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# DETERMINANT FACTORS OF INSERTION IN GLOBAL VALUE CHAINS: AN ANALYSIS OF THE MINING INDUSTRY PARTICIPATION

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ABSTRACT

**Objective:** This study aims to investigate the factors that contribute to the participation of the global mining industry in global value chains (GVCs).

**Method:** With an explanatory nature and a quantitative approach, this study uses multiple regression as a statistical technique using the Fixed Effect Model. The data structure is in a panel, referring to 62 countries, and corresponds to the period from 2001 to 2015.

**Main results:** The results show that 77% of developing countries have a low share of their mining industries in GVCs compared to the average presented by the sample countries. Also, the result of the model suggests that the trade openness and qualified labor are fundamental to increase the participation of this industry in GVCs.

**Relevance / originality:** The mining industry is strategic from an economic point of view for many countries and besides, it offers essential inputs for a productive chain of most of the goods used by modern society. Despite this, few studies analyze this industry under a theoretical lens of GVCs.

**Theoretical / methodological contributions:** This study seeks to expand the GVC literature by providing evidence of what factors contribute to the participation of the mining industry in these chains.

**Social / management contributions:** There are possible ways that can improve the participation of countries that have a poorly integrated mining industry in GVCs.

## 1 INTRODUCTION

Global value chains (GVCs) are considered a new productive paradigm, and their analysis has aroused interest due to the great changes that have occurred in international trade. The production processes started to become dispersed but at the same time connected and providing competitive advantages for many countries (Smith, 2015; Tinta, 2017). Thus, many nations have been looking for ways to improve their participation in GVCs, as there are many benefits of participating in these chains (Gereffi, 2014, 2018; Pahl & Timmer, 2019).

Among the several concepts related to participation in GVCs, one of the most traditional considers the origin of the added value incorporated in a country's exports (Greenville & Kawasaki, 2018; Hummels, Ishii & Yi, 2001). To promote and/or improve this participation, some studies have evaluated what would be the determining factors that would promote this integration at the regional level, as was the case of the member states of the European Union (Kersan-Škabić, 2019) and in the case of specific countries as in China (Wang et al., 2019), Zimbabwe (Masunda & Mupaso, 2019) and other African countries (Tinta, 2017).

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Despite these contributions, there is a scarcity of studies that identify and analyze the factors that enable greater participation in GVCs at the level, for example, of specific economic sectors and industries. This is a relevant issue that deserves to be investigated, given that certain industries contribute a significant portion of the economic performance of many nations, and therefore, they must be assessed as "key pieces" in the GVC dynamic. This is the case for industries belonging to the extractive sector, which constitute the main source of income for many emerging economies. To get an idea of this reality, a single commodity in thirty-eight countries is responsible for more than 50% of its income (UNCTAD, 2016).

In this scenario, the mining industry stands out in a special way, which is a supplier of essential primary inputs for GVCs and which has a demand for primary goods increasing considerably over the years. The search for mineral commodities, especially strategic ones, is increasingly due to the growth of emerging economies and the spread of new technologies (Fortier et al., 2018; Henckens et al., 2014; Katz & Pietrobelli, 2018). Despite this, the mining industry does not receive much attention in the GVC literature, even though natural resources play an indispensable role along these chains (Smith, 2015).

In GVCs literature, the most common is to find works that deal with natural resources in general (Piorski & Xavier, 2018; Smith, 2015), and when specific, they mostly deal with agricultural commodities (Dolan & Tewari, 2001; Heery, O'Donoghue & Fathartaigh, 2016; Heron, Prado & West, 2018; Purcell, Martinez-Esguerra & Fernandez, 2018). Other research on GVCs provides an overview of several sectors together, with few being dedicated to analyzing a specific industry. In the latter case, the few studies identified that analyzed the mining industry from a GVC perspective seem to have two main strands: The first is dedicated to analyzing innovation opportunities in the mining industry (Katz & Pietrobelli, 2018; Pietrobelli, Marin & Olivari, 2018; Stubrin, 2017), and the second one, is dedicated to evaluating the possibilities of productive diversification through the development of connections from this industry with other economic sectors (Bamber, Fernandez-Stark & Gereffi, 2016; Fessehaie, 2012; Morris & Fessehaie, 2014; Morris, Kaplinsky & Kaplan, 2012; Piorski & Xavier, 2018).

However, no studies have been found to investigate the level of participation of the global mining industry - in particular, of developing countries in GVCs - or about what factors are essential to promote the integration of this industry in these chains. In this respect, the empirical evidence is much lower than expected. Based on this scenario, this study aims to answer the following research question: What are the determining factors for the participation of the global mining industry in GVCs? The objective is to investigate the factors that contribute to the participation of the mining industry in the GVCs of the sample countries. In this regard, analysis from the perspective of GVCs can significantly benefit marginalized industries and their prospects for improvement (Tejada, Santos & Guzmán, 2011).

The novelty of this article is, therefore, the extent of existing research that mostly focuses on the discussion of the conditioning factors for participation in GVCs at the country and/or region level. In this study, on the contrary, we focus on the industrial level, on an activity in the extractive sector that provides essential inputs for the productive chains of most of the goods used by modern society. In addition, we have included for analysis categories that are fundamental in the theoretical lens of GVC, such as macroeconomic aspects and structural conditions of a country, and at the same time, categories that include specific information about the mining industry. This effort becomes important since the determinants of the participation of industries in GVCs are still little explored in empirical studies.

The choice of the mining industry as an object of study was due to its strategic importance for many nations, and the opportunity to obtain new insights due to its specificity in relation to other industries. It is cited, for example, the fact that this productive activity is not very fragmented, contrasting with other sectors that are usually recurrent in surveys on GVCs, as is the case of the manufacturing sector.

As a social contribution, we intend to present the possible paths to be taken by formulators of public policies that can improve the participation of the mining industry in GVCs, especially for countries dependent on mineral commodities, as is the case of Brazil. In addition, the lessons learned may also be useful for other types of industries, such as agriculture and energy, which in many countries are configured as main economic activities.

This manuscript is structured, in addition to this introduction, in seven sections. Section 2 presents the theoretical framework that will be subdivided into two axes: The first will deal with participation in GVCs and some determining factors for positioning improvements, and the second will provide an overview of the mining industry in the context of GVCs. Section 3 presents the development of hypotheses, while section 4 discusses the methodological procedures that will be applied. Then, in section 5 the results are shown and in section 6 there are discussions. Finally, section 7 presents the main conclusions of the work.

## 2 THEORETICAL REFERENTIAL

Next, in subsection 2.1, a brief description of the role and opportunities of the mining industry in GVCs will be presented. Then, in subsection 2.2, the concept of participation in these chains will be discussed, followed by the development of the hypotheses that will be tested in this study.

### 2.1 The mining industry in the context of GVCs

The term "mining" derives from Latin (minerallis) and refers to the process of extracting minerals from the earth's crust that has economic value and utility for society (CNI, 2012). The mining cycle consists of six main stages according to Balasubramanian (2016): (a) Mineral Research and Exploration: search for mineral deposits, (b) Development: preparation of the mine to start mining, (c) Exploration: mining operation mining, (d) Mine Closure: recovery of the degraded area and termination of mining operations. The mining industry covers, in this case, all the processes involved in the process of withdrawing and processing mineral goods, including metallic and non-metallic minerals, coal, and mineral water.

It is an essential activity for modern life whose products are essential inputs for a range of sectors downstream, in particular, for the manufacturing and manufacturing industries. This is the first aspect that makes the analysis of this industry-relevant in the theoretical lens of GVC, in a specific way, due to the possibility of capturing value through the development of links between the mining industry and other economic segments. This has become an interesting point of analysis, because although the mining industry has traditionally been little fragmented, in recent years there has been a trend of vertical disintegration of large mining companies (Bravo-Ortega & Muñoz, 2018; Pietrobelli et al., 2018; Stubrin, 2017). These companies began to focus more on their internal capabilities and to outsource other non-essential services.

This trend presented interesting business and development opportunities for mining suppliers and, as a consequence, for the strengthening of links downstream and upstream of the mining industry (Bravo-Ortega & Muñoz, 2018). Bamber et al. (2016) for example, analyzed Peru's participation in the GVC of equipment and presented evidence that the development of upstream connections in mining offered an attractive development alternative that enabled the upgrading of function, for capital-intensive activities in GVCs.

The development of connections from mining was also essential to support the success of supply companies in the copper value chain in Zambia (Fessehaie, 2012) and to contribute to the industrialization of Africa by generating significant opportunities for these countries (Morris & Fessehaie, 2014; Morris et al., 2012). This is basically because these connections stimulate productive diversification into other types of industries that add greater value, in addition to generating higher export revenues and exchange gains. These studies point out that the mining industry may be the link to increase the participation of many countries in GVCs. For this, however, it is necessary that these industries are internationally competitive and effectively integrated with GVCs (Gereffi, Humphrey & Sturgeon, 2005; Morris & Fessehaie, 2014).

In addition to stimulating the development of intersectoral links, the increase in outsourcing and global changes in the mining industry (in terms of more efficient technologies for mining research, mining exploitation, ore beneficiation, operational research, and mainly green technologies) in many cases local innovation in host countries. The emergence of a group of highly innovative suppliers associated with mining activities in Brazil, Chile, and Peru (Pietrobelli et al., 2018) and the innovation opportunities seized by Chilean supplier companies that entered dynamic segments of the copper value chain ( Stubrin, 2017) is proof of that. The latter customized products and services considering specific local production conditions and using new

technologies as a platform to develop exclusive solutions to unresolved mining problems.

It is clear that the mining industry has become a dynamic area of transformation and technological innovation (Katz & Pietrobelli, 2018) and therefore the need to break with the technical restrictions of the sector, developing the downstream industries to insert themselves in more advanced stages in GVCs (Piorski & Xavier, 2018). From this point of view, it is therefore important to assess which factors contribute to the participation of the mining industry in GVCs, and how this participation is currently taking place, especially in developing countries. This analysis consists of a diagnosis of the level of value capture of these nations in GVCs based on this economic activity.

## 2.2 A brief overview of GVC approaches and participation in these chains

The literature on GVCs can be analyzed from different perspectives that take into account their technical and strategic diversity. In general, the different currents seek to explain how and why these chains arise and what are their main effects within the context of international fragmentation of production. In this study, two approaches widely used in research involving GVCs will be used.

The first one is called “GVC approach”. This current was developed by scholars of sociology and political science and has a fundamentally microeconomic character of the analysis. It is linked to multinational companies, global strategies and seeks to investigate development opportunities for emerging economies (Gereffi & Lee, 2016; Humphrey & Schmitz, 2002; Kaplinsky, 2014; Sturgeon & Gereffi, 2009).

The GVC approach is constituted from two opposing points of view: top-down and bottom-up (Gereffi, 2014). The central concept of the top-down view is that of "governance[2]" which refers to how GVCs are coordinated by the actors in these chains. In the bottom-up view, the main concept is "upgrading[3]", which refers to the possibility of advancing along the GVCs towards stages of greater added value and thus improving participation in these chains.

The four types of upgrading identified by Humphrey and Schmitz (2002) are traditionally the most cited in empirical studies in the analysis of GVCs. Product upgrading promotes the improvement of product/service quality, while process upgrading reduces the unit cost in production through the reorganization of the production system. The function upgrading, in turn, consists of changing the coverage of activities in the value chain to higher value-added functions, and the chain upgrading occurs from the use of functional knowledge in a chain allowing the expansion to a similar function found in another chain in a different industrial sector. While product and process upgrading is about the internal improvement of a firm, functional and chain upgrading are related to moving to higher positions in GVCs (Fleury & Fleury, 2001), and therefore involve industries and economic sectors.

The second approach, on the other hand, analyzes GVCs at a macroeconomic level and was developed by economists in the area of international economics and macroeconomics. Hummels et al. (2001) who first presented the concept of participation in vertically specialized[4] trade and which was later refined by Koopman et al. (2010). Vertical specialization was the first empirical measure of participation in GVCs, in which Hummels et al. (2001) dedicated themselves to the analysis of the use of imported inputs in the production of goods to be exported. Further on, other researchers began to develop new metrics and indicators to measure international trade (Antràs & Chor, 2018; Antràs et al., 2012; Caliendo & Parro, 2015; Fally, 2011; Wang et al., 2017).

Fally (2011) provided quantitative analyzes on the average length of the production chains, which made it possible to calculate the number of stages between production and final consumption. Subsequently, Antràs et al. (2017) derived two different approaches to measure upstream industry production. Wang et

[2] Gereffi (1994) defined the concept of governance in the context of GVCs as being the “relations of authority and power that determine how financial, material and human resources are allocated and flow within a chain.”

[3] Upgrading in GVCs occurs when companies, countries, or regions move to higher-value activities to increase the benefits of participating in global production (Gereffi, 2005).

[4] Vertical specialization is defined as the use of foreign intermediaries in the production of exported products (Hummels et al., 2001).

al. (2017) proposed a structure to decompose the total production activities in the country and, more recently, Antràs & Chor (2018) extended the structure of Caliendo and Parro (2015) and provided a structural interpretation of all entries in a table of world entry and exit.

This evolution in international trade measures was only possible with the development of new databases made available by international organizations. Among the main bases, the Organization for Economic Co-operation and Development (OECD), United Nations Conference on Trade and Development (UNCTAD), and the World Trade Organization (WTO) stand out. The data are mostly based on the decomposition of input and output matrices (IOTs) in which it is possible to measure the value-added trade, and not gross as it was done decades ago.

The most well-known bases are the WIOD (World Input-Output Database) and TiVA (Trade in value-added), which have in common the use of ICIO[5] country tables as a data source, and differ basically because the first account with trade to balance the ICIO tables, while the second uses national accounts (Greenville, Kawasaki & Beaujeu, 2017). The UNCTAD-EORA data set, on the other hand, uses data interpolations in place of the ICIO table. This bank uses tables of national IOTs and through methods of cross-entropy interpolates the data for those countries that do not have the integrated data.

In this way, this second current has a more empirical focus, since the objective, in general, is the development of new methodologies to measure the fragmentation of international production and the added value along the stages in the GVCs. The studies cited analyzed several economic sectors together precisely to validate the proposed models and indicators. Although this was the focus of these works, a multisectoral analysis hardly allows us to explore in-depth the nuances of a specific industry, as is the objective of this study. Also, questions such as what are the determinants of the positioning of a sector and/or the country in GVCs remain unanswered (Antràs & Chor, 2018).

In this sense, one of the challenges that have been investigated in several surveys on the subject of GVCs is to understand how countries and their specific sectors are inserted in terms of participation in GVCs. This is because the distribution of gains between countries in GVCs is still uneven, especially in emerging economies (Banga, 2013; Gereffi & Korzeniewicz, 1994; Kersan-Škabić, 2019; Reis & Almeida, 2014). It is at this point of confluence that the two approaches discussed above complement each other and become relevant as tools to understand the issue addressed in this study. The understanding of which factors are relevant to provide better participation in the GVCs of an industry that produces goods with low added value - essential for the economy of many countries - becomes relevant.

In this regard, despite the diversity of methodologies available in the literature to measure the level of participation of countries, sectors, and industries in GVCs, the participation indicator proposed by Koopman et al. (2010) remains one of the most used in empirical works (De Backer & Miroudot, 2014; Kersan-Škabić, 2019; Mikhailov et al., 2017; Reis & Almeida, 2014; Vlckova & Thakur-Weigold, 2019). The reason is that it can be applied to a larger sample since it is not necessary for the calculation of this measure to have complete input and output tables, which in many cases are not available for a wide range of countries (Kersan-Škabić, 2019).

Koopman et al (2011) integrated several measures on vertical specialization and value-added trade to adjust the trade-in intermediaries and presented GVC's position and participation indexes to assess the extent to which a country sector is involved in the global market. Thus, this measure provides a comprehensive assessment of the participation of a country or sector in GVCs, both as a user of foreign inputs (upstream participation) or as a supplier of intermediate goods and services used in exports from other countries (downstream participation) (Banga, 2013; Sturgeon et al., 2013).

## 2.3 DEVELOPMENT OF HYPOTHESES AND CONCEPTUAL MODEL

Some factors have been reported as determining factors for participation in GVCs. It is necessary to

[5] The ICIO (Inter-Country Input-Output) tables show the structure of the input and output of the countries involved in international trade.

meet a certain number of conditions to join the GVC and, mainly, to advance along these chains, and thus participate in stages with greater added value. Macroeconomic policy, a country's structural conditions, foreign trade, and industry characteristics are often cited in the literature as being the essential and priority factors to achieve this objective.

In the first case, political factors are based on the institutional approach and are indirectly associated with trade openness, adequacy of preferential trade agreements, foreign direct investment, and commercial performance indicators that can affect the competitiveness of the entire value chain (Tinta, 2017). Countries that wish to enter the GVC dynamic and benefit from the advantages of international trade along the lines of this productive paradigm need to distance themselves from outdated practices such as high trade barriers for imports and strong protection to the domestic market.

Trade barriers inevitably hurt the countries that implement them (Sturgeon et al., 2013). Instead of protecting the domestic market, protectionist policies can have a reverse effect on countries' participation in international trade. In this sense, trade openness is a fundamental factor to sustain a country's competitiveness (Ali & Msadfa, 2016). This factor influences the process of integration in GVCs and some studies suggest that the countries generally more inserted are those whose trade regimes are relatively liberal (Beverelli et al., 2019; De Backer & Miroudot, 2014; (Kummritz, Taglioni & Winkler, 2017).

Besides, there is evidence of a positive relationship between foreign direct investment (FDI) and participation in GVCs. One of the main reasons is the gains provided by the technological overflows that usually occur through the relationship between leading companies and local suppliers in the host country, which certainly promotes the industrial development of these nations. FDI is seen as a primary channel for accessing global markets, capital, technology, and skills (Amendolagine et al., 2017; Staritz, Plank, & Morris, 2016), and all of this affects a country's participation in GVCs, regardless of their governance structure (Kummritz et al., 2017). Based on these arguments, we postulate two initial hypotheses to be tested in this study:

Hypothesis 1a. The opening up of a country to trade contributes positively to raising its level of participation in GVCs, and, consequently, of the mining industry.

Hypothesis 1b. The flow of foreign direct investment from a country contributes positively to increase the participation of the mining industry in GVCs.

The structural condition of the country also plays an important role in promoting the integration of countries in GVCs, since an infrastructure and logistics capacity is essential to promote the flow of outlets and the receipt of production. Also, the qualification of the workforce is indispensable to increase productivity and promote the innovation necessary for the development of new goods and services that promote the capture of value in GVCs. The increase in participation in GVCs and, consequently, “the escape” from the low added value trap” requires the combination of several success factors, mainly related to logistics and infrastructure, innovation and the supply of qualified labor (Gereffi , 2014; Kummritz et al., 2017; Landesmann & Stöllinger, 2019).

The insertion capacity in the value chains is dependent on the infrastructure conditions and for the mining industry, in particular, these factors take an even more essential direction for a greater participation in the GVCs. Upgrading in the mining industry requires a more holistic approach and a greater focus on innovation and infrastructure (Tijaja & Faisal, 2014). As it is an industry characterized by locational rigidity, since mineral deposits are found in certain locations which are often removed from shopping centers, infrastructure and logistics become essential. Besides, despite being a basic industry, more and more technology has been used in the mining stages (Katz & Pietrobelli, 2018) and therefore the need for constant innovations and qualified labor. From the above, we present the following hypotheses related to structural conditions:

Hypothesis 2a. A country's infrastructure contributes positively to raising its level of participation in GVCs and, therefore, in the mining industry.

Hypothesis 2b. Innovation contributes positively to increase the participation of the mining industry in GVCs.

Hypothesis 2c. The qualified labor contributes positively to increase the participation of the mining industry in the GVCs.

The characteristics of foreign trade, both in terms of exports and imports, also say a lot about a country's participation in GVCs and are an excellent indicator of the capture of value by national industries. The intensity of participation in GVCs is approximated by the use of imported inputs and the intensity of exports (Andrzej, Jan Jakub & Krzysztof, 2019). Thus, export competitiveness remains crucial, but today's exports are now the result of participation in GVCs and, therefore, often depend on imports from these global production networks (Milberg, 2013).

One of the strategies most used by many nations is to import intermediate goods to be used to build capacity in local companies and then be exported. The capture of value along these lines, and consequently, the increase in participation in GVCs, is carried out through re-exported intermediate imports (Dean, Fung & Wang, 2008). Therefore, we launched the next hypothesis of the study:

Hypothesis 3a. Intermediate imports re-exported from the mining industry contribute positively to increase the participation of this industry in GVCs.

Other factors that may have an impact on the participation of the mining industry in GVCs and that will be investigated in this study concern the diversification of production (in terms of the variety of mineral goods produced by the country) and the gross production of ore. These variables deserve attention because they can indicate how the productive characteristics of this industry impact on international trade. For example, in developing countries rich in mineral resources, the apparent consumption rate is expected to be lower than that of developed countries. As a result, a large gross production tends to intensify exports. In this sense, participation in GVCs can be measured through the variety of exports, as diversification offers more export opportunities (Ali & Msadfa, 2016; Staritz et al., 2016; Tinta, 2017). This rationale supports the last two hypotheses:

Hypothesis 4a. The productive diversification of the mining industry contributes positively to raise the level of participation of this industry in the GVCs.

Hypothesis 4b. The gross production of the mining industry contributes negatively to increase the participation of this industry in GVCs.

Thus, these hypotheses will be tested to assess which of these factors are in fact determinants of the participation of the mining industry in GVCs. This investigation is important in a context where governments are looking for strategies for greater participation with GVCs, especially for the extractive sector (Smith, 2015). For this reason, policymakers are looking for more and better evidence that examines the position of countries and consequently of their industrial sectors within GVCs (De Backer & Miroudot, 2014). All the hypotheses formulated above are shown in Figure 1:

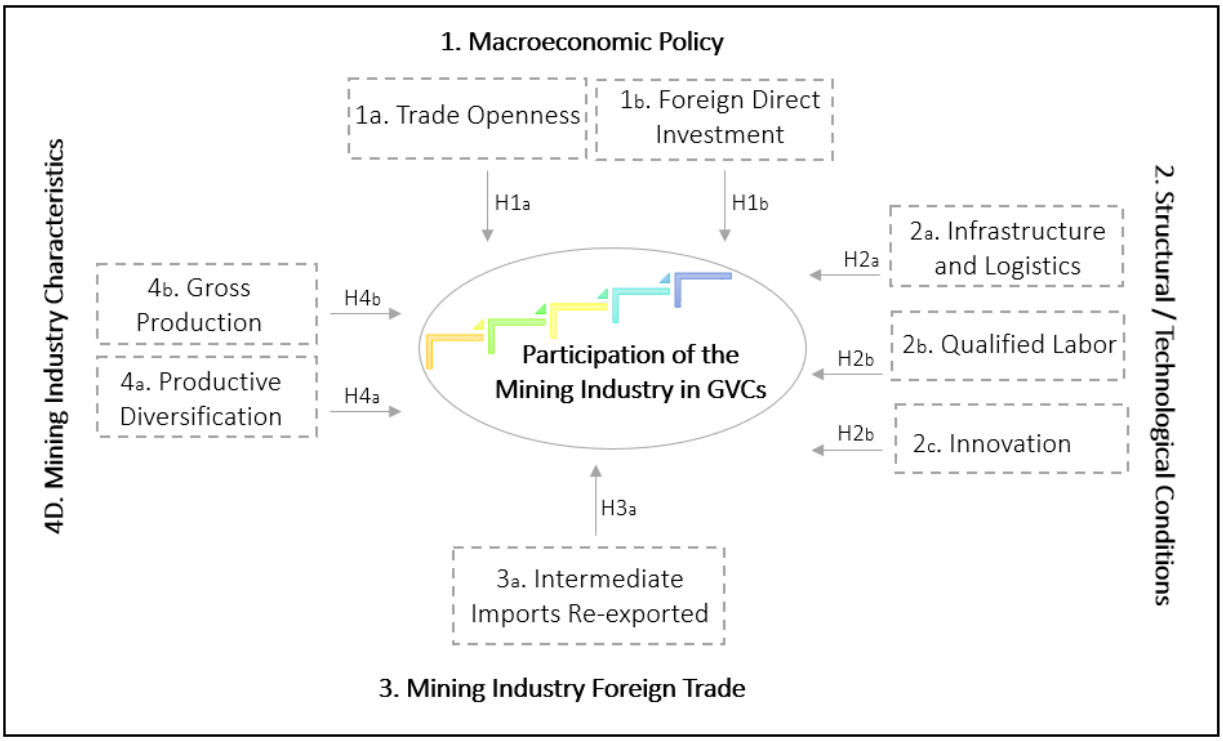



Figure 1: Theoretical-Empirical Conceptual Model.

Figure 1 presents the eight independent variables and their respective hypotheses that will be tested on the dependent variable - participation of the mining industry in the GVCs. These variables are classified into four categories: Macroeconomic Policy, Structural Conditions, Foreign Trade in the Mining industry, and Characteristics of the Mining industry. The data for the first two categories will be at country level, since it is not possible to find them disaggregated at an industrial level for all countries in the sample.

## 3 METHODOLOGICAL PROCEDURE

This study has an applied nature, its approach is quantitative and its objective is explanatory, since it seeks to investigate the determinants that contribute to the participation of the mining industry in GVCs. This type of research is concerned with identifying the factors that determine or contribute to the occurrence of the phenomena (Gil, 2002).

### 3.1 Description of the sample and variables

The selection of variables was made based on evidence from the literature about their influence on the participation rate in the GVCs. One of them (Gross Production) was proposed to investigate whether this cause and effect relationship exists. The participation rate in GVCs (Pa) is the model-dependent variable and the other variables are independent, except for the Exchange (Ca), Per-capita GDP (GDP) and Natural Resource Income (Ren) variables, which were considered to be variables of control. Table 1 shows what these variables are, their definition and the source from which they were extracted.

Table 1
Model variables

| Variable | Definition | Source |
|---|---|---|
| Dependent Variable | | |
| Mining industry participation in GVCs (Pa) | Measures upstream and downstream participation in GVCs (in this case, the mining industry). The index is calculated from the domestic added value for foreign exports and the foreign added value for domestic exports. The higher the value, the greater the participation of the industry or the country in GVC. | OECD (2018) |
| Independent variables | | |
| Trade Openness (Li) | The trade openness index is based on two indicators: the weighted average trade tariff and non-tariff barriers (including quantity, price, regulatory, customs and investment restrictions, and direct government intervention). | World Bank (2019) |
| Foreign Direct Investment (FDI) | It shows the net inflows (new investments fewer divestments) in the economy reported by foreign investors and is divided by GDP. | |
| Infrastructure and Logistics (Ifr) | The proxy will correspond to the country's transport service. Transport covers all transport services (sea, air, land, inland waterway, pipeline, space, and electricity transmission) performed by residents of one economy to those of another and which involve passenger transport, goods handling (freight), rental of crewed carriers, and related support and auxiliary services. | |
| Innovation (In) | The innovation proxy used will be the number of patent applications registered by country. Patent-based statistics reflect the innovative performance of countries, regions and companies, as well as other aspects of the dynamics of the innovation process. | |
| Qualified Labor (Qu) | The proxy is the number of enrollments in high school. This rate is the proportion of total enrollments in relation to the population of the age group that officially corresponds to the level of education shown. | |
| Intermediate imports re-exported (Re) | Re-exported intermediate imports measure intermediate imports from one country's industry that are incorporated into another nation's gross exports. | OECD (2018) |
| Diversification (Di) | Number of mineral commodities produced by the country's mining industry. | USGS (2020) |
| Gross Production (Pr) | It refers to the difference between the production of an industry (in this case, the mineral) and the sum of its intermediate inputs for goods and services. | OECD (2018) |
| Control Variables | | |
| Exchange (Ca) | The proxy will be the real effective exchange rate. This measure refers to the nominal effective exchange rate divided by the cost index. | World Bank (2019) |
| GDP per capita (PIB) | Per capita GDP is the gross domestic product divided by the country's population. | |
| Income from Natural Resources (Ren) | It refers to accounting for the contribution of natural resources to economic production. It consists of the sum of income from the extraction of oil, natural gas, coal, minerals and inputs from the forest. | |

Source: Elaborated by the authors

The analysis of Table 1 shows that the main source from which most of the data was extracted was the Trade-in Value Added (TiVA) database made available by the OECD. The set of data available on this basis

measures trade flows in terms of the value-added internally by a country for the production of any good or service that is exported. They help to investigate the competitiveness of companies, regions, and countries in international markets and specific sectors (De Backer & Miroudot, 2014). Also, it was decided to include control variables in search of a better adjustment of the model, since in addition to the independent variables, other factors such as the exchange rate and the country's GDP may also influence the participation index industry concerned.

The analyzed period corresponded to the years 2001 to 2015 and the collection covered a biennial interval. The choice of this interim was since the data available in the TiVa bank (OECD, 2018) cover only this period. The object of the study consists of a sample of sixty-two countries with different levels of economic development. In terms of the analysis of the mining industry in these countries, it can be considered that the data used for the model of this study will be representative of the world reality since this sample contains the G20 member countries. In addition to covering two-thirds of the world population, in 2018, these countries alone accounted for around 85% of world economic production and 75% of global exports (CRS, 2019).

### 3.2 Empirical Strategy

The *R* software was used to estimate the model of this study because it is robust and free. Estimations were made using the regression technique with the panel data structure, since there was variation between individuals (countries) and overtime in the sample, thus justifying this type of analysis. In this sense, the regression analysis based on panel data makes it possible to understand the relationship between a specific variable and multiple prediction variables, thus offering predictive models of differences in observations over a series of time.

Initially, all variables were normalized in order to narrow their amplitude and thus avoid outliers that could cause heteroscedasticity, thus interfering in the estimation of the model. Below is expressed the multiple regression model to be tested, where a negative sign is expected for the variable Pr and positive for the others:

$$y_{it} = \beta_0 + \beta_{1\,Pa} X_{it} + \beta_{2\,Li} X_{it} + \beta_{3\,IED} X_{it} + \beta_{4\,Ifr} X_{it} + \beta_{5\,In} X_{it} + \beta_{6\,Qu} X_{it} + \beta_{7\,Re} X_{it} + \beta_{8\,Di} X_{it} + \beta_{9\,Pr} X_{it} + \beta_{10\,Ca} X_{it} + \beta_{11\,PIB} X_{it} + \beta_{12\,Ren} X_{it} + \alpha_{it} + u_{it} \quad (1)$$

Where: $y_{it}$ = Participation of the mining industry in GVCs; $\beta_0$ = intercept; $\beta_1$ a $\beta_9$ = intercept; $\beta_{10}$ a $\beta_{12}$ = control variables, $\alpha_{it}$ = factors not observed constant in time that affect $y_{it}$; $u_{it}$ = idiosyncratic error.

On the other hand, depending on the number of variables, and based on the analysis of the covariance matrix (attached), we chose to use the multilevel form to test this model. This format ensures that the significance of the variables is not influenced by the interference of one variable over the other. Thus, model (1) will be decomposed into four sub-models to cover the four categories of variables shown in Figure 1.

### 3.3 Model Specification Test

Some specification tests were carried out to determine which would be the ideal estimation model. The first was the F Test, which helped determine between the use of the Pooled model and the Fixed Effects Model. As the p-value was less than 0.05 the null hypothesis was rejected, and therefore, the Pooled Model was not considered. Then, to define between the first differences model and the fixed effects model, based on the efficiency of the estimator, the second option again remained.

Finally, the Hausman test was used to define between the random effect model and the fixed effect model. In this test, if fixed effects are present, the estimation by the random model will not be consistent. As the p-value was greater than 0.05, the null hypothesis was rejected, indicating the presence of the fixed effect. To confirm, the Honda Test also did not indicate the presence of the random effect and, for this reason, the choice was again made by the Fixed Effects Model.

## 4 RESULTS

### 4.1 Analysis of Descriptive Statistics

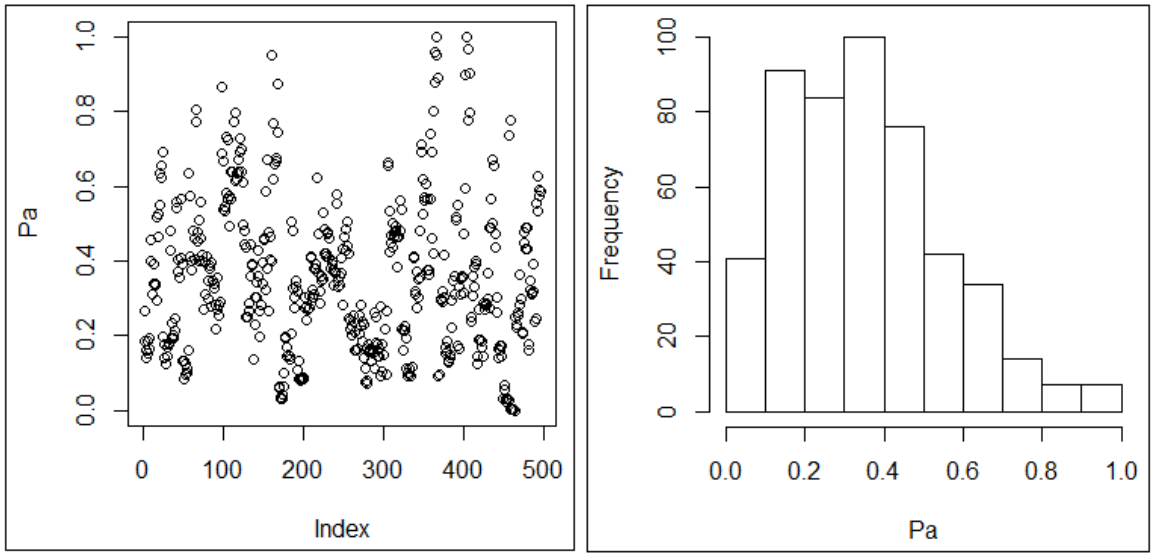
An important step that precedes the estimation of the model is the analysis of descriptive statistics. Table 2 shows the average results for each of the variables, minimum, maximum, median, and number of observations.

Table 2
Descriptive statistics

| Variables | Minimum | Maximum | Median | Average | Observations |
|---|---|---|---|---|---|
| Pa | 0,000 | 1,000 | 0,332 | 0,355 | 496 |
| IED | 0,000 | 1,000 | 0,049 | 0,074 | 494 |
| Li | 0,000 | 1,000 | 0,806 | 0,770 | 486 |
| Ifr | 0,000 | 1,000 | 0,288 | 0,325 | 457 |
| In | 0,000 | 1,000 | 0,001 | 0,021 | 456 |
| Qu | -0.1305 | 1,000 | 0,550 | 0,547 | 431 |
| Re | 0,000 | 1,000 | 0,019 | 0,057 | 496 |
| Di | 0,000 | 1,000 | 0,271 | 0,293 | 488 |
| Pr | -0.0000185 | 1,000 | 0,006 | 0,006 | 495 |
| Descriptive statistics of the dependent variable "Pa" | | | | | |
| Between groups | 0,038115 | 0,802042 | | | |
| Within groups | 0,376563 | 0,585442 | | | |

The analysis of Table 2 points out a significant difference between the minimum and the maximum of the variables - in particular, for qualified labor (Qu) and gross production. This indicates a high discrepancy between the values of these quantities between countries, a high breadth of data, in addition to the presence of outliers. As for the dependent variable, the Index of participation of the mining industry of the countries in GVCs (Pa), Table 2 shows that the average of this variable is 0.355, while the minimum value is 0.000 and the maximum of this participation is 1,000. The descriptive statistics within the groups showed that the participation of the mining industry in the same country varied significantly over the fifteen years analyzed. This suggests how this industry can be influenced by external factors, especially by macroeconomic and structural factors.

Besides, the descriptive statistics between the groups, that is, between the countries, points out a considerable difference between the minimum and maximum of the variable “Pa”, showing that the participation of the mining industry in their GVCs is uneven. In this sense, Figures 2 and 3 also point out this difference. The values of the participation index (Pa) showed refers to the year 2015.




**Figures 2 and 3:** Bubble chart and Histogram of the participation of the mining industry of the sample countries in the GVCs.

From the analysis of Figure 2, it is observed that if a horizontal imaginary line in the value of 0.5 is drawn on the axis of the ordinates of Figure 2, it is possible to infer that from the 496 observations made in this research, a considerable number of the countries that compose the sample has its respective mining industries little integrated into the GVCs. If the same procedure is performed on the Histogram shown in Figure 3, but this time, by drawing an imaginary vertical line on the abscissa of 0.5, it is also noteworthy an uneven integration of these industries.

4.2 Estimating the Model

After identifying the ideal model to estimate the regression, some tests were performed to identify the presence of serial correlation and individual/temporal effects. The existence of some of them requires robust inference in the fixed-effect model to ensure that the significance of the test is not affected and the estimator is efficient. The Baltagi conditional test pointed to the existence of a serial correlation in the errors of the fixed-effect model. Likewise, the Durbin Watson test and the Breush-Goldfrey test indicated the serial correlation.

From the result of these tests, the regression coefficients were calculated from the robust standard error. This process estimates the covariance matrix, relaxing the hypotheses of homoscedasticity and independent errors while guaranteeing the robustness of the estimator. Table 3 shows the coefficient of the variables tested:

Table 3
Model estimation using the random effect method

| Variables | Effect of Macro-Economic Policy Model 1.1 | | Effect of structural conditions Model 1.2 | | Effect of Foreign Trade Model 1.3 | | Effect of Mineral Industry Characteristics Model 1.4 | | Complete Model | |
|---|---|---|---|---|---|---|---|---|---|---|
| Li | 0,106339 | . | | | | | | | 0,043514 | |
| IED | 0,601623 | | | | | | | | 0,047561 | |
| Ifr | | | -0,14463 | * | | | | | -0,18504 | * |
| In | | | 0,394936 | | | | | | -1,592122 | *** |
| Qu | | | 0,104263 | ** | | | | | 0,127641 | |
| Re | | | | | -0,449144 | | | | 0,290437 | ** |
| Di | | | | | | | -0,203703 | *** | -0,062842 | |
| Pr | | | | | | | 1,023575 | | -0,204767 | *** |
| Ca | -0,114943 | *** | -0,177498 | *** | -0,136488 | *** | -0.076279 | ** | -0,18814 | ** |
| Pib | -7,137003 | * | -0,82387 | | -2,942263 | | -8,372641 | * | -0,24903 | ** |
| Ren | -0,526494 | * | -0,522633 | * | -0,436419 | * | -0,331675 | | -0,218707 | * |

Significance Level: · p< 0,05; * p < 0,01; ** p < 0,001; *** p < 0

Table 3 indicates a difference in estimation for the multilevel model and the complete model. When comparing them, there is a difference in the level of significance of certain variables, and even the statistical non-significance of some of them. This is because, in the complete model, certain variables interfere with others. For this reason, the multilevel model was used for the following analysis.

## 5 DISCUSSION

Among the many challenges faced by developing countries, one of them is the estimation of the degree of participation in GVCs and the net gains of added value collected, and therefore the importance of sectoral analyzes (Banga, 2013). In this sense, the results shown below shed some light in this direction. Of the 62 countries that were analyzed, only 28 of them have their mining industry integrated above the average in GVCs (greater than 0.355 as indicated by

descriptive statistics), and 77% of developing countries - according to the criterion used by the United Nations ( United Nations, 2014) - are below this value (South Africa, Saudi Arabia, Argentina, Brazil, Brunei Darussalam, Philippines, Chile, China, Colombia, Costa Rica, India, Indonesia, Malaysia, Mexico, Peru, Russia, Singapore, Tunisia, and Turkey). This evidence suggests that the mining activity in developing countries, for the most part, does not have effective participation in GVCs. Figure 4 shows the highest participation rates of the global mining industry in GVCs for 2015:

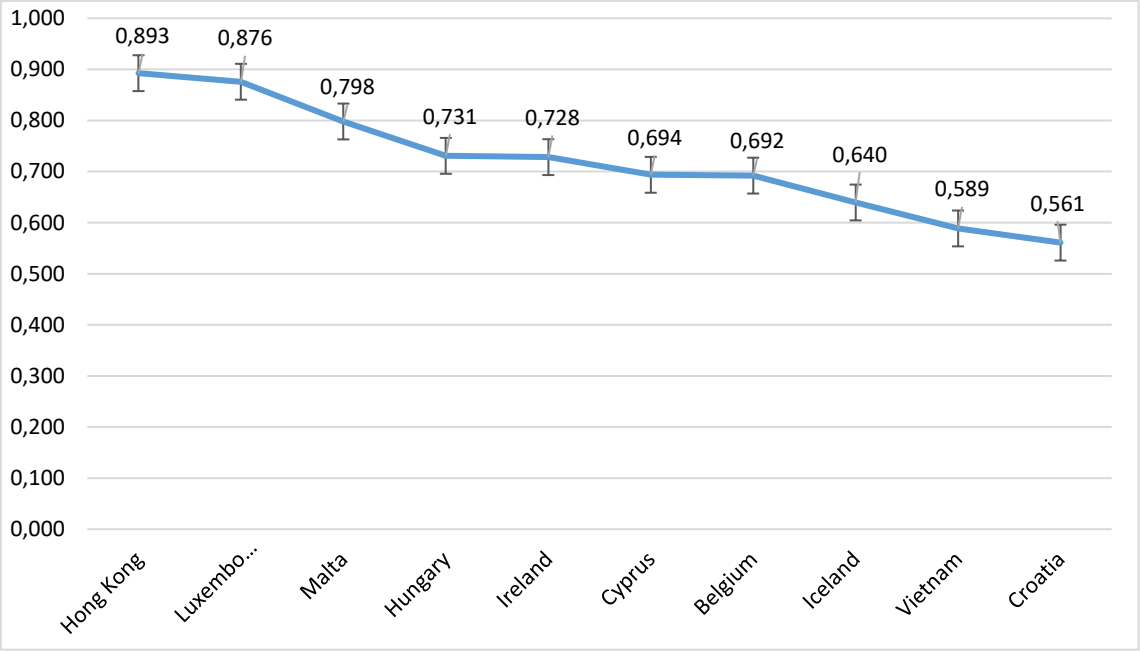



**Figure 4:** Ranking of the positioning of the global mining industry with the best participation in GVCs.

As can be seen in Figure 4, in this ranking, countries with developed economies prevail (except for Hong Kong and Vietnam). An interesting finding is that no country with a tradition in mining or that has extensive mineral reserves is included in this classification. Despite the growing demand for mineral goods and most developing countries are major sources of global supply, many of them still have a low capacity to extract value from the production chains of which they are inserted. Many of these nations are still limited to the supply of primary goods, especially from mining at GVCs (Piorski & Xavier, 2018; Makasheva et al., 2017).

A concrete example of this reality is Russia, a country that participates significantly in the global market for minerals and raw materials, and is considered one of the main exporters of various types of ore (Makasheva et al., 2017). However, this country is not present among the countries shown in Figure 4 and the participation rate of its mining industry is 0.173, well below the average shown in Table 2. Brazil, for example, obtained a value of 0.280, which could undoubtedly be higher when considering its geological potential and its status as a major exporter of mineral commodities. In other words, trade-in intermediate products from the mining industry are less significant in the total trade in these countries.

Iceland, for example, is a country that has no proven reserves of base metals, precious metals, or industrial minerals, and is highly dependent on imports of numerous mineral commodities to meet domestic demand (Perez, 2014). However, that nation ranks eighth as shown in Figure 3. Many factors can justify this result and the analysis of Belgium's performance helps to understand the privileged position of the mining industry in these countries. In the Belgian case, this country is a significant processor of mineral raw materials and in 2014, it accounted for 7.6% of raw material imports from the European Union (EU), with 75.9% of all Belgian exports being for EU members (Perez, 2014). The significant presence of steel and metallurgical companies presupposes the importation of mineral

goods for later exportation, due to the volume of ore that would not be consumed entirely by the domestic market.

### 5.1 Macroeconomic Policy

As for the factors that may influence the participation of the mining industry in the countries analyzed in the GVCs, the result of the estimated model helps in this investigation. Concerning macroeconomic policy variables, the analysis in Table 3 shows that trade openness (Li) was positively significant, which confirms the importance of trade openness in countries that wish to enter and participate in GVCs as reported in several studies (Beverelli et al., 2019; De Backer & Miroudot, 2014; Gereffi, 2014). The GVC literature emphasizes that greater commercial freedom reflects lower trade barriers, which in turn contributes to greater integration of all sectors of the economy in GVCs. Gereffi (2014), for example, showed that an essential element of Mexico's success in GVCs is its high degree of trade openness. This country has free trade agreements with 44 countries, which is more than double that of China and four times more than Brazil.

On the other hand, Foreign Direct Investment (FDI) did not obtain statistical significance, contradicting several studies that report the role of this factor in the dynamics of company investments and how it can affect the improvement of participation with GVCs (Amendolagine et al., 2017; Staritz et al., 2016). In the case of the mining industry, as in many others, participation with GVCs generally occurs through vertical integration through FDI through mergers and acquisitions that multinational mining companies carry out on state or small companies (Smith, 2015; Tinta, 2017). The attraction of FDI to this specific industry is adopted by many countries, especially those in development, to foster this activity. Attractive and facilitating FDI policies and laws are essential foundations for mining (Haddow, 2014).

However, the factor that may have contributed to the low significance of this variable in this study is the fact that this quantity refers to general foreign investment, directed to all sectors of the country, and not only to the mining industry. It was not possible to find a specific IED proxy for the mining industry that covered the entire sample and period analyzed. To have an idea of the difference this can cause, in the period from 2003 to 2014, the largest share of FDI in new ventures in Brazil was destined for the mining and steel sector - 21.4% of the total (Silva Filho, 2015). In other words, the FDI proxy for the mining industry would more realistically show the effect of these investments for the integration of this industry in GVCs and possibly change the result obtained. Thus, Hypothesis 1a was validated while Hypothesis 1b was rejected.

### 5.2 Structural and technological conditions

Regarding the variables related to structural conditions, our results also did not confirm the influence of Innovation (In) for the integration of the mining industry in GVCs. Again, the difficulty of finding proxies for innovation for the analyzed period, and specifically for mining, forced the choice of the number of patent applications registered by country as an alternative. Therefore, further studies are needed to analyze this relationship in the case of the mining industry, as evidence from other sectors points to the considerable positive influence of innovation and advancement in GVCs (Giuliani et al., 2005; Haakonsson, 2009).

On the other hand, it is emphasized that the effects of innovation in the mining industry demand time to be noticed as one of the factors responsible for the improvement of this industry's participation in GVCs. The reason is that many of the patent registrations observed for mineral activity require a period considered to be implemented at the industry level, thus harming the perception of results. At the firm level, in general, it is the multinational mining companies that develop the main innovations (which enable product and process upgrading) and not the small and medium-sized companies that make up the majority in this industry. Likewise, many of the technologies developed in mineral development research centers and universities are made on a pilot scale, and often due to lack of investment, they do not have continuity or are not commercialized. In Indonesia, for example, many universities have developed prototypes for mineral processing and refining equipment, but none of them have been applied by the industry (Tijaja & Faisal, 2014).

Regarding the other variables "Qu" and "Ifr", both were statistically significant. In the first case, the qualified labor (Qu) was shown to positively impact participation in GVCs, in line with the results of Andrzej et al. (2019), which showed that this factor

was decisive to improve the participation of companies in the GVCs of 29 countries. Other empirical analyzes also confirm that education and the development of technical capacities are fundamental for integration in GVCs, and consequently for the structural transformation of a country (Ali and Msadfa, 2016; Lee and Malin, 2013).

On the other hand, the infrastructure (Ifr) has a negative impact on the integration in the GVCs, which contradicts the analyzes of Kaplinsky (2014), Morris et al. (2012), and Staritz et al., 2016). The empirical findings of Kaplinsky (2014), for example, pointed out that the development of links in the mining industry of nine African economies occurred in particular, through the development of infrastructure. According to this author, this factor affects not only the cost of exporting resources but also the natural protection offered to local suppliers and their input and logistics costs. Once again, we believe that the proxy used, due to the absence of an indicator covering the analyzed period, was responsible for this unexpected result.

The reason is that the value of the transport service proxy tends to be all the greater the more transport services (be they sea, air, land, inland waterway, pipeline, etc.) are carried out by the analyzed country for another partner. The point is that, due to the characteristics of the extractive sector (of large-scale production and export), transportation services for the export of commodities tend to be more intense than, for example, the export of manufactured goods with high technological content. In other terms, it is not about the intensity of the transport service, which would be a demonstration of the good infrastructure and logistics of the country, but of the good that is being transported. Because of these results, Hypotheses 2a and 2b were rejected, while Hypothesis 2c was supported by the model estimate.

### 5.3 Foreign trade in the mining industry

As for the variable related to foreign trade “Re”, which refers to intermediary imports re-exported from the mining industry, the results did not indicate any influence of the same for the participation of the mining industry in GVCs. Thus, Hypothesis 3a was also rejected. This finding differs from the evidence found by Dean et al. (2008) and Sturgeon & Gereffi (2009), who argue that the increase in the trade-in intermediate goods has impacted on the geographical fragmentation of the production process and, consequently, on integration with the GVCs. Dean et al. (2008) showed that instead of engaging in progressive import substitution as domestic capacities increased - as predicted by most development theories - China increased its dependence on imported intermediaries as exports increased. This strategy contributed to the advancement of countless sectors and, consequently, to the increase in this country's participation in GVCs.

In the case of this study, the justification for the irrelevance of the “Re” variable to contribute to the participation of the mining industry in the countries analyzed in the GVCs may be associated with the fact that this strategy is still little practiced in many developing countries in the analyzed sample. The import substitution policy presupposes the production and aggregation of domestic value in the total production of a certain good, to the detriment of the import of an intermediate good and its subsequent aggregation of value. Although highly condemned in the GVC literature (Gereffi, 2014; Kaplinsky, 2014), this policy is still practiced in many countries, and proof of this is that the value of intermediate re-exported imports and domestic added value incorporated in exports related to the mining industry it is different between countries.

According to the OECD TiVa database (2018), the value of “Re” in 2015 for Russia, Saudi Arabia, Japan, and Korea were 3,623.00 respectively; 295.4; 24,920.4, and 47,225.4 whereas the domestic added value was 106,656.5; 139,024.8; 474.1 and 306.2 (in millions of dollars) for those same countries. That is, the two economies developed in this example, are dedicated to adding value to imported goods, and not in domestic production. This is one of the “keys” strategies to improve the participation of industries, and consequently, of a nation in GVCs (Milberg, 2013).

### 5.4 Characteristics of the mining industry

Finally, with regard to the variables related to the characteristics of the mining industry, the result of the model did not point out statistical significance relating the gross production of ore (Pr) to the increase in the participation of the mining industry in GVCs, while for the variable “Di” related to productive diversification, there was a negative statistical

significance. Thus, Hypotheses 4a and 4b have not been validated. In the first case, this variable was chosen to be investigated because it was not identified in the empirical studies that deal with the determinants of participation in GVCs.

This factor was expected to be influenced by the fact that countries dependent on exports of mineral commodities are generally those that have a high gross ore production. Many of them depend in part on exports of these goods and mining contributes significantly to the gross domestic product (Makasheva et al., 2017). However, the result generated can be understood due to the drop in the price of commodities that began with the global financial crisis of 2008 and had repercussions until mid-2013. Due to the decrease in foreign demand for mineral goods, gross production fluctuated sudden changes over the analysis period, which possibly influenced the result of this variable.

Regarding the diversification variable "Di", its negative influence on the level of participation in GVCs differed from the findings by Ali and Msadfa, (2016), Staritz et al. (2016) and Tinta (2017). Tinta (2017) found in his study on the role of intra-regional trade in the integration of Africa in GVCs that the increase in diversification has generated an increase in added value. Staritz et al. (2016), presented evidence that market diversification offered more export opportunities in the clothing sector in Ethiopia. However, the result obtained in the present study can be understood according to the structure of the global mining industry shown in the reports of the United States Geological Survey (USGS, 2020).

The analysis of these documents shows that the mineral goods produced and declared by the countries encompass the production of ore in various stages of added value, from fresh ore to the processing stages with higher added value. Thus, a country can have high diversification in the production of mineral goods, and, however, a large part of them come from gross production and proceed to export without adding foreign content. In other words, when it comes to the mining industry, diversification of the portfolio will only have a positive effect on the integration in GVCs if it does not provide for the addition of gross exports of other mineral goods in addition to those already produced by the country.

A concrete case that illustrates this reasoning is that of Croatia's mining industry, which obtained the tenth highest participation rate in GGVs ("Pa") among the sixty-two countries analyzed (Figure 3). However, this country has a trade deficit in mineral goods and has recently stopped mining metal ores. The production of the mining industry in this country takes place from secondary raw materials - from domestic recycling and imports (Perez, 2014). That is, in addition to having low diversification of mineral goods, the data suggest that mineral commodities imported by Croatia, in addition to being essential to that country's economy, still contribute to the effective participation of its mining industry in GVCs.

Based on this discussion, the following reading can be made, based on the result of the econometric model presented in Table 3: Countries that have greater trade openness and a better qualified labor have greater participation of their respective mining industries in GVCs. This evidence is in line with the current GVC literature and reinforces the findings of other studies that analyzed different types of industries or participation at the country or regional level. On the other hand, infrastructure and productive diversification negatively impacted the participation of the mining industry in GVCs, which differs considerably from many studies. However, these results are understood when considering the intrinsic characteristics of the mining industry, such as large scale production and low added value.

## 6 CONCLUSION

In a context where countries increasingly seek to insert themselves in the dynamics of international trade, the extractive sector is fundamental to feed the productive process along the global value chains (GVCs). In particular, the mining industry stands out, an economic activity essential for many emerging economies and which is still little analyzed under the theoretical lens of GVCs. Using the multiple regression technique and employing a panel data structure for the period 2001 to 2015 for sixty-two countries, this study sought to investigate the determinants for the participation of the global mining industry in GVCs.

From the estimation of the fixed effect model, we discuss the influence of the selected variables on the participation index along these chains. Our findings suggest that the determining factors for the participation of the mining industry in GVCs in the countries analyzed are the trade openness and qualified labor. On the other hand, infrastructure and

productive diversification have a negative impact. In the latter case, the results differ to a large extent from many empirical studies in the GVC literature, which reinforces the theoretical contribution of this study, in addition to demonstrating, in certain aspects, the intrinsic characteristics of the mining industry in relation to the others. We thus seek to contribute to the GVC literature by presenting empirical evidence on the determinants of participation in these chains, as pointed out by Antràs & Chor (2018), the identification and analysis of these factors still remain unanswered and deserve attention.

In addition, the descriptive analyzes allowed to identify which countries have the mining industry best positioned in the GVCs. The results showed that the mining industry of 77% of developing countries has a below average participation in GVCs and that the countries with the highest participation are not those with a tradition in mining activity. This shows the importance of industrial policies that contribute to the insertion of this industry at higher levels in GVCs and that live up to the mineral potential that many countries have and from which many do not derive the due value from this activity. From the "GVC approach" perspective, these results corroborate the need for upgrading for the mining industry in these countries, in search of greater value capture, and consequently, greater participation in GVCs. Especially in the Brazilian case, one of the main challenges is to increase the technological content of exports in order to upgrade the function in the extractive sector (Milberg, Jiang & Gereffi, 2014).

In this way, we seek to cooperate to understand the question of why some mining industries in certain countries are better inserted in GVCs than others, even if these are not large producers of mineral goods. Our findings support that the gains of the same industry in GVC dynamics can be uneven across countries, especially in emerging economies, as shown in studies by Banga (2013), Kersan-Škabić (2019), among others. In particular, we emphasize the importance of policies that promote the qualification of the labor for this industry, in particular, the development of technological centers for mineral research and expansion of technical, higher, and postgraduate courses. Specifically in Brazil, as pointed out by the national mining plan (2011-2030), there is a shortage of specialist professionals for mineral research and processing, in addition to researchers for the development of new technologies related to mining.

Also, industrial policies must focus on trade openness, promoting, above all, regional trade agreements, in particular, between large ore producing countries. Recent literature has shown an increasing tendency for GVCs to become increasingly local than global. Thus, we encourage future studies that go deeper into this theme, especially, incorporating other factors that were not mentioned in this study, but that can bring valuable insights to this discussion. For example, the links of the mining industry with sectors upstream and downstream, the profile of local suppliers and mining companies (mainly in terms of the degree of ownership), etc.

We emphasize as limitations of this study the lack of current data for most of the investigated variables, which made the most recent data refer to the year 2015. Besides, the unavailability of specific data for the mining industry has caused some proxies relative "country-level" were used to portray the reality of this industry. In this sense, other variables also with explanatory power on the participation of the mining industry in GVCs could not be used due to the unavailability of specific data for this industry.

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## Annex - Covariance Matrix

| Variable | Pa | IED | Li | Ifr | In | Qu | Re | Di | Pr |
|---|---|---|---|---|---|---|---|---|---|
| Pa | 1 | | | | | | | | |
| IED | -0,1526 | 1 | | | | | | | |
| Li | 0,1906 | 0,0636 | 1 | | | | | | |
| Ifr | -0,1689 | -0,1207 | 0,1240 | 1 | | | | | |
| In | -0,1403 | 0,3314 | -0,0263 | 0,0014 | 1 | | | | |
| Qu | 0,1362 | 0,1149 | 0,5289 | 0,1671 | -0,0532 | 1 | | | |
| Re | -0,1390 | 0,3583 | 0,0190 | -0,0521 | 0,6834 | 0,0361 | 1 | | |
| Di | -0,3772 | 0,2599 | -0,2070 | -0,1264 | 0,4288 | -0,1969 | 0,3795 | 1 | |
| Pr | -0,3507 | 0,4114 | -0,0542 | -0,1398 | 0,4288 | -0,0810 | 0,5469 | 0,5600 | 1 |

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# FATORES DETERMINANTES DE INSERÇÃO NAS CADEIAS GLOBAIS DE VALOR: UMA ANÁLISE DA PARTICIPAÇÃO DA INDÚSTRIA MINERAL

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Modelo de Efeito Fixo

RESUMO

**Objetivo:** Investigar os fatores que contribuem para a participação da indústria mineral nas cadeias globais de valor (CGVs) dos países que serão analisados.

**Método:** De cunho explicativo e abordagem quantitativa, este estudo utilizou como técnica estatística a regressão múltipla por meio do Modelo de Efeito Fixo. A estrutura dos dados i é em painel, referente a 62 países, e corresponde ao referente a sessenta e dois países para o período de 2001 a 2015.

**Principais resultados**: Os resultados apontam que 77% dos países em desenvolvimento possuem baixa participação de suas respectivas indústrias minerais nas CGVs em relação à média apresentada dos países da amostra. Além disso, o resultado do modelo sugere que a abertura comercial e a qualificação da mão de obra são fundamentais para elevar a participação desta indústria nas CGVs.

**Relevância/originalidade**: A indústria mineral é estratégica do ponto de vista econômico para muitos países e além disso, fornece insumos essenciais para a cadeia produtiva de grande parte dos bens utilizados pela sociedade moderna. Apesar disso, são poucos os estudos que analisam esta indústria sob a lente teórica das CGVs.

**Contribuições teóricas/metodológicas:** Este estudo busca expandir a literatura CGV ao trazer evidências de quais fatores contribuem para a participação da indústria mineral nestas cadeias.

**Contribuições sociais / para a gestão (opcional):** São apresentados possíveis caminhos que podem melhorar a participação dos países que possuem a indústria mineral pouco integrada.

# PARTICIPACIÓN DE LA INDUSTRIA MINERAL MUNDIAL EN CADENAS DE VALOR GLOBALES: ANÁLISIS DE LOS FACTORES DETERMINANTES DE INSERCIÓN

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RESUMEN

**Objetivo:** Investigar los factores que contribuyen a la participación de la industria minera global en las cadenas de valor globales (GVC).

**Método:** De naturaleza explicativa y con enfoque cuantitativo, este estudio utiliza la regresión múltiple como técnica estadística utilizando el Modelo de Efecto Fijo. La estructura de datos está en un panel, correspondiente al período de 2001 a 2015 y se refiere a 62 países.

**Resultados principales:** Los resultados muestran que el 77% de los países en desarrollo tienen una participación baja de sus industrias mineras en las cadenas de valor mundiales en comparación con el promedio presentado en los países de la muestra. Además, se desprende del modelo necesario que la apertura comercial y la calificación de la mano de obra son fundamentales para incrementar la participación de estas cadenas sectoriales.

**Relevancia / originalidad:** La industria minera es estratégica desde el punto de vista económico para varios países y, además, ofrece insumos esenciales para una cadena productiva de la mayoría de los bienes utilizados por la sociedad moderna. A pesar de esto, existen pocos estudios que analicen esta industria desde la perspectiva teórica de las GVC.

**Aportes teóricos y metodológicos:** Este estudio tiene como objetivo ampliar la literatura de la GVC, mostrando qué factores contribuyen a la participación de la industria minera en estas cadenas.

**Contribuciones sociales / de gestión (opcional):** hay formas posibles de mejorar la participación de los países que tienen una industria minera poco integrada en las cadenas de valor mundiales.

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