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Impactof COVID-19 on Traditional-Mining Exportsfrom Perú

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Summary:

Context: *The COVID-19 pandemic caused a drop in real world GDP in 2020 to -3.5%, mainly due to the decrease in production and international trade. In Peru, the impact of COVID-19 was marked by a drop in exports in general, being theexports of mining products which fell by more than 200%.*

Purpose: *This study analyzes the impact of COVID-19 on mining exports during the period of sanitary isolation by COVID-19.*

Method: *The empirical strategy of the study is based on the use of an econometric model of Ordinary least squares (OLS)with time series.*

Results: *The results of the investigation indicate that mining exports were negatively affected during the period of sanitary isolation by the COVID-19 pandemic. However, the measure given by the Peruvian government on June 30, 2020, through Supreme Decree No. 117-2020-PCM, to resume all mining activitiescaused a positive effect on mining exports. Likewise, this study finds thatcopper and gold exports, as well as the percentage change in China's GDP play a significant role in the performance of Peru's mining exports. However, both the international price of copper and gold were not significant at 95%.*

Conclusion: *The findings of this study imply that the government should promote the responsible production of these minerals, always with a responsible social commitment to care for the environment; and with a look to the future, the development of copper and gold industrialization should be promoted in order to advance towards the levels of a developed economy.*

Key words: *COVID-19, exports -traditional, mining products, copper, gold.*

JEL: *F130, F410, O130*

1. Introduction

The COVID-19 epidemic took the world by surprise in early 2020. It was initially thought to be a China-only problem and later believed to be a South East Asian issue. However, due to various natural, political and regulatory factors, the epidemic spread rapidly to the rest of the world, causing havoc in the areas of health and the economy mainly. According to estimates by the International Monetary Fund (IMF) in 2020, the annual percentage change in world real GDP was -3.5%.

In advanced economies, GDP fell on average by -4.9%. This variation was more striking in some nations than in others. For example, in the United States the fall was -3.4%, in Germany -5.4%, in France -9.0%, in Italy -9.2%, in Spain -11.1%, in Japan -5, 1%, in the United Kingdom -10.0% and in Canada -5.5%. The situation was no different for emerging and developing economies, which also saw their real GDP fall by -2.4%. This variation was more striking in some countries than in others. For example, in India the fall was -9.0%, in Russia -3.6%, in Brazil -4.5%, in Mexico -8.5%, in Saudi Arabia -3.9%, in Nigeria - 3.2%, in South Africa -7.5%, and in Latin America and the Caribbean -7.4%. China was the only country that registered a positive variation of 2.3% (IMF, 2021).

The drop in world GDP was also reflected in the decline in international trade, basically in the import and export of products and services. However, there was naturally an increase in trade in products and services directly related to the COVID-19 pandemic. For example, according to World Bank data, there was an increase in the trade of medicines, medical equipment and instruments, hygiene and cleaning articles, textile raw materials for masks and blankets, and the manufacture of masks (World Bank, 2020a). The import of these products was highly concentrated in emerging economies during the first quarter of 2020. Therefore, certain restrictions were imposed on the quantity to be imported in order to supply global demand. For instance, a restriction of 39.5% for regular masks and 46.1% for medical masks was imposed for Peru.

The COVID-19 pandemic forced governments to take restrictive measures to prevent the imminent spread of the virus. These restrictive measures included quarantine measures with the respective border closures, which not only affected international trade but also employment (Baek, McCrory, Messer & Mui, 2020) and consumption (Goolsbee&Syverson, 2021), causing a significant drop in the incorporation of small companies to the market especially in the areas of art, culture and recreation (Beland, Fakorede&Mikola, 2020). In international food trade, the impact of COVID-19 is diverse and is linked to several factors. For example, in developing countries the risk of food safety is more linked to access to the food supply (i.e. food inflation). While in developed countries the risk and availability of food are more relevant (Erokhin & Gao, 2020). In the near future, developing and developed economies are expected to join forces through international cooperation in order to maintain the food supply chain (Kerr, 2020).

Baldwin &Tomiura (2020) found a shock in the world's economies both in demand and supply of exports due to COVID-19. The worst hit sector was manufacturing in at least the 6 main world economies: China, South Korea, Italy, Japan, the United States and Germany. It is expected that in the short term the consequences, although critical, can be adequately manageable. In the medium and long term, the effects could be more profound than initially thought because it would change the way of doing business (Gruszczynski, 2020).

In Peru, the impact of COVID-19 was marked by a drop in both traditional and non-traditional exports, including mainly mining products (GBR, 2020). This is due, among other causes, to the restrictive measures adopted by the government to counteract the pandemic, such as the closing of borders and social distancing. Before the pandemic, Peruvian exports maintained a growing trend with seasonal fluctuations.Graph 1 shows that total exports for the period 2006-2020fell in 4 periods: 2010, 2015, 2016 and 2020. The first significant fall was in 2010 due to the 2008-2009 world economic crisis that caused the fall in prices of raw materials. The second significant drop is observed in the second quarter of 2020, mainly due to the expansion of the national health emergency due to COVID_19 that affected the normal transit of goods (see dotted red line in the graph).

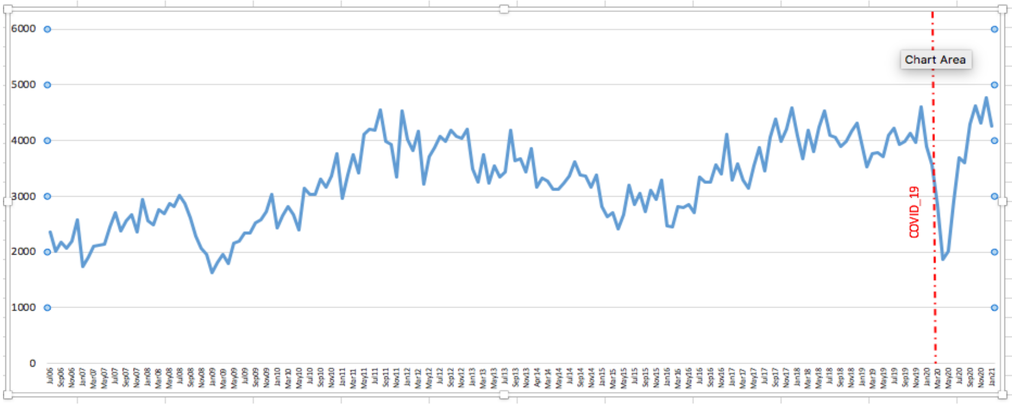

Figure1.*Exports in millions of dollars monthly period July 2006 - December 2020.*

Source: Central Reserve Bank of Perú/Series exports. Own elaboration

However, it should be noted that despite the COVID-19 pandemic, international prices for some mining products such as lead, silver and zinc remained unchanged. In graph 2 it is observed that the prices of gold showed an increase especially in the last quarter of 2020. The same trend is observed for tin, while zinc, silver and lead remained stable.

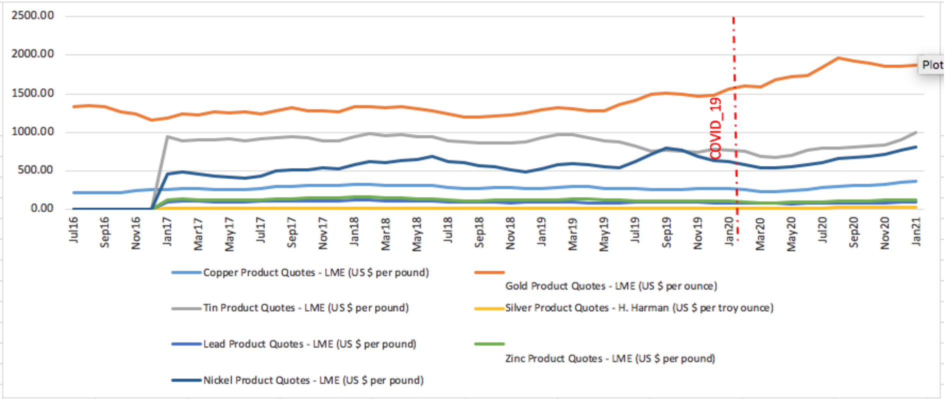

Figure2.*International mineral prices - monthly period July 2016 - January 2021 in millions of dollars.*

Source: Central Reserve Bank of Perú/Statistical Series. Own elaboration

2. THEORETICAL FRAMEWORK

Empirical evidence of the impact of COVID-19 on international trade at a global level

Hayakawa & Mukunoki (2020) analyzed the impact of COVID-19 on world international trade in 186 countries during the first quarter of 2020. The effect of the COVID-19 disease was measured in terms of the number of cases and deaths using the method Poisson distribution. Thus, they found that COVID-19 in exporting countries has a significantly negative effect, but this negative impact is observed in exports from developing countries, but not in those of developed countries. They also found that COVID-19 has positive effects on trade in the agricultural industry, while in the textile, footwear and plastic industries the effect is negative.

Carreño, Dolle, Median &Brandenburger (2020) evaluated the impact of government measures to combat COVID-19 using the qualitative-analytical method. Thus, evaluating the regulations and policies implemented by the various multilateral organizations such as the UN, OECD and others, they found that export restrictions caused a shortage of products necessary to combat COVID-19 such as special masks, ventilators and antimalarial drugs used to fight the epidemic.

Erokhin & Gao (2020) analyzed the impact of COVID-19 on food trade in 45 emerging economies. The variables analyzed included: New COVID-19 cases, inflation, and exchange rate volatility. The method applied was the time series. The results showed that in developing countries, the risk of food security is more linked to access to the food supply (i.e. food inflation). While in developed countries, risk and food availability were more relevant.

Baldwin &Tomiura (2020) analyzed the impact of COVID-19 at the level of the global economy. The variables analyzed included the export of total goods and services. Through an analysis of Ordinary Least Squares (OLS) they found a shock in the world's economies both in demand and supply of exports due to COVID-19. The worst hit sector was manufacturing in at least the 6 main world economies (China, South Korea, Italy, Japan, the United States and Germany).

Gruszczynski (2020) analyzed the impact of COVID-19 on international trade in the short and long term using the qualitative-analytical method. This evaluation focused on the restrictive border closure measures given by governments in order to contain the spread of the virus. In this sense, the author argues that in the short term the consequences may be adequately manageable. While in the medium and long term the effects could be more profound than initially thought due to the fact that it would change the way of doing business.

Empirical evidence of the impact of COVID-19 on the international trade of specific economies

Vasiev, Bi, Denisov &Bocharnikov (2020) analyzed the impact of COVID-19 on the provinces and industries of the Chinese economy in order to identify which were the most vulnerable. The methodology used is the OLS - time series - SARIMA model. The variables used are a set of economic sustainability factors such as: production level of the provinces, migration, financial flow, transportation and communication routes between the provinces. The findings include a significant correlation between regional production and migration. They also found a non-significant relationship between financial flow and migration.

He, Sun, Zhang & Li (2020) studied trends in Chinese industries amid the COVID-19 pandemic. The main purpose was to analyze the impact of COVID-19 on the stock market. For this they used the event method. The variables used included: Average price in the market of technology and information industries, sports and entertainment, manufacturing, sales by departments, research, food, finance, transportation, construction, environment, electricity and heating, real estate, health, education, agriculture and mining. The study concluded that the transportation, mining, electricity, heating and environment industries were the most impacted by COVID-19, while the sectors that endured the pandemic were manufacturing, technology, and other industries.

Fried & Zhang (2020) evaluated the impact of COVID-19 on Chinese exports in 3 aspects: the shock in domestic supply, the shock in international demand and the effects of chain infections. They used the gravity equation method and considered the following variables: Total exports, COVID-19 cases nationwide, COVID-19 cases globally, COVID-19 deaths nationwide. The researchers found that the 3 mentioned shocks affected China's international trade.

Baek, McCrory, Messer & Mui (2020) analyzed the effects of restrictive measures such as border closures to contain the advance of COVID-19 in the United States. The method applied was the OLS method considering the following variables: New cases of COVID-19, applications for unemployment insurance at the national level, unemployment rate, and the work-at-home index. The authors found that each week of the study period (March 2020) resulted in an increase in applications for unemployment insurance as a result of job loss, which consequently affected production and consumption.

Goolsbee&Syverson (2021) analyzed the factors causing the decline in economic dynamism in the United States during the month of March 2020. The variable studied comprised the behavior of consumers during the pandemic, which included compliance with restrictive orders to stay at homes given by the government. This variable was measured through the number of visits to shopping centers and establishments. By doing a linear OLS regression, the authors found that the decline in economic dynamism was due in a small percentage to changes in consumer behavior.

Jaramillo and Ñopo (2020) analyzed COVID-19 and its economic impacts in Peru. The study finds that a consequence of the disruptions caused by the coronavirus epidemic is the fall in the price of raw materials in general, but in particular of minerals. Using descriptive statistical analysis, they found that mineral exports accounted for around 60% of the country's total exports in 2019 and that copper alone accounted for half of mining exports and close to 30% of the country's total exports.

Also, for the Peruvian context, Martínez (2020) analyzed the situation of mining activity in mid-2020 in the midst of the COVID-19 pandemic. The author used a qualitative-analytical methodology to analyze the 4 phases of the reactivation of mining in Peru: restart of activities in the main mining companies, restart of exploration activities, restart of mining operations, medium-sized mining companies, and re-initiation of mining conventions. Accordingly, the author concluded that a fall in mining activity is projected in Peru, for which he recommends that innovation be promoted to maintain the flow of income and expenses.

Empirical evidence of export determinants

Bielekova&Pokrivcak (2020) identified the influencing factors in the dynamics of global beer exports (2000-2017). The researchers used the Poisson-Gravity Model estimator, considering the following variables: GDP of exporting and importing countries, population of importing countries, level of production, distance between exporting and importing countries, and a series of dummy variables for costs and cult aspects. The results showed that the GDP of importing countries and cultural similarity positively impact beer exports worldwide.

In Norway, Straume&Asche (2020) evaluated the determinants of marine products for the period 2004-2014. Using the gravity model, they evaluated the following variables: Value of exports of the main marine products, geographical distance in relation to importing countries, GDP of the importing country, internal transport, and international transport (freight). The results showed that the costs of internal transport and international transport (freight) are the variables that most impact Norwegian exports of marine products.

In India, Adhikari, Sekhon& Kaur (2020) evaluated the determinants of the export of basmati rice from India for the period 1980-2013. For this they used the time series methodology considering the following variables: national rice production, national and international price of rice, national rice consumption, and the real exchange rate. The results showed that domestic and international rice prices, domestic consumption and the exchange rate are the main determinants of rice exports from India.

In Pakistan, Javed, Rehman, Nabi, Razzaq, Saqib, Bakhsh, Mohibullah & Luqman (2020) analyzed the determinants of the export of basmati rice from Pakistan using the data panel and considering the following variables: The exchange rate of Pakistan, the exchange rate of the importing countries, the national inflation index, the inflation index of the importing countries, and dummy variables for borders and religion. The results of the study showed that the Pakistani exchange rate has a negative and significant effect on the exports of basmati rice. On the contrary, the exchange rate of the importing countries has a positive and significant effect on the exports of basmati rice.

In addition,Jadoon, Guang, Ahmad & Ali (2018) identified the determinants of Pakistan's global exports for the period 1990-2016. For this, the researchers used the time series considering the following variables: foreign direct investment, national GDP, level of employment, and consumer spending. The results evidenced the strong significance of foreign direct investment and national GDP in Pakistani exports.

In Ethiopia, Gachena, Haji, Legesse, &Ketema (2020), analyzed the determinants of the export of spices (turmeric and korarima) in Ethiopia. They mainly used the GLS gravity model and the data panel to estimate the determining variables of spice exports for the period 2005-2016 in the entire territory of Ethiopia. The variables used were: value of annual exports, bilateral exchange rate, national GDP, annual national population, GDP of the importing country, annual foreign direct investment, quality of national transport infrastructure, Ethiopia institutional quality index, index of foreign trade policy, distance between Ethiopia and importing countries.

In Bangladesh,Alam, Selvanathan&Selvanathan (2017) identified the determinants of Bangladeshi garment exports within the multi-fiber post-development context for the period 1983-2014 using the OLS methodology. To do this, they considered the following variables: manufacturing cost, productivity, industry size, availability of raw materials, location of industries in port cities, product and market diversification, preferential market access, proactive policies, corruption and political instability, and working conditions. The results showed that the manufacturing cost, productivity, the size of the industry, the availability of raw materials, and the location of industry in port cities are the most significant determinants of Bangladesh's garment exports.

Likewise, Islam (2016) evaluated the determinants of Bangladesh's global export and import functions for the period 1981-2013. The author used the OLS considering the following variables: inflation index, national GDP, exchange rate and government policies. The results indicate that the national GDP is the main determinant of Bangladesh's exports and imports.

In global Asia, Malhotra & Kumari (2015) identified the determinants of exports in the main Asian economies including China, Japan and South Korea for the period 1980-2012. To do this, they used the OLS using the variables of world export demand (measured by imports from purchasing countries), the real exchange rate, production level (measured by GDP), relative prices, foreign investment, and commercial opening. The authors found that world demand, GDP, foreign investment and the opening of international trade were the factors that significantly impacted exports.

In Turkey, Hatirli&Onder (2010) evaluated the determinants of the export function of textile products. They considered the real effective exchange rate, the euro zone industrial production index, and the relative price of textiles as independent variables. Using the time series methodology, the authors found a long-term relationship between the variables real effective exchange rate and clothing. Accordingly, an increase in the real effective exchange rate has a negative impact on the export of clothing.

In Spain, García, Gordo, Martínez-Marín & Tello (2009) evaluated the determinants of the export function for the Spanish market. Using the OLS, they considered exports of goods and services from Spain as a dependent variable and as independent variables: export demand and price competitiveness for the period 1993-2008. The export variable is “the growth of the Spanish export market, constructed from the sum of the growth in the volume of imports of goods and services from importing countries weighted by their share in exports of Spanish goods" (p.29). Also, competitiveness-price is the relative price of exported products.

In Colombia, Sarmiento-Castillo, Pérez-Rincón& Gómez-Sánchez (2018) evaluated the economic benefits of the extractivist model in Colombia. They used 2 logarithmic models to show the relationship between the macroeconomic variables related to mining and economic growth in Colombia. The variables used included the GDP of the developing countries importing Colombian mining products (China, India, Panama, Peru and Venezuela), foreign direct investment to the mining sector, international prices of oil, coal, nickel, gold and silver. The results showed that in the long term the variables are related, finding a high significance and an inelastic relationship compared to mining exports.

In Peru, Cano &Otárola (2018) analyzed the trends of mining exports in Peru for the period 1950-2016 in order to make the projection of exports of the main export metals. They used the descriptive statistical analysis of volatility and unit root tests. The variables evaluated included: international prices of the 4 metals with the highest participation (copper, gold, lead and zinc). The results show a growing trend in the price of these metals, which together with higher volumes exported to the requirements of China will allow, according to the authors, a growing path of the exported value.

3. Statement of the Problem

Despite efforts to assess the impact of COVID-19 in the various economic sectors and in international trade, it is necessary to evaluate the impact of COVID-19 specifically on traditional-mining exports from emerging economies rich in mining products such as case of Peru. For this purpose, the period July 2016-January 2021 will be evaluated. This is due to the fact that the COVID-19 pandemic has occurred in the government period 2016-2021.

General ResearchQuestion:

- Was it the decrease in copper and gold exports that affected the total value of Peru's traditional mining exports during the period of sanitary isolation by COVID-19?

SpecificResearchQuestions:

- What is the relationship between the international price of copper and the traditional-mining exports of Peru (July 2016 - January 2021)?
- What is the relationship between the international price of gold and Peru's traditional-mining exports (July 2016 - January 2021)?
- Does Chinese demand for copper significantly affect traditional mining exports in Peru (July 2016 - January 2021)?

General ResearchHypothesis

- The decrease in copper and gold exports affected the total value of Peru's traditional mining exports during the period of sanitary isolation due to COVID-19.

SpecificResearchHypotheses

- There is a positive relationship between the international price of copper and Peru's traditional-mining exports (July 2016 - January 2021).
- There is a positive relationship between the international price of gold and Peru's traditional-mining exports (July 2016 - January 2021).
- Chinese demand for copper significantly affects traditional mining exports in Peru (July 2016-January 2021).

4. Methodology

In order to determine the relationship and the degree to which the dependent variable is related to the independent variables, this study applies the econometric model of Ordinary Least Squares (OLS) with time series (Stock & Watson, 2012). The econometric model is designed according to the theory proposed by García et al. (2009),Baldwin &Tomiura (2020), Vasiev, Bi, Denisov &Bocharnikov (2020), and Malhotra & Kumari (2015) discussed above.

Variables

For this research, the dependent variable is the US FOB value of traditional mining exports from Peru for the period July 2016- January 2021. This variable was considered taking into accountGarcía, Gordo, Martínez-Marín& Tello (2009) who evaluated the determinants of exports for the Spanish economy.

The independent variables arethe US $ FOB value of copper exports, the US $ FOB value of gold exports, the International price (period average) of Copper, and the International price (period average) of gold. These two variables of international quotation are taken according toSarmiento-Castillo, Pérez-Rincón& Gómez-Sánchez (2018), Cano &Otárola (2018), Malhotra & Kumari (2015), and Hatirli&Onder (2010).

Likewise, the export demand constructed according to García et al. (2009) is an independent variable in the model. In the same way, we consider the percentage change in the GDP of our largest importer China as an independent variable. This variable is taken according to Straume&Asche (2020),Gachena, Haji, Legesse, &Ketema (2020), andSarmiento et al. (2018). Finally, COVID-19 is considered a dummy variable.

Econometric model proposed

$$Y_t = \hat{\beta}_0 + \hat{\beta}_1 X_{1t} + \hat{\beta}_2 X_{2t} + \hat{\beta}_3 X_{3t} + \hat{\beta}_4 X_{4t} + \hat{\beta}_5 X_{5t} + \hat{\beta}_6 X_{6t} + \hat{\beta}_7 X_{7t} + \hat{\varepsilon}_t$$

Where:

Y = Exports of traditional products - mining FOB values

X1 = Exports of traditional products - copper miners - FOB values

X2 = Exports of traditional products - Gold miners - FOB values

X3 = International price - Copper

X4 = International price - Gold

X5 = COVID-19

X6 = Chinese demand for copper Monthly variation rate. % (export demand)

X7 = Monthly variation rate of China's GDP%

5. RESULTS

Table1.*Model estimation*

Estimation Results				
Variable	**Coefficient**	**Standard Error**	**t - Statistic**	**Probability**
C	-185.6314	109.3416	-1.697719	0.0963
X1	1.069582	0.048359	22.11749	0.0000
X2	1.219319	0.089327	13.65014	0.0000
X3	0.011543	0.003417	3.378674	0.0015
X4	0.068197	0.077962	0.874750	0.3863
X5	-42.20305	41.81012	-1.009398	0.3181
X6	0.536613	1.426670	0.376130	0.7085
X7	4.437363	1.542741	2,876286	0.0963
R-squared	0.981683	Mean dependent var		2,269,937
Adjusted R-squared	0.978896	SD dependent var		365.0339
SE of regression	53.02936	Akaike info criterion		10.91552
Sum squared resid	129357.2	Schwarz criterion		11.21019
Log likelihood	-286.7191	Hannan-Quinn criterion.		11.02916
F-statistic	352.1947	Durbin-Watson stat		2.035851
Prob (F-statistic)	0.0000			

Source: author's elaboration

Variables X4, X5 and X6 are not individually significant since the probability of their t statistic is less than the 5% level of significance. The model is jointly significant since the probability of the F statistic is less than the 5% level of significance. The model presents a good goodness of fit since the value of its R2 coefficient is greater than 0.9. It should be added that taking into account the decision criteria for the Durbin Watson statistic, there is no first-order autocorrelation since the Durbin Watson coefficient falls into an autocorrelation rejection zone. However, from the analysis of the results, large standard deviations are observed, so logarithms need to be applied.

Transformation of Variables into Logarithms

Taking into account the results of the first estimation, it was decided to transform the variables Y, X1, X2, X3 and X4 into logarithms because the standard deviations of these variables are large, which implies that their variances are also large, a variance of Great magnitude implies that the results are far from the mean and to avoid variability, the transformation must be made to reduce this variability. The variable X5 is not transformed since it is a dichotomous variable and the variables X6 and X7 are not transformed because they are percentage rates and present negative values. Table 2 presents the descriptive statistics of the transformed variables.

Table2. *Descriptive statistics of the variables transformed into logarithms*

	Ly	LX1	LX2	LX3	LX4	X5	X6	X7
	7.7128	7.0135	6,5091	10.2194	7.2380	0.2222	0.5856	1.2037
Standard deviation	0.1810	0.2143	0.1829	0.1105	0.1452	0.4196	5.2420	5.1226
Asymmetry	-1.6007	-0.8290	-2.2155	-0.3888	1.0728	1.3363	0.1272	-0.1920
Kurtosis	7.1370	3.8753	10.5515	2.9625	2.9347	2.7857	3.2942	3.6052
No. of observations	54	54	54	54	54	54	54	54

Source: author's elaboration

It can be seen that the standard deviation of the variables transformed into logarithms has decreased with respect to the data in Table 1, which indicates that the use of the transformation has been effective in reducing the variability with respect to the mean of these variables. The transformation of the variables has not changed the sign of the correlations of the variables, as can be seen in the new correlation matrix presented in the following table.

Table3. *Correlation matrix between variables transformed into logarithms*

	Ly	LX1	LX2	LX3	LX4	X5	X6	X7
Ly	1.0000	0.9229	0.8353	0.6510	-0.0784	-0.2441	0.1388	0.3066
LX1	0.9229	1.0000	0.6024	0.6418	-0.1066	-0.2341	0.1729	0.1531
LX2	0.8353	0.6024	1.0000	0.4344	-0.0505	-0.2113	0.0604	0.3591
LX3	0.6510	0.6418	0.4344	1.0000	0.1319	0.0565	0.0447	-0.0113
LX4	-0.0784	-0.1066	-0.0505	0.1319	1.0000	0.8844	0.0206	-0.0877
X5	-0.2441	-0.2341	-0.2113	0.0565	0.8844	1.0000	0.0181	-0.1707
X6	0.1388	0.1729	0.0604	0.0447	0.0206	0.0181	1.0000	-0.0596
X7	0.3066	0.1531	0.3591	-0.0113	-0.0877	-0.1707	-0.0596	1.0000

Source: author's elaboration

Regarding the normality of the variables, it can be seen in Table 4 that the Jarque Bera test only the variables X3, X6 and X7 follow a normal distribution.

Table4. *Jarque Bera Normality Test of variables transformed into logarithms*

	Ly	LX1	LX2	LX3	LX4	X5	X6	X7
Jarque-Bera Statistician	61.5679	7,9092	172.4845	1.3639	10.3683	16.1747	0.3405	1.1561
Probability	0.0000	0.0192	0.0000	0.5056	0.0056	0.0003	0.8435	0.5610

Source: author's elaboration

Stationarity of Variables

The stationarity of each of the variables was analyzed with the exception of the variable X5 because it is a dichotomous variable. Stationarity analysis was performed using the Augmented Dickey Fuller (ADF) test under the three auxiliary models with trend and intercept, only with intercept and without trend or intercept. The decision criterion indicates that the statistic must be greater than the critical values of MacKinnon and the p-value must be less than 0.05, in addition, depending on the auxiliary model, the t statistics of the coefficient associated with the trend and the intercept must be significant, andonce the criteria are met, the null hypothesis of the presence of a unit root or non-stationarity can be rejected.

Table 5 presents a summary of the results of the test carried out for the study variables. It can be seen that the variables LX1, LX2, LX6 and LX7 are stationary at the level, which implies that they are zero-order integrated. While in the case of the variables LY, LX3, and LX4 they are not level stationary and must be evaluated in their first difference.

Table5. *Results of the ADF Test for Stationary Level Variables*

		MacKinnon's Critical values			**Statistical ADF**	**Statistical Trend**	**Statistical intercept**	**p-value**
		1%	**5%**	**10%**	**τ**	**τβ**	**τα**	
LX1	With trend and intercept	-4.1409	-3.497	-3.1776	-3.1296	0.2722	3.1223	0.1102
	With intercept	-3.5600	-2.9177	-2.5967	-3.1602		3.1675	0.0281
	No trend or intercept	-2.6093	-1.9471	-1.6129	0.2579			0.7571
LX1	With trend and intercept	-4.1409	-3.497	-3.1776	-4.4011	0.2707	4.3892	0.0049
	With intercept	-3.5600	-2.9177	-2.5967	-4.4383		4.4438	0.0008
LX2	With trend and intercept	-4.1409	-3.497	-3.1776	-3.7087	0.101	3.6912	0.0303
	With intercept	-3.5600	-2.9177	-2.5967	-3.7605		3.7644	0.0057
LX3	With trend and intercept	-4.1446	-3.4987	-3.1786	-2.4358	0.6393	2.4438	0.3576
	With intercept	-3.5627	-2.9188	-2.5973	-2.3689		2.3800	0.1554
	No trend or intercept	-2.6102	-1.9472	-1.6128	1.0587			0.9222
LX4	With trend and intercept	-4.1409	-3.497	-3.1776	-1.7494	2.675	1.723	0.7149
	With intercept	-3.5600	-2.9177	-2.5967	0.594		-0.5651	0.9883
	No trend or intercept	-2.6093	-1.9471	-1.6129	1.5176			0.9667
LX6	With trend and intercept	-4.1409	-3.497	-3.1776	-12.1291	-0.2234	0.8775	0.0000
	With intercept	-3.5600	-2.9177	-2.5967	-12.2418		1.3940	0.0000
	No trend or intercept	-2.6093	-1.9471	-1.6129	-12.0534			0.0000
LX7	With trend and intercept	-4.1409	-3.497	-3.1776	-5.0073	-0.3985	0.9304	0.0008
	With intercept	-3.5600	-2.9177	-2.5967	-5.0541		1.1682	0.0001
	No trend or intercept	-2.6093	-1.9471	-1.6129	-4.902			0.0000

Source: author's elaboration

The results indicate that evaluating the variables LY, LX3 and LX4 in first difference are stationary, which implies that these variables are stationary of order 1.

Table6. *Results of the ADF Test for the Stationarity of the Variables in First Difference*

		MacKinnon's Critical values			**Statistical ADF**	**Statistical Trend**	**Statistical intercept**	**p-value**
		1%	**5%**	**10%**	**τ**	**τβ**	**τα**	
	With trend and	-4.1485	-3.5005	-3.1796	-6.5052	0.2159	0.0487	0.0000

DLY	intercept							
	With intercept	-3.5654	-2.9200	-2.5979	-6.5673		0.5193	0.0000
	No trend or intercept	-2.6111	-1.9474	-1.6127	-6.5965			0.0000
DLX3	With trend and intercept	-4.1446	-3.4987	-3.1786	-4.3487	0.1330	0.4000	0.0057
	With intercept	-3.5627	-2.9188	-2.5973	-4.4017		2.3800	0.0009
	No trend or intercept	-2.6102	-1.9472	-1.6128	-4.2759			0.0001
DLX4	With trend and intercept	-4.1446	-3.4987	-3.1786	-5.7209	1.5968	-0.8606	0.0001
	With intercept	-3.5627	-2.9188	-2.5973	-5.4125		-0.5651	0.0000
	No trend or intercept	-2.6102	-1.9472	-1.6128	-5.2902			0.0000

Source: author's elaboration

Having carried out the transformation of the variables into logarithms and obtained their stationarity, a last step is carried out prior to the final estimation. It is about changing the dummy variable X_{5t}, which in the first model represented the effect of COVID-19 but which was not statistically significant individually and therefore did not contribute to the goodness of fit of the model. Therefore, it was replaced by the variables D_{1t} and D_{2t} that correct two breaks originated in June and August 2020 respectively during the COVID-19 pandemic.

Table7. *Estimation of the Final Model by OLS*

VARIABLES
Dependent Variable:
LY = Exports of traditional products - mining FOB values (US$ millions)
Independent Variables:
LX1 = Exports of traditional products - mining FOB values (US$ millions)
LX2 = Exports of traditional products - Gold miners - FOB values (US$ millions)
LX3 = International price - Copper
LX4 = International price - Gold
X6 = Chinese demand for copper Monthly variation rate % (export demand)
X7 = Monthly variation rate of China's GDP%
D20M06 = D_{1t} variable that corrects the break originated in June 2020 during the COVID-19 pandemic.
D20M08 = D_{2t} variable that corrects the break originated in August 2020 during the COVID-19 pandemic

Regression Equation

$$\widehat{LnY}_t = 0.3991 + 0.5496LnX_{1t} + 0.3966LnX_{2t} + 0.083LnX_{3t} + 0.0037LnX_{4t} + 0.0005X_{6t} + 0.0016X_{6t} - 0.0724D_{1t} + 0.0661D_{2t} + E_t$$

Variable	**Coefficient**	**Standard Error**	**t - Statistic**	**Probability**
C	0.3991	0.3731	1.0699	0.2904
LX1	0.5496	0.0272	20.1765	0.0000
LX2	0.3966	0.0249	15.9461	0.0000
LX3	0.0830	0.0445	1.8682	0.0683
LX4	0.0037	0.0253	0.1468	0.8839
X6	0.0005	0.0007	0.7406	0.4628
X7	0.0016	0.0007	2.1069	0.0407
D20M06	-0.0724	0.0263	-2.7545	0.0085
D20M08	0.0661	0.0300	2.2037	0.0327
R-squared	0.9849	Mean dependent var		7.7128
Adjusted R-squared	0.9822	S.D. dependent var		0.1810
S.E. of regression	0.0241	Akaike info criterion		-4.4586

Sum squared resid	0.0262	Schwarz criterion		-4.1272
Log likelihood	129.3835	Hannan-Quinn criter.		-4.3308
F-statistic	366.7331	Durbin-Watson stat		2.3421
Prob(F-statistic)	0.0000			

Source: author’s elaboration

The variables X1 (Copper exports), X2 (Gold exports)and X7 (percentage change in China's GDP) are individually significant since the probability of their t statistic is less than the 5% significance level. The model is jointly significant since the probability of the F statistic is less than the 5% level of significance.

The model presents a good goodness of fit since the value of its R2 coefficient is greater than 0.9. It should be added that taking into account the decision criteria for the Durbin Watson statistic, there is no first-order autocorrelation since the Durbin Watson coefficient falls into an autocorrelation rejection zone.

On the other hand, as mentioned above, two dichotomous variables were added to this model that serve to correct breaks on specific dates during the COVID-19 pandemic. In this case, they correct breaks that occurred in June and August 2020, the coefficients of these variables are significant and in the case of June 2020 it turns out that the effect on mining exports has been negative. Therefore, as both dichotomous variables are statistically significant, they are a good replacement for the variable X5 (COVID-19) of the first model.

6. Discussion

According to the results obtained in the final regression, there is scientific evidence that verifies the general hypothesis. Exports of copper (with a statistical T of 20.17 and a p-value of 0.0000) and gold (with a statistical T of 15.94 and a p-value of 0.0000) significantly and positively affect the total value of traditional mining exports from Peru. In this sense, during the period of sanitary isolation due to COVID-19, the decline in Peru's traditional mining exports is explained by the decline in its copper and gold exports.

Regarding the behavior of the dichotomous variable of COVID-19 in this last model, they appear in two moments of break, one in June 2020 and another in August of the same year. The first is significant negative and the second is significant positive. This responds to 2 important moments in the Peruvian economy specifically for mining. Until the end of June 2020, the mining activity was operating in basic activities. By order of the government with Supreme Decree No. 101-2020-PCM, only mining exploration, storage, transportation and closure of mines were allowed as part of Phase 2 of resumption of economic activities in certain cases. These measures resulted in a negative effect on mining exports. However, on June 30, 2020 Supreme Decree No. 117-2020-PCM ordered the resumption of all mining activities as part of Phase 3 of resumption of economic activities. The implications of this trade opening had a positive effect on mining exports.

Regarding specific hypothesis 1, the results verify that there is a positive relationship between the international price of copper and traditional-mining exports from Peru. However, with the correlation coefficient of 0.65, we observe that said correlation is not very strong. Regarding specific hypothesis 2, it was expected to find a positive relationship between the international price of gold and traditional-mining exports from Peru, but it was found that this relationship is negative and very weak.

The results agree with the findings ofVasiev, Bi, Denisov &Bocharnikov (2020), He, Sun, Zhang & Li (2020) and Fried & Zhang (2020). Regarding the finding of high significance of copper and gold exports in Peru's total mining exports,Cano&Otárola (2018) and Martínez (2020) obtained similar results. In addition,Bielekova&Pokrivcak (2020), Adhikari, Sekhon& Kaur (2020), Javed, Rehman, Nabi, Razzaq, Saqib, Bakhsh, Mohibullah&Luqman (2020), Gachena, Haji, Legesse&Ketema (2020),Alam, Selvanathan&Selvanathan (2017) Hatirli&Onder (2010) found a positive impact of the exports of flag products from the countries analyzed.

In relation to the positive correlation found between the international price of copper and the total value of Peruvian mining exports, Cano &Otárola (2018) also found the same positive correlation and predicted that the evolution of the international copper price would significantly affect the total mining exports. Regarding the negative correlation found between the international price of gold and the total value of mining exports, Sarmiento-Castillo, Pérez-Rincón& Gómez-Sánchez (2018) found the same relationship for Colombian gold exports.

In relation to the demand for copper exports to China calculated according to García, Gordo, Martínez-Marín & Tello (2009), the variable was not significant but with a positive sign according to the aforementioned authors.

Regarding the positive significance of the percentage variation of the GDP of China (main buyer of Peruvian copper), it can be verified that it coincides with various authors who in their evaluations found positive significance for the percentage variation of the GDP of the countries that import products from the economies analyzed (Sarmiento-Castillo, Pérez-Rincón& Gómez-Sánchez (2018), Bielekova&Pokrivcak (2020), Straume&Asche (2020) andGachena, Haji, Legesse&Ketema (2020).

Finally, in relation to specific hypothesis 3, evidence was found that the Chinese demand for copper, measured by the percentage variation of its monthly GDP, significantly affects traditional-mining exports in Peru.

7. Conclusions

The results of this research indicate that copper and gold exports, as well as the percentage change in China's GDP play an important role in the performance of Peru's mining exports. These exports were negatively affected during the period of sanitary isolation by the COVID-19 pandemic. However, with the measure given by the government on June 30, 2020, through Supreme Decree No. 117-2020-PCM, all mining activities were resumed, causing a positive effect on mining exports.

Both the international price of copper and gold were not significant at 95%. However, in the world there is a considerable gap to be covered in the current demand for copper. This is due to the increase in industrial activity in the world, which increasingly demands copper for the development of its industries. Furthermore, this mineral currently represents a “green energy”alternative and is being considered within the green energy and decarbonization strategy in developed economies. Likewise, there is a growing demand for gold as reserves of the central banks of the different economies of the world, as well as for its use in technological applications.

8. Recommendations

Considering the findings of this research and the international economic outlook for gold and copper, it is recommended that the government and related public and private entities join forces to strengthen the responsible production of these minerals, always with a responsible social commitment to care for the environment. and to respect individual and social rights in order to avoid social conflicts and rather to achieve economic and social development for all. Likewise, looking to the future, the government is recommended to promote the development of copper and gold industrialization, which would lead to progress towards the levels of a developed economy.

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