	(4.78)	(4.40)
Potential experience^2	-0.003	-0.001**	-0.001**	-0.001**
	(-0.98)	(-3.79)	(-3.79)	(-3.75)
Tenure	-0.031	0.015**	0.016**	0.012
	(-1.31)	(2.27)	(2.40)	(0.51)
Job characteristics				
Economic sector				
Private services (ref.)				
Agriculture	-0.264	0.165	0.162	0.162
	(-1.01)	(1.24)	(1.22)	(1.02)
Industry	-0.277	-0.125*	-0.123*	-0.126*
	(-1.45)	(-1.91)	(-1.88)	(-1.74)
Construction	-0.232	0.215	0.208	0.214**
	(-0.77)	(1.64)	(1.58)	(2.00)
Trade & Transport	-0.252	-0.022	-0.026	-0.021
	(-1.55)	(-0.37)	(-0.42)	(-0.34)
Public services	0.007	0.248**	0.256**	0.252**
	(0.03)	(2.80)	(2.88)	(3.31)
Firms size				
Less than 5 employees (ref.)				
From 6 to 19 employees	-0.207	0.265**	0.274**	0.155
	(-1.48)	(4.09)	(4.23)	(1.33)
From 20 to 50 employees	0.213	0.334**	0.342**	0.445**
	(1.39)	(5.03)	(5.14)	(3.41)
From 51 to 100 employees	0.225	0.361**	0.376**	0.545**
	(1.22)	(4.59)	(4.78)	(4.37)
More than 100 workers	0.172	0.466**	0.477**	0.473**
	(1.10)	(7.52)	(7.70)	(7.37)
Constant	10.441**	11.246**	11.150**	11.320**
	(3.98)	(52.74)	(53.27)	(48.79)
$\hat{\lambda}_{it}$				
2009				-0.099
				(-1.47)
2010				-0.180**
				(-2.52)
$\overline{X_i}$				✓
N (observations)	*992*	*992*	*992*	*992*

Source: Authors calculations using the Social Longitudinal Survey (ESLF 2009-2010). The dependent variable is the logarithm of real wages. Controls include year and city indicators. Significance levels: * = .10, ** = .05, t-statistics in parentheses.

Table 11: Employment conditions in period *t* after receiving training in *t-1*

	Employee	*Long term contract*
Individual attributes		
Gender	0.008	-0.008
	(0.48)	(-0.24)
Partnered	-0.020	-0.010
	(-1.14)	(-0.28)
Years of education	-0.004	0.005
	(-1.23)	(0.67)
Training lag	0.066**	0.019
	(2.43)	(0.44)
Training finance lag		
Employer (ref.)		
Government	-0.013	-0.135
	(-0.30)	(-1.52)
Others	-0.121**	0.006
	(-2.95)	(0.09)
Level of education		
Primary and secondary (ref.)		
Technical & University	-0.029	0.026
	(-1.16)	(0.53)
Potential experience	-0.009**	0.006
	(-3.77)	(1.14)
Potential experience^2	0.000**	-0.000
	(2.31)	(-1.01)
Tenure	-0.006**	0.014**
	(-5.97)	(5.82)
Job characteristics		
Economic sector		
Private services (ref.)		
Agriculture	0.155**	-0.173
	(2.42)	(-1.25)
Industry	0.035	0.011
	(1.44)	(0.23)
Construction	-0.109**	0.179
	(-3.22)	(1.48)
Trade & Transport	-0.032	0.108**
	(-1.57)	(2.35)
Public services	0.192**	0.009
	(4.64)	(0.15)
Firms size		
Less than 5 employees (ref.)		
From 6 to 19 employees	0.502**	0.081
	(21.57)	(1.38)
From 20 to 50 employees	0.601**	0.090
	(23.32)	(1.56)
From 51 to 100 employees	0.660**	0.189**
	(19.87)	(2.95)
More than 100 workers	0.644**	0.129**
	(25.97)	(2.37)
Constant	0.511**	0.317**
	(10.78)	(2.86)
N (observations)	*2201*	*855*

Source: Authors' calculations using data from the Social Longitudinal Survey (ESLF 2009-2010).
Include controls for city and years. Significance levels: * = .10, ** = .05, t-statistics in parentheses.

Appendix

Appendix A. Wooldridge error correction (1995)[15]:

In this section we present the procedure followed to implement the Wooldridge error correction. It is important to point out that the notation is expressed observation by observation, where s_{it} indicates the observation of an individual $\boldsymbol{i}$ in time $\boldsymbol{t}$.

The dimensions of the variables used in the ***selection equation*** (equation (4)**)** and the ***equation of interest*** (equation (6)) are defined as follows:

Selection equation

$$s_{it} = 1(s_{it}^{*} > 0) = 1\left(\eta_0 + \overline{X_i^{*}}\eta + X_{it}^{*}\delta + \mu_{it} > 0 \right)$$

- X_{it}^{*} is an $1xG$ row vector defined for each $\boldsymbol{i}$ in all $\boldsymbol{t}$ as:
  $X_{it}^{*} = \left[x_{it}^{(1)} \quad ... \quad x_{it}^{(G)}\right]$, $x_{it}^{(1)}$ indicates the first variable of the individual $\boldsymbol{i}$ at time $\boldsymbol{t}$ and $x_{it}^{(G)}$ indicates the variable G of individual $\boldsymbol{i}$ at time $\boldsymbol{t}$.
- $\overline{X_i^{*}}$ is an $1xG$ row vector of variable averages for each individual $\boldsymbol{i}$.
  $\overline{X_i^{*}} = \left[\bar{x}_i^{(1)} \quad ... \quad \bar{x}_i^{(G)}\right]$; $\bar{x}_i^{(G)} = T^{-1}\sum_{t=1}^{T} x_{it}^{(G)}$
- η and δ are column vectors of size: $Gx1$ unknown parameters, μ_{it} and η_0 are scalars

Equation of interest

$$lnw_{it} = \alpha + \bar{X}_i\psi + X_{it}\,\beta + \hat{\Lambda}_{it}\gamma + e_{it}$$

- X_{it} is an $1xK$ row vector defined for each $\boldsymbol{i}$ in all $\boldsymbol{t}$ as:
  $X_{it} = \left[x_{it}^{(1)} \quad ... \quad x_{it}^{(K)}\right]$
- $\overline{X_i}$ is an $1xK$ row vector of variable averages for each individual $\boldsymbol{i}$.
  $\overline{X_i} = \left[\bar{x}_i^{(1)} \quad ... \quad \bar{x}_i^{(K)}\right]$; $\bar{x}_i^{(K)} = \frac{\sum_{t=1}^{T} x_{it}^{(K)}}{\sum_{t=1}^{T} s_{it}}$
- $\hat{\Lambda}_{it}$ is an $1xT$ row vector of inverses Mills ratios

  $\hat{\Lambda}_{it} = [\hat{\lambda}_{i1}\ \hat{\lambda}_{i2}\ ...\ \hat{\lambda}_{iT}]$, where each $\hat{\lambda}_{ij}$ is zero when $\neq t$.

- γ is $Tx1$ column vector, therefore γ is defined as the coefficients associated whit the inverses Mills ratio
- ψ and β are column vectors of size: $Kx1$ unknown parameters, e_{it} and α are scalars.

[15] The notation presented in this Appendix is similar to the one used in Jäckle and Himmler (2010)

Therefore, the ***selection equation*** have $1 + 2G$ variables and the ***interest equation*** have $1 + 2K + T$ variables, with $G \geq K$ since the ***selection equation*** should have additional variables to identify the selection, as suggested by Heckman (1976) in his correction with cross section data.

Procedure step by step:

1. Define from the ***selection equation*** (equation (4)**)** the row vector of variables: $h_{it} = \left[1 \ \overline{X_i^*} \ X_{it}^*\right]$ with dimensions $1x[1 + 2G]$, thus the simplified ***selection equation*** could be written as:

   $s_{it} = h_{it} \cdot \varphi + \mu_{it} \quad where \quad \varphi = \begin{bmatrix} \eta_0 \\ \eta \\ \delta \end{bmatrix}$, being φ a column vector of dimensions $[1 + 2G]x1$.
2. For each $t = 1, \dots, T$ estimate the selection equation with a probit regression, in which case the estimated parameters depends on time ($\hat{\varphi}_t$) and do the following:
   a. Calculate the inverse Mills ratio defined as $\hat{\lambda}_{it}$.

      Remember: $\hat{\lambda}_{it} = \frac{\phi(h_{it} \cdot \hat{\varphi}_t)}{\Phi(h_{it} \cdot \hat{\varphi}_t)}$, where $\phi(h_{it} \cdot \hat{\varphi}_t)$ is the normal density and $\Phi(h_{it} \cdot \hat{\varphi})$ accumulative normal density. Attention $\hat{\lambda}_{it}$ is a scalar per individual $\boldsymbol{i}$ at time $\boldsymbol{t}$.
   b. Calculate the derivative of the inverse Mills ratio evaluated at $h_{it}\hat{\varphi}$ defined as v_{it}

      $$\hat{v}_{it} = -\frac{\phi(h_{it}\hat{\varphi}_t) \cdot [h_{it}\hat{\varphi}_t \cdot \Phi(h_{it}\hat{\varphi}_t) + \phi(h_{it}\hat{\varphi}_t)]}{\Phi(h_{it}\hat{\varphi}_t)^2}$$

      Notice that $\hat{v}_{it}$ is a scalar per individual $\boldsymbol{i}$ at time $\boldsymbol{t}$.
   c. Calculate the column vector of partial derivatives per individual at time $\boldsymbol{t}$. Defined as Score:

      $$Sc_{it} = \frac{\partial log L_{it}}{\partial \varphi_t} = \frac{\phi(h_{it}\hat{\varphi}_t) \cdot (s_{it} - \Phi(h_{it} \cdot \hat{\varphi}_t))}{\Phi(h_{it} \cdot \hat{\varphi}_t) \cdot (1 - \Phi(h_{it} \cdot \hat{\varphi}_t))} \cdot h'_{it}$$ with dimensions $[1 + 2G]x1$

      (see Wooldridge, (2002, p. 392-393 & 460).

      Note that the expression $\frac{\phi(\cdot)(s_{it} - \Phi(\cdot))}{\Phi(\cdot)(1 - \Phi(\cdot))}$ is a scalar, that multiply by $[1 + 2G]x1$ column vector h'_{it}.

      Note: Using the Stata program we can easily calculate the Sc_{it}. Using the Score option and then multiplying by the h'_{it} column vector it is possible to obtain Sc_{it} with dimensions $[1 + 2G]x1$.
   d. Calculate the covariance matrix of each probit model, with dimensions $[1 + 2G]x[1 + 2G]$ defined as

      $$-E[Hessiana(\hat{\varphi}_t) \mid h_{it}]^{-1} = \widehat{var}(\hat{\varphi}_t) = \left\{\sum_{it}^{N} \frac{(\phi(h_{it} \cdot \hat{\varphi}_t))^2}{\Phi(h_{it} \cdot \hat{\varphi}_t) \cdot (1 - \Phi(h_{it} \cdot \hat{\varphi}_t))} \cdot h'_{it} \cdot h_{it}\right\}^{-1}$$

      (see Wooldridge, (2002, p. 460-461).

Note: Stata calculates the covariance matrix automatically, therefore, we just need to save the covariance matrix when estimating the probit for each time period $\boldsymbol{t}$.

3. Built the column vector $R_i = \begin{bmatrix} r_{i1} \\ \vdots \\ r_{iT} \end{bmatrix}$ with dimensions $[T(1+2G)]x1$. The column vector R_i is built by T column vectors r_{it} with dimension $[1+2G]x1$, where $r_{it} = \widehat{var}(\hat{\varphi}_t) \cdot Sc_{it}$.
4. Multiply $\hat{v}_{it} \cdot h_{it}$ to create $1x(1+2G)$ row vector.
5. Built the $Tx[1+2G]$ matrix $\hat{Z}_{it}$ that contains the product $\hat{v}_{it}h_{it}$ at the position $\boldsymbol{t}$ per each observation. E.g.

- For $t = 1$ $\quad \hat{Z}_{i1} = \begin{bmatrix} \hat{v}_{i1}h_{i1} \\ 0 \\ \vdots \\ 0 \end{bmatrix} = \hat{v}_{i1} \cdot \begin{bmatrix} 1 & \bar{x}_{i1}^{(1)} & \dots & \bar{x}_{i1}^{(G)} & x_{i1}^{(1)} & \dots & x_{i1}^{(G)} \\ & & & 0 & & & \\ & & & \vdots & & & \\ & & & 0 & & & \end{bmatrix}$
- For $t = 2$ $\quad \hat{Z}_{i2} = \begin{bmatrix} 0 \\ \hat{v}_{i2}h_{i2} \\ \vdots \\ 0 \end{bmatrix}$
- For $t = T$ $\quad \hat{Z}_{iT} = \begin{bmatrix} 0 \\ 0 \\ \vdots \\ \hat{v}_{iT}h_{iT} \end{bmatrix} = \hat{v}_{iT} \cdot \begin{bmatrix} & & & 0 & & & \\ & & & 0 & & & \\ & & & \vdots & & & \\ 1 & \bar{x}_{iT}^{(1)} & \dots & \bar{x}_{iT}^{(G)} & x_{iT}^{(1)} & \dots & x_{iT}^{(G)} \end{bmatrix}$

Remember $\hat{v}_{i1}h_{i1}$ is dimensions $1x[1+2G]$ and $\hat{Z}_{it}$ contains $T-1$ row vectors of zeros with dimensions $1x[1+2G]$ and only one $\hat{v}_{i1}h_{i1}$, thus $\hat{Z}_{it}$ is a matrix with dimensions $Tx[1+2G]$.

6. Built the matrix $\hat{F}_{it} = \begin{bmatrix} 0 & \dots & 0 & 0 & \dots & 0 \\ 0 & \dots & \hat{Z}_{it} & 0 & \dots & 0 \end{bmatrix}$ where the position of $\hat{Z}_{it}$ changes according to the time $\boldsymbol{t}$. As you can see, $\hat{F}_{it}$ is a matrix of matrices. therefore, to make its construction easier you can proceed as follows:
    a. First built a $[1+2K]x[1+2G]$ matrix of zeros, which correspond to each zeros of the first row of the matrix $\hat{F}_{it}$.
    b. Second, built a $Tx[1+2G]$ matrix of zeros, which correspond to each zeros of the second row of the matrix $\hat{F}_{it}$.
    c. Finally, replace $\hat{Z}_{it}$ on the position corresponding to the time $\boldsymbol{t}$.

Note: $\hat{F}_{it}$ is a matrix of two rows and T columns. Since each internal element has a specific size, $\hat{F}_{it}$ is a matrix of dimensions $[1+2K+T]x[T(1+2G)]$.

- For $t = 1$ $\quad \hat{F}_{i1} = \begin{bmatrix} 0 & 0 & \dots & 0 & \dots & 0 \\ \hat{Z}_{it} & 0 & \dots & 0 & \dots & 0 \end{bmatrix}$
- For $t = 2$ $\quad \hat{F}_{i2} = \begin{bmatrix} 0 & 0 & \dots & 0 & \dots & 0 \\ 0 & \hat{Z}_{i2} & \dots & 0 & \dots & 0 \end{bmatrix}$
- For $t = T$ $\quad \hat{F}_{iT} = \begin{bmatrix} 0 & 0 & \dots & 0 & \dots & 0 \\ 0 & 0 & \dots & 0 & \dots & \hat{Z}_{iT} \end{bmatrix}$

Example: $\mathrm{K} = 1;\ \mathrm{G} = 2;\ \mathrm{T} = 2$

$\hat{F}_{i2} = \begin{bmatrix} 0^{(1)} & 0^{(1)} \\ 0^{(2)} & \hat{Z}_{i2} \end{bmatrix}$ with each internal element being a matrix, then

$0^{(1)} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}_{[3]x[5]}; \quad 0^{(2)} = \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 \end{bmatrix}_{[2]x[5]}$

$\hat{Z}_{i2} = \begin{bmatrix} 0 \\ \hat{v}_{i2} h_{i2} \end{bmatrix} = \hat{v}_{i2} \cdot \begin{bmatrix} 0 & 0 & 0 & 0 & 0 \\ 1 & \bar{x}_{i2}^{(1)} & \bar{x}_{i2}^{(2)} & x_{i2}^{(1)} & x_{i2}^{(2)} \end{bmatrix}_{[3]x[5]}$. These zeros are not matrices.

Now, the matrix $\hat{F}_{it}$ will be:

$$\hat{F}_{i2} = \hat{v}_{i2} \cdot \begin{bmatrix} 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 0 & 0 & 1 & \bar{x}_{i2}^{(1)} & \bar{x}_{i2}^{(2)} & x_{i2}^{(1)} & x_{i2}^{(2)} \end{bmatrix}_{[5]x10}$$

7. Define the row vector $\widehat{W}_{it} = [1 \ \ \bar{X}_i \ \ X_{it} \ \ \widehat{\Lambda}_{it}]$ with dimensions $1x[1 + 2K + T]$.
8. Estimate the ***equation of interest*** defined as $lnw_{it} = \widehat{W}_{it} \cdot \theta + e_{it}$ by Pooled-OLS only when $s_{it} = 1$.

   Remember: $\hat{\theta} = \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \left(s_{it} \cdot \widehat{W}'_{it} \cdot \widehat{W}_{it} \right) \right)^{-1} \cdot \left(\sum_{i=1}^{N} \sum_{t=1}^{T} \left(s_{it} \cdot \widehat{W}'_{it} \cdot lnw_{it} \right) \right)$ and $\hat{\theta}$ is an $[1 + 2K + T]x1$ column vector.
9. Estimate the Pooled-OLS' residuals defined as $\hat{e}_{it} = lnw_{it} - W_{it} \cdot \hat{\theta}$ only for observations such that $s_{it} = 1$.
10. Built the $[1 + 2K + T]x[T(1 + 2G)]$ matrix $\widehat{D}$ defined as:

$$\widehat{D} = N^{-1} \cdot \sum_{i=1}^{N} \sum_{t=1}^{T} s_{it} \cdot W'_{it} \cdot \hat{\theta}' \cdot \hat{F}_{it}$$

11. Calculate

$\hat{q}_i = \sum_{t=1}^{T} s_{it} \cdot \widehat{W}'_{it} \cdot \hat{e}_{it}$	$\hat{q}_i$ is the dimension $[1 + 2K + T]\ x1$
$\hat{p}_i = \hat{q}_i - \widehat{D} \cdot \hat{R}_i$	$\hat{p}_i$ is the dimension $[1 + 2\mathrm{K} + \mathrm{T}]$ x1
$\hat{B} = N^{-1} \sum_{i=1}^{N} \hat{p}_i \cdot \hat{p}'_i$	$\hat{B}$ is the dimension $[1 + 2K + T]x[1 + 2K + T]$
$\hat{A} = N^{-1} \sum_{i=1}^{N} s_{it} \cdot \widehat{W}'_{it} \cdot \widehat{W}_{it}$	$\hat{A}$ is the dimension $[1 + 2K + T]x[1 + 2K + T]$

12. Finally, calculate the $[1 + 2K + T]x[1 + 2K + T]$ matrix $avar(\hat{\theta})$ defined as

$$avar(\hat{\theta}) = (A^{-1} B A^{-1}) \cdot N^{-1}$$

Remember: by calculating the square root of the main diagonal of $avar(\hat{\theta})$, you will find the corrected standard errors of the parameters in $\hat{\theta}$.

$$\sqrt{N}(\hat{\theta} - \theta) \xrightarrow{d} Normal(0, A^{-1}BA^{-1})$$

Appendix B. Additional tables

Table B.1 Number of households interviewed per city and year

Year	Cities	Households interviewed per city	Total number households
2009	Bogotá Cali Bucaramanga Medellín Barranquilla Rest of cities	1090 1100 458 383 228 704	3963
2010	Bogotá Cali Bucaramanga Medellín Barranquilla Rest of cities	1089 1100 78 377 214 634	3492

Source: Social Longitudinal Survey (ESLF 2007-2010)

Table B.2 Number of households interviewed per socio-economic strata.

	Low social strata	Middle social strata	High social strata	Total
2007	729	963	173	1865
2008	2070	2005	431	4506
2009	1860	1701	402	3963
2010	1667	1473	352	3492

Source: Social Longitudinal Survey (ESLF 2007-2010)

Table B.3 % of households that were followed up each year.

	2007	2008	2009	2010
Same household, same house	60.5%	70.2%	71.8%	70.7%
Same household, different house	3.9%	1.2%	4.9%	4.7%
New household, same house	0.5%	0.8%	2.1%	1.2%
New household, new house	351%	27.8%	21.2%	23.4%

Source: Social Longitudinal Survey (ESLF 2007-2010)


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