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Innovation and wage inequality in argentinean manufacturing firms

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Abstract

Latin American economies are increasingly applying the neo-Schumpeterian approach to innovation when seeking to address development problems. However, although inequality is particularly critical in the region, the topic of inequality is curiously absent from studies which adopt the neo-Schumpeterian approach. Applying the efficiency wage hypothesis, this article examines the relationship between innovation efforts and wage inequality among Argentinean firms, employing a quantile regressions methodology on firm-level wages with data from the National Survey of Employment and Innovation Dynamics (ENDEI) for 2010-2012. The results are articulated with a sectoral analysis as a conditioning factor of the relationship studied, revealing the intense and enduring techno-productive imbalances characteristic in the region.

Keywords: innovation; wages; inequality; industry.

1. INTRODUCTION¹

For a decade, starting in 2002, the Argentine economy and its industrial sector reclaimed a growth path which benefitted from a combination of internal and external factors (Arza and López, 2011). This encouraged various manufacturing firms to start innovative processes associated with improvements in employment (Pereira and Tacsir, 2019), productivity (Gómez and Borrastero, 2018) and competitiveness (Da Silva Catela and Tumini, 2017). These firms had to overcome various obstacles, many of which were historically related to traits characteristic of Latin American economies. First, the impact of structural heterogeneity, due to which productive networks, labor relations and technological conditions are deeply asymmetrical between sectors, companies and workers, results in strong developmental limits, productivity gaps and persistent economic inequality in the region (Grazzi *et al.*, 2016; Pagés, 2010). Second, barriers to innovation and public policies' limited reach in peripheral economies, affecting business strategies for facing innovative processes (Arza and López, 2021; Chudnovsky *et al.*, 2004). As a corollary, it was around 2012 when the numbers seen in Argentina for innovative intensity were lower than those in the 1990s (Bernat, 2017).

From another perspective, inequality is permanently linked to the technological side. However, it cannot only be measured at the interpersonal level. Another area where innovation becomes relevant is functional inequality, where focus shifts to different productive factors responsible for generating income (Gasparini *et al.*, 2012). The Economic Commission for Latin America (Comisión Económica para América Latina [CEPAL], 2012) links both aspects by means of the structural heterogeneity hypothesis. If one abandons the neoclassical approach which equates productivity with wages, the gaps in productivity that define a heterogeneous productive structure translate into labor income inequality and inequality in capital and labor remunerations. This phenomenon merits special attention thanks to high levels of inequality in Latin America (Bourguignon and Morrison, 2002; Gasparini *et al.*, 2012).

Given the state of affairs, it is possible to identify the extent to which technological innovation and wage inequality among Argentine manufacturing companies are linked and assess whether this link differs according to the industrial sector, defined by factor intensity. The underlying hypothesis indicates that these companies which make monetary innovation efforts are associated with salary premiums which differ according to the company's position in intra-industry distribution and sectoral specificities. To this effect, data is used from the National Survey of Employment and Innovation Dynamics (ENDEI),² corresponding to the period 2010-2012 (Ministerio de Ciencia, Tecnología e Innovación y Ministerio de Trabajo, Empleo y Seguridad Social [MINCyT and MTEySS],³ 2015). The unit for analysis in this study is that of the firm, though as such one needs to abandon the interpersonal viewpoint in order to think in terms of inequality between firms or sectors.

The article is organized as follows: the next section contains a review of the historical background of innovation and wages, followed by a hypothesis that allows one to connect them. The third and fourth section present the data and empirical strategy employed and report the results for the different proposals. In the fifth section, the final observations are presented.

2. A REVIEW OF THE LITERATURE

The literature consulted for this article arose from economic perspectives which, paradoxically, do not present many connections. On the one hand, studies on inequality within a neoclassical framework consider changes in technology to be an exogenous shock and do not delve into the conditions in

which it develops, the processes and actors involved, nor the firms' performances. On the other hand, studies from a Neo-Schumpeterian perspective focus, for the most part, on innovative processes and their impact on commerce, production or labor, leaving by the wayside the question of distribution.

The idea of technological progress or change and its connection with inequality is approached mainly from two central hypotheses in the neoclassical framework. First, Kuznets' (1955) "inverted-U" hypothesis which sets forth the quandary between inequality and structural progress in an economy that goes from a traditional sector to a "modern" one. Various authors currently dismiss this hypothesis as they find that this connection becomes illusory upon incorporating regional, sectoral and social particularities (Alejo, 2013; Anand and Kanbur, 1993; Piketty, 2006). The income dispersion is not an automatic and inevitable consequence of technological change, but rather of many institutions and policies which have an impact on inequality dynamics (Bruno *et al.*, 1999; Piketty, 2006).

Second, Tinbergen's (1975) supply and demand model proposes the idea of a "race" between education and technology, such that the population's rising educational level drives the supply of qualifications while technological change drives demand (Goldin and Katz, 2009; Haveman, 1977). Stemming from this framework, the hypothesis of technological change favoring qualifications posits that this change springs from the supply of skilled labor itself, induces the development of compatible technologies, drives demand for them and widens the wage gap between qualifications (Acemoglu, 2002). Initially proposed in developed countries (Acemoglu, 2002; Card and DiNardo, 2002), it was later expanded to cover developing countries (Conte and Vivarelli, 2011; Pi and Zhang, 2018). Some variants of this model focus on information and communication technologies or labor operations (Acemoglu and Autor, 2011; Autor, 2014).

Studies on Argentina generally adopt the view of exogenous technological change. Like studies on developing countries (Acosta and Gasparini, 2007; Bustos, 2011; Caselli, 2014; Conte and Vivarelli, 2011; Cruces and Gasparini, 2008), they treat technology as a central point in this hypothesis. The assumption of exogeneity, its conception as a public good, freely and universally available, or measuring it with indirect variables (which reflect neither its nature nor its dynamism) oversimplify its link with the productive system (Conceição and Galbraith, 2001). They ignore the facets of the innovative process and how it is interconnected with commercial and productive structures or the impact of macroeconomic conditions. In light of this, some authors move forward by incorporating aspects of the innovative process (Bustos, 2011; Caselli, 2014; Vivarelli, 2014).

The conditions of inequality under a new technological paradigm are also addressed by sociology. Castells (1998) considers the capitalist articulation between productivity, competitiveness and equity, which was somewhat benevolent in the past, to display a disarticulation of equity from the rest. The current developmental context, the individualization of work and the company-employee link that favors the individual's ability to negotiate and the flexibility of tasks, exacerbate inequalities and mechanisms of social exclusion. Recent proposals in labor economics, technology, and skills are remarkably accurate (Acemoglu, 2002; Acemoglu and Autor, 2011; Autor, 2014).

Schumpeter's studies (1934, 1975) are a different approach and are at the core of the evolutionary school of Nelson and Winter (1982). The Neo-Schumpeterian view of economics as a dynamic and changing phenomenon departs from neoclassical economics which bases itself on equilibrium and comparative statics. Companies act as coalitions of human agents that aim to satisfy objectives rather than optimize; they follow to simple and stable rules for taking action so that they may face scenarios of constant change and ensuing uncertainty (Morero, 2007).

An aspect relevant to this study involves Schumpeter's definition of quasi-rents. The idea is that within a dynamic context where innovation arises, companies seek "non-price" competitiveness. This means a differentiation strategy and extracting value from products, whose benefits are achieved as long as their innovations maintain their novelty in the market (Nelson and Winter, 1982).

That said, it is necessary to conceptualize innovation. In a broad sense of the word, innovation consists of making an effort to introduce novelties in the market, whose potential to be fully realized depends on multiple factors (Organization for Economic Cooperation and Development [OCDE], 2005; Jaramillo *et al.*, 2000).⁴ These innovation efforts (IE) mean investing in different areas such as machinery and equipment, software or hardware, developing or outsourcing R&D, industrial design, training for the introduction of innovations, technological transfer, industrial design and internal engineering activities, or consultants for organizational changes.

In summary, two main lines of analysis of the Neo-Schumpeterian approach are adopted by this article: the criteria adopted to define and measure innovation and the notion of quasi-rents in innovative companies. Next, I will expand on the hypothesis herein adopted on wage premiums at company level.

Technological innovation and wage inequality. An unexplored link

The Neo-Schumpeterian approach lacks a key aspect for economic analysis: distribution. In the words of Pianta and Tancioni (2008, p. 101), "the analysis of technological change's distributive effects is generally absent from the literature."^{5,6} It focuses on the dynamics of the innovative, productive and commercial system in which companies operate, ignoring the aspect of wage related to labor conditions. Although there is a consensus on the role played by innovation in productivity and growth in the economy, this perspective does not address the impact it has on income distribution (Borrastero, 2012). Despite inequality's presence in academic literature and public discourse, little is known about its links with how firms are organized (Bapuji and Neville, 2015). This is even truer in the case of developing countries due to less empirical evidence and data available (Oberdabernig, 2016).

In short, literature on companies' innovative strategies and the link to their wage policies is scarce. An important precedent for this study is that provided by Días Bahia and Arbache (2005), whose analysis of the firms' nature and its association with theories about wage differentials. The authors follow efficiency wage theory (Shapiro and Stiglitz, 1984; Stiglitz, 1987), whereby companies have the leeway to pay their better employees and thereby increase their productivity and efficiency, generating greater competitiveness and, more importantly, a higher income.⁷

Using Schumpeter's (1934) definition of quasi-rents, wage differentials can be connected to innovation. The idea is that innovative companies, based on their monopolistic position in the short-term, have access to this benefit. Días Bahia and Arbache (2005) assume that this benefit which innovative companies enjoy lasts until the innovation is fully disseminated and standardized.

Combining efficiency wage theory in innovative companies and the Neo-Schumpeterian approach to innovation, I posit the study of the innovation-wage link within a framework of wage premiums in Argentinean manufacturing firms. If one considers it desirable and necessary for the Neo-Schumpeterian school to advance in the aspects of distribution which can be influenced by innovation, then one understands that these relationships can be approached using efficiency wage theory.

Some recent studies estimate wage differentials in innovative Latin American companies distinguish the difference between the traditional viewpoint of "price" based profitability (Días Bahia and Arbache, 2005; Lugones *et al.*, 2007; Cirillo, 2014; Brambilla and Peñaloza Pacheco, 2018; Gómez and Borrastero, 2018). Lugones *et al.* (2007), which seeks to reduce labor costs and "non-price" based profitability which can be obtained through innovation. Activities which entail a greater level of knowledge and longer links in the chain succeed in increasing their share of production and exports, ensure sustained increases in wage levels, and access to better opportunities and greater prospects for profitability. For this to be possible, it is necessary to drive activities, value chains and productive conglomerates which succeed in creating competitive advantages through innovation, thereby avoiding isolated patches of modernity, through strong complementarities with the rest of the productive network (Cimoli, 2005).

I posit then that innovation is associated with wage premiums, which enables the company to become more compatible with labor which is more qualified, productive and open to international markets. This is possible due to the definition of competitiveness in terms of non-price strategies, where the added value and differentiation of innovative products in the market are the key to succeeding.

From these studies a common hypothesis emerges: companies with greater innovation intensity show wage differentials, confirming the positive and significant relationship between innovation and wages. However, these analyses focus on the central or average value, without delving into the conditions of wage distribution. It is here that this study's contribution resides: the distributive analysis of wage premiums due to innovation, both at the firm level as well as the sectoral level.

With regard to the latter, it is important to delve into how the productive structures in peripheral countries can affect the relationship between innovation and wages. We understand structural heterogeneity to refer to the structural inequality present in these countries' sectoral growth, productive factors, modes of production and the distribution of their income (Chena, 2010). This approach is aware that there are differences in sectoral productivity in developed countries which are resolved with dynamics which are more or less intense and displace capital in order to equalize the rates of profit, as happens in advanced countries (Barrera Insua and Fernández Massi, 2017). Rather, in peripheral countries, these conditions tend to reproduce over time (Chena, 2010). These combinations reinforce the inequalities inherent in peripheral countries and hinder the successful dissemination of their innovations (Porta *et al.*, 2015). To be precise, with underdevelopment, the loss of shares in sectors which spread knowledge throughout industrial production is systematic (Cimoli, 2005; Katz, 2000). Homogenization of the economic structure, development and a better distribution of income are only possible if the industry's technological capabilities improve.

In the Argentinean industry, with the productive dynamics seen so far in the 21st century, its capacity to generate employment and surplus has not been homogeneous over the years nor within the different branches that make up the sector (Porta *et al.*, 2015). Barrera Insua and Fernández Massi (2017) analyze inter-industrial differentials in productivity and wages. They concluded that for the period 2003-2007 wages generally grew faster than productivity, driven by the reactivation of collective bargaining and lump-sum increases. These policies influenced inequality between workers by reducing the gaps between the average wage in each sector. In the period 2008-2012, along with increasing prices, one can see a differential growth in productivity in relation to wages. As inflation becomes part of the basis for wage agreements, inter-industrial inequality keeps inter-industry relative wages stable (Marshall, 2013), although productive dispersion increases. To sum up, the authors go beyond these comparisons and argue that the drop in wage inequality is not explained by a drop in productive inequality, but by active policies dedicated to regulating wages.

On the other hand, sectoral heterogeneity in firms' technological profiles is mirrored by a great disparity in innovation efforts. Bernat (2017) makes a distinction between productive sectors and degrees of innovative intensity in the Argentinean industry. He divides productive sectors into three groups: capital-intensive and natural resource-intensive (food and beverages, wood, paper, rubber and plastics, non-metallic mineral products, base metals and the automotive sector); labor-intensive (textiles, clothing, leather, publishing and printing, metal products and furniture); and knowledge-intensive (chemicals, machinery and equipment, electrical machines and appliances; radio and TV equipment, medical instruments and other transportation equipment).

Based on these classifications, the author identifies that the labor-intensive and capital and natural resource-intensive sectors have internal gaps with regards to their investment in innovation. This results in conflicting levels of innovation, where really high and really low levels of technological investment coexist, with companies which develop their activities at the forefront of technology on one side, and on the other, companies which invest relatively little in innovation (relative to the industrial average). On the other hand, knowledge-intensive branches have significantly lower technological heterogeneity, with a high rate of investment in technology on average and low intra-sector dispersion. In terms of wages, Gómez and Borrastero (2018) place the wages of capital and natural resource intensive branches very close to the industry's average levels. Labor-intensive sectors meanwhile pay on average the lowest wages in the manufacturing sector and the knowledge-intensive branches report wages significantly higher than the rest.

In summary, these sectoral disparities, compared to the technological ones presented in the previous paragraph, do not allay the concern of whether or not the innovation-wage connection is homogeneous between sectoral levels. *A priori*, wage premiums for innovation are expected to be higher in branches that reflect greater homogeneity in regards to technological investment.

3. DATA AND EMPIRICAL STRATEGY

Data from the ENDEI is used for the period of 2010-2012 (MINCyT and MTEySS, 2015). The ENDEI addresses the reality of the Argentinean industrial complex with regards to production, labor and innovation. The sample unit is the manufacturing company with at least ten workers registered in the Argentine Integrated Social Security System (SIPA)⁸. The database is stratified by field of activity and the size of the firm. Thanks to its reach across the population, it provides information on 18,900 firms in the sector.

A key aspect of the data is its temporal nature (2010-2012), which prevents an analysis of the evolution and impact of different variables in the long term. That is why the response variable refers to 2012, while the primary covariable –innovation efforts– refers to 2010. I recognize the endogenous nature of the innovative process, which combines everything from innovation's absorptive capacity to the impact on the companies' performance, including innovation efforts and results in terms of introducing innovations to the market. However, an analysis that establishes causal relationships goes beyond the empirical and theoretical context proposed herein. As such, the analysis of wage premiums due to innovation is approached in terms of the innovation-wage correlation.

Analysis at the company level presents a challenge at the time of defining and examining inequality, considering companies' distribution between those with higher and lower wages in a sector or in the industry.

To favor the control of unobserved heterogeneity and the comparison between proposed empirical strategies, missing or atypical values were eliminated in monetary variables and data from companies without a sectoral allocation was filtered out. Furthermore, when the equations were presented in logarithms, the analysis was limited to innovative companies, companies which registered a positive investment in the period. The final sample consists of 1,719 companies.⁹

To estimate the wage premium for innovation, I adapted the salary equation proposed by Brambilla and Peñaloza Pacheco (2018):¹⁰

$$w_i = \varphi(g_i, x_i) + \epsilon_i \quad (1)$$

Where w_i indicates the average real wage in company i (in logarithms) for 2012;¹¹ g_i indicates innovation spending per worker for 2010; x_i indicates the set of control variables; ϵ_i indicates the random error which captures the firm's characteristics which are unobserved in this relationship and is distributed as $N(0, \sigma^2)$.

Wage premiums for innovation are estimated based on real spending on innovation per worker (in logarithms) in 2010 in order to filter out the effects associated with companies' sizes. Spending on innovation represents investments in the field and reflects the intensity of company's innovative efforts in the hopes of obtaining results (Bustos, 2011; Crespi and Zuniga, 2012). This includes the expenses that their innovation activities accrue: R & D, purchasing tools and machinery or hardware and software, industrial design, technology transfer, consulting or training.

The five estimated coefficients for this variable (corresponding to each of the estimated wage quantiles) are expected to be positive, although without previously identifying a pattern between coefficients throughout the wage distribution.

In line with Lugones *et al.*'s proposal (2007), labor productivity is included and measured as the real value added per worker for 2012. The hope is to reflect on one hand the correlation between productivity and wages (which innovation influences) and, on the other, the innovation-wage relationship untouched by innovation, with an expectation of estimated coefficients which are positive.

The rest of the control variables are associated with company conditions proven to be linked to wages.

- The state of exports is measured by a variable equal to 1 if the company exports. Based on evidence from developing countries, positive premiums due to exports are expected (Brambilla *et al.*, 2017; Días Bahía and Arbache, 2005).
- Foreign capital indicates whether the company has capital which is foreign in origin. The expectation is that the results will yield wage premiums in foreign firms (Glass and Saggi, 2002; Novick *et al.*, 2011).
- The size (based on their workforce) is divided into the categories of medium and large, without an expectation in regards to the sign of the coefficients, given the mixed evidence found in the literature (Cobb and Lin, 2017; Sayago, 2015; Bloom *et al.*, 2018).
- Age distinguishes companies older than 10 years. A positive correlation is expected with workers' experience, which raises the average wage.
- Controls by industrial field according to the CIIU¹² codes available in the database.

Seeking to identify distributive patterns, the conditional quantile regression method was applied to a series of percentiles representative of the industry's wage distribution (p10, p25, p50 or median, p75 and p90), in accordance with Koenker and Bassett (1978). An advantage of this method is that, by not dealing with a summary measure of inequality, the coefficients can be broken down into different sections of the distribution. Based on an inter-quantile regression, one can test whether there is a significant differential effect on different points of the distribution. Furthermore, they are especially useful with atypical or heteroscedastic data.¹³ ¹⁴ Finally, Wald tests were performed to verify the differences found between different variables' coefficients for each percentile. Standard errors were estimated using the Bootstrap technique with 200 replicas.

One aspect worth pointing out is that associated with the multiple causal relationships among the covariables themselves and the response variable. Alejo (2012) in particular argues that incorporating instrumental variables (IV) in a quantile regression results in inefficient estimators that differ

significantly from the original estimates, even achieving a change in level, although without modifying the inter-quantile dispersion pattern. One must add to this the difficulty in obtaining good instruments. In general, there are numerous criticisms of the IV methodology as a strategy for resolving potential endogeneity biases, linked to the nature of the procedure and the difficulties associated with interpreting the results in a purely economic sense.¹⁵

Innovation premiums and sectoral interaction

What has been proposed herein so far assumes a singular innovation-wage correlation at each point of company's distribution in the industry, regardless of which sector they belong to. In order to explore the differences which the sectoral structure imposes on this relationship, I propose interactions between innovation spending and three industrial groups defined based on factor intensities, in accordance with Cimoli (2005), Chena (2010) and Bernat (2017) (see description in Table 1).

Table 1. Grouping of manufacturing sectors. Argentinean industry

<i>Sectors</i>	<i>Branches included (CIIU Code)</i>
Capital (K) intensive and/or natural resource (NR) intensive	Food (15); Refrigerated goods (1511); Dairy products (1520); Wines and fermented beverages (1552); Wood (20); Paper (21); Rubber and plastic products (25); Base metals (27); Other non-metallic minerals (26); bodywork, trailers and semi-trailers (3420); Auto parts (3430).
Labor-intensive (L)	Textiles (17); Clothing (18); Leather (19); Furniture; Publishing (22); Other metal products (28).
Knowledge intensive (KNO)	Chemicals (24); Pharmaceuticals (2423); Medical instruments (33); Electrical, radio and television equipment (3012); Household appliances (2930); Machinery and equipment (29); Machinery and tools in general (299); Agricultural and forestry machinery (2921); Other transport equipment (35).

Source: Created by the author using data from the ENDEI (MINCyT and MTEySS, 2015) and based on Bernat (2017).

I then seek to identify whether innovation premiums differ according to the industrial sectors under consideration, as evidence of the conditioning provided by structural heterogeneity in the technological and labor aspects of the Argentinean industry.

Finally, I outline the aspects in which wage inequality will be analyzed:

- As the pay gap between the most and least innovative companies.
- In inter-quantile terms, between the companies with the highest and lowest wage levels in the industry.
- In sectoral terms, according to the differences in wage premiums (considering the same quantile).

RESULTS

Table 2 presents descriptive statistics that outline the context of innovation in the Argentinean industry.

Table 2. Description of the sample's descriptive variables and statistics. Argentinean industry

<i>Variable</i>	<i>Definition</i>	<i>Median</i>	<i>Std. Dev.</i>	<i>Gini</i>	<i>Min.</i>	<i>Max.</i>
Wage	Natural Log. for real average wage per company. 2012	8.798	0.402	0.214	7.089	10.03
Innovation spending	Natural Log. for real innovation spending per worker. 2010	8.716	1.514	0.641	2.407	14.246
Productivity	Natural log. for real added value per worker. 2012	12.109	0.822	0.494	8.577	16.081
Exporter	(=1) if the company claims to have customers abroad	0.513	0.500	-	0	1
Foreign capital	(=1) if at least 1% of the company's capital comes from abroad	0.111	0.314	-	0	1
Small	(=1) if the company is small (10-25 employees)	0.321	0.467	-	0	1
Medium	(=1) if the company is medium (26-99 employees)	0.386	0.487	-	0	1
Large	(=1) if the company is large (100 or more employees)	0.293	0.455	-	0	1
Age	(=1) if the company is more than 10 years old	0.767	0.423	-	0	1
Sectors	Capital and Natural Resource Intensive (KNR-INT) (0.439); labor intensive (L-INT) (0.228); knowledge intensive (KNO-INT) (0.333).					

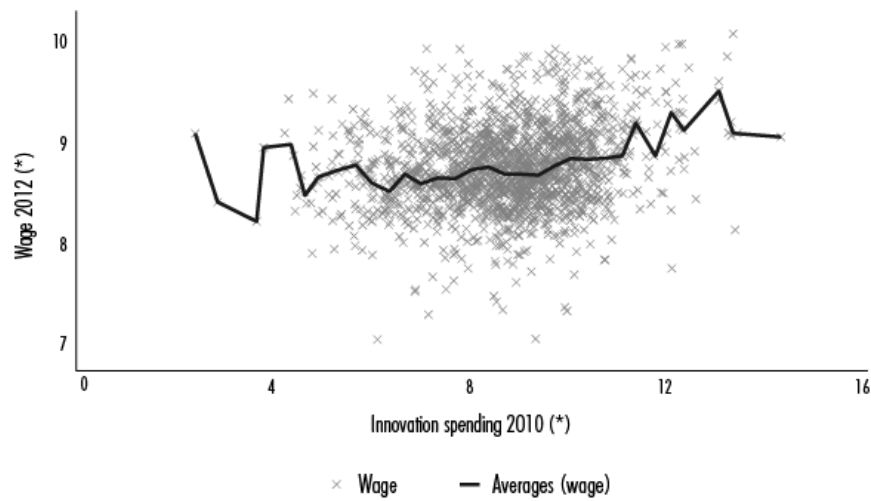
Source: Created by the author using data from the ENDEI (MINCyT and MTEySS, 2015).

First, innovation spending demonstrates an average close to the average industrial wage. However, one can identify greater variability in effort indicators (with a Gini coefficient of 0.64, almost triple the wage Gini). Labor productivity is also highly dispersed, although less than innovation spending. In the sample, 32% of companies are small and only 29% employ 100 or more workers. Companies which innovate and export account for 51% and only 11% have foreign capital. Finally, 77% have more than 10 years of experience. This is not unexpected given that those who innovate tend to have previous experience.

The industrial group that has the most companies is the one which is capital and/or natural resources intensive (KNR-INT), accounting for 44% of the industry's total. This group includes food sectors, producers of rubber and plastics, glass and ceramics, the cement industry, steel mills, autos and auto parts, among others. The knowledge-intensive sectors account for 33%, with the chemical and pharmaceutical industries, producers of medical instruments, household appliances (white goods), radio and television devices (brown goods), machinery and equipment, among others. The labor-intensive sectors account for 23% and primarily consists of textile, clothing, leather and furniture producers.¹⁶

Figure 1 shows a scatter plot for wages and innovation spending per company, which confirms greater variability in observations of the latter. Likewise, the moving averages curve for wages per each innovation spending value reveals a slight positive slope, mirroring a certain relationship between the variables.

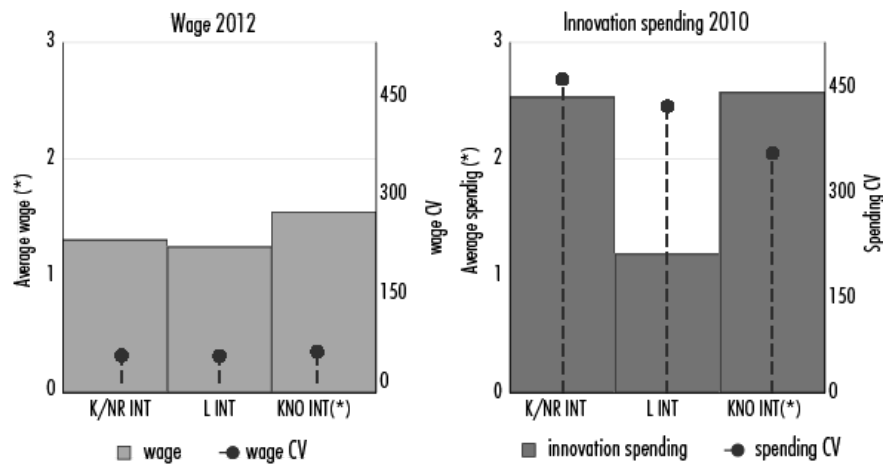
Figure 1. Wages and Innovation spending. Moving averages and dispersion.
Argentinean industry (2010-2012)



Source: created by the author using data from the ENDEI (MINCyT and MTEySS, 2015).

Furthermore, it is of interest to explore wages and innovation spending at the sectoral level. Figure 2 shows the dispersion and average level for each industrial sector.

Figure 2. Wage and innovation spending according to industrial sectors.
Argentine industry (2010-2012)



Source: created by the author with data from the ENDEI (MINCyT and MTEySS, 2015).

A low dispersion for wages is verified, while the situation for innovation spending is significantly different. The average investment per company in the KNR-INT and KNO-INT sectors are almost double that in the L-INT sector, where innovation is quite low.¹⁷ In terms of dispersion, the variation coefficient in the knowledge-intensive sector is limited. Combining a high technological investment and low dispersion within the category, companies in this sector demonstrate they have the best ability to innovate in the entire industry.

Next are the estimates considering a single innovation premium for the whole industry or a set according to the industrial grouping.¹⁸

Wage premiums for technological innovation

The results verify the presence of innovation premiums throughout the industry's wage distribution, which implies that companies with greater innovation efforts achieve higher wages. If the results of labor productivity are considered, one can see in the left panel of Table 3 that the five estimated quantiles have positive premiums from innovation spending, albeit relatively low. The coefficients of labor productivity mirror guidelines of neoclassical theory which posit wages as a function of productivity, although without distinguishing the order of causality.

Table 3. Wage equations at the company level. Quantile and inter-quantile regressions

	Quantile					Inter-quantile			
	(p10)	(p25)	(p50)	(p75)	(p90)	(p10-p90)	(p25-p75)	(p10-p50)	(p50-p90)
Innovation spending ⁽¹⁾⁽²⁾	0.019** (0.009)	0.019*** (0.007)	0.024*** (0.007)	0.025*** (0.008)	0.024*** (0.009)	0.006 (0.014)	0.005 (0.009)	0.006 (0.010)	0.000 (0.010)
Productivity	0.101*** (0.020)	0.130*** (0.015)	0.129*** (0.011)	0.139*** (0.014)	0.135*** (0.019)	0.034 (0.026)	0.009 (0.018)	0.027 (0.020)	0.006 (0.021)
Exporter	0.096*** (0.030)	0.068*** (0.020)	0.071*** (0.020)	0.037 (0.023)	0.070** (0.033)	-0.026 (0.039)	-0.030 (0.028)	-0.024 (0.031)	-0.002 (0.034)
Foreign capital	0.205*** (0.061)	0.201*** (0.037)	0.217*** (0.032)	0.193*** (0.038)	0.171*** (0.046)	-0.034 (0.071)	-0.008 (0.044)	0.012 (0.053)	-0.046 (0.048)
Medium	0.098*** (0.032)	0.105*** (0.024)	0.088*** (0.023)	0.108*** (0.027)	0.142*** (0.036)	0.044 (0.047)	0.003 (0.030)	-0.010 (0.034)	0.054 (0.040)
Large	0.192*** (0.040)	0.210*** (0.029)	0.200*** (0.027)	0.275*** (0.032)	0.265*** (0.039)	0.073 (0.057)	0.064* (0.039)	0.009 (0.041)	0.064 (0.043)
Age	0.139*** (0.036)	0.105*** (0.030)	0.108*** (0.024)	0.125*** (0.030)	0.089** (0.040)	-0.050 (0.003)	0.020 (0.002)	-0.031 (0.002)	-0.019 (0.002)
Constant ⁽³⁾	6.726*** (0.246)	6.586*** (0.189)	6.731*** (0.139)	6.789*** (0.175)	7.024*** (0.225)	0.298 (0.306)	0.203 (0.220)	0.005 (0.225)	0.293 (0.228)
Observations	1 719								

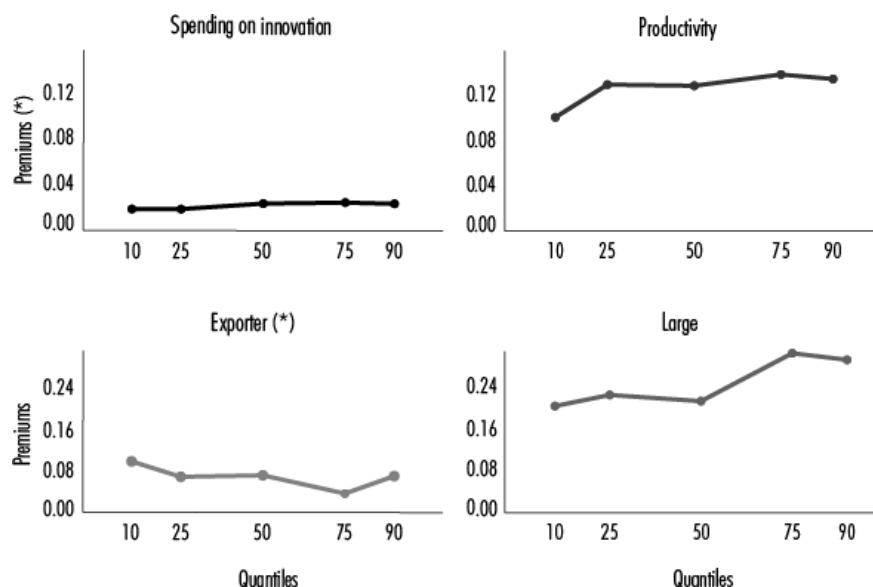
Notes: ⁽¹⁾ Significance *** p<0.01; ** p<0.05; * p<0.1; ⁽²⁾ Standard errors estimated via Bootstrap (200 replicas); ⁽³⁾ 26 branch activity related control variables were eliminated.

Source: created by the author using data from the ENDEI (MINCYT and MTEySS, 2015).

The rest of the variables are significant and show the expected signs. Export companies and those which have foreign capital registered higher wages, confirming the previous evidence (Brambilla and Peñaloza Pacheco, 2018; Novick *et al.*, 2011). The largest and oldest companies also demonstrate differential wages with regards to the rest of the companies. A hypothesis behind the result in the age variable is that the work history of employees is correlated to companies' ages, especially in those with a low turnover. In the case of size related premiums, the data seems to confirm what Cobb and Lin (2017) and Sayago (2015) have pointed out.

The results of the inter-quantile regression show that premiums do not vary between companies with higher and lower wages, thereby confirming that they remain relatively uniform throughout the distribution.¹⁹ Figure 3 allows one to visualize this for the main variables:

Figure 3. Premiums by innovation, productivity, export and size.
Argentinean industry (2010-2012)



Note: (*) coefficient for p75 not significant at 5%.
Source: created by the author with data from the ENDEI (MINCyT and MTEySS, 2015).

In relative terms, the premium from innovation is verified to be far less than returns on productivity. Furthermore, moderate slopes explain why inter-quantile regressions do not show differences in this regard. In summary, one can conclude that companies which invest in technology, are the most productive, export, have foreign capital, are large or have been in the market for a certain amount of time, and have higher wage premiums than the rest. Most importantly, the innovation wage gap does not differ between the companies with the highest and lowest wages in the industry.

Wage premiums without productivity control

An alternative path is explored in parallel to the proposed wage equation in which productivity is not included as a control variable, akin to what Brambilla and Peñaloza Pacheco (2018) did. The results are shown in the Appendix (see Tables A1 and A2). In the case of premiums according to innovation or export, omitting labor productivity does not seem to indicate significant changes in the coefficients, all of which are statistically significant.²⁰ The variables for foreign capital and size of the company reflect relatively greater changes with respect to the original specifications, indicating in this alternative a higher wage premium in multinational, medium and large companies. As expected, the value of the constant is higher, suggesting that equation (1) explains a larger portion of the observed variability in wages. In inter-quantile terms, the distribution of premiums in the industry is also uniform using this alternative.

Innovation premiums according to industrial sectors

Sectoral estimates indicate that knowledge- or labor-intensive sectors register premiums regardless of their wage levels (see Table 4). Meanwhile, capital- or natural resource-intensive industries (which have greater weight in the Argentinean industry) show a partial innovation-wage connection, with significant premiums in the 50th (median) and 75th percentiles, which represents only 25% of wage distribution among companies in the sector.

Table 4. Wage premiums according to innovation by industrial sector. Quantile and inter-quantile regression. Argentinean industry (2010-2012)

	Quantile					Inter-quantile			
	(p10)	(p25)	(p50)	(p75)	(p90)	(p10-p90)	(p25-p75)	(p10-p50)	(p50-p90)
Innovation spending – K and/or NR intensive ⁽¹⁾⁽²⁾	0.005 (0.009)	0.012* (0.007)	0.018*** (0.007)	0.016** (0.008)	0.017 (0.011)	0.012 (0.015)	0.004 (0.009)	0.013 (0.010)	-0.002 (0.010)
Innovation spending – L Intensive	0.023** (0.011)	0.022** (0.009)	0.019** (0.008)	0.022** (0.011)	0.033** (0.016)	0.010 (0.018)	0.000 (0.011)	-0.004 (0.012)	0.014 (0.015)
Innovation Spending – KNO intensive	0.019** (0.009)	0.025*** (0.008)	0.032*** (0.008)	0.034*** (0.010)	0.032** (0.012)	0.013 (0.015)	0.009 (0.010)	0.013 (0.010)	-0.000 (0.012)
Observations	1 719								

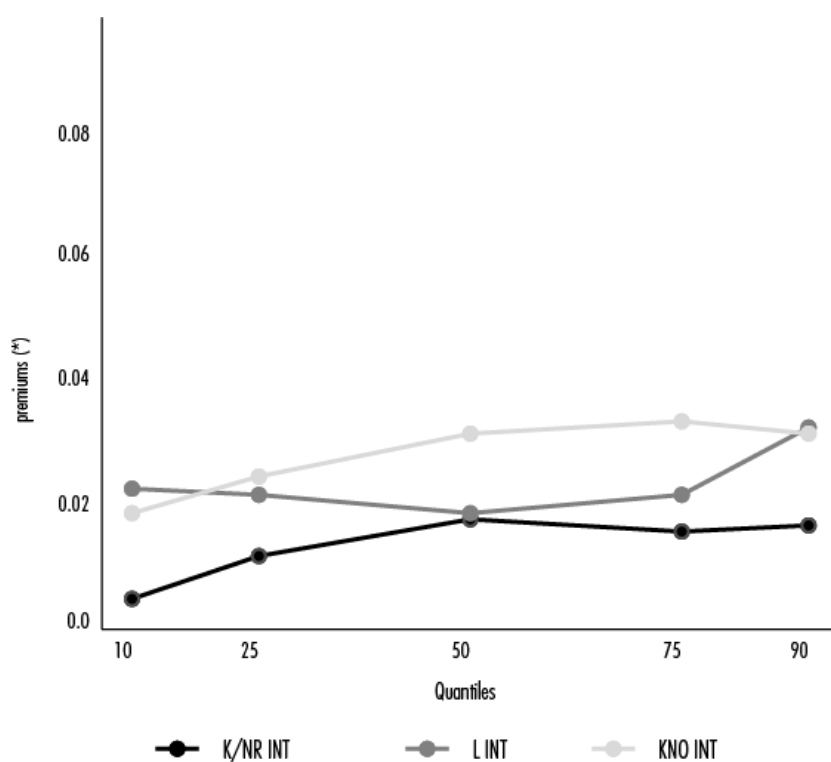
Notes: ⁽¹⁾Significance *** p<0.01, **p<0.05, *p<0.1; ⁽²⁾ Standard errors derived via Bootstrap (200 replicas).

Source: created by the author using data from the ENDEI (MINCyT and MTEySS, 2015).

Once again, the inter-quantile regressions confirm that innovation premiums do not define patterns of inequality according to companies' wages levels, mirroring an intra-industry uniformity regardless of sector.

If one compares the innovation premiums by sector, it is possible to see differences throughout the respective distributions, statistically verified by Wald tests. ²¹ Figure 4 makes it possible to identify not only their relative uniformity throughout wage distribution, but also differences between sector, with higher premiums in knowledge-intensive sectors than in capital- or natural resource-intensive sectors.

**Figure 4. Premiums according to innovation by industrial sectors.
Argentinean industry (2010-2012)**



Note: (*) coefficients not significant at 5%: K and NR INT: p10 and p90.

Source: created by the author with data from the ENDEI (MINCyT and MTEySS, 2015).

In short, the sectors in which the innovative effort correlates least with wage are those which are intensive in capital and natural resources with significant wage premiums in only one group of companies. One aspect that can have an impact is the extremely heterogeneous technological,

productive and working conditions between its branches. In particular, the food and beverage sector, composed of 15 branches in the ENDEI, represents the largest sector in the industry and has an extremely high techno-productive heterogeneity. The natural resource-intensive branches (cement, glass, paper and pulp industries) have the smallest share of industry's value added in all sectors. The automotive complex has an intermediate share of the industry and registers the lowest dispersions in productivity and technological intensity. All three sectors pay wages close to the industry average.

The L-INT and KNO-INT sectors verify innovation premiums throughout their wage distributions. In most of the knowledge-intensive branches, they work with high levels of technological investment (Bernat, 2017), often finding themselves on the international technological forefront (chemical and pharmaceutical sectors), with the highest productivity and wages in the industry (Barrera Insua and Fernández Massi, 2017; Gómez and Borrastero, 2018). It is what Cimoli (2005) defines as pockets of high productivity.

Labour-intensive sectors are the most difficult to characterize. They have the lowest wages in the industry. Their dispersion in technological intensity and productivity is so high that their average levels lose all meaning (see Figure 2). It is a group with a strong dichotomy. It combines basic metalworking and publishing – highly innovative and productive sectors – with leather and furniture production – which invest little in technology and productivity – (Bernat, 2017). The path of textiles starts with highly concentrated, productive and innovative companies producing fibers and threads, and moves towards, usually small, producers of fabrics and clothing, with little or no innovative intensity, and which border on informality. The path of the logging complex is similar, although more vertically integrated.²² Finally, in the midst of a landscape with extreme dispersion, the only aspect which is relatively homogeneous is wages, with the lowest levels in industry.

5. FINAL THOUGHTS

Through the link between innovation and wage inequality, this article empirically integrates analytical fields which had heretofore taken independent paths: the Neo-Schumpeterian approach and the efficiency wage hypothesis. Premiums were identified according to innovation intensity in Argentinean manufacturing companies using an overview of the industry and, alternatively, a sectoral structure founded on the heterogeneities of the sector.

The results indicate that companies that invest more in innovation show higher wages than those with smaller innovative efforts. This correlation is revealed to be uniform throughout manufacturing companies regardless of their wage levels, without delving into wage dispersion as a result of this link.

In sectoral terms, innovation premiums were estimated in three sectors: labor-intensive, knowledge-intensive, and capital- and natural resource-intensive. Of these, the sectors which disseminate knowledge are those that demonstrate the highest premiums, a fact confirmed by their reaching the highest techno-productive and qualification indicators in the industry. In sectors with a strong dichotomy in terms of productivity, market concentration, innovation intensity and competitiveness – as in the L-INT sector – the results can be somewhat inconsistent with previous evidence. Finally, in the KNR-INT sector, the branches that compose it show a deep heterogeneity in its aspects.

In short, the hypothesis that greater innovation correlates with greater wage inequality is partially verified, with this inequality examined in two lights. One differentiates companies according to their investment in technology (where the most innovative ones achieve better wages) and the sectoral one, which shows the knowledge-intensive sectors and the capital and natural resource intensive ones to have the highest premiums. On the other hand, according to the industry's wage levels, no differences are identified between wage premiums.

The partial nature of the results shows the complexity of the manufacturing sector. Here an influencing factor is not its structural heterogeneity, but rather the impact had by other wage regulating policies not included in this analysis. Throughout the article, a low rate of wage inequality was verified in relation to the variability of innovation spending and productivity, as were relatively low wage premium values. There are four possible explanations: *i*) wages, measured at 2012 levels, reached the lowest levels of inequality in the post-convertibility era, which simply leads one to recognize that inequality in the interregnum is moderate. This has been demonstrated by a variety of empirical evidence (Piselli, 2018; Trujillo-Salazar, 2019; among others); *ii*) in the first decade of this century there was an important process of formalizing labor and a revitalization of collective bargaining (Alejo and Casanova, 2016; Gómez, 2020; Trujillo-Salazar, 2019), with a particularly important impact on the industry which had significant effects on wage standardization; *iii*) the greater variation in productivity and innovation intensity due to permanent inequalities in industrial sectors due to heterogeneous conditions (Porta *et al.*, 2015). Between 2003 and 2012, wage dispersion shrank while productivity dispersion grew (Barrera Insua and Fernández Massi, 2017); *iv*) measuring the average wage per company entails standardization, which translates into significantly lower inequality rates between companies than between individuals.

Some limitations of the analysis should be noted. First, the sample unit prevents any study of *intra-company* wage distribution. One alternative to explore is the wage inequality between qualifications and job hierarchies. Second, the structure of the data makes a long-term analysis difficult, which would allow for employing other methodologies or hypotheses on peripheral economies. Finally, the Neo-Schumpeterian approach highlights the endogeneity in the innovation-productivity-wage connection. Given the complexity inherent in these interconnected relationships, we have not identified an alternative that can address it.

APPENDIX

Table A1. Wage equation at company level.

Quantile regression. Alternative model without productivity. Argentinean industry (2010-2012)⁽¹⁾

	(p10)	(p25)	(p50)	(p75)	(p90)
Innovation spending ^{(2) (3)}	0.030*** (0.008)	0.033*** (0.008)	0.042*** (0.007)	0.038*** (0.009)	0.039*** (0.009)
Exporter	0.084*** (0.030)	0.085*** (0.023)	0.076*** (0.022)	0.052** (0.023)	0.058* (0.035)
Foreign capital	0.177*** (0.064)	0.190*** (0.041)	0.213*** (0.039)	0.199*** (0.047)	0.243*** (0.065)
Median	0.129*** (0.033)	0.101*** (0.028)	0.112*** (0.020)	0.115*** (0.028)	0.175*** (0.038)
Large	0.242*** (0.042)	0.249*** (0.033)	0.257*** (0.029)	0.307*** (0.034)	0.313*** (0.048)
Age	0.125*** (0.032)	0.135*** (0.027)	0.115*** (0.024)	0.120*** (0.031)	0.102*** (0.038)
Constant ⁽⁴⁾	7.815*** (0.077)	7.972*** (0.081)	8.100*** (0.063)	8.323*** (0.071)	8.511*** (0.078)
Observations	1 771				

Notes: ⁽¹⁾ Alternative model according to base specifications, following Brambilla and Peñaloza Pacheco (2018); ⁽²⁾ Significance *** p<0.01; ** p<0.05; * p<0.1; ⁽³⁾ Standard errors estimated via Bootstrap (200 replicas); ⁽⁴⁾ Control variables according to branch activity were eliminated.

Source: created by the author with data from the ENDEI (MINCYT and MTEySS, 2015).

Table A2. Interquantile regression for wages at the company level. Alternative model without productivity control. Argentinean industry (2010-2012)⁽¹⁾

	(p10-p90)	(p25-p75)	(p10-p50)	(p50-p90)
Innovation Spending ⁽²⁾⁽³⁾	0.006 (0.014)	0.005 (0.009)	0.006 (0.010)	0.000 (0.010)
Exporter	-0.026 (0.039)	-0.030 (0.028)	-0.024 (0.031)	-0.002 (0.034)
Foreign capital	-0.034 (0.071)	-0.008 (0.044)	0.012 (0.053)	-0.046 (0.048)
Median	0.044 (0.047)	0.003 (0.030)	-0.010 (0.034)	0.054 (0.040)
Large	0.073 (0.057)	0.064* (0.039)	0.009 (0.041)	0.064 (0.043)
Age	-0.050 (0.003)	0.020 (0.002)	-0.031 (0.002)	-0.019 (0.002)
Constant ⁽⁴⁾	0.298 (0.306)	0.203 (0.220)	0.005 (0.225)	0.293 (0.228)
Observations	1 771			

Notes: ⁽¹⁾ Alternative model according to base specifications, following Brambilla and Peñaloza Pacheco (2018); ⁽²⁾ Significance *** p<0.01; ** p<0.05; * p<0.1; ⁽³⁾ Standard errors estimated via Bootstrap (200 replicas); ⁽⁴⁾ Control variables according to branch activity were eliminated.

Source: created by the author using data from the ENDEI (MINCYT and MTEySS, 2015).

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² TL note: Acronym from the original Spanish, *Encuesta Nacional de Dinámica del Empleo e Innovación*.

³ TL note: Ministry of Science, Technology and Productive Innovation and Ministry of Labor, Employment and Social Security.

⁴ Efforts in Argentina have a high correlation with innovation results. According to data from the ENDEI, 94% of firms which carried out efforts to innovate saw some results.

⁵ The authors discuss the "missing link" between innovation and distribution and propose a dynamic analysis of productivity-driven wages and benefits.

⁶ TL note: translated from the original Spanish.

⁷ Three reasons provide an explanation: *i*) adverse selection in labor demand or training costs for specifically qualified workers; *ii*) costs related to supervising/monitoring employees; *iii*) better remuneration creating a moral incentive.

⁸ From the original Spanish: *Sistema Integrado Previsional Argentino*.

⁹ I explored the possible alternative of adding the value of 1 to the spending variable (given that $\ln(1)=0$). This alternative did not provide satisfactory results.

¹⁰ Días Bahía and Arbache (2005) propose a similar equation, with the sum of variables for each worker and its being combined with variables at the company level.

¹¹ Monetary variables were deflated with the producer price index (INDEC) to two CIIU codes and four in the case of some food sectors.

¹² TL note: CIIU normally refers to ISIC codes but the numbering in Argentina is different.

¹³ This method applies a regression to the difference between two wage quantiles. If the coefficient is significant, it implies an increasing or decreasing correlation in the interval, depending on its sign.

¹⁴ The methodology requires identifying whether the data is heteroscedastic. With the Breusch-Pagan (1979) and Cook-Weisberg (1983) tests, it was possible to reject the constant variance hypothesis.

¹⁵ For a discussion of the use of IV in different contexts, see Goldthorpe (2001), Deaton (2009) and Ravallion (2020).

¹⁶ Given that the sample only includes companies which have at least 10 employees registered on their payroll, it is possible that the labor-intensive sector is underrepresented, especially when it comes to the field of textiles.

¹⁷ This is not the case in all its branches. Ludmer (2019) highlights in Argentina the innovation capabilities present in the clothing production chain, especially at the design stage.

¹⁸ In the logarithmic equation, wage premiums for categorical or discrete variables follow the rule of $[(e^{bi} - 1) * 100]$ with bi representing the coefficients in tables.

¹⁹ The exception is the premium in large companies, which increases slightly in the p25-p76 range.

²⁰ The only exception is the export premiums for the 90th percentile, with $p < 0.1$.

²¹ The tests show differences only between KNO-INT and KNR-INT sectors up to the 75th percentiles. There are no gaps between KNO-INT and L-INT or between KNR-INT and L-INT.

²² By only incorporating innovative companies, there can be a strong bias towards greater techno-productive performance due to a relatively greater number of "upstream" actors.