

# 中国人民大学

## 硕士学位论文

(中文题目) 1992-2016 年期间秘鲁矿业部门与经济增长的关系  
THE RELATION BETWEEN MINING SECTOR AND  
(英文题目) ECONOMIC GROWTH IN PERU DURING THE PERIODS  
1992-2016

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## **Abstract**

The purpose of this thesis is to investigate whether imperative results about dynamic relations between economic growth and mining sector variables are valid in a small open economy such as the Peruvian. Using time series econometric approaches like cointegration technique and Vector Error Correction Model (VECM) on annual data from 1992 to 2016. The author examines how the Real GDP, mining investments, mining exports and mining sector growth, simultaneously affects one each other in the long and short-run. The present study is made on secondary data retrieved from the Central Reserve Bank of Peru (BCRP) and Ministry of Energy and Mines of Peru (MINEM).

Firstly, the study presents a diagnosis analysis which describes the evolution of the economic growth and mining sector variables in the Peruvian economy. Secondly, the study provides empirical results that the economic growth and mining economic variables are cointegrated. There is existence of a long-run relationship between them. In the short-run results suggest that changes in mining investments affect the economic growth and mining sector growth, in addition the mining sector growth affects the economic growth, all variables presented unidirectional relationships.

**Keywords:** Economic Growth; Mining; Exports; Investment.

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## Terminology

Agency for the Promotion of Private Investment .....	(PROINVERSION)
Central Reserve Bank of Peru .....	(BCRP)
Institute of Geology, Mining and Metallurgy .....	(INGEMMET)
Integrated Foreign System Trade Information System .....	(SIICEX)
Ministry of Energy and Mines of Peru .....	(MINEM)
National Institute of Statistics and Informatics .....	(INEI)
National Superintendency of Tax Administration .....	(SUNAT)
Supervisory Body for Investment in Energy and Mining .....	(OSINERGMIN)
Augemented Dickey Fuller .....	(ADF)
Akaikei Information Criterion .....	(AIC)
Hanna-Quinn Information Criterion .....	(HQIC)
Schwarz Criterion .....	(SBIC)
Error Correction Term .....	(ECT)
Vector Error Correction Model .....	(VECM)

## Chapter 1 Introduction

### 1.1 Research Background Problem

Over the time, many countries have become aware of the diverse kinds of minerals in their geographic zone and have exploited big mineral quantities. These minerals have presented a great potential for the economic growth of these countries, the role of mining activity has taken importance in terms of the generation of value added, poverty reduction, job creation and other productive sectors development, like transportation, equipment manufacturing, construction and geological services. In addition, the size of the mining industry also plays a huge factor in an open economy, trading brings funds that can flow as investments across the country, these permits foreign exchange generation and foreign direct investment increase.

After long periods of exploiting minerals, several of the richest countries in the world have gained great benefits from mineral extraction. Australia, Canada, Germany and the United States (U.S.) possess important mineral industries, which have been served as a base platform of industrial development, for instance, the U.S. become a potential economy and a manufacture leader in the last century by been the world's dominant producer of the major industrial minerals (Wright and Czelusta, 2003).

In Latin America, Peru economy stands out as it is highly influenced by economic sectors, industries such as manufacture, commerce and mining. These three major economic sectors contribute to the structure of the gross domestic product (GDP). Firstly,



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regarding the diagnosis analysis insights of this study, the manufacture sector as noted from Table 1-1 is the largest sector, followed by commerce and mining economic sectors.

Table 1-1: Real GDP by Structure (%) 1992-2016

Economic sectors	1992	1997	2002	2007	2012	2016
Manufacture	17	16	16	17	15	13
Commerce	10	10	10	10	11	11
Metallic Mining	6	7	11	10	8	11
Construction	4	6	4	5	7	6
Agriculture and livestock	6	6	7	6	6	5
Other sectors	57	55	52	52	53	54

Source: INEI. Author's table designed.

Note: The numbers correspond to ended years at i.e 2016.

As can be seen from table above, the metallic mining sector is one of the most representative an important sectors which contribute a significant percentage in the composition of the Peruvian economic growth over the sample period. From the table, it can be appreciated that all the sectors contracted their participation for about 1% and 2% in 2007 and 2012, respectively. However it is important to point out that the metallic mining sector has presented a more participation in 2016, for about 3% increase, while other sector decreased.

During the past 25 years, the Peruvian State has implemented investment promotion strategies and laws encouraging mining sector development. As a result Bautista (2014) states that since 1990s the metal resources in Peru have attracted many foreign investors who bring their capitals and work in tremendous investment projects, the mining companies expect to make huge profits from metal export oriented activities. Similarly, Olano (2013) contended that the National private investment has increased, due to the

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increase in the commitment of large mining projects over the country. Mining firms, particularly, multinational mining corporations have brought new technology and have developed production, distribution and employment generation in the regions, together with the development of other productive sectors. These investors usually concentrate their capitals in mining infrastructure, exploitation activities and mining equipment.

In this context, since the Peruvian nation is blessed with a wide variety of metals resources and mining firms are exploiting great amounts of mineral, over the time the metallic production has been increasing. In 2016, according to the U.S. Geological Survey (USG), Peru was ranked as the second largest copper, zinc and silver producer in the world, see Table 1-2. In Latin America, it ranks first in the production of gold, zinc and lead. From the table, it is inferred the position of Peru not only reflects the wealth in mineral resources reserves, but also the production capacity of Peruvian mining.

Table 1-2: Peru in the Worldwide Ranking of Mining Products in 2016

Product	Latin America	World
Gold	1	6
Copper	2	2
Silver	2	2
Zinc	1	2
Lead	1	4
Tin	2	6
Molybdenum	2	4

Source: U.S. Geological Survey-USGS

Today, Peru is exploiting in 23 out of 25 total administrative regions, and exporting the most demanded minerals and metals for the international market. The Peruvian nation is exporting a great quantity of extractive metals products mainly to China, Switzerland

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and Canada. Mining has constantly been a major source of foreign currency generation through huge metallic exports, reason why the role of mining exports in the national economy is important since it presented a constant trend increase in the past years, as indicator metallic exports accounted to 59% to total exports in 2016. It is notable that the major shares come from gold, copper, gold and zinc. However to Bautista (2014), the mining exports the increase reason near 2007 was due to the upward trend in the prices of minerals than to the increase in exported volume. Metals were driven by a super high mineral price cycle mainly for China's demand to be the world manufacturing leader as stated by Santillana (2016).

Secondly, regarding the empirical analysis made in this thesis, there have been a number of studies within financial economics exploring the relationship between the mining sector and economic growth. The vast majority of these studies showed a clear link between the importance of mineral exports and economic growth, the econometrics analysis of FDI in the mining sector and export capacity, the role of mining and the economic growth, causalities relationship between mining exports and GDP growth. These studies have presented empirical and descriptive evidenced in the many countries. Although still much of the established literature have focused on how mining variables together affect economic growth, in other words, how simultaneously these four variables, which are mining exports, mining investments, mining sector growth and economic growth, affect one another have been less documented.

Previous studies mostly rely only describe the importance of mining resources mining sector and economic growth, some of them give some empirical results about mining

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investments from FDI and the impact in economic growth, others find the relationship between mining exports and economic growth using Granger Causality, some others employed in their research the Vector Autoregressive (VAR) model.

This study employs the cointegration technique devised by Johansen (1988) that allows one to model several nonstationary endogenous variables similar to that of a VAR framework. It allows one to include the possibility of an existing linear combination of nonstationary variables that is a stationary series, in itself. This model is known as the Vector Error Correction model (VECM) and it essentially makes one able to differentiate between long- and short-run equilibrium relationships between selected variables, specifically for this study between Real GDP, mining exports, mining investments and mining sector growth.

### 1.2 Problem Statement

1. What is the diagnosis analysis about evolution of economic growth, mining exports, mining investments and mining sector growth during the periods 1992-2016?
2. Are there any long-run equilibrium relationships between mining variables and economic growth during the sample period?
3. Are there any unidirectional or bidirectional short-run causalities between mining variables and economic growth in Peru at National level during the sample period?

### 1.3 Research Objectives

The main scope of this thesis has been to provide empirical results to examine the presence of long- and short-run causalities running from the variables chosen from mining sector and the economic growth. Before that a diagnosis analysis is described

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regarding evolution of economic growth, mining exports, mining investments and mining sector growth.

This study generally seeks to determine the dynamic relationship between mining sector and economic growth in Peru during the periods 1992-2016.

1. Describe the diagnosis analysis about evolution of economic growth, mining exports, mining investments and mining sector growth during the periods 1992-2016
2. Examine if there is a long-run equilibrium relationships between mining variables and economic growth.
3. Examine if there is an unidirectional or bidirectional short-run causalities between mining variables and economic growth in Peru at National level.

### **1.4 Hypothesis**

This study hypothesis is that economic growth, mining exports, mining investments and mining sector growth do not have any relationship in the short-run and long –run in Peru over the periods from 1992 to 2016 (the null hypothesis ( $H_0$ )). On the other hand, the alternative hypothesis ( $H_1$ ) states that these mining variables and economic growth have had significant relations in the short and long-run in the context of Peru over the same period of time.

### **1.5 Research Contributions**

1. It is expected that the information provided in this research could provide an understanding to future investors about the mining sector and Peruvian economic growth performance.

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2. It is expected that the present study could inform policy makers about the long and short-run relationship between the mining exports, mining investment, mining sector GDP and economic growth, giving relevant information and imperative results using cointegration techniques and Vector Error Correlation Model (VECM).
3. It is expected that this research will benefit and be addressed to future mining investors; Policy makers; Financers; Economists; Scholars of Economics; Scholars of Finance; Mining companies; Representatives of Economic Organizations; In matters all organization analyzing the mining sector and Peruvian economic growth.

### **1.6 Scope and Limitations**

The metallic mining is one of the most representatives sectors of the Real GDP, which contributes a significant percentage in the GDP's composition. The study is limited to the brief qualitative insights developed in diagnosis analysis and mainly to the empirical results given by an econometric model developed in the research to examine the short and long-run relationship between mining variables and the Peruvian economic growth.

Overall, the results presented in this thesis are most likely sensitive towards the chosen sample period (1992-2016) and Peruvian economy, as well as the choice of time-series model and variables. However, the explicit results will not change the implications of this analysis. The study demonstrates how important are mining exports, mining investments, mining sector growth to the economic growth while describing in a diagnosis analysis, but also the cause and effect relationship among these mining variables and economic growth. The VECM, either as employed by Johansen (1988) or

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Engle & Granger (1987), has been known to be sensitive to lag order. For that reason, results from the cointegration analysis were presented at the 5% level of significance. The practical interpretation of this implies that the estimates are not efficient but still consistent.

### **1.7 Systematic Study of Writing**

In order to answer the research questions, the master thesis was divided into six chapters as follows: Following the introduction; Chapter 2 Literature Review involves the theoretical, empirical framework and previous studies regarding mining sector and economic growth, these subsections will provide the content necessary to understand the evolution and dynamic relations among mining variables and economic growth. Chapter 3 Research Methodology introduces research methods, research design, description of variables, population and sample, types and sources of data and data collection techniques. Chapter 4 Diagnosis Analysis includes the evolution of the economic growth and mining variables, using trends and describing the main important facts during the sample period. Chapter 5 Empirical Results, Interpretations and Findings, includes the creating of a model using econometric techniques to determine the short and long-run relationship between Real GDP, mining exports, mining investments and mining GDP. Finally, Chapter 6 contains the Conclusions Remarks of the research.

## **Chapter 2 Literature Review**

This section contains two parts, firstly empirical framework, including previous studies. Followed by the theoretical framework which includes theories related to economic growth, international commerce and mining regulatory aspect.

### **2.1 Empirical Framework**

#### **2.1.1 Previous Studies on Mining Sector and Economic Growth**

Over the past decades, there have been a number of studies within financial economics exploring the relationship between the mining sector and economic growth. From literature review, the main drivers of economic growth in the endogenous growth theory are the abundance of natural resources especially in the mining sector. There are a vast majority of these studies showed a clear link between the importance of mineral resource and economic growth. There are some studies that found that mineral resources and specifically in the mining sector are an input of economic growth. The United States, New Zealand, Norway, Australia, Canada, Iceland, etc. are clear examples of countries where preliminary economic development have been induced by natural resource abundance using (Mehlum et al., 2006). In this respect, Atkinson and Hamilton (2003) describe the advantage of mineral wealth as two folds. First, the discovery and development of mineral resources can lead to a short-term increase in the rate of economic growth; second, this can raise the level of income that can be sustained into the future. Additionally some papers analyze that economic development is linked with institutional regulatory performance in the mining sector. According to North (1990), by



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creating an environment that encourages voluntary transactions, risk-taking, and engaging in productive activities in general, institutions spur economic growth. One of the reasons of growth through mining resources is discussed by Sobel (2008), who stated that economic institutions are important for economic growth since they determine how economic inputs human, physical, and natural resource capital are transformed into economic outputs such as economic growth. Moreover, Ilomo (2007), in his study indicates that mineral resources are positively related to economic performance in United Arabs Emirates. However, there are some other studies that relate mining source as a course and this subject emerged since 1990s. Onyeukwu (2006) did a paper for Nigeria which showed that the country was under a resource curse during the period the study was carried out. Further work by Weeks (2008) showed that Zambia was under a resource curse trap even though the country has large reserves of the precious copper mineral amongst others. In addition, Sachs and Warner (1995) were some of the people to investigate the mining paradox, in which resource rich countries are outperformed by non-resource rich countries in economic growth and development, since there is a presence of mining course. As it can be seen there seem to be no consensus on this point at this time on whether economic growth is being boosted by natural resources, practically each country has specific factors that explain the nature of the relationship between mineral resources and, social and economic performance.

On the other hand, past studies have used macroeconomic and institutional factors to analyze the relationships between mining and economic growth in many developing economies, many studies on this areas postulate that mining investments can play a

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significant role in generating export supply to enable countries expand their international trade. It is often thought that foreign firms, particularly multi-national mining corporations have already established their production and they engage in mining export oriented activities than local firms do. In this sense, Kwan and Singh (1996) examined the determinants of FDI in developing countries. They found that among other factors, exports in general and mining sector in particular, are significant determinants for high investment in a recipient country. Using standard regressions analysis and Granger causality tests, they found that the direction of causation is predominantly from exports to FDI. Furthermore, Aloysius (2003) examined the effect of Investments on Export growth in Cameroon using Grange Causality approach. The hypothesis of the study indicated that, FDI had a positive impact on Cameroon export performance. He also found evidence that FDI inflows contributed to higher supply capacity and spillover effects in Cameroon, leading to higher export growth during the period of study.

As it can be seen, mining investments especially from FDI influence exports, in this regard, mining exports and economic growth have been studied together, different studies and researches were done by academics and policy makers were they include exports, economic growth as variables. A variety of studies shows different results about the relationship of these variables. Recently, most of studies have attended to focus on VAR and VEC models and cointegration approach. Khan (2012) presented results through cointegration analysis and VECM, and found that GDP and Exports are bidirectional related in the long run.

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Even though, there is literature regarding the mining variables and economic growth, which are the variable used in this study, there is still not much of the established literature have focused on how these mining variables and economic growth work together, in other words how mining variables and economic growth simultaneously affect one another have been less documented. The study employs the cointegration technique devised by Johansen (1988) that allows one to model several nonstationary endogenous variables similar to that of a vector autoregressive (VAR) framework. It allows one to include the possibility of an existing linear combination of nonstationary variables that is a stationary series, in itself. This model is known as the Vector Error Correction Model (VECM) and it essentially makes one able to differentiate between long- and short-run equilibrium relationships between selected variables, specifically for this study between Real GDP, mining exports, mining investments and mining GDP.

### **2.2 Theoretical Framework**

#### **2.2.1 A Brief Summary of Economic Growth Theories**

Different economists have come up with theories that describe economic growth, and over time they generate economic models using various inputs such as the population present in the country, the labor force, the investment rate, capital and consumption. This thesis will be looking at a brief summary of the Solow model, the neoclassical growth model and Romer's theory.

The neoclassical growth theory (Solow-Swan Model) is based on production functions with strict neoclassical assumptions, such as, constant returns to scale, diminishing returns to inputs and the perfect competition assumption. Only two factors, capital and

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labor, are considered in the production function. According to this model economic growth performance of a country is influenced by exogenous factors, namely, technology and population growth. According to Solow (1956), time was the only variable that affected the level of productivity.

The most important prediction of the neoclassical theory was that the poor countries would eventually converge to the per capita income levels of the rich countries. But in reality the gap between the rich and some poor countries in the world has increased. Moreover, there was divergence in incomes across nations in the world rather than convergence over the postwar era. Therefore, with its limited scope and strict neoclassical assumptions the original neoclassical growth theory failed to bring explanations to the realities observed in the world. Nevertheless, Mankiw et al. (1992) augmented Solow's model to overcome some of the above mentioned criticisms.

Later on with the new growth theories endogenous factors within the economies were recognized to be the main source that caused economic growth and accounted for the observed differences of the economic growth of countries as stated by Romer's Theory. Lucas and Romer have stressed the importance of human capital and technological progress in growth theory.

Overall, economic growth can be modeled in a basic way by three functions: the production function, the saving function, and the function that exists between saving and the size of the capital stock. Economic growth is the source by which poverty alleviation of nations or regions is sought, is the main objective of poor countries. The production function is the relationship between the level of national income and the quantities of

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production used to produce national income. If it is the level of income, the factors of production are: the stock of capital, labor, and the amount of resources used.

### **Open Economy GDP**

An open economy is an economy in which there is economic activity between local residents and outsiders. For example, people, including businesses, can trade goods and services with other people and businesses in the international community, and the funds flow in the form of investment in both directions of the border. International trade can take place in the form of management exchange, technology transfers, or all kinds of goods and services. In an open economy, the production is sold domestically and part of it is exported to be sold abroad. Furthermore, there are three approaches to measure production (GDP):

- The Expenditure approach.
- The Production approach
- The Income approach

The variables used in this study are chosen for their relation in the components of production domestic function based on GDP.

Overall, the expenditure approach is the basic and common approach:

$$Y = C + I + G + NX \quad , \text{or} \quad Y = C + I + G + (X - M)$$

- Consumption (C): These are personal consumption expenditures.
- Investment (I): This is gross private investment.
- Government (G): This category includes government spending.

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- Net Exports (NX): This is calculated by subtracting a nation's imports (M) from exports (X). Imports are goods and services produced outside the country and consumed within, and exports are goods and services produced domestically and sold to foreigners.

### 2.2.2 A Brief Summary of International Commerce Theories

Adam Smith developed the first theory on international trade or foreign trade, helping to explain the reasons why international trade occurs, if it is a phenomenon that should be considered as beneficial or harmful to society. However, Smith is positioned against mercantilist protectionism, standing in favor of the liberalization of international exchanges to promote greater welfare. He states the theory of absolute advantage, since if free trade existed, the production of the good would disappear in the countries where the elaboration of it would be inefficient due to inferior endowments of factors of production or technological reasons.

On the other hand, David Ricardo (1817) contradicted the previously established by Smith when he presented the comparative advantage theory, which explains why trade protectionism does not work in the long run. Comparative advantage is when a country produces a good or service for a lower opportunity cost than other countries.

In those times, classical economists have not yet bothered to determine what price it is to sell goods in liberalized foreign markets. Until the economist John Stuart Mill who first introduced the notion of international price. His research served to base the future concept of real relation of exchange, which was not directly deduced from the propositions of Smith and Ricardo.

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Finally, at the beginning of the twentieth century two Swedish economists explained international trade by the existence of different factors endowments of production between countries. Minerals are natural resource endowments and their uneven geographical distributions play a critically important part in explaining international trade. The Heckscher-Ohlin theory states that a country will export the good which requires the intensive use of the country's relatively abundant factor for its production, and import the good which requires the intensive use of the country's relatively scarce factor for its production. This model assumes that the technologies are similar between the different countries, and that although the exchanges of goods are free internationally, the same does not happen with the natural endowments, which cannot be moved from one nation to another.

### **2.2.3 A Brief Scope of the Peruvian Mining Regulation**

The Mining sector in Peru is regulated for many governmental institutions and legal laws. This subsection only focuses in describing the Institutional and Legal Framework. The Regulation in the mining sector is subject to the aims of a policy that promotes the rational use of mineral resources, respecting the environment and creating conditions for progress in a stable and harmonious framework for business and society.

#### **A) Institutional Regulation**

The Ministry of Energy and Mines (MINEM), one of the principal ministers in the government body in Peru, has the authority to regulate mining activities within the Peruvian territory. Likewise, the Vice Ministry of Mines is composed of three directorates:

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- General Directorate of Mining Environmental Affairs, composed by the Normative Direction of Mining Environmental Issues and the Directorate of Mining Environmental Management;
- General Directorate of Mining, composed by the Mining Technical Direction, the Mining Promotion Directorate and the Mining Regulations Directorate;
- General Directorate of Mining Formalization.

An institute related to the MINEM, is the Institute of Geology, Mining and Metallurgy (INGEMMET), a public body that has as objectives the obtention, storage, registration, procedure, administration and efficient dissemination of geoscientific information and topics related to basic geology, subsoil resources, geological risks and the geo-environment. In addition, this public entity is in charge of conducting the Ordinary Mining Procedure.

Furthermore, MINEM counts with the Energy and Mining Investment Supervisory Body (OSINERGMIN), a public entity in charge of regulating and supervising that mining companies comply with the legal provisions and technical standards in the mining sector activities related to the security aspects of infrastructure, facilities and the management of large and medium mining operations. On the other hand the regulation of small and artisanal mining is under the responsibility of MINEM and regional governments.

In this sense, OSINERGMIN executes its functions in line with the compliance of the mining policy established by the MINEM. It thus contributes to the development of mining activities in conditions of greater safety for workers and society.



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### **B) Legal Regulation**

The Peruvian State plays an important role in the organization and operation of each productive sector. In respect to mining sector, the Peruvian State dictates the laws, norms and dispositions that form part of social and economic regulation. This regulation has its premises in the Political Constitution of Peru in 1993, which represents the main source of Peruvian legal system regarding natural resources. Likewise, the Organic Law for the Exploitation of Natural Resources (Law No. 26821) and the Consolidated Text of the General Mining Law (Supreme Decree - No. 014-92), are the support of the basis of the legal framework regulation in the mining sector, see Figure 2-1. The objective of the Legal Regulation is to promote efficiency for the benefit of companies and society.

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Figure 2-1: Main Legislative Instruments of the Mining Sector



Source: OSINERGMIN

In respect to the mechanisms of management of natural resources, according to the Constitution, renewable and non-renewable resources are part of the National patrimony and the State is sovereign in the use of them. In this framework, the extractive activities can only be carried out under the concession system. The mining and hydrocarbon concessions grant the owner the right to exploration and exploitation of the resources found in the subsoil of the granted area. The concession is a real right, irrevocable and indefinite term. Overall, any investments from abroad that are destined to income-generating economic activities, under any of the schemes established in Article N°1 of the Leg. D. No. 662, must be registered with PROINVERSION. In addition, all the income derived from their investments, including from the sale of shares, stocks or rights, capital reduction, partial or total liquidation of companies. All the earnings or net profit derived from their investments, as well as any considerations for the use or enjoyment of

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goods physically located in Peru, and any royalties and considerations for the use and transfer of technology, including any other industrial property asset, must have been authorized by the Competent National Agency.

Therefore, the success of the structural reforms and the great mining potential of Peru generated in the last two decades, the mining industry is characterized by the arrival of foreign investors (FDI) from great global leadership, who have established important investment commitments with the country. One of PROINVERSION key principles is the equality in the treatment of national and foreign investments. The main regulation of the treatment of foreign investments is the Legal Stability Scheme for Foreign Investments (Legislative Decree No 662).

### **2.3 Definition of Related Concepts**

The main definitions stated in the research are divided in two groups: Economic Growth and mining variables. The concepts were based on papers reviews and books. **A)**

#### **Economic Growth**

Economic growth is the result of the increase in GDP as a whole or as an average of some competitive economic sectors and leaders in national and/ or globalized markets. When there is greater economic growth, there is greater wealth but it does not necessarily benefit all economic agents or the entire population of a country according to Plascencia and Minano (2015). The National Institute of Statistics and Informatics (INEI) define economic growth as the positive percentage variation (Var. %) of the GDP of an economy in a given period. In addition, Jimenez (2006) defines GDP as the sum of the aggregate values of each of the economic branches. The productive units that contribute

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to the generation of the GDP can be classified by productive sectors. Therefore, GDP represents the final result of the productive activity of the resident production units, which is measured from three points of view: of the added value, of the final demand and the primary income distributed by the resident production units. GDP can be calculated by the macroeconomic model of an open economy, in this study the dependent variable is Real GDP.

In this regard, the Real GDP measures the production of goods and services destined for final demand at constant prices; that is, it eliminates the distortion of the variations in prices (as much of inflation as of deflation), taking the prices of the year that is taken as a basis. The Real GDP can account for changes in price level and provide a more accurate figure of economic growth, it is usually represented by Real GDP Variation (Var %).

### **B) Mining Sector Variables**

#### **Mining GDP**

The mining sector is defined as an activity eminently linked to the extraction, production and trade of non-renewable mineral resources, with the exception of hydrocarbons, in order to obtain an economic benefit. The metallic mining activity contributes to economic growth, creates employment direct and indirect and generates income for society. Raw materials can be negotiated at spot prices and at future prices in the international financial markets, being the main stock markets United Kingdom, United States and China.

Moreover, mining is the exploitation of a mineral based on wells, drilling and galleries or opencast. The finding of useful minerals usually precede geological analyzes of the

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rock strata that surface, or geophysical studies of the subsoil, using magnetic, gravimetric, electrical, seismic, geothermal or radioactive methods, or based on drilling and exploratory drilling. In respect, metals have multiple uses and their demand is derived from the consumption of goods endings such as cars, cell phones, homes, among many others. The demand for minerals as raw material for the production of final goods depends on per capita income. On the supply side, there are countries which have a comparative advantage, both in the production and in the reserves of minerals worldwide. The mining is divided into metallic and non-metallic. In the present study, the mining sector refers exclusively to metallic mining

Table 2-2: Metallic Minerals

Type	Group	Minerals
Metallic	Precious	Gold, silver and metals of the platinum group.
	Ferrous	Iron, nickel, cobalt, titanium, vanadium, chromium.
	Basic	Copper, lead, tin and zinc
	Radioactive	Uranium, radio and thorium.
	Others	Light metals (magnesium and aluminum) and Special metals (lithium, germanium, gallium or arsenic).

Source: OSINERGMIN

### Mining Exports

It includes all the exports of metal product that are sales out of the country. Bello (2012) argues that exports come with an increasing trend, with the mining sector contributing the most to the trade balance. During the period 2007-2011, Bello mentions that the largest volume registered in Peruvian exports, correspond essentially to the mining sector, and point to gold and copper as the main responsible for this growth.

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The price level of metals influences their demand. A higher metal price causes higher costs of production of the final good. If this increase were transferred to the price of the final good (keeping the rest constant), it would generate a decrease in the quantity of its demand as articulated by Bautista J. (2014).

### **Mining Investment**

The capital injections made by enterprises in the mining sector with the expectation to generate profits after a period of time through the commitment of investment projects of the State. The mining companies usually made investments operations in plant and equipment, mining exploration, exploitation, infrastructure, among others. In order to receive capitals from local or foreign investors, the State implements monetary policies to promote mining investments.

## **Chapter 3 Research Methodology**

### **3.1 Research Design**

The first part of the research is based on literature review and data analysis describing the evolution of economic growth and mining variables. Firstly, the paper provides a descriptive approach in the diagnosis analysis section. This type of research in accordance to Brewer (2000) with attempts to qualitative describe, explain and interpret conditions of the present i.e. 'what is'. The purpose of a descriptive research is to examine the phenomenon that is occurring at specific place(s) and time.

The second inquiry of the paper is an empirical analysis, which refers specifically to the quantitative approach. A quantitative research is adopted as a research strategy for this dissertation. Quantitative research method is adopted because it allows the researcher to get the facts and not abstract about the aim of dissertation. According to Brewer (2000), quantitative research methods are basically applied to the collection of data that is structured and which could be represented numerically. Generally quantitative data is collected when researcher has adopted the positivist epistemological approach and data is collected that can be scientifically analyzed. In this regard, the study adopts the Vector Error Correction Model (VECM) regression to probe the hypothesis of relationship existence among the variables selected showed in the Empirical Results section.

### **3.2 Types Sources and Data Collection Techniques**

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The data used in this research is secondary data available in the official websites of the organizations as well as the institutional statistical memoirs, economic reports and virtual books.

For the realization of the present investigation the main sources of data are:

- Central Reserve Bank of Peru (BCRP);
- Ministry of Energy and Mines of Peru (MINEM).

Moreover, the research includes data retrieved from institutions such as:

- Supervisory Body for Investment in Energy and Mining (OSINERGMIN);
- Agency for the Promotion of Private Investment (PROINVERSION);
- Integrated Foreign System Trade Information System (SIICEX);
- National Institute of Statistics and Informatics (INEI);

Brewer, M. (2000) had argue that data collection is fundamental, the purpose is not only to measure variables to carry out inferences and statistical analyzes, but also to obtain data (that becomes information) of people, living beings, communities, situations or processes in depth. They are collected in order to analyze and understand them, so that the data obtained answer research questions and generate knowledge. As part of achieving the primary objectives, the following techniques and tasks were completed:

- Extensive literature study within the fields of economic theories, international trade theories and regulatory mining framework.
- Qualitative approach with the use of Excel.
- Design of models with the use of Stata, Eviews.
- Methodological validation of finalized models.



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### 3.3 Population and Sample

Brewer, M. (2000) states population is an entire group of individuals, objects, elements or phenomena in which a certain characteristic susceptible of being studied can be presented. The population of the research involves all the economic sectors that contribute to the economic growth in Peru among the years.

Sample is each of the elements of a set that the investigator wants to observe. The study sample is based only in the mining sector variables and the economic growth during the periods 1992-2016.

### 3.4 Description of Variables

The study has chosen a four set of variables. These includes the Real Gross Domestic Product of Peru (US\$ millions), domestic economic variables of the mining sector like the mining sector GDP, mining exports and mining investments (US\$ millions). The variables are included in the VECM as the following abbreviations:

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Table 3-1: Variables description

Variable	Abbreviation	Source	Frequency	Data type	Publication date
Real Gross Domestic Product of Peru	GDP	BCRP	Annually	Real in millions US\$.	End of each year
Total Mining Exports	MEXP	BCRP, MINEM	Annually	FOB in millions US\$.	End of each year
Total Mining Investments	MINV	MINEM, PROINVERSION	Annually	Gross in millions US\$.	End of each year
Mining GDP	GRMIN	BCRP	Annually	Real in millions US\$.	End of each year

Source: Author's table designed.

This thesis makes use of annually data spanning from 1992 to 2016, resulting in a total of 25 time series observations, which is considered sufficient for an analysis. In order to diminish the issues of multicollinearity and heteroscedasticity, all variables were converted into natural logarithm (log-transformed).

## The dependent Variable (Y)

The dependent variable is the variable that is influenced or affected by the explanatory variables in this study.

In this research the dependent variable is the Real Gross Domestic Product of Peru (Y) in Peru.

## Explanatory Variables (X1, X2, X3)

The explanatory variable is often the predictor variables which affect the depended variable. Independent variables cause a change in other variables. The independent variables in this study are the mining variables.

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In the study, these are the total mining exports, total mining investments and mining GDP.

### **3.5 Empirical Analysis**

#### **3.5.1 Unit Root and Stationarity Test**

In standard regression methods such as ordinary least squares (OLS), variables need to be covariance stationary. A variable is said to be covariance stationary if its mean and all its autocorrelation are finite and do not change over time. However, when variables do not meet the assumption of covariance stationarity, the cointegration methodology presents a framework for estimation, inference and interpretation. In general, many economic time series are not covariance stationary. Hence, the first step in the analysis was testing stationarity properties of the variables, using a unit root test. If a time series have a unit root, the independence assumption of the ordinary least squares methodology will be violated and the results are not valid, i.e. there will be a regression that provides statistical evidence of linear relation between independent non-stationary variables and this is regression problem and the results might be incorrect and misleading. The time series included in the model should be stationary. This means that the variance and mean should be constant over time and the covariance between two time periods should only depend on the distance between the two time periods and not the actual time at which the covariance is estimated. In stationary time series, the effect of a shock will be temporary and over time, the series will revert back to their long-run mean values. Nonstationary time series have variance and mean that depend on time.

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The cointegrating analysis requires pre-testing of the data in order to examine the stationary properties of the time series. If the time series is stationary in level, it is a covariance-stationary process and if the variables become stationary after first differencing, they are said to be integrated of order 1, or I (1) processes (Wooldridge, 2009). Only variables integrated of the same order may be cointegrated and to check the stationary nature of the series, in this research only the Augmented Dickey-Fuller (ADF) is employed. However, there are other tests such as Philips-Perron (PP) and Kwiatkowski-Philips-Schmidt-Shin (KPSS).

The Augmented Dickey-Fuller Test:

In statistics and econometrics, the ADF tests the null hypothesis (Ho) that a unit root is present in a time series sample. The alternative hypothesis is different depending on which version of the test is used, but is usually stationarity or trend-stationarity. The testing procedure for the ADF is the following equation:

$$\Delta y_t = \alpha_0 + \beta T + \theta y_{t-1} + \sum_{i=1}^N \alpha_i \Delta y_{t-i} + \epsilon_t$$

$$\Delta y_t = \alpha_0 + \beta T + \theta y_{t-1} + \epsilon_t$$

Where  $\theta = (\rho - 1)$ ,  $y_t$  is the variable of interest, where  $\alpha$  is a constant,  $\beta$  the coefficient on a time trend and is the intercept,  $T$  is a linear time trend,  $\Delta$  is the first difference operator, and  $\epsilon_t$  is assumed to be identical and independently distributed with zero mean and constant variance.

### **3.5.2 Selection of Optimal Lag**

An appropriate lag length for the model has to be chosen before applying the Johansen cointegration test. The lag length is often dictated by the frequency of the data, however the chosen technique will be misspecified if the lag length is too small and over parameterized if the number of lags is too large. The lag order selection includes some information criteria's such as Akaike's Information Criterion (AIC), Hanna-Quinn Information Criterion (HQIC) and Schwarz Criterion (SBIC)

In this study we base the optimal lag length selection employing Akaike's Information Criterion, which is one of the most commonly used information criteria.

Akaike's Information Criterion:

AIC is an estimator of the relative quality of statistical models for a given set of data. Given a collection of models for the data, AIC estimates the quality of each model, relative to each of the other models. The idea of AIC (Akaike, 1973) is to select the model that minimizes the negative likelihood penalized by the number of parameters as specified in the equation. Given a set of candidate models for the data, the preferred model is the one with the minimum AIC value.

### **3.5.3 Cointegration Test**

Cointegration refers to the situation where nonstationary time series of the same order have a long-run relationship. Variables that are cointegrated share common stochastic trends and would not drift apart over time. The presence of cointegration improves long-run forecast accuracy and allows separation of short- and long run relationship among variables. After determining the order of integration of each variable,

we performed cointegrating tests to examine if there were any cointegrating relations present in the model.

Two popular cointegrating tests used in the empirical works are the Engle & Granger (1987) test and the Johansen test (1988). This study employed the Johansen test to seek for the existence of long-run equilibrium relationship between the variables of equal order of integration via the design of cointegration equation(s). The Johansen and Juselius test method uses two principle which involve in comparing the trace statistics to their corresponding critical values at each stage. The the number of characteristic roots can be tested by considering Trace and Maximum Eigenvalue tests.

#### 3.5.4 Vector Error Correction Model

The Vector Error Correction Model (VECM) is a restrictive vector auto regressive (VAR) model that can be used to approximate time series data that are non-stationary and which are known to be cointegrated. It is planned in such a manner that it limits the long-run relationship of the explanatory variables to meet their cointegration relationship and at the same time permit for short-run correction. This equation helps to describe the situation:

$$\Delta x_t = \pi_0 + \sum_{i=1}^n \pi_1 \Delta x_{t-i} + \sum_{i=1}^m \pi_2 \Delta y_{t-i} + \delta ECT_{t-1} + \epsilon_{1t}$$

Where  $\Delta$  is the first difference operator,  $n$  and  $m$  are the optimal lag lengths of the variables,  $\delta$  and  $\lambda$  are the coefficients of the error correction term (ECM) which represents the speed of adjustment to the long-run equilibrium,  $ECT_{t-1}$  are the residuals

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from the cointegrating equation and  $\epsilon_{1t}$  and  $\epsilon_{2t}$  are the error terms where  $E(\epsilon_{it}) = 0$  and  $i = 1, 2$ .

The equation is used to test the causality running from  $x_t$  to  $y_t$ , where causality can be divided into short-run and long-run relations. The significant coefficient of the lagged error correction term determines the long-run causality. For instance, a significant and negative  $ECT_{t-1}$  implies that there is a long-run causality running from the explanatory variables to the dependent variable. The coefficient of this lagged  $ECT$  represents the short-term percentage adjustment by which the long-run disequilibrium in the dependent variable is corrected in each period.

The short-run causality is tested either by the looking at the significance of each lagged explanatory variable, if the t-test is insignificant, it indicates that the dependent variable is strictly exogenous. It is possible for a model to exhibit short-run causality without any long-run causality and viceversa.

### 3.6 Model Specification

For the model, in order to diminish the issues of multicollinearity and heteroscedasticity, all variables were converted into natural logarithm (log-transformed). In further, the stationary variables at first difference in the model can be denoted as the followings ADF equation (1):

$$\begin{aligned}\Delta GDP_t &= L\_GDP_t - L\_GDP_{t-1} = \frac{L\_GDP_t}{L\_GDP_{t-1}} \\ \Delta MEXP_t &= L\_MEXP_t - L\_MEXP_{t-1} = \frac{L\_MEXP_t}{L\_MEXP_{t-1}} \\ \Delta MINV_t &= L\_MINV_t - L\_MINV_{t-1} = \frac{L\_MINV_t}{L\_MINV_{t-1}}\end{aligned}$$

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$$\Delta GRMIN_t = L\_GRMIN_t - L\_GRMIN_{t-1} = \frac{L\_GRMIN_t}{L\_GRMIN_{t-1}}$$

$$\Delta GDP_t = \alpha_0 + \alpha_{MEXP} * \Delta MEXP_t + \alpha_{MINV} * \Delta MINV_t + \alpha_{GRMIN} * \Delta GRMIN_t$$

In respect to GDP, the corresponding model can be written as follows within the VECM framework to express long run causalities:

$$\begin{aligned} \Delta GDP_t = \pi_0 + \sum_{i=1}^2 \pi_1 \Delta GDP_{t-i} + \sum_{i=1}^2 \pi_2 \Delta MEXP_{t-i} + \sum_{i=1}^2 \pi_3 \Delta MINV_{t-i} \\ + \sum_{i=1}^2 \pi_4 \Delta GRMIN_{t-i} + \delta ECT_{t-1} + \epsilon_t \end{aligned}$$

In this equation, the coefficient ( $\delta$ ) represents GDP's speed of adjustment to its long-run equilibrium, while  $ECT_{t-1}$  refers to error corrector term, and  $\pi_0, \pi_1, \pi_2, \pi_3, \pi_4$ , are the coefficients of the lagged short-run relationships for the different variables towards  $\Delta GDP_t$ . The VECM for the other variables ( $\Delta MEXP_t, \Delta MINV_t, \Delta GRMIN_t$ ) can be expressed similarly.

In this paper, there are four variables. The error correction model (ECM) can be extended to the following equation:

$$\delta GDP_{t-1} = \delta(\beta_1 L\_GDP_t + \beta_2 L\_MEXP_t + \beta_3 L\_MINV_t + \beta_4 GRMIN_t)$$



## **Chapter 4 Diagnosis Analysis**

The analysis in this chapter corresponds only to examine the evolution of economic growth and mining variables, followed by the preliminary results of the variables.

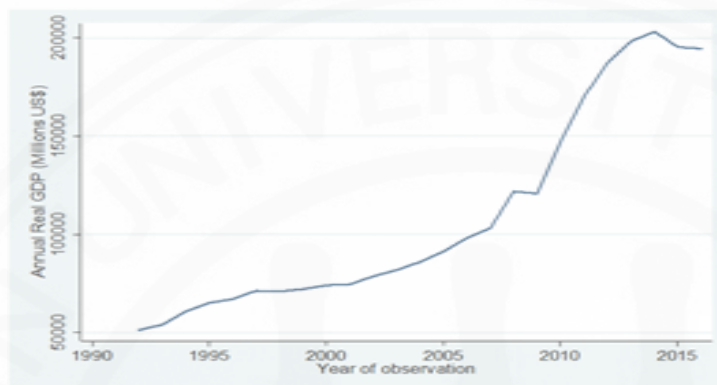
### **4.1 Economic Growth Variable**

A country of 31.5 million people is one of Latin America's fastest-growing economies. Peru has rich deposits of copper, gold, silver, lead, zinc, natural gas and petroleum. It is also a very diverse country due to climatic, natural and cultural variations of its regions. Peru's economy reflects its varied geography, an arid coastal region, the Andes further inland, and tropical lands bordering Colombia and Brazil. Abundant mineral resources are found mainly in the mountainous areas, and Peru's coastal waters provide excellent fishing grounds.

After a weak 2.4% growth in 2014, mainly caused by the global decline of commodity prices influenced by the international financial crisis of U.S. and Europe, Peru's economy has gradually recovered showing a grew of 3.3% in 2015 and nearly 4% in 2016. The economic growth showed exactly a Real GDP of 3.9%. In the last years, the acceleration was largely driven by a recovery of mining export volumes, which has gone hand in hand with trade and private investment opening that permitted several foreign investor to develop large-scale mines which entered into exploration, exploitation and production.

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Figure 4-1: Real GDP (US\$ millions) 1992-2016



Source: Graph plotted using Stata.

Table 4-1: Real GDP (US\$ millions) 1992-2016

Annual Time Series	1992	1997	2002	2007	2012	2016
Real GDP	51,339	71,343	78,591	103,127	187,510	194,706

Source: BCRP

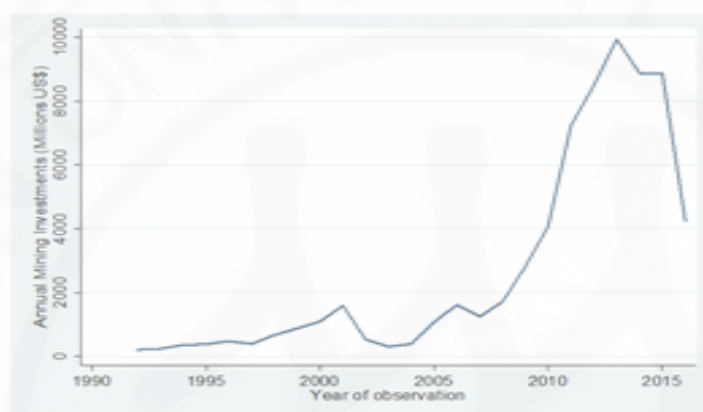
The country's positive growth performance has much to do with the competent monetary and fiscal policy pursued particularly over the last decade, with falling levels of public indebtedness (from 44.3% of GDP in 2004 to just 23.3% in 2015) and foreign reserves reaching US\$ 61.9 billions based on information available in December 2016.

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### 4.2 Mining Variables

#### 4.2.1 Mining Investments

Figure 4-2: Mining Investments (US\$ millions) 1992-2016



Source: Graph plotted using Stata

Table 4-2: Mining Investments (US\$ millions) 1992-2016

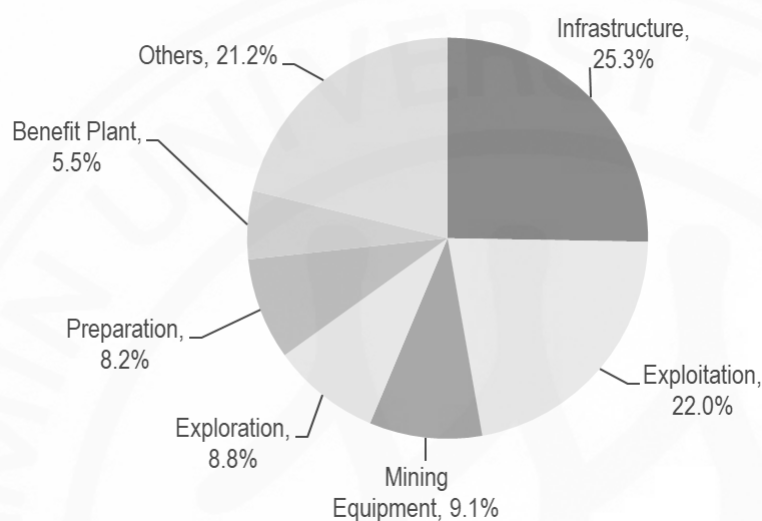
Annual Time Series	1992	1997	2002	2007	2012	2016
Mining Investments	215	389	529	1,249	8,504	4,251

Source: MINEM

In Peru, investment performance of the mining sector obtained its greatest expansion between 2004 and 2013. In 2016, investment was affected by changes in the market and business strategies to meet the external demand for basic metals accompanied by the State with the objective of strengthening the activity by designing promotion strategies to reach and exceed the maximum levels registered three years ago, of which the results will be seen from 2018. Thus, in 2016, mining investment in Peru fell by 44% totaling US\$ 4,251 million.

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Figure 4-3: Mining Investments by Categories (% Structure) 2016



Source: MINEM

Regarding the mining investments by category, in 2016, the Exploitation field, investments totaled US\$933 million; which highlights the increase by Mining Company Antapaccay S.A. of 69% which positions it in the first place in this category followed by Mining Consortium Horizonte S.A. and La Arena S.A. (US\$ 155 and US\$100 million, respectively), among others, which raised 294 companies.

The investments in the Mining Equipment item totaled US\$ 386 million, which is 41% lower than that registered in the previous year. Southern Peru Copper Corporation is in the top positions in this category; Mining Company Antapaccay S.A. and Society Mining Cerro Verde S.A.A. with US\$ 73, US\$ 68 and US\$ 60 million, respectively. In total 236 companies declared investments in this area.

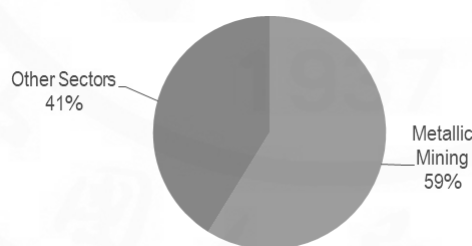
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Meanwhile, the investments executed in the "Exploration" attack fell for the third year in a row to its lowest level in seven years, totaling US\$ 373 million, which represents a fall of 29% compared to 2015. This drop reflects a trend world.

Most the economy's Domestic private investment (DPI) is sustained by projects in the mining and hydrocarbon sectors, with the mining sector also receiving about a quarter of the economy's FDI. DPI and FDI have been increasing thanks to economy's macroeconomic stability, laws encouraging investment and the community involvement initiated by some mining operating companies. Furthermore, the FDI in Peru helps to encourage technology transfer and brings with it additional management expertise. The stability of the Peruvian judicial framework has also helped to encourage investment in mining.

### 4.2.2 Mining Exports

Figure 4-4: Participation (%) of Mining Exports in National Exports



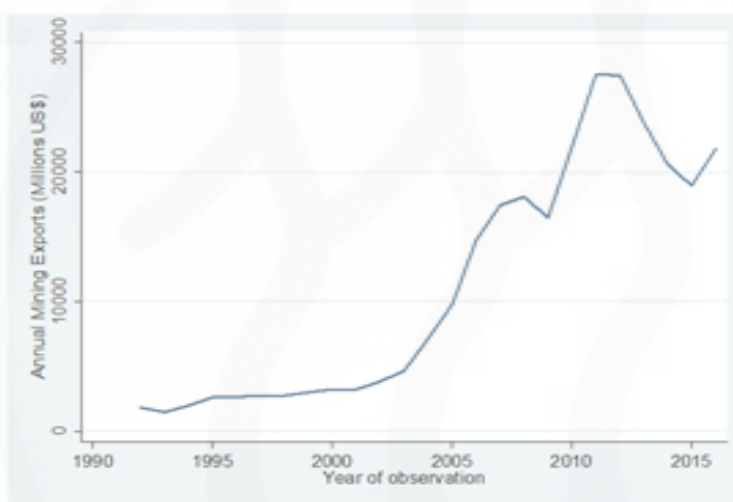
Source: BCRP

In 2016, Peruvian exports are classified in two largest groups, these are traditional exports and non-traditional exports. However, traditional exports contribute the most in the Peruvian trade balance.

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The traditional products are decomposed mainly in mining metals, oil and derivatives, fishing and agricultural products. In 2016, the metallic mining products reached a 58.8%, oil and derivatives 6%, fishing 3.4% and agricultural 2.4% of the total participation of traditional exported products.

Figure 4-5: Mining Exports (US\$ millions) 1992-2016



Source: Graph using Stata

Table 4-3: Mining Exports (US\$ millions) 1992-2016

Annual Time Series	1992	1997	2002	2007	2012	2016
Mining Investments	215	389	529	1, 249	8, 504	4, 251

Source: MINEM

In 2016, according to the information given by the Ministry of Energy and Mines of Peru (MINEM), total mining exports accounted to 58% of the total country's exports, this include:

- Metallic products (58.8% of total exports);

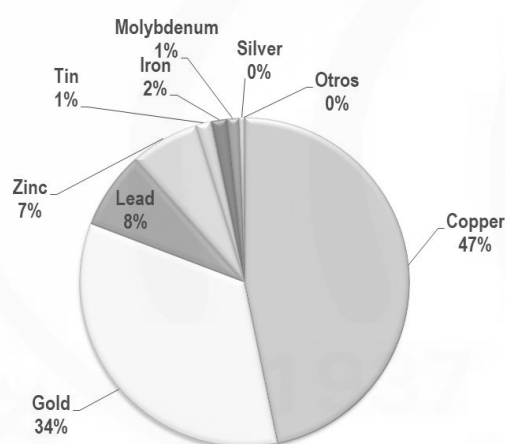
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- Non-metallic minerals; Iron and steel, and jewelry products; and metal mechanic products. (together 6.2% of total exports).

Among the main export destinations for metallic products, China stands out, accounting for 34% of shipments (US \$ 7,405 million), mainly copper, gold, zinc, iron and molybdenum; it is followed by Switzerland with 12% (US \$ 2,539 million mostly gold and silver) and the United States with 10% (US \$ 2,250 million). Then follow Canada (6%), South Korea and Japan (5%), India (4%), Brazil (3%), among others.

### Major Metallic Exports Products

Figure 4-6: Main Metals in Mining Metals Exports (%) 2016



Source: BCRP

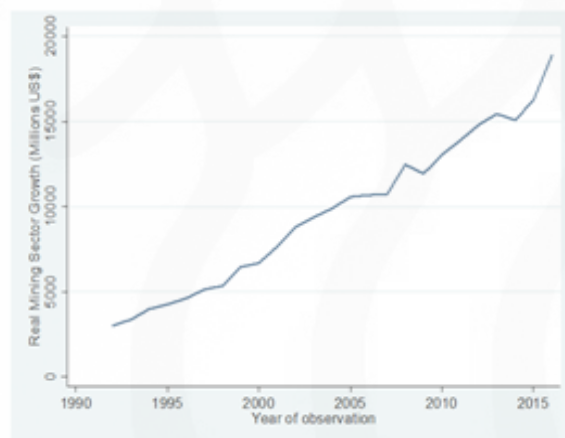
As mentioned, Metallic products accounts to 58.8% of National exports. In Peru, the main metallic products by the external demand market are copper by 47%, followed by gold by 34%, lead 8% and zinc by 7%, among others, of the metallic products exports (US\$ 21,777 million) in the period 2016.

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In the following graph, it is noted that copper is currently the main export product, representing 27.5% (US\$ 10,168 million) of the value of total Metallic exports (US\$ 21,777 million) abroad. Gold represented 20% in the same year, finally lead and zinc with 4.5% and 4%, respectively.

### 4.2.3 Mining Sector GDP

Figure 4-7: Mining Sector GDP (US\$ millions) 1992-2016



Source: Graph using Stata

Table 4-4: Mining Sector Growth (US\$ millions) 1992-2016

Annual Time Series	1992	1997	2002	2007	2012	2016
Mining Sector GDP (GRMIN)	3,012	5,150	8,810	10,727	14,802	18,861

Source: MINEM

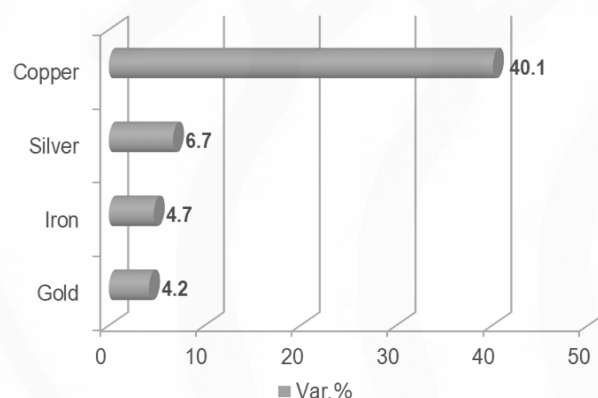
The extraction activity of oil, gas, minerals and related services presented a rise of 16.3% in 2016, compared to the year 2015, mainly due to the increase in the production of minerals and related services by 21.2%, supported by the increase in copper production (40.1%), mainly from the companies Mining Society Cerro Verde S.A.A., Mining



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Company Antamina S.A., Mining Company Las Bambas S.A., and Mining Company Antapaccay S.A. The increase of silver production (6.7%) due to rise in volumes extracted by companies Mining Company Buenaventura S.A.A., Mining Company Antamina S.A. and Mining Company Ares S.A.C. Additionally, the production increase of iron (4.7%) made by the company Shougang Iron Peru S.A.A., the main company that extracts this mineral, finally an increase in gold production (4.2%) among others.

Figure 4-8: Extraction of Main Mining Products, 2016 (Var. %)  
Physical Volume Index



Source: INEI

### 4.3 Summary of Diagnosis Analysis of Variables

According to the preliminary results presented in the following Table 4-1, the dataset consists of 25 annual time series observations, presented in millions (US\$) with no missing gaps between observations. The table presents an outline of the statistical description of each of the four variables which in this case the variables are measured on different scales, hence the variables have very different means and standard deviations.

Table 4-5: Summary Statistics of Variables (1992- 2016)

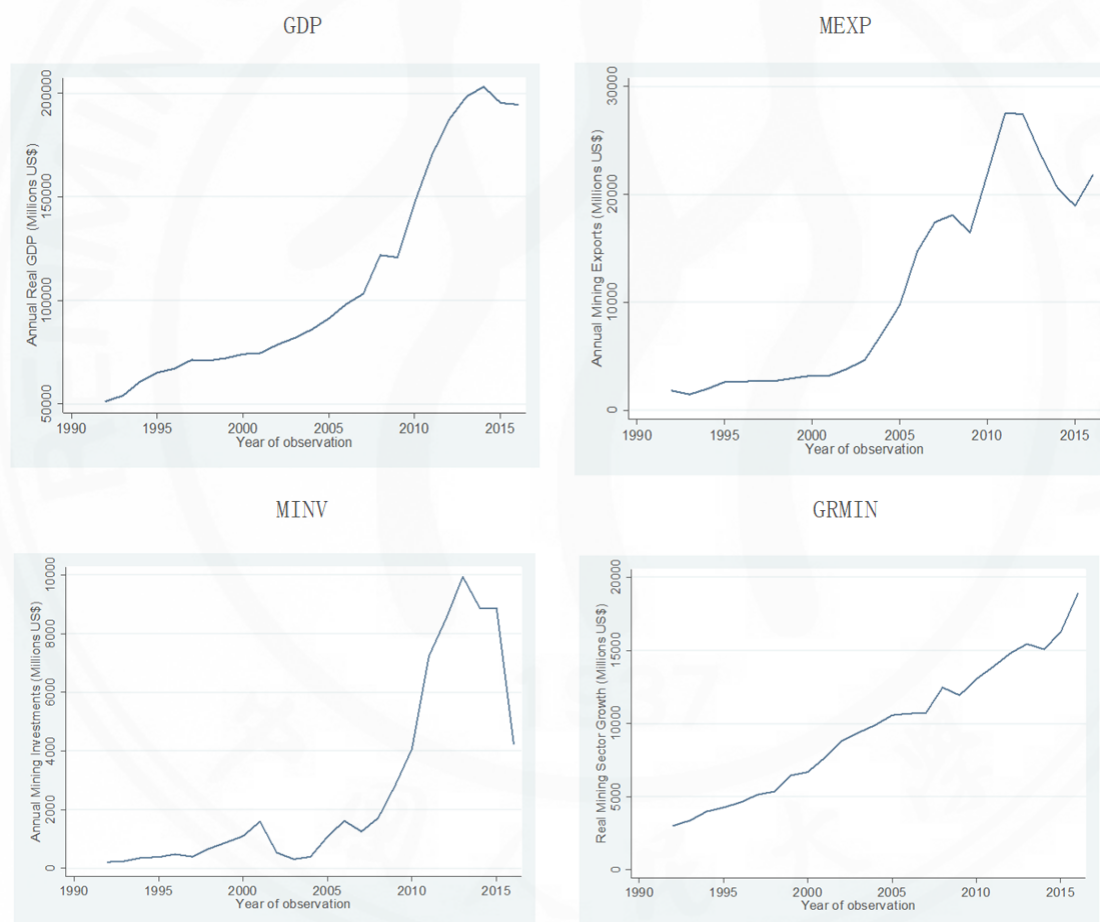
Variable	GDP	MEXP	MINV	GRMIN
----------	-----	------	------	-------

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Obs	25	25	25	25
Mean	109,596.20	11,182.80	2,710.27	9,697.65
Std. Dev.	52,051.66	9,261.01	3,255.46	4,547.17
Min	51,339.00	1,472.55	215.00	3,011.82
Max	203,231.70	27,525.67	9,940.42	18,861.25

Source: Table designed using Stata.

Figure 4-9: Graphical Analysis of Variables at Level



Source: Graphs plotted using Stata.

In general, the table provides a general idea of the internal consistency of GDP, MEXP, MINV and GRMIN. In order to interpret the behavior of the time series through years, Figure 1 presents the graphical analysis of all the variables.

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As can be observed from Figure 4-9, the visual graphs of the variables at level show a clear approach of trends for the time series. It can be deducted about the character of trend in all the graphics there is a smooth growth over the span of 25 years, although it can be appreciated that since 2007 the increase is even greater. Overall, in all the cases considered, it can be seen there is a relationship among the variables and it seems there is a causal relationship, however it cannot be affirmed from graphical insights.

## Chapter 5 Empirical Results, Interpretations and Findings

The analysis in this chapter can be divided into five parts. The first part tests the stationarity properties of the time series, the second part selects the optimal lag for the model, followed by the tests for cointegration relations by utilizing the Vector Error Correction Model (VECM). Finally, in the fourth part the model is evaluated for the test of normally distributed disturbances and test of stability condition.

Table 5-1: Definitions of Variables and Time Series Transformation

Variable	Definitions of Variables
$L\_GDP_t$	Natural logarithm of the annual Real Gross Domestic Product of Peru in millions US\$.
$L\_MEXP_t$	Natural logarithm of the annual total Mining Exports in millions US\$.
$L\_MINV_t$	Natural logarithm of the annual total Mining Investments in millions US\$.
$L\_GRMIN_t$	Natural logarithm of the annual Mining Sector GDP in millions US\$.
Transformation	Definitions of Transformations
$\Delta GDP = D\_L\_GDP = L\_GDP_t - L\_GDP_{t-1}$	Annual change in the Real Gross Domestic Product of Peru in millions US\$.
$\Delta MEXP = D\_L\_MEXP = L\_MEXP_t - L\_MEXP_{t-1}$	Annual change in the total Mining Exports in millions US\$.
$\Delta MINV = D\_L\_MINV = L\_MINV_t - L\_MINV_{t-1}$	Annual change in the Mining Investments in millions US\$.
$\Delta GRMIN = D\_L\_GRMIN = L\_GRMIN_t - L\_GRMIN_{t-1}$	Annual change in the Mining Sector GDP in millions US\$.

Source: The variables are denoted at level and first difference.

### 5.1 Results of Unit Root and Stationarity Test

Many economic time series have a common tendency of growing over time and

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one must recognize that some series contain a time trend in order to draw causal inference in time series analysis. Ignoring the fact that two series are trending may lead to false interpretation of the causal relationship as articulated Wooldridge (2009).

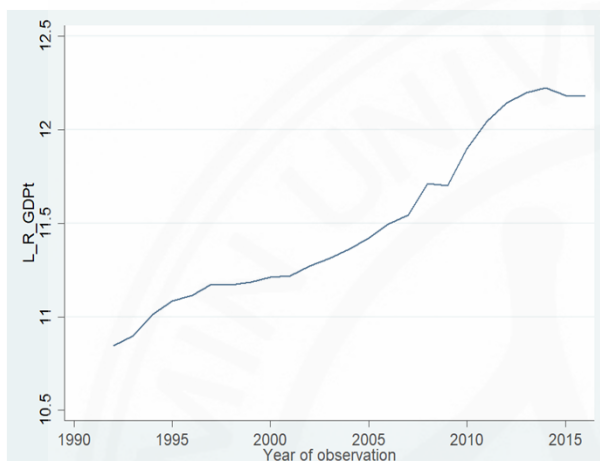
When testing the stationary properties of all the variables in a model, one has to specify which model of the unit root test is utilized, it refers whether to include a constant, a constant and a trend, or neither a trend or a constant in the test regression. The critical values of the test statistics generally increase when including a time trend (Wooldridge, 2009).

In respect, Figure 5-1 presents the graphical plots comparison between variables in natural logarithms at level and first difference of the annual time series from 1992 until 2016. The following graphs reveal that  $L\_GDP$ ,  $L\_EXP$ ,  $L\_INV$  and  $L\_GRMIN$  exhibited linear trend characteristics at level, because the four variables increased in the sample period, for that reason, a trend and a constant were included when testing the stationary properties of these variables. On the other hand, after taking the first difference ( $\Delta$ :  $D\_L\_GDP$ ,  $D\_L\_MINV$ ,  $D\_L\_MEXP$ ,  $D\_L\_GRMIN$ ) the linear trends from the series are removed. For that reason, a model that only includes an intercept will be used when testing for stationarity.

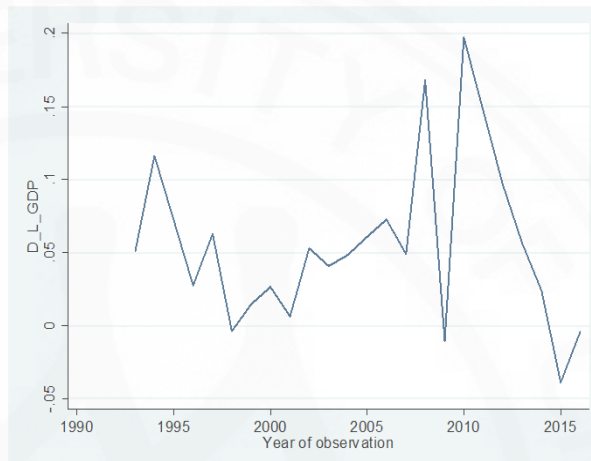
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Figure 5-1: Graphical Analysis Comparison at Level and First Difference

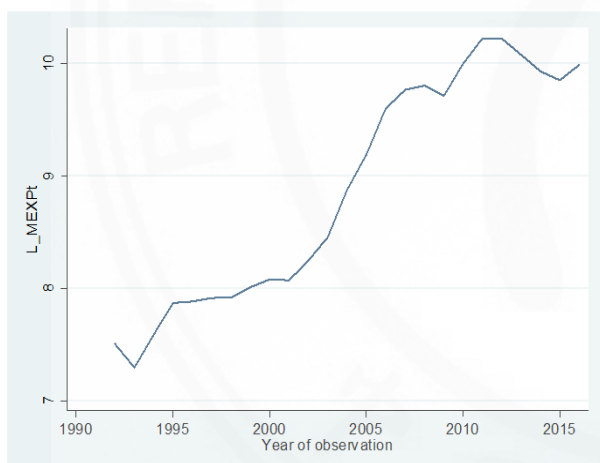
At Level: L\_GDP



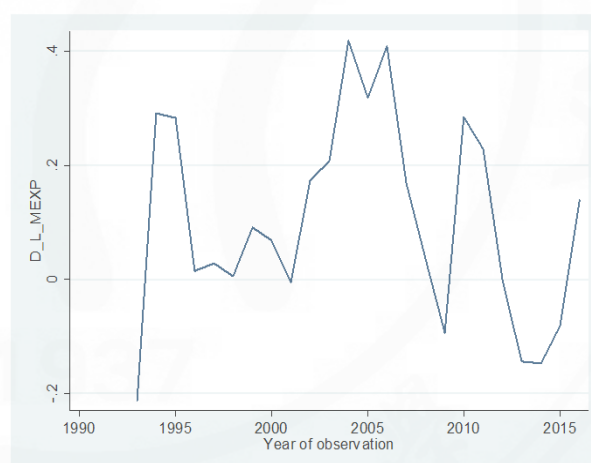
At First Difference: D\_L\_GDP



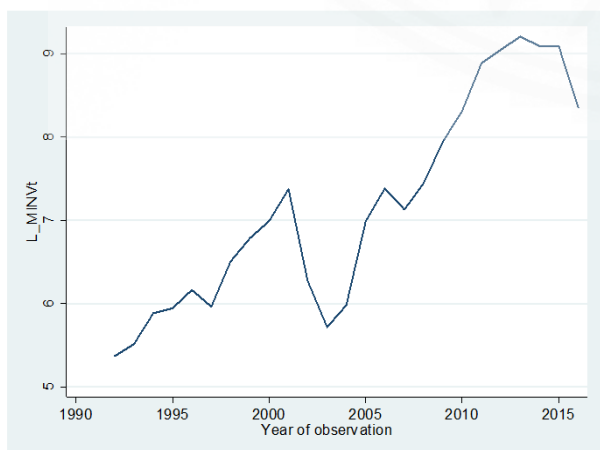
At Level: L\_MEXP



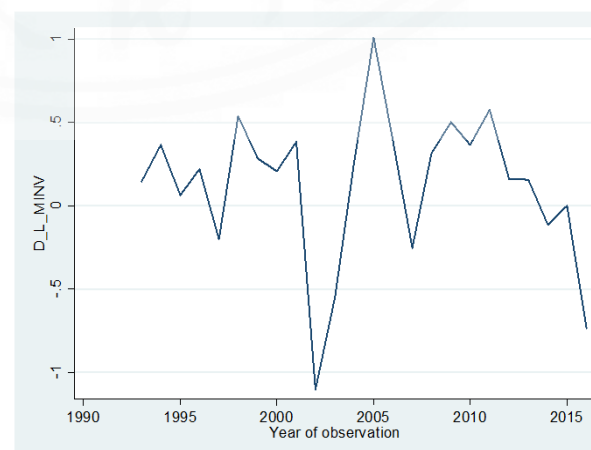
At First Difference: D\_L\_MEXP



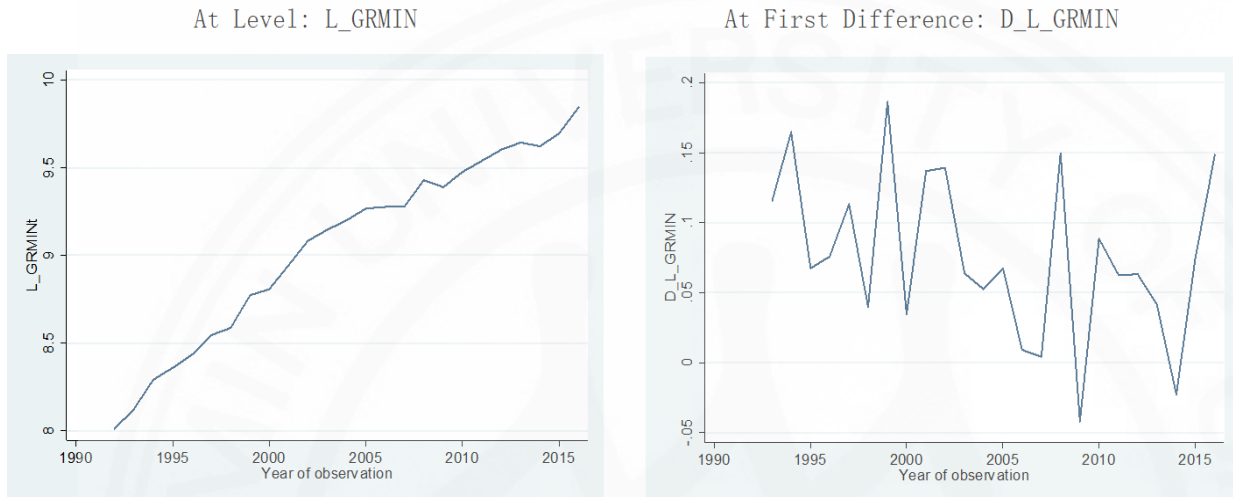
At Level: L\_MINV



At First Difference: D\_L\_MINV



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Source: Graphs plotted using Stata.

The stationarity is employed through Unit Root Test which checks whether each data series is integrated and has a unit root. The study employed Augmented Dickey Fuller (ADF) stating if a unit root was rejected at level in the latter model, there was no reason to perform additional testing at first difference.

From the Table 5-2 it is inferred evidently that the ADF test suggest the presence of unit root in levels, which implies that the four series are non-stationarity and has unit root, technically known as integrated to order zero  $I(0)$ . Therefore, the null hypothesis ( $H_0$ ) of unit root cannot be rejected as the ADF test statistics does not exceed the critical values at level.

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Table 5-2: Augmented Dickey Fuller - Stationarity Test Results

Variable	t-Statistic	At Level		Conclusion
		Critical Value		
		1%	5%	
L_GDP	-1.536	-4.380	-3.600	Non-stationary
L_MEXP	-2.032	-4.380	-3.600	Non-stationary
L_MINV	-2.225	-4.380	-3.600	Non-stationary
L_GRMIN	-1.264	-4.380	-3.600	Non-stationary

Variable	t-Statistic	At First Difference		Conclusion
		Critical Value		
		1%	5%	
D_L_GDP	-3.727**	-3.750	-3.000	Stationary
D_L_MEXP	-3.364**	-3.750	-3.000	Stationary
D_L_MINV	-3.260**	-3.750	-3.000	Stationary
D L GRMIN	-5.281**	-3.750	-3.000	Stationary

Source: Author's summary estimation using Stata.

Notes: \*\*Denotes for 5% significance level. At first difference, the optimal lag length according to Akaike's information criterion for  $\Delta$  were zero (0) lags.

On the other hand, while first differencing the four variables yield apparent lack of a unit root, since the test statistics exceed the critical value at least at 5%, which implies the study to reject the  $H_0$  of unit root in ADF test results shown in Table 5-2. In other words, the four series are stationary and are integrated at order one  $I(1)$ .

For instance, the result of ADF test for the four variables are not stationary  $I(0)$  'at level' but the all the variables becomes stationary at order  $I(1)$  'at first difference', which qualify the study to follow with the cointegration test in further.

## 5.2 Selection of Optimal Lag

An appropriate lag length for the model has to be chosen before applying the Johansen cointegration test. The technique will be misspecified if the lag length is too



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small and over parameterized if the number of lags is too large. The lag order selection includes some information criteria's such as Akaike's Information Criterion (AIC), Hanna-Quinn Information Criterion (HQIC) and Schwarz Criterion (SBIC), however the study has chosen the AIC as the best parameter for lag selection considering that the variables are stationary at order one I (1).

Since the annual data sample is small, the study only estimates the unrestricted Vector Autoregressive (VAR) model with all the variables from the lag 0 to lag 3. From the results of Table 5-3, AIC and HQIC suggest the optimal lag length of 2, which is determined by the minimized value of the information criteria, referring specifically to AIC criteria. Therefore, this 2 lags order will be the input when testing Johansen cointegration analysis and Vector Error Correction Model (VECM).

Table 5-3: Lag Order Selection by Criterion

Lag	AIC	HIC	SBIC
0	-4.9492	-4.9103	-4.75005*
1	-5.1165	-4.9222	-4.1208
2	-5.29397*	-4.9441*	-3.5017
3	-5.2128	-4.7074	-2.6239

Source: Author's summary estimation using Stata.

Note: \*The lag with the smallest value is the order selected by the criterion.

### 5.3 Result of Cointegration Test

Due to there are multivariate time series, the multivariate cointegration technique employed in the study is Johansen Cointegration test through two criterions, Trace test and Maximum Eigenvalue which compare the probability of the unconstrained model

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(include cointegrating equations) with the constrained model (not include cointegrating equations). The tests were employed using the optimal 2 lag length in order to obtain whether the stationarity variables are cointegrated or not in the long-run relation. The principle involves in comparing the trace statistics to their corresponding critical values at each stage. The test is completed when the null hypothesis ( $H_0$ ) is not rejected at the first time.

Table 5-4: Unrestricted Cointegration: Trace Test

Ho	Eigenvalue	Trace Statistic	5% Critical Value	Decision
none	.	59.2424	47.21	Accept Ho
At most 1	0.40473	21.7574*	29.68	Accept Ho
At most 2	0.80403	9.8263	15.41	Reject Ho

Source: Author's summary estimation using Stata.

Note:\* Implies at most 1 integration equation at the 5% level.

Table 5-5: Unrestricted Cointegration: Maximum Eigenvalue

Ho		Max Statistic	5% Critical Value	Decision
none	.	37.485	27.07	Accept Ho
At most 1	0.80403	11.9310*	20.97	Accept Ho
At most 2	0.40473	8.1355	14.07	Reject Ho

Source: Author's summary estimation using Stata.

Note:\* Implies at most 1 integration equation at the 5% level.

As shown in Table 5-4 Trace test results, 59.24 is greater than 47.21 of critical value of the trace statistic  $\boldsymbol{\theta}(0)$ . Therefore, we reject the null hypothesis of no cointegrating vector, and instead we accept the alternative hypothesis that one or more cointegrating vectors have founded. Next, the  $\boldsymbol{\theta}$  trace statistic is performed to test the null hypothesis of at most 1 cointegrating equation, the  $\boldsymbol{\theta}(1)$  trace statistic is 21.76, which is

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less than the critical value of 29.68. Hence, there is 1 cointegrating relation in the model. In addition, the results in Table 5-5, the comparison of Maximum Eigenvalue and critical values indicate the presence of 1 cointegrating vector, confirming Trace test results. Therefore, having a cointegration equation in the model means the variables adjust in order to eliminate short-run deviations from the long-run equilibrium. And now the study can conclude that there is indeed a long-run dynamic relationship among the four variables.

### 5.4. Results of Vector Error Correction Model

Given the finding that variables are cointegrated with 1 equation, the paper utilizes the cointegration vector to construct the Vector Error Correction model (VECM).

#### 5.4.1 Evaluation of the Equation in VEC Model

Table 5-6: Unrestricted Cointegration: Maximum Eigenvalue

Equation	Parms	RMSE	R-sq	chi2	P>chi2
D_L_GDP	6	0.060347	0.5754	23.03941	0.0008
D_L_MEXP	6	0.138901	0.6491	31.44879	0.0000
D_L_MINV	6	0.364868	0.5504	20.81106	0.0020
D_L_GRMIN	6	0.05731	0.7305	46.08163	0.0000

Source: Table designed using Stata.

The results of Table 5-6 show the fit of the cointegrating equation in the VEC Model along sides their corresponding P-value. The table presents that each of the equation are statistically significant. Thereby, it is implied that the equation fit well in the VECM model.

#### 5.4.2 Evaluation of the Long-Run Causalities

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Table 5-7: Normalization Cointegration Coefficients ( $\beta$ )

Cointeg. Equation\_1

$(\beta)$	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
L_GDP	1	.	.	.	.	.
L_MEXP	-0.4148	0.0898	-4.6200	0.0000	-0.5909	-0.2388
L_MINV	-0.3498	0.0369	-9.4900	0.0000	-0.4220	-0.2776
L_RGMIN	0.6139	0.1491	4.1200	0.0000	0.3217	0.9061
constant	-10.8273	.	.	.	.	.

Source: Author's summary estimation using Stata.

Note: P-value less than 1%

From Table 5-7, the normalization with respect to GDP yields the following cointegrating equation:

$$L\_GDP_t = 0.4148 L\_MEXP + 0.3498 L\_MINV - 0.6139 L\_RGMIN + 10.8273$$

The coefficients of L\_MEXP and L\_MINV are positive and statistically significant at 1% level. However, the coefficient of L\_RGMIN is negative and significant. The Real GDP cointegration equation reveals that p-value is significant in all the variables. It implies that there is a long run relationship.

The cointegration result reveals that there is an inverse and significant long-run relationship causality between the mining GDP (RGMIN) and the economic growth. This is consistent with a number of studies such as Atkinson (2003), Onyeukwu (2006) and other studies presents in the literature review, these researchers found that there is a negative long run relationship, it can be inferred whether in the long-run Peru creates more dependency on mining sector, this might causes serious decrease to the GDP. From previous studies, the reason is mainly due to poor regulatory framework and corruption

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with the official that direct the mining sector and overall the country and Peru does not escape of crude reality.

On the other hand, at annual frequency the cointegration results reveal that there are positive long term structural effects running from Mining Exports and Mining Investments (L\_MEXP and MINV). Other studies has shown same results respect to the positive long run relationship as stated by Khan (2012), Kwan and Singh (1996) and Aloysius (2003). An explanation of mining exports is when in the long term mining exports growth, Peru will experience economic growth. This implies the metallic major exports might play a determinant variable of economic growth in the long term. Thereby, the explanation of mining investments is also associated with the increase of the Real GDP of the country. Implying that high investments made in mining sector by foreign or local companies might also result in a rise of the GDP in the long-run.

The cointegration results reported in Table 5-7 suggest the existence of a long-run relationship between the economic growth and the following variables: mining exports, mining investments and mining GDP. It can be deducted that all the variables are also relevant from the cointegration point of view.

The VECM methodology allows the long-run behavior of the endogenous variables to converge to their long –run equilibrium, while allowing a range of short-run deviations. Table 5-8 shows the coefficient of the error term in determination of GDP carries the correct sign and is statistically significant at the 1% level, with the speed of convergence to the equilibrium at 7.01%. This suggests that 7.01% of any previous disequilibrium in

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the long run will be corrected in the short run, consequently confirming the stability of the model. Overall the GDP's speed of adjustment towards equilibrium is slow.

Table 5-8: Adjustment of Error Correction Coefficients ( $\alpha$ )

( $\alpha$ )	Coef.	Std. Err.	p-value	[95% Conf. Interval]	
$\Delta$ GDP					
_ce L1	-0.07007	0.09180	0.44500	-0.25000	0.10985
$\Delta$ MEXP					
_ce L1.	0.48813	0.21130	0.02100	0.07399	0.90226
$\Delta$ MINV					
_ce L1	1.72135	0.55504	0.00200	0.63349	2.80921
$\Delta$ GRMIN					
_ce L1	-0.04091	0.08718	0.63900	-0.21178	0.12996

Note: The cointegration equation and lag 1 refers to “\_ce1” and “L1”, respectively. Source:Stata

As seen from the table respects to the cointegration equations of MEXP, MINV at lag 1 in the long run, the study states:

## 5.4.3 Evaluation of the Short-Run Causalities

In order to supplement the long run relations, the following statements will focus on the short-run dynamics of the model. The results in Table 5-9 illustrate the short-run causality relationships among the 4 variables for each equation in the VECM. When determining the significance of the variables in the short-run, the study adopts the ordinary significance at 5% level.

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Table 5-9: Short-Run Causalities

	Variable	Short-run	Coef.	Std. Err.	P>z	[95% Conf.	Interval]
(a)	D_L_GDP	_cons	0.0612	0.0233	0.0090	0.0156	0.1068
(b)	D_L_MEXP	_cons	0.0791	0.0536	0.1400	-0.0259	0.1841
(c)	D_L_MINV	L_GDP	5.7415	1.8015	0.0010	2.2107	9.2723
		L_GRMIN	-4.1110	1.5510	0.0080	-7.1509	-1.0711
(d)	D_L_GRMIN	L_GDP	0.5679	0.2830	0.0010	1.1225	3.0133
		_cons	0.1101	0.0221	0.0000	0.0668	0.1534

Note: The constant “\_cons”. Source: Author’s table design from Stata.

Regarding the equation (s) in Table 5-9, the VEC Model reveals several short-run relations. The significant ones only are shown in the table (p-value greater than 5%). The study infers that:

- From equation (a), there is not short-term causality relationship running from the Real GDP to the rest of the variables, since the other variables presented insignificant results less than the parameter stated and excluding the constant.
- From equation (b), is not short-term causality relationship running from the mining exports to the rest of the variables, same reason as equation (a).
- From equation (c), there are short-term causality relations running from mining investments to the Real GDP and mining GDP since the other variables presented significant results.
- From equation (d), there is a short-run causality relationship running from mining sector GDP to the Real GDP, at annual frequency.

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## 5.5 Model Evaluation

### Autocorrelation Test:

The study adopts the Lagrange Multiplier (LM) test to evaluate the performance of the model at lags ( $j=1$ ), for each “j”, the null hypothesis ( $H_0$ ) of the test is that there is no autocorrelation at lag  $j$ .

Table 5-10: Lagrange Multiplier

Lag	LM	
	chi2	P-values
1	19.89900	0.22481
2	9.33690	0.89890

Source: Author's summary estimation using Stata.

The results of Table 5-10 show there is no autocorrelation in the model, hence lag 3 was used as optimal lag when performing the Johansen cointegration analysis and Vector Error Correction Model (VECM).

### Distribution of Error:

Table 5-11: Jarque-Bera Test

Equation	chi2	df	Prob > chi2
D_L_GDP	1.100	2	0.57683
D_L_MEXP	1.851	2	0.39641
D_L_MINV	1.135	2	0.56690
D_L_RGMIN	0.522	2	0.77029
ALL	4.608	8	0.79852

Source: Table extracted from Stata.



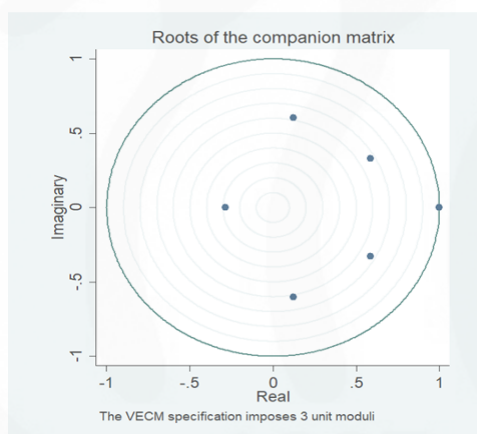
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The study adopts the Jarque Bera test to see how errors are distributed. The results indicate that we can strongly reject the null hypothesis ( $H_0$ ) of normally distributed errors. Most of the errors are well distributed.

Stability condition:

The research employed the Eigenvalue stability condition. The graph shows that none of the remaining eigenvalues appears close to the unit circle. The stability check does not indicate the model presented in this study is misspecified.

Figure 5-2: Eigenvalue Stability Condition



Source: Table extracted from Stata.

## Chapter 6 Conclusion Remarks

As stated in the objectives, the main scope of this thesis has been to provide empirical results to examine the presence of long- and short-run causalities running from mining sector variables and the economic growth. After doing the diagnosis analysis and mainly doing the empirical analysis using the VECM in the four variables chosen with a sample of 25 annual observations from 1992-2016, the study concludes that we can reject the  $H_0$  of this study and accept the alternative hypothesis ( $H_1$ ) that states that these mining variables and economic growth have had significant relations in the short and long-run.

Main conclusions:

1. There is inverse and significant long-run relationship causality from Mining GDP (RGMIN) to the economic growth. It can be inferred whether in the long run Peru creates more dependency on mining sector, this might causes serious decrease to the GDP. Although, in the short run an unidirectional causality was found in the short-run, implying that the Mining Sector positively affects the economic growth of Peru.
2. There are positive long term structural effects running from Mining Exports and Mining Investments to the Real GDP. An explanation of mining exports is when in the long term mining exports growth, Peru will experience economic growth. Besides, high investments made in mining sector by foreign or local companies might also result in a rise of the GDP in the long-run. In addition in the short-run, there is an unidirectional causality was found, implying that the only mining investments affect the economic growth of Peru, not mining exports.

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3. The short-run analysis also reveals one more unidirectional causality, running from mining investments to the Mining GDP with a positive nature.

Remarks:

Overall, the results presented in this thesis are most likely sensitive towards the chosen sample period (1992-2016) and Peruvian economy, as well as the choice of time-series model and variables. However, the explicit results will not change the implications of this analysis. The study demonstrates how important are mining exports, mining investments, mining sector growth to the economic growth while describing in a diagnosis analysis, but also the cause and effect relationship among these mining variables and economic growth. The VECM, either as employed by Johansen (1988) or Engle & Granger (1987), has been known to be sensitive to lag order. For that reason, results from the cointegration analysis were presented at the 5% level of significance. The practical interpretation of this implies that the estimates are not efficient but still consistent.

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*“Call to me and I will answer you and tell you great and unsearchable things you do not know” (Jeremiah 33:3).*

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## Appendix

### 1. STATIONARITY TEST

#### Selection of Lag Length Variables at Level

##### *L\_GDP : LAG 1*

Selection-order criteria

Sample: 1996 - 2016 Number of obs = 21

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-10.6312				.177272	1.10773	1.11853	1.15747
1	30.0804	81.423*	1	0.000	.00404*	-2.67432*	-2.65273*	-2.57484*
2	30.3847	.60872	1	0.435	.004322	-2.60807	-2.57568	-2.45885
3	31.9012	3.033	1	0.082	.004126	-2.65726	-2.61408	-2.4583
4	31.9683	.13422	1	0.714	.00453	-2.56841	-2.51444	-2.31972

++

Endogenous: L\_GDP

Exogenous: \_cons

##### *L\_MEXP: LAG 2*

Selection-order criteria

Sample: 1996 - 2016 Number of obs = 21

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-27.3521				.871443	2.7002	2.71099	2.74994
1	8.74289	72.19	1	0.000	.030824	-.64218	-.62059	-.542701
2	12.0245	6.5632*	1	0.010	.024838*	-.859473*	-.827089*	-.710256*
3	12.7375	1.426	1	0.232	.025596	-.83214	-.788961	-.633183
4	12.7462	.01745	1	0.895	.02826	-.737733	-.683759	-.489037

++

Endogenous: L\_MEXP

Exogenous: \_cons

##### *L\_MINV: LAG 2*



# THE RELATION BETWEEN MINING SECTOR AND ECONOMIC GROWTH IN PERU DURING THE PERIODS 1992-2016

Selection-order criteria

Sample: 1996 - 2016 Number of obs = 21

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-32.4964				1.42238	3.19014	3.20093	3.23988
1	-13.1941	38.605*	1	0.000	.249016	1.44706	1.46865*	1.54654*
2	-12.1308	2.1266	1	0.145	.247864*	1.44103*	1.47342	1.59025
3	-11.7481	.76543	1	0.382	.263594	1.49982	1.543	1.69878
4	-11.5059	.48438	1	0.486	.28463	1.57199	1.62597	1.82069

Endogenous: L\_MINV

Exogenous: \_cons

*L\_RGMIN: LAG 2*

Selection-order criteria

Sample: 1996 - 2016 Number of obs = 21

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-10.3578				.172715	1.0817	1.09249	1.13143
1	31.1588	83.033*	1	0.000	.003645	-2.77703	-2.75544	-2.67755*
2	32.6574	2.9971	1	0.083	.003481*	-2.82451*	-2.79213*	-2.67529
3	33.1646	1.0145	1	0.314	.003658	-2.77758	-2.7344	-2.57863
4	33.2106	.09194	1	0.762	.004025	-2.68672	-2.63275	-2.43803

Endogenous: L\_RGMIN

Exogenous: \_cons

**At level ADF**

. dfuller L\_GDP, trend lags(1)

Augmented Dickey-Fuller test for unit root Number of obs =

----- Interpolated Dickey-Fuller -----				
Test	1% Critical	5% Critical	10% Critical	
Statistic	Value	Value	Value	
Z(t)	-1.536	-4.38	-3.6	-3.24

MacKinnon approximate p-value for Z(t) = 0.8165

# THE RELATION BETWEEN MINING SECTOR AND ECONOMIC GROWTH IN PERU DURING THE PERIODS 1992-2016

. dfuller L\_MEXP, trend lags(2)

Augmented Dickey-Fuller test for unit root                      Number of obs    =                      22

	Test Statistic	----- Interpolated Dickey-Fuller -----		
		1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.032	-4.380	-3.600	-3.240

MacKinnon approximate p-value for Z(t) = 0.5840

. dfuller L\_MINV, trend lags(2)

Augmented Dickey-Fuller test for unit root                      Number of obs    =                      22

	Test Statistic	----- Interpolated Dickey-Fuller -----		
		1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.225	-4.380	-3.600	-3.240

MacKinnon approximate p-value for Z(t) = 0.4758

.  
. dfuller L\_RGMIN, trend lags(2)

Augmented Dickey-Fuller test for unit root                      Number of obs    =                      22

	Test Statistic	----- Interpolated Dickey-Fuller -----		
		1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.264	-4.380	-3.600	-3.240

MacKinnon approximate p-value for Z(t) = 0.8966

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**Selection of Lag Length Variables at First Difference**

*D\_L\_GDP: LAG 0*

Selection-order criteria

Sample: 1997 - 2016

Number of obs = 20

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	28.2331				.003845*	-2.72331*	-2.71359*	-2.67352*
1	28.5661	.66606	1	0.414	.004112	-2.65661	-2.63717	-2.55704
2	30.1121	3.0919	1	0.079	.0039	-2.71121	-2.68205	-2.56185
3	30.1128	.00157	1	0.968	.004323	-2.61128	-2.57241	-2.41214
4	31.8339	3.4421	1	0.064	.004044	-2.68339	-2.63479	-2.43446

Endogenous: D\_L\_GDP

Exogenous: \_cons

*D\_L\_MEXP: LAG 1*

Selection-order criteria

Sample: 1997 - 2016

Number of obs = 20

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	7.59369				.030283	-.659369	-.64965	-.609583
1	11.5518	7.9161*	1	0.005	.022542*	-.955176*	-.935738*	-.855603*
2	12.1502	1.1969	1	0.274	.023503	-.915023	-.885866	-.765663
3	12.9332	1.566	1	0.211	.024095	-.893322	-.854446	-.694175
4	13.2091	.55172	1	0.458	.026044	-.820908	-.772314	-.571975

Endogenous: D\_L\_MEXP

Exogenous: \_cons

*D\_MINV: LAG 0*

Selection-order criteria

Sample: 1997 - 2016

Number of obs = 20

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-13.6992				.254647*	1.46992*	1.47963*	1.5197*
1	-13.1593	1.0798	1	0.299	.266794	1.51593	1.53536	1.6155
2	-12.3621	1.5944	1	0.207	.272699	1.53621	1.56537	1.68557

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	3		-11.8575	1.0092	1	0.315	.287462	1.58575	1.62462	1.7849	
	4		-11.8541	.00683	1	0.934	.319294	1.68541	1.734	1.93434	
-----											
Endogenous: dL_TMInvmentst											
Exogenous: _cons											

***D\_L\_RGMIN: LAG 0***

Selection-order criteria

Sample: 1997 - 2016

Number of obs = 20

lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	28.1484				.003877*	-2.71484*	-2.70512*	-2.66505*
1	28.7417	1.1865	1	0.276	.004041	-2.67417	-2.65473	-2.57459
2	28.7994	.11549	1	0.734	.004447	-2.57994	-2.55078	-2.43058
3	29.7401	1.8814	1	0.170	.004488	-2.57401	-2.53513	-2.37486
4	29.7458	.01149	1	0.915	.004983	-2.47458	-2.42599	-2.22565

Endogenous: D\_L\_RGMIN

Exogenous: \_cons

**At First Difference ADF**

. dfuller D\_L\_GDP, lags(0)

Dickey-Fuller test for unit root

Number of obs = 23

----- Interpolated Dickey-Fuller -----				
Test	1% Critical	5% Critical	10% Critical	
Statistic	Value	Value	Value	
Z(t)	-3.727	-3.750	-3.000	-2.630

MacKinnon approximate p-value for Z(t) = 0.0037

.

```
. dfuller D L MEXP, lags(0)
```

		----- Interpolated Dickey-Fuller -----		
	Test	1% Critical	5% Critical	10% Critical
	Statistic	Value	Value	Value
Z(t)	-3.364	-3.750	-3.000	-2.630

```
. dfuller D_MINV, lags(0)
```

		----- Interpolated Dickey-Fuller -----		
	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.260	-3.750	-3.000	-2.630

```
. dfuller D_L_RGMIN, lags(0)
```

		----- Interpolated Dickey-Fuller -----		
	Test	1% Critical	5% Critical	10% Critical
	Statistic	Value	Value	Value
Z(t)	-5.281	-3.750	-3.000	-2.630

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# THE RELATION BETWEEN MINING SECTOR AND ECONOMIC GROWTH IN PERU DURING THE PERIODS 1992-2016

## 2. OPTIMAL LAG LENGTH SELECTION

### Selection of Lag Length Variables at Level

Selection-order								
criteria								
Sample: 1996 - 2016					Number of obs		=	21
lag	LL	LR	df	p	FPE	AIC	HQIC	SBIC
0	-18.1362				.000097	2.10821	2.15139	2.30716
1	83.7722	203.82	16	0.000	2.8e-08	-6.07354	-5.85765	-5.07876
2	104.168	40.791	16	0.001	2.3e-08	-6.49215	-6.10355	-4.70154
3	130.244	52.153	16	0.000	1.6e-08	-7.45183	-6.89051	-4.86539
4	192.131	123.77*	16	0.000	1.1e-09*	-11.822*	-11.088*	-8.43977*
Endogenous: L_GDP, L_MEXP, L_MINV, L_RGMIN								
Exogenous: _cons								

## 3. COINTEGRATION TEST

Johansen tests for cointegration

Trend: constant                      Number of obs =            23

Sample: 1994 - 2016                      Lags =            2

			5%		
maximum			trace	critical	
rank	parms	LL	eigenvalue	statistic	value
0	20	79.849003	.	59.2424	47.21
1	27	98.5915	0.80403	21.7574*	29.68
2	32	104.55701	0.40473	9.8263	15.41
3	35	108.62477	0.29793	1.6908	3.76

					5%
maximum					max
rank	parms	LL	eigenvalue	statistic	critical value
0	20	79.849003	.	37.4850	27.07
1	27	98.5915	0.80403	11.9310	20.97
2	32	104.55701	0.40473	8.1355	14.07
3	35	108.62477	0.29793	1.6908	3.76

Sample: 1994 - 2016	Number of obs	=	23
	AIC	=	-6.225348
Log likelihood = 98.5915	HQIC	=	-5.890109
Det(Sigma ml) = 2.22e-09	SBIC	=	-4.892376

Equation	RMSE	R-sq	chi2	P>chi2
D_L_GDP	0.060347	0.5754	23.03941	0.0008
D_L_MEXP	0.138901	0.6491	31.44879	0.0000
D_L_MINV	0.364868	0.5504	20.81106	0.0020
D_L_GRMIN	0.05731	0.7305	46.08163	0.0000

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L_GRMIN LD.	-0.1959	0.2565	-0.7600	0.4450	-0.6986	0.3069
_cons	0.0612	0.0233	2.6300	0.0090	0.0156	0.1068

	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
D_L_MEXP _cel L1.	0.4881	0.2113	2.3100	0.0210	0.0740	0.9023
L_GDP LD.	-0.5010	0.6858	-0.7300	0.4650	-1.8451	0.8431
L_MEXP LD.	0.3174	0.2018	1.5700	0.1160	-0.0781	0.7129
L_MINV LD.	0.1604	0.0910	1.7600	0.0780	-0.0179	0.3386
L_GRMIN LD.	-0.1003	0.5904	-0.1700	0.8650	-1.2575	1.0570
_cons	0.0791	0.0536	1.4800	0.1400	-0.0259	0.1841

	Coef.	Std. Err.	z	P>z	[95% Conf.	Interval]
D_L_MINV _cel L1.	1.7214	0.5550	3.1000	0.0020	0.6335	2.8092
L_GDP LD.	5.7415	1.8015	3.1900	0.0010	2.2107	9.2723
L_MEXP LD.	0.4376	0.5300	-0.8300	0.4090	-1.4764	0.6012
L_MINV LD.	0.5909	0.2389	2.4700	0.0130	0.1226	1.0592



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L_GRMIN	—					
LD.	4.1110	1.5510	-2.6500	0.0080	-7.1509	-1.0711
_cons	0.0173	0.1408	-0.1200	0.9020	-0.2932	0.2586

	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]
D_L_GRMIN _cel					
L1.	-0.0409	0.0872	-0.4700	0.6390	-0.2118 0.1300
L_GDP LD.	-0.5679	0.2830	-2.0100	0.0450	-1.1225 -0.0133
L_MEXP LD.	-0.0135	0.0832	-0.1600	0.8710	-0.1767 0.1497
L_MINV LD.	-0.0099	0.0375	-0.2600	0.7930	-0.0834 0.0637
L_GRMIN LD.	-0.04091	0.08718	0.1100	0.08718	-0.2118 0.1300
_cons	0.1101	0.0221	4.9800	0.0000	0.0668 0.1534

**Johansen normalization restriction imposed**

Cointegration Equation

1

beta	Coef.	Std. Err.	z	P>z	[95% Conf. Interval]
L_R_GDP	1	.	.	.	.
L_MEXP	-0.4148	0.0898	-4.6200	0.0000	-0.5909 -0.2388
L_MINV	-0.3498	0.0369	-9.4900	0.0000	-0.4220 -0.2776
L_RGMIN	0.6139	0.1491	4.1200	0.0000	0.3217 0.9061
constant	-10.8273	.	.	.	.

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## 5. MODEL EVALUATION

Lagrange-multiplier test

lag	chi2	df	Prob > chi2
1	19.8990	16	0.22481
2	9.3369	16	0.89890
3	17.6509	16	0.34473

H0: no autocorrelation at lag order

Eigenvalue stability condition

Eigenvalue	Modulus
1	1
1	1
1	1
.5860548 + .3291332i	.672152
.5860548 - .3291332i	.672152
.1210174 + .6025269i	.61456
.1210174 - .6025269i	.61456
-.2866861	.286686

The VECM specification imposes 3 unit moduli.

Jarque-Bera test

Equation	chi2	df	Prob > chi2
D_L_GDP	1.100	2	0.57683
D_L_MEXP	1.851	2	0.39641
D_L_MINV	1.135	2	0.56690
D_L_RGMIN	0.522	2	0.77029
ALL	4.608	8	0.79852

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Skewness test

Equation	Skewness	chi2	df	Prob > chi2
D_L_GDP	.53533	1.099	1	0.29458
D_L_MEXP	.04769	0.009	1	0.92561
D_L_MINV	-.49059	0.923	1	0.33679
D_L_RGMIN	-.20585	0.162	1	0.68693
ALL		2.192	4	0.70044

Kurtosis test

Equation	Kurtosis	chi2	df	Prob > chi2
D_L_GDP	2.9557	0.002	1	0.96544
D_L_MEXP	1.6136	1.842	1	0.17473
D_L_MINV	3.4709	0.213	1	0.64479
D_L_RGMIN	2.3875	0.360	1	0.54876
ALL		2.416	4	0.65977