BANCO CENTRAL DE COSTA RICA

NOTA TÉCNICA
N.º 05 | 2021

Wage inequality and firm productivity: analysis with employer-employee data

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Fotografía de portada: “Presentes”, conjunto escultórico en bronce, año 1983, del artista costarricense Fernando Calvo Sánchez. Colección del Banco Central de Costa Rica.

Desigualdad salarial y productividad de las firmas: análisis con datos de empresas y trabajadores

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Resumen

En los últimos años ha habido un aumento de la desigualdad de los ingresos en Costa Rica. Esta nota técnica estudia la relación entre la desigualdad salarial entre firmas y la productividad de las empresas en el país, en el marco del proyecto LinkEED de la OCDE. El análisis se llevó a cabo utilizando un procedimiento empírico proporcionado por la OCDE con una base de datos del Banco Central de Costa Rica que vinculada información entre empleadores y empleados en el período 2006 a 2017. Los resultados indican que la desigualdad salarial aumentó levemente en Costa Rica entre 2006 y 2017. El 36% de ese aumento se debió a la dispersión salarial entre empresas. Esto parece explicarse completamente por un aumento de las diferencias en la composición de la fuerza laboral entre empresas, mientras que la dispersión entre empresas debido a factores relacionados con el premio salarial que pagan las empresas se redujo. Además, se estimó que, en este periodo, el traspaso de la productividad de las firmas a los salarios fue de alrededor de 0,05%.

Palabras clave: desigualdad salarial, prima salarial, productividad laboral, composición de la fuerza de trabajo

Clasificación JEL: J24, J31

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Abstract

In recent years there has been an increase in income inequality in Costa Rica. This technical note shows the study of the relationship between-firm wage inequality and firm productivity for the country under the framework of the OECD LinkEED project. The analysis was carried out using an empirical procedure provided by the OECD with a dataset from the Costa Rican Central Bank that matches employer-employee data in the period 2006 to 2017. The results indicate that wage inequality slightly increased in Costa Rica between 2006 and 2017. The results also show that of this increase 36% was due to between-firm dispersion. This increase seems to be completely explained by an increase of differences in the workforce composition between firms, while the dispersion between firms due to factors related to firm wage premia was decreased. The estimates of the pass-through of firm productivity to wages was around 0.05%.

Key words: wage inequality, wage premium, labor productivity, workforce composition

JEL codes: J24, J31

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Between-firm wage inequality and productivity: analysis with employer-employee data

1 Introduction

Standard microeconomic theory establishes that firms have no control over wages in a perfectly competitive market (McConnell et al., 2016). Instead, wages are taken as given. However, some firms pay higher wages than others; risk compensation or demand on high-skilled workers might explain this. But also, in some cases, the payment between firms is different even for the same type of workers (Messina et al., 2016).

The hypothesis of firm productivity dispersion, as a driver of wage inequality, has become more popular by developed countries (Berlingieri et al., 2017; Faggio et al., 2007).[1] As workers' payment is linked to their productivity, an increasing wage inequality should be related to productivity dispersion: workers with similar demographic characteristics and work experience, but with a wide productivity distribution, and wage dispersion (Faggio et al., 2007).

Low productivity growth and rising inequality have coincided in many countries of the Organisation for Economic Co-operation and Development (OECD). One of the hypothesis explains that widening wage and productivity gaps between firms contributes to this phenomenon. In order to analyse the role of firms in wage inequality, the OECD created the LinkEED project[2], which uses harmonised cross-country linked employer-employee data

[1] For example, this is the case of some OECD countries for which Berlingieri et al. (2017) found a link between wage dispersion and the increase in differences between high and low productivity firms .

[2] It was created by the Economics Department, the Directorate for Science, Technology and Innovation and the Department for Employment, Labor and Social Affairs of the OECD.

for several countries. Particularly, its goal is to provide evidence of the extent in which firms affect aggregate productivity and wage inequality (Criscuolo et al., 2020).

On its first stage, the LinkEED project analysed data on 14 countries from early 1990s to around 2013-18.[3] The results in this stage did not include Costa Rica[4], as its involvement took place until January 2020 through the Central Bank, BCCR. Given the importance of the analysis of wage inequality, this technical note pretends to present the results for Costa Rica within the framework of the LinkEED project as it is of particular relevance for the country due to evidence of increasing wage inequality in recent years (González-Pandiella and Gabriel, 2017; Messina and Silva, 2017; Alfaro-Urena, Manelici, Vasquez and Mendoza-Fernandez, 2020).[5]

For Costa Rica, different studies have analysed income distribution (household income or labor income) and its determinants (see Loría and Umaña (2015) and references therein) from a perspective of workers' characteristics (like education) as predictors of income inequality[6], or from a perspective of the impact of specific public policies (like trade, public expenditure, tax) on earning distribution.[7] However, evidence on firm partaking in wage inequality is scarce; studies such as Gindling and Trejos (2003, 2013), and Fernández (2016) have only included variables as firm size, institutional sector, among others (Loría and Umaña, 2015).

In recent years, labor productivity has increased in Costa Rica, Escobar and Meehan (2018) reported an average annual growth of 4%, from 2007 to 2016.[8] However, there is evidence that point out the growth varies between productive groups due to discrepancies in economic performance, such as differences among exporter or domestic-oriented firms,

[3] It included Canada, Estonia, France, Germany, Italy, Japan, Netherlands, Norway, New Zealand, Portugal, Spain, Sweden, United Kingdom and the United States. See Criscuolo et al. (2020), p.11, for more details.

[4] An updated version of the study is ongoing and considers four more countries, including Costa Rica.

[5] González-Pandiella and Gabriel (2017) found an increase of the Gini index (the inequality measure) from 0.511 to 0.518 between 2010-2014. The labor income explained around the 30% of inequality in average in this period. Messina and Silva (2017) and Alfaro-Urena, Manelici, Vasquez and Mendoza-Fernandez (2020) measured inequality by the labor income variance. The former found an increase in men's income inequality in period 2006-2011 explained mainly by the increase wage heterogeneity between firms. While Alfaro-Urena, Manelici, Vasquez and Mendoza-Fernandez (2020) found that in general earning inequality rose between 2006 and 2016.

[6] See for example Céspedes and Jiménez (2007); Fernández and del Valle (2011); Gindling and Trejos (2013), and Fernández (2016).

[7] Some studies are Trejos and Oviedo (2012); Chacón et al. (2013), and Sauma and Trejos (2014).

[8] See also Ivancovich and Martínez (2020) and references therein.

wages (Padilla and Alvarado, 2014), and employment growth (Sandoval et al., 2017). There is also evidence of higher labor productivity in firms that become suppliers of Multinational Corporations (MNCs) (Sandoval et al., 2018; Alfaro-Urena et al., 2019).

Some other studies for Costa Rica, have analyzed the contribution of firms to wage inequality through variance decomposition techniques using employer-employee data. For example, Messina and Silva (2017) found that the increase in dispersion of men's labor income, for the period 2006-2011, was explained, in 33%, by factors related to a greater heterogeneity of labor income between firms. Some possible reasons for an increase in between-firm wage inequality are heterogeneity in productivity, foreign trade participation, labor market policies, among others.

Alfaro-Urena, Manelici, Vasquez and Mendoza-Fernandez (2020) found a similar result; with a variance decomposition of an estimated wage from the formal sector, and the Central Bank employer-employee dataset, for the period 2006-2017, found that an increment in wage inequality is explained in 60% by the change in the distribution of worker fixed effects and 30% by the change in the distribution of firms fixed effects. The authors argue that the number of MNCs, and their share on employment have increased inequality related to the firm's fixed effects. The reason is that, as MNCs pay higher salaries than domestic firms, the right tail of the earnings distribution widens, enlarging inequality (Alfaro-Urena, Manelici and Vasquez, 2020, p.3).

The present research intends to provide more evidence on the subject as it studies the relationship between firm wage inequality and firm productivity in Costa Rica within the framework of the LinkEED project. On this first stage, it estimates wage inequality based on variance decomposition, and estimates the productivity pass-through (rent sharing). Data analysis was carried out with the project's conceptual framework and empirical procedure (see Criscuolo et al., 2020); details are included in Section 2.

Parallel to other results, our estimates indicate that wage inequality increased between 2006 and 2017, from which 64% responds to within-firm dispersion and 36% to between-firm dispersion.[9] The increase in wage inequality between firms seems to be completely explained by a more heterogeneous workforce composition, while factors related to firm wage premia contributed to reduce the wage dispersion between firms. This happened in

[9] Alfaro-Urena, Manelici, Vasquez and Mendoza-Fernandez (2020) found the increase in inequality was more evenly shared by within-firms and between-firms variance, but still the former was higher.

micro, small and medium firms, while in large firms evidence showed an increase of wage premia dispersion. This finding may be related to the pass-trough of firm productivity to wages. The preliminary estimate of such elasticity was near 0.05% for the whole period, including all type of firms.

2 Empirical procedure

Criscuolo et al. (2020)[10], state that wage inequality may be the result of wage differences between firms or wage differences within firms. The first case is explained by differences between firms in the workforce composition or in the firm wage premia. On one hand, workforce composition refers, for example, to differences in firms' payments due to different intensity of the use of high-skilled workers that are payed at high wage rates because of diverse economic activities or the use of technologies with different skill requirements. On the other hand, wage premia refers to differences in revenues related to firm productivity and the extent to which these are shared with workers. This might happen due to the adoption of more advanced technologies in some firms, differences in the intensity or quality of capital, product innovation or barriers to competition. The differences in wage premia related to productivity rents may also generate sorting of workers across firms, with concentration of the best workers in the best-performing firms. This is called worker-to-firm sorting.

When wage inequality comes from within-firm dispersion (the second case), the general source is worker heterogeneity and the return differential of characteristics such as education level, work experience and gender. Additionally, workforce composition can also explain wage inequality within firms, but its effect is on the opposite direction when compared to between-firms wage inequality. Mainly because the larger disparity on skills' demand between firms, it is more likely for workers to be similar within firms.

This means that wage differentials can be also explained by rents from firm productivity and not only by worker's characteristics, as it has been mostly studied. In accordance, Criscuolo et al. (2020) implemented an empirical approach which firstly, estimates wage inequality as the total variance of logarithmic wages, and secondly, subdivides it in between

[10] See Criscuolo et al. (2020), Section 2, p.8.

and within-firm dispersion.

To begin[11], a wage equation with firm fixed effects is estimated based on Barth et al. (2016):

$$\ln w_{ij} = \beta\, x_i + \gamma_j + e_{ij} \tag{1}$$

where w_{ij} denotes the wage of worker i in firm j; x_i is a vector of observable worker characteristics; β is the estimated return of these characteristics; γ_j is the estimated firm fixed effects; and e_{ij} is the error term. Based on equation 1, the total variance of lnw_{ij} can be written as follows:

$$V^{total} = V(\hat{s}) + V(\hat{\gamma}) + 2cov(\hat{s}, \hat{\gamma}) + V(\hat{e}). \tag{2}$$

Estimated coefficients and variables are denoted with superscript $\hat{}$; $\hat{s} \equiv x_i\beta$ is defined as workers' predicted wages based on observable earnings characteristics and $V(\hat{s})$ is its variance. $V(\hat{\gamma})$ is the variance of firm-specific wage premia; $cov(\hat{s}, \hat{\gamma})$ is the covariance of predicted wages with firm specific wage premia and $V(\hat{e})$ is the variance of residual wages. As $\rho_\gamma \equiv \frac{cov(\hat{s},\hat{\gamma})}{V(\hat{s})}$ is the correlation of workers predicted wages based on observable earnings characteristics with the estimated firm-fixed effects and $\rho \equiv \frac{cov(\hat{s},\hat{S})}{V(\hat{s})}$ is the correlation of workers' predicted wages with the average predicted wage in their firm ($\hat{S}$), then the total variance can be re-written as:

$$V^{total} = [V(\hat{s})\rho + 2V(\hat{s})\rho_\gamma + V(\hat{\gamma})] + [V(\hat{s}) + V(\hat{e}) - V(\hat{s})\rho] \tag{3}$$

$$V^{total} = V^{between} + V^{within}$$

From equation 3, the between-firm variance component in a year is $[V(\hat{s})\rho + 2V(\hat{s})\rho_\gamma + V(\hat{\gamma})]$; where $V(\hat{s})\rho$ is worker-to-worker sorting; $2V(\hat{s})\rho_\gamma$ is the worker-to-firm sorting and $V(\hat{\gamma})$ is the variance of firm-specific wage premium.

The second part of the equation represents the within-firm variance, $[V(\hat{s}) + V(\hat{e}) - V(\hat{s})\rho]$;

[11] The next parts in this section are based on *Subsection 2.2 Empirical implementation*, pages 9-11, from Criscuolo et al. (2020).

where $V(\hat{s}) + V(\hat{e})$ are the contributions from the returns to observed and unobserved earnings characteristics and $-V(\hat{s})\rho$ is the worker-to-worker sorting. The worker-to-worker sorting component cancels out in the equation.

One limitation of this framework is a possible bias of the estimation of the between-firm variance components due to the presence of worker unobservables. Specifically, the variance of the firm-wage premia to overall wage inequality represents an upper-bound of the true contribution because firm fixed effects consider the presence of worker unobservables. And, it also represents a lower bound estimate of the worker-to-firm sorting contribution because of the presence of sorting on unobservable ability.

In order to tackle this limitation, Criscuolo et al. (2020) compared the results between the baseline model, (Barth et al., 2016), with the method developed by Abowd et al. (1999), AKM. The latter, includes worker fixed effects in a panel data structure to account for the unobservable earning characteristics on the wage variance. As a result, they found evidence which indicates that unobservable differences in workers between firms frequently reduces the contribution of firm-wage premia to the overall level of wage dispersion, but there is no systematic impact on the contribution to changes in overall wage dispersion.

3 Data

The employer-employee dataset of the Central Bank of Costa Rica (CRLEED) derives from the Centralized Tax-Collection System (SICERE[12]); an informational platform of the Costa Rican Social Security Agency (CCSS). It contains wage and demographic statistics for all workers registered in the formal sector through the CCSS.[13] This dataset uniquely records each worker and firm by their time-invariant identification. The firm's identification number is yearly linked to the employee data.

Employer data also comprises administrative information; REVEC is a database in which the BCCR gathers information for the formally constituted firms from different sources. It comprises yearly[14] averaged data on income, expenditure, and employment per firm. It

[12] Sistema Centralizado de Recaudación in Spanish.
[13] In Table 1, Appendix A, presents more details on this database.
[14] Over the calendar year.

also includes the economic activity, and the information on imports and exports of the firm.

The full sample database has 13,608,803 observations from 2006 to 2017[15]. There are 2,277,013 unique employees and 260,359 unique firms. However, the sample was downsized for harmonization purposes, as it eliminated observations where wages were below the legally established minimum, workers from the public sector, workers younger than 25 or older than 60 years old, firms with less than two employees, and missing values in the occupation variable. Therefore, this research, uses a database for wage inequality estimations (restricted sample) with a total of 6,629,213 observations. Table 1 presents some of its descriptive statistics.

The dependent variable is the logarithm of wage. The monthly wage is the monthly average wage of the worker. As data was monthly recorded, it was aggregated as an annual payment and divided by the registered number of months. The worker observable control variables are gender, age, and occupation (see Table 2 in Appendix A). All values are in gross terms, nominal and not censored. There is no information on the number of worked hours or even if the employee has a full or part time job. Occupation codes were grouped in three categories[16] according to the skill level (low, medium and high) based on the Costa Rican Occupation Manual (COCR-2011), which is identical to the International Standard Classification of Occupations (ISCO-2008) at the major group level.

At the firm level, variables such as economic activity, firm size and productivity were included as part of the analysis. Originally the economic activity was coded according to the ISIC rev.4, at four digit level, hence some codes were grouped in order to have the industrial aggregation required by the project. Additionally, it was decided to exclude three categories (97, 98, and 99) as they were not classified in any aggregated code.

For labor productivity variables, two measures were computed: the logarithm of revenue and the logarithm of value-added (sales plus salaries less costs) per worker. The number of workers in the firm per year is calculated as the monthly average number of workers.

[15]There are differences per year. For example, there are 1,078,578 observations in 2009, and 1,209,633 in 2017.

[16]High skilled includes occupational groups 1 "Managers," 2 "Professionals," 3 "Technicians and Associate Professionals." Middle skilled includes 4 "Clerical Support Workers," 5 "Services and Sales Workers," 6 "Skilled Agricultural, Forestry and Fishery Workers," 7 "Craft and Related Trades Workers," 8 "Plant and Machine Operators, and Assemblers." Lower skilled bases on 9 "Elementary Occupations."

Firms are classified in micro (between 2 and 10 employees), small (between 11 and 50), medium (between 51 and 250) and large (more than 250).

Table 1: List of variables (mean and count), 2006-2017

Variables	Full sample		Restricted sample	
	mean	count	mean	count
Worker variables				
Wage (colones)	571,434.0	12,018,186	504,496.2	6,629,213
Age (years)	35.3	13,608,803	36.9	6,629,213
Male (%)	65.2	13,608,803	70.5	6,629,213
Lower skilled (%)	27.4	12,913,297	26.6	6,629,213
Middle skilled (%)	41.8	12,913,297	45.7	6,629,213
Highly skilled (%)	30.8	12,913,297	27.7	6,629,213
Private sector (%)	78.9	13,608,803	100.0	6,629,213
Firm size (%)				
Micro	11.0	13,168,630	10.7	6,629,213
Small	15.2	13,168,630	19.5	6,629,213
Medium	19.0	13,168,630	23.7	6,629,213
Large	54.8	13,168,630	46.2	6,629,213
Firm industry (%)				
Agriculture	11.2	11,752,746	11.8	6,598,877
Mining	0.1	11,752,746	0.2	6,598,877
Manufacturing	17.4	11,752,746	21.0	6,598,877
Utilities	3.5	11,752,746	0.6	6,598,877
Construction	6.8	11,752,746	6.7	6,598,877
Market services	43.4	11,752,746	48.7	6,598,877
Financial and Insurance activities	5.1	11,752,746	4.1	6,598,877
Non Market Services	12.6	11,752,746	7.0	6,598,877
Firm productivity measure				
Ln sales per worker	16.9	11,007,716	17.0	6,534,111
Ln value added per worker	15.6	10,776,865	15.6	6,417,610

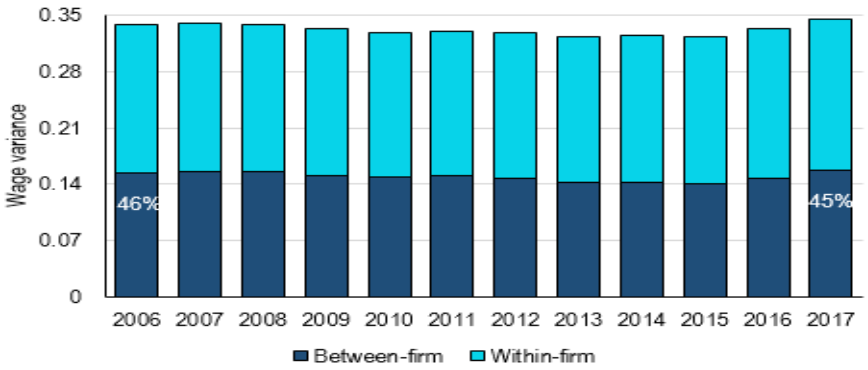
Note: Values are expressed in Costa Rican colones. In 2015, $1 was 534 colones; approximately it is equivalent to $0.002 USD. Source: results from the Third Round LinkEED Project Stata routine using CRLEED data.

4 Results

4.1 Variance decomposition

The estimated level of the log-wage variance is presented in Figure 1; the dispersion of the total variance do not seems to have changed much through the analysed period, ranging from around 0.32 to 0.34. For 2017, the dispersion of the average wages between-firm variance was about 0.15 in the extent and accounted for about half of the overall dispersion of wages (45%). This share is similar to the results obtained for countries like Spain, Great Britain, Italy and France where it accounts for 40-50% of the overall variance (see Criscuolo et al., 2020). This reflects that an important part of the wage inequality can be attributed to differences in rents related to firm productivity or differences in the composition of the workforce.

Figure 1: Costa Rica: Level of (log) wage variance, 2006-2017



Source: authors based on the Third Round LinkEED Project Stata routine using CRLEED data.

Between 2006 and 2017, the overall wage variance increased by 0.006. Of this increment, 0.004 was due to changes in within-firm variance and 0.002 was due to changes in between-firm variance (see Table 2); which means that the augmentation in wage variance between firms accounts for a 36% of the increase in inequality, while the remainder part is explained by changes in the dispersion of wages within firms.

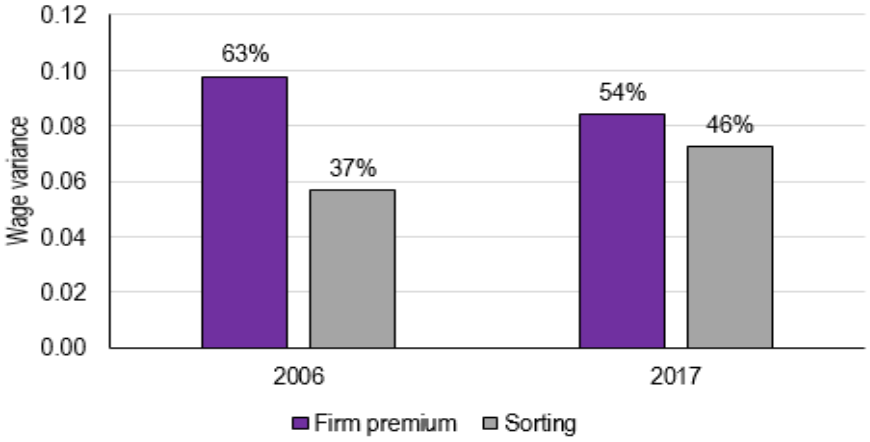
As it was mentioned, firms' contribution to inequality can be estimated by the between-firm component, which might be the result of differences in firm premium related to productivity rents or differences in sorting of workers. From the estimated results, the dispersion explained by differences in firm wage premium accounted for 63% of between-firm wage inequality in 2006, but it decreased to 54% in 2017 (see Figure 2). Even though its weight has reduced over time, this result suggests that around half of inequality in average wages between firms reflect differences in productivity-related rents.

Table 2: Costa Rica: decomposition of wage variance in between-firm and within-firm components, 2006 and 2017

Decomposition of wage variance	2006	2017	Change	Change (% of 2006)
Total variance	**0.339**	**0.345**	**0.006**	**1.8**
Within	0.185	0.189	0.004	2.1
Earnings characteristics[1]	0.202	0.214	0.012	6.0
Worker-to-worker sorting	-0.017	-0.025	-0.008	48.0
Between	0.154	0.157	0.002	1.4
Firm premium	0.098	0.084	-0.014	-14.1
Sorting	0.037	0.049	0.012	32.8
Worker-to-worker sorting	0.017	0.025	0.008	48.0
Worker-to-firm sorting	0.040	0.047	0.008	19.7

Note: 1/ It includes observed and unobserved earnings characteristics.
Source: authors based on the Third Round LinkEED Project Stata routine using CRLEED data.

Figure 2: Costa Rica: estimates of (log) wage variance between-firm, 2006 and 2017



Source: authors based on the Third Round LinkEED Project Stata routine using CRLEED data.

On the other hand, sorting increased the contribution to between-firm inequality from 37% in 2006 to 46% in 2017 (see Figure 2). This indicates that higher differences in workforce composition between firms have contributed to augment wage inequality. This might be consequence of raised concentration of high skilled workers at high-paying firms versus low skilled workers at low-paying firms. This result supports the evidence found on occupational segregation by Alfaro-Urena, Manelici, Vasquez and Mendoza-Fernandez (2020) in which the average wage of firms become more disperse due to the existence of

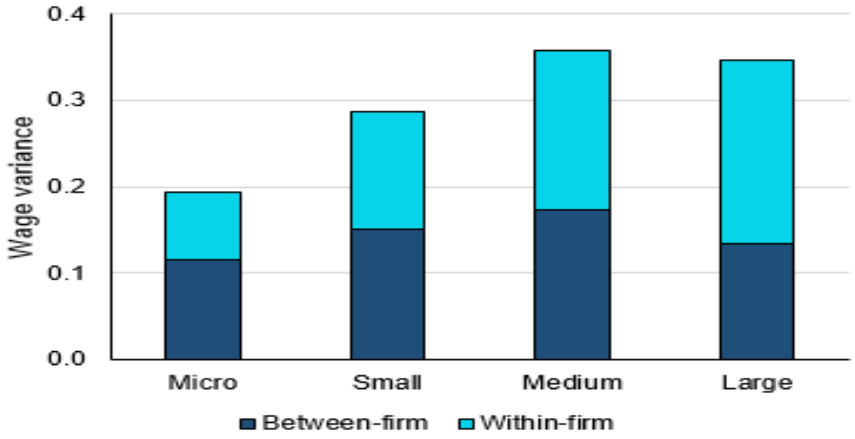
clusters of workers with specific occupations.

4.2 Variance decomposition: a firm size comparison

Figure 3 shows the total wage variance and the estimated wage variance between and within-firm in 2017 by firm size; the total wage dispersion is higher in medium and large firms. The wage dispersion in large firms is explained by higher within firms wage differences as it represents 61% of the total variance.

Within-firm dispersion increases, both in levels and in relative terms, with the firm size. This might be explained as there is more worker heterogeneity within large firms. In contrast, wage dispersion within micro firms is lower, as possibly its employees generally carry out multiple duties, have similar skills and receive similar salaries. For example, wage differences between occupations (hierarchy levels) in the same firm are more likely to occur in large firms which are prone to have more levels. Muller et al. (2017) found for the United Kingdom, that large firms have higher pay differences when comparing lower hierarchy jobs to higher hierarchy jobs, as these require more managerial skills.

Figure 3: Costa Rica: estimates of (log) wage variance by firm size, 2017

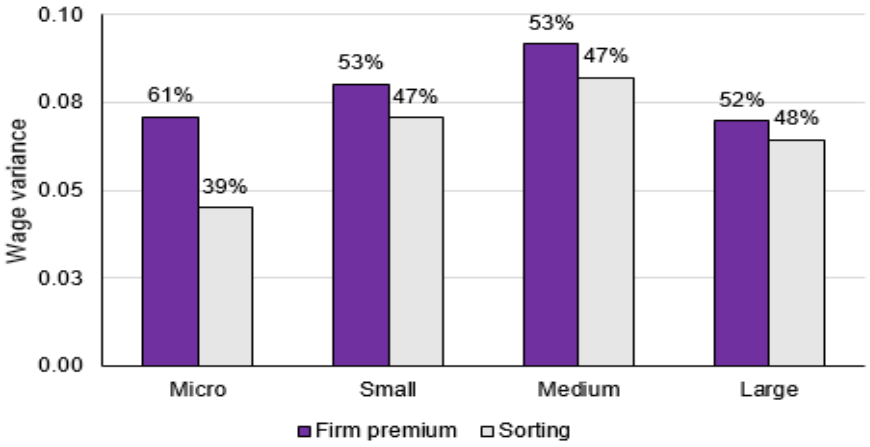


Source: authors based on the Third Round LinkEED Project Stata routine using CRLEED data.

Between-firm wage dispersion in 2017 was similar for micro and large firms, 0.12 and 0.13, respectively, while for small and medium firms it was higher, 0.15 and 0.17, respectively

(Figure 3). For small, medium and large firms, the relative contribution to between-firm wage dispersion of firm premium given by productivity rents represented a bit over its half, 53% (see Figure 4). This result suggests an even distribution between the contribution of firm premium and sorting to between firm wage inequality. However, in micro firms the firm premium related to productivity represented 61%. The latter might be the response to higher productivity differences between firms given the firm's activity, and therefore, to larger differences in rent-sharing corespondent to that productivity.

Figure 4: Costa Rica: estimates of (log) wage variance between-firm by firm size, 2017



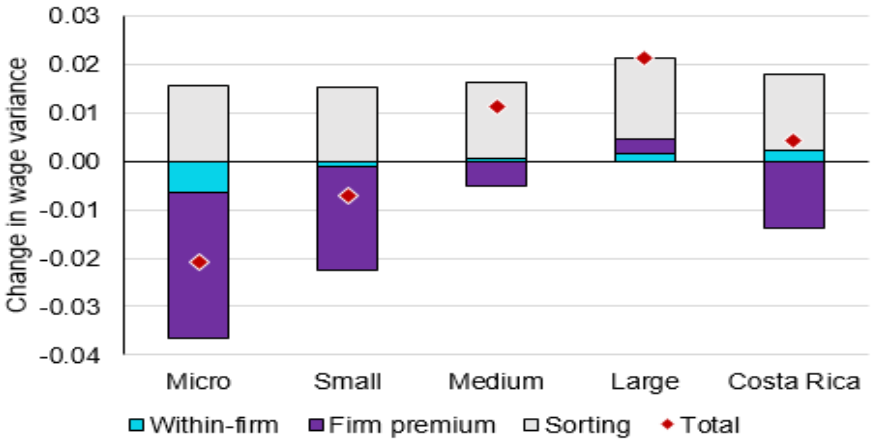
Source: authors based on the Third Round LinkEED Project Stata routine using CRLEED data.

There is variability in wage inequality (variance) changes between 2006 and 2017 when considering the firm size. In fact, for the time considered, wage inequality decreased in micro and small firms, but increased in medium and large ones. As an aggregate result, total wage inequality slightly increased (see Figure 5); wage inequality within firms remained practically constant between 2006 and 2017 for all firm sizes, except for micro firms where the dispersion decreased.

When looking wage inequality between-firm, there is an increase due to workforce composition similar for all groups, which implies that differences between firm size respond to changes on the dispersion in firm productivity wage premium (Figure 5). It means that this payment became more similar in micro, small and medium firms, but more heterogeneous between the large ones.

A possible explanation behind this result is that as less productive firms exit the market,

Figure 5: Costa Rica: change in (log) wage variance between 2006 and 2017



Source: authors based on the Third Round LinkEED Project Stata routine using CRLEED data.

the resulting firms have a more homogeneous payment distribution. There are other factors that might have also affected differences in payments, for example, institutional or structural changes (minimum wage). There is evidence for Costa Rica in Trejos (2016) that income distribution is not neutral to the minimum wage policy, but it has little space to move the distribution alone.

In contrast, wage dispersion related to firm wage premia has increased between large firms. This group includes most of the multinational corporations which have decided to invest in Costa Rica and which are characterized by hiring relatively more skilled and educated workers. Alfaro-Urena, Manelici and Vasquez (2020) found a direct MNCs wage premium of 9% above market wages in the country, which supports the hypothesis of the effect of MNCs on wage dispersion. Additionally, this finding (for large firms) is aligned to that from different OECD countries where, on average, between firm components increased wage inequality (Criscuolo et al., 2020).

4.3 Pass-through of firm productivity to wages

The previous findings suggest that there is a significant contribution of firms to wage inequality drove by differences in firm's workforce composition (sorting of workers across

firms), and differences of revenue productivity between firms or differences in the allotment of productivity rents shared with workers.

Now, to carry out a rent-sharing study that relates the worker's wage with firm productivity, Costa Rica has an advantage, as it is part of a limited subset of countries for which productivity revenues are available at firm-level in the LinkEED database. Therefore, it is possible to estimate the pass-through between firm-level productivity to wages, which may explain pay differences between identical workers, hence, the intervention of firms in wage inequality (Criscuolo et al., 2021).

The empirical implementation estimates the following earning equation over a panel data of workers between 2006 and 2017:

$$\ln w_{ijst} = \rho \ln y_{jt} + \beta x_{it} + \delta_s + \delta_t + e_{jst}, \tag{4}$$

where $\ln w_{ijst}$ denotes the logarithmic wage of worker i, firm j, sector s and year t; $\ln y_{jt}$ is the logarithmic labor productivity at the firm level; ρ represents the elasticity of worker wage with respect to firm productivity; x_{it} is a vector of observable worker characteristics such as age and gender; β is the estimated return of these characteristics; δ_s and δ_t are sector and time fixed effects, respectively; and e_{jst} is the error term.

Table 3: Estimation of the elasticity of wages with respect to firm productivity 2006-2017

Variables	(1) Ln(wage)	(2) Ln(wage)	(3) Ln(wage)
Ln(sales per worker)	0.210***	0.048***	-
	[0.0093]	[0.0020]	-
Ln(value added per worker)	-	-	0.057***
	-	-	[0.0028]
Observations	5,002,719	5,002,719	4,908,947
Worker fixed effects	No	Yes	Yes
Industry fixed effects	Yes	Yes	Yes
Year fixed effects	Yes	Yes	Yes

Note: results from regressions of the Third Round LinkEED Project Stata routine using CRLEED data. Standard error in brackets. Source: BCCR

Table 3 shows the estimated elasticity for two alternative productivity measures, the logarithmic sales per worker (column 1 and 2) and the logarithmic value added (VA) per worker

(column 3). Column 1 shows that, on average, about 0.21% of productivity-related rents are shared with workers. According to Criscuolo et al. (2021), because the model specification includes industry fixed effects the result can be interpreted as a within-industry pass-through.

When the estimate controls for the workers' fixed effects (column 2), the elasticity goes down to 0.048%. The drop in the estimated elasticity can be explained by the removal of worker's unobserved characteristics that are correlated with firm productivity and worker's wage. That factors may be affecting firm productivity and wages at the same time. The remaining 0.048% is the estimated pass-through from firm productivity to wages in Costa Rica. Then, the use of a distinct productivity measure generates similar results. Column (3) shows that the estimated elasticity is 0.057% when productivity is measured as the log of VA per worker and workers' fixed effects are controlled for.

Criscuolo et al. (2021) showed, from a sample of countries with firm-level productivity data, cross-country variation in the pass-through elasticity within a range from 0.08% in the Netherlands to 0.22% in Hungary, while Costa Rican comparable estimate was 0.21%, the one excluding worker's fixed effects. Also, from that sample, there are differences in the elasticity of wages with respect to productivity over the countries according to worker skill levels and gender.

In general, for the countries included in Criscuolo et al. (2021), the productivity pass-through was higher for high-skilled workers. In the case of gender, men receive a higher productivity pass-through, except for Costa Rica, France, and Portugal, where evidence showed a larger pass-through for women. A possible explanation is monopsonic wage discrimination by firms that maximise benefits based on differences between men and women in opportunities for job mobility (Criscuolo et al., 2021, p.20).[17]

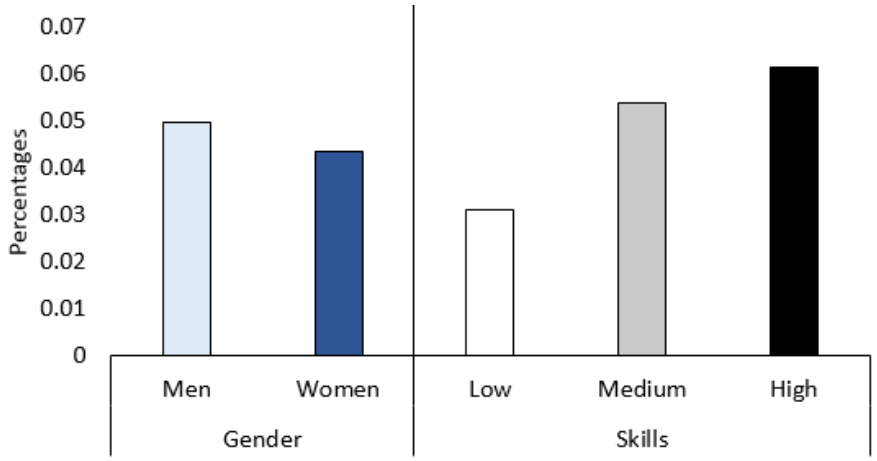
Specifically for Costa Rica, the estimates of the pass-through by gender and the skill level of workers are shown in Figure 6. These results are consistent with the estimation of Table 3, Column (2). However, they are different from those presented in Criscuolo et al. (2021), which are based on a model specification that do not control for worker's fixed effects. The estimated pass-through is around 12% higher for men (0.050%) than women (0.044%), reflecting differences that may be related to men flexibility or different costs in hiring men

[17]This hypothesis will be explored by LinkEED group in the near future as the stages of the project advance.

and women.[18]

Then, worker' skills are grouped into high, medium and, low according to occupation classification as described in Section 3. The estimated pass-through is higher for high-skilled workers than the other types. In fact, it doubles the pass-through received by low-skilled workers and it is a 12.5% higher than the medium-skill group. A possible explanation for such differences is that more productive firms have a higher demand for skilled workers relative to other kind of workers, and pay a higher productivity-related wage. This fact can be related to the presence of MNCs in Costa Rica, which has been found to play an important role in widening wage distribution (Alfaro-Urena, Manelici, Vasquez and Mendoza-Fernandez, 2020).

Figure 6: Costa Rica: elasticity of wages to firm productivity by gender and worker' skills 2006-2017



Source: authors based on the Third Round LinkEED Project Stata routine using CRLEED data.

5 Final remarks

For the past few years, research for Costa Rica has found evidence of an increase in la-

[18]In Costa Rica it has also been observed differences in other employment indicators like participation in the labor market, which tend to be lower for women (around a 50%) compared to men (75%) according to National Institute of Statistics and Census.

bor income inequality (González-Pandiella and Gabriel, 2017; Messina and Silva, 2017; Alfaro-Urena, Manelici, Vasquez and Mendoza-Fernandez, 2020). Also, productivity has incremented, but heterogeneously. There are differences between productive groups due to discrepancies in their economic performance (Padilla and Alvarado, 2014; Sandoval et al., 2017, 2018; Alfaro-Urena et al., 2019).

In general, reducing income inequality is relevant because it can promote a higher and faster growth of the economy, and improve people's welfare by reducing poverty (World Bank, 2016). Given that in Costa Rica labor income inequality is an important driver of the level of earning inequality, to know and study the sources that generates it is a first step that can support the formulation of policies that can lower inequality. This is the reason to study the role of firms in wage inequality in Costa Rica.

The aim of this work was to complement the empirical evidence gathered for this emerging economy by estimating the relationship between-firm wage inequality and firm productivity under the framework of the OECD LinkEED project.[19] Specifically, we estimate wage inequality, based on variance decomposition, and firm-productivity pass-through to wages (Criscuolo et al., 2020), with an employer-employee data set (from the BCCR), from 2006 to 2017.

Based on the results, for 2017 the overall wage inequality (measured by the variance of wages) was explained in a 45% by between-firm wage inequality (measured by the variance -dispersion- of the firms' average wage), which reflects that a significant part of wage inequality can be attributed to the role of firms. This was decomposed into two parts: differences in the composition of the workforce between firms (46%), and differences in payments related to firm productivity or firm rent-sharing (54%).

When analyzing the full time period, from 2006 until 2017, the evidence showed a subtle growth of wage inequality. From it, wage inequality between firms contributed 36%, while the 64% was explained by wage inequality within firms. This result is aligned with those found by Messina and Silva (2017) and Alfaro-Urena, Manelici, Vasquez and Mendoza-Fernandez (2020).

The reading of these results should not lose sight that, to properly assess the existence of a variance change in that period, it would be important to use tests of statistical significance

[19]Data analysis was carried out using an empirical procedure provided by the OECD to all participant countries.

that can take into account the uncertainty added by the estimation process. The literature reviewed did not apply tests for this, however, it could be developed in future research using re-sampling techniques such as Bootstrap.

In general, the increase in between-firm inequality seems to be explained by an increase of the differences in workforce composition, while the wage inequality between firms due to factors related to firm wage premia, was reduced. However, there are differences relative to the firm size. The wage inequality related to firm productivity wage premia decreased between micro, small and medium firms (wages related to firm productivity became more homogeneous between that firms), but increased between the large ones. The latter result is similar to the evidence found for the OECD countries (Criscuolo et al., 2020).

A hypothesis of the increase between large firms wage inequality is the relatively higher presence of MNCs in this group regarding the others (Sandoval et al., 2018). MNCs are characterized for having higher levels of productivity related to the local firms, and for paying above-market wages (Alfaro-Urena, Manelici and Vasquez, 2020). As these companies pay higher wages and the local firms remain to pay similar wages, between-firm wage inequality in the group of large firms increases.

Finally, the estimated pass-through of firm productivity to wages in Costa Rica was 0.05% when controlling for worker's fixed effects. However, there are differences in the estimated pass-through by workers' skills and gender for Costa Rica, and for other OECD countries (Criscuolo et al., 2021). Men and high-skilled workers receive, on average, a higher pass-through of firm productivity to wages, which may be a reflect of differences in hiring costs between groups, but other reasons are also possible. In that line, the following step on the research of wage inequality of the LinkEED project is focusing on the analysis of the gender wage gap and on labor market concentration.

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A Appendix

A Data

Table 1: Details on data

Source	Coverage	Employer	Sample structure	Longitudinal	Earnings data	Working time	Worker skills	Productivity data
REVEC	All workers affiliated to social security, 2006-2017	Firm	Universe	Yes	Gross monthly earnings	No information	Occupation	Yes, sales and value added

Table 2: Costa Rica: observable variables

Country	Age	Gender	Education	Occupation	Part time
Costa Rica	Yes	Yes	No	Yes	No