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Mining and Structural Change: How Mining Affects Participation in the Global Value Chain.

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Abstract

We examine the relationship between mining activity and participation and positioning in the global value chain in 74 developing countries from 1995-2018. Mining activity can impact countries' participation and especially their positioning in this chain through the changes it induces in the industrial and institutional structure of countries. We use the event study method, taking the activation of mines as the event to be studied, with a study time horizon of five years. Our relatively robust results show that mining activity harms positioning in the global value chain through specialization towards start-of-the-chain industries. The type of mineral extracted, the mode of extraction, and the geographical position play an essential role in this relationship. Three transmission channels explain this result: human capital, total factor productivity, and the Dutch disease.

Keywords: Dutch disease, natural resources, mining, global value chain.

JEL codes : L72, F15, Q23, F14

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1 Introduction

Globalization has had its heyday since the early 1980s, giving rise to the “Age of the World Value Chain.” However, recent events, including the economic war between China and the United States, the COVID-19 crisis, and finally, the war in Ukraine, have led various governments to question their participation and positions on globalization [Antràs \(2020\)](#). Some authors, such as [Jaax *et al.* \(2023\)](#), even go so far speaking of a risk of deglobalization.

The global value chain can be defined in several ways. However, all definitions agree that it refers to the productive activities carried out by firms in different geographical areas. Furthermore, these globally fragmented activities aim to bring a product or service from the initial design stage to the final product or good stage, as can be read in [Freund *et al.* \(2020\)](#) and [Amador *et di Mauro* \(2015\)](#). Therefore, the global value chain is only an essential part of globalization. Thus, it has been spreading rapidly since the 1980s, as has globalization. Several factors are at the origin of this growth at the world level. These are, among others, the revolution in the information and communication sector and a decrease in trade restrictions on manufactured goods, notably with China’s entry to the WTO in 2001. Finally, the political changes that have brought several countries into the capitalist economic system ([Freund *et al.*, 2020](#); [Antràs, 2015](#)). This form of trade organization offers specialization and efficiency advantages and market access ([Katz *et Pietrobelli*, 2018](#); [Taglioni *et Winkler*, 2016](#)).

Countries rich in natural resources have a natural advantage in participating in trade by exporting raw materials. Thus, in most cases, these countries are likely to end up at the beginning of the chain. Indeed, countries rich in natural resources export these resources, enabling them to participate in the global value chain. On the other hand, the disadvantage of this participation is that countries position themselves at the beginning of the chain by exporting natural resources, mostly raw materials destined for producing finished products. Faced with this ambiguity, it is legitimate to ask about the actual effect of the exploitation of natural resources on participation and positioning

in the global value chain.

The literature on the Dutch disease and the Natural Resource curse shows that a shock of income due to natural resources could lead to a collapse of the industrial structure of a country, as stressed by [Corden et Neary \(1982\)](#) and [Bresser-Pereira \(2008\)](#). Indeed, according to this literature, the positive income shock resulting from the exploitation of natural resources leads to a loss of competitiveness in other sectors due to an appreciation of the real exchange rate. Also, the increase in mining revenues can lead to a deterioration in institutional quality, which will, in turn, impact the country's attractiveness and the companies' working environment. The second transmission channel that could explain our intuition is the relationship between the level of resource rents and human capital. Work such as that of [Gylfason \(2001\)](#) shows the negative relationship between natural resource rents and human capital. Indeed, in his work, he lists the different factors that caused the weak growth of countries rich in natural resources. These are the Dutch disease, the rent-seeking behavior of countries, overconfidence, and finally, the neglect of education. Natural capital crowds out human capital since in resource-rich countries, educational expenditures and education levels are relatively low ([Gylfason et al., 1999](#); [Gylfason, 2001](#)). The third transmission channel, which can explain the relationship between rents and positioning in the global value chain, is the negative relationship between the level of rents and aggregate factor productivity ([Gill et Kharas, 2015](#)). Specialization in the export of natural resources leads countries to neglect technological development, which impacts aggregate factor productivity. Indeed, in the literature, several authors use natural resource returns as a factor in explaining the middle-income trap. Indeed, authors such as [Ohno \(2009\)](#) and [Garrett \(2004\)](#) before them have examined the question. They explain the difficulty of several middle-income countries by the fact that these countries rely on natural resources and foreign direct investment flows. [Garrett \(2004\)](#) notes the need for technological progress to enable middle-income countries to move beyond this trap.

A country with a given economic structure that experiences such a shock will likely

change its participation and position within the chain due to the factors we have listed above. Exploiting natural resources or a rent shock can increase a country's participation in the global value chain. At the same time, this exploitation can negatively impact this participation by reducing the competitiveness of this country. The reasons why we are trying to answer two questions in our paper. First, how does mining affect participation in the global value chain? Second, how does a country's position in the GVC change following a shock at the level of these rents? The contribution of this paper to the literature is as follows: First, we study the relationship between a shock from natural resource rents, here is the start of mining activity, and positioning into the global value chain. To our knowledge, this relationship has yet to be addressed, and it is the first to study the process of loss of industrial competitiveness mentioned in the literature on Dutch disease. In this paper, we want to highlight the effect of a shock from the mining sector on the participation of a given country in the global value chain in the first part and the same effect on its positioning in that chain in the second part. Also, this study uses two built indexes (Backward and forward participation indexes) to assess the positioning in the global value chain and to see more clearly the effect of mining activity on the positioning in that chain. The richness of the Minex database enables us to study the heterogeneity of the results that will be obtained. This database provides information on the type of ore mined, the size of the mine, and the mining method. Thus, this relationship is studied according to the size of the mines, the type of ore extracted, and the extraction mode. The originality of the study also lies in the method used. Indeed, we use an event study method as the primary method, and this allows us to see the relationship evolve over our chosen time window. Finally, our study focuses on developing countries over a more extended period than most studies in the field. All these elements make our contribution to the relevant literature.

We studied 74 developing countries from 1995 to 2018 according to data availability. The choice of developing countries is motivated by the literature. Indeed, according to this, these countries are experiencing significant changes within their industrial sector,

and therefore, their industries are likely to be strongly impacted by shocks. Also, developing countries are the most affected by natural resource rent shocks due to the low diversification of their economies. Last but not least, the poor institutional quality in these countries makes them less able to put in place policies to take advantage of these rents and reduce their dependence on these resources. Therefore, using this logic, we focus on 74 of these developing countries in the context of our study.

To identify the relationship that we want to highlight, we use a methodology that allows us to consider the activation of a mine as a shock that can impact the economy's structure. As mentioned above, the methodology adopted is that of the event study. [Kouevi-Gath *et al.* \(2021\)](#) has used this method in studying the relationship between the banking crisis and democracy. This method allows us to study the repercussions of activating a mine over a time horizon of our choice and in our case, this horizon is five years.

The main finding highlighted in this article is that mining activity significantly negatively impacts positioning in GVC. Indeed, it is associated with a specialization in upstream value chain industries. This means that the industrial sector of countries is changing by moving towards less finished products, that is to say, less complex. The result was robust to the addition of additional control variables, to the use of an alternative explained variable, namely the economic complexity index, to the extension of the study horizon, and, finally, eliminating the base of countries having experienced the opening of more than one mine during the study period. Also, we highlight results depending on the type of resource extracted, the extraction method, and the country's geographical position.

The rest of the paper will be presented as follows: First, we will review the literature on the relationship between mine activity and positioning in the global value chain in Section 2. That section allows us to formulate assumptions presented in subsection 2.4. Then, we will study the different data used in Section 3. After that, we will present the model chosen to highlight the relationship between mining activity and participation

in the global value chain in Section 4. Finally, in the last three parts (Section 5, 6 and 7), we will present the results, the robustness of these results, and their heterogeneity.

2 Literature

In this section, we will first present the literature on defining and measuring the GVC. Then, we will present the literature on the determinants of participating in the GVC, particularly for developing countries. Finally, we will present a study of the literature on the relationship between mining and participation in the GVC. We conclude with some hypotheses derived from our literature review.

2.1 Definition and measurement of the GVC

The global value chain refers to the decomposition of production steps between several countries ([Antràs et Chor, 2022](#); [Amador et di Mauro, 2015](#); [Johnson, 2018](#)). It gained momentum in the 1980s due to a combination of revolution in the information and communication technology sector, reduced trade barriers, and finally, the popularity of the capitalist system ([Freund et al., 2020](#)). Furthermore, the increasing importance of GVCs has resulted in a fragmentation of production in different countries according to the comparative advantages.

One of the most critical concerns is the measurement of GVC. The literature is broken down into macroeconomic studies that study the phenomenon at the level of the entire country and microeconomic studies that study the same phenomenon at the level of individual firms. At all levels, measuring the global value chain has been an essential step in understanding it ([Johnson, 2018](#)), and allows for a better comprehension of global economy mechanisms.

At the micro level, studies focus on firms. The availability of micro-level data makes it easier to identify the mechanisms behind firms' participation in the global value chain. They have been made possible by the laborious construction of firm-to-firm databases

(Blum *et al.*, 2010), by the use of customs data from certain countries, or even by data on firms available at the country level (Kramarz *et al.*, 2020). Empirical work has shown that only a small proportion of firms in each country participate in the global value chain (Bernard *et al.*, 2007). Also, the firms participating most in this chain are larger and have higher productivity than other firms in the same country, as pointed out in studies like Bernard *et Jensen* (1999); Clerides *et al.* (1998); Melitz (2007).

On the macro level, much of the work on the global value chain is based on global input-output tables. The measurement of participation in the GVC is based on the trade-in value added. This means measuring the participation of each country in value-added trade. General equilibrium models based on input-output linkages have been used extensively at the micro and macro levels to understand the global value chain phenomenon better. The most important aspect of this question is the possibility of measuring the position of a country in global value flows. This question refers to the notions of "upstreamness" and "downstreamness" (close to final demand) that we find in the works of Bosma *et al.* (2005), Antràs *et Chor* (2013) and Fally (2012). The position of a country in the global value chain can depend on the difference in productivity or geography. This availability of data and measurement of participation in the global value chain has made it possible to highlight the determinants of this participation.

2.2 Determinants of participating in the GVC

In the literature, the drivers of participation in the global value chain have been discussed at length. The main factors are the size of the market, the level of development, the structure of the industry, the location of the country, the level of foreign direct investment, the quality of the infrastructure, and finally, the regulations on trade openness at the level of each country (Kowalski *et al.*, 2015). Firms or countries opened to the rest of the world are the most likely to participate in the global value chain. In this case, the literature has differentiated between importing and exporting countries. So opened countries participate differently to the GVC.

According to the World Bank report (Freund *et al.*, 2020), all countries participate in GVC, but not in the same way. Thus, North American, Western European, and East Asian countries specialize in producing complex products, while Africa, Central Asia, and Latin America produce less complex intermediate goods. So, we have an implicit idea of the positioning of the different countries in the different regions in the GVC. This way, the first group of countries is located at the end of the chain, while the second group is at the beginning or middle. According to the literature, it is not easy to highlight a clear relationship between the level of development and participation in the GVC. Indeed, the difference in level of development may reflect the difference in labor or capital productivity, as well as the difference in institutional quality and business climate (Kowalski *et al.*, 2015). Also, according to the literature, the economy's structure evolves along with the level of economic development, which is seen through participation in the global value chain. Thus, among developing countries, those at the beginning of the chain will tend to specialize in trading primary goods, while the wealthiest countries among developing countries will specialize in exporting finished goods. However, this relationship is not linear, as shown by (López González *et al.*, 2012).

The participation of developing countries in the GVC should not be taken for granted (Taglioni *et al.*, 2016; Bamber *et al.*, 2014). These countries must implement the conditions to allow them to participate fully in the GVC. These include trade openness, human capital development, infrastructure development, and improving the quality of institutions and the business climate (Bamber *et al.*, 2014; Publishing, 2013). In principle, for developing countries, participation in the GVC should guarantee entry into the global market. The specialization in the tasks allows the companies of these countries to participate in world trade without having to develop specific industrial fields beforehand (Rodrik, 2018). Countries rich in natural resources have a natural disposition to participate in the GVC, so the mining sector is a factor in participation in the GVC.

2.3 The mining sector as a factor in participation in the GVC

Two questions arise when discussing the relationship between mining and GVC: the first is whether mining promotes participation in GVC, and the second is whether it keeps countries at the beginning of the chain or leads them to specialize in it. Firstly, the mining sector is a factor of participation in the global value chain because countries with natural resources have a comparative advantage. The need to export natural resources is leading countries to open up and participate in the global value chain. Around one-fifth of world trade is made up of natural resources. The share of natural resources in international trade proliferated between 1900 and 1955 before declining and rising again, as we can read in [Ruta et Venables \(2012\)](#). Thus, differences in natural resource endowment can explain differences in participation in the global value chain.

Secondly, when we talk about mining activity and positioning in the GVC, we are referring in part to the literature on Dutch disease, the first studies of which date back to [Corden et Neary \(1982\)](#) and [Corden \(1984\)](#). Indeed, in the literature on Dutch disease, it is demonstrated that the economy's structure can change following positive shocks (notably the discovery of natural resources, an increase in the international price of exported goods, or a massive and sustained influx of capital). Moreover, this change in structure is characterized by a contraction or stagnation in sectors other than those affected by the positive shock. In practical terms, in countries that have experienced Dutch disease, there has been a contraction in the manufacturing and agricultural sectors ([Corden et Neary, 1982](#)). Thus, a high income for a given country, particularly from natural resource rents, could affect the productivity of the country's manufacturing sector in question and thus, by ricochet, impact its participation and positioning in the global value chain. Also, through the resource curse mechanism, low growth induced by mining revenues can, in turn, impact the productivity and competitiveness of a given country and, thus, its participation in the GVC.

The relationship between mining activity and participation in the global value chain also calls upon the literature on the curse of natural resources, the notion of which was

introduced by [Sachs et Warner \(1995\)](#). Indeed, natural resource rents, which should be sources of growth for the countries that hold them, have very often been shown to be obstacles to their growth and, therefore, to their development ([Gelb et al., 1988](#); [Sachs et Warner, 2001](#)). Still, in this sense, [North \(1991\)](#) already underlined the decline of the kingdom of Castile, which was rich in natural resources. Several factors, such as the deterioration of institutional quality and the increase in the risk of conflicts, contribute to keeping countries at the bottom of the GVC. Studies show that the natural resource curse only appears in countries with institutional quality ([Mehlum et al., 2006](#)). New approaches have been developed concerning the relationship between the natural resource curse and globalization. Works such as those of [Adams et al. \(2019\)](#), [Kolk et Lenfant \(2010\)](#), and [Kopiński et al. \(2013\)](#) address the issue in the sense of globalization. According to these works, the curse of natural resources could be explained by globalization and, more precisely, by the behavior of multinationals in the mining sector. Indeed, companies in countries rich in natural resources implement various strategies, such as legitimization, tax evasion, and transfer pricing, depriving countries of potential resources to finance development. In other words, mining is a factor of natural resources curse which can negatively impact countries participation to the GVC.

In addition to these well-stocked literatures, the questions we try to answer also refers to the literature on the relationship between natural resource rents and human capital. The economic literature has highlighted a negative relationship between rents and human capital. [Gylfason \(2001\)](#) shows that the education sector is neglected in rentier countries. The most important factor he highlights is that natural capital crowds out human capital. This results in a low level of educational expenditure in the rentier countries ([Gylfason et al., 1999](#); [Gylfason, 2001](#)). The last literature to which we will appeal is that of the middle-income trap and that one dealing with the aggregate productivity factor. Countries dependent on natural resource exports neglect technological development, leading to low aggregate factor productivity. This theory explains

the middle-income trap, in which many countries depend on natural resources and foreign direct investment (Ohno, 2009; Garrett, 2004).

From the above, we note that a country's participation in international trade generally depends on its productivity and geography. Also, mining can favor this participation or not. It is therefore important to study the relationship between mining and participation to the GVC.

2.4 Assumptions

From different elements of the literature, we can formulate a set of testable hypotheses :

- The first hypothesis concerns the overall effect of mining activity on participation in the global value chain. Given the resource curse and Dutch disease theories, the relationship between rents and human capital, and aggregate factor productivity, we expect mining to have a negative impact on a country's participation in the global value chain. However, at the same time, mining activity can boost that participation while it can increase exportation. The effect is, therefore, ambiguous.

- Given the commodity nature of natural resources, we expect to see a positive effect between mining activity and specialization in industries at the lower end of the value chain. Indeed, resource-rich countries are often not very diversified, which leads them to export mainly natural resources in a raw form, thus placing them at the bottom of the global value chain. The countries' development level or institutional quality could condition this result. Furthermore, mining activity should be negatively correlated with end-of-pipe industrial activities. This is explained by the fact that, as in the previous case, since rentier countries mainly export raw resources, they are at the bottom of the scale.

3 Data

The data presentation section will be divided into two main parts. In the first part, we will present variables, their construction, and their sources. Then, in the second part, we will present descriptive statistics and stylized facts that will give us a first intuition of the results we can obtain.

3.1 The variables

Dependent variables

Among the main variables in our study are those related to participation and positioning in the global value chain, which comes from the UNCTAD-Eora database,¹ the methodology of which is described in [Casella *et al.* \(2019\)](#). This UNCTAD-Eora database offers us a large global coverage (about 189 countries) and a broad time horizon (from 1990 to 2018). However, the number of countries is much smaller due to missing data. From this database, we find key indicators of GVC participation, namely foreign value added (FVA), domestic value added (DVA), and indirect value added (DVX). FVA is the foreign value added contained in the exports of a given country; DVX is the domestic value added of a given country contained in another country's exports; and finally, DVA is the domestic value added which is embodied in this country's exports. These indicators helped us to construct our main variables. Following [Aslam *et al.* \(2017\)](#), [De Backer et Miroudot \(2014\)](#) and [Najarzadeh *et al.* \(2021\)](#), we use the following ratios to determine the upstream and downstream participation of each country in the global value chain. In the literature, the terms backward and forward are also used to designate the position of countries in the GVC. Backward refers to downstream participation, and forward to upstream participation. We use the notions of backward and forward to name our GVC participation variables.

$$Backward_{it} = \frac{FVA_{it}}{GrossExports_{it}} \quad (1)$$

¹[Casella *et al.* \(2019\)](#)

$$Forward_{it} = \frac{DVX_{it}}{GrossExports_{it}} \quad (2)$$

To construct the gross exports variable, we based ourselves on the work of [Koopman *et al.* \(2010\)](#) and [Koopman *et al.* \(2014\)](#) who decompose these exports into two components: foreign value added (FVA) and domestic value added (DVA). Thus, the sum of these two indicators in the UNCTAD-Eora database allows us to reconstruct the gross exports.

The *Backward* variable is defined from the FVA variable "Foreign Value Added" (which is the foreign value added contained in the exports of a given country) as we see in the equation 1 above. This refers to downstream participation in the global value chain in the literature. This is referred to as "Backward GVC participation" or "Downstream GVC participation". The variable measures the dependence of a country's exports on imported products. The higher the values of this variable for a country, the further forward in the GVC that country is.

The *Forward* variable is the second component of the global value chain that we will use. It was constructed from the DVX variable (defined as the domestic value added of a given country contained in another country's exports) as indicated above in equation 2. In the literature, this variable refers to upstream participation in the global value chain. It is referred to as "Forward GVC participation" or "Upstream GVC participation". The higher the values of this variable for a country, the closer it is to the beginning of the value chain.

Finally, the *GVC* variable is the sum of the previously described variables. In a formal way: $GVC = Backward + Forward$. We saw that participation in the global value chain could be in both directions. Participation in the global value chain involves activities located upstream and downstream of the global value chain. A supplier country upstream of the chain provides value-added (intermediate goods) to a downstream country. The latter will add value to the intermediate goods received to produce products for export. More synthetically, the variable *GVC* corresponds to the participation

variable in the global value chain, while *Backward* and *Forward* variables correspond to those of positioning in this chain.

It is important here to differentiate between participation in the global value chain and commercial openness. Both are all linked to trade, but do not reflect the same reality. In this sense, Wang *et al.* (2019) precised that trade volume, trade openness, and GVC participation are not substitutable. GVC participation mainly refers to the extent of a country's involvement in vertical international specialization. Participation in the global value chain only considers added value, while trade openness considers the total value of trade with the rest of the world. Countries with greater trade openness tend to have greater participation in the global value chain since this allows firms to access inputs from other countries, which can lead to greater specialization and efficiency in production.

Interest variable

This variable of interest is a dummy variable taking the value 1 in the year a mine becomes operational and the following five years and zero value otherwise. The Minex database gives this information.² This database gives the geolocalized position of each mine, the date of discovery of each mining deposit, and especially the date of the start of activity of the deposit and its date of closure in case of closure. Based on this database, we constructed a dummy variable *Activity* capturing mining activation. Thus, for example, for a given country, it takes the value of 0 for all the years except the year of the opening of a mine and the four years following the opening. This allows us better to capture shocks to the effects of natural resource revenues. This variable offers us the advantage of having the mine opening date, which is essential for measuring the effect of mines using the event study methodology.

Control variables

To add control variables to our analysis, we rely on the literature that lists the critical factors of mining activity in a country and, to some extent, the key determinants of participation in the global value chain. Among these factors, the first is the coun-

²<https://minexconsulting.com>

try's development level. In order to take this determinant into account, we take the logarithm of GDP per capita as a variable (*LogGDP*). We also consider the country's economic dynamics through the growth of GDP (*GDPgrowth*). These two variables are essential since, to put a mine into operation, exploration work is first necessary, which is quite expensive and therefore depends on the economic conditions of each country. The degree of openness in the countries concerned is also a determining factor. Indeed, openness is a key determinant of a country's ability to trade with the rest of the world, and it conditions the import and export capacities of different countries. To this end, we have included an analysis of the degree of trade openness variable from Penn World Table (*Openness*).³ We include the urbanization rate (*UrbanPop*) from the World Development Indicator (WDI) database. This variable is a good proxy of the industrial transformation stage in which a country is. Indeed, when the agricultural sector becomes more productive, we have a shift of workforce from rural areas to urban ones. So, this variable will control for the level of industrial development. The level of natural resources rent (*Rent*) given by the World Development Indicator (WDI) database has also been included, as it is an important factor in positioning in the global value chain. The final control variable we included is the level of capital openness (*Capital*) since the capital allows financing investment, which can affect the positioning in the GVC. We do not include institutional variables, since one of the transmission channels of the relationship we want to highlight is the degradation of institutional quality.

3.2 Descriptive statistics and stylized facts

The various descriptive statistics are summarized in table 1, and variables' definitions and sources are available in table 11. Table 1 allows us to get an idea of the distribution of our variables.

Then, the first graph (graph 1) allows us to see the evolution of the average participation in the global value chain. Moreover, following the literature highlighting a trend

³Feenstra *et al.* (2015)
<https://www.rug.nl/ggdc/productivity/pwt/>

Table 1: Descriptive Statistics

	Unit	Mean	SD	Min	Max	N
Dependent variables						N
GVC	Share	0.47	0.12	0.23	0.94	1,776
Backward	Share	0.18	0.10	0.03	0.58	1,776
Forward	Share	0.29	0.11	0.08	0.81	1,776
Interest variable						N
Activity	Dummy	0.45	0.50	0	1	1,776
Control variables						N
Openness	Percentage	72.83	33.07	0	290	1,776
Manufacture	Percentage	14.15	6.40	2	50	1,619
GDPgrowth	Percentage	2.49	4.01	-31	33	1,759
Capital	Percentage	0.14	1.44	-1.92	2.31	1,747
LogGDP	Percentage	7.82	1.23	4.63	11.35	1,767
Rent	Percentage	9.41	11.28	0.00	61.95	1,766
UrbanPop	Percentage	56.21	21.06	12.85	100	1,761

Note: As a reminder, the control variable is a binary variable taking the value 1 over the five years following the opening of a mine.

increase in participation in the global value chain, we observe an apparent increase over the years of this participation. This increase was slowed down by the economic crisis of 2008. Moreover, since then, this upward trend is no longer clear.

Figure 2 contains two graphs representing the evolution of the average positioning in the GVC for countries. These graphs allow us to see the dynamic of countries in the chain. Each of these two graphs can be divided into three main parts. The first part covers the period before 2001 and corresponds to the development period of specialized industries on average. The second part corresponds to the period between 2001 and 2008. During this period, there were both a drop and a development in specialization, so there was more participation to the GVC characterized by some countries exporting raw materials while others export more complex products. Finally, the last part in these two graphs corresponds to a slow-down of the specialization process.

Furthermore, graphs 3 allows seeing the distribution of this participation and this positioning between the five years following the mine and the others years. Indeed, let us recall that our variable of interest is dichotomous, taking the value one over our

“period of interest” and the variable 0 otherwise. Over our period of interest, namely the five years following the activation of a mine, we have a greater participation in the global value chain than in the other years. This activation of a mine is also associated with industries located at the beginning of the chain.

Graph 4 shows us that this effect is more significant at the level of rentier countries. Indeed, we divided our sample in two according to the initial level of natural resource rents to highlight the correlation between resources from mining activity and participation in the global value chain. Furthermore, we see that for rentier countries, the effect of activating a mine is more significant in reducing participation in the global value chain.

Regarding our mine activation variable, 53 countries experienced at least one mine opening, and the mine opening dynamic has been growing until 2010, when it started decreasing. The graph 9 clearly shows us the dynamic of the mine activation.

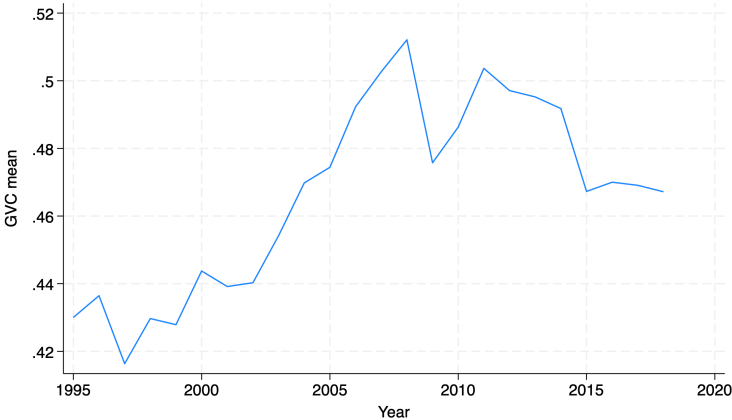
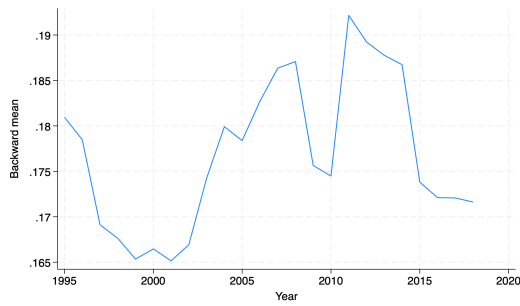


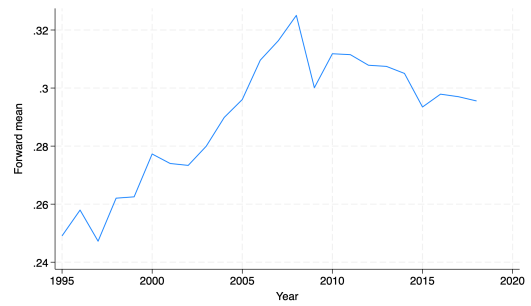
Figure 1: Evolution of the average participation in the global value chain

4 Econometric setup

This paper aims to establish the effect of mining activity on participation in the global value chain in one and, in the other, the effect of mining activity on positioning in this chain. Furthermore, the objective is to isolate the causal effect of mining activity on participation and positioning in the GVC. In the literature, the gravity model is



Backward participation



Forward participation

Figure 2: Evolution of the average positioning in the Global Value Chain

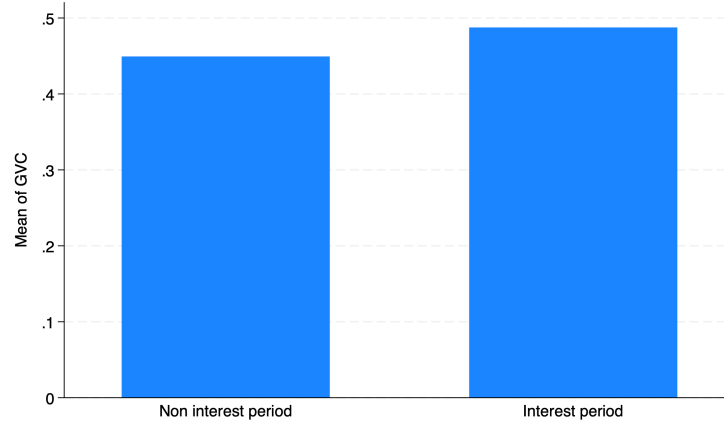
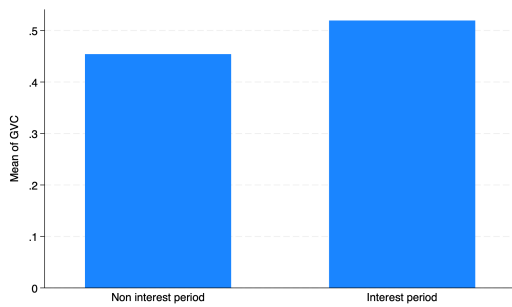
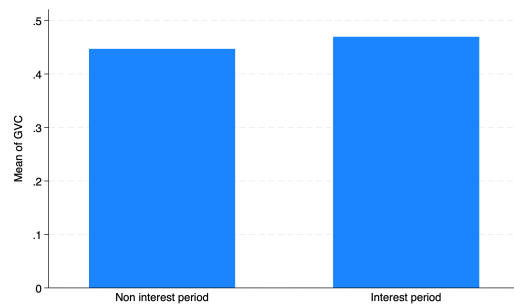


Figure 3: Participation between our two types of periods



Rentier countries



Non-rentier countries

Figure 4: Participation between our two types of periods for rentier and non-rentier countries

usually used. However, using such a model would not suit us, since the construction of participation indices in the GVC causes losing this bilateral nature of the data.

Among the multitude of methodologies available to estimate the desired effect, we have opted for the event study methodology (Corrado, 2011). The choice of this methodology is to shed light on the effect of the activation of a mine on a country's evolution participation and positioning in the GVC. The event study methodology was initially used to measure effects of economic events, such as the effect of price shocks on firm performance, and is very popular in the financial world. It has been adopted by the macroeconomics research community to measure the effect of events such as interest rate announcements or central bank policies on economic variables, or to study the effect of banking crises on various economic variables (Kouevi-Gath *et al.*, 2021).

We will use this methodology to study a mine activation's effect on a country's participation and positioning in the GVC. To do so, we must go through the two steps necessary in the event study methodology. The first step is to define the event around which we will study the evolution of our variable of interest. This event will be the activation of a mine. We will then study the evolution of the position in the global value chain following the opening of a mine. The estimated equation will be the following:

$$Depend_{it} = \alpha + \beta Activity_{it} + \sum_{j=1}^j \rho_j X_{jit} + \delta_i + \mu_t + \epsilon_{it} \quad (3)$$

In this equation, the *Depend* variable refers to one of our three dependent variables: *GVC*, *Backward*, and *Forward*. The variable *Activity* represents our variable of interest. It has been constructed as a dummy variable taking the unit value over the period $t + d$ (in our case here $d = 4$), with t the year a mine is in operation. The variable X_j refers to the control variables used in our study. These are the logarithm of GDP per capita, the level of trade openness, The value added of the manufacturing sector as a percentage of GDP, GDP growth, the level of internal stability captured by the level of internal conflict, and the level of corruption. In addition to these control variables, we control for country and year fixed effects, represented respectively in the

equation by δ_i et μ_t . Finally, ϵ_{it} represents the error term.

The choice of a study window is a difficult one, as it involves a trade-off between the length of the study period and the time horizon for studying the impacts of mine development. The longer the study window, the shorter the estimation period. Also, the smaller the study window, the smaller our study horizon. In this logic and according to our period of study, we first study the repercussions in the first five years after the setting of the activity of the mine and, thus, in our case, $T = 5$. In addition to the reasons cited above, the choice of the five-year study horizon allows us to capture the effect of mining activity essentially. Indeed, taking a broader horizon, the captured effect could be confused with policies supporting the industrial sector or boosting exports following the consequences of mining activity.

We test our model with a Tobit model on a panel dataset of 74 countries from 1990 to 2018 as the participation and positioning variables in the chain are between 0 and 1 and our sample only contains some values of all possible values (censored data). The use of this method requires two particular conditions. The first condition is the hypothesis of parallel trends between the countries that have experienced the activation of a mine and the other countries. We tested this hypothesis through the introduction of a time trend variable and the interaction of this variable with our variable of interest. The interaction variable is insignificant, table 14.

The second condition is that the activation of a mine must be exogenous. The activation of a mine can undoubtedly depend on several macroeconomic factors, such as the level of stability of the country. Nevertheless, when we take a closer look, more macroeconomic factors, such as the world level of commodity prices, determine the start-up of mines. Mines are active even in countries at war, for example.

5 Results

In line with the literature on event study methodology, we will focus only on the mining activity variable and will study its significance and sign in the first part, and

its magnitude in the second.

Table 2: Main Results and additional controls robustness

	Main model			Robustness: Econfree			Robustness: FDI		
	GVC	Backward	Forward	GVC	Backward	Forward	GVC	Backward	Forward
Activity	0.0032 (0.0024)	-0.0060*** (0.0020)	0.0090*** (0.0020)	0.0025 (0.0025)	-0.0064*** (0.0021)	0.0087*** (0.0022)	0.0028 (0.0024)	-0.0062*** (0.0020)	0.0089*** (0.0020)
Openness	0.0009*** (0.0001)	0.0008*** (0.0000)	0.0001 (0.0000)	0.0010*** (0.0001)	0.0011*** (0.0001)	-0.0001 (0.0001)	0.0008*** (0.0001)	0.0008*** (0.0000)	0.0001 (0.0000)
Manufacture	-0.0022*** (0.0003)	-0.0004 (0.0003)	-0.0018*** (0.0003)	-0.0013*** (0.0004)	-0.0002 (0.0003)	-0.0012*** (0.0003)	-0.0022*** (0.0003)	-0.0004 (0.0003)	-0.0018*** (0.0003)
GDPgrowth	0.0010*** (0.0002)	0.0005*** (0.0002)	0.0005*** (0.0002)	0.0009*** (0.0003)	0.0004* (0.0002)	0.0005** (0.0002)	0.0010*** (0.0002)	0.0005** (0.0002)	0.0005** (0.0002)
UrbanPop	0.0003 (0.0003)	0.0006*** (0.0002)	-0.0003 (0.0002)	-0.0007** (0.0003)	0.0002 (0.0003)	-0.0009*** (0.0003)	0.0002 (0.0003)	0.0006** (0.0002)	-0.0003 (0.0002)
Capital	-0.0009 (0.0012)	0.0000 (0.0010)	-0.0008 (0.0010)	-0.0019 (0.0015)	-0.0012 (0.0012)	-0.0006 (0.0013)	-0.0010 (0.0012)	-0.0001 (0.0010)	-0.0008 (0.0010)
LogGDP	0.0251*** (0.0023)	-0.0012 (0.0019)	0.0263*** (0.0019)	0.0264*** (0.0026)	0.0035 (0.0021)	0.0229*** (0.0022)	0.0255*** (0.0023)	-0.0009 (0.0019)	0.0265*** (0.0019)
Rent	0.0002 (0.0002)	-0.0005*** (0.0002)	0.0006*** (0.0002)	-0.0001 (0.0002)	-0.0008*** (0.0002)	0.0006*** (0.0002)	0.0001 (0.0002)	-0.0006*** (0.0002)	0.0006*** (0.0002)
Ecofree				0.0077*** (0.0029)	0.0048** (0.0024)	0.0033 (0.0025)			
FDI							0.0005*** (0.0001)	0.0003** (0.0001)	0.0002 (0.0001)
Observations	1589	1589	1589	1281	1281	1281	1588	1588	1588

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table presents the main results as well as the robustness results by adding additional control variables.

Estimations:

The results are presented in the first three columns of table 2. First, there is no significant effect in the first column presenting the GVC variable. This result shows that mining does not reduce a country's participation in the global value chain. Then, in the column [2], the results concerning the Backward variable. The relationship between this variable and mining activity is negative and significant at the 1% level. Finally, the third column (column [3]) shows a positive and significant at the 1% level relationship between our Forward variable and mining activity.

So far, our results suggest that mining activity impacts positioning in the global value chain. Indeed, Columns 2 and 3 of our main results table (table 2) show that mining activity tends to change the placement of countries in the global value chain, causing them to export fewer and fewer finished products. The higher the Forward index, the greater the participation in the industries at the beginning of the chain. Moreover, here, the mining activity positively impacts our index. Then, the higher the Backward Index, the more industries the country has at the end of the chain, and results shows that mining hurts our Backward Index.

An important result is that the coefficient of the GVC participation variable (*GVC*) in column [1] is insignificant. This means that although the activation of a mine increases the participation in the GVC through a greater export of ore, it is accompanied by the decline of the export in other sectors such that the final effect is not significant. This result supports the results of the following two columns.

Magnitude of the effects

Our results show an impact on participation in the global value chain by moving countries towards less and less complex industries. To better understand the scope of these changes induced by mining activity, comparing these different coefficients to the averages of the Forward and Backward variables is necessary. First, regarding the Forward variable, the mean is 0.8232, and the mean for the Backward variable is 0.1768. Thus, a country with an average annual forward participation index of 0.8232 will increase its forward participation index by 1.09 percent. A country with an annual average backward participation index of 0.1768 will drop backward participation by 3.39 percent. The results, therefore, have reasonable proportions.

6 Robustness

In this section, we will first analyze the robustness of our results by adding additional variables to our baseline model. Then, we will extend the study horizon and remove from the sample countries that have experienced several simultaneous mines openings.

Finally, we will use the economic complexity index to measure positioning in the global value chain.

6.1 By varying our control variables

A method used to demonstrate the results' robustness is adding other control variables. We do this by successively including the economic freedom index (*Ecofree*) and the level of foreign direct investment (*FDI*). These two variables can affect the participation in the global value chain. First, economic freedom is a natural determinant of participation in the global value chain, as it is necessary for consumption and production activities that impact participation in the chain. Next, FDI can lead a country to have a more productive industrial sector, leading to a better positioning in the GVC. Results are presented in Table 2. Columns [4-6] of the table 2 show that our results are robust to adding economic freedom. The last three columns (columns [7-9]) confirm this robustness after adding the FDI level variable. Another exciting result of this robustness analysis is that economic freedom and net foreign direct investment flows counteract the adverse effects of mine development, as shown in Table 2. Greater economic freedom and foreign direct investment allow countries to better benefit from the activation of mines by increasing participation in GVC through an evolution towards the end of the chain.

6.2 By extending the study horizon

As we indicated in the section dealing with the methodology, the choice of the study horizon of the repercussions of initiating a mine is the result of a compromise. We undertake to widen the time horizon here as a robustness measure. So, instead of taking the five years after the opening of the mine, we take the ten years after it opened. We expect the results to be qualitatively similar to the primary results. This is what we observe in columns [1-3] of Table 3. It means that the effect of the mine opening has relatively long-lasting effects.

We also included lagged variables of mines activation to see what happened before the mine opened and ten years after. So, the new window is composed of five years before the mine activation and ten years after that opening. The results remain qualitatively the same, as we can see in graphs 5, 6, and 7. Mine activation is like a rupture in the trend of our GVC positioning variables. In the short term, there is no effect of mine activation on participation in the GVC. But there is an effect on position, as found in the main results. In the medium term, however, the trend is beginning to change, as we can see that employee participation is starting to rise again, probably as a result of company adaptation and adjustment policies.

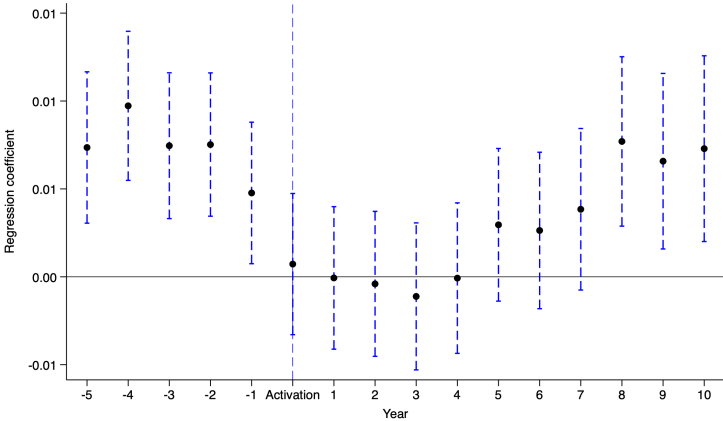


Figure 5: Effect of Mine activation on the GVC participation (GVC variable)

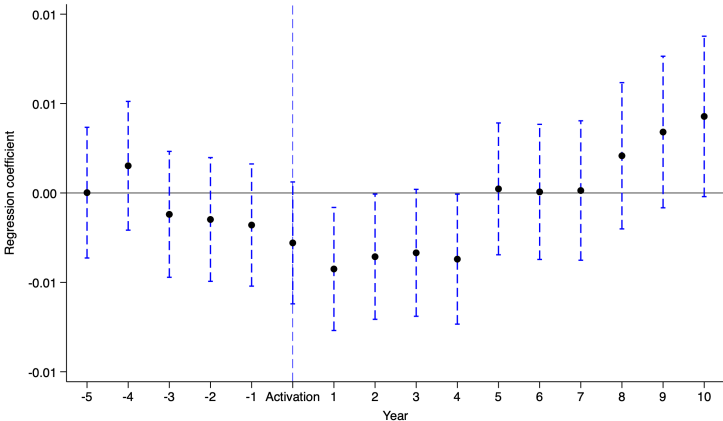


Figure 6: Effect of Mine activation on the GVC positioning (Backward variable)

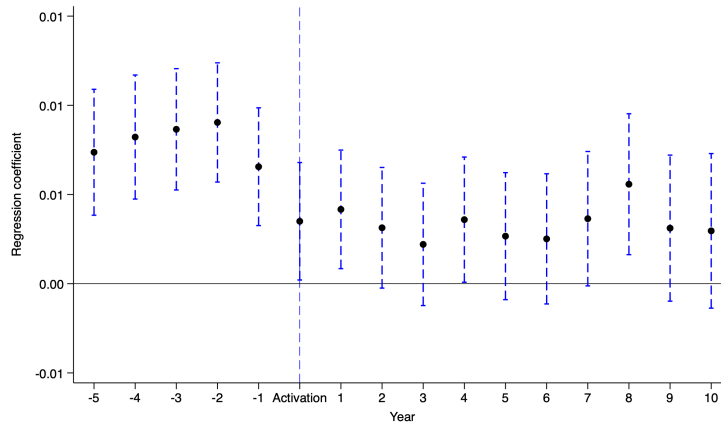


Figure 7: Effect of Mine activation on the GVC positioning (Forward variable)

6.3 By removing the countries for which there has been more than one mine opening

Several mines may open during the same study horizon. We look at how sensitive our results are to overlapping mine opening periods. In this robustness test, we exclude countries experiencing this situation. Thus, we expect to have results that are qualitatively similar to the main results. The results are presented in columns [4-6] of table 3, confirming our expectations. The only difference with the main result is that the coefficient of the *Forward* is no longer significant. However, the conclusions of the results remain the same since the coefficient of the *Backward* variable is significant and negative, meaning that mines' opening leads to the move away from the final product.

6.4 Using an alternative explained variable: the economic complexity index

The fourth robustness test consists of using an alternative explained variable. We use the economic complexity index (*ECI*). This index measures the production capacity of an economic system, especially countries. According to statistical models, the economic complexity index is a crucial explanatory variable explaining growth and competitiveness. It considers not only the level of complexity of the national industry but also the level of human development. A country improves its index by improving the

Table 3: Robustness Table

	(1)	(2)	(3)	(4)	(5)	(6)	(7)
	10 years window			Excluding more than one mine opening			ECI
	GVC	Backward	Forward	GVC	Backward	Forward	ECI
Activity(10 years)	-0.0007 (0.0022)	-0.0072*** (0.0022)	0.0065*** (0.0020)				
Openness	0.0004*** (0.0000)	0.0006*** (0.0000)	-0.0002*** (0.0000)	0.0008*** (0.0001)	0.0009*** (0.0001)	-0.0001 (0.0001)	0.0003 (0.0007)
Manufacture	-0.0018*** (0.0003)	-0.0002 (0.0002)	-0.0016*** (0.0002)	-0.0026*** (0.0003)	-0.0003 (0.0002)	-0.0022*** (0.0003)	0.0102*** (0.0027)
GDPgrowth	0.0005*** (0.0002)	0.0004** (0.0002)	0.0001 (0.0002)	-0.0008*** (0.0003)	-0.0000 (0.0002)	-0.0008*** (0.0003)	0.0022 (0.0029)
UrbanPop	-0.0011*** (0.0003)	-0.0001 (0.0003)	-0.0010*** (0.0003)	-0.0016*** (0.0004)	-0.0013*** (0.0003)	-0.0003 (0.0004)	0.0195*** (0.0030)
Capital	-0.0022** (0.0010)	0.0005 (0.0010)	-0.0027*** (0.0009)	-0.0028** (0.0013)	0.0015 (0.0010)	-0.0043*** (0.0013)	0.0191* (0.0109)
LogGDP	-0.0173*** (0.0030)	-0.0270*** (0.0029)	0.0098*** (0.0026)	-0.0027 (0.0046)	-0.0073** (0.0035)	0.0045 (0.0045)	-0.2064*** (0.0352)
Rent	-0.0007*** (0.0002)	-0.0006*** (0.0002)	-0.0001 (0.0001)	-0.0009*** (0.0003)	-0.0008*** (0.0002)	-0.0000 (0.0003)	-0.0140*** (0.0023)
Activity				-0.0033 (0.0029)	-0.0055** (0.0022)	0.0022 (0.0028)	-0.0357* (0.0205)
R^2							0.9123
Observations	1589	1589	1589	798	798	798	1579

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table presents the results of robustness tests. Columns [1-3] present results about the study window extension. Columns [4-6] present results about excluding countries that have experienced more than one mine opening. The last column (column [7]) presents the result of the robustness test when using economic complexity index as explained variable.

quantity and complexity of its products. Since this index allows us to see the evolution towards a more complex industry, it can be used in the case of our study as an alternative measure of participation or positioning in the global value chain. Some authors, such as [Ndubuisi et Owusu \(2021\)](#), show that upgrading in the GVC is equivalent to exporting more complex products. The result is presented in the column [7] of the table 3. Our results remain qualitatively the same. Thus, the relationship between mining activity and participation and positioning in the global value chain we highlighted is confirmed. With our economic complexity variable, we conclude that mining activity leads to a decrease in the complexity of the products exported by a country.

7 Heterogeneity

7.1 Heterogeneity depending on the mine properties

7.1.1 Depending on the type of mineral

The different mines in our database produce different minerals. Thus, it would be interesting to study the impact of each type of mineral extraction on the position in the global value chain. Gold, copper, coal, nickel, and zinc are the main extracted minerals; the other minerals are minor. So, we have broken down the mines into groups according to the main ore extracted. Our results, presented in tables 4, 5 and 6, show significant heterogeneity in the relationship we have uncovered.

Gold is the only mineral that affects the participation in the GVC (see column [1] of Table 4). Two minerals have significant coefficients when we observe the aggregate positioning variable in the global value chain in tables 5 and 6. These are copper and coal. The significant results of these three minerals agree with our main results.

The observed heterogeneity in the relationship is a direct result of the distinct properties of the various ores. Some ores lend themselves to on-site transformation, while others do not, often due to technological limitations. Additionally, certain ores confer an advantage to the industry sector, particularly those that find application in

Table 4: Heterogeneity by Mineral Type for the GVC variable

	(1)	(2)	(3)	(4)	(5)
	Gold	Copper	Coal	Nickel	Zinc
	1	2	3	4	5
Gold	0.0071*** (0.0026)				
Openness	0.0009*** (0.0001)	0.0009*** (0.0001)	0.0009*** (0.0001)	0.0009*** (0.0001)	0.0009*** (0.0001)
Manufacture	-0.0021*** (0.0003)	-0.0022*** (0.0003)	-0.0022*** (0.0003)	-0.0021*** (0.0003)	-0.0022*** (0.0003)
GDPgrowth	0.0010*** (0.0002)	0.0010*** (0.0002)	0.0010*** (0.0002)	0.0010*** (0.0002)	0.0010*** (0.0002)
UrbanPop	0.0003 (0.0003)	0.0003 (0.0003)	0.0003 (0.0003)	0.0003 (0.0003)	0.0003 (0.0003)
Capital	-0.0008 (0.0012)	-0.0007 (0.0012)	-0.0009 (0.0012)	-0.0009 (0.0012)	-0.0008 (0.0012)
LogGDP	0.0245*** (0.0023)	0.0261*** (0.0023)	0.0256*** (0.0023)	0.0253*** (0.0023)	0.0252*** (0.0023)
Rent	0.0002 (0.0002)	0.0002 (0.0002)	0.0002 (0.0002)	0.0002 (0.0002)	0.0002 (0.0002)
Copper		-0.0043 (0.0038)			
Coal			-0.0007 (0.0072)		
Nickel				0.0072 (0.0057)	
Zinc					0.0044 (0.0048)
Observations	1589	1589	1589	1589	1589

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table shows the results of the heterogeneity analysis according to mineral type for the GVC variable, which is the global variable for participation in the global value chain. Our main minerals are gold, copper, coal, nickel, and zinc.

the manufacturing industry. These factors contribute to the diverse impact of mineral extraction on the global value chain.

7.1.2 Depending on the extraction method

In this section on the analysis of the heterogeneity of our results, we analyze the sensitivity of the results according to the ore extraction method. We have three main

Table 5: Heterogeneity by Mineral Type for the Backward variable

	(1)	(2)	(3)	(4)	(5)
	Gold	Copper	Coal	Nickel	Zinc
Gold	-0.0019 (0.0022)				
Openness	0.0008*** (0.0000)	0.0008*** (0.0000)	0.0008*** (0.0000)	0.0008*** (0.0000)	0.0008*** (0.0000)
Manufacture	-0.0004 (0.0003)	-0.0004 (0.0003)	-0.0005* (0.0003)	-0.0004* (0.0003)	-0.0004 (0.0003)
GDPgrowth	0.0005*** (0.0002)	0.0005** (0.0002)	0.0005** (0.0002)	0.0005*** (0.0002)	0.0005*** (0.0002)
UrbanPop	0.0006** (0.0002)	0.0006*** (0.0002)	0.0007*** (0.0002)	0.0006** (0.0002)	0.0006** (0.0002)
Capital	-0.0001 (0.0010)	0.0002 (0.0010)	-0.0003 (0.0010)	-0.0001 (0.0010)	-0.0001 (0.0010)
LogGDP	-0.0018 (0.0019)	-0.0004 (0.0019)	-0.0020 (0.0019)	-0.0019 (0.0019)	-0.0023 (0.0019)
rent	-0.0006*** (0.0002)	-0.0005*** (0.0002)	-0.0005*** (0.0002)	-0.0006*** (0.0002)	-0.0006*** (0.0002)
Copper		-0.0132*** (0.0032)			
Coal			-0.0200*** (0.0060)		
Nickel				-0.0055 (0.0048)	
Zinc					0.0024 (0.0040)
Observations	1589	1589	1589	1589	1589

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table shows the results of the heterogeneity analysis according to mineral type for the Backward variable. The Backward variable refers to “Backward GVC participation” or ”Downstream GVC participation”. The higher the values of this variable for a country, the further forward in the GVC that country is. Our main minerals are gold, copper, coal, nickel, and zinc.

Table 6: Heterogeneity by Mineral Type for the Forward variable

	(1)	(2)	(3)	(4)	(5)
	Gold	Copper	Coal	Nickel	Zinc
Gold	0.0089*** (0.0022)				
Openness	0.0001 (0.0000)	0.0001 (0.0000)	0.0001 (0.0000)	0.0001 (0.0000)	0.0001 (0.0000)
Manufacture	-0.0017*** (0.0003)	-0.0017*** (0.0003)	-0.0017*** (0.0003)	-0.0017*** (0.0003)	-0.0017*** (0.0003)
GDPgrowth	0.0005** (0.0002)	0.0005*** (0.0002)	0.0005*** (0.0002)	0.0005** (0.0002)	0.0005** (0.0002)
UrbanPop	-0.0003 (0.0002)	-0.0003 (0.0002)	-0.0004 (0.0002)	-0.0003 (0.0002)	-0.0003 (0.0002)
Capital	-0.0005 (0.0010)	-0.0008 (0.0010)	-0.0004 (0.0010)	-0.0006 (0.0010)	-0.0006 (0.0010)
LogGDP	0.0263*** (0.0019)	0.0266*** (0.0019)	0.0277*** (0.0019)	0.0273*** (0.0019)	0.0276*** (0.0019)
Rent	0.0007*** (0.0002)	0.0007*** (0.0002)	0.0006*** (0.0002)	0.0007*** (0.0002)	0.0007*** (0.0002)
Copper		0.0086*** (0.0032)			
Coal			0.0191*** (0.0060)		
Nickel				0.0125*** (0.0047)	
Zinc					0.0018 (0.0040)
Observations	1589	1589	1589	1589	1589

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table shows the results of the heterogeneity analysis according to mineral type for the Forward variable. The Forward variable refers to "Forward GVC participation" or "Upstream GVC participation". The higher the values of this variable for a country, the closer it is to the beginning of the value chain. Our main minerals are gold, copper, coal, nickel, and zinc.

methods of extracting ore: surface mining, underground mining, and finally, surface and underground mining. The method of ore extraction depends on the type of ore and the deposit size. As seen above, the type of mineral plays a role in the relationship we have highlighted. It, therefore, makes sense to see the sensitivity of the results depending on the extraction method. The results of the breakdown of mines by mode of exploitation confirm our intuition, since surface mines negatively impact positioning in the global value chain, as shown in table 7. In contrast, underground and both open and underground mines positively impact the participation in the GVC. Surface mines require less investment than underground mines. Low investments are linked to low raw material processing, which leads countries to export raw materials, thus explaining our result.

7.2 Heterogeneity depending on macroeconomic factors: Transmission channels

7.2.1 Quality of institutions and level of openness

Talking about participation in the global value chain also leads to discussing countries' levels of trade openness. This level of openness is a significant determinant of countries' participation in world trade. We should test the sensitivity of our results according to the countries' trade openness level by examining the interaction between our variable of interest and the new trade openness. We did the same for the level of institutional quality, represented in our case by the level of corruption. Indeed, institutional quality can significantly impact economic activity and participation in world trade.

The results obtained are presented in table 8 and are highly instructive. Indeed, whether for the level of institutional quality (in the first three columns) or the level of trade openness (in the three last columns), the effect is significant on participation and forward positioning in the global value chain. This is what we observe at the level of the significance of the interactive variables. These results are somewhat intuitive.

Table 7: Heterogeneity by extraction method

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
	Both open and underground				Open			Underground	
	GVC	Backward	Forward	GVC	Backward	Forward	GVC	Backward	Forward
Both	0.0100*** (0.0031)	-0.0004 (0.0026)	0.0102*** (0.0026)						
Openness	0.0008*** (0.0001)	0.0008*** (0.0000)	0.0001 (0.0000)	0.0009*** (0.0001)	0.0008*** (0.0000)	0.0001 (0.0000)	0.0008*** (0.0001)	0.0008*** (0.0000)	0.0001 (0.0000)
Manufacture	-0.0022*** (0.0003)	-0.0004 (0.0003)	-0.0018*** (0.0003)	-0.0022*** (0.0003)	-0.0004 (0.0003)	-0.0018*** (0.0003)	-0.0022*** (0.0003)	-0.0004 (0.0003)	-0.0018*** (0.0003)
GDPgrowth	0.0010*** (0.0002)	0.0005*** (0.0002)	0.0005** (0.0002)	0.0010*** (0.0002)	0.0005*** (0.0002)	0.0005*** (0.0002)	0.0010*** (0.0002)	0.0005*** (0.0002)	0.0005** (0.0002)
UrbanPop	0.0002 (0.0003)	0.0006** (0.0002)	-0.0003 (0.0002)	0.0003 (0.0003)	0.0006*** (0.0002)	-0.0003 (0.0002)	0.0002 (0.0003)	0.0006** (0.0002)	-0.0003 (0.0002)
Capital	-0.0010 (0.0012)	-0.0001 (0.0010)	-0.0008 (0.0010)	-0.0009 (0.0012)	0.0000 (0.0010)	-0.0008 (0.0010)	-0.0010 (0.0012)	-0.0001 (0.0010)	-0.0008 (0.0010)
LogGDP	0.0245*** (0.0023)	-0.0020 (0.0019)	0.0266*** (0.0019)	0.0251*** (0.0023)	-0.0012 (0.0019)	0.0263*** (0.0019)	0.0245*** (0.0023)	-0.0020 (0.0019)	0.0266*** (0.0019)
Rent	0.0002 (0.0002)	-0.0006*** (0.0002)	0.0007*** (0.0002)	0.0002 (0.0002)	-0.0005*** (0.0002)	0.0006*** (0.0002)	0.0002 (0.0002)	-0.0006*** (0.0002)	0.0007*** (0.0002)
Open				0.0032 (0.0024)	-0.0060*** (0.0020)	0.0090*** (0.0020)			
Under							0.0100*** (0.0031)	-0.0004 (0.0026)	0.0102*** (0.0026)
Observations	1589	1589	1589	1589	1589	1589	1589	1589	1589

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table shows the results of the heterogeneity analysis according to the extraction method for our two variables of participation in the global value chain. The GVC variable refers to the global index of participation in the global value chain. The Backward variable refers to “Backward GVC participation” or ”Downstream GVC participation”. The higher the values of this variable for a country, the further forward in the GVC that country is. The Forward variable refers to ”Forward GVC participation” or ”Upstream GVC participation”. The higher the values of this variable for a country, the closer it is to the beginning of the value chain. There are three extraction methods: open (surface) mining, underground mining, and mining combining both (open and underground).

Table 8: Heterogeneity by quality of institutions and level of openness

	(1)	(2)	(3)	(4)	(5)	(6)
	Institutional quality			Trade openness		
	GVC	Backward	Forward	GVC	Backward	Forward
Activity	0.0132** (0.0057)	-0.0035 (0.0047)	0.0167*** (0.0047)	0.0180*** (0.0052)	-0.0076* (0.0044)	0.0254*** (0.0043)
Openness	0.0008*** (0.0001)	0.0008*** (0.0000)	0.0000 (0.0000)	0.0009*** (0.0001)	0.0008*** (0.0000)	0.0001** (0.0000)
Manufacture	-0.0021*** (0.0003)	-0.0003 (0.0003)	-0.0018*** (0.0003)	-0.0022*** (0.0003)	-0.0004 (0.0003)	-0.0018*** (0.0003)
GDPgrowth	0.0010*** (0.0002)	0.0005** (0.0002)	0.0005*** (0.0002)	0.0010*** (0.0002)	0.0005*** (0.0002)	0.0005** (0.0002)
UrbanPop	0.0001 (0.0003)	0.0005* (0.0002)	-0.0003 (0.0002)	0.0003 (0.0003)	0.0006*** (0.0002)	-0.0003 (0.0002)
Capital	-0.0011 (0.0012)	0.0003 (0.0010)	-0.0012 (0.0010)	-0.0008 (0.0012)	-0.0000 (0.0010)	-0.0007 (0.0010)
LogGDP	0.0257*** (0.0023)	0.0007 (0.0019)	0.0251*** (0.0019)	0.0244*** (0.0023)	-0.0011 (0.0019)	0.0256*** (0.0019)
Rent	0.0002 (0.0002)	-0.0004*** (0.0002)	0.0006*** (0.0002)	0.0002 (0.0002)	-0.0005*** (0.0002)	0.0007*** (0.0002)
Corruption	-0.0032** (0.0015)	0.0003 (0.0013)	-0.0034*** (0.0013)			
Activité_Corruption	-0.0044** (0.0021)	-0.0010 (0.0018)	-0.0035* (0.0018)			
Activité_Openness				-0.0002*** (0.0001)	0.0000 (0.0001)	-0.0002*** (0.0001)
Observations	1581	1581	1581	1589	1589	1589

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table shows heterogeneity according to quality of institutions and level of openness analysis' results. The GVC variable refers to the global index of participation in the global value chain. The Backward variable refers to "Backward GVC participation" or "Downstream GVC participation". The higher the values of this variable for a country, the further forward in the GVC that country is. The Forward variable refers to "Forward GVC participation" or "Upstream GVC participation". The higher the values of this variable for a country, the closer it is to the beginning of the value chain.

Institutional quality is a factor that directly affects the level of economic activity. This level of economic activity directly impacts the goods and services produced and participation in the chain. The same applies to trade openness, which directly impacts the goods and services traded with the rest of the world.

7.2.2 Geographical position

In the introduction, we specify that countries do not participate similarly in the global value chain according to [Freund *et al.* \(2020\)](#). Indeed, in international trade, we have the formation of sub-regional industrial clusters. For example, Europe, North America, and East Asia specialize in manufacturing complex products with high added value. In contrast, for the countries of Africa, Latin America, and Central Asia, it is instead the opposite. Based on this information, we have decided to study the sensitivity of our result according to the geographical area to which each country belongs. We thus have six regions to which our countries belong according to the IMF classification. These are East Asia and Pacific(EAandP), Europe and Central Asia(EandCA), Latin America and the Caribbean(LAandC), Middle East and North Africa(MEandNA), South Asia(SA), and Sub-Saharan Africa(SSA). Our results in tables [9](#) and [10](#) show that Sub-Saharan African countries mainly explain the main results. For the countries of these regions, the opening of mines leads to a movement towards less complex industries.

8 Conclusion

This article presents an empirical analysis of the relationship between mining activity and participation and the positioning in the global value chain in a sample of 74 developing countries from 1995 to 2018. Using an event study methodology that allows us to measure the effect in the medium term (five years here), we first found that mining activity does not affect countries' participation in the global value chain in the short term. In other words, it does not reduce or increase that participation. However, it led countries to specialize in industries at the beginning of chains by pro-

Table 9: Heterogeneity by geographic position 1

	Sub-Saharan Africa			South Asia			Middle East and North Africa		
	1	2	3	4	5	6	7	8	9
SSA	-0.0012 (0.0039)	-0.0122*** (0.0033)	0.0107*** (0.0033)						
Openness	0.0009*** (0.0001)	0.0008*** (0.0000)	0.0001 (0.0000)	0.0009*** (0.0001)	0.0008*** (0.0000)	0.0001 (0.0000)	0.0009*** (0.0001)	0.0008*** (0.0000)	0.0001 (0.0000)
Manufacture	-0.0021*** (0.0003)	-0.0003 (0.0003)	-0.0018*** (0.0003)	-0.0022*** (0.0003)	-0.0004 (0.0003)	-0.0018*** (0.0003)	-0.0022*** (0.0003)	-0.0004 (0.0003)	-0.0017*** (0.0003)
GDPgrowth	0.0010*** (0.0002)	0.0005*** (0.0002)	0.0005** (0.0002)	0.0010*** (0.0002)	0.0005*** (0.0002)	0.0005** (0.0002)	0.0010*** (0.0002)	0.0005*** (0.0002)	0.0005*** (0.0002)
UrbanPop	0.0003 (0.0003)	0.0007*** (0.0002)	-0.0004 (0.0002)	0.0003 (0.0003)	0.0006** (0.0002)	-0.0003 (0.0002)	0.0003 (0.0003)	0.0006** (0.0002)	-0.0003 (0.0002)
Capital	-0.0008 (0.0012)	-0.0001 (0.0010)	-0.0006 (0.0010)	-0.0008 (0.0012)	-0.0001 (0.0010)	-0.0006 (0.0010)	-0.0007 (0.0012)	-0.0001 (0.0010)	-0.0005 (0.0010)
LogGDP	0.0256*** (0.0023)	-0.0016 (0.0019)	0.0273*** (0.0019)	0.0251*** (0.0023)	-0.0022 (0.0019)	0.0274*** (0.0019)	0.0247*** (0.0023)	-0.0023 (0.0019)	0.0270*** (0.0019)
Rent	0.0002 (0.0002)	-0.0005*** (0.0002)	0.0007*** (0.0002)	0.0002 (0.0002)	-0.0006*** (0.0002)	0.0007*** (0.0002)	0.0001 (0.0002)	-0.0006*** (0.0002)	0.0006*** (0.0002)
SA				0.0307*** (0.0111)	0.0078 (0.0094)	0.0227** (0.0093)			
MEandNA							0.0260*** (0.0069)	0.0053 (0.0058)	0.0205*** (0.0058)
Observations	1589	1589	1589	1589	1589	1589	1589	1589	1589

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table shows heterogeneity according to geographical analysis' results. The GVC variable refers to the global index of participation in the global value chain. The Backward variable refers to "Backward GVC participation" or "Downstream GVC participation". The higher the values of this variable for a country, the further forward in the GVC that country is. The Forward variable refers to "Forward GVC participation" or "Upstream GVC participation". The higher the values of this variable for a country, the closer it is to the beginning of the value chain.

Table 10: Heterogeneity by geographic position 2

	Latin America and Caribbean			Europe and Central Asia			East Asia and Pacific		
	1	2	3	4	5	6	7	8	9
LAandC	-0.0013 (0.0045)	-0.0040 (0.0038)	0.0030 (0.0037)						
Openness	0.0009*** (0.0001)	0.0008*** (0.0000)	0.0001 (0.0000)	0.0009*** (0.0001)	0.0008*** (0.0000)	0.0001 (0.0000)	0.0009*** (0.0001)	0.0008*** (0.0000)	0.0001 (0.0000)
Manufacture	-0.0022*** (0.0003)	-0.0004 (0.0003)	-0.0017*** (0.0003)	-0.0022*** (0.0003)	-0.0004* (0.0003)	-0.0018*** (0.0003)	-0.0021*** (0.0003)	-0.0004 (0.0003)	-0.0017*** (0.0003)
GDPgrowth	0.0010*** (0.0002)	0.0005*** (0.0002)	0.0005** (0.0002)	0.0010*** (0.0002)	0.0005** (0.0002)	0.0005** (0.0002)	0.0010*** (0.0002)	0.0005*** (0.0002)	0.0005** (0.0002)
UrbanPop	0.0003 (0.0003)	0.0006** (0.0002)	-0.0003 (0.0002)	0.0002 (0.0003)	0.0006** (0.0002)	-0.0003 (0.0002)	0.0003 (0.0003)	0.0006** (0.0002)	-0.0002 (0.0002)
Capital	-0.0008 (0.0012)	-0.0001 (0.0010)	-0.0006 (0.0010)	-0.0008 (0.0012)	-0.0001 (0.0010)	-0.0005 (0.0010)	-0.0009 (0.0012)	-0.0001 (0.0010)	-0.0006 (0.0010)
LogGDP	0.0256*** (0.0023)	-0.0021 (0.0019)	0.0277*** (0.0019)	0.0263*** (0.0023)	-0.0017 (0.0019)	0.0281*** (0.0019)	0.0254*** (0.0023)	-0.0021 (0.0019)	0.0275*** (0.0019)
Rent	0.0002 (0.0002)	-0.0006*** (0.0002)	0.0007*** (0.0002)	0.0002 (0.0002)	-0.0006*** (0.0002)	0.0007*** (0.0002)	0.0002 (0.0002)	-0.0006*** (0.0002)	0.0007*** (0.0002)
EandCA				-0.0154** (0.0068)	-0.0078 (0.0057)	-0.0080 (0.0057)			
EAandP							0.0122* (0.0071)	-0.0026 (0.0059)	0.0147** (0.0059)
Observations	1589	1589	1589	1589	1589	1589	1589	1589	1589

Standard errors in parentheses; * $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$. This table shows heterogeneity according to geographical analysis' results. This table shows heterogeneity according to geographical analysis' results. The GVC variable refers to the global index of participation in the global value chain. The Backward variable refers to "Backward GVC participation" or "Downstream GVC participation". The higher the values of this variable for a country, the further forward in the GVC that country is. The Forward variable refers to "Forward GVC participation" or "Upstream GVC participation". The higher the values of this variable for a country, the closer it is to the beginning of the value chain.

ducing less complex products. This result is consistent with the literature on Dutch disease and the natural resource curse. However, when we look at the medium term, the effect of mining on the global value chain starts changing due to adaptation and policies implemented. This relationship highlighted is very heterogeneous depending on the type of ore extracted and the mode of extraction of the ore, as well as on the level of trade openness, the institutions' quality, and the geographical position.

Three transmission channels explain how mining activity could impact participation in the global value chain. The first is the mechanism highlighted in the Dutch disease theory. The second is the decline in human capital due to abundant natural resources. Finally, the third is the negative relationship between rents and total factor productivity.

This paper makes a significant contribution to the literature by being the first to delve into the relationship between mining activity and participation in the global value chain. Using a start of mining as an event to study, our innovative approach allows for precise measurement of mining activity. From a theoretical standpoint, we've shed light on the link between natural resource rents and the industrial sector's competitiveness. We've taken this relationship further by examining how mining activity directly impacts participation in the global value chain, a crucial aspect of the industrial sector's competitiveness.

The contribution of this paper in terms of economic policy recommendations is immense. Indeed, countries with large reserves of resources should implement policies to transform these resources locally into semi-finished materials instead of exporting them raw. Indeed, this will bring more value to the exports of the various countries. This will increase the country's income and the resources to finance development. The second recommendation lies in protecting other sectors other than the extractive sector. As we have seen, the non-extractive sectors lose competitiveness following income shocks from the extractive sector through investments in these sectors.

This paper presents limitations that represent avenues for improvement. The first limitation of the database is the absence of oil sites in our database. Indeed, the Minex

database needs to take into account oil sites. However, we know from the literature that oil is a resource that impacts the economy the most. Thus, one of the possible extensions of this work is to focus on the effect of the activation of oil mines on participation and positioning in the global value chain. For this, each activation date will be necessary. The other limit of our paper lies in our sample size, which only includes 74 developing countries due to missing data from our various databases. Thus, a more complete base will make it possible to produce more precise results.

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9 Appendix

Table 11: List and definition of variables

Variables	Definition	Nature	Unity	Source
1. Dependent variable				
Activity	Dummy	Discrete		Calculation of authors based on Minex
2. Variables of interest				
GVC	Global Value Chain participation	Continuous	Percentage	UNCTAD-Eora Casella et al. (2019)
Forward	Forward GVC participation	Continuous	Percentage	UNCTAD-Eora Casella et al. (2019)
Backward	Backward GVC participation	Continuous	Percentage	UNCTAD-Eora Casella et al. (2019)
eci	Economic Complexity Index	Continuous		The Atlas of Economic Complexity
3. Control variable				
LogGDP	Log of GDP per capita	Continuous		Calculation of authors and WDI
Openness	Trade openness	Continuous		Feenstra et al. (2015)
Manufacture	Manufacturing VA	Percentage	Percentage	WDI, World Bank
GDPgrowth	Annual GDP growth	Percentage	Percentage	WDI, World Bank
Corruption	Level of corruption	Continuous		ICRG
UrbanPop	Urbanization rate	Continuous	Percentage	WDI, World Bank
Rent	Rents from natural resources	Continuous		WDI, World Bank
Capital	Financial Openness	Continuous		The Chinn-Ito index

Table 12: List of countries

Angola	Sri Lanka	Ecuador	Qatar	Botswana	Namibia	India
Albania	Morocco	Egypt, Arab Rep.	Russian Federation	Chile	Nigeria	Iran, Islam. Rep.
Argentina	Madagascar	Finland	Saudi Arabia	China	Nicaragua	Jamaica
Armenia	Mexico	Gabon	Senegal	Cote d'Ivoire	Pakistan	Jordan
Azerbaijan	Mali	Ghana	El Salvador	Cameroon	Panama	Kazakhstan
Bangladesh	Mongolia	Guatemala	Togo	Congo, Dem. Rep.	Peru	Kenya
Bulgaria	Mozambique	Honduras	Thailand	Colombia	Philippines	Kuwait
Bolivia	Malawi	Hungary	Trinidad and Tobago	Costa Rica	Papua New Guinea	Lebanon
Brazil	Malaysia	Indonesia	Tunisia	Dominican Republic	Poland	Liberia
Algeria					Paraguay	

Table 13: Cross-correlation table

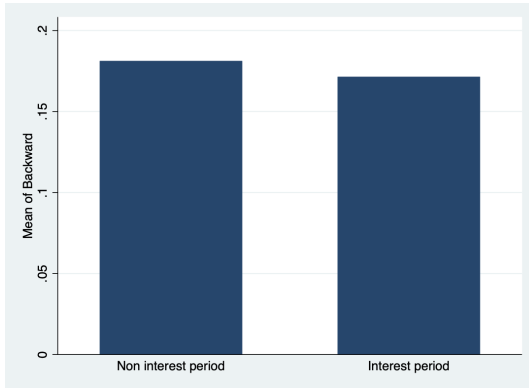
Variables	GVC	Backward	Forward	Activity	Openness	Manufacture	GDPgrowth	UrbanPop	Capital	LogGDP	Rent
GVC	1.000										
Backward	0.461	1.000									
Forward	0.629	-0.400	1.000								
Activity	0.164	-0.049	0.212	1.000							
Openness	0.303	0.512	-0.136	-0.099	1.000						
Manufacture	0.139	0.186	-0.019	-0.041	0.014	1.000					
GDPgrowth	0.061	0.101	-0.025	0.048	0.069	0.057	1.000				
UrbanPop	0.115	0.112	0.020	0.049	0.077	0.106	-0.106	1.000			
Capital	-0.023	0.181	-0.204	-0.126	0.195	-0.059	-0.036	0.319	1.000		
LogGDP	0.160	0.216	-0.025	0.062	0.179	0.137	-0.035	0.780	0.348	1.000	
Rent	0.160	-0.428	0.540	0.104	0.142	-0.243	-0.029	0.131	-0.023	0.097	1.000

Table 14: Parallel trend assumption test

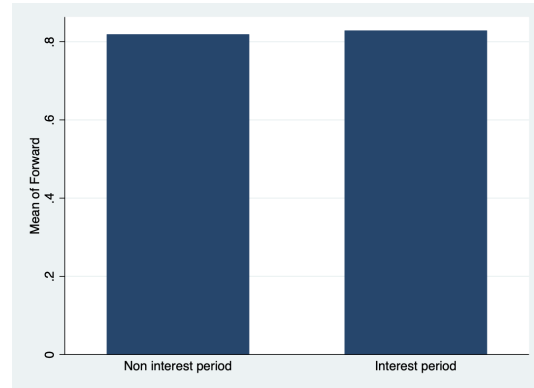
	(1)	(2)	(3)
	GVC	Backward	Forward
Activity	-0.0062 (0.0056)	-0.0124** (0.0055)	0.0124** (0.0055)
Trend	0.0025*** (0.0007)	0.0010 (0.0007)	-0.0010 (0.0007)
Interact	0.0003 (0.0004)	0.0004 (0.0004)	-0.0004 (0.0004)
Openness	0.0004*** (0.0001)	0.0006** (0.0002)	-0.0006** (0.0002)
Manufacture	-0.0018*** (0.0006)	-0.0002 (0.0007)	0.0002 (0.0007)
GDPgrowth	0.0005 (0.0004)	0.0004* (0.0003)	-0.0004* (0.0003)
UrbanPop	-0.0011 (0.0010)	-0.0001 (0.0010)	0.0001 (0.0010)
Capital	-0.0021 (0.0024)	0.0006 (0.0018)	-0.0006 (0.0018)
LogGDP	-0.0177** (0.0083)	-0.0276*** (0.0087)	0.0276*** (0.0087)
Rent	-0.0007* (0.0004)	-0.0006** (0.0003)	0.0006** (0.0003)
R^2	0.9460	0.9408	0.9408
Observations	1589	1589	1589
Country FE	Yes	Yes	Yes
Year FE	Yes	Yes	Yes

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$



Backward participation



Forward participation

Figure 8: Positioning in the GVC between our two types of periods

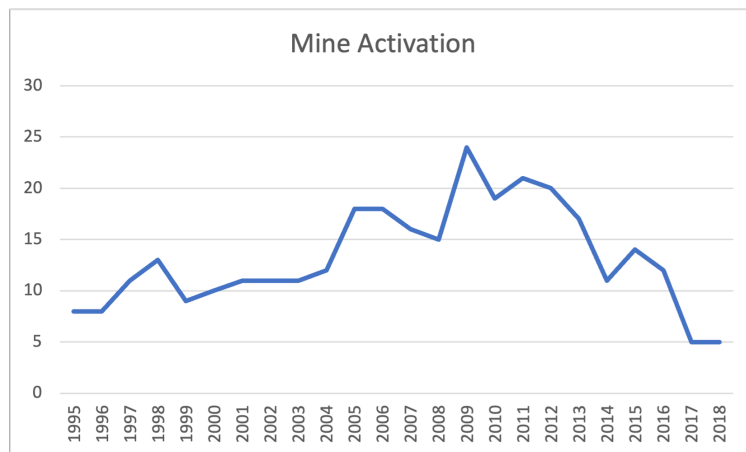


Figure 9: Evolution of number of mines activation

Table 15: Result from the representation

	(1)	(2)	(3)
	GVC	Backward	Forward
main			
-5	0.0074*** (0.0026)	0.0000 (0.0022)	0.0074*** (0.0021)
-4	0.0097*** (0.0026)	0.0015 (0.0022)	0.0082*** (0.0021)
-3	0.0075*** (0.0025)	-0.0012 (0.0021)	0.0087*** (0.0021)
-2	0.0075*** (0.0025)	-0.0015 (0.0021)	0.0090*** (0.0020)
-1	0.0048* (0.0024)	-0.0018 (0.0021)	0.0066*** (0.0020)
Activation	0.0007 (0.0024)	-0.0028 (0.0021)	0.0035* (0.0020)
1	-0.0001 (0.0025)	-0.0043** (0.0021)	0.0042** (0.0020)
2	-0.0004 (0.0025)	-0.0036* (0.0021)	0.0031 (0.0021)
3	-0.0011 (0.0025)	-0.0033 (0.0022)	0.0022 (0.0021)
4	-0.0001 (0.0026)	-0.0037* (0.0022)	0.0036* (0.0021)
5	0.0030 (0.0026)	0.0002 (0.0022)	0.0027 (0.0022)
6	0.0026 (0.0027)	0.0001 (0.0023)	0.0025 (0.0022)
7	0.0038 (0.0028)	0.0001 (0.0024)	0.0036 (0.0023)
8	0.0077*** (0.0029)	0.0021 (0.0025)	0.0056** (0.0024)
9	0.0066** (0.0030)	0.0034 (0.0026)	0.0031 (0.0025)
10	0.0073** (0.0032)	0.0043 (0.0027)	0.0030 (0.0026)
Observations	1589	1589	1589

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$