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HUMAN CAPITAL AND ITS CONTRIBUTION TO SALES GROWTH IN ECUADORIAN METALWORKING COMPANIES: PANEL DATA ANALYSIS

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ABSTRACT

Investment in education and training is a form of capital that increases productivity and long-term economic performance. Therefore, human capital as a set of skills, knowledge, and abilities creates economic benefits for the firms. The main objective of this study is to evaluate the characteristics of human capital and its relationship with the sales of firms in the metal–mechanical sector in Ecuador. The data for this research were taken from the Encuesta de Estructura Empresarial 'ENESEM,' using descriptive statistics and an econometric model with panel data with fixed and random effects, testing the most appropriate model of analysis by means of the Hausman Test. The main results obtained with robust model allowed to determine that the variables 'total directors and managers' and 'total science and engineering technicians' show a significant impact on sales in the sector studied. The findings of the study highlight the importance of public policy in supporting specialized human talent in the industry under investigation and in other sectors in Ecuador.

KEYWORDS: Education, Qualification, Innovation, Research and Development, Industrial Organization.

1. INTRODUCTION

Continuous investment in education and training results in improvements in the productive process, emergence of new enterprises, and economic growth of a region (Alvarado et al., 2019). Human capital accounts for 10–30% of per capita income across countries (Ríos Martha et al., 2019). Despite the importance of human capital, this factor has not grown in Latin America in recent years and has shown stagnation (Lasio Virginia et al., 2020). Compared to the rest of the world, some Latin American countries are experiencing a slower pace of educational transformation (Banco de Desarrollo de América Latina & el Caribe, 2018). Approximately 80% of the income gap between Latin America and the United States is attributable to low human capital (RED, 2018).

Innovation is the main source of competitive advantage and engine of economic change (Schumpeter, 1947). SMEs achieve greater utility and higher returns when adopting innovation as a business strategy (Mendoza, 2021). In addition, they have a positive and significant impact on their innovation activities when they work collaboratively with different suppliers and organizations (Grilli et al., 2023). Despite this, micro and small enterprises, owing to their resources and operating processes, have greater difficulties in introducing new ideas, technologies, and products into the market (Estanislao et al., 2022).

Currently, studies on human capital in small and medium-sized enterprises find that 41.6% of SMEs in Mexico City do not carry out training activities, and by not promoting improvements in human capital, they are at a disadvantage in terms of both innovation and productivity (Camarena & Saavedra, 2018). In the United States, studies show that workers trained in science, technology, engineering and mathematics (STEM) fields are more profitable for companies than unskilled human capital because they have R&D skills (Robles et al., 2019). Narula (2004), in its study on R&D collaboration in SMEs, concluded that small and medium-sized enterprises in developing countries lack the human resources to engage in research and development (R&D) activities, which reduces the chances of business growth and higher total profits.

The development of new enterprises is a fundamental pillar of economic growth in each country (Schumpeter, 1934). Among the factors of development, people are defined as the most valuable assets for achieving development (Ramírez Torres, 2022). (1960)(1964)Investment in human capital is essential for increasing productivity, as it enhances workers' skills, competencies, and knowledge, which directly impact the efficiency of the productive system. Becker (1964), through his human capital theory, argued that education, training, and health are key forms of investment that raise individuals' productive capacity. Complementarily, Schultz (1960) emphasized that sustained economic growth in modern economies cannot be understood without considering improvements in the quality of human resources, highlighting that human capital is as vital as physical capital for development. In this context, the accumulation of capabilities through investments in education and health not only strengthens individual productivity but also fosters innovation, competitiveness, and overall economic progress.

In this regard, the working hypothesis is: Higher levels of human capital—measured through directors and managers, scientific and intellectual professionals, technicians, science, and engineering—are positively and significantly associated with increased sales performance of firms in the metal–mechanical sector in Ecuador.

The relationship between skilled human capital and entrepreneurship development has increased in recent years and some researchs are focused in this field , (Ahsan & Haque, 2017; Alvarado et al., 2019; Lenihan et al., 2019).Human capital is not the only determinant of new firms' development. There are other elements, such as technological and intangible capital . (Alakbarov et al., 2023; Vergara et al., 2021).

In Ecuador, human capital is not given sufficient importance or recognition in the economic development of a company (Llerena, 2023). Many of the small and medium-sized enterprises in the country have been in existence for no more than six months. This is because businesses are born out of necessity rather than knowledge (RED, 2022). By investing in training and skills development programs, companies can help reduce the skills gap and facilitate workers' access to higher-quality jobs (Coba Gabriela, 2021).

Despite the importance of human capital in metal-mechanic sector ventures, Ecuador lacks specific research that directly addresses this relationship. Most studies have focused on other aspects, leaving a knowledge gap on the impact of human capital on sales and new venture development. Based on the above, this study assesses the characteristics of human capital and its relationship with the sales of firms in Ecuador's metal mechanics sector.

This paper is structured as follows:, section two section describes the methodology and data sources;

section three presents the discussion and results; and finally, the main conclusions of the study are presented.

2. METHODOLOGY

2.1. Data and Sample

This work is quantitative and explanatory in scope, considering data from 222590 companies surveyed in the ENESEM business structure survey for the period 2016-2021, published by the Ecuadorian Institute of Statistics and Census of Ecuador (INEC). A sample of 446 small and medium-sized enterprises in the metal-mechanic sector in Ecuador was selected from this group of companies and **classified into five ISIC codes as follows**

Table 1: Classification of Metal-Mechanical Companies.

Code	Industry
C24	Base metal manufacturing
C25	Manufacture of fabricated metal products, except machinery and equipment
C28	Manufacture of machinery and equipment NCP
C29	Manufacture of vehicles, railcars, trailers and semi-trailers.
C30	Manufacture of other transport equipment.
Note. National classification of economic activities ISIC 4.0	

2.2. Variables and Measures

The variables are selected from a set of companies and industrial activities.

a) Dependent Variable.

- **Sales** corresponds to the sales of companies in US dollars.

b) Independent Variables:

- **Directors and Managers** The number of workers in executive positions reported by companies.
- **Scientific and Intellectual Professionals** The total number of scientists and intellectuals reported by the organization. Includes workers with PhD degrees who are employed by the company.
- **Technicians, Science, and Engineering** The total number of people reported by the company as belonging to technical and scientific areas. Includes workers who hold technical, technological, or engineering degrees and are employed by the company.
- **No Qualified Workers** without professional training or academic qualifications.

These variables were treated and analyzed using descriptive statistics. Econometric estimations were subsequently applied. Owing to the characteristics of the data and the availability of information, this study considers the use of panel data as a method to estimate the causality between the study variables (Alberto and Nieto, 2012; Pao and Tsai, 2011; Younsi and Nafla, 2019). **The panel for this study considers unbalanced panels and can be represented as follows**

$$Ti \neq T \forall i \quad (1)$$

For the present study, the model equation was constructed as follows:

$$Y\_it=\beta\_0+\beta\_1 X\_1it+\beta\_2 X\_2it+\beta\_3 X\_3it+\beta\_4 X\_4it+\alpha\_i+\in\_it \quad (2)$$

Where

I = Number of companies surveyed.

t = Time period (2016-2021).

Y_it = Variable sales for a single unit (i) in time period (t).

β_0 = common intercept for all units.

β_1 X_1it+β_2…= Human capital characteristics for individual unit (i) in time period (t)

α_i = fixed or random effects specific to each individual unit.

∈_it = Term of mistake.

Estimates were made for the fixed- and random-effects panels. To decide the most appropriate estimation, the Hausman test was used, which compares the β obtained and identifies whether the differences between them are significant or not. Therefore, if Prob>chi2 is greater than 0.05, a random estimator should be used. Otherwise, if Prob<chi2 is less than 0.05, the fixed-effects estimator is used (Labra & Torrecillas, 2016).

3. RESULTS

This section presents the results of applying the methodology described in the previous section. The information shows that there are 1010 small and medium-sized enterprises in the metal–mechanics sector. They were distributed as shown in Table 2.

Table 2: Companies Based on Economic Activities.

Main activity	Number of companies	%age	Cumulative percentage
Base metal manufacturing	234	23.1	23.1
Manufacture of fabricated metal products, except machinery and equipment.	369	36.6	59.7
Manufacture of machinery and equipment n.e.c.	40	4.0	63.7
Manufacture of motor vehicles, trailers and semi-trailers	350	34,6	98.3
Manufacture of other transport equipment	17	1.7	100.0

Total	1010	100.0	

Once the panel was declared, it was identified as an unbalanced panel for six years and between 93 and 95 companies. The descriptive statistics of the variables are shown in Table 3.

Table 3: Description of Variables.

Variable		Mean	Std. Dev.	Min	Max	Observations
Sales	overall	2485638	1463432	0	4955448	N = 96
	between		1393168	0	4927798	n = 68
	within		652602.9	660124.1	4311152	T-bar = 1.41176
Directors and managers	overall	1.810.526	1.401.327	0	6	N = 95
	between		1.399.775	0	6	n = 67
	within		0.512261	0.3105263	3.810.526	T-bar = 1.41791
Scientific and Intellectual	overall	4.172.043	4.661.647	0	22	N = 93
	between		3.609.103	0	16.5	n = 68
	within		2.473.409	-7.827.957	1.350.538	T-bar = 1.36765
Technicians and engineers	overall	4.177.778	6.145.388	0	37	N = 90
	between		6.349.183	0	37	n = 65
	within		2.465.872	-5.322.222	1.367.778	T-bar = 1.38462
No qualified	overall	5.488.889	1.199.274	0	65	N = 90
	between		1.316.722	0	65	n = 65
	within		2.057.916	-1.511.111	1.248.889	T-bar = 1.38462

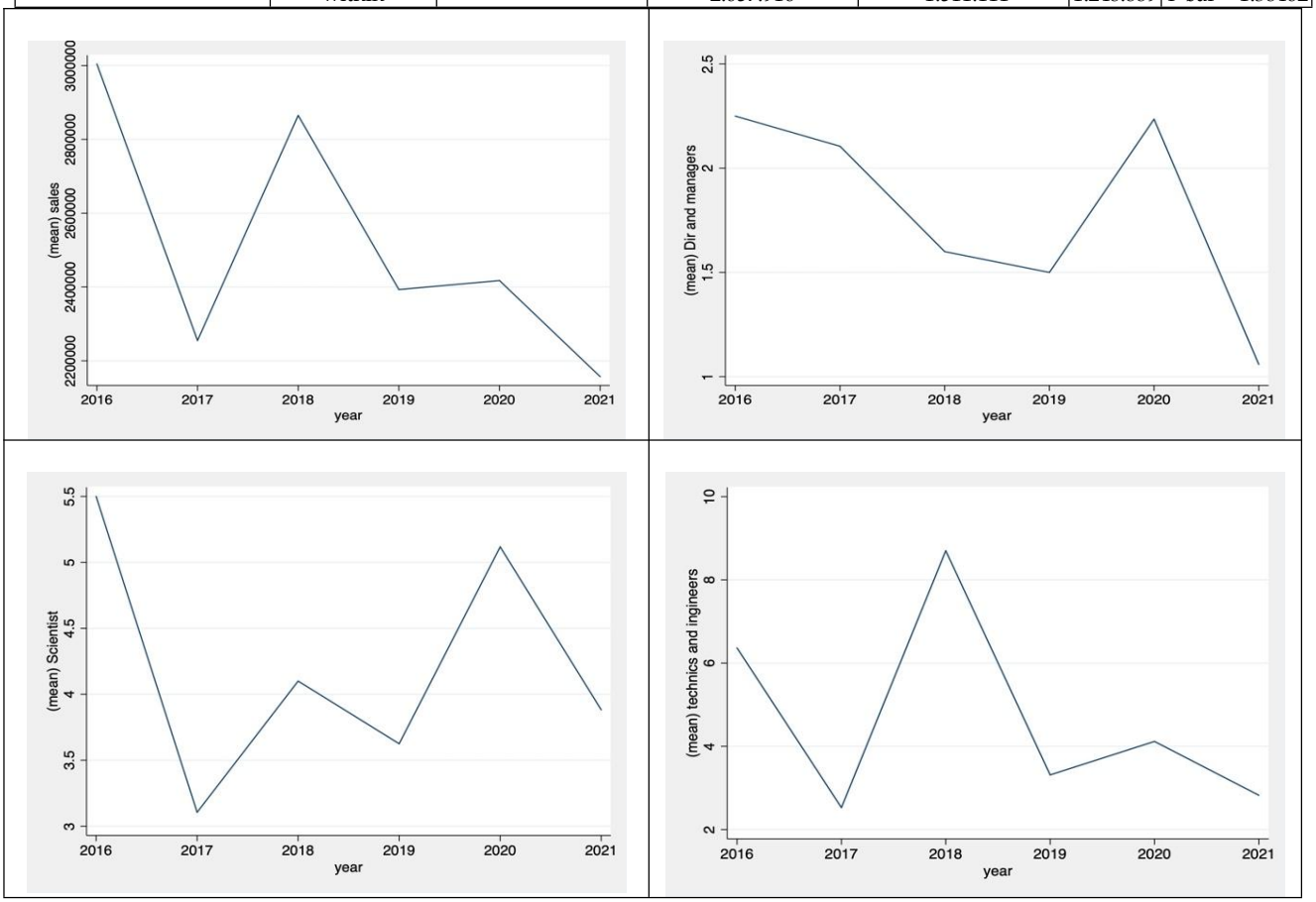

Figure 1: Trends Variables Over Time.

Figure 1 shows four graphs on the trend over time of sales and human capital variables. It is important to note that in April 2016, Ecuador was affected by the Manta earthquake, which contracted the economy and whose effects were seen in 2017, explaining the drop in sales and the reduction in the hiring of scientists and technicians.

During 2019, the economy contracted again due to political instability affecting the country. In 2020, COVID-19 had a strong impact, affecting companies and workers. Company directors and managers were the least affected during the economic cycles; in 2020, they show a positive trend due to the creation of new management departments in some

companies.

The estimations of econometric panel data models with fixed and random effects are presented below.

Table 4: Fixed Effects Model.

Fixed-effects (within) regression	Number of obs = 85
Group variable: id	Number of groups = 64
R-sq:	Obs per group:
within = 0.2961	min = 1
between = 0.0067	avg = 1.3
overall = 0.0007	max = 3
Corr (u_i, Xb) = -0.6586	F (4,17) = 1.79
	Prob > F = 0.1778

Sales	**Coef.**	**Std. Err.**	**t**	**P>|t|**	**[95% Conf.**	**Interval]**
Directors and Managers	763058.7	401614	1.9	0.08	-84272.99	1610390
Scientists	54370.13	73515.8	0.74	0.47	-100734.7	209475
Technicians and Engineers	80225.36	64225.1	1.25	0.229	-55277.83	215729
No qualified	-12972.07	75383.6	-0.2	0.865	-172017.5	146073
_cons	565229.5	1016299	0.56	0.59	-1578974	2709433
sigma_u	1969725.5					
sigma_e	1139023.3					
Rho	0.7494059					
F test that all u_i=0:	F(63, 17)=	1.92	Prob	> F=	0.0678	

Table 5: Random Effects Model.

Random-effects GLS regression	Number of obs = 85
Group variable: id	Number of groups = 64
R-sq:	Obs per group: 85
within = 0.0498	min = 1
between = 0.0302	avg = 1.3
overall = 0.0268	max = 3
	Wald chi2(4) = 2.41
Corr(u_i, X) = 0 (assumed)	Prob > chi2 = 0.6616

Sales	**Coef.**	**Std. Err.**	**z**	**P>|z|**	**[95% Conf.**	**Interval**
Directors and Managers	30009.16	124111.8	0.24	0.81	-213245.4	273264
Scientists	18518.5	35519.44	0.52	0.602	-51098.32	88135.3
Technicians and Engineers	22565.66	27095.35	0.83	0.405	-30540.25	75671.6
No qualified	-18963.43	14526.64	-1.3	0.192	-47435.11	9508.26
_cons	2258888	313516.4	7.21		1644407	2873369
sigma_u	882988.11					
sigma_e	1139023.3					
Rho	0.3753742					

Table 6: Robust Fixed Effects Model.

Fixed-effects (within) regression	Number of obs = 85
Group variable: id	Number of groups = 64
R-sq:	Obs per group:
within = 0.2961	min = 1
between = 0.0067	avg = 1.3
overall = 0.0007	max = 3
corr(u_i, Xb) = -0.6586	F(4,63) = 7.12
	Prob > F = 0.0001

Sales	**Coef.**	**Robust Std. Err.**	**T**	**P>|t|**	**[95% Conf.**	**Interval**
Directors and Managers	763058.7	331422.1	2.3	0.03**	100764.5	1425353
Scientists	54370.13	55348.33	0.98	0.33	-56234.67	164975
Technicians and Engineers	80225.36	33655.06	2.38	0.02**	12971.08	147480
No qualified	-12972.07	53842.51	-0.2	0.81	-120567.8	94623.6
_cons	565229.5	780458.1	0.72	0.47	-994391.4	2124851
sigma_u	1969725.5					
sigma_e	1139023.3					

Rho	0.7494059	(fraction of variance due	to u_i)	

4. DISCUSSION

The largest share of business participation at the national level is in the manufacture of fabricated metal products, except for machinery and equipment (36.6%), followed by companies engaged in the manufacture of motor vehicles, trailers, and semi-trailers (34.6%). Between the two activities, they account for more than 70% of the economic activities analyzed (Table 2).

Table 3 provides important information on the composition of human talent in metal-mechanical enterprises. On average, there are two managers or directors, four scientists, four technicians, and five unskilled workers. In the case of the latter, there are companies with considerable peaks, with up to 65 cases of workers without formal qualifications.

The study is divided into 64 groups of 85 observations each, being a fixed effects model it is important to take into account the result of 'within=0.2961' which indicates the average change in the sales variable associated with a one unit change in the human capital characteristics variables, after controlling for fixed effects, this means that individual differences between firms are excluded and how they change over time is analyzed. The non-significant coefficients show that none of the human capital characteristics are significant in relation to the sales of SMEs in the metal-mechanical sector in Ecuador. Even so, the most closely related are directors and managers, together with science and engineering technicians. The overall significance of the study (F=0.1778) indicates that the independent variables together do not really explain companies'sales, which is why the individual analysis is important (Table 4).

Table 5 shows the results of the random effects model, (R-sq: 0.0268) and (Prob > chi2 = 0.6616), indicating in general terms that there is little correlation between the independent variables versus the dependent variable, the result of 'Corr(u_i, X = 0 (assumed)' without the need to issue a value that there is no correlation between the independent and dependent variables. 6616) indicates, in a general way, the low correlation between the independent variables versus the dependent variable, the result of 'Corr(u_i, X) = 0 (assumed)' without the need to issue a value that there is no correlation between the random effects and the independent variables. It is important to mention that these results evaluate the overall significance of the model and do not provide detailed information on the individual significance of the variables. The results of P>|z| show that none of the independent variables is related to the sales of SMEs in the studied sector.

The Hausman test (0.0131) was applied to identify the most representative methodology between fixed and random effects. In this sense, the most relevant and consistent panel data econometric model to assess the incidence of human capital characteristics on sales in the metal–mechanical sector in Ecuador is the fixed effects method. Subsequently, the Wooldridge test for autocorrelation (0.8231) and the Wald test for heteroscedasticity (0.000) were performed. In the first case, there was no autocorrelation, but the effects model was not homoscedastic. To correct for this situation, the fixed effects model was re-estimated in a robust manner, and the results are shown in Table 5.

The estimation in Table 6 addresses the problem of heteroscedasticity. The model was valid in explaining the dependent variable (F=0.0001). The fit of the fixed-effects model improved (R-sq within = 0.2961). In this model, there is a positive significance between the variables Directors and Managers (0.03) and Science and Engineering Technicians (0.02). This result affirms that the inclusion of qualified technicians and managers has a positive impact on the sales of organizations in the metal-mechanic industry, which leads to an increase in sales. These results confirm those of previous studies that highlight the importance of having skilled workers and top management in organizations (Amadu & Danquah, 2019; Cortes & Herrmann, 2021; Damanpour & Schneider, 2009; Kiss et al., 2022; Teslenko et al., 2021). On the other hand, in the sample of companies analyzed, the non-significant results indicate that the inclusion of 'Professionals, scientists and intellectuals' and 'Unskilled workers' have no causal relationship on the sales of the organizations, i.e. they have no effect on sales, the reasons may be linked to the small number of scientists working within the companies, which does not allow capturing the results of their inclusion in the data. It is important to note that 90% of companies in Ecuador are SMEs, which do not have R&D departments, budgets dedicated to research, or partnerships with universities or organizations for the development of new products. Therefore, hiring academic researchers with PhD degrees is not a priority. However, in the case of unskilled workers, as they are practically constant within companies, it is impossible to measure them in real terms.

6. CONCLUSIONS

This study provides some relevant conclusions. The application of panel data and the selection of fixed effects estimation in the selected metal-mechanical companies allowed us to identify the impact of the variables (managers and technicians) within the companies and how they change over time. The change in these variables within the companies has a positive effect on the sales of the companies analyzed. According to the literature, directors and managers are individuals with specific and general competencies who steer businesses to potential and sustained success by acting as company leaders (Cortes & Herrmann, 2021; Kiss et al., 2022; Marín Quero, 2020). For this reason, it is essential that each manager has the specific skills and knowledge needed to address day-to-day challenges and lead the organization to achieve its goals.

The number of science and engineering technicians is very important, as their theoretical and practical knowledge translates into effective project implementation, operational problem-solving, machinery maintenance, and process improvement (Moreira, 2022; Teslenko et al., 2021). The ability of these technicians to adapt to technological advances and their participation in R&D can directly contribute to the competitiveness and progress of SMEs in this sector. These two variables, described as the characteristics of human capital, are key factors in financial performance and success.

The evolution of the metal–mechanics sector allowed information to be gathered before and after the recognition of human capital as a determining factor in business success. Previously, the focus was on purely technical and production aspects, underestimating the importance of human capital in the business performance equation (Cortes & Herrmann, 2021; Teslenko et al., 2021). However, the evolution over time of sales and human capital variables shows that there are external factors (shocks) that affected the hiring of skilled workers and companies' sales results. Two shocks in particular: the Manta earthquake in 2016 and COVID-19.

Sales have a direct relationship with the human capital characteristics studied, which means that SMEs in Ecuador should focus on developing strategies to strengthen their employees' training and competencies. This could include continuous training programs and incentives for acquiring specialized knowledge.

As a recommendation to increase the hiring of technical staff in metalworking companies, it is possible to develop a STEM scholarship program in order to increase the supply of specialized workers. It would also be interesting to develop an incentive program for companies that hire young people with specialized training, or for those companies that develop specialized R&D spaces.

The main limitations of the analysis of human capital in Ecuador's metal-mechanic sector enterprises were limited information on human capital, limited entrepreneurial base, and incomplete data.

As a future line of research, it is possible to compare human capital between different sectors or in the same sectors in different Latin American countries. In this way, it contributes to the construction of scientific information for Latin America.The results emphasize the importance of implementing regulations to control market concentration and avoid the formation of monopolies and oligopolies.

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