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Personnel expenses and productivity change in Peruvian stock mining companies

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C H R O N I C L E

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A B S T R A C T

More than half of Peruvian exportations are made by mining companies, which also are a traditional employment source that attracts thousands of Peruvian workers because of their high economic benefits. This paper aims to find whether there is a relationship between personnel expenses change and productivity change in Peruvian stock mining companies from 2011 to 2018. Malmquist index and multiple regression were used to analyze data of 17 Peruvian mining companies both metallic and nonmetallic ones. It was found that there was a negative relationship between personnel expenses change and productivity change in metallic mining companies while there was a positive one for nonmetallic companies.

1. Introduction

Peru is a country located in a privileged zone in South America where exists plenty of natural resources both renewable and nonrenewable. Among the nonrenewable resources stand out the mining resources that started being exploited by ancient Peruvians 19, 000 years ago from these days (Petersen & Brooks, 2010). When primitive inhabitants developed sophisticated ways of social organization, mining exploitation was an important activity for them. The first known civilization in Perú, called Chavín, made objects mainly of "gold, silver copper and bronze and with minor use of platinum, tin, lead and mercury" (Petersen & Brooks, 2010, p.20). After them, following pre-Hispanic civilizations had the mining exploitation along with agriculture, stone carving and animal taming as their principal economic activities (Tello in Lumbreras et al., 2008). Later, the Spanish conquer considered the mining activity as a pillar where the colonial economy was established (Contreras et al., 2009). When Peru reached its independence from the Spanish crown, metallic mining exploitation [especially the silver one] continued to be "the nation main source of wealth" (Morales & Ugalde in Cosamalón et al., 2011, p.164). Moreover, in this Republican stage, nonmetallic mining exploitation [guano and saltpeter] exportations were valued in more than 6 times the value of the principal metallic exportation [silver] (Cosamalón et al., 2011). Nowadays, Peru is the global major producer of gold, zinc, lead and tin and one of the preeminent producers of copper, silver, and zinc in the world; besides, the mining sector contributes about 10% of the Peruvian Gross National Product (Ministerio de Energia y Minas, 2018). Furthermore, the exportations of the country are composed in 60% of mining resources (Instituto Peruano de Economia, 2017). Consequently, mining companies are considered as essential Peruvian economics drivers.

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Like every industry, mining companies´ main goal is to get as much profit as possible. One way to get higher levels of firm profitability is by stimulating firm productivity. For instance, Muminović and Barać (2015) revealed that increasing productivity affected profitability positively in the dairy processing industry of Croatia. Also, Margaretha and Supartika (2016) demonstrated that in the Indonesian stock market companies, there was a positive relationship between productivity and profitability. Besides, Krekel et al. (2019) found a significant positive correlation between workers´ satisfaction and workers´ productivity, and a positive correlation of wellbeing at work with business profitability. Additionally, the New Economics Foundation (2014) found that, alongside other components, fair payments in the workplace contribute to workers´ wellbeing. Payments, which are contained in a section called personal expenses for countable purposes, are an important issue for workers since they "reflect the value of their work among the workers themselves, their families and communities" (Gunawan & Amalia, 2015, p.350). Also, the higher the earnt salary is, the higher of workers´ and their families´ living standard is (Chong & Khong, 2018). For industries, personnel expenses are important since they "reflect the industry´s efforts to defend human resources and to have high loyalty and commitment to the industry" (Gunawan & Amalia, 2015, p.350).

Mining companies create wealth in the zone of operations through direct and indirect employment alongside their investments in machinery, supplies, and infrastructure (International Council on Mining & Metals & Oxford Policy Management, 2014). Mining companies´ personnel expenses are huge since they take on count the risks of the mining job and the isolation of the workplace (Mori Mojalott & Alarcón-Novoa, 2017). Although those hard work conditions, new employees´ numbers continue growing because of the attractiveness of the payment (Cámara de Comercio de Lima, 2019). However, through the years these expenses changed and the mining companies' productivity levels. So, is there any link between the changes in personnel expenses and the mining companies' productivity change? Therefore, the main objective of the current research is to know if the personnel expenses changes had effects on the productivity changes of the mining companies in Peru during the period 2011-2018.

Studies about wages effects on productivity have been carried in other parts of the world. Paul (2014) explored the wage rate and productivity in Indian manufacturing companies. To get the productivity data, the researcher found and analyzed data from 57 industries from 1993-1994 to 2007-2008. After correlating both variables, the author found that there was a positive relationship between wage rate and productivity among Indian manufacturing workers. The researcher pointed out that there were other factors like archaic labor law, ineffective enforcement systems, and poor firm training programs that may weak productivity.

Mohamud et al. (2017) analyzed the effect of motivation factors on the workers´ performance in a company in Mogadishu. The motivation factors were monetary rewards, job enrichment [job quality], and training programs. Next, the researchers applied a correlation and regression analysis in order to explore how much the independent variables [motivators] explain the dependent variable. Both correlation and regression analysis found that the major motivator was the monetary reward along with job enrichment while the weakest motivator was the training programs. Therefore, researchers concluded that wages had a positive effect on worker performance and this one in firm productivity. Researchers remarked that for workers, good salaries are perceived as good recognition; hence, companies must establish an effective performance measurement system to reward workers according to their performance.

Umar (2014) analyzed the consequences of wages, work motivation, and job satisfaction on workers' performance in an Indonesian city manufacturing industry. To get causal relationships, structural equation modeling technique was used. The results showed that there was a significant effect of wages on worker performance, work motivation, and job satisfaction. Also, about 40% of the workers did agree that their main motivations to work in those manufacturing industries were the payment and benefits. Therefore, at the workers' glance, a good payment would increase their feelings of pleasure at their job, thus growing their quality, quantity, and effectiveness of the job.

Okeke et al. (2017) explored the impact of effective wages and salary management on civil service productivity in a Nigerian city. By using chi-square and t-test analysis researchers found that there was a significant relationship between minimum wage politics in Nigerian civil service workers and their productivity. Tongo in Okeke et al. (2017) suggested that low productivity and inefficiency of public workers could be erased if workers get better salary conditions. Also, researchers revealed that even though it seems that wages had a strong correlation with public worker's productivity, cooperation with the government by putting common objectives could also improve productivity levels. Finally, investigators suggest that poor salary management would increase low levels of productivity and high corruption levels.

Gunawan and Amalia (2015) researched the impact of extrinsic motivation [i.e. wages] and intrinsic motivation [i.e. quality of work life] on workers of a manufacturing company in Asia. Thus, by interviewing and analyzing manufacturing data they found that extrinsic motivation influenced only in 16% to workers to be more productive.

In consequence, research about wage effects on productivity in different productive sectors was carried showing miscellaneous results. However, little research was made to measure personnel expenses in the mining companies or any other extractive sector around the world. In Peru, no research was found even though the mining sector is one of the most important economic activities in the country. This paper aims to find whether there is a relationship between personnel expenses change and productivity change for Peruvian mining stock companies.

2. Material and Methods

2.1 Productivity change

Data Envelopment Analysis (DEA) is a non-parametric mathematical approach that uses linear programming concepts for estimating productive indexes to any Decision Management Unit (Avkiran, 2006). Although DEA was initially conceived as an efficiency index tool (Farrel, 1957); progressive investigations have made possible that DEA could be used as a productivity index like the Malmquist Index also. Malmquist index was proposed by Caves, Christiensen and Diewert in 1982, who improved former Malmquist´s ratios distance function work in 1953 (Aghayi et al., 2019), and prior Shephard´s theoretical indexes distance functions (Mohammadi & Ranaei, 2011). Posteriorly, Fare, Grosskopf, Lindgren, and Roos decomposed productivity evolution with Farrel´s efficiency measures (Delfín & Navarro, 2015). Therefore, the Malmquist index was linked with DEA. Malmquist index evaluates the product of efficiency – catching up - and frontier changes or technology change (Forsund, 2002), as follows:

$$M(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)} \left[\frac{D^t(x^{t+1}, y^{t+1})}{D^{t+1}(x^{t+1}, y^{t+1})} \frac{D^t(x^t, y^t)}{D^{t+1}(x^t, y^t)}\right]^{1/2} \quad (1)$$

where:

d^t: t period distance
d^{t+1}: t+1 period distance
x^t: t period input vector
x^{t+1}: t+1 period input vector
y^t: t period output vector
y^{t+1}: t+1 period output vector
Δ*CE: Technical efficiency change:* $\frac{D^{t+1}(x^{t+1}, y^{t+1})}{D^t(x^t, y^t)}$
Δ*CT: Technological progress change:* $\left[\frac{D^t(x^{t+1}, y^{t+1})}{D^{t+1}(x^{t+1}, y^{t+1})} \frac{D^t(x^t, y^t)}{D^{t+1}(x^t, y^t)}\right]^{1/2}$

The first component calculates relative efficiency evolution from the first-period *t* to the following one *t+1*, while the second one is measured by the geometrical mean of the frontier change of the *t* and *t+1* period (Vargas et al., 2016). In consequence, when the Malmquist index product -hereinafter M_o- result >1 indicates productivity gain; $M_o < 1$ means productivity loss, and $M_o = 1$ denotes no productivity change (Mohammadi & Ranaei, 2011). Analogously, the interpretation of those scores is similar for each Malmquist component. Later, Fare, Grosskopf, Norris y Zhang proposed a major decomposition of the previous ratio by including pure efficiency change and efficiency scale change while maintaining technological changes (Zofio, 2007)) as follows:

$$M(x^t, y^t, x^{t+1}, y^{t+1}) = \frac{D^{t+1}_{BCC}(x^{t+1}, y^{t+1})}{D^t_{BCC}(x^t, y^t)} \left(\frac{D^{t+1}_{CCR}(x^{t+1}, y^{t+1})}{D^{t+1}_{BCC}(x^{t+1}, y^{t+1})} \frac{D^t_{BCC}(x^t, y^t)}{D^t_{CCR}(x^t, y^t)}\right) \left[\frac{D^t_{CCR}(x^{t+1}, y^{t+1})}{D^{t+1}_{CCR}(x^{t+1}, y^{t+1})} \frac{D^t_{CCR}(x^t, y^t)}{D^{t+1}_{CCR}(x^t, y^t)}\right]^{1/2} \quad (2)$$

where:

$\Delta CP^{t;t+1}$*: Pure technical efficicency change:* $\frac{D^{t+1}_{BCC}(x^{t+1}, y^{t+1})}{D^t_{BCC}(x^t, y^t)}$
$\Delta CS^{t;t+1}$*: Efficiency scale change:* $\left(\frac{D^{t+1}_{CCR}(x^{t+1}, y^{t+1})}{D^{t+1}_{BCC}(x^{t+1}, y^{t+1})} \frac{D^t_{BCC}(x^t, y^t)}{D^t_{CCR}(x^t, y^t)}\right)$
$\Delta CT^{t;t+1}$*: Technological progress change:* $\left[\frac{D^t_{CCR}(x^{t+1}, y^{t+1})}{D^{t+1}_{CCR}(x^{t+1}, y^{t+1})} \frac{D^t_{CCR}(x^t, y^t)}{D^{t+1}_{CCR}(x^t, y^t)}\right]^{1/2}$

It is important to add that relative efficiency change score is taken from *Charnes, Cooper and Rhodes* efficiency amount [herein after*, CCR*] which evaluates the global efficiency of all *decision-making units* [hereinafter *DMU*] by comparing them with a *DMU* of reference or references (Jaime, 2016). On the other hand, the pure efficiency change score is taken from *Banker, Charnes and Cooper* efficiency amount [herein after *BCC*] which takes into consideration the different sizes of *DMU*; hence, *BCC* only compares a *DMU* with one of similar magnitude (Lai, 2013). Scale efficiency is a relative ratio between the long term efficiency [i.e. *CCR*] and the short term one [i.e. *BCC*] (Banker et al., 1984). This ratio shows if a *DMU* works in an optimal operation scale or in a shortened or oversized one (Bruno & Erbetta, 2013). Finally, technology change refers to the way companies produce their outputs using their inputs, a better technology enables obtaining more outputs with the same inputs (Çalışkan, 2015).

2.2 Personnel expenses change

Kumar (2017) stated that fair payments were an important component for attracting and retaining human talent. Wages and salaries are part of what is called extrinsic motivators which are the force to make something for an outcome (Ryan & Deci, 2000). However, extrinsic motivators do not act solely in human talent performance. Also, intrinsic motivators enable people to do something but because of the enjoyment of the task (Hennessey et al., 2015). Therefore, in a work environment employees are motivated for a combination of both of them (Singh, 2016). Also, "every employee has different ways to become motivated" (Ganta, 2014, p.223). In consequence, it is important for a company to know what motivates its employees and make an accurate combination for retaining and increasing employee's motivation (Turner, 2017). Incomes for both business and workers' pay taxes that are gathered by "Superintendencia Nacional de Administración Tributaria y Aduanas" –hereinafter SUNAT - which is the regulatory agency for taxes in Perú (Decreto Legislativo Nº 501, 1988). Also, expenditures made by the business have tributary and law effects (Contadores & Empresas, 2013). Thus, every business expense should be registered because of tributary effects; thus, omitting expenditure information may be considered as a tributary infraction or tax evasion which is a crime in Perú (Código Tributario, 2013). As a consequence of this, companies collect expenditures in human resources under the name "personnel expenses" or "gastos de personal" which includes salaries and other allowances made in favor of the employees (Contadores & Empresas, 2013). For research purposes, personnel expenses were divided into two variables which were called (a) administrative expenses and (b) operative expenses. In the administrative expenses' variable, payments like salaries, dividends, and legal benefits were added not only of administrative personnel but also for sales personnel and the directors allowance. In the operative expense variable, charges were added but only for personnel that was directly related to mining exploitation and exploration.

3. Materials and Methods

The current section will show the data recollection form as long as the analysis methodology of this paper. The first step of data collection was to search for companies that do mining activities. According to the Peruvian mining regulator agency, there were 8938 both people and companies that did mining activities in Peru in the research years (2011-2018) (Ministerio de Energia y Minas, 2020). Thus, the current research focused only on companies that were open societies and participated in the Peruvian stock market since its regulator [Sociedad de Mercados y Valores, hereinafter *SMV*] requests every stock company to have an open access policy regarding their financial reports (Ley 29720, 2011). However, as every open society mining company does not take part in the stock market, not all mining financial reports were openly published. Although that information limitation, mining companies that were analyzed in this research produce more than 70% of the principal Peruvian metallic minerals (Ministerio de Energia y Minas, 2019) and 90,6% of the non-metallic [cement] minerals which are highly concentrated in a few companies (Peru Construye, 2019). Thus, the effects of personnel expenses on productivity were analyzed in seventeen mining companies which fifteen were metallic and three nonmetallic ones during the years of 2011 to 2018 as showed in Table 1.

Table 1
Companies analyzed

Company Name	Subtype	Company short term
BUENAVENTURA	Metallic	BUENAV
PODEROSA	Metallic	PODER
SAN IGNACIO DE MOROCOCHA	Metallic	MOROCO
SANTA LUISA	Metallic	LUISA
MINSUR	Metallic	MINSUR
NEXA RESOURCES PERU	Metallic	NEXAPE
SHOUGANG HIERRO PERU	Metallic	SHP
CERRO VERDE	Metallic	CVERDE
CORONA	Metallic	MINCOR
EL BROCAL	Metallic	BROCAL
SOUTHERN PERU	Metallic	SCCO
VOLCAN	Metallic	VOLCA
UNIÓN ANDINA DE CEMENTOS	Nonmetallic	UNACEM
CEMENTOS PACASMAYO	Nonmetallic	CPACAS
YURA	Nonmetallic	YURA

The research main goal was to determine the impact of the personnel expenses' variation in mining companies' productivity change for the period from 2011 to 2018. For this reason, personnel expenses were divided into administrative and operative expenses in order to get a better analysis as Table 2 shows.

Table 2
Research variables

Independent	Dependent
Administrative personnel expenses variation	Productivity change
Operative personnel expenses variation	

In order to get productivity indexes for the current research, data was gathered and analyzed following Périco et al. (2017) methodological steps for carrying efficiency analysis since the Malmquist index is linked with *DEA* efficiency analysis. First of all, they propose to choose the elements that are needed for analysis. Elements that were chosen as inputs were fixed assets; operational expenses, and sales expenses while the ones for outputs were sales; earnings before interest, taxes, depreciation, and amortization [i.e. EBITDA] and net profit. After, Périco et al. (2017) recommend carrying a correlation test. Avkiran (2013) states that this analysis is for avoiding redundant elements for input/output that may decrease the discrimination power of *DEA* analysis. Even though he suggests that a high score may be considered from .9, he remarks researcher criteria for choosing what element to delete is important. Then, correlation analysis was carried for the three years and it suggested to erase fixed assets [high correlation with sales expenses, i.e. >.9] and EBITDA in the output elements [high correlation with sales, i.e. >0.9]. Consequently, final input elements were operational expenses and sales expenses while final output elements were sales and net profit as Table 3 presents.

Table 3
Elements proposed for the productivity analysis

Inputs	Outputs
Operational expenses	
Sales expenses	Sales
Personnel expenses	

Moreover, it is mandatory to choose what model orientation [i.e. output or input orientation] and return to scale [constant return to scale or variable return to scale] is suitable for the analysis. An input-oriented model´s main objective is to minimize inputs at a given output level while an output-oriented model aims to minimize outputs at a given input level (Aziz et al., 2013). Lai (2013) explains this point by asking the researcher whether it is possible in the real world to minimize inputs or maximize outputs. Since in the current research sector is more feasible to maximize outputs rather than minimizing inputs, output orientation on was chosen. On the other hand, the return to scale specification was not necessary since this research is focused on productivity rather than efficiency. Furthermore, researchers like Alemán et al. (2003), Avkiran (2006), Charles et al. (2011); Wang et al. (2016), Deza (2019) among others recommend verifying whether the variables accomplish with the isotonicity condition which means "the level of outputs is at least the same, and do not fall when inputs increase" (Wang et al., 2016, p.8). Therefore, correlation analysis was carried and showed that all variables had positive correlation coefficients proving the explanatory power of the variables in the model. After getting the Malmquist index scores, it was necessary to fix them by carrying logarithmic transformations in order to achieve normality distribution. After that, data were analyzed in order to get the Malmquist index scores with the software DEA solver by Springer and then compared with DEAP by Tim Coelli. For the independent variables data were obtained from financial reports stored in the *SMV* database. However, reports structure was not the same for all mining companies since some mining companies' reports totalize all personal expenses while others put them into components. Thus, it was necessary to find and sum those components [by consulting their notes] in order to get homogenous personnel expenses criteria for all mining companies. Also, there were mining companies in which financial reports were expressed in dollars while others were in the local currency in Perú [i.e. "soles"]; then, currency exchange conversation was necessary. According to the Peruvian policy (*Reglamento Del Decreto Legislativo N° 1264*, 2017), the last working day exchange rate is taken for currency conversion purposes, such exchange rate is published by the Peruvian bank regulator agency, which is called Sociedad de Banca y Seguros or *SBS*. Subsequently, variation rates of personnel expenses were obtained of each pair year. Due to market behaviors, it was also necessary to divide mining companies according to their production. Therefore, companies were classified into metallic and non-metallic mining companies. In this study, metallic producers are the ones who extract minerals such as gold, silver, copper among other metallic minerals while non-metallic producers in this study are mainly the cement producers. Since metallic production is mainly focused on satisfying developed and industrialized countries´ demand, companies are particularly susceptible to external market drivers such as commercial wars, international prices, external crises and others (PwC, 2019). On the other side, non-metallic mining companies' production is highly focused on satisfying the national market (Peru Construye, 2019); therefore, they are not so vulnerable to external drivers. When data of both dependent and independent variables were obtained, it was necessary to verify whether they have a normal distribution. For this purpose, the skewness/kurtosis normality distribution test was carried. Logarithmic transformation was applied when necessary in both variables in order to achieve normality distribution for further parametric analysis (Charpentier & Flachaire, 2014). Also, Johnson´s transformation was employed for getting normality distribution due to negative numbers [negative variations] (Aichouni et al., 2014). Along with normality tests, homoscedasticity test was also used both to make valid conclusions of the regression model and for lowering the probability of getting biased results (Yang et al., 2019). Next, multiple regression was applied for panel data. Both random and fixed effects regressions were carried and Hausman´s test was performed for choosing the accurate model (Bell et al., 2018). Finally, Pesaran´s test was executed in order to reassure that there was independence among the variables (Pesaran, 2004). All the statistical process was executed by using STATA software.

4. Results

In this part, results are shown and discussed.

4.1. Productivity analysis

Table 3
Malmquist Index and its components

DMU	Malmquist Index							Mean
	2011 - 2012	2012- 2013	2013- 2014	2014- 2015	2015- 2016	2016- 2017	2018- 2019	
BUENAV	0.9272	1.0425	0.8696	0.9200	1.2274	0.8268	0.8111	0.9464
PODER	1.0040	0.9276	0.9955	1.0687	1.0879	1.0336	0.9706	1.0125
MOROCO	1.3601	0.7713	1.0441	0.8823	1.8890	1.1961	0.5804	1.1033
LUISA	0.8224	0.8839	0.9923	0.9719	1.3713	1.3739	0.7970	1.0304
MINSUR	0.7276	0.9269	0.8482	0.8151	1.2220	0.9598	0.9366	0.9195
NEXAPE	0.8667	1.3122	0.9969	1.0783	0.9985	1.2345	0.8727	1.0514
SHP	0.7028	1.1069	0.8059	0.8211	1.0319	1.2408	0.8007	0.9300
CVERDE	1.0003	1.0514	0.8758	0.6803	1.2078	1.0124	0.9216	0.9642
MINCOR	0.6524	0.8240	1.1037	0.7969	1.0792	1.1732	1.0780	0.9582
BROCAL	1.0876	0.9115	1.1113	0.7251	1.0402	1.0578	1.0697	1.0004
SCCO	0.8102	1.1664	0.9551	0.8897	0.8681	1.6528	0.8824	1.0321
VOLCA	0.9199	1.5329	0.9641	0.6277	1.1211	0.7504	1.0060	0.9889
UNACEM	1.0068	1.0375	0.9409	1.0792	0.8983	1.0007	1.0116	0.9964
CPACAS	0.9933	1.0085	1.0165	1.0458	0.9344	0.9107	1.0392	0.9926
YURA	0.9370	0.9976	0.9931	0.9928	1.0119	0.9267	0.9899	0.9784
Mean	0.9212	1.0334	0.9675	0.8930	1.1326	1.0900	0.9178	0.9937
% growth	33.33	53.33	26.67	26.67	73.33	66.67	33.33	40.00
% constant	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
% decrease	66.67	46.67	73.33	73.33	26.67	33.33	66.67	60.00
Max	1.3601	1.5329	1.1113	1.0792	1.8890	1.6528	1.0780	1.1033
Min	0.6524	0.7713	0.8059	0.6277	0.8681	0.7504	0.5804	0.9195
SD	0.1691	0.1871	0.0855	0.1425	0.2411	0.2218	0.1279	0.0467

Table 3, shows that about 40% of mining companies' productivity index increased on average in the studied period while six out of ten decreased its productivity. The highest average Malmquist index score was reached by MOROCO, while the minimum productivity average score was reached by MINSUR. Furthermore, MOROCO, had the highest productivity scores in the periods 2011-2012 and 2015-2016, VOLCA in 2012-2013, BROCAL in 2013-2014, UNACEM in 2014-2015, SCCO in 2016-2017 and MINCOR in 2018-2019. On the other hand, MOROCO also had the lowest productivity index scores in the periods 2012-2013 and 2018-2019, MINCOR in 2011-2012, SHP in 2012-2014, VOLCA in 2014-2015 and 2016-2017 and SCCO in 2015-2016. Also, there were no companies that had positive Malmquist scores in all the periods since at least in one period all companies had decreasing scores. Similarly, companies increased their productivity score at least in one period.

Table 3 also shows that among non-metallic companies - UNACEM, CPACAS, and YURA- average productivity scores were mixed (both increasing and decreasing productivity scores) such as their metallic partners; among them, UNACEM had the highest productivity scores while YURA had the lowest. Additionally, there were no companies that had constant productivity scores [neither growth nor decrease].

Moreover, the term in which the majority of companies had growing Malmquist index scores was the 2015-2016 period, while the worst ones were the 2013-2014 and 2014-2015 periods since only 27% of the mining companies had growing scores.

4.2. Personnel expenses

Table 4 shows that on average the maximum increase in administrative personnel expenses was done by CVERDE while the major reduction was executed by BROCAL. All companies made at least one reduction in their administrative personnel expenses in the period studied. Also, those companies increased their expenses at least in one period. In the non-metallic mining companies, YURA made the highest increase in its expenses while UNACEM reduced its costs the most.

On average 53.33% increased their administrative personnel expenses from 2011 to 2018 while 46.47% decreased their expenses. In the non-metallic mining companies, only YURA increased their costs on average.

Table 4
Administrative personnel expenses variation

	Administrative personnel expenses variation							
DMU	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	Average
BUENAV	0.2229	-0.0016	-0.0861	-0.0076	-0.0299	0.0529	0.2078	0.0512
PODER	0.0995	-0.2884	-0.1478	0.2172	0.7919	0.1453	0.1157	0.1333
MOROCO	0.0208	0.1525	-0.3293	-0.1189	0.0353	0.2717	-0.2845	-0.0361
LUISA	-0.0279	0.1947	-0.0628	-0.0331	0.0713	0.3338	-0.0393	0.0624
MINSUR	-0.1097	0.2790	0.1242	-0.2115	-0.1700	0.1010	0.1218	0.0193
NEXAPE	0.7159	-0.2189	-0.2202	-0.3243	-0.0078	0.1502	0.0305	0.0179
SHP	-0.4360	0.0612	-0.1400	-0.1885	0.2109	-0.1004	0.1044	-0.0698
CVERDE	-0.0909	-0.0116	-0.1672	0.2017	1.1946	0.0067	0.0629	0.1709
MINCOR	-0.1542	-0.2517	-0.2026	-0.2276	0.0088	0.5236	0.2784	-0.0036
BROCAL	-0.1790	-0.2970	0.0863	0.0695	-0.1210	-0.0023	-0.7762	-0.1743
SCCO	-0.1522	0.0258	-0.1515	-0.1333	-0.2484	0.0531	-0.0199	-0.0895
VOLCA	-0.0835	0.2873	-0.2248	-0.4860	0.6094	-0.2396	0.3337	0.0281
UNACEM	0.2126	-0.0222	0.0863	-0.2202	0.1366	-0.3190	-0.0001	-0.0180
CPACAS	0.1732	0.0421	-0.1064	-0.1479	0.0669	-0.0012	-0.0840	-0.0081
YURA	0.3126	0.0095	-0.0760	-0.2852	0.0935	0.2862	0.0107	0.0502
Average	0.0349	-0.0026	-0.1079	-0.1264	0.1761	0.0841	0.0041	0.0089
Max	0.7159	0.2873	0.1242	0.2172	1.1946	0.5236	0.3337	0.1709
Min	-0.4360	-0.2970	-0.3293	-0.4860	-0.24836	-0.3190	-0.7762	-0.1743
Growth %	46.67	53.33	20.00	20.00	66.67	66.67	60.00	53.33
Decrease %	53.33	46.67	80.00	80.00	33.33	33.33	40.00	46.67
SD	0.2705	0.1911	0.1268	0.1911	0.3918	0.2178	0.2630	0.0850

The period of time when most mining companies increased their administrative personnel expenses were the ones from 2015 to 2017. On the other hand, the period in which the majority of mining companies reduced their expenses was from 2013 to 2015. When comparing Tables 3 and 4, they show that the period when certain companies increased their productivity matches with the period when they had growths in their administrative personnel expenditure. Analogously, the period when a number of companies had decreases in their productivity matches with the reduction in their administrative personnel expenditure.

Table 5
Operative personnel expenses variation

	Operative personnel expenses variation							
DMU	2011-2012	2012-2013	2013-2014	2014-2015	2015-2016	2016-2017	2017-2018	Average
BUENAV	0.1016	0.2878	-0.1023	-0.1758	-0.1306	0.2611	0.1345	0.0538
PODER	0.1474	0.0427	-0.0369	0.0062	0.1287	0.0908	0.0162	0.0564
MOROCO	0.2436	0.0704	-0.2734	-0.1695	0.0559	0.555	-0.087	0.0564
LUISA	0.01213	-0.1096	-0.0235	-0.1266	-0.1438	0.3365	-0.0412	-0.0137
MINSUR	-0.0892	0.2912	-0.0290	-0.2551	0.0464	0.0209	-0.0552	-0.0100
NEXAPE	-0.0860	-0.5704	0.0896	-0.2211	0.2274	0.0222	-0.1443	-0.0975
SHP	-0.1411	-0.0022	-0.2477	-0.2117	0.0615	0.1898	-0.0606	-0.0589
CVERDE	-0.2509	0.1229	-0.2034	-0.1471	0.4744	0.3253	0.2504	0.0817
MINCOR	0.05025	-0.1895	0.1216	-0.2071	0.1399	0.4484	0.2358	0.0856
BROCAL	-0.2641	-0.1860	0.0165	0.33483	0.5126	0.4286	0.1251	0.1382
SCCO	-0.0715	-0.1167	-0.0458	-0.1170	-0.1156	0.1724	0.1451	-0.0213
VOLCA	0.0591	0.6476	-0.0668	-0.4776	0.3851	-0.2254	-0.0409	0.0402
UNACEM	0.1422	-0.1542	0.1103	-0.1753	0.2047	0.1323	-0.0198	0.0343
CPACAS	0.25407	-0.0246	-0.0797	-0.1680	0.3537	-0.1243	0.063	0.0392
YURA	0.8033	-0.0082	-0.0333	0.0387	-0.0248	0.1168	-0.035	0.1225
Average	0.0607	0.0068	-0.0536	-0.1381	0.1450	0.1834	0.0324	0.0338
Max	0.8033	0.6476	0.1216	0.3348	0.5126	0.5550	0.2504	0.1382
Min	-0.2641	-0.5704	-0.2734	-0.4776	-0.1438	-0.2254	-0.1443	-0.0975
Growth %	60.00	40.00	26.67	20.00	73.33	86.67	46.67	66.67
Decrease %	40.00	60.00	73.33	80.00	26.67	13.33	53.33	33.33
SD	0.2599	0.2744	0.1186	0.1747	0.2132	0.2151	0.1200	0.0645

Table 5 displays that on average the maximum increase in operative personnel expenses was made by BROCAL. On the other hand, the biggest reduction was performed by NEXAPE. As in Table 4, all companies made at least one reduction and one increase in their operative personnel expenditure. All non-metallic companies made increases in their operative personnel expenditure on average. On average 66.67% increased their operative personnel expenses from 2011 to 2018 while 33.33% decreased their expenses. The biggest increase in those expenses was reached by YURA in the period 2011-2012 while the largest reduction was performed by NEXAPE in the 2012-2013 period.

As in Table 4, periods when certain mining companies made their biggest operative personnel expenditure in average matches with the ones when they reached their highest productivity evolution. Similarly, periods when a number of companies made reductions in their operational personnel expenditure matches with their productivity change reduction period.

4.3. Regression analysis for metallic mining companies

Table 6
Regression analysis (random effects) for metallic mining companies

Variable	Coefficient	Standard deviation	Z	Probability	Prob > chi2	R2
Ape	-0.0158	0.0116	-1.37	0.172		
Ope	-0.0302	0.0129	-2.33	0.02	0.0005	0.1787
Constant	1.0191	0.0106	95.73	0		
sigma u	0					
sigma e	0.1007					
rho	0					

Table 7
Pesaran's test

Pesaran test statistic	Probability
2.9111	0.0036

First of all, Haussmann's test was performed and it suggested to choose the random-effects model [.8396, α =.05]. According to Table 6, administrative personnel expenses [Ape] and operative personnel expenses [ope] of mining companies had both a negative determination coefficient. This coefficient exhibits that only a negative variation of both administrative and operative expenditure would make productivity grow. Thus, those results represent the average effect of the independent variables over the dependent variable when the independent variable changes across time by one unit. Then, it can be stated that on average a decrease in operative personnel expenditure had a major effect than a reduction of administrative personnel expenditure in order to get a productivity variation. Additionally, only the effect of operational personnel expenditure had a negative significant influence on productivity change. Therefore, it can be stated that a reduction of operational personnel expenditure would increase metallic mining company productivity. Besides, for mining company decision-maker it would be more appropriate to cut off operative expenses rather than administrative ones in order to increase productivity. As shown in Table 6, the model is solid because of the score of .0005 [α= .05]. The R^2 score shows that only 17.87% of the productivity change could be explained thorough personnel expenses. Table 7 shows the results of Pearson´s test. Due to the fact that the probability score is lower than 0.05, it can be stated that there is no codependence in the independent variables. Thus, the probability of a possible bias because of the codependence of both administrative and operative personnel expenses can be erased.

4.4. Regression analysis for non-metallic mining companies

Table 8
Regression analysis (random-effects) for non-metallic mining companies

	Coefficient	Standard deviation	Z	Probability	Prob > chi2	R2
Ape	0.0101412	0.00649	1.56	0.118		
Ope	0.0114779	0.0064765	1.77	0.076	0.0025	0.3872
Constant	1.003721	0.0045921	218.57	0		
sigma u	0					
sigma e	0.02123673					
rho	0					

Table 9
Pesaran 's test

Pearson´s test statistic	Probability
1.222	0.2216

Previously, Haussmann's test was executed and it suggested choosing the random-effects model [.7767, α =.05]. Table 7 shows the regression results for nonmetallic mining companies. According to them, there was a positive determination coefficient for both administrative personnel expenditure variation and operative personnel expenditure with the changes in productivity. Thus, increasing both administrative and operative personnel expenditure would make productivity growth. Even though the difference in weights is little, a positive change in operational personnel expenditure had a bigger effect than a change in administrative personnel expenditure. However, in this case, none of the variables had a significant influence on productivity change. This Table also shows that this regression model is solid due to the score lower than α=.05 [.0025]. *R2* score reveals that personnel expenses change explains 38.72% of productivity change. Finally, Table 9 shows that there is no codependence between the independent variables which avoids interference of the independent variable responses.

5. Discussion

As stated, even though both metal mining companies and non-metal mining companies have huge similarities, they have differences at the time of selling. On one side, metal mining companies are focused on selling to other countries [mainly China] while non-metal mining companies have a huge intern demand. Thus, it was necessary to make a separate analysis for them since the selling amount was the only output for productivity analysis. For one side, in metallic mining companies, there was a negative correlation between salaries variation and productivity change [even though only operational personnel expenditure was significant] which contradicts findings of Paul (2014), Mohamud et al. (2017), Umar (2014), Okeke et al. (2017) and Gunawan and Amalia (2015) since those authors found a positive relationship between salaries and productivity. These results can be explained since the way metallic mining companies have incomes and by the fact that they rely on external drivers that could not be handled by them. Therefore, these external drivers can make international market demand [and price] for metals growth or fall at any moment. Moreover, their operations can be interrupted because of social conflicts motivated by the environmental impacts of the activity (Castellares & Fouché, 2017). As a consequence of this, mining companies' production and sales plan can be turned into a wrong one at any moment. Hence, planned operative and administrative personnel expenditures rather than making productivity growth, make them fall because of the new scenario, so mining companies could cut them in order to gain productivity. In that situation, current research indicates that cutting off operative personnel expenses may have a major effect rather than cutting off administrative personnel expenses in order to raise productivity.

On the other hand, nonmetallic mining companies' sales rely more on the national market rather than the international one. Therefore, the uncertainties of the international market do not affect them in the same way as in the metallic ones. Also, these companies enjoy the good environment of the Peruvian economy. For instance, in 2019 cement consumption was forecasted to increase by 6.5%. Also, since 2000 so far the building sector grew by about 223% (Cámara de comercio de Lima, 2020). In consequence, nothing seems that the demand for buildings supplies [mainly cement] be stopped. Hence, sales and production forecasting for non-metallic companies are targeted for an expansion period, thus these companies can expand their costs [like personnel expenditures] expecting to get more revenues. As a consequence of this, increasing both operative and administrative expenses could increase positively its productivity change. Although those results were not statistically significant, the explanatory variables cannot be considered as worthless because of their explanatory impact [about 40] for productivity change. Therefore, it could be stated that for nonmetallic companies´ personnel expenses have a major impact on productivity than in metallic companies.

6. Conclusions

The research main objective was to research whether personnel expenses had effects on the productivity changes for mining companies in Peru. After analyzing the variables and data methodologically; the current research found that for metallic mining companies', operative and administrative expenditures changes had a negative effect on their productivity change. Although this result, only the variable operational expense change was statistically significant. Then, it can be stated that increasing the personnel expenses could decrease productivity for mining companies or analogously cutting off personnel expenses could increase mining companies' productivity. However, the continuously changing international scenarios may also contribute to that effect. On the other hand, for non-metallic mining companies, the current research encountered that both operative and administrative positive expense change had a positive effect on productivity change even though not significant. Therefore, it can be concluded that making major investments in personnel expenses could deliver growth in productivity. These results could also be explained along with the market characteristics the nonmetallic companies are in.

Recommendations

For further research, it is recommendable to analyze other components that may affect mining companies' productivity such as fixed assets investments, outsourcing or tax benefits.

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