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# How does the worker's contribution to productivity explain the decrease in inequality in South America?

*¿Cómo la contribución del trabajador a la productividad explica la disminución de la desigualdad en América del Sur?*

*Como a contribuição do trabalhador para a produtividade explica a diminuição da desigualdade na América do Sul?*

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*The considerable reduction of inequality in South America in the period 2002–2011, consistent with the economic cycle, is directly related to the decrease in the skill premium among workers, whose main cause is productivity. When analyzing the relationship between wage qualification and productivity, we observe how unskilled workers have increased their contribution to production, which explains a retribution in the form of a higher wage for their work than that of skilled workers. The effort that has been made to improve the quality of initial and primary education and to emphasize the capacity of higher education to respond to the real economic needs of South America is therefore coherent.*

*La considerable reducción de la desigualdad en América del Sur durante el período 2002–2011, consistente con el ciclo económico, se relaciona directamente con la disminución de la prima de cualificación entre trabajadores, cuya principal causa es la productividad. Al analizar la relación entre cualificación salarial y productividad, observamos cómo los trabajadores no cualificados han incrementado su contribución a la producción, lo que explica una retribución en forma de un salario más alto por su trabajo, que el de los trabajadores cualificados. Por lo tanto, es coherente el esfuerzo que se ha venido dando, enfocado en mejorar la calidad de la educación inicial y primaria y poner el acento en la capacidad de la educación superior para responder a las necesidades económicas reales de América del Sur.*

*A considerável redução da desigualdade na América do Sul durante o período 2002–2011, consistente com o ciclo econômico, está diretamente relacionada à diminuição do prêmio de qualificação entre os trabalhadores, cuja principal causa é a produtividade. Ao analisar a relação entre qualificação salarial e produtividade, observamos como os trabalhadores não qualificados aumentaram sua contribuição para a produção, o que explica uma remuneração na forma de um salário mais alto pelo seu trabalho do que a dos trabalhadores qualificados. Portanto, o esforço que tem sido feito., focando na melhoria da qualidade do ensino inicial e primário e enfatizando a capacidade do ensino superior para responder às reais necessidades econômicas da América do Sul, é coerente.*

# 1. Introduction

South American inequality was reduced in 2002-2011 in a context of unprecedented growth in the region's economy. Despite the fact that inequality is one of the main limits for South American development, it is the first time that it descended continuously in its recent history (De la Torre et al., 2017; Guerra-Salas, 2018). Moreover, it is the region that registered the most pronounced recoil in the world during the period (Lakner and Milanovic, 2013; Alvaredo and Gasparini, 2015). Thus, in this research, we try to give an answer to the question: what reduced income inequality in South America in 2002-2011?

Although it is not possible to scorn the role of transfer in the behavior of inequality during the period, the reduction in the labor income gap explains approximately 75% of the decline in income inequality. Among the causes of the narrowing in the labor income gap, despite the fundamental influence of variables such as gender or ethnicity, the weight of the decline in the skill premium stands out, i.e., the reduction of the wage difference between people with low and high skill, which measured in function on the achieved academic degree, reached 64%[2].

The wages of people with high skill increased less than the wages of the people with low skill, which reduced the difference between people with more or less labor income and, in consequence, income inequality. After the decade of the nineties, in which the skill premium had not stopped from increasing, the wage of people with high skill took less advantage of the extraordinary growth in the region in 2002-2011, actively contributing to reduce inequality. Given this empirical evidence, the question regarding inequality reduction can be transformed into what caused the skill premium to fall?

Results from the economic literature suggest that the skill of workers is determined by variations in trade openness, technological progress, physical capital, local labor market structure or education. These same variables have in common that, in addition to being related to the skill premium, they have also been shown to be determinants of productivity in the region (Sala-i-Martin et al., 2004; OCDE, 2016; Izquierdo et al., 2016).

If the skill premium is related to multiple variables related to productivity, our first hypothesis is that the skill premium is directly related to productivity, especially in the period 2002-2011. The relationship between productivity and skill premium can also be addressed through microeconomic theory with respect to firm behavior. In this context, firms determine their optimal level of inputs at the point where the marginal productivity of these factor equals their corresponding costs. In this case, skilled and unskilled workers must constitute the total labor factor, so their respective wages correspond to their marginal productivity. Given the fact that productivity was on rise and the skill premium was reduced, the less skilled workers would have contributed more to the increase in productivity during the period than the more skilled workers. As a result, low-skilled workers increased their payment over the more qualified. If so, the variations in the skill premium would be responding to variations in the contribution to the productivity of workers with high and low skills. This finding would be consistent with the labor market structure of people with less capacity, which significantly improved in the period 2002-2011, without the necessary capacity to meet the needs of qualified personnel of companies in the region.

## 2. The channels of the reduction of South American inequality (2002-2011)

South American[3] inequality was continuously reduced in 2002-2011 in a context of unprecedented growth of the economy in the region (De la Torre et al., 2017). After the last two decades of rising inequality (Gasparini and Lustig, 2011) and stagnation (Cord et al., 2017), South America achieved the largest decline in inequality in the world in 2002-2011 (Williamson, 2015).

Moreover, as shown below, it is the period in which inequality in the region was significantly and inversely linked to the economic cycle. For the analysis, we took the disposable income Gini of the Standardized World Income Inequality Database (Solt, 2019). Hence, the simple regression follows **equation (1)**.

(1) $$Gini_{it} = \alpha + \gamma (GDP\ cycle)_{it} + u_{it}$$

Where *Gini* represents the disposable income Gini, *α* the constant term, *γ* the effect of the economic cycle on the disposable income Gini, *u* is the error term, *i* represents a South American country and *t* the year. To calculate the economic cycle, we apply the Hodrick-Prescott filter (1981) that decomposes the series into a trend component and a cyclical one and identifies the trend component that minimizes the deviations with respect to the center of the series, as stated in **equation (2)**.

(2) $$\min_{\tau_t} \left\{ \sum_{t=1}^{T} (y_t - \tau_t)^2 + \lambda \sum_{t=2}^{T-1} [(\tau_{t+1} - \tau_t) - (\tau_t - \tau_{t-1})]^2 \right\}$$

Where $y_t$ is the logarithmic series of real GDP such that $y_t = \tau_t + c_t$, $\tau_t$ is the trend component, $c_t$ is the cyclical component, and $\lambda$ is a positive real number that penalizes changeability in the growth component series. **Figure 1** shows, how in the period 2002-2011, inequality in South America began to decline steadily in an unprecedented cycle of expansion in the region, after an ascending period in the context of intense variability. The downward trend of inequality stagnated again in 2012-2016, in a new period of instability of the cycle. **Table 1** shows the results of a panel data regression with random effects between inequality and the economic cycle in the periods 1990-2001, 2002-2011 and 2012-2016, based on **equation (1)**. To avoid the possible presence of heteroskedasticity we estimated the model with robust standard errors. The results are consistent with the analysis carried out by Guerra-Salas (2018) until 2011. We observe that only for the period 2002-2011 the effect of economic cycle was significant and countercyclical in the evolution of inequality. Results show that an increase in 1% in the economic cycle is associated with a decrease of 0.13 points in the Gini coefficient.

Figure 1. Gini coefficient and economic cycle (SA average)
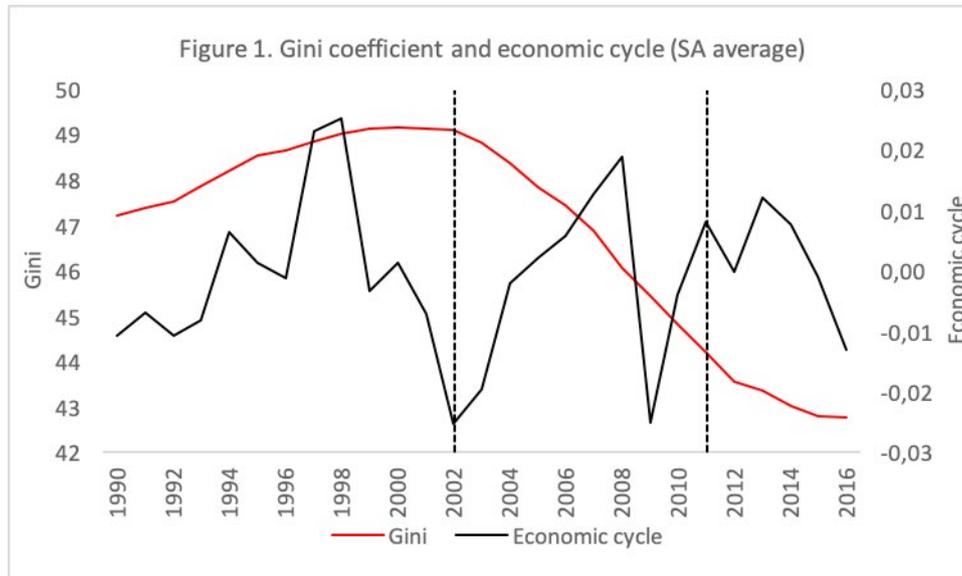
Source: Authors' calculations, based on Solt (2019) and The World Bank (2019).

**Table 1 – Results of the regression between Gini coefficient and the economic cycle**

|  | 1990-2001 | 2002-2011 | 2012-2016 |
|---|---|---|---|
| *Economic cycle* | 0.034 (0.049) | -0.13** (0.063) | -0.071 (0.17) |
| *Constant* | 0.0037* (0.0021) | -0.011*** (0.0016) | -0.0066*** (0.0015) |
| *Obs* | 106 | 90 | 45 |
| *R2 (within)* | 0.0061 | 0.11 | 0.019 |
| *R2 (overall)* | 0.011 | 0.079 | 0.0088 |
| *R2 (between)* | 0.24 | 0.040 | 0.12 |

Note: Robust standard errors in parentheses. Significance level at * p < 0.1, ** p<0.05, *** p<0.01.

## 2.1. What made inequality relate for the first time as expected to the economic growth cycle in 2002-2011?

The channels that enable the reduction of income inequality are wages and transfers. In this case, although it is not possible to scorn the role of transfers in the behavior of inequality during the period, the reduction of the labor income gap accounts for around 75% of the decline in income inequality in Latin America (Alejo et al., 2013). Among the causes of the narrowing in the labor income gap, although socio-cultural variables have a fundamental influence (Ferreira et al., 2017), the weight of the decline in the skill premium stands out, i.e., the reduction of the wage difference between people with low and high skill measured in function on the achieved academic degree. In Latin America, this decrease was 64% (Azevedo et al., 2013).

To observe inequality based on per capita income and inequality based on labor income, we used data from SEDLAC, In South America, as shown in **Figure 2**, there is a very similar relationship between the Gini index for income, the Gini index for labor income and the skill premium. The skill premium is measured as the ratio of monetary labor income of the main activity of skilled and unskilled workers. **Table 2** shows the correlation between these variables for three periods, which are 1990-2001, 2002-2011 and 2012-2016. In all three periods, a significant correlation higher than 80% between income and labor income Gini is observed. For the period 2002-2011, the correlation was about 88%. We can also see that both the per capita income Gini and the labor income Gini have a positive correlation with skill premium, which implies that when the inequality was in a period of decreasing, the skill premium was also in a period of falling. For the period 2002-2011 the correlation was around 62% and 70%, respectively.
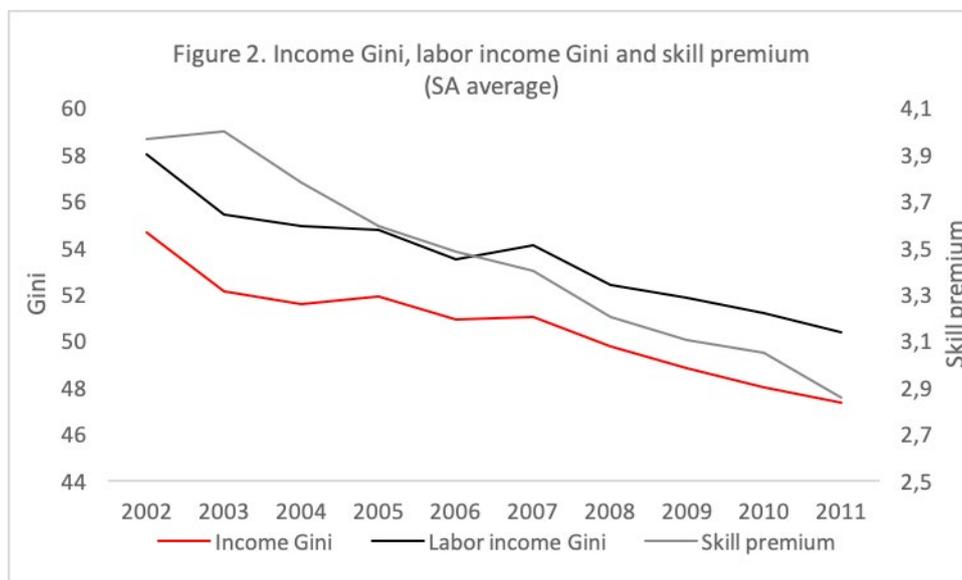


Figure 2. Income Gini, labor income Gini and skill premium (SA average)

Source: Authors' calculations, based on data from the Socio-Economic Database for Latin American and the Caribbean, SEDLAC (Center for Distributive, Labor and Social Studies, CEDLAS, and The World Bank) (2019) and Harmonized Household Surveys of Latin America and the Caribbean (IADB, 2019).

Table 2 – Correlations: Income Gini, labor income Gini and skill premium

|  | Overall | 1990-2001 | 2002-2011 | 2012-2016 |
| --- | --- | --- | --- | --- |
| *Gini (Per capita income) - Gini (Labor income)* | 0.93 | 0.93 | 0.88 | 0.94 |
| *Obs* | 172 | 53 | 77 | 42 |
| *Gini (Per capita income) - Skill premium* | 0.71 | 0.78 | 0.62 | 0.59 |
| *Obs* | 165 | 48 | 77 | 40 |
| *Gini (Labor income) - Skill premium* | 0.76 | 0.81 | 0.70 | 0.68 |
| *Obs* | 165 | 48 | 77 | 40 |

Note: Significance level at $p<0.05$.

If the skill premium fell for the first time during 2002-2011 and both the wages of skilled and unskilled workers increased, as shown in **Figure 3**, then the wages of workers with low qualifications should have taken more advantage of the positive economic cycle of the period than the wages of the most qualified workers. To see the relation between unskilled and skilled workers with the economic cycle we estimated simple regressions expressed in **equations (3) and (4)**.

(3)
$$\ln wage^H{}_{it} = \alpha^H + \gamma^H (GDP\ cycle)_{it} + u^H{}_{it}$$

(4)
$$\ln wage^L{}_{it} = \alpha^L + \gamma^L (GDP\ cycle)_{it} + u^L{}_{it}$$

Where *wage* represents the monetary labor income of the main activity; superscripts H and L represent skilled workers and unskilled workers, respectively; *α* represents the constant term, *γ* is the effect of the economic cycle on wages; and *u* is the error term. **Table 3** shows the results of the regressions with random effects for the periods 1990-2001, 2002-2011 and 2012-2016. To avoid the possible presence of heteroskedasticity we estimated the model with robust standard errors.



Figure 3. High and low qualification wages (SA average variation)

Source: Authors' calculations, based on data from the Socio-Economic Database for Latin American and the Caribbean, SEDLAC (Center for Distributive, Labor and Social Studies, CEDLAS, and The World Bank) (2019).

**Table 3 – Results of the regression between economic cycle and wages**

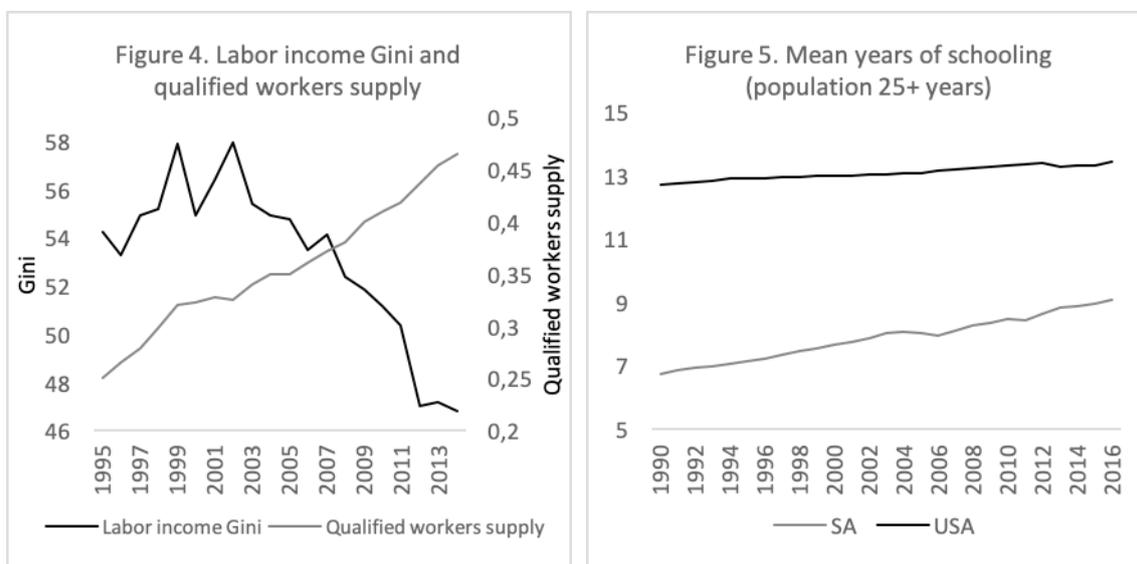| | Unskilled wages | | | Skilled wages | | |
|---|---|---|---|---|---|---|
| | 1990-2001 | 2002-2011 | 2012-2016 | 1990-2001 | 2002-2011 | 2012-2016 |
| Economic cycle | -3.18 (2.12) | 1.77*** (0.20) | 2.55 (1.57) | -3.70* (2.14) | 1.09*** (0.21) | 0.30 (1.39) |
| Constant | 0.17** (0.067) | 0.10*** (0.015) | 0.068** (0.029) | 0.20*** (0.066) | 0.059*** (0.015) | 0.074*** (0.028) |
| Obs | 57 | 83 | 42 | 57 | 83 | 42 |
| R2 (within) | 0.020 | 0.18 | 0.18 | 0.028 | 0.11 | 0.0079 |
| R2 (overall) | 0.021 | 0.13 | 0.045 | 0.026 | 0.064 | 0.0016 |
| R2 (between) | 0.0028 | 0.053 | 0.10 | 0.0094 | 0.56 | 0.17 |

Note: Robust standard errors in parentheses. Significance level at * $p < 0.1$, ** $p<0.05$, *** $p<0.01$.

From **Table 3** we can see that the economic cycle has a positive and significant effect in the period 2002-2011 on both unskilled and skilled workers. Hence, the results suggest that in the period 2002-2011, there was a procyclical relationship, that is, when the economic cycle improves, wages increase. The increase is greater in the wages of workers with low skill. When the economic cycle improves by 1%, unskilled wages increase by 1.77% and skilled wages by 1.09%. These results suggest, again, that the wages of unskilled workers have responded in greater proportion to the change in the economic cycle in relation to the wages of skilled workers on average in the period 2002-2011. This therefore implies a decrease in the skill premium, which was observed in the period.

## 2.2. What led the lowest wages to increase proportionally more than the highest ones?

The wages of people with high skill increased less than the wages of people with low skill, which reduced the difference between people with more or less labor income and, consequently, income inequality. What made low-skilled wages better able to take advantage of the region's extraordinary growth in 2002-2011?

The volume of highly qualified people increased significantly during the period 2002-2011 following the trend defined since the nineties, but it is not until the 21st century when the skill premium decreased (**Figure 4**), so it does not seem that the increase in the number of skilled workers could be an explanation for the decrease in the skill premium. Looking at the period 2002-2011, we can observe how the gap with the USA has not been reduced yet (**Figure 5**), which invites us to consider the necessity that the region still has for people with at least secondary education.

Figure 4. Labor income Gini and qualified workers supply

Figure 5. Mean years of schooling (population 25+ years)

Source: Authors' calculations, based on data from the Socio-Economic Database for Latin American and the Caribbean, SEDLAC (Center for Distributive, Labor and Social Studies, CEDLAS, and The World Bank) (2019) and UIS Statistics (2019).

## 2.3. Causes of the reduction in the skill premium in South America

After ruling out a possible excess in the supply of skilled labor, the variation of the skill premium in the region is tried to be explain through a set of causes that separately have, as the authors themselves point out, a limited impact capacity on the skill premium.

In terms of the impact of trade liberalization on the skill premium, the work done in Mexico and Brazil shows how it varies depending on the economic structure of the trading partners. The negative relationship occurs when the trade openness is made to countries producing non-labor-intensive goods, which increase the demand for domestic little transformed products, producing an increase in the wages of unskilled workers (Robertson, 2004). Moreover, they also reduce national skilled wages by lowering the price of imported goods, highly processed and intensive in skilled labor (Gonzaga et al., 2006) in a sort of fulfillment of Stolper-Samuelson theorem[4]. Qualified wages are also reduced, if contrary economic policies are not generated, because trade openness limits the price of capital goods, complementary to skilled labor, pushing down the qualified wage (Cañonero and Werner, 2002). Trade openness generates an increase in the skill premium if labor-intensive countries protect unskilled labor-intensive industries, which cannot benefit from increased external demand for goods with reduced levels of transformation (Harrison and Hanson, 1999).

However, it remains to be explained a good part of the direct relationship between the trade openness and the increase of the skill premium (Ferreira et al., 2007), contrary to the generally accepted Heckscher Ohlin theory, and questioning whether there is a natural relationship between trade openness and skill premium (Esquivel and Rodríguez-López, 2003). When the trade openness is linked to contextual factors such as the structure of the economy of the partner countries or the national economic policy of the moment, it loses weight in its ability to directly affect the skill premium.

In the case of technological change, successive improvements are expected to increase the skill premium. The greater the technology in a country, the better it will be able to replace unskilled labor, which will reduce its demand and therefore its wage. This is confirmed for Argentina (Galiani and Porto, 2010) and for Peru (Mazumdar and Quispe-Agnoli, 2002). In the case of skilled workers, Gallego and Hernando (2010) concludes for Chile that improvements in technology translate into increases in the salaries of skilled workers. Better technology generates new lines of complementary goods and services that require highly qualified people, which means an increase in their salary. The positive relationship between technological change and the skill premium is expected to intensify in the future, in a process of globalization capable of speeding up more and better the transfer of technology (Acemoglu, 2003). The effect is expected to be less intense in the short term.

A similar effect occurs when considering the impact of the capital increase. To improve the efficiency and effectiveness of the targeted sector, capital growth needs to be complemented by the skilled labor needed to achieve it. The increase in demand leads to higher wages for highly skilled workers. In addition, following the sequence of a technological change, and in what is known as the "subcontracted capital accumulation hypothesis" (Feenstra and Hansen, 1997), the increase of capital in a sector, necessarily produces or strengthens complementary sectors, generating successive increases in the demand for skilled workers, as collected by Mazumdar and Quispe-Agnoli (2002) for Peru, Acosta and Gasparini (2007) for Argentina or Pavcnik (2003) for Chile. As in the case of technological improvement, the effect of the increase in capital will generate, a priori, a smaller impact in the short term, which will continue into the medium term.

While changes in the national economic structure have a greater or lesser impact on the demand for workers with different skills, the structure of the labor market, in general, and changes in minimum wages, in particular, capture much of the related literature. Increases in the minimum wage boost the income of less qualified groups in periods of growth, reducing the skill premium. While Mauritius (2014) found evidence for Argentina in the formal and even the informal sector; for Corseuil et al (2015) the effect in Brazil was produced not only in the deciles with the lowest wages, but also in the following economic groups, generating up to almost a 20% reduction in the skill premium (Ferreira, et al. 2017). For Guzmán (2018), it reaches almost half in the analysis for Ecuador. In terms of possible reductions in the employment rate, in practice, according to the work of Grau and Landerretche (2011) for Chile and Alves et al. (2012) for Uruguay, the decline was marginal. When the increase occurred in periods of stagnation and even decrease, the results were very limited in terms of inequality and employment was reduced even more, as Messina and Silva (2017) reported for Paraguay and Ferreira et al. (2017) for Brazil.

As for the causes related to the supply of workers, the analysis of the impact that the quality of higher education could have stands out. The "degraded tertiary" hypothesis of Lustig et al. (2016) postulates that the notable expansion of coverage in post-primary education was accompanied by a growing dispersion in the quality of educational centers, reducing the average quality of post-primary studies, especially at the tertiary level. The extension of tertiary education coverage applies mainly at the margin to students from the lower end of the income distribution. Given that the quality of primary education is still below the OECD average (World Economic Forum, 2010; PISA, 2018), the only way for them to access tertiary education is to reduce, on average, the level of higher education, which would be related to a reduction in the skill premium.

From literature, trade openness, technology, capital, institutionality and education are understood as different contributions to a phenomenon that, as a whole, are capable of generating changes in the skill premium with a scope that goes beyond inequality. In common, they also have been defined as limits to

improve productivity for the region. While higher levels of trade openness show ambiguous impacts on productivity (Rodrik, 2005), better levels are directly related to improvements in technology and capital (Renda and Dougherty, 2017), labor market conditions (Lotti, 2018), and the quality of education (Aedo and Walker, 2012).

Thus, as mentioned above, if the skill premium is actively related from the literature to different variables related to productivity, then our hypothesis is that the skill premium is directly related to productivity. If so, it would be worth going deeper into the process that generates the relationship, taking into account the behavior of unqualified and qualified salaries. In the following section we analyze the behavior of productivity in the South American region in the reference period

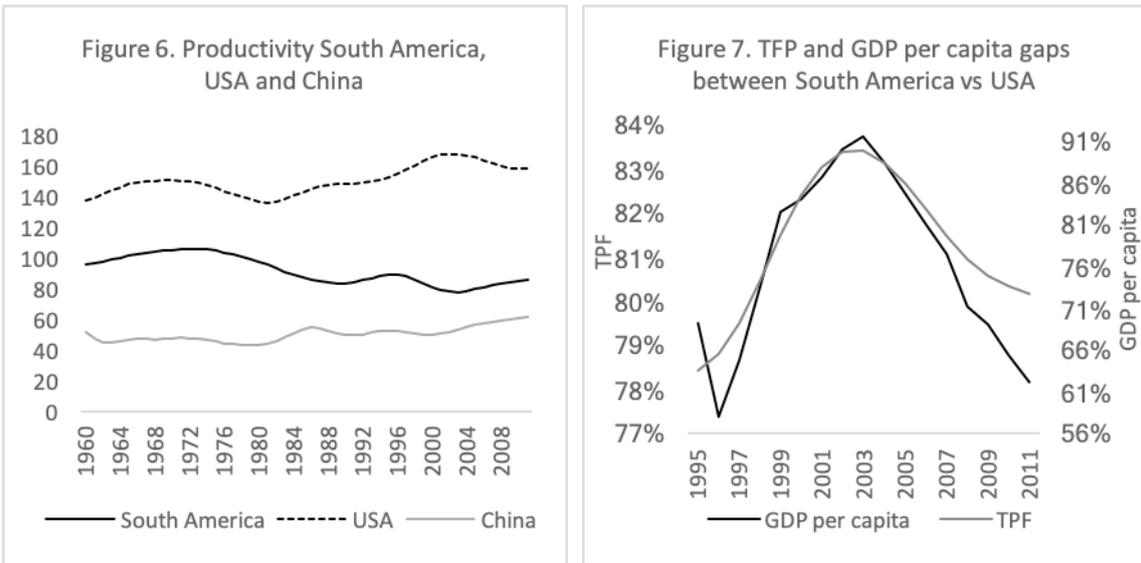## 2.4. South American productivity

Total Factor Productivity *(TFP)* shows how capable a country is of transforming its production factors to generate the national Gross Domestic Product *(GDP)*. For the calculation we follow the methodology of Fernández-Arias (2015) stated in **equation (5)**.

(5)
$$TFP_{it} = \frac{GDP_{it}}{K_{it}{}^{\alpha}(H_{it})^{1-\alpha}} = \frac{GDP_{it}}{K_{it}{}^{\alpha}(h_{it}L_{it})^{1-\alpha}}$$

The factors considered are physical capital (*K*), which includes fixed production factors such as land, factories and machinery, and human capital (*H*). Human capital considers the number of people able to work, i.e., the labor force (*L*) and the average number of years of schooling of the labor force (*h*). The elasticity of capital is represented by α, which, on average, is assumed to be 1/3 (Klenow and Rodríguez-Clare, 2005). The Total Factor Productivity for South America (*TFP*$_{SA}$) is calculated as the average *TFP* of each country.

**Figure 6** shows TFP data for South America, the United States and China. From 1960 to 2011, the TFP for South America, despite some periods of improvement, has been below the U.S. data. The gap widened especially from the late 1990s to a peak in 2002, when the U.S. nearly doubled the South American figure. In recent years, the gap has tended to close slightly, especially due to good South American performance. Also, since the end of the 1990s, the TFP for China has tended to close its gap with the TFP for South America.

The TFP is a determining factor in the region's economy. As can be seen in **Figure 7**, the difference in productivity between the countries of South America and the United States is very similar, considering the GDP per capita. In fact, it is recognized as the main limit to growth in the Latin American region and to integration into the global value chain (Blyde, 2014).

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Figure 6. Productivity South America, USA and China

Figure 7. TFP and GDP per capita gaps between South America vs USA

Source: Author's calculation based on Fernandez-Arias (2015) and The World Bank (2019)

The relationship between productivity and the skill premium, if it exists, will allow us to know who is contributing most to productivity, whether the most skilled or the least skilled. If the relationship exists and is positive, then increases in productivity are related to increases in the skill premium, so unskilled wages should be less related to productivity than skilled wages. Thus skilled workers would be contributing more to productivity. If the ratio is negative, unskilled workers would be contributing more to productivity and would, therefore, be better paid.

Figures 8 and 9 shows the productivity growth and the skill premium growth and skill premium ratio, respectively. For 2011, the skill premium decreased by 30.9% compared to 2002; while, in average, the productivity increased in 23.7%. In the period 2002-2011, in average, the skill premium rate of change per year was of about -2.66%.
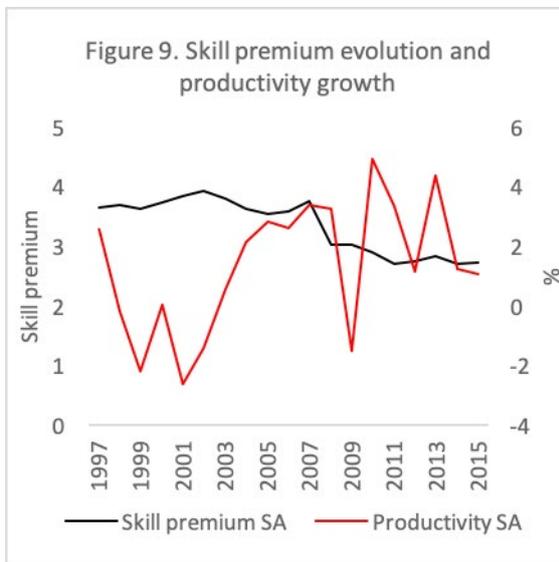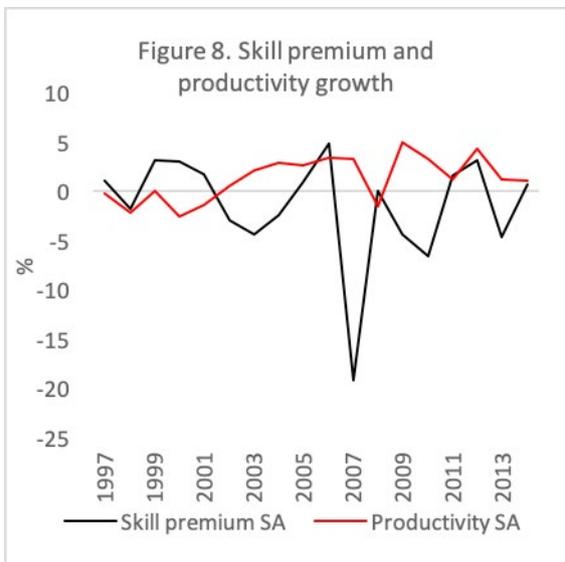
Figure 8. Skill premium and productivity growth

Figure 9. Skill premium evolution and productivity growth

Source: Authors' calculations, based on data from the Socio-Economic Database for Latin American and the Caribbean, SEDLAC (Center for Distributive, Labor and Social Studies, CEDLAS, and The World Bank) (2019) and ILOSTAT (2019).

## 3. Methodology

As mentioned above, there is a relationship between the variables associated with the skill premium and which have also been seen as determinants of productivity in the economic literature. In view of this, it was established that there is a relationship between productivity and the skill premium. As mentioned earlier, the data show that wages of unskilled workers have increased in more proportion that those of skilled workers. In addition to the relationship between the skill premium and productivity through factors that determine both, the relationship between wages and productivity can also be established through the behavior of firms based on microeconomic theory. In this context, firms determine their optimal level of labor at the point where the marginal productivity of this factor equals its cost. In this sense, if we disaggregate the labor factor between unskilled and skilled workers, the salary that workers in these groups receive is related to their productivity. Due to the fact that there was an increase in productivity in South America in the period 2002-2011 and based on the theoretical framework, then, the increase in unskilled wages in relation to skilled wages would be a response to an increase in low skill workers' productivity. Therefore, as stated above, our hypothesis is that the productivity cycle negatively affects the skill premium. In other words, we expect that an increase in the productivity cycle is associated with a negative impact on the skill premium. So we expect a negative sign in the coefficient associated with productivity over the skill premium.

For this we estimated three regressions, with three dependent variables. First we considered that the dependent variable is the skill premium to see its response to the productivity cycle, which, as stated

above, should reflect a negative coefficient. Then, we estimated regressions for the unqualified and qualified wages to see the impact of the productivity cycle and determine which of these salaries reacted more to the productive cycle. If what has been stated above is correct, the sign of the coefficient associated with productivity should be positive and should be greater in the case of unskilled wages in relation to skilled wages. Thus, productivity would have to be associated with an increase in the wages of unskilled workers that was greater in proportion to the increase in the wages of skilled workers in the reference period, on average.

In addition to this explanatory variable, we added some control variables. If the labor market is taken into account, an increase in the supply of workers reduces the level of wages for a given demand for labor. Therefore, if we consider the labor market of qualified people, the increase in the supply of qualified people will imply a decrease in the salary of qualified workers. The increase in the supply of skilled people in the labor force may be approximated by an increase in the tertiary education enrollment rate. This implies that an increase in the tertiary education enrollment rate reflects an increase in the supply of skilled persons in the future, this increase in the supply of skilled persons in the labor market determines a lower wage for skilled workers which reduces the skill premium (Topel, 1997). Thus, a negative sign is expected in the coefficient associated with tertiary education enrollment, reflecting the inverse relationship with the skill premium

When considering variables corresponding to the external sector, an economy's dependence on the degree of dependence on raw materials can have effects on the wages of the labor force (Topel, 1997). In the period 2002-2011, a boom in the price of several commodities was empirically observed. A boom in the price of commodities favored the tradable sectors of the economy, increasing their real labor income and employment gains in relation to the non-tradable sector. Because of the composition of the labor force in these sectors, the least qualified workers are those who obtained an increase in wages in greater proportion to the most qualified workers, which reduced poverty and inequality. (IMF, 2018). For this, we take into consideration the terms of trade because it captures the ratio, in general terms, of the price of exports in relation to the price of a country's imports. Due to the above, an increase in terms of trade is expected to increase the wages of unskilled workers in greater proportion, implying a reduction in the skill premium. Therefore, we expect a negative coefficient associated with the impact of the terms of trade on the skill premium.

To analyze the relationship between the skill premium and the productivity cycle in 1990-2001, 2002-2011 and 2012-2016 we used the Harmonized Household Surveys of Latin America and the Caribbean from the IADB. The source of data for both tertiary enrollment and terms of trade is the World Bank. As mentioned above, the skill premium is measured as the ratio of monetary labor income of the main activity of skilled and unskilled workers. We used the Output per worker (GDP constant 2010 US $) modeled by ILO (ILOSTAT, 2019) to calculate the productivity cycle. For this, we applied the same Hodrick-Prescott filter (1981) applied to get the economic cycle (equation 2). The model is specified in **equation (6)**:

(6)     $spremium_{it}=\alpha+\gamma(prod\ cycle)_{it}+\beta enrollment_{it}+\delta tot+u_{it}$

Where **spremium** represents the ratio between skill and unskilled wages, i.e., the skill premium, **prod cycle** represents the productivity cycle estimated by the Hodrick-Prescott filter, **tot** represents the terms of trade, **enrollment** is the tertiary education enrolment rate and **u** represents the error term.

For the analysis of the relationship between unskilled and skilled wages and the productivity cycle for the three periods, **equations (7) and (8)** are applied.

(7)        $\ln wage^H_{it} = \alpha^H + \gamma^H (prod\ cycle)_{it} + \beta^H enrollment_{it} + \delta^H tot + u^H_{it}$

(8)        $\ln wage^L_{it} = \alpha^L + \gamma^L (prod\ cycle)_{it} + \beta^L enrollment_{it} + \delta^L tot + u^L_{it}$

Where the superscripts *H* and *L* represent skilled workers and unskilled workers, respectively.

For the variables in **equations 6, 7 and 8**, the natural logarithm was applied, with the exception of the productivity cycle, due to the nature of the data. The variables are stationary in the first difference. Since we considered a panel data model the Hausman test was applied in order to determine the estimators to be used. In this case, the Hausman test established that random effects should be chosen. In order to correct for the possible presence of heteroskedasticity, **equations 6, 7 and 8** were estimated with both robust standard errors and Driscoll-Kraay standard errors.

# 4. Results

As shown in **Table 4**, the productivity cycle did not have significant effects on the skill premium in the periods 1990-2001 and 2012-2016. Unlike these periods, in the period 2002-2011 the relationship between the skill premium and the productivity cycle is significant. In this sense, the results suggest that the skill premium showed countercyclical behavior with respect to productivity, implying that an increase in productivity reduced the gap between the wages of skilled and unskilled workers. Specifically, a 1% increase in the productivity cycle is reflected in a 1.29% decrease in the skill premium in the years 2002-2011. It can also be observed that in this period, the increase in the enrolment rate in tertiary education similarly reduced the skill premium. This may be approximating the growth in the supply of skilled persons in the labor market. The result is similar to that found by Fernández and Messina (2018) in Argentina, Brazil and Chile. In this case, an increase of 1% in the tertiary education enrollment rate decreases the skill premium by 0.47%. Thus, for the period 2002-2011, the results in Table 4 corroborate what was expected, as set out in previous sections. For both the 1990-2001 and 2002-2011 periods, despite having the expected sign, the terms of trade do not have a significant effect on the skill premium. However, in the 2012-2016 period, the sign of this variable is reversed and becomes significant.

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### Table 4 – Results from the estimation of equation (6)

| | (1) 1990-2001 | (2) 2002-2011 | (3) 2012-2016 | (4) 1990-2001 | (5) 2002-2011 | (6) 2012-2016 |
|---|---|---|---|---|---|---|
| *Productivity cycle* | -1.12 (1.97) | -1.29*** (0.35) | 0.24 (1.36) | -1.12 (2.17) | -1.29** (0.41) | 0.24 (0.74) |
| *Tertiary enrollment* | 0.12 (0.10) | -0.47*** (0.096) | 0.0019 (0.11) | 0.12 (0.094) | -0.47*** (0.057) | 0.0019 (0.12) |
| *Terms of trade* | -0.028 (0.42) | -0.025 (0.11) | 0.20*** (0.037) | -0.028 (0.20) | -0.025 (0.069) | 0.20** (0.048) |
| *Constant* | 1.03 (1.98) | 3.09*** (0.35) | 0.095 (0.64) | 1.03 (1.07) | 3.09*** (0.48) | 0.095 (0.60) |
| *Obs* | 35 | 59 | 26 | 35 | 59 | 26 |
| *R2 (within)* | 0.16 | 0.61 | 0.31 | | | |
| *R2 (overall)* | 0.034 | 0.33 | 0.0030 | 0.034 | 0.33 | 0.0030 |
| *R2 (between)* | 0.15 | 0.27 | 0.00072 | | | |

Note: Robust standard errors in parentheses in (1), (2) and (3). Driscoll-Kraay standard errors in parentheses in (4), (5) and (6). Significance level at * p < 0.1, ** p<0.05, *** p<0.01.

The results in **Table 4** are consistent with the results of regressions between unskilled and skilled wages and the productivity cycle. As shown in **Table 5 and 6**, both wages maintain a procyclical relationship with productivity, that is, increases in productivity are related to an increase in the wages of both skilled and unskilled workers in the period 2002-2011. The relationship has the expected sign and is significant only for this period. With respect to the salaries of qualified workers, in the period 1990-2001, it is possible to observe a negative behavior of these as a consequence of increases in productivity. For the period 2002-2011, the coefficient of unskilled wages is higher than that of skilled workers, i.e., low-skilled workers received a marginal increase in their wages that was higher in times of productivity growth than that of more skilled workers. Specifically, a 1% increase in the productivity cycle is related to a 1.53% increase in the wages of unskilled workers and a 1.19% increase in the wages of skilled workers, on average. Hence, as the wages of unskilled workers increased in greater proportion to the wages of skilled workers, the skill premium was reduced. As shown by the results in **Table 4**, in the case of **Tables 5 and 6**, the negative impact of tertiary education enrolment on the evolution of the salaries of skilled workers can also be observed.

### Table 5 – Results from the estimation of equations (7) and (8) (Robust standard errors)

| | Unskilled wages | | | Skilled wages | | |
|---|---|---|---|---|---|---|
| | 1990-2001 | 2002-2011 | 2012-2016 | 1990-2001 | 2002-2011 | 2012-2016 |
| *Productivity cycle* | -4.10 (4.58) | 1.53*** (0.33) | 0.18 (2.01) | -9.57* (5.57) | 1.19** (0.46) | -1.12 (2.36) |
| *Tertiary enrollment* | -1.14 (1.20) | -0.14 (0.098) | 0.23 (0.77) | -0.67 (1.37) | -0.47*** (0.16) | 0.065 (0.45) |
| *Terms of trade* | -0.0019 (0.0031) | 0.00076 (0.0011) | 0.0013 (0.0026) | -0.0050 (0.0042) | -0.00068 (0.0021) | 0.0070*** (0.0021) |

| | | | | | | |
|---|---|---|---|---|---|---|
| *Constant* | 0.12 (0.090) | 0.096*** (0.025) | 0.087 (0.063) | 0.17 (0.11) | 0.097*** (0.022) | 0.12** (0.052) |
| *Obs* | 21 | 52 | 22 | 21 | 52 | 22 |
| *R2 (within)* | 0.29 | 0.35 | 0.023 | 0.51 | 0.19 | 0.21 |
| *R2 (overall)* | 0.13 | 0.22 | 0.026 | 0.26 | 0.20 | 0.29 |
| *R2 (between)* | 0.0045 | 0.0087 | 0.0077 | 0.000096 | 0.29 | 0.39 |

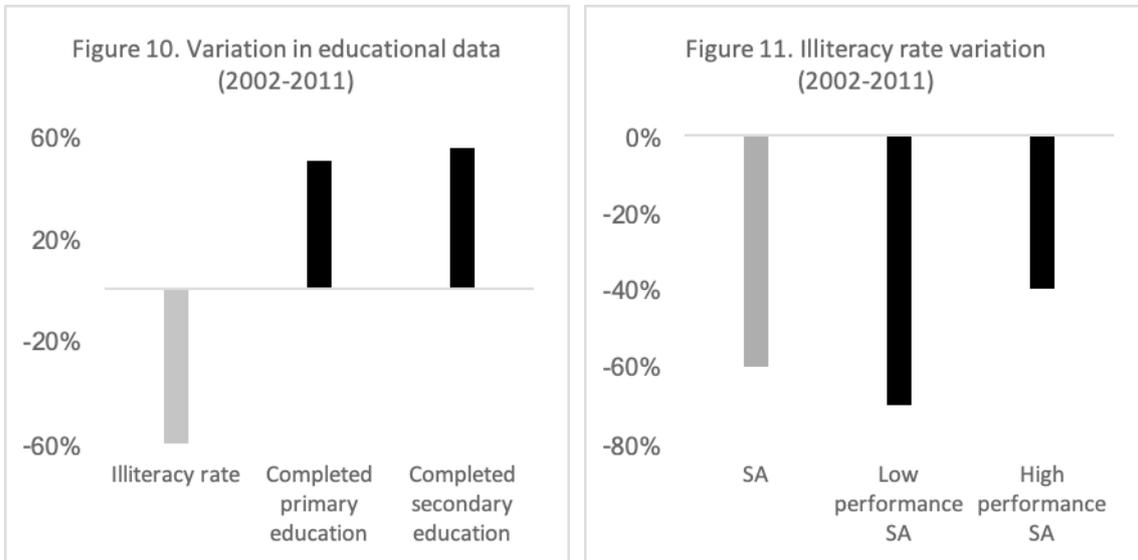Note: Robust standard errors in parentheses. Significance level at * p < 0.1, ** p<0.05, *** p<0.01.

**Table 6 – Results from the estimation of equations (7) and (8) (Driscoll-Kraay standard errors)**

| | *Unskilled wages* | | | *Skilled wages* | | |
|---|---|---|---|---|---|---|
| | *1990-2001* | *2002-2011* | *2012-2016* | *1990-2001* | *2002-2011* | *2012-2016* |
| *Productivity cycle* | -4.10 (3.72) | 1.53** (0.47) | 0.18 (1.65) | -9.57*** (2.84) | 1.19** (0.46) | -1.12 (2.87) |
| *Tertiary enrollment* | -1.14 (0.49) | -0.14 (0.072) | 0.23 (0.15) | -0.67 (1.00) | -0.47*** (0.098) | 0.065 (0.54) |
| *Terms of trade* | -0.0019 (0.0031) | 0.00076 (0.00079) | 0.0013 (0.0024) | -0.0050 (0.0030) | -0.00068 (0.00060) | 0.0070*** (0.0035) |
| *Constant* | 0.12 (0.15) | 0.096*** (0.020) | 0.087 (0.021) | 0.17 (0.11) | 0.097*** (0.031) | 0.12** (0.026) |
| *Obs* | 21 | 52 | 22 | 21 | 52 | 22 |
| *R2 (overall)* | 0.13 | 0.22 | 0.026 | 0.26 | 0.20 | 0.29 |

Driscoll-Kraay standard errors in parentheses. Significance level at * p < 0.1, ** p<0.05, *** p<0.01.

In addition to the results, the reasons behind this may be related to the degree of education of the different workforce groups considered. In this sense, in terms of education, we expect that, considering the improvement in terms of assistance at least for the population with primary education who attended secondary school without completing it and the improvement in literacy, there was an improvement in education that is related to an increase in the capacity of low skill workers. Since there is an increase in their ability, there is an increase in their productivity. This cause unskilled wages to increase.

As for low-skilled workers, from 1990 to 2011 there were very significant improvements in the field of education, especially in terms of school attendance. The years of schooling increases, the percentage of the population with a primary school degree who had attended secondary school without completing it and the literacy rate increased, as shown in **Figure 10**. As can be seen in **Figure 11**, illiteracy rates decreased in all South American countries in the period 2002, 2011, especially in those countries with low economic performance. The data are significantly better when considering the low-performing countries, Argentina, Brazil and Ecuador, which started the period 1990-2011 with worse socioeconomic data than the high-performing countries, namely, Chile, Colombia and Uruguay.

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## Figure 10. Variation in educational data (2002-2011)

## Figure 11. Illiteracy rate variation (2002-2011)

Source: Authors' calculations, based on data from the Socio-Economic Database for Latin American and the Caribbean, SEDLAC (Center for Distributive, Labor and Social Studies, CEDLAS, and The World Bank) (2019)

Therefore, the improvement in education, at least in terms of assistance and literacy, is also related to a better job performance of unskilled groups, and therefore it is also related with a better remuneration. In addition, having a better capacity, although limited to primary education, improves their ability for management in the workplace and the exercise and negotiation of their rights.

In terms of skilled work, studying more years in South America was not related to a better labor income during the first decade of the 19th century. Although the correlation between years of education and salary was positive in the 1990s (0.48) it became negative in 2000 (-0.008) (De la Torre et al., 2017). In Colombia (González-Velosa et al., 2015) and Chile (Reyes et al., 2013) heterogeneous results were found. In Peru, during the year 2012, four out of ten university students were occupying jobs below their capacity, receiving wages below their qualification (Lavado et al., 2014).

This phenomenon does not respond to an excess of qualified labor, as we saw in Section 2. On the contrary, companies require more highly qualified workers. For a third of Latin American companies, the largest percentage in the world, the greatest limit to their operations and innovation was the inadequate training of their employees. In Brazil, the percentage reached 69% and in Argentina 57% (World Bank, 2010). Trained workers are getting skills that are not demanded by the market and, therefore, end up in lower-paying jobs, reducing the skill premium

# 5. Conclusions

The analysis of the reduction of inequality in South America in the period 2002-2011, unique in the recent history of the region, necessarily invites us to understand the behavior of the skill premium, since the evidence shows that skilled wages increased less, proportionally, than unskilled wages in the period under review. When trying to understand the causes, we necessarily find several explanations related to productivity. Although wages are influenced by many issues, by definition they related to microeconomic foundations, so they constitute the remuneration of the work performed. In other words, the wages received would correspond or be proportional to the marginal labor productivity. If a disaggregation of the workforce, between skilled and unskilled workers, is taken into consideration, then we can relate skilled and unskilled wages to changes in productivity. By doing this, the results suggest that unskilled wages have a stronger relationship with productivity than skilled wages, which allows us to confirm that, on average, in the period 2002-2011, unskilled workers were able, in the eyes of the employers, to contribute more to productivity, which would explain why the wages of the unskilled workers increased at a higher rate than that of the skilled workers, which implies a reduction in the skill premium. The result would be consistent with the reduction of literacy and the improvement of education in the region, which would have obtained the expected prize through a better wage. Skilled workers should review their ability to contribute to productivity in the region, in line with related literature.

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*Notes*

2. Following the methodology by the Socio-Economic Database for Latin America and the Caribbean (SEDLAC) (CEDLAS and The World Bank), we consider that low skill people are those who have less than 9 years of schooling, while high skill people are those with more than 13 years of schooling. We estimated these variables using the Harmonized Household Surveys of Latin America and the Caribbean by the Inter-American Development Bank.

3. The countries considered in this paper are Argentina, Brazil, Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, and Uruguay. Venezuela is not considered due to inconsistency in its data.

4. The Stolper-Samuelson theorem (1941) proposes that the higher the rate of exports of a certain good, more quantity of the necessary factors is needed for its production, which will increase its price.