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How trade flows have affected income distributions within countries, theoretical expectations versus empirical analysis

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How trade flows have affected income distributions within countries, theoretical expectations versus empirical analysis

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Abstract

This research shows how commodity price shocks affect income distribution in oil, coffee and wheat exporting countries. We first identify the channels through which shocks are transmitted. We then analyzed the evolution of commodity prices and inequality over long periods (1960-2019, 1970-2019) to see if a link could be established between price instability and inequality dynamics. Finally, we estimated regression models on an unbalanced panel of 159 countries over the period 1991-2019. Our results show that after 1973, oil prices became more volatile than coffee and wheat prices, but the peaks of the three series coincide, indicating a strong correlation in the relative prices of these commodities. This means that shocks have systemic repercussions on commodity markets because they are accelerated by financial globalization, which is itself a result of globalization. The dynamics of inequality reveals that developing regions most dependent on commodities for their exports such as Sub-Saharan Africa, Latin America & Caribbean and East Asia & Pacific are also those where inequality is very high and where the wealthiest 10% of the population has the lion's share of national income, often between 51 and 69%. While the developed regions of Europe and Australia are the most egalitarian. The world's economies have become richer over the years. However, countries that are not dependent on commodities have seen their wealth grow faster than others. This has been accompanied by a divergence in income levels between developed and developing countries. It is inferred from the econometric model estimates that commodity price shocks increase inequality in exporting countries. However, this relationship differs by commodity type and exporting country. The coefficient of the relative oil price shock is positive and strongly significant for the Gini fixed-effects model while it is negative and non-significant for coffee and wheat. Country-specific effects were found to be significant, suggesting that other location-specific factors impact on the level of inequality, including weak institutions (Soran and David, 2019), market power (Stiglitz, 2010), differences in capital initial conditions and education (Piketty, 2014). In addition, the results show that commodity price shocks have a positive but not significant impact on government revenue in exporting countries. However, the shock becomes significant when studying interaction with non-dependent-countries, we found a negative coefficient equal to -6.131e+12. That mean non-dependent-countries are less expose to those three commodities shocks. Country-specific-effects were found to be significant for oil, coffee and wheat, suggesting that others location-specific-factors impact on government revenue, including the quality of institutions (Soran and David, 2019), fiscal policy, the size of the tax base and the structure of the economy.

I. Introduction

I.1 General context of the topic

Global exports have boomed over the past 40 years, with the share of low and middle-income economies rising significantly from 12% in 1985 to 29% in 2015 (Pavcnik, 2017). The main consequence of these increase in the volume of world exports is the rise in dependency between economies through the international trade channel (Hanson, 2012; Pavcnik, 2017). Developing countries have signed numerous trade agreements and become integrated into the global trade system, now accounting for over 40 percent of world trade (WTO[1], 2016). Despite the efforts made in terms of liberalization, some developing countries are experiencing difficulties in diversifying their production and in effecting structural transformation. Their economic growth remain weak (UNCTAD[2], 2012, 2017; UN/CEFACT, 2003).

According to Pavnick (2017),*"openness to trade has long been seen as an important element of sound economic policy and trade facilitation is a necessary step for achieving it*." There is no claim that international trade affects the distribution of benefits, inequality, poverty, employment, economic growth, business productivity and local education (Goldberg and Pavcnik, 2007; Helpman, 2016; Pavnick, 2017). One thing is certain is that international trade has changed the face of the world. Physical and moral entities are taking advantage of the revenue streams generated and others are seeing their incomes decline. In this zero-sum or non-zero-sum economic game, the big winners are the multinational firms capable of profiting from the opportunities generated[1] and the big losers are sometimes poor countries with deficit trade balances that fail to keep up. This unbalance of forces not only exacerbates dependency between countries but can lead to market imperfections that cause differences in income distribution. The COVID-19 crisis has shown that the interconnectivity of markets facilitates the spread of macroeconomic shocks, it is still far from being able to assess the damage it will cause to humankind in terms of loss of humans life, money, jobs and psychological costs to find only these few misdeeds. In this regard, the idea that international trade implies economic

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[1] World Trade Organization (WTO).
[2] United Nations Conference on Trade and Development (UNCTAD).

interdependence between states and positive income streams are naively advanced and this profoundly alters the real economies of countries. One of the interesting areas to study is the impact of international trade on income distribution in countries. Thus, it is relevant to assess the extent of the inequalities generated and the dynamics of poverty and frictions in the labor market.

Can we state that international trade has improved the living conditions of households and the economic health of countries as Pavcnik (2017) defended for developing countries including China and India in studies entitled *"The Impact of Trade on Inequality in Developing Countries"?* This study argues that developing countries are the main advantaged in international trade with developed countries. The decor is beautiful on board, one can even easily be convinced by the arguments in favor of trade, but this is without counting on the loss of jobs in the sectors most impacted. In the same vein, Autor, Dorn and Hanson (2013) demonstrated that China's imports led to job losses in the US in 1990 and 2000 in the manufacturing sector.

It seems in the light of the aforementioned authors that trade does not always feed the dream of a win-win partnership, in many cases there are winners, who have a sophisticated supply chain, but also losers, who have been overwhelmed by the circumstances seeing in their territory like inequalities, poverty, unemployment and a slowdown in economic growth. One wonders what can encourage a poor country that leaves disadvantaged on the international stage to sign up to a free trade agreement with countries more competitive than it. Is-it due to tariffs rates? Or why even developed countries do not always benefit from international trade despite they dominate the value chain? The reality is that international trade on the same level as technical progress destroys and creates jobs, which changes the distribution of income in the countries involved (Pavcnik, 2017). The impact varies depending on several factors, including the geographic region, the effect of concentration, the demographic profile of workers (sex, age, level of education, etc.), the industries where they work, their home environment, the low adjustment of capital, the inter-regional and cross-sector mobility of workers following trade policy shocks. However, we should not believe that openness to international trade is the only source of inequality in countries, it would have been very naïve (Goldberg and Pavcnik, 2007; Helpman, 2016). But, many studies tend to show the positive effects of trade liberalization on the welfare of society.

The real challenge is not only to accurately identify and estimate the positive or negative effects of trade on income distribution as many authors did but also to understand the mechanisms for transmitting the gains and losses of international trade on income distribution. It is therefore with great enthusiasm that we enter this field of research, building on the 30 years of research that many economists have undertaken to study the effects of trade on income distribution in developed and developing countries. Some studies have addressed the mechanisms by which trades shape the mobility of workers, employment and wages in countries through microeconomic surveys of firms, households, individuals before, during and after the coming of shock trades (Pavnic, 2017), but many other approaches have been identified. According, to UNCTAD (2012), trade liberalization has improved welfare but the gains are small and changes in welfare are measured through price volatility. One important question is what is causing this price volatility and how this can modify income distribution within countries through trade?

I.2 Research question

When the price of wheat, petroleum or coffee falls in the commodity market, that implies export earnings fall in developed and developing countries. It is the income of the peasants that is weakened and they may become discouraged from producing in the following years. When the price increases, importing countries are affected. Are commodities traded at the right price to allow trade gain between countries, or is the price volatility of some basic commodities artificial? If so, this is a burden on international trade.

In the perspective of bringing a rational approach to the problem that is treated in this paper, we formulate the following research question: **What is the impact of commodities price shocks of some of the most traded commodities (coffee, wheat, crude oil) on income distribution in developing and developed countries?**

Many authors in the literature argue that openness to international trade has a positive effect on growth and thus increases the income of the poor, can we reverse or confirm this thesis by studying the channel of commodities price?

This central question is broken down into specific axes that we translate into questioning but which will form the basis of our work, that is to say:

- **By which channels commodities price shocks affect income distribution? Study cases for crude oil, coffee and wheat.**
- **Does the shocks in commodities price positively or negatively affect income distribution?**

I.3 Motivation of the study

Many developing countries had ratified trade agreements to facilitate sub-regional, regional and international trade. It is often argued in the literature that international trade have a positive effect on economic growth and development. Similarly, opinions tend to conflict in the light of many studies on this area, since many countries, despite having ratified trade agreements, still do not see their economies take off. In many of them there are marked inequalities and high rates of poverty and unemployment. This is the particular case for Sub-Saharan African countries which depend mainly on commodities in theirs exports.

What interests us as researcher is to understand how commodities price affect income distribution and why some nations benefit from trade and others do not. How African countries can move from their original conditions to build a solid foundation for trade, including inequalities, poverty, unemployment and economic growth, as China has done (Pavcnik, 2017). We want to examine the mechanisms by which shocks in prices of coffee, wheat and crude oil affect income distribution in developing and developed countries.

Speaking of numbers, according to the Common Fund of Commodities (CFC) of the 2.5 billion people engaged in agriculture in developing countries, 1 billion have incomes that depend solely on exports. All the more so as some underdeveloped countries have a heavy dependence on exports and imports of these products (Brown, 2008). We expect to highlight the "patterns" that are conducive to profitable trade and those that accentuate inequality and poverty in these countries.

This work will be useful for:

- Authorities in developing countries to help them improve their trade policies;

- The active community of researchers in international economics so that our work brings a precious stone to the scientific edifice already undertaken;

- International organizations such as the World Trade Organization (WTO), United Nations Conference on Trade and Development (UNCTAD), to help them methodologically in their efforts to support and regulate trade policies between states.

II. Literature review

The literature review on the impact of trade flows in income distribution is quite rich and the paths taken are often as diverse as they are surprising. Hecksher-Ohlin's model based on comparative advantages tells us that the price change induced by international trade changes the distribution of income. The theory of comparative advantages must be outdated, it can be minimalist when considering new forms of industrialization and trade flows that have intensified with globalization. Models proposed by researchers such as Paul Krugman (1995) on *"equilibrium trade theory"* need to be studied in depth. He is recognized for work on the importance of international trade in correcting market imperfections, business-benefiting economies of scale and consumer preference for diversity. With regard to economies of scale, international trade theory predicts that the best performing firms are better able to benefit from imports and exports of inputs (Harrison and Rodriguez-Clare, 2010; De Loecker and Goldberg, 2014; Melitz and Redding, 2014). Trade flows are essential for balancing global supply and demand. Trade also promotes the mobility of factors of production which leads to a change in the distribution of income in economies (Goldberg and Pavnik, 2007).

II.1 Trade, poverty and inequality

A section of academic work addresses the costs of international trade in developing and developed countries. In this regard, Amjadi and Yeats (1995) note that high freight rates in Sub-Saharan Africa have contributed to the region's underperformance. Also, landlocked countries experience higher transport costs (Limao and Venables, 2000; UN/CEFACT, 2003). According to Looikee and al.(2009), poor countries face higher barriers on their exports than advanced countries.

In general one identified two types of studies in the literature, those who defend that international trade helps reducing inequality, poverty and improve economic growth, and those that promote the negative effects. In their analysis of the impact of trade facilitation (seen on the angle of liberalization) on income distribution, UN/CEFACT (2003) argue that liberalization positively affects the efficiency of the trading environment, increases average income and therefore provides the resources needed to reduce poverty in recipient countries. In the same study, the mechanism for transmitting trade income to the poor is described as:

"*International trade flows that modify the prices of goods and factors of production (capital and labour); government revenue which can be used for pro-poor and social expenditures; economic growth...*"

In summary, the UN/CEFACT (2003) study identified three links by which trade facilitation can impact income distribution and poverty: through *the channel of economic growth,* through *international trade* and through *government income.* Trade-induced economic growth is one of the most studied chains and it appears that its positive effects are generally more advantageous than the inequalities it generates (see Demery and Squire (1996) on Africa, Chen and Ravallion (1996), Bruno et al. (1996), Dollar and Kraay (2001)). With regard to the international trade channel, four approaches are often studied, *transaction cost theory* (Samuelson, 1954; UN/CEFACT, 2003), *effects on production* (market factors), *effects on consumption,* i.e. the convenience *price transmission mechanism* (Hecksher-Ohlin model) and the *second-round effect.* These paper focus on price change of commodities and show the impact on income distribution (Williamson and Sambit, 2015).

One of the advantages often brandished by theorists of openness to international trade is that they provide an efficient trading environment, resulting in accessibility to products absent from the local market (Romer, 1994), lower import prices, more competitive export prices and increased labor demand. They also refer to the argument of induced sectoral competition, which has the effect of reducing the demand for goods and services traded and their price. Declining demand for labor coupled with lower prices will have a negative effect on real wages and employment - variables intrinsically linked to poverty and inequality.

II.2 Trade and employment

Trade liberalization can deteriorate income distribution, for instance by encouraging the adoption of skill-based workers (Feenstra, 2008). Developing countries have a higher proportion of less skilled workers, so markets show imperfections and rigidities that expose them to adverse effects. Some thesis argue that price shocks caused by trade facilitations have reductive effects on labour-intensive sectors, especially for workers who are not protected by social security. For instance, Feenstra explains in this terms:

"If a country is assumed to be producing three commodities (export crops, subsistence agriculture and manufactures) using three factors (land, capital and labor) in different combinations. Assume export crops are more land-intensive and less intensive plowing than subsistence agriculture and capital does not perfectly move across sectors: trade facilitation by raising export crops' domestic price causes an expansion of the export sector at the expense of subsistence farming. This lower opportunities for labor and reduces wages."

This problem would be all the more important since these sectors are dominated by a few firms that not only set prices but retain a large part of the profits from trade at the expense of the poorer sections of society. Low-income countries tend to have low-skilled labor. With international integration, we are witnessing a specialization from poor countries to industries with low capital intensity (agriculture, manufacturing, etc.).

Also, non-quality workers find it more difficult to move into sectors generated by international trade, especially when they require advanced knowledge and technology (Goldberg and Pavcnik, 2007; Pavnik, 2017). If these workers are also poor, their economic situation (wages, others incomes) can be deteriorate. It would be of great benefit to put in place policies to accompany them and facilitate their reintegration into the workforce. At this stage of research we cannot yet take a position on the nature or causal link that exists between international trade flows and income distribution. Scientific rigor requires us to conduct our own investigations with a view to having an objective understanding of the problem.

II.3 International trade interconnectivity and commodities prices

In this section we show how commodities play a role in correcting imbalances in markets and present the factors explaining the volatility of their prices upon international market.

II.3.1 International trade interconnectivity

In this fast-moving world, let us put ourselves in the shoes of an average consumer in Africa. He or she can build up consumption habits if he or she has an income, such as a wage. Consumer can even pursue an existence indifferent to the underlying forces at work in the economy to ensure the availability of goods in their consumption basket. However, in an economy, supply is not always sufficient to meet demand and the resulting imbalances can create price distortions leading to uncontrollable levels of inflation. A poor harvest in one country can be compensated for by imports. In addition, some domestic companies cannot always find the raw materials they need locally in the production process.

It is on the basis of these observations that international trade between countries has become essential as a channel through which globalization maintains an interconnection between countries. It is enough to read the packaging of the products consumed to understand that the market has become globalized. We buy domestic products and goods of foreign origin, including 'Made in China', 'Made in USA', etc., made available by a flow of commercial transactions. Most of these products use commodities as inputs. According to the IMF (2017), trade openness does not affect inequality, trade integration increases economic activity and low integration does not promote economic growth. On the other hand, Branko Milanovic (2019) argued that more international trade increases wealth and income inequality.

II.3.2 Factors of commodity price fluctuation

According to GATT: "*Commodity or primary product is understood to be any product of farm, forest, or fishery, or any mineral, in its natural form or which has undergone such processing as is customarily required to prepare it for marketing in substantial volume in international trade*".

According to UNCTAD (2019) a country is commodity dependent if commodities account for more than 60% of its merchandise exports and more than 1/3 of its exports come from commodities.

There is a plethora of commodities (wheat, crude oil, cotton, coffee, cocoa, precious metals, etc.) that are traded by sea, rail, road and air. Their prices fluctuate on the stock exchanges according to international supply and demand. The volume of exports worldwide is constantly increasing and commodity prices fluctuate due to endogenous and exogenous factors. The more

the price fluctuates the less incentive producers have to produce next year, and some commodity traders and rent-seekers anticipate this volatility and take out futures or call options to gain rents at the expense of the local workers and producers who actually create the value. Many factors related to supply and demand can explain price volatility of primary commodities in developed and developing countries:

- **The elasticity of supply and demand** which can lead to over or undersupply. When the elasticity price of supply is small, the price diminishes then the demand will increase.

- **Business cycles.** If advanced economies face downturns, the price of primary commodities can increase because those countries are the main producers and consumers of this commodities.

- **Changing weather patterns.** Climate change can rise the frequency of extreme weather events and then can cause price hikes in commodity-producing countries.

- **Political instabilities** can stop commodities supplies and make spikes in price. This is particularly the case in developing countries plagued by civil unrests and wars.

- **Price speculation.** Investors and hedge funds can, through transactions in derivatives, induce artificial price changes. "*As of January 2007, Wall Street investment funds accounted for 20 to 50 percent of futures contracts for several agricultural commodities, including wheat, corn, cattle and live hogs. These funds, which are not allowed to trade in physical commodities, must "roll-over" expiring contracts and re-balance their portfolios each month, creating changes in demand for futures contracts that are unrelated to physical demand for the actual goods*" (Williamson and Sambit ,2015 ; Barrionuevo and Anderson, 2007).

- **Export dumping.** When a state decides to finance exports of a commodity, it can influence the price downwards.

- **Exchange rate fluctuations.** "*Even if international commodity prices are stable, exchange rate fluctuations affect a commodity's value in local currency, since major markets denominate prices in US dollars or in euros, but producers are paid in their local currency*" (Williamson and Sambit, 2015).

In the following section we will describe some of the channels by which commodity price shocks impact distribution.

III. Channels transmission of commodities prices shocks on income distribution

According to Rudiger et al (2018), commodities account for more than 80% of total exports, including 40% for crude oil in Sub-Saharan African countries. Almost a third of the world's population depends on commodity production (Oli et al. 2008), our study will be focus on three main commodities: coffee, crude oil and wheat. Coffee is the most traded commodity in the world, with Arabica coffee being the most demanded variety in the market. Many Sub-Saharan African countries are dependent on crude oil for their budgetary revenues, and it is hard to imagine a world without the wheat that bakers use to make bread. The three commodities selected, wheat, coffee and crude oil, are classified as food, tropical beverages and energies respectively, according to the Standard International Trade Classification (SITC).

The IMF (2017) maintains that international trade does not impact inequality, yet some studies presented in the introduction and in the literature review have shown that the impact is real, notwithstanding geographical concentration effects that cannot always be generalised to the entire population of a country affected by commodity price volatility.

We need to define the notion of impact, because we can very quickly fall into a quantitative bias and think that the volatility of commodity prices modifies the distribution of income in the associated sectors. This dimension seems to be limited to characterise the definition of the impact on income distribution, as it is possible that a factor such as political instability may keep the populations of a developing country in poverty and maintain the level of inequality. By comparing the distribution of income in that country at different periods of time and developing precise causal links with commodity price change, one can then measure precisely the change in distribution induced with an inequality measure such as the Gini index or the share of the 10% richs in the national income. It is by drawing a parallel with the fluctuation of commodity prices and their impact on the economy of countries dependent on coffee, oil or wheat that we felt it was important to understand the channels by which a price shock influences income distribution.

According to Katsuya (2010), price fluctuations affect economic activity through the supply-side (production cost) and the demand-side (income transfer) channels. We draw the following lessons from our research:

- The mechanisms by which commodity price fluctuations affect income distribution are complex (see figure 1 below by UNCTAD, 2019). This is because there are many actors involved in the value chain, including farmers and other producers, governments, investors, transporters, logisticians, financiers, insurers, manufacturers, speculators, national and international regulators. All of them can influence commodity prices up or down. Developing countries produce more and developed countries control the value chain (UNCTAD, 2019).

- Commodity price change directly impacts the income of value chain actors (households, producers, governments, financiers and insurers, transporters, etc.).

- The exchange rate is a well-known channel of income shocks (IOC, 2020). Indeed, devaluation can increase the competitiveness of local coffee and wheat producers but increase inequality and poverty.

- The transmission of shocks can be through domestic prices, which can deteriorate or improve household purchasing power. The generalised increase in commodity prices on the international market can lead to imported inflation on the local market.

- According to economic theory, oil price fluctuations have a direct impact on economic activity and investment in that production costs may rise or fall.
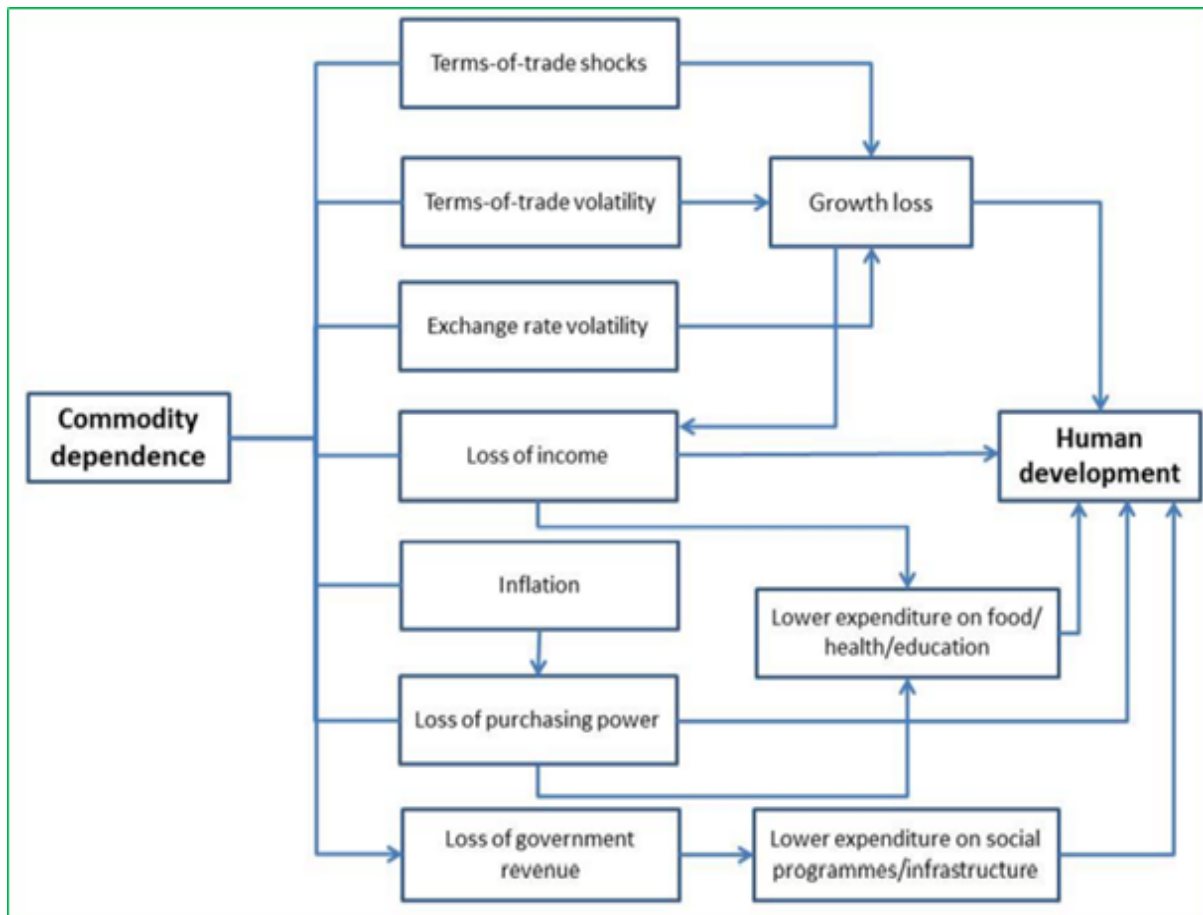
Fig. 1 Transmission channels *(Sources: UNCTAD (2019)).*

IV. Methodology framework review

It is of interest to understand the consequences of commodity price fluctuation on the economic welfare of a nation. This section focuses on proposing a rigorous scientific methodology that can be used to assess how commodity price shocks affect income distribution.

We start by presenting the methodological approaches that have been proposed in the literature. We will then present the data sources and the variables used. There are two types of data in general. The first relates to macroeconomic indicators (GDP per capita, inequality, poverty, etc.) of countries classified according to their level of development (developed or developing) for which we have a large number of observations over a period. The second concerns trade

data about the evolution of international prices of coffee, wheat and crude oil. We will define a measure of commodity price shocks. The diagram opposite summarizes our approach:
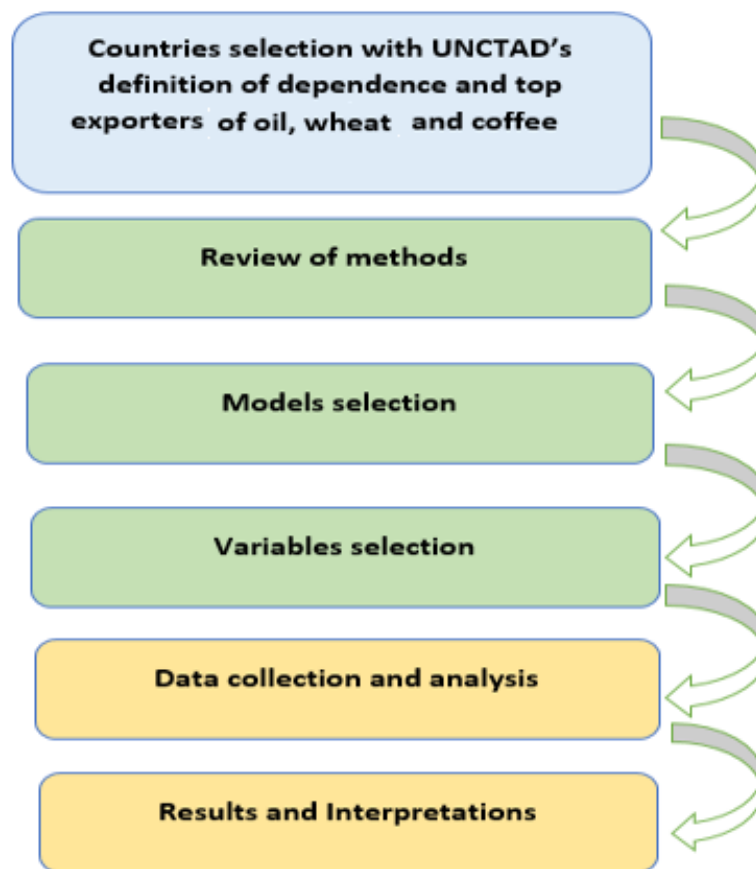
Fig. 2 Methodology Framework *(Source: The author).*

This study covers both developed and developing countries that export one of the three commodities selected. It should first be noted that the transmission channels for shocks differ from one commodity to another. In the case of crude oil, high international price volatility will have a short-term impact on the income of exporting countries as well as that of firms operating in this sector. If the government adopts a subsidy policy to stabilize the domestic price, then households will not feel the impact of volatility on their income or consumption patterns.

Nevertheless, the decline in government revenue reduces public investment, increases public debt and may negatively impact the distribution of income in the economy. Wheat and coffee are produced by local producers in Brazil, Canada, USA, and Ethiopia for instance, a disruption in the international price impacts their income. We do not have microeconomic data on surveys of producers and households in commodity-dependent countries over a long period. We want to better understand the phenomenon over the long term at the macroeconomic level with macroeconomic data from these countries because it is the causality between the fluctuation of

commodity prices and the distribution of income that interests us and not the effects restricted to groups of producers or households, which have been widely studied in the literature (Calderon and Chong, 2000).

IV.1 Econometric approaches review

Several studies have shown that there is a correlation between trade, inequality and income, but endogeneity issues which means the presence of simultaneous feedbacks between variables can affect statistical inference (Diego and Andras, 2017). Countries that are highly open to trade tend to have high income levels and lower inequalities. In order to answer the research question of how the volatility of international wheat, coffee and crude oil prices affects the distribution of income we have identified several econometric approaches proposed in the literature.

IV.1.1 Gravity model

Authors like Frankel and Romer (1999), Head and Mager (2014) have used geographic variables (distance, area, etc.) as determinants of bilateral trade and have shown that they are good instruments for estimating the opening of a pay to international trade. According to Diego and Andras (2017), "*a 1% increase in openness to international trade will lead to an increase in per capita GDP of 2 to 3%*". Frankel and Romer (1999) used cross-section data to estimate a gravity model. This approach has been defeated by Diego and Andras (2017) who used the Poisson Pseudo-Maximum Likelihood (PPML) method to counter the limits of OLS regression and the panel data approach. Satheesh and Tauhidur (2007) had also severely criticized the approach of Frankel and Romer by prejudicing the use of more or less balanced panel data to better estimate the long-term effects of trade on income (Pavcnik, 2017). The real scientific challenge will be to propose a robust and precise model that can separate the real effect of price shocks of commodities on income distribution in the countries of our panel, because income distribution can be of various origin (price production, size of the labor force, institutional framework, macroeconomic and political stability, etc.).

IV.1.2 Error Correction Model (ECM)

Williamson and Sambit (2015) used a single equation Error Correction Model (ECM) to estimate the effect of commodity price shocks on inequality, the latter measured by the income share on the 1, 0.05 and 0.01 percent during 1921-2008. They used the ratio of export to import prices as a measure of commodity price movements. In other to make the link with non-tradable goods in domestic economy, Williamson and Sambit (2015) divided import and export price by the GDP implicit price deflator. Because high and persistent inequality harms economic growth and affects institutions, the authors argue that it is useful for resource-rich-developing-countries to design policies to reduce inequality.

IV.1.3 Vector Autoregressive Model (VAR)

Many studies use the VAR model to capture the macroeconomic effects of commodity price volatility and the results show in most cases a regressive effect. For example, Oriakhi and Osaze (2013) cited by Adegbie et al.(2019) used the VAR model to show that fluctuating crude oil prices directly impact real government expenditure, exchange rate, real imports and indirectly GDP per capita, real GDP, real GNP, inflation and money supply in Nigeria. The VAR model was proposed by Sims (1980) and is specified as follows:

$$Y_t = \mu + \sum_{i=1}^{p} A_t Y_{t-i} + \varepsilon_t \, , \, \varepsilon_t \sim iid(0, \Omega) \tag{1}$$

Y_t is the vector of dependent and independent variables, A_i the matrix of coefficients, μ the vector of constants and ε_t the vector of error terms. The optimal lag p is determined by the Akaike Information Criterion (AIC).

If the variables are non-stationary following the Dickey-Fuller unit root test, Engle and Granger (1987) and Johansen (1988) cointegration tests are applied to see the existence of cointegration relationships between the variables. The null hypothesis of the cointegration test states that the number of cointegrating vectors is less than or equal to 0.

If no cointegration is detected, we apply the simple VAR model and if not, we use the Vector Error Correction (VEC) model developed by Johansen in 1988:

$$Y_t = \mu + \sum_{i=1}^{p} B_i \Delta Y_{t-i} + \pi Y_{t-1} + \varepsilon_t \tag{2}$$

Δ is the difference operator, B_i is the coefficients matrix and π is a cointegration matrix.

IV.1.4 Social Accounting Matrix (SAM)

Other approaches use the Leontief Miyazawa model (see Guilhoto et al., 2014) and construct the Social Accounting Matrix (SAM) for a basket of commodities. Households are divided into rural (farmers, traders) and urban (workers by distributional quartiles) groups. Each cell of the SAM matrix is a calculation of the price elasticity of the income of the product corresponding to the column, these elasticities are the impacts of fluctuations in international commodity prices (1% change) on the income of the household groups. When prices rise, the income of farmers should also rise, as should that of workers in these sectors. For households not working in these sectors, the transmission of shocks can take place at different levels, for example by acting on the prices of domestic products. Guilhoto et al., (2014) propose the following transmission pattern between changes in international demand, price fluctuations, domestic prices and the income of household types:
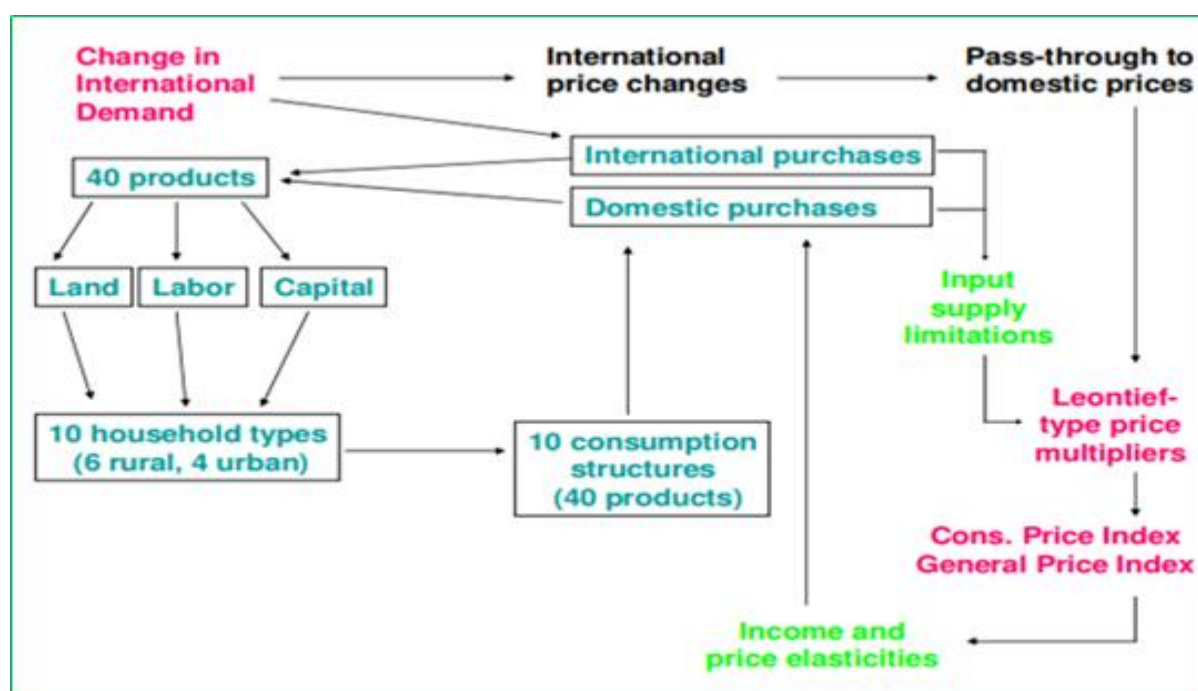
Fig. 3 Model solution schematics *(Sources: Martins et al. (2006)).*

SAM is used to apply a structural computable general equilibrium (CGE) in the purpose to show how a shock can impact income distribution. It must be said that this method requires data from national accounts and the calculation of Leontief coefficients. This challenge is

compounded by the fact that our research topic requires data from both developed and developing countries, which are difficult to get access.

IV.1.5 Dynamic panel regression

Arellano and Bover (1995), Calderon and Chang (2000) and Soran and David (2019) advocate using a dynamic panel model with GDP per capita, government income, real wages (Oli et al. 2008), Gini index and poverty rate as variables to measure inequality. The particularity of dynamic models is that the dependent variable is explained with its past and explanatory variables that are listed in subsection 4.2. The model also has a country-specific effect that is correlated with the explanatory variables and the estimates are made by the GMM method of generalized moments. To eliminate the country-specific effects it is then sufficient to differentiate the variables. The equations of the in-level and the differentiated model are as follows:

$$Y_{i,t} = \beta_1 Y_{i,t-1} + \beta_2 X_{i,t} + \delta_i + \varphi_t + \varepsilon_{i,t} \tag{3}$$

$$\Delta Y_{i,t} = \beta_1 \Delta Y_{i,t-1} + \beta_2 \Delta X_{i,t} + \Delta \varphi_t + \Delta \varepsilon_{i,t} \tag{4}$$

δ_i is an unobserved time-invariant heterogeneities across the country, β_i the parameters of the model, φ_t an unobserved country-invariant heterogeneities. When δ_i is a random variable, we are talking about random effects model, otherwise it is a fixed effects model.

To avoid endogeneity with the explanatory variables it is Calderon and Chang (2000) recommend to use instruments (differentiated explanatory variables), the errors are assumed not to be auto correlated. The disadvantage of this method is that the estimators used have very low asymptotic precision and are biased for small samples. The Sargan test allows testing the null hypothesis that the instruments are not correlated with the errors. The LM (Lagrange Multiplier) test is used to evaluate the serial correlation at order 1, 2,....P. Positive beta coefficients indicate positive effects on income or on the income distribution. Calderion and Chang (2000) cited by Guilhoto et al. (2014) advocate the use of a dynamic panel to show that

capital intensity, type of export and volume of trade are variables that affect income distribution in the long run. This model fits well with our problem we consider it for modeling.

The table below identified some variables used by some authors in their econometric estimations.

Table 1: Some approach and variables used

Source	Methodology	Variables
Williamson and Sambit (2015)	Correction Model (ECM) to estimate the effect of commodity price shocks on inequality	- Commodity Export Price relative to GDP deflator - Export Price of wool relative to GDP deflator - Export Price of mining relative to GDP deflator - Export Price of agricultural commodities relative to GDP deflator - Import Price relative to GDP deflator - Income Shares of the top 1%, 0.05%, 0.01% (dependent variables) - GDP Growth Rate - Non-Farm GDP Growth Rate - Trade Union Density - Direct Tax Share - Primary Exports Share to GDP
IMF(2017), South Centre (2005)	GARCH	- The share of export earnings of the top single commodity (or top three export commodities) in GDP, in total merchandise exports, and in total agriculture exports - The percentage of people engaged in commodity production

Source	Methodology	Variables
		- The share in government revenue - All primary commodities' monthly price index - Real food prices - Rate of change of commodity prices (dependent variables)
Oriakhi and Osazee (2013)	Vector Autoregressive Model (VAR)	- Real Government Expenditures (dependant), - Real Import (dependant) - Exchange rate (dependant) - oil price volatility
Adegbie et al.(2019)	Multiple Regression in Nigeria	- Government (dependant) - Gross National Product (dependant) - Per Capital Income (dependant) - oil price volatility

IV.2 Data and sampling

Our empirical analysis is built up over an unbalanced panel dataset containing 159 countries over the period 1960 to 2019. Especially for econometric estimations, we will consider only the period 1991-2019 because of missing data in many countries. A long period analysis help us to clarify the cyclical correspondences between the fluctuation of the international price of wheat, coffee and crude oil and the distribution of income in the commodity-dependent countries. Our panel contains developed and developing countries. The data comes from the official websites of Standard World Income Inequality Database (SWIID), United Nations Conference on Trade and Development (UNCTAD), Foods and Agriculture Organization of the United Nations (FAO) and the World Bank Group (WBG). The following variables and indicators will be collected to support our analysis:

IV.2.1 Inequality and income variables

As variables for measuring income distribution, we have the variables for measuring inequality, namely the **Gini index, the share of the richest 10% and the share of the bottom 50% in national income** (Solt, 2016; Soran and David, 2019). As macroeconomic variables for

measuring national income, we have **real GDP, Gross National Income (GNI) and government income**. We use head count ratio, to determine the number of poor people in countries to support the analysis of inequalities but not in the estimations.

IV.2.2 Control variables

One of the causes of bias in the estimation of the parameters of a linear model is the presence of multicollinearity between the explanatory variables. The explanatory variables used in the estimation of the model must be independent and identically distributed and provide explanatory power.

✓ **Commodity prices.** To answer our research question, which is to know how commodity prices shocks influences the distribution of income in countries whose exports depend on them, we must use commodity price shocks among the explanatory variables. We have shown in previous explanations that commodity export-dependent countries are exposed to commodity price instability and that inequality has risen. The following formula allows us to calculate the shocks (see Soran & David, 2019):

$$S_{i,t} = (logP_t - logP_{t-1}) x \frac{EX_{it}}{GDP_{i,t}} \tag{5}$$

$logP_t$ represents the logarithm of the real price of the commodity at date t, EX export shares of commodity and GDP the Gross Domestic Product.

✓ **Economic growth.** Growth is a good indicator of business cycles, which are often the cause of short-term fluctuations in income. In a recession output falls, employee wages are reduced and unemployment rises. In periods of expansion economic activity is fluorescent, output increases and income rises. These short-term fluctuations affect the distribution of income.

✓ **The exchange rate** affects the price on the domestic market as well as exports and imports. If the currency appreciates, imports increase and exports decrease. Households now have more purchasing power. Short-term fluctuations in the exchange rate can affect income distribution through inflationary pressures on commodity prices (Soran and David, 2019). The exchange rate of the dollar when it depreciates will have an impact on commodity prices because international prices are generally expressed in US dollars (Baffes and Haniotis 2010).

✓ **Commodity-dependence.** A dummy variable constructs with exports of commodities. If the share of commodity exports to the total of merchandizes exports is greater than 60% (UNCTAD criteria) the country is commodity-dependent.

✓ **Income group**. The classification of countries by income level as defined by the World Bank with four groups: Low Income (LI), Lower Middle Income (LMI), Upper Middle Income (UMI) and High Income (HI).

✓ **Development group**. In the classification by level of development, two groups are considered: developing countries and developed countries. We have retained the classification proposed by UNCTAD and the IMF.

✓ **Region.** Seven geographical regions are to be distinguished: Sub-Saharan Africa (SSA), North America (NA), South Asia (SA), Middle East & North Africa (MENA), East Asia & Pacific (EAP), Europe & Central Asia (ECA), and Latin America & Caribbean (LAC).

✓ **Export**. Total export in volume and in value, we use this variable when constructing the dummy commodity-dependence and to compute shocks for each commodity in study. These data are provided by UNCTAD.

✓ **GDP per capita**. Is used to explain income inequality at a country level (Soran & David, 2019).

On the exploratory level, we will make a point of using quality data and the results will be presented using methods of visualization of clear and ergonomic data to facilitate reading (tables, graphs and maps). As software, we use R and Excel for data analysis.

V. Main results of the study

This section presents the results of the data analysis. First, we will study the geographical and economic profile of the so-called commodity dependent countries. These countries are those whose volume of exported commodities represents more than 60% of total exported goods according to the criteria defined by UNCTAD (2017). We will then analyse the evolution of oil, coffee and wheat prices. This analysis will allow us to understand the origin of price volatility and the trends in historical prices. Once we have an understanding of price trends, we will graphically study the link between commodity dependence and macroeconomic variables, notably real GDP, GDP per capita, gross national product, government revenue (% GDP), variables that measure poverty (poverty head count and poverty gap ratio at $1.90 a day) and inequalities such as the Gini index, the share of the richest 10%, and the share of the bottom

50% of income distribution. It is only after having acquired this statistical knowledge that we will estimate regression models on unbalanced panels to measure empirically the impact of the variation of the prices of the said commodities on the dependent variables of income, inequality and poverty.

V.1 Study of commodity-dependence
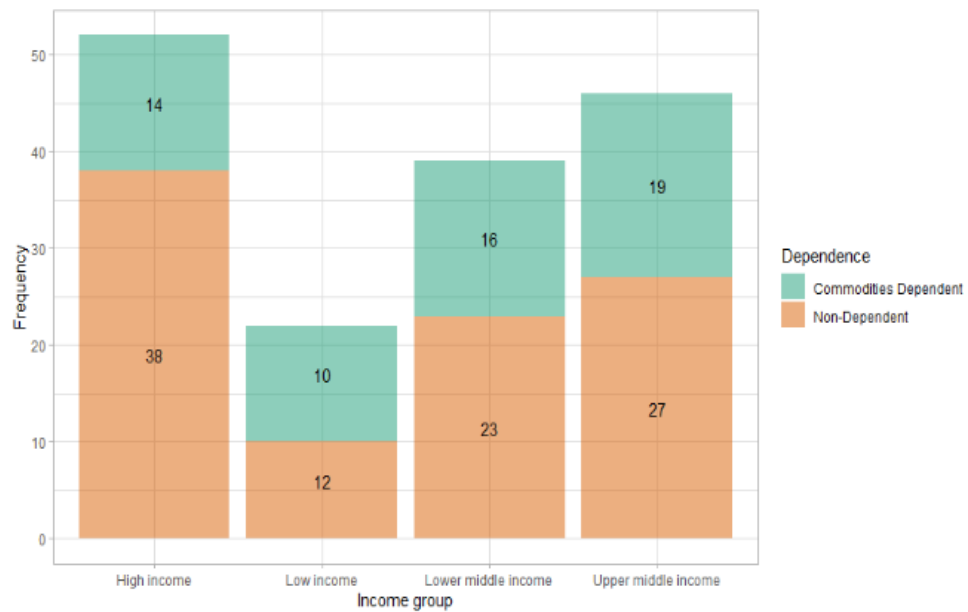
Fig. 4 Commodity dependence by income group.

In order to establish the link between commodity price trends and income distribution, we first asked ourselves whether associations could be observed in an exploratory way between the commodity dependence of an economy and characteristics such as its region, its level of development and its income level. This initial discussion allows us to describe the profile of commodity-dependent and non-commodity-dependent countries.

The analysis is carried out on a representative sample of 159 countries and continues by distinguishing the following groupings:

✓ The classification of countries by income level as defined by the World Bank with four groups: Low Income (LI), Lower Middle Income (LMI), Upper Middle Income (UMI), and High Income (HI).

✓ In the classification by level of development, two groups are considered: developing countries and developed countries. We have retained the classification proposed by UNCTAD and the IMF.

✓ The geographical region: Sub-Saharan Africa (SSA), North America (NA), South Asia (SA), Middle East & North Africa (MENA), East Asia & Pacific (EAP), Europe & Central Asia (ECA), Latin America & Caribbean (LAC).

From the figure above, it can be seen that 38 (73%) out of a total of 52 high-income countries do not rely primarily on commodities for their exports. Indeed, high-income countries are more specialised in industrialisation and product processing. They have diversified economies and developed financial systems that make them less vulnerable to commodity price shocks. 45.45% (10 out of 22) of low-income countries depend mainly on commodity exports, notably agricultural products, hydrocarbons and minerals. This figure is 41.02% (16 out of 39) for low middle income countries against 41.30% (19 out of 46) for upper middle income countries. This finding is consistent with the observations of Rudiger et al (2018) who stated that *"many least developed countries (LDCs) face commodity dependence on the export and import side"*. This dependence generates macro-level disturbances and income distribution effects. In the following analysis, we show that countries dependent on exports of the three commodities in the study almost all have a strong positive correlation between their real gross domestic product and the price of these commodities.

Fig. 5 Commodity dependence by region.

Dependence on commodities is very marked in sub-Saharan Africa, with 61.53%, i.e. 25 of the 39 countries in our sample (see figure 5 above) being essentially dependent on commodities for their exports. The majority of these countries are LMICs, LIs countries. These countries include Angola, Cape Verde, Ghana, Cameroon, Côte d'Ivoire, Kenya, Gabon, Equatorial Guinea and Ethiopia. Indeed, the export structure of these countries is essentially made up of primary agricultural products and their trade balance is generally in deficit because it is marked by the import of manufactured products from more competitive countries in Asia and Europe and agricultural products such as wheat and rice from Asia and North America. Gabon and Equatorial Guinea are heavily dependent on crude oil exports, and their economies have generally been hit hard by the oil price shocks of 2008, 2014 and 2016. The East Asia & Pacific is the second region with the highest dependence on commodities in its exports.

In contrast, regions such as South Asia and Europe & Central Asia have a low dependence on commodities, in terms of proportion, at 11.11% (or 1 in 8) and 20.45% (or 9 in 44) respectively. Afghanistan is the only country in South Asia that is commodity-dependent. The country is known as an exporter of precious stones, animal skins, especially leather, cotton and wool. In Europe & Central Asia, in the category of dependent countries we have Armenia, Azerbaijan, Greenland, Iceland, Kazakhstan, Montenegro, Norway, Russian Federation and Tajikistan. Azerbaijan imports mainly food products from Russia. Greenland specialises in the export of seafood (shrimps, crabs, fish, etc.). Kazakhstan exports raw materials including crude oil, natural gas, uranium and copper. In Norway, food products, chemicals, raw materials and hydrocarbons are the main drivers of the economy. Azerbaijan is focused on export industries such as oil, gas, cement, textiles, iron, chemicals and foodstuffs. In Russia, the main exports are natural gas, wood, cars and equipment, armaments and mineral fertilisers.

Developing countries have a higher proportion of commodity-dependent countries in their exports at 46.55% (54 out of 116), while this data is only 16.30% (3 out of 43) for developed countries. This clearly shows that this phenomenon is the prerogative of developing countries, whose export structure is more concentrated on commodities, particularly agri-food and hydrocarbons.
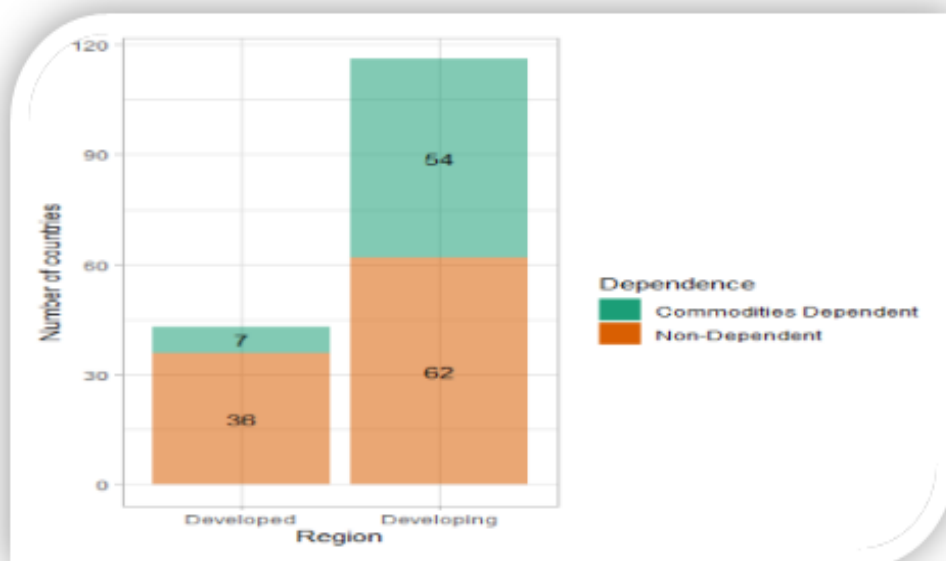
Fig. 6 Commodity dependence by level of development.

V.2. Dynamics of oil, coffee and wheat prices and inequality in the world

This sub-section is for us, and we also want it to be for the readers of this research, a pedagogy of the commodity market studied, but also of the factors that can explain the price instability despite a general upward trend. When observing the evolution of commodity prices, one of the distinguishing features is volatility. Prices are in constant motion and can reach all-time highs. And as we have seen before, this fluctuation has various origins, including the elasticity of supply and demand, geopolitical instabilities, climatic and environmental disasters, and speculation in the derivatives market, among others. High prices benefit exporting countries, but low prices are just as dangerous as they often reduce oil revenues. Our study focuses on the distributional effects of commodity prices. From a microeconomic point of view, households and companies specialising in the production and export of commodities also benefit from the price increase, provided that it is not offset by inflation. For it is recognised that purchasing power is the key to whether the welfare of society is ultimately improved.

The figure below shows the monthly evolution of the price of a barrel of Brent and the average price of oil over the period from January 1960 to February 2021. A phase of timid growth from 1960 to 1980, a phase of stagnation from 1980 to 2002, a phase of take-off from 2002 to 2008 and finally a phase of decadence which began in 2014 and will continue in 2021.

During the period 1960-1980, the price of oil increased more than tenfold but always remained below the $50/bbl mark. This period is marked by the two oil shocks of 1973 and 1978 which gave a boost to the price. During the so-called stagnation period (1980-2002), the price of oil first fell sharply from 1980 to 1986, from $39/bbl in January 1980 to $9.62/bbl in July 1986, a decrease of 75.33%. This was followed by a period of slight calm from 1986 to 2002 during which the price remained stable at around $17/bbl, which can be explained by the production surpluses of the member countries of the Organisation of the Petroleum Exporting Countries (OPEC), the firmness of world demand and the efficiency in the use of energy resources.

Between 1999 and 2008, the price rose sharply from $11.4/bbl in January 1999 to $133/bbl in July 2008, due to the structural increase in oil demand from Asia, America and Europe, before falling sharply after the financial crisis of 2008. It must be said that the global distribution of oil is mainly driven by OPEC countries, which alone account for almost two-thirds of global reserves. This means that any domestic shock, such as geopolitical tensions or external factors directly affecting a Middle Eastern OPEC member country, will have a major impact on the financial markets and increase the volatility of the oil price. The upward trend that started in 1999 is re-established one year after the 2008 crisis but is just fading in 2014, when the oil price has again exceeded $100/bbl. The low price elasticities of demand and supply make prices very sensitive to fluctuations in supply and demand (OECD, 2004). Furthermore, according to the OECD, "*other bottlenecks such as shortages of transport capacity and regional imbalances between the quality of oil demanded and supplied have contributed to increasing the premium on low-sulphur oil*". Other major explanations include the drying up of excess capacity in OPEC countries.

Between 2014 and 2021, the oil price began a downward trend, sometimes slowed by periods of recovery due to short-term factors that boost the price but have no major impact on the persistence of the trend. Among the accelerators of the price decline is the emergence of the electric vehicle industry and the renewable energy industry in Asia, Europe and the Americas,

which has substantially reduced the global demand for oil. It should also be said that the number of oil reserves has changed as a result of price fluctuations and technological advances, which have helped to increase the amount of oil that can be extracted from a field. That said, new reserves discovered are generally more expensive and less consistent in absorbing rising global demand. At the same time, this period has shown the vulnerability of economies that rely heavily on oil for government revenues, particularly those in sub-Saharan Africa.
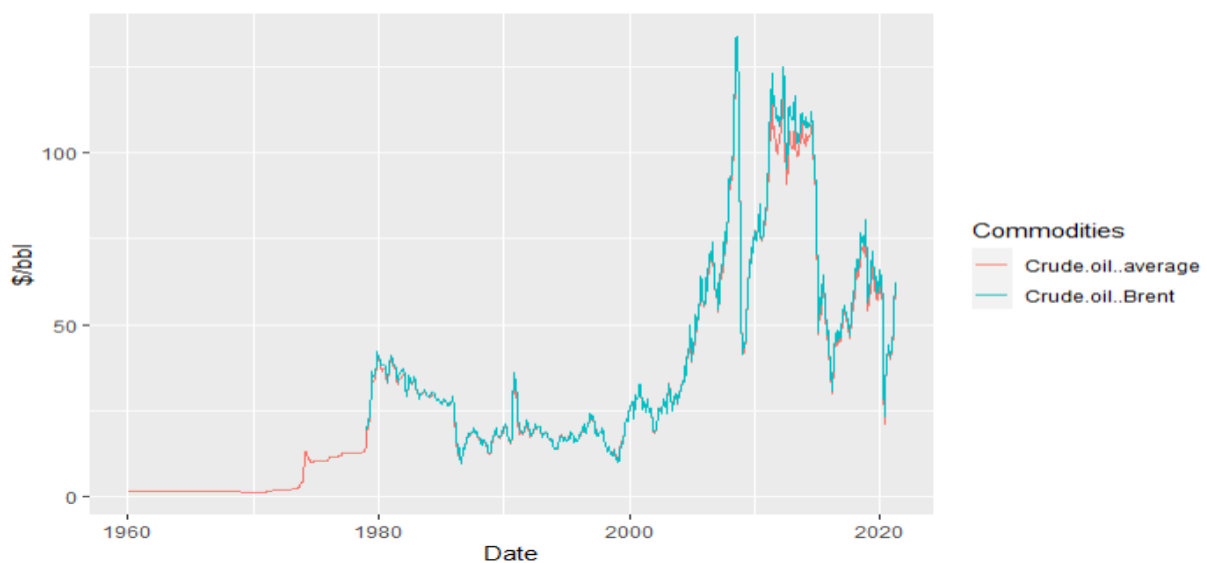
Fig. 7 Evolution of the price of Brent and the average price of crude oil.

(*Source: The World Bank Commodity Price Data*)

Notes: Crude oil, average spot price of Brent, Dubai and West Texas Intermediate, equally weighed. Crude oil, UK Brent 38` API.

V.2.2 Coffee

Coffee is the most traded commodity in the world, and it is necessary to distinguish between two types of coffee, Arabica coffee, which alone accounts for 70% of world production, mainly because of its good quality, and 30% for Robusta coffee. The production of this commodity is located in equatorial zones, mainly on the African continent (Ethiopia and Cameroon produce Robusta) and on the South American continent, which is home to the world's leading producers of Arabica coffee, Brazil and Colombia. In Asia, Vietnam, the world's largest producer of Robusta, and Indonesia are the main Robusta producers. A distinction is made between the

actual coffee market, known as the physical market, where real quantities of coffee are traded, and the futures market, where contracts for the sale or purchase of a standard quality of coffee at a later date are negotiated.

Two markets are responsible for pricing coffee according to its quality[3]. The London ICE quotes Arabica coffee, while the Euronext market quotes Robusta coffee, which is quoted in dollars per tonne, while Arabica coffee is quoted in dollars per pound. For the purposes of comparison, the figure below shows the price of coffee in dollars per kilogram ($/kg) as provided by the World Bank Commodity Data (WBCD). From this representation, we can see that both series are extremely volatile and evolve in a procyclical manner. The price of Arabica coffee outperforms that of Robusta by more than doubled over the last 20 years, whereas in the years before 1980, the two commodities had almost the same value. At a glance, coffee is consumed in large quantities in developed countries, with a significant part of the demand being located in the USA, the European Union (EU) and Japan. Europe is the continent that consumes the most coffee with 10kg/inhabitant, while Africa consumes only 4.5kg/inhabitant. Several factors affect the price of coffee, including: the characteristics of the coffee (flavour, quality); weather conditions; psychological factors on the American market of the NYMEX or the New York Mercantile Exchange; the elasticity of supply and demand for coffee; seasonal variations due to the four-year delay between planting and harvesting; and shocks to international trade. These factors induce micro-movements in prices with permanent oscillations that give a sawtooth pattern to prices, making their predictability uncertain and thus increasing macroeconomic volatility in producing countries. On rare occasions, the price of Arabica has exceeded the low $6/kg, as was the case between March and May 1977 and between February and June 2011. In contrast, Robusta price volatility has been somewhat less pronounced since 2010, with prices hovering around $2/bbl.

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[3] [Cours du café, notre analyse. (it2rhine2020.eu)](it2rhine2020.eu) for more details.
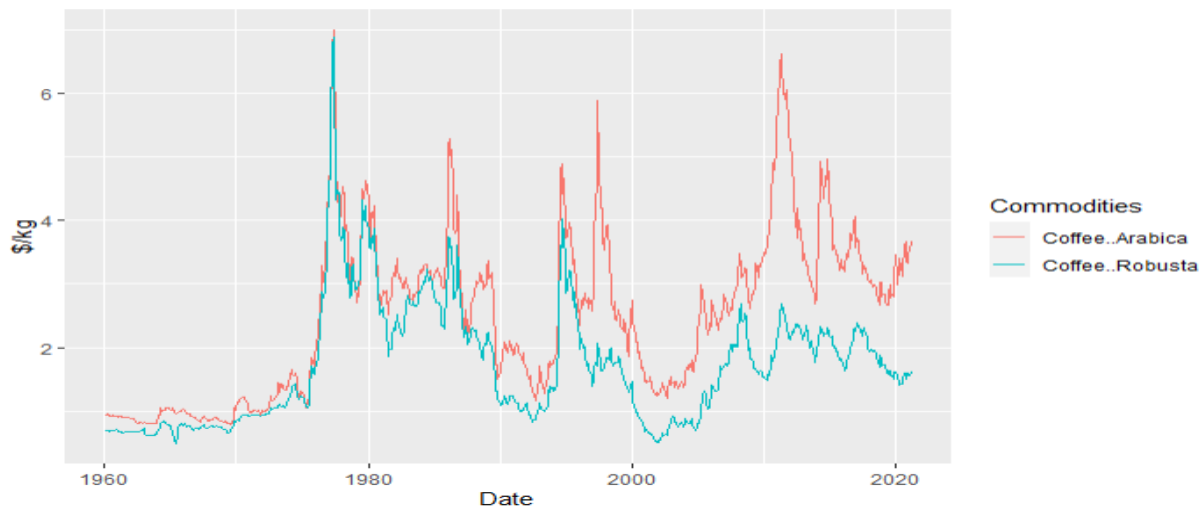
Fig. 8 Evolution of Arabica and Robusta coffee prices.

(Source: The World Bank Commodity Price Data)
Note: Coffee (ICO), International Coffee Organization indicator price, other mild Arabicas, average New York and Bremen/Hamburg markets, ex-dock. Robustas, average New York and Le Havre/Marseilles markets, ex-dock.

V.2.3 Wheat

Wheat is an agricultural product that has become familiar in the gastronomy of human beings, with a per capita consumption of about 66kg per year (Terrones and Burny, 2012). This foodstuff is strategic in that it allows certain countries to ensure world leadership in its distribution. It is also safe in that it contributes to food security objectives in countries with high poverty rates. As a commodity, it is easily traded on the spot and futures markets. Since the 1960s the leadership in wheat production has been shared between the USA, the former USSR, the EU, India, China and Canada. The evolution of wheat prices shows a long-term upward trend with more or less regular fluctuations. This evolution is concomitant with that of world wheat consumption and production, which determine the price level but are not its only determinants. As we have seen with the price of coffee, factors such as product quality, delivery times, geopolitical instabilities, extreme climatic phenomena (droughts), the occurrence of fires, logistical difficulties, speculation on the stock markets, poor harvests, the use of agrofuels and, above all, the level of world stocks and their geographical location in the world (Terrones and Burny, 2012). These are the most recurrent problems in the cereals market (rice, maize, wheat). Take, for example, the waves of droughts accompanied by fires that shook the former USSR (Russia, Ukraine, Kazakhstan) in the years 2010/2011. As we can see from the graph

below, these climatic episodes caused wheat prices to rebound by almost 60% in the months that followed. We can also recall the crisis of 2007/2008 due to the violence in poor countries.

It can be seen from the evolution of the price of wheat that repeated fluctuations are sometimes due to economic or financial crises or to events in the producing countries. The first episode of high volatility occurred in 1972 following the monetary destabilisation of the oil crisis and the first Soviet purchases of wheat. In direct connection with the Russian and Asian crises of 1998 and 1997, the price of wheat fell. It had in fact exceeded the $250/mt mark before approaching $100/mt in 2000, i.e. a drop of almost 60%. Between 2000 and 2008 the price increased almost fourfold, reaching a record level of $419.51/mt in March 2008. The financial crisis of 2008 left its mark on the price of wheat, resulting in a drop as marked as the meteoric rise between 2000 and 2008. The price of wheat is historically very volatile, with instability being the rule and stability the exception. The price displayed is the result of the confrontation between supply and demand. The distributional effects resulting from these fluctuations are explained by the idea that actors internalise price information in their decisions. If in the short term the price increases, producers will be more inclined to increase their production volumes by buying new land, going into debt, and investing in more profitable production techniques. As for world demand, it does not fluctuate much in the short term. The price of wheat in itself does not necessarily impact the distribution of income for all economic actors because they have the possibility of substituting it for other products, particularly maize and rice. Since we do not have specific data on the income of producers, consumers, traders and merchants whose income is directly affected by price fluctuations, we have focused throughout this research on the study of linear relationships between commodity price trends and national income and inequality.

To conclude this analysis of the wheat price, we say that overall this market is clearly balanced and the upward trend is continuing despite the new tensions created by the recent Covid-19 crisis. Current world stocks are sufficient to meet global wheat demand.
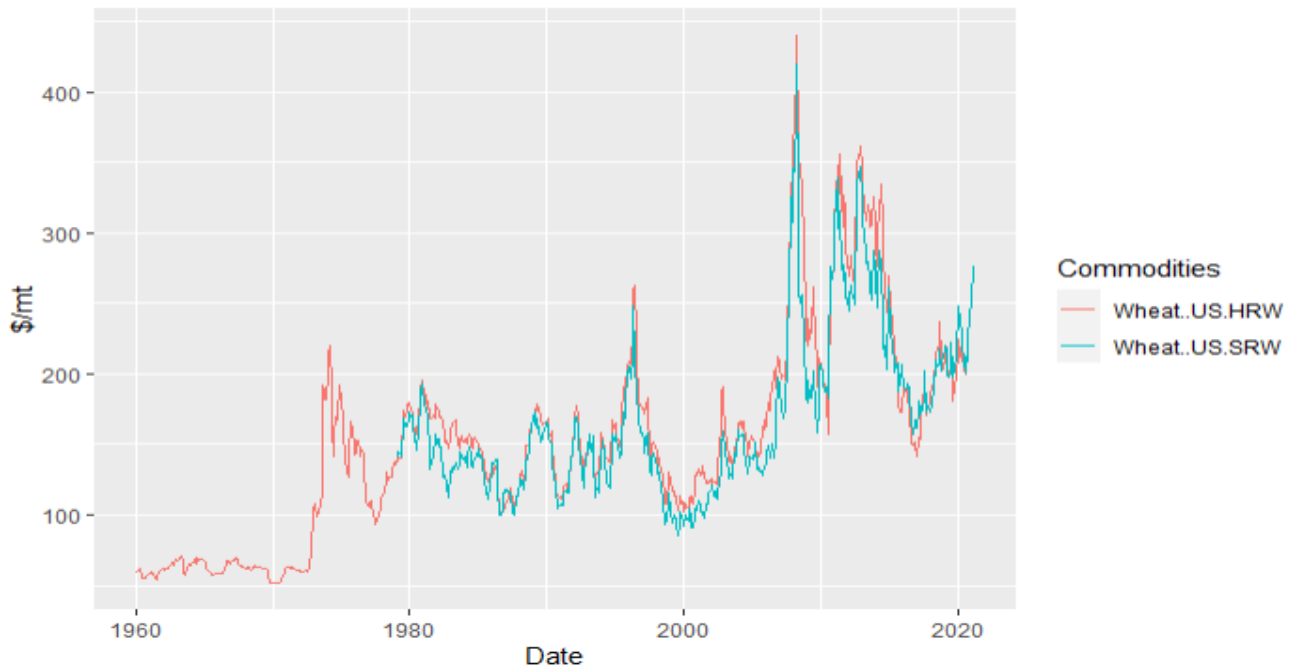
Fig. 9 Evolution of the price of wheat.

(Source: The World Bank Commodity Price Data)

Note: Wheat (U.S.), no. 1, hard red winter (HRW), ordinary protein, export price delivered at the US Gulf port for prompt or 30 days shipment. Wheat (U.S.), no. 2, soft red winter (SRW), export price delivered at the US Gulf port for prompt or 30 days shipment.

V.2.4 Relative prices of wheat, oil and coffee
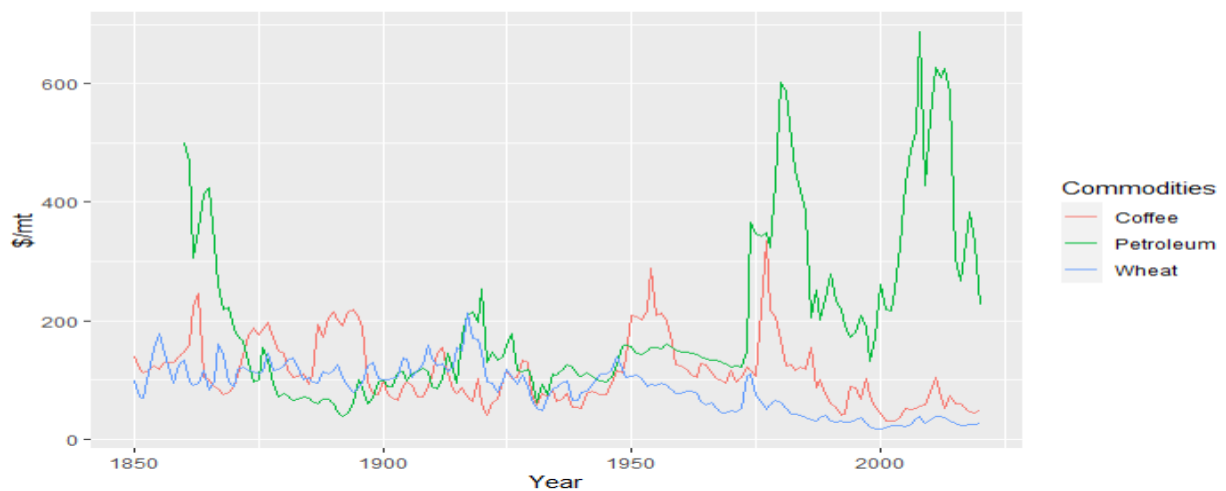
Fig. 10 Relative price trends (base 1900 = 100) for wheat, oil and coffee. *(Source World Bank Group)*

After analysing the prices of three commodities, the main lessons learned are the high volatility, a long-term upward trend and the influence of common factors such as financial and economic crises, product characteristics, climatic phenomena and their consequences, the confrontation

of world supply and demand and stock market speculation, to name but a few. To see these coincidences clearly, prices in monetary units are not adequate because they are expressed in different quantities. The evolution of the relative price or real price of the three commodities studied from 1850 to 2021 presented in the figure 10 above shows that the three series are procyclical and fluctuate regularly over time. Overall, the series evolve with more or less regular oscillations. Before 1973, the volatility of the three series was practically the same, although there was a sharp drop between 1850 and 1875 in the relative price of oil compared to the base year 1900. This is explained by the increase in world oil production due to the contribution of OPEC countries. After 1973 the price of oil became more volatile than that of coffee and wheat, but the peaks of the three series coincide, indicating a strong correlation in the relative prices of these commodities. This result is instructive in that it shows that shocks have systemic repercussions on commodity markets because they are accelerated by financial globalization, which is itself a result of globalisation.

V.2.5 Dynamics of global inequality

In this sub-section, we will analyse the dynamics of inequalities in the world. Let us recall that this research aims to answer the nagging question of how international trade impacts the distribution of income and more precisely through the price channel in wheat, coffee or oil exporting countries. The analysis of inequalities allows us, thanks to photographic views of the world situation at regular intervals, 10 years from now, to look for clusters of presumptions that would allow us to establish a scientific link between the upward evolution of the price of the commodities established in the previous subsections and the distribution of income.

To understand the dynamics of inequality in the world, we need to go back to the work of Kuznets (1953), cited by Thomas Piketty (2014), who, through a titanic piece of work, showed that inequality is decreasing in the world. Two indicators for measuring inequality are represented: the share of the richest 10% in national income and the Gini index. The maps show the global distribution of inequality in 1990, 2000, 2010 and 2019. The data comes from the Standard World Inegality Income Database (SWIID), a freely accessible online database at https://wid.world.

It is clear from the share of the wealthiest 10% in national income that Africa and South America are the most unequal continents and we have seen that they also have the highest proportion of commodity-dependent developing countries in their exports. Over the last 30 years, there is more of a sense that the rich have become richer. In Brazil, the largest exporter

of Arabica coffee, this share has always remained in the 53-80% range. In South Africa and Sub-Saharan Africa, the share of the rich is very high at 49-53% and 53% or more for the vast majority. In contrast, Kuznets' findings seem to be more valid in North and West Africa, where countries such as Senegal, Mali, Morocco and Ghana have seen a reduction in the share of the richest. In the US, on the other hand, the rich have become richer, with their share rising from 31-43% in 1990 and 2000 to 43-48% in 2010 and 2019. Russia has also seen the wealth of its rich grow, in 1990 their share was between 21 and 31% in 2000 it rose to 49-53% and since 2010 it has stabilized in the 43-48% range. The Gini index does not contradict these observations, as Africa and South America remain the most unequal continents. Inequality is increasing more specifically in the regions of Asia and North America. In 2019, Cameroon is among the most unequal countries in Central Africa, along with southern african countries such as Zimbabwe, Botswana, South Africa, Namibia and Angola.

It appears from the dynamics of inequality that the developing regions most dependent on commodities for their exports are also those where inequality is very high and where the wealthiest 10% of the population has the largest share of national income, often between 51 and 69%. The developed regions of Europe and Australia are the most egalitarian.
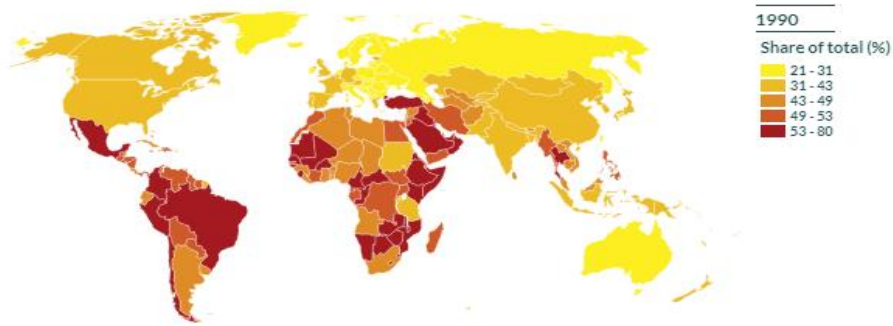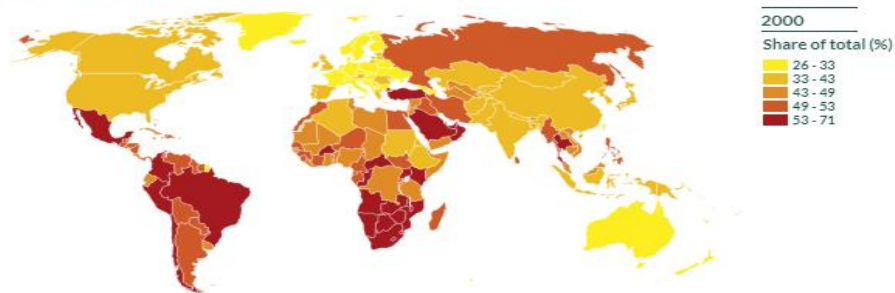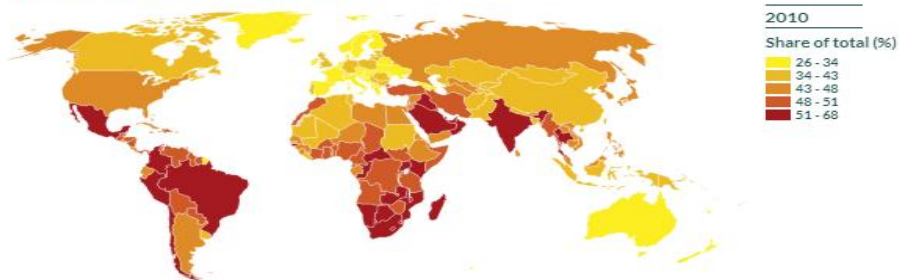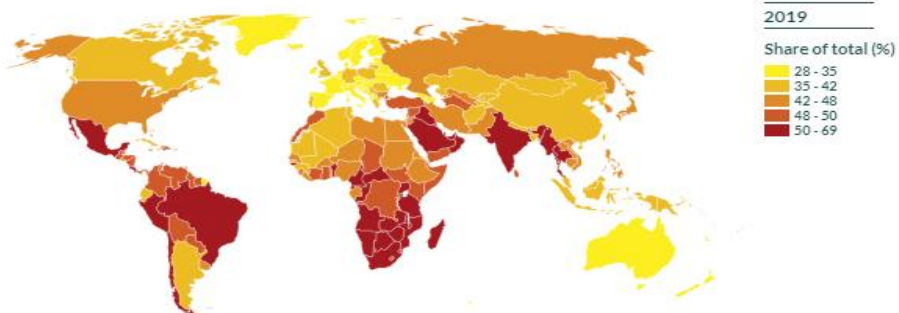
Fig. 11 Evolution of the share of the wealthiest 10% in 1990, 2000, 2010 and 2019 *(Source SWIID)*.

Gini index of national income
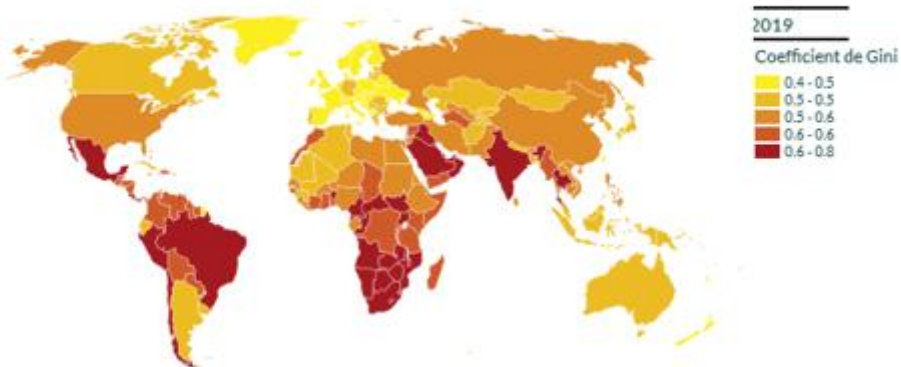
Fig. 12 Evolution of Gini index in 1990, 2000, 2010 and 2019 *(Source SWIID)*.

This phenomenon seems to be amplified by "*animal capitalism*" and other governance problems such as corruption and political instabilities rather than by a natural convergence or

even a causality directly attributable to commodity price volatility. One simple diagnosis, however, is that the long-term upward trend in commodity prices is associated with a general rise in global inequality and the enrichment of the wealthiest.

Once these preconditions are in place, we can go a little deeper into the analysis of the link between commodity dependence and income distribution. In the previous sections, we presented the shortcomings that may prevent research from going deeper into the study of this link at the microeconomic level. Indeed, it would be necessary to have microeconomic data on all the actors in the supply chain (producers, retailers, wholesalers, traders, the state, traders, households, banks, etc.) who benefit in some way from the activities revolving around these commodities. Then to show the precise impact of the price variation on their income by following a well-represented panel in different countries. But this ambition is very quickly curtailed by the resources it requires to mobilise. What can be studied at the macroeconomic level is the relationship between price variation and macroeconomic indicators of income, inequality and poverty such as real GDP, GDP per capita, government income as a % of GDP, gross national income (GNI), the Gini index, the poverty rate in the sense of the head count ratio and the poverty gap ratio at a threshold of $1.90 per day.

V.3 Income, Inequality and commodities dependence

V.3.1 Income variables

Before analysing quantitatively and qualitatively the long-term dynamics of the macroeconomic variables used to measure national income, i.e. real GDP, GDP per capita, government income as a % of GDP and gross national income (GNI), it is worth recalling the approach that led to the graphical representations presented in the following pages. The countries were first categorised according to their dependence on commodities in their exports. Two groups are distinguished: commodity-dependent and non-commodity-dependent. Then we calculated simple arithmetic averages for each group on an annual basis, taking care to exclude missing data. This is a recurring problem given the length of the observation period, which is either 1960-2019 (60 years) or 1970-2019 (50 years). The exclusion of missing data did not increase the bias and geographical representativeness was respected. However, it is

likely that the same countries are not included in the average calculation from one year to the next.

The figures below allow us to see how these macroeconomic indicators evolve in commodity dependent and non-commodity dependent countries. It is clear that each series shows an increasing long-term trend in each group. This suggests that the world's economies have become richer over the years. Nevertheless, countries that are not commodity dependent have seen their wealth grow faster than others. There is also a divergence in income levels between these two categories.

The average real GDP of non-commodity dependent countries rose from $97,472,477,555 in 1960 to $551,160,799,914 in 2019, an increase of 465%. In contrast, the average real income of dependent countries rose from $31,355,404,204 in 1960 to $176,532,025,327 in 2019, an increase of 463%. We saw in the section V.1 on commodity dependence that this characteristic is associated with the level of development, the level of income and the geographical region to which the country belongs. Developing countries are dependent on commodities, which impacts on their GDP through exports and imports. Developed countries have a monopoly on the commodity supply chain and specialise in the production of capital-intensive goods and services, which sets them apart from other economies.

Average gross national income (GNI) also shows a long-term upward trend, also characterised by divergence between the two groups since 1970. In 1970, the GNI of the non-dependent countries was US$16,353 million, which rose to US$503,830 million in 2018, a 2980% increase. For dependent countries, the increase between 1970 and 2018 was also strong, i.e. 3260% (US$4,662 million in 1970, compared to US $15,669 in 2019). Non-dependent countries are now 3.21 times richer than other countries, whereas in the early 1970s they were 3.5 times richer. Inequalities between these two groups have been maintained and at the same time the wealth of the top 10% has increased and social inequalities in the countries crystallised.

GDP per capita shows the same pattern, with non-dependent countries being 1.6 times richer than dependent countries in 1960. In 2019, this ratio has remained constant. Inequalities between developed and developing countries with high commodity dependence have been maintained over the long term. Dependent countries have lower per capita income than other countries. The average GDP/capita of dependent countries has increased from $3,713 in 1960 to $5,847 in 2019, an increase of 57.47%. This increase is rather 60.88% for non-dependent countries. The period 1975-1980 is exceptional because for the first time the commodity-

dependent countries have an average GDP/capita above the non-dependent countries. This was the result of the oil shocks of 1972 and 1978 and the systemic repercussions on commodity prices, but this inversion was only short-lived. From 1981 onwards, GDP/capita falls for dependent economies due to the fall in commodity prices and the divergence is re-ignited until 2019.

As regards government income as a % of GDP, it appears that the two classes studied are on the same growth line, but the income of dependent countries is twice as volatile as that of non-dependent ones. Between 1972 and 2019 the standard deviation of the commodity-dependent countries is 3.44 while it is only 1.8 for the non-dependent countries.

Fig. 13 Evolution of real GDP, GDP/capita, GNI and government income (% GDP).

Note: Series end in 2018 for the GNI and in 2019 for the other macroeconomic indicators.

V.3.2 Inequality and commodity-dependence

Let us now analyse the link between commodity dependence and inequality. The revenue variables described in the graphs above show a divergence in national income between dependent and non-dependent countries. Tax revenues are twice as volatile for dependents because of the volatility of commodity prices. In addition to these characteristics, commodity-dependent and non-dependent countries have an unprecedented level of inequality (see figure 14 below). From 1980 to 2019, the average Gini index is 3 points higher for the former group, in the range 0.57-0.6 and 0.52-0.55 for the non-dependents. Both curves seem to have a long-term convergence towards a homogeneous level of inequality. Developed countries that do not depend on commodities see their level of inequality increase and commodity-dependent developing countries show a slight discount but the level of inequality is still high. The same trend can be observed in the evolution of the share of the richest 10% and the bottom 50% in national income. As for poverty, it is clearly higher in the dependent economies, as shown in figure 15, which shows the evolution of the poverty gap and the poverty head count at the $1.90 threshold.
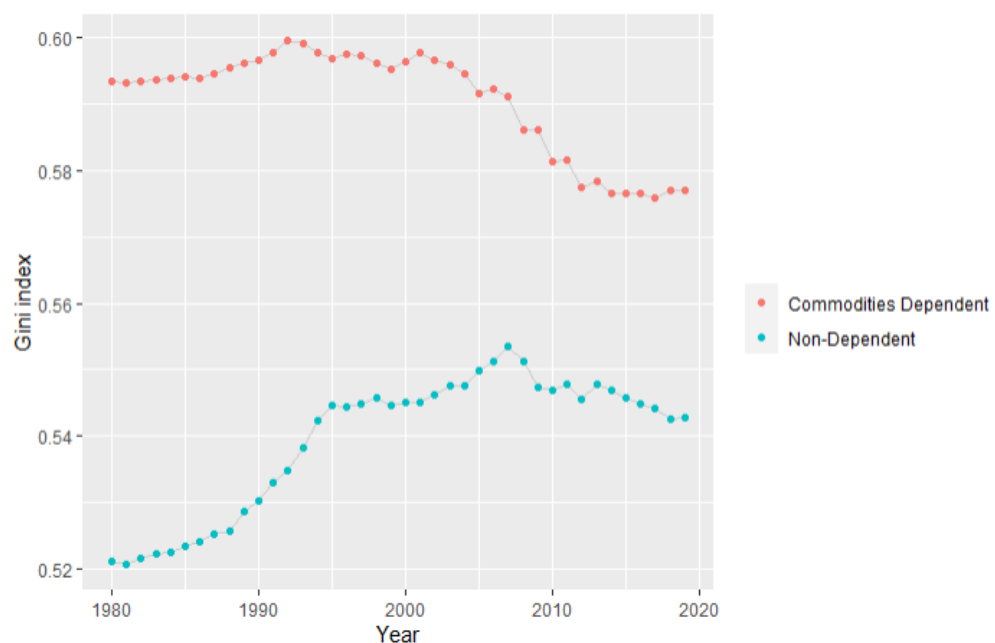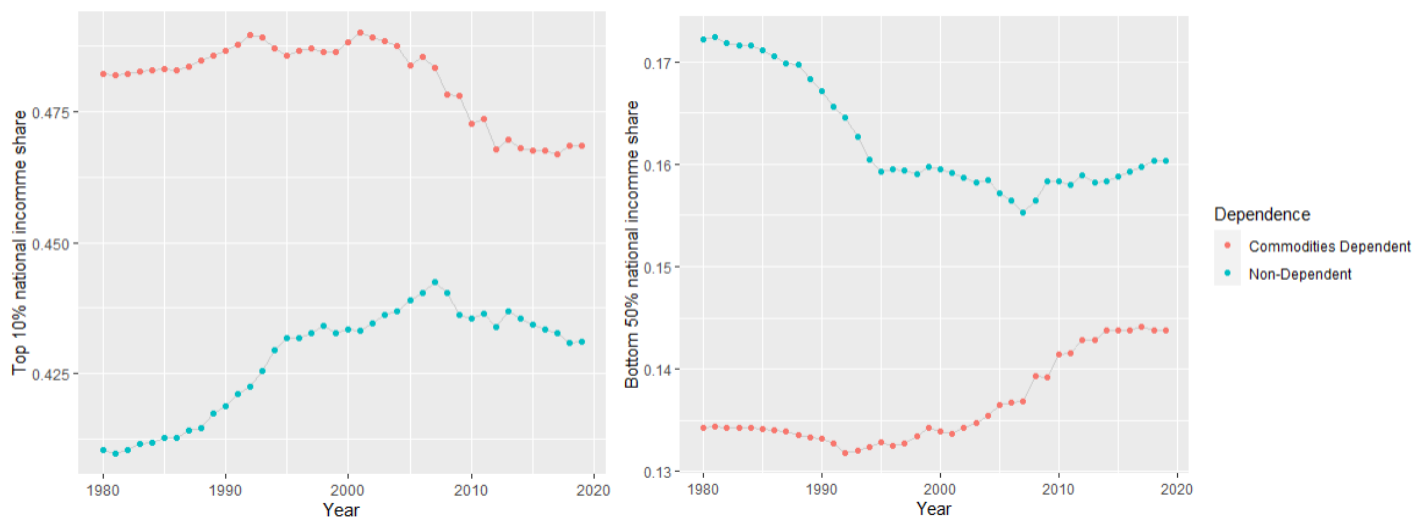
Fig. 14 Evolution of indicators for measuring inequality by group of commodity dependence.
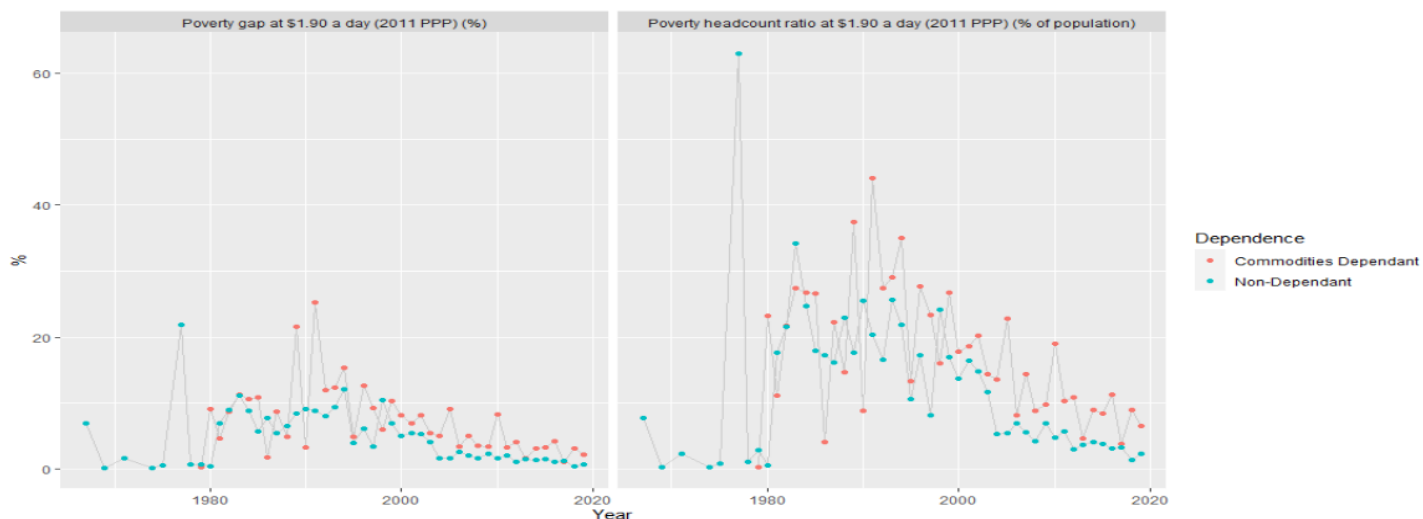
Fig. 15 Evolution of poverty indicators by group of commodity dependence.

V.4. Analysis of the correlation between national income and commodity prices

The analysis of correlations between national income and the price of commodities (oil, coffee and wheat) follows the descriptive analysis made earlier. Countries dependent on the export of these commodities are selected each time. We want to have a multidimensional representation of the relationship between the price of the commodities studied and national income in the exporting countries. As a macroeconomic indicator, we use real GDP. In this respect, the Pearson correlation coefficient is the usual statistical indicator for measuring the strength of

the linear relationship between two quantitative variables. By proceeding to a cartographic representation we add the spatial dimension. The correlation coefficient does not reflect the existence of a cause and effect relationship. For this reason, we make it clear that all the analyses provided here are only intended to provide a rational answer to the research question that was posed at the beginning of this research.

V.4.1 Correlation between crude oil price and real GDP

It appears from the map below (Figure 16) that the real GDP of oil export-dependent countries is strongly correlated (above 0.6) with the oil price (see Appendix A for detailed figures). Equatorial Guinea, a Sub-Saharan African country, has the highest correlation of 0.89. It is closely followed by two other countries, the United States and Japan. In Latin American & Caribbean, Suriname and Trinidad and Tobago with 0.87 and 0.86 show high correlations.

In sub-Saharan Africa, Gabon scores 0.61, Cameroon 0.69, Nigeria 0.79, Chad 0.80 and Angola 0.82. Latin American & Caribbean countries are better represented, including Argentina (0.8), Brazil (0.795), Cuba (0.78), Ecuador (0.76) and Peru (0.76). In the Middle East & North Africa, there is Kuwait (0.83), the United Arab Emirates (0.76), Saudi Arabia (0.75), Bahrain (0.75), Tunisia (0.75) and Algeria (0.75) to name but a few. In Europe & Central Asia the countries with the highest correlation are Albania (0.80), Kazakhstan (0.76), Estonia (0.74) and Poland (0.74). In East Asia & Pacific we find Australia (0.72), China (0.72), New Zealand (0.71), Mongolia (0.70) and Malaysia (0.70). In North America, Canada also has a correlation of 0.75, and is the only developed country in the top 20 countries with the highest correlation (see Figure 17), the rest being developing countries. South Sudan has the lowest correlation -0.13 followed by Georgia (0.09) and Libya (0.20).

The negative effects of oil price changes are disproportionate. Sub-Saharan African and East Asian countries have no weight in global crude oil production. They bear the brunt of price fluctuations that are determined by OPEC countries and conditions in the physical and futures markets. When the price rises, these countries benefit from oil export revenues, but this is short-lived because of the high volatility that has increased their vulnerability and makes economic planning difficult (Stefan et al. 2016). The income of the inhabitants is impacted by the distributional effects this generates. This is not conducive to reducing inequality in these countries.

Correlation between real GDP and average price of Brent in exporting countries

Fig. 16 Spatial representation of the correlation between real GDP and oil prices for oil exporting countries.

Correlation between real GDP and average price of Brent in exporting countries
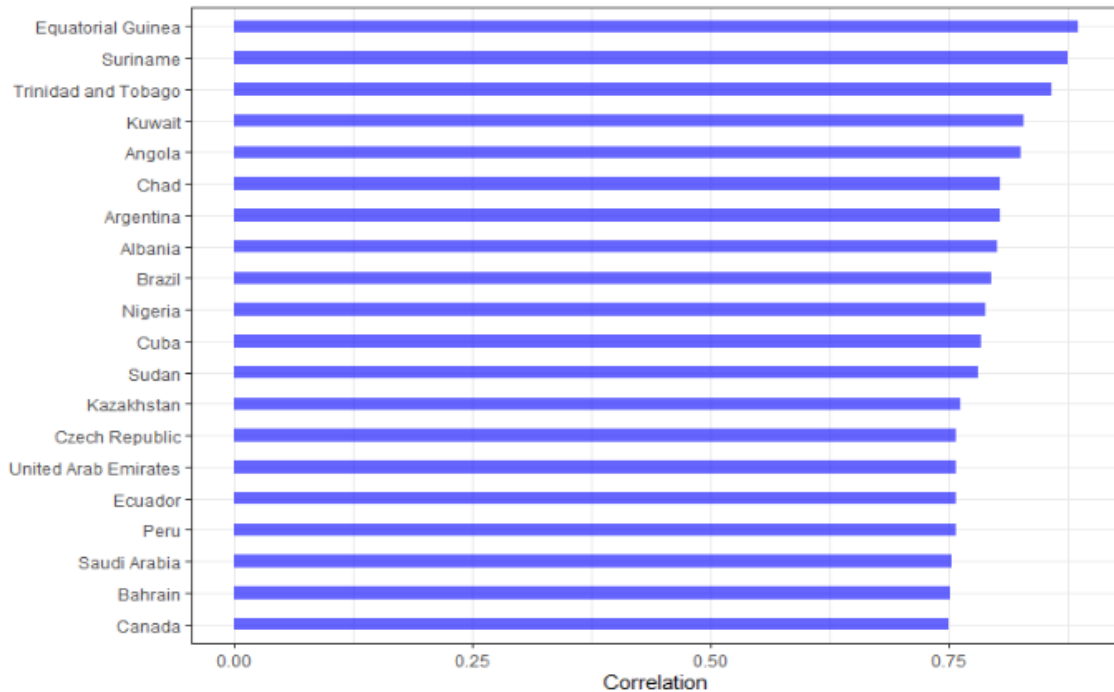
Fig. 17 Correlation between real GDP and oil prices, top 20 exporting countries.

V.4.2 Correlation between coffee price and real GDP

With regard to the correlation between coffee prices and real GDP shown on the map below, it can be seen that the link is less pronounced compared to the analysis done for oil exporting countries. All 19 countries that depend on the export of this commodity show a correlation of less than 0.45 (see map below and Appendix B for details data). Leading the way is Brazil, the largest Arabica coffee exporter with 0.43, Nicaragua (0.40), both Latin American & Caribbean countries, and Canada (0.40) (see Figure 19). Italy, Belgium and France show 0.38. These three countries are specialized in the export of roasted coffee and in the re-exports of coffee to the European Union (EU). Indonesia, the largest exporter of Robusta coffee, shows a correlation of 0.38.

 The lowest correlations are recorded in Germany (0.06), Uganda (0.18) and Ethiopia (0.20). This low level of production shows that the national income of coffee-exporting countries is not strongly influenced by the price of coffee and therefore the macroeconomic impact of the volatility of this commodity is low.
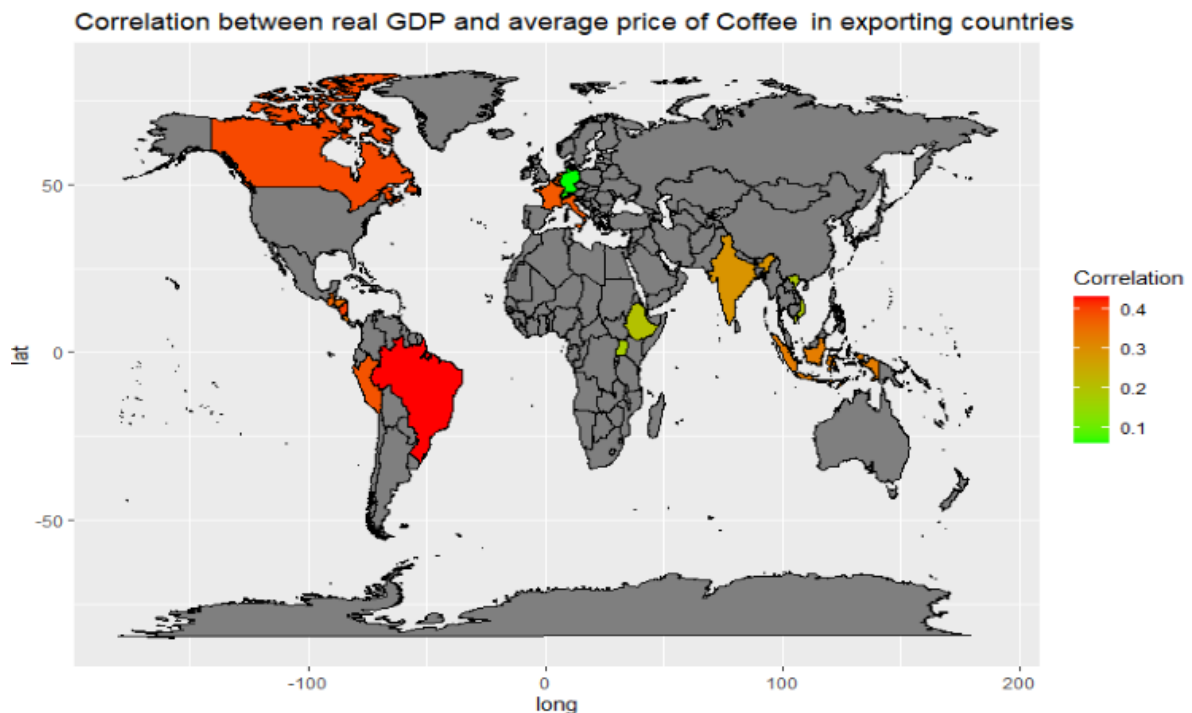
Fig. 18 Spatial representation of the correlation between real GDP and coffee prices for coffee exporting countries.
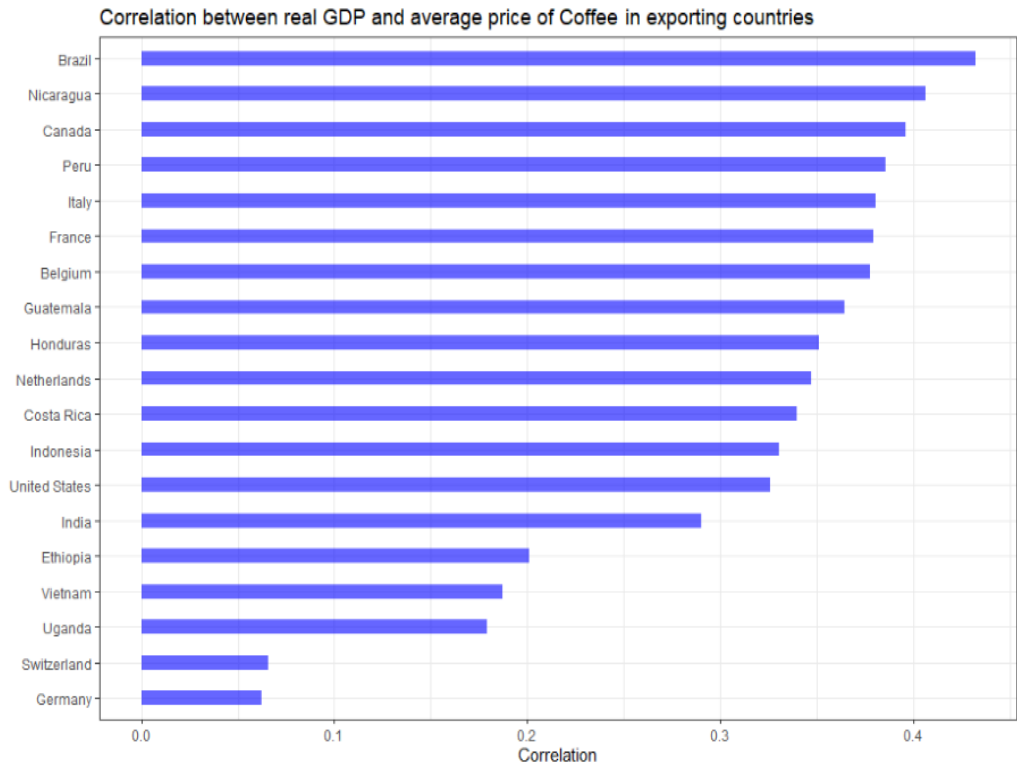
Fig. 19 Correlation between real GDP and coffee prices, top 20 exporting countries.

V.4.3 Correlation between wheat prices and real GDP

The correlation between wheat prices and real GDP reveals regional patterns (see figure 20). Most of the countries dependent on wheat exports have a real GDP that is strongly correlated (above 0.6) to the oil price (see Appendix C for detailed data). Brazil, Argentina, South Africa, Canada, Algeria and Nigeria show linear correlations above 0.70. This pattern was already observed in the mapping of the real GDP/oil price correlation where we saw that Canada, Nigeria, Argentina and Brazil are in the top 20 countries whose GDP is highly correlated with the oil price, i.e. with a value greater than or equal to 0.75. This again highlights the strong correlation between agricultural commodity prices and oil prices. If the price of oil rises, this increases the cost of transport for farmers, who can charge it to the price of the crop to offset the costs.

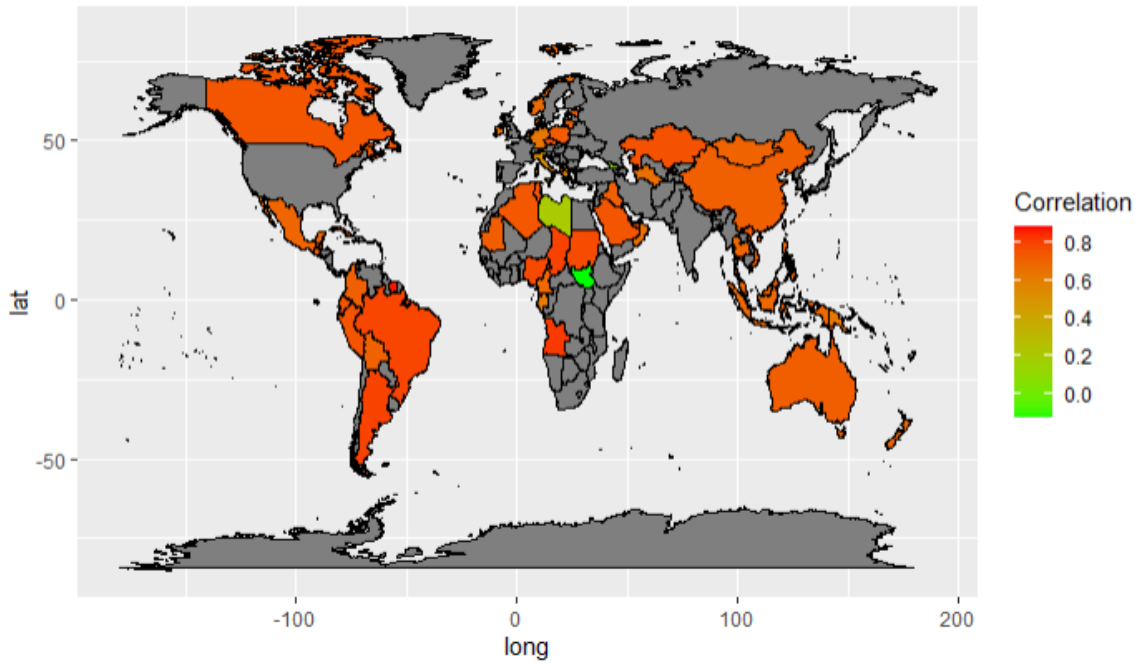Correlation between real GDP and average price of Wheat in exporting countries
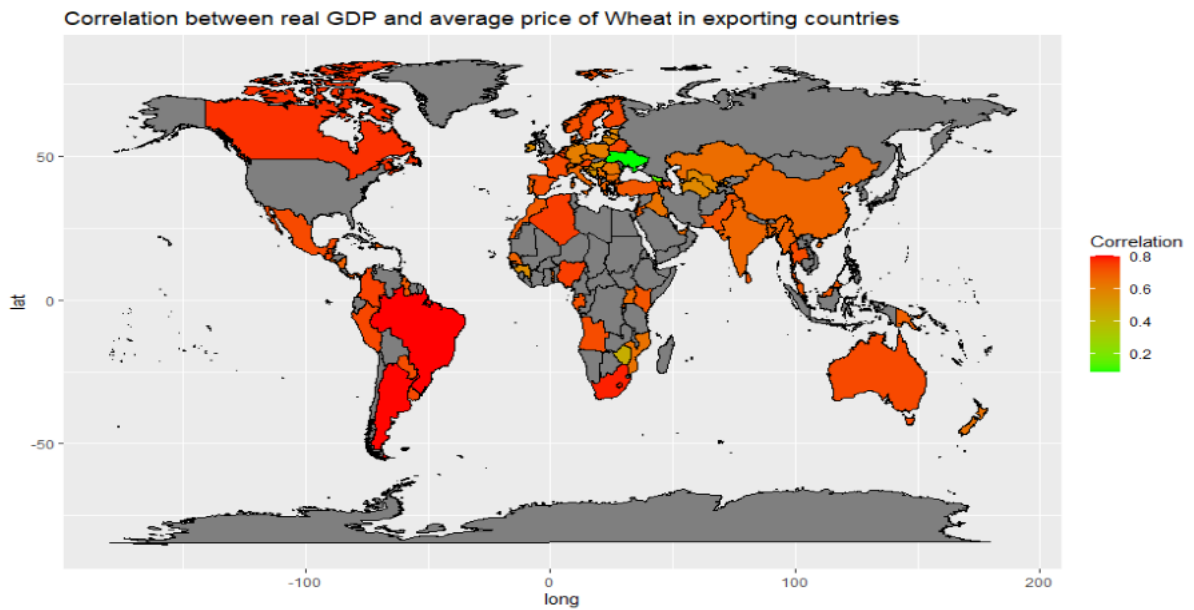
Fig. 20 Spatial representation of the correlation between real GDP and wheat prices for wheat exporting countries.

Correlation between real GDP and average price of Wheat in exporting countries (top 20)
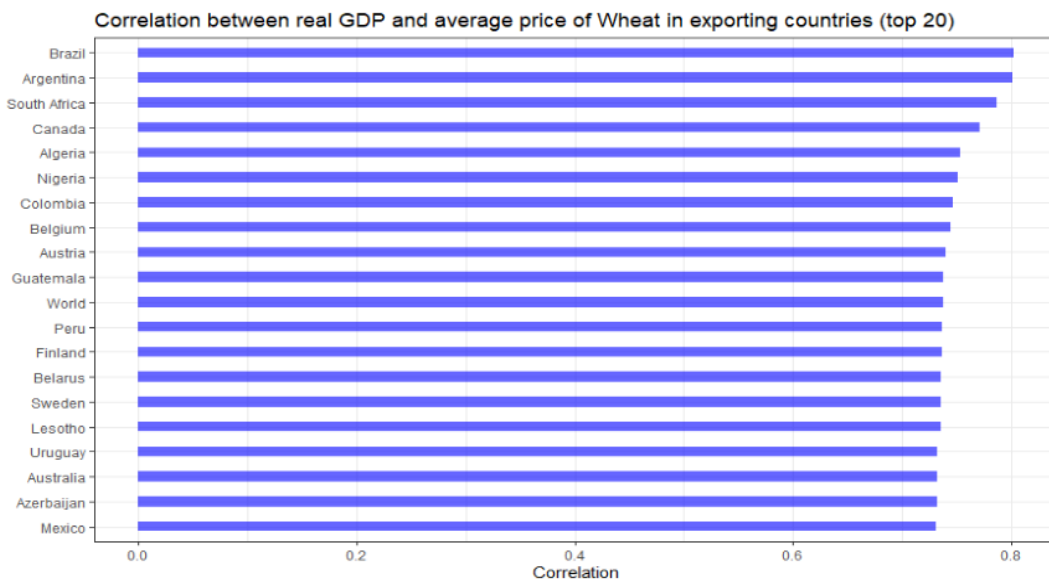
Fig. 21 Correlation between real GDP and wheat prices, top 20 exporting countries.

V.5. Analysis of the correlation between inequality and commodity prices

The analysis of correlations between the level of inequality and commodity prices (oil, coffee and wheat) is essential to understand the relationship between inequality dynamics and commodity price fluctuations. To support this analysis, we use the Gini index as a measure of inequality. By proceeding to a cartographic representation we add the spatial dimension to have a visibility on the regional patterns that are taking shape.

V.5.1 Correlation between crude oil price and the Gini index

An analysis of the map below reveals three profiles, the one of exporting countries for which the level of inequality is positively correlated with the oil price, the one for which this correlation is weak and the last one for which the said correlation is negative (see Appendix D for the detailed data). This result is consistent with Soran and David (2019).

The first group is dominated by North American countries, including Mexico (0.90) and Canada (0.65). The Middle East & North Africa (MENA) countries include the United Arab Emirates (0.86) and Saudi Arabia (0.86). In Sub-Saharan Africa we find Chad (0.80), Equatorial Guinea (0.60) and Sudan (0.56). In Europe & Central Asia we find Germany (0.79), Norway (0.72), the Netherlands (0.69), Georgia (0.62) and Lithuania (0.57). In this group of countries the oil price and inequality moved in the same direction. The upward fluctuation of the oil price has occurred at the same time as the increase in inequality in these countries. That is, when the price of oil rises, inequality increases in these countries and the opposite effect occurs when the price falls.

The second group is composed of countries with a very low correlation, such as Nigeria (-0.03), Papua New Guinea (-0.12), South Sudan (0.18). In the last group, the correlation between the oil price and the Gini index is negative and strong. For these countries, the dynamics of inequality have moved in the opposite direction to the oil price. The oil-producing countries of North Africa are Libya (-0.84), Tunisia (-0.77) and Algeria (-0.69). Almost all South American countries are present, including Peru (-0.66), Cuba (-0.63), Suriname (-0.60). In East Asia & Pacific, Thailand (-0.80) and Timor-Leste (-0.87).
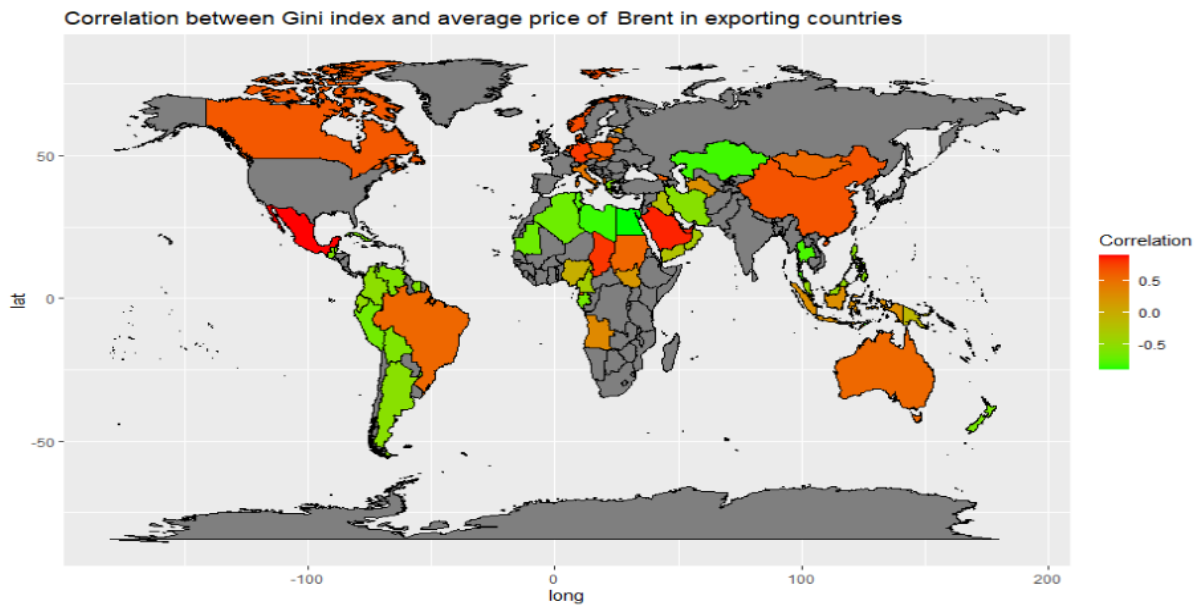
Fig. 22 Spatial representation of the Gini index and oil price correlation for oil exporting countries.
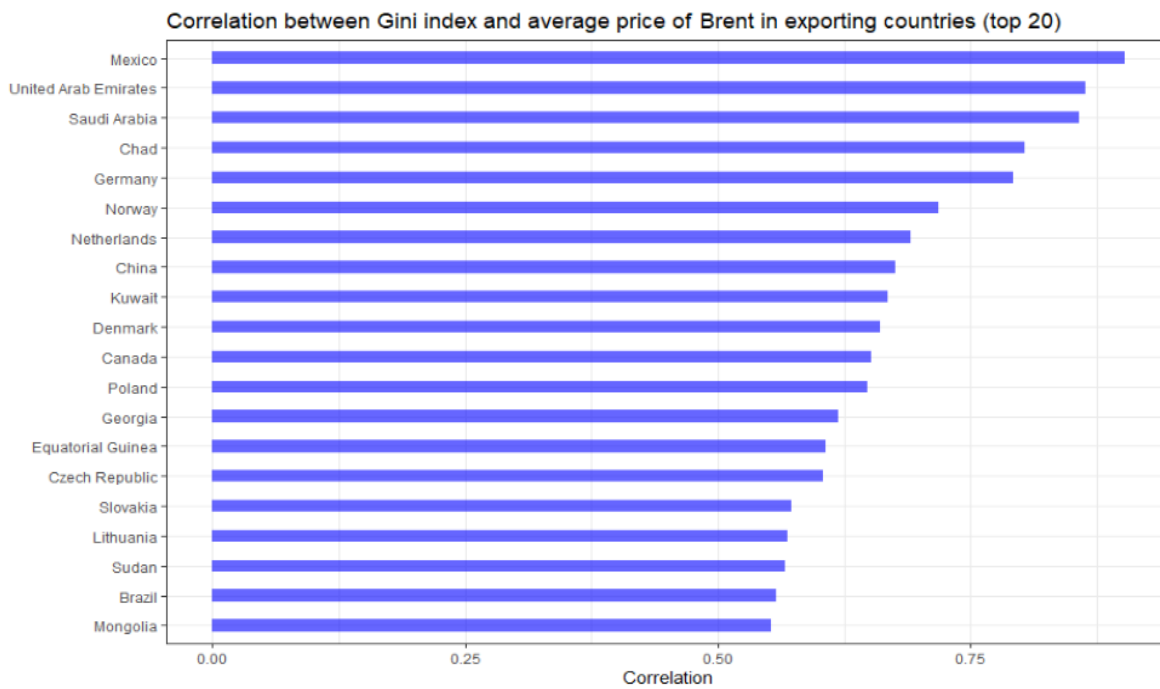
Fig. 23 Correlation between Gini index and crude oil prices, top 20 exporting countries.

V.5.2 Correlation between coffee price and Gini index

The correlation between coffee prices and the Gini index is more towards a negative relationship as illustrated in figure 24. This relationship is rather weak for the majority of exporting countries (see Appendix E for data) with the exception of Peru which shows -0.44. This finding seems to show that there is no linear relationship between the dynamics of inequality and the price of coffee on the international market. We agree with Soran and David (2019) that the impact of price volatility on income distribution depends on the nature of the commodity.
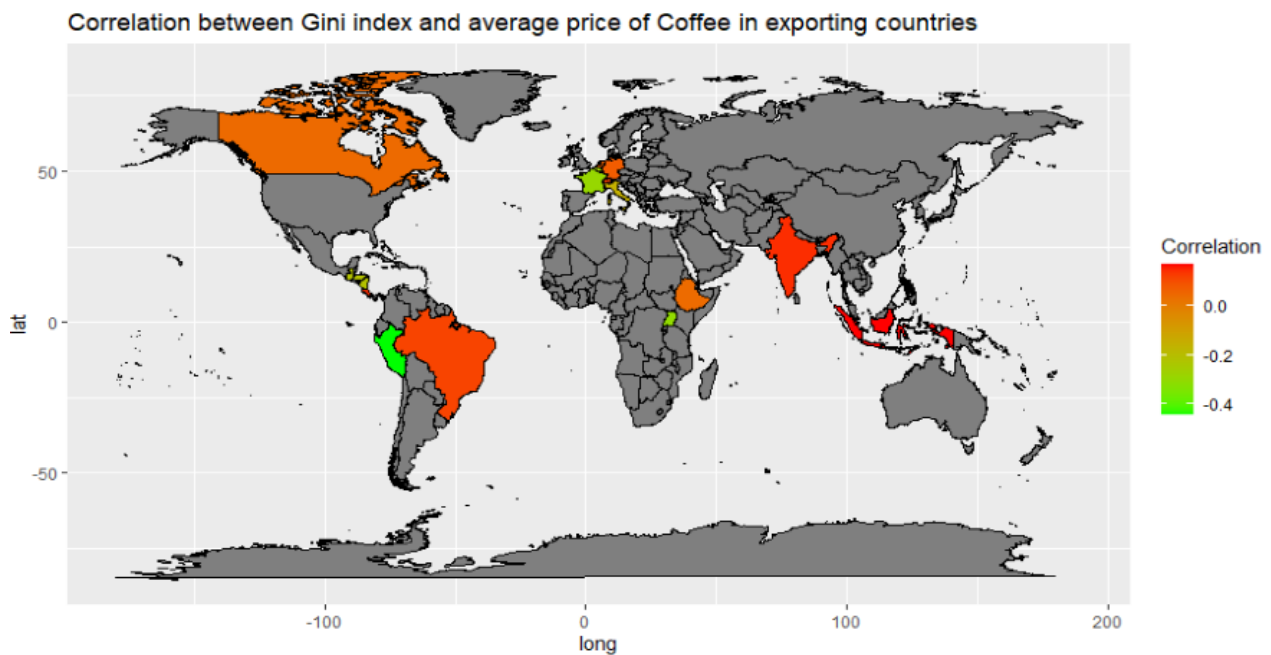
Fig. 24 Spatial representation of the correlation between the Gini index and coffee prices for coffee exporting countries.
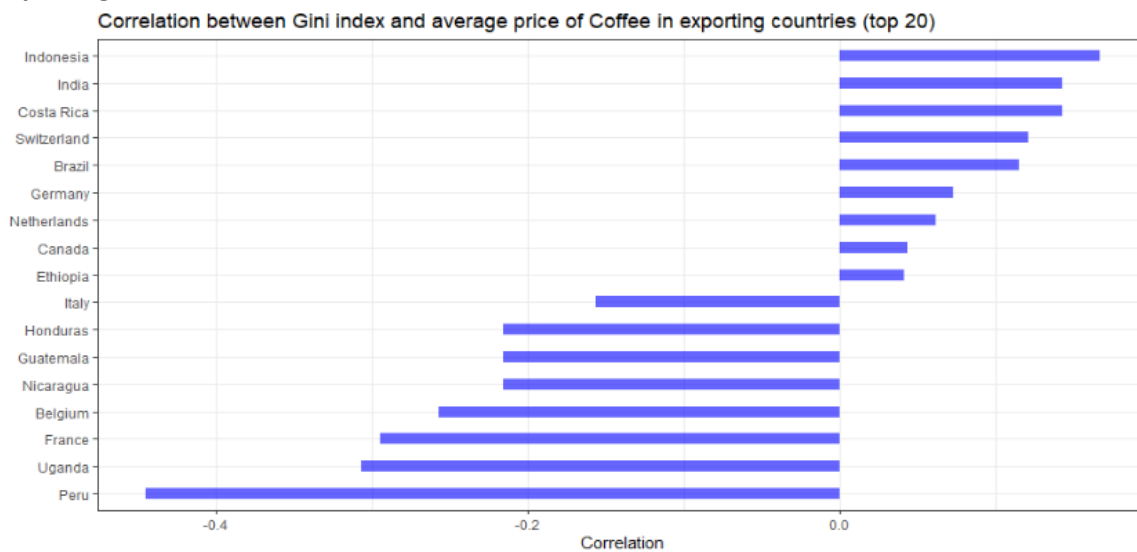
Fig. 25 Correlation between Gini index and coffee price, top 20 exporting countries.

V.5.3 Correlation between wheat price and Gini index

The analysis of the correlation between wheat prices and the Gini index provides the same information as the correlation between oil prices and the Gini index. Three groups of countries stand out, the wheat exporting countries whose inequality dynamics are positively and significantly correlated with the oil price, the countries for which this correlation is weak and the last one for which the correlation is negative and strong (see Appendix F for the detailed data).

In the first group, we find mostly North American and Middle East & North African countries, notably Mexico (0.86), Lebanon (0.81) and the United Arab Emirates (0.76). In Sub-Saharan Africa, this includes South Africa (0.67), Togo (0.60). In Europe & Central Asia it is Serbia (0.73), Germany (0.68), Romania (0.63). The second group is composed of countries with a very low correlation, such as Nigeria (0.07), Papua New Guinea (0.04), South Sudan (0.18), Uganda (-0.13). In the last group, the correlation between the oil price and the Gini index is negative and significant. For these countries, the dynamics between the level of inequality and the price of wheat were countercyclical. This means that a rise in the price of wheat led to a decrease in inequality in these countries. This includes Kazakhstan (-0.79), Guinea (-0.75), Turkey (-0.74), Thailand (-0.71), several South American countries including Peru (-0.65) and El Salvador (-0.64).
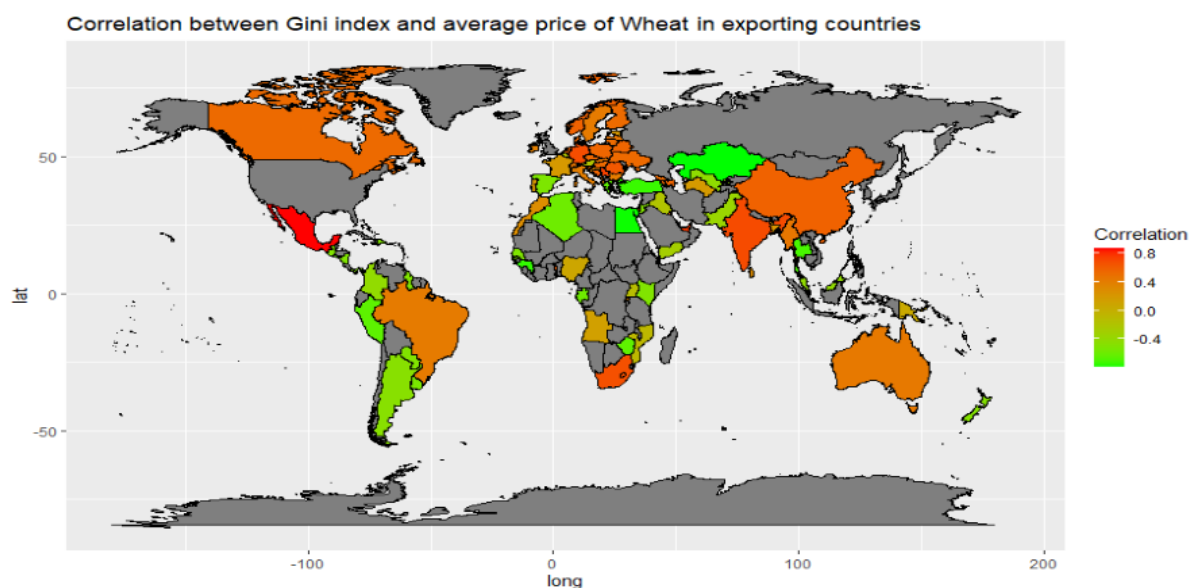
Fig. 26 Spatial representation of the correlation between the Gini index and wheat prices for wheat exporting countries.
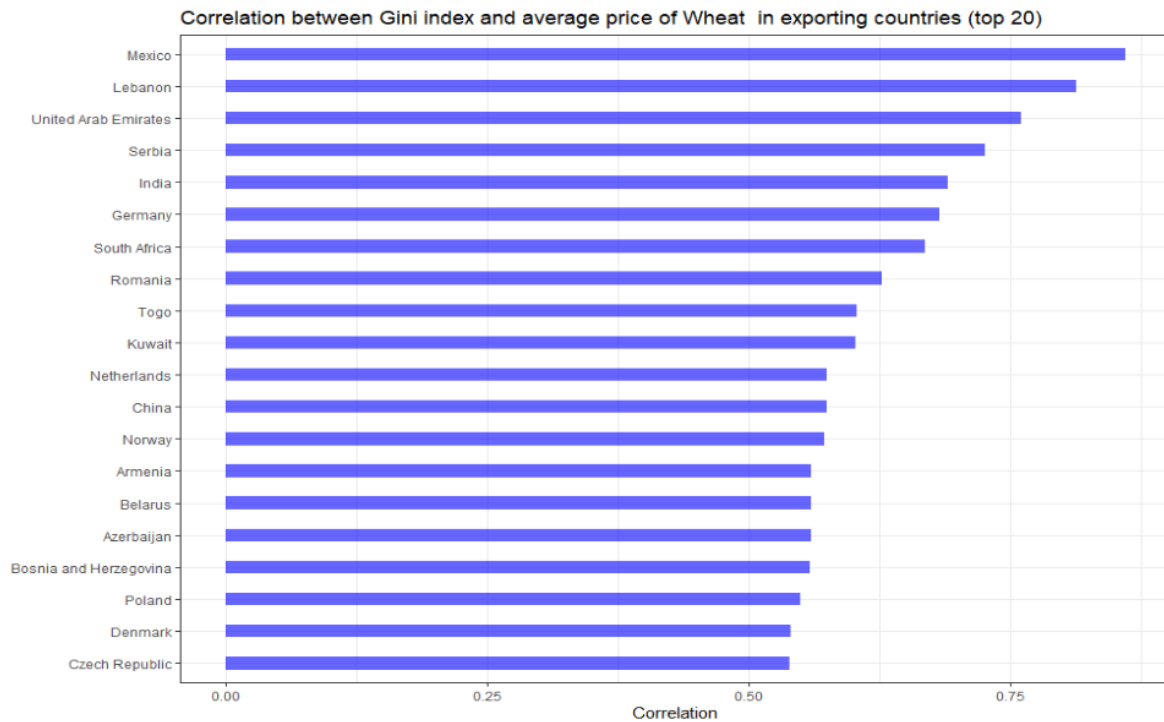
Fig. 27 Correlation between Gini index and wheat price, top 20 exporting countries.

In summary, it appears that the relationship between commodity prices and income inequality is not monotonic. It differs according to the geographical region and the macroeconomic characteristics of the exporting countries. For some countries, price fluctuations move in the opposite direction to inequality (South America, Middle East & North Africa and Europe & Central Asia), while for others this dynamic was unidirectional (North America, Central Africa, Europe & Central Asia and Australia). The impact of commodity prices on income distribution also differs according to the nature of the commodity and the degree of vulnerability of the country to macroeconomic shocks. A commodity-dependent economy increases its vulnerability to international commodity prices, the so-called "resource curse". Consequently, in countries with abundant natural resources and low institutional quality, high levels of inequality have been observed, as well as increased poverty and a greater propensity for conflict (Le Billon, 2014; Saran & David, 2019; Krieger and Meierrieks, 2016).

V.6. Specification of the econometric models

We have estimated the econometric model on unbalanced panels. For each of the three commodities, we constitute a sample of countries that depend on the export earnings of the commodity. We then estimate the linear regression models on unbalanced panels as the observation periods may differ between countries.

V.6.1 Models specification

In this subsection we will assess the effect of the commodity price shock on Gini index and government revenue. The econometric estimates are each time made on a sample of countries that depend on the export of the commodities studied. This allows us to write the following models:

$$
\begin{aligned}
GINI_{i,t} = {} & \beta_1 GINI_{i,t-1} + \beta_2 S_{i,t} + \beta_3 EXCHANGE_{i,t} + \beta_4 GROWTH_{i,t} + \beta_5 GDPCAPITA_{i,t} \\
& + \beta_6 REGION_{i,t} + \beta_7 DEVGROUP_{i,t} + \beta_8 DEPENDENCE_{i,t} + \beta_9 REGION_{i,t} * S_{i,t} \\
& + \beta_{10} DEVGROUP_{i,t} * S_{i,t} + \beta_{11} DEPENDENCE_{i,t} * S_{i,t} + \delta_i + \varphi_t \\
& + \varepsilon_{i,t} \tag{6}
\end{aligned}
$$

$$
\begin{aligned}
GOVREV_{i,t} = {} & \beta_1 GOVREV_{i,t-1} + \beta_2 S_{i,t} + \beta_3 GROWTH_{i,t} + \beta_4 GDPCAPITA_{i,t} + \beta_5 REGION_{i,t} \\
& + \beta_6 DEVGROUP_{i,t} + \beta_7 DEPENDENCE_{i,t} + \beta_8 REGION_{i,t} * S_{i,t} \\
& + \beta_9 DEVGROUP_{i,t} * S_{i,t} + \beta_{10} DEPENDENCE_{i,t} * S_{i,t} + \delta_i \\
& + \varphi_t + \varepsilon_{i,t}
\end{aligned}
$$

$$\tag{7}$$

GINI represents the Gini coefficient, GOVREV the government revenue, REGION the geographical region, $S_{i,t}$ represents the commodity price shock, DEVGROUP represents the classification by level of development (developed and developing countries), DEPENDENCE the commodity-dependence variable, EXCHANGE the exchange rate, GROWTH the economic growth rate and GDPCAPITA the GDP per capita. δi controls for time-invariant country-specific characteristics. Period-specific effects, φ_t, useful to control for common global shocks. The most important coefficient is β_2 which measures the impact of commodities shocks. $\varepsilon_{i,t}$ is the error term. In order to bring out specific results in terms of region, level of development and dependence on amenities, we added the interaction effects between the variables REGION, DEVGROUP and DEPENDENCE with the shocks S.

V.6.2 Estimation of the relation between inequality and commodity price shocks

Tables 2, 3 and 4 present the results of the estimations of equation (6), they consist of four columns. The first presents the Pooled-OLS model, the second is about the model with countries-specific fixed effects and the third presents the model with years and countries-specific effects. We have chosen to present only the estimates of the economic variables with regard to the additional variables in particular region, development group and commodity-dependence group. We summarize the information they provide on the line "additional controls". All the estimated models have an R² greater than or equal to 0.99, which means that the explanatory power of the explanatory variables is excellent.

Table 2 shows that the coefficient of the relative oil price shock is positive and strongly significant for the three models. A 0.1% shock to the relative price of oil increases the Gini coefficient by 11.29 that imply more inequality in the world. On the other hand, the coefficient of the lagged Gini index (Gini lag 1) is significant at the 1% level but is almost equal to 1, which means that the Gini coefficient does not vary substantially from one year to another translating a stationarity into a first difference. The coefficients for economic growth is significant at 10% in column (1) but the one of exchange rate is also significant for column (2). However, when we add the effect of time (column 3), they are no longer significant. The Fisher and Haussmann tests led us in each case to reject the model with time fixed effect, random effects and the Pooled-OLS in favour of the model with individual fixed effects. It should also be noted that the coefficient on GDP per capita is not significant for all four models estimated in Table 2. We also notice that the coefficients of growth, exchange rate and GDP per capita very low. For instance, if growth increases by one point, the Gini coefficient increases by 5.383e-05 with the fixed-effects-model in column (2). And if in an oil exporting country the currency appreciates by one unit, the Gini coefficient will only decrease by -6.157e-07 in the long run according to column (2) of Table 2. We also find that the interaction between shock and being a developing country has a coefficient of -92.66 significant at 5%. This indicates that the shock is more intense in developing countries than in developed countries. All additional controls are strongly significant it is the same for the country-specific effects this means there are other factors specific to countries, region and the level of development which can impact the level of inequality.

Tables 3 and 4 show a negative but insignificant relationship between the coffee and wheat price shocks and the Gini index. The one-year lag in the Gini coefficient is always highly

significant. GDP per capita is found to be the only significant control but it coefficient is weak, i.e. of the order of 10^{-7} to impact on the level of inequality in coffee and wheat exporting countries (see Table 3 and 4). The majority of control variables, especially the region, are significant at 1% implying the existence of region-specific effects. The effects of interactions between control variables and shocks are not significant with the exception of the Latin America & Caribbean region for wheat exporting countries.

In light of these results, we deduce that commodity price shocks increase inequality in exporting countries. However, this relationship differs by commodity type and exporting country. Country-specific effects were found to be significant, suggesting that other location-specific factors impact on the level of inequality, including weak institutions (Soran and David, 2019), market power (Stiglitz, 2010), differences in initial conditions and education (Piketty, 2014).

Table. 2

Main results Gini coefficient
and petroleum price shocks

	(1)	(2)	(3)
(Intercept)	1.358e-02*** (6.533)	-	-
Gini lag 1	9.747e-01*** (266.419)	9.005e-01 *** (117.67)	8.98e-01*** (115.887)
Petroleum price shocks	1.057e+02** (2.513)	1.129e+02 *** (2.675)	1.193e+02*** (2.788)
GROWTH	6.950e-05* (1.834)	5.383e-05 (1.38)	2.459e-05 (0.613)
Exchange rate	-1.520e-07 (-0.983)	-6.157e-07* (-1.785)	-4.584e-07 (-1.296)
GDP per capita	-2.038e-08 (-1.596)	-7.139e-08 (-1.301)	3.567e-08 (0.544)
Shock*Non-Dependent	8.064e-05 (0.188)	2.031e+00 (0.069	1.065e+01 (0.356)
Shock*Developing	-9.261e+01**	-9.266e+01**	-9.708e+01***

	(-2.524)	(-2.518)	(-2.518)
Shock*Region	Not significant for each region	Not significant for each region	Not significant for each region
Additional Controls	No	Yes***	Yes***
Year FE	No	No	Yes
Country FE	No	Yes***	Yes***
R^2	0.9877	0.9997	0.9997
Observations	3008	3009	3009
No. Of Countries	135	135	135
No. Of Years	-	1-30	1-30

Notes: Dependent variable: the Gini coefficient. Additional Controls include: Region, Development group, commodity-dependence group. The time span goes from 1991 to 2019. All estimations are done with multiple-estimation regressions. The t statistics are in parentheses. ***P<0.01, **P<0.05, *P<0.1.

Table. 3

Main results Gini coefficient and coffee price shocks

	(1)	(2)	(3)
(Intercept)	1.225e-02 *** (6.055)	-	-
Gini lag 1	9.762e-01 *** (274.636)	8.878e-01 *** (120.569)	8.841e-01 *** (118.605)
Coffee price shocks	-1.197e+00 (-0.064)	-2.113e+00 (-0.116)	-1.943e+00 (-0.107)
GROWTH	7.133e-05 ** (2.027)	6.212e-05* (1.734)	2.971e-05 (0.808)
Exchange rate	-1.520e-07 (-0.983)	-4.792e-07 (-1.207)	-2.135e-07 (-0.525)
GDP per capita	-4.623e-08 (-0.294)	-1.433e-07** (-2.369)	-2.769e-08 (-0.394)
Shock*Non-Dependent	2.557e-01 (0.735)	1.788e-01 (0.531)	1.668e-01 (0. 495)
Shock*Developing	8.656e-01 (0.047)	1.943e+00 (0.107)	1.798e+00 (0.099)
Shock*Region	Not significant for each region	Not significant for each region	Not significant for each region
Additional Controls	No	Yes***	Yes***

Year FE	No	No	Yes
Country FE	No	Yes***	Yes***
R²	0.9872	0.9997	0.9997
Observations	3159	3150	3150
No. Of Countries	135	135	135
No. Of Years	-	8-25	8-25

Notes: Dependent variable: the Gini coefficient. Additional Controls include: Region, Development group, commodity-dependence group. The time span goes from 1991 to 2019. All estimations are done with multiple-estimation regressions. The t statistics are in parentheses. ***$P<0.01$, **$P<0.05$, *$P<0.1$.

Table. 4

Main results Gini coefficient and wheat price shocks

	(1)	(2)	(3)
(Intercept)	1.291e-02***	-	-
	(5.372)		
Gini lag 1	9.762e-01 ***	8.878e-01 ***	8.677e-01 ***
	(231.945)	(90.092)	(88.915)
Wheat price shocks	-5.884e+00	-5.305e+00	-6.149e+00
	(-1.532)	(-1.416)	(-1.639)
GROWTH	6.099e-05	5.514e-05	2.306e-05
	(1.500)	(1.334)	(0.543)
Exchange rate	-3.141e-08	-4.004e-07	-1.989e-07
	(-0.168)	(-0.743)	(-0.363)
GDP per capita	-1.726e-08	-1.101e-07*	-2.532e-08
	(-1.203)	(-1.688)	(-0.325)
Shock*Non-Dependent	2.893e-01	-2.535e-01	6.991e-02
	(0.173)	(-0.155)	(0.043)
Shock*Developing	-3.225e+00	-3.333e+00	-3.184e+00
	(-1.232)	(-1.308)	(-1.251)
Shock*Region	Only significant at 10% for Latin America & Caribbean	Only significant at 10% for Latin America & Caribbean	Only significant at 10% for Latin America & Caribbean
Additional Controls	No	Yes***	Yes***
Year FE	No	No	Yes
Country FE	No	Yes***	Yes***

R²	0.9872	0.9997	0.9997
Observations	2368	2369	2369
No. Of Countries	135	135	135
No. Of Years	-	8-25	8-25

Notes: Dependent variable: the Gini coefficient. Additional Controls include: Region, Development group, commodity-dependence group. The time span goes from 1991 to 2019. All estimations are done with multiple-estimation regressions. The t statistics are in parentheses. ***P<0.01, **P<0.05, *P<0.1.

V.6.3 Estimations of the relation between government income and commodity price shocks

Government income is one of the channels by which commodity price shocks alter the distribution of income in exporting countries. Tables 5, 6 and 7 present our results of equation (7) considering crude oil, coffee and wheat price shocks respectively. All the estimated models have an R² greater than or equal to 0.99, which means that the explanatory power of the explanatory variables is excellent. In each table, column (1) represents the Pooled-OLS estimate, column (2) the individual fixed effect model and column (3) the individual and time fixed effect model. The Fisher and Haussmann tests lead us to prefer the country-fixed-effects model (column (2)) to the other two at the 1% significance level.

Table 5 shows that the oil price shock has a positive and insignificant coefficient (columns (1), (2) and (3)). A positive real price shock of 1% increases the average government revenue of oil exporting countries by $1.796e+12 according to column (2). Economic growth has a positive and significant impact on the Pooled-OLS and the individual fixed effects model. An increase in growth of 1% will increase the average government revenue of oil exporting countries by $6.195e+08 according to column (2). The lagged government income is also significant at 1% and with a coefficient of approximately 1 suggesting that government income last amount is relevant to predict the next amount. In none of the estimated models is GDP per capita significant. The interaction between the shock on the price of oil and the fact of being a country non-dependent of the oil in its exports has a significant coefficient at 10% and equal to -6.131e+12. This coefficient explains the gaps of the shock between non-dependent-countries and dependent-countries on government revenue, that mean non-dependent-countries are less expose to crude oil shocks.

Table 6 also shows that the coefficients on lagged government income and economic growth are significant at 1%. However, the shock to the relative price of coffee has a positive impact on government revenue of $1.282e+11 according to column (2). The economic growth is the only significant (at 1%) economic variable. A change in the growth rate of 1 percentage point will increase the average government revenue of coffee exporting countries by $5.501e+08 (see column (2)). The interaction between the shock and the fact of being a country non-dependent-country of coffee exports has a significant coefficient at 10% and equal to -6.131e+12. This coefficient explains the gaps of the shock between non-dependent-countries and dependent-countries on government revenue, that mean non-dependent-countries are less expose to crude oil shocks.

Table 7 shows that the relative wheat price shock has a positive and insignificant effect of around $1.796e+12 according to the estimates of the individual fixed effect model (column 2). Also in column (2), economic growth and lagged government revenue have significant coefficients at the 1% level. A change in the growth rate of 1% will increase the average government revenue of coffee exporting countries by $6.195e+08 in average. Country-fixed-effects are strongly significant, the same results are found for additional controls. As found with crude oil and coffee, the interaction between the wheat-price-shock and the fact of being a non-dependent-country of coffee exports has a significant coefficient at 10% and equal to -6.131e+12. This coefficient explains the gaps of the shock between non-dependent-countries and dependent-countries on government revenue, that mean non-dependent-countries are less expose to crude oil shocks.

In sum, the results show that commodity price shocks have a positive but not significant impact government revenue in exporting countries. However, the shock becomes significant when studying interaction with non-dependent-countries, we found a negative coefficient. Country-specific-effects were found to be significant for oil, coffee and wheat, suggesting that others location-specific-factors impact on government revenue, including the quality of institutions (Soran and David, 2019), fiscal policy, the size of the tax base and the structure of the economy.

Table. 5

*Main results government
revenue and petroleum
price shocks*

	(1)	(2)	(3)
(Intercept)	1.889e+09	-	-
	(0.818)		
Gov lag 1	1.029e+00***	9.815e-01***	9.793e-01***
	(512.295)	(114.002)	(110.482)
Petroleum price shocks	2.651e+12	1.796e+12	2.190e+11
	(0.403)	(0.293)	(0.036)
GROWTH	2.651e+12***	6.195e+08***	3.610e+08
	(7.162)	(4.648)	(2.450)
GDP per capita	-2.038e-08	1.625e+05	7.846e+04
	(-1.220)	(1.334)	(0.512)
Shock*Non-Dependent	-5.640e+12*	-6.131e+12*	-5.155e+12*
	(-1.914)	(-2.225)	(-1.859)
Shock*Developing	-3.008e+12	-4.238e+12	-1.223e+12
	(-0.35)	(-0.531)	(-0.153)
Shock*Region	Not significant for each region	Not significant for each region	Not significant for each region
Additional Controls	Yes***	Yes*	Yes
Year FE	No	No	Yes
Country FE	No	Yes	Yes
R^2	0.9988	0.9992	0.962
Observations	2416	1750	1750
No. Of Countries	103	103	103
No. Of Years	1-25	1-25	1-25

Notes: Dependent variable: the Gini coefficient. Additional Controls include: Region, Development group, commodity-dependence group. The time span goes from 1991 to 2019. All estimations are done with multiple-estimation regressions. The t statistics are in parentheses. ***$P<0.01$, **$P<0.05$, *$P<0.1$.

Table. 6

*Main results government
revenue and coffee price
shocks*

	(1)	(2)	(3)
(Intercept)	3.852e+08	-	-
	(0.202)		
Gov lag 1	1.029e+00***	9.811e-01***	9.795e-01***

	(564.883)	(125.874)	(123.121)
Coffee price shocks	2.370e+12	1.282e+11	-4.099e+11
	(0.074)	(0.004)	(-0.014)
GROWTH	7.769e+08***	5.501e+08***	3.288e+08
	(7.632)	(5.304)	(2. 875)
GDP per capita	-2.598e+04	1.559e+05	6.766e+04
	(-1.088)	(1.439)	(0.513)
Shock*Non-Dependent	2.340e+11	-6.131e+12*	2.207e+11
	(0.302)	(-2.225)	(0.306)
Shock*Developing	-2.191e+12	-4.238e+12	-1.416e+12
	(-0.068)	(-0.531)	(-0.048)
Shock*Region	Not significant for each region	Not significant for each region	Not significant for each region
Additional Controls	Yes***	Yes**	Yes
Year FE	No	No	Yes
Country FE	No	Yes	Yes**
R^2	0.9945	0.9992	0.962
Observations	2117	1750	2118
No. Of Countries	94	94	94
No. Of Years	-	1-25	1-25

Notes: Dependent variable: the Gini coefficient. Additional Controls include: Region, Development group, commodity-dependence group. The time span goes from 1991 to 2019. All estimations are done with multiple-estimation regressions. The t statistics are in parentheses. ***$P<0.01$, **$P<0.05$, *$P<0.1$.

Table. 7

Main results
government revenue
and wheat price shocks

	(1)	(2)	(3)
(Intercept)	1.889e+09	-	-
	(0.818)		
Gov lag 1	1.029e+00***	9.815e-01***	9.793e-01***
	(512.295)	(1114.002)	(110.482)
Wheat price shocks	2.651e+12	1.796e+12	2.190e+11
	(0.403)	(0.293)	(0.036)
GROWTH	9.254e+08***	6.195e+08***	3.610e+08**
	(7.162)	(4.648)	(2. 450)

GDP per capita	-3.281e+04	1.625e+05	7.846e+04
	(-1.220)	(1.334)	(0.512)
Shock*Non-Dependent	-5.640e+12*	-6.131e+12**	2.207e+11
	(-1.914)	(-2.225)	(0.306)
Shock*Developing	6.380e+08	-4.238e+12	-1.416e+12
	(0.583)	(-0.531)	(-0.048)
Shock*Region	Not significant for each region	Not significant for each region	Not significant for each region
Additional Controls	Yes	Yes**	Yes**
Year FE	No	No	Yes
Country FE	No	Yes***	Yes***
R^2	0.9981	0.9964	0.9987
Observations	1752	1750	1753
No. Of Countries	75	75	75
No. Of Years	1-25	1-25	1-25

Notes: Dependent variable: the Gini coefficient. Additional Controls include: Region, Development group, commodity-dependence group. The time span goes from 1991 to 2019. All estimations are done with multiple-estimation regressions. The t statistics are in parentheses. ***$P<0.01$, **$P<0.05$, *$P<0.1$.

Conclusion and recommendations

The objective of this research was to show how commodity price shocks affect income distribution in oil, coffee and wheat exporting countries. We first analysed the evolution of commodity prices and inequality over long periods (1960-2019, 1970-2019) to see if a link could be established between price instability and inequality dynamics. Subsequently, we estimated regression models on an unbalanced panel of 159 countries over the period 1991-2019. The processing of the databases was the main difficulty of this project. It was necessary to find the join key between the UNCTAD, SWIID, FAO and WBG databases. Indeed, using the name of the country and the year as join keys, we found that the names of the countries were not written in the same way. This could lead to loss of information in the estimates.

Our results show that after 1973, the price of oil became more volatile than that of coffee and wheat, but the peaks of the three series coincide, indicating a strong correlation of the relative prices of these commodities. This result is instructive in that it shows that shocks have systemic repercussions on commodity markets because they are accelerated by financial globalisation, which is itself a product of globalisation.

The dynamics of inequality show that the developing regions most dependent on commodities for their exports are also those where inequality is very high and where the wealthiest 10% have the lion's share of national income, often between 51 and 69%. The developed regions of Europe and Australia are the most egalitarian.

The world's economies have become richer over the years. However, countries that do not depend on commodities have seen their wealth grow faster than others. There is also a divergence in income levels between these two categories.

The relationship between commodity prices and income inequality is not monotonic. It differs according to the geographical region and the macroeconomic characteristics of the exporting countries. For some countries, price fluctuations move in the opposite direction to inequality (South America, Middle East & North Africa and Europe & Central Asia), while for others this dynamic was unidirectional (North America, Central Africa, Europe & Central Asia and Australia). The impact of commodities on income distribution differs according to the nature of the commodity and the degree of vulnerability of the country to macroeconomic shocks.

It is inferred from the econometric model estimates that commodity price shocks increase inequality in exporting countries. However, this relationship differs by commodity type and exporting country. The coefficient of the relative oil price shock is positive and strongly significant for the Gini model while it is negative and non-significant for coffee and wheat. We also find that the interaction between shock and being a developing country has a coefficient of -92.66 significant at 5%. This indicates that the shock is more intense in developing countries than in developed countries. Country-specific effects were found to be significant, suggesting that other location-specific factors impact on the level of inequality, including weak institutions (Soran and David, 2019), market power (Stiglitz, 2010), differences in initial conditions and education (Piketty, 2014). In addition, the results show that commodity price shocks have a positive but not significant impact on government revenue in exporting countries. However, the shock becomes significant when studying interaction with non-dependent-countries, we found a negative coefficient. Country-specific-effects were found to be significant for oil, coffee and wheat, suggesting that others location-specific-factors impact on government revenue, including the quality of institutions (Soran and David, 2019), fiscal policy, the size of the tax base and the structure of the economy.

By way of recommendations according to our results, we advise governments to:

Diversify their industrial base. To reduce the exposure of developing countries to commodity export revenues, it is increasingly urgent for them to diversify their economies. Sub-Saharan African countries need to invest in processing industries, renewable energy, research and development (R&D) to increase the vertical diversification of their economies and capture revenues from processed products and advanced technologies that are priced much higher than commodities. This will have the effect of reducing their trade deficit. Diversification also reduces countries' vulnerability to commodity price volatility.

Reduce commodity subsidies to invest these revenues in growth-enhancing projects that will improve social welfare, create new jobs to absorb poverty and reduce unemployment.

Invest in education and support for small and medium-sized enterprises (SMEs). Young people and entrepreneurs are the engine of innovation that drives economic diversity. Governments in developing countries must put an emphasis on developing high quality human capital of international standards. Indeed to quote Thomas Piketty (2014) in Capital in the 21st Century:

"*The process of diffusion of knowledge and skills is the central mechanism that enables both overall productivity growth and the reduction of inequality, both within countries and internationally, as illustrated by the current catching up of emerging countries, starting with China*".

We do not have microeconomic data on surveys of producers and households in commodity-dependent countries over a long period to have a precise evaluation of how a shock on commodity prices affects income distribution. This is the main limit of this paper.

Acknowledgements

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Appendix

Appendix A: Ranking of oil export-dependent countries according to the correlation between real GDP and oil price

Country	Correlation	Code	Region	Income.group	Group
Equatorial Guinea	0,886975396	GNQ	Sub-Saharan Africa	Upper middle income	Developing
Suriname	0,87560003	SUR	Latin America & Caribbean	Upper middle income	Developing
Trinidad and Tobago	0,858105151	TTO	Latin America & Caribbean	High income	Developing
Kuwait	0,829208413	KWT	Middle East & North Africa	High income	Developing
Angola	0,826117381	AGO	Sub-Saharan Africa	Lower middle income	Developing
Chad	0,805127965	TCD	Sub-Saharan Africa	Low income	Developing
Argentina	0,803718935	ARG	Latin America & Caribbean	Upper middle income	Developing
Albania	0,80156287	ALB	Europe & Central Asia	Upper middle income	Developed
Brazil	0,795238192	BRA	Latin America & Caribbean	Upper middle income	Developing
Nigeria	0,789090603	NGA	Sub-Saharan Africa	Lower middle income	Developing
Cuba	0,783988917	CUB	Latin America & Caribbean	Upper middle income	Developing
Sudan	0,781752338	SDN	Sub-Saharan Africa	Low income	Developing
Kazakhstan	0,762510212	KAZ	Europe & Central Asia	Upper middle income	Developing
United Arab Emirates	0,758490066	ARE	Middle East & North Africa	High income	Developing
Ecuador	0,757738334	ECU	Latin America & Caribbean	Upper middle income	Developing
Peru	0,757542681	PER	Latin America & Caribbean	Upper middle income	Developing
Saudi Arabia	0,753132234	SAU	Middle East & North Africa	High income	Developing
Bahrain	0,752633348	BHR	Middle East & North Africa	High income	Developing
Canada	0,750968247	CAN	North America	High income	Developed
Tunisia	0,750741664	TUN	Middle East & North Africa	Lower middle income	Developing
Algeria	0,74820272	DZA	Middle East & North Africa	Lower middle income	Developing
Estonia	0,742883251	EST	Europe & Central Asia	High income	Developed
Poland	0,736433506	POL	Europe & Central Asia	High income	Developed
Guatemala	0,729668539	GTM	Latin America & Caribbean	Upper middle income	Developing
Mauritania	0,728787797	MRT	Sub-Saharan Africa	Lower middle income	Developing
Australia	0,724126526	AUS	East Asia & Pacific	High income	Developed
Lithuania	0,723889571	LTU	Europe & Central Asia	High income	Developed
Belize	0,723157995	BLZ	Latin America & Caribbean	Upper middle income	Developing
Colombia	0,719488657	COL	Latin America & Caribbean	Upper middle income	Developing
Iraq	0,718773303	IRQ	Middle East & North Africa	Upper middle income	Developing
China	0,718252483	CHN	East Asia & Pacific	Upper middle income	Developing
New Zealand	0,709794049	NZL	East Asia & Pacific	High income	Developed
Mongolia	0,703926011	MNG	East Asia & Pacific	Lower middle income	Developing
Malaysia	0,703280334	MYS	East Asia & Pacific	Upper middle income	Developing
Mexico	0,700437729	MEX	Latin America & Caribbean	Upper middle income	Developing

Country	Correlation	Code	Region	Income.group	Group
Thailand	0,699156115	THA	East Asia & Pacific	Upper middle income	Developing
Indonesia	0,689130682	IDN	East Asia & Pacific	Upper middle income	Developing
Barbados	0,688596047	BRB	Latin America & Caribbean	High income	Developing
Cameroon	0,687931302	CMR	Sub-Saharan Africa	Lower middle income	Developing
Philippines	0,68632182	PHL	East Asia & Pacific	Lower middle income	Developing
United Kingdom	0,679890557	GBR	Europe & Central Asia	High income	Developed
Netherlands	0,678465473	NLD	Europe & Central Asia	High income	Developed
Norway	0,673490494	NOR	Europe & Central Asia	High income	Developed
Oman	0,664543961	OMN	Middle East & North Africa	High income	Developing
Turkmenistan	0,663450882	TKM	Europe & Central Asia	Upper middle income	Developing
Germany	0,634833456	DEU	Europe & Central Asia	High income	Developed
Denmark	0,63471009	DNK	Europe & Central Asia	High income	Developed
Ireland	0,631464529	IRL	Europe & Central Asia	High income	Developed
Papua New Guinea	0,630932652	PNG	East Asia & Pacific	Lower middle income	Developing
Gabon	0,609957115	GAB	Sub-Saharan Africa	Upper middle income	Developing
Greece	0,5716078	GRC	Europe & Central Asia	High income	Developed
Qatar	0,54964891	QAT	Middle East & North Africa	High income	Developing
Italy	0,518860069	ITA	Europe & Central Asia	High income	Developed
Timor-Leste	0,440192997	TLS	East Asia & Pacific	Lower middle income	Developing
Libya	0,19970855	LBY	Middle East & North Africa	Upper middle income	Developing
Georgia	0,091121777	GEO	Europe & Central Asia	Upper middle income	Developing
South Sudan	-0,127460695	SSD	Sub-Saharan Africa	Low income	Developing

Source: Our calculations.

Appendix B: Ranking of coffee export-dependent countries according to the correlation between real GDP and coffee prices

Country	Correlation	Code	Region	Income.group	Group
Brazil	0,431916541	BRA	Latin America & Caribbean	Upper middle income	Developing
Nicaragua	0,406426372	NIC	Latin America & Caribbean	Lower middle income	Developing
Canada	0,396133444	CAN	North America	High income	Developed
Peru	0,385349877	PER	Latin America & Caribbean	Upper middle income	Developing
Italy	0,380554451	ITA	Europe & Central Asia	High income	Developed
France	0,379495824	FRA	Europe & Central Asia	High income	Developed
Belgium	0,377299359	BEL	Europe & Central Asia	High income	Developed
Guatemala	0,364516663	GTM	Latin America & Caribbean	Upper middle income	Developing
Honduras	0,350932988	HND	Latin America & Caribbean	Lower middle income	Developing
Netherlands	0,347265292	NLD	Europe & Central Asia	High income	Developed
Costa Rica	0,339305361	CRI	Latin America & Caribbean	Upper middle income	Developing
Indonesia	0,330136955	IDN	East Asia & Pacific	Upper middle income	Developing
India	0,290086276	IND	South Asia	Lower middle income	Developing
Ethiopia	0,201008268	ETH	Sub-Saharan Africa	Low income	Developing
Uganda	0,17882512	UGA	Sub-Saharan Africa	Low income	Developing

Country	Correlation	Code	Region	Income.group	Group
Germany	0,062262409	DEU	Europe & Central Asia	High income	Developed

Source: Our calculations.

Appendix C: **Ranking of coffee export-dependent countries according to the correlation between real GDP and wheat prices**

Country	Correlation	Code	Region	Income.group	Group
Brazil	0,431916541	BRA	Latin America & Caribbean	Upper middle income	Developing
Nicaragua	0,406426372	NIC	Latin America & Caribbean	Lower middle income	Developing
Canada	0,396133444	CAN	North America	High income	Developed
Peru	0,385349877	PER	Latin America & Caribbean	Upper middle income	Developing
Italy	0,380554451	ITA	Europe & Central Asia	High income	Developed
France	0,379495824	FRA	Europe & Central Asia	High income	Developed
Belgium	0,377299359	BEL	Europe & Central Asia	High income	Developed
Guatemala	0,364516663	GTM	Latin America & Caribbean	Upper middle income	Developing
Honduras	0,350932988	HND	Latin America & Caribbean	Lower middle income	Developing
Netherlands	0,347265292	NLD	Europe & Central Asia	High income	Developed
Costa Rica	0,339305361	CRI	Latin America & Caribbean	Upper middle income	Developing
Indonesia	0,330136955	IDN	East Asia & Pacific	Upper middle income	Developing
India	0,290086276	IND	South Asia	Lower middle income	Developing
Ethiopia	0,201008268	ETH	Sub-Saharan Africa	Low income	Developing
Uganda	0,17882512	UGA	Sub-Saharan Africa	Low income	Developing
Germany	0,062262409	DEU	Europe & Central Asia	High income	Developed

Source: Our calculations.

Appendix D: **Ranking of coffee export-dependent countries according to the correlation between Gini index and crude oil prices**

Country	Correlation	Code	Region	Income.group	Group
Mexico	0,902575972	MEX	Latin America & Caribbean	Upper middle income	Developing
United Arab Emirates	0,863931469	ARE	Middle East & North Africa	High income	Developing
Saudi Arabia	0,857308226	SAU	Middle East & North Africa	High income	Developing
Chad	0,80298284	TCD	Sub-Saharan Africa	Low income	Developing
Germany	0,791589414	DEU	Europe & Central Asia	High income	Developed
Norway	0,718686196	NOR	Europe & Central Asia	High income	Developed
Netherlands	0,690233032	NLD	Europe & Central Asia	High income	Developed
China	0,675028761	CHN	East Asia & Pacific	Upper middle income	Developing
Kuwait	0,667905183	KWT	Middle East & North Africa	High income	Developing
Denmark	0,659949128	DNK	Europe & Central Asia	High income	Developed
Canada	0,651913044	CAN	North America	High income	Developed
Poland	0,64843216	POL	Europe & Central Asia	High income	Developed
Georgia	0,61873773	GEO	Europe & Central Asia	Upper middle income	Developing

Country	Correlation	Code	Region	Income.group	Group
Equatorial Guinea	0,606703712	GNQ	Sub-Saharan Africa	Upper middle income	Developing
Lithuania	0,568963774	LTU	Europe & Central Asia	High income	Developed
Sudan	0,566296339	SDN	Sub-Saharan Africa	Low income	Developing
Brazil	0,557346365	BRA	Latin America & Caribbean	Upper middle income	Developing
Mongolia	0,55299017	MNG	East Asia & Pacific	Lower middle income	Developing
Australia	0,552266788	AUS	East Asia & Pacific	High income	Developed
Ireland	0,530966077	IRL	Europe & Central Asia	High income	Developed
Albania	0,521365171	ALB	Europe & Central Asia	Upper middle income	Developed
Italy	0,451706466	ITA	Europe & Central Asia	High income	Developed
United Kingdom	0,374156482	GBR	Europe & Central Asia	High income	Developed
Angola	0,306621522	AGO	Sub-Saharan Africa	Lower middle income	Developing
Turkmenistan	0,255886357	TKM	Europe & Central Asia	Upper middle income	Developing
Indonesia	0,253567343	IDN	East Asia & Pacific	Upper middle income	Developing
Qatar	0,224686012	QAT	Middle East & North Africa	High income	Developing
Estonia	0,215433278	EST	Europe & Central Asia	High income	Developed
South Sudan	0,186920786	SSD	Sub-Saharan Africa	Low income	Developing
Nigeria	-0,03005403	NGA	Sub-Saharan Africa	Lower middle income	Developing
Papua New Guinea	-0,127146329	PNG	East Asia & Pacific	Lower middle income	Developing
Iraq	-0,219143461	IRQ	Middle East & North Africa	Upper middle income	Developing
Oman	-0,315390823	OMN	Middle East & North Africa	High income	Developing
Cameroon	-0,361784413	CMR	Sub-Saharan Africa	Lower middle income	Developing
Malaysia	-0,475947796	MYS	East Asia & Pacific	Upper middle income	Developing
Ecuador	-0,47970411	ECU	Latin America & Caribbean	Upper middle income	Developing
Colombia	-0,521808086	COL	Latin America & Caribbean	Upper middle income	Developing
Argentina	-0,545759087	ARG	Latin America & Caribbean	Upper middle income	Developing
Philippines	-0,551216166	PHL	East Asia & Pacific	Lower middle income	Developing
Trinidad and Tobago	-0,59736642	TTO	Latin America & Caribbean	High income	Developing
Guatemala	-0,597366922	GTM	Latin America & Caribbean	Upper middle income	Developing
Suriname	-0,597367459	SUR	Latin America & Caribbean	Upper middle income	Developing
Belize	-0,597435424	BLZ	Latin America & Caribbean	Upper middle income	Developing
Greece	-0,612428266	GRC	Europe & Central Asia	High income	Developed
Cuba	-0,627719347	CUB	Latin America & Caribbean	Upper middle income	Developing
New Zealand	-0,643252333	NZL	East Asia & Pacific	High income	Developed
Gabon	-0,656553161	GAB	Sub-Saharan Africa	Upper middle income	Developing
Peru	-0,660010346	PER	Latin America & Caribbean	Upper middle income	Developing
Mauritania	-0,68637249	MRT	Sub-Saharan Africa	Lower middle income	Developing
Algeria	-0,687623061	DZA	Middle East & North Africa	Lower middle income	Developing
Bahrain	-0,697996077	BHR	Middle East & North Africa	High income	Developing
Tunisia	-0,770976562	TUN	Middle East & North Africa	Lower middle income	Developing
Thailand	-0,79980145	THA	East Asia & Pacific	Upper middle income	Developing
Kazakhstan	-0,829510069	KAZ	Europe & Central Asia	Upper middle income	Developing
Libya	-0,83909469	LBY	Middle East & North Africa	Upper middle income	Developing
Timor-Leste	-0,866232368	TLS	East Asia & Pacific	Lower middle income	Developing

Appendix E: Ranking of coffee export-dependent countries according to the correlation between the Gini Index and the price of coffee

Country	Correlation	Code	Region	Income.group	Group
Indonesia	0,167523174	IDN	East Asia & Pacific	Upper middle income	Developing
India	0,143081275	IND	South Asia	Lower middle income	Developing
Costa Rica	0,143051875	CRI	Latin America & Caribbean	Upper middle income	Developing
Brazil	0,115506981	BRA	Latin America & Caribbean	Upper middle income	Developing
Germany	0,073297709	DEU	Europe & Central Asia	High income	Developed
Netherlands	0,06216109	NLD	Europe & Central Asia	High income	Developed
Canada	0,044026516	CAN	North America	High income	Developed
Ethiopia	0,04130046	ETH	Sub-Saharan Africa	Low income	Developing
Italy	-0,156215872	ITA	Europe & Central Asia	High income	Developed
Honduras	-0,215556298	HND	Latin America & Caribbean	Lower middle income	Developing
Guatemala	-0,215556347	GTM	Latin America & Caribbean	Upper middle income	Developing
Nicaragua	-0,215556748	NIC	Latin America & Caribbean	Lower middle income	Developing
Belgium	-0,257168902	BEL	Europe & Central Asia	High income	Developed
France	-0,29464639	FRA	Europe & Central Asia	High income	Developed
Uganda	-0,306671846	UGA	Sub-Saharan Africa	Low income	Developing
Peru	-0,445634722	PER	Latin America & Caribbean	Upper middle income	Developing

Appendix F: Ranking of coffee export-dependent countries according to the correlation between the Gini Index and coffee prices

Country	Correlation	Code	Region	Income.group	Group
Mexico	0,860072266	MEX	Latin America & Caribbean	Upper middle income	Developing
Lebanon	0,813248019	LBN	Middle East & North Africa	Upper middle income	Developing
United Arab Emirates	0,760499552	ARE	Middle East & North Africa	High income	Developing
Serbia	0,725930972	SRB	Europe & Central Asia	Upper middle income	Developed
India	0,690613093	IND	South Asia	Lower middle income	Developing
Germany	0,682890519	DEU	Europe & Central Asia	High income	Developed
South Africa	0,669151013	ZAF	Sub-Saharan Africa	Upper middle income	Developing
Romania	0,627789301	ROU	Europe & Central Asia	High income	Developed
Togo	0,603346692	TGO	Sub-Saharan Africa	Low income	Developing
Kuwait	0,602541148	KWT	Middle East & North Africa	High income	Developing

Country	Correlation	Code	Region	Income.group	Group
Netherlands	0,575335634	NLD	Europe & Central Asia	High income	Developed
China	0,57474978	CHN	East Asia & Pacific	Upper middle income	Developing
Norway	0,573066512	NOR	Europe & Central Asia	High income	Developed
Armenia	0,560113902	ARM	Europe & Central Asia	Upper middle income	Developing
Belarus	0,560113794	BLR	Europe & Central Asia	Upper middle income	Developed
Azerbaijan	0,560113772	AZE	Europe & Central Asia	Upper middle income	Developing
Bosnia and Herzegovina	0,558338952	BIH	Europe & Central Asia	Upper middle income	Developed
Poland	0,549791304	POL	Europe & Central Asia	High income	Developed
Denmark	0,54005556	DNK	Europe & Central Asia	High income	Developed
Georgia	0,53013877	GEO	Europe & Central Asia	Upper middle income	Developing
Ukraine	0,530138739	UKR	Europe & Central Asia	Lower middle income	Developed
Hungary	0,525259682	HUN	Europe & Central Asia	High income	Developed
Canada	0,524942798	CAN	North America	High income	Developed
Lithuania	0,523553145	LTU	Europe & Central Asia	High income	Developed
Finland	0,518720192	FIN	Europe & Central Asia	High income	Developed
Israel	0,50096932	ISR	Middle East & North Africa	High income	Developed
Slovenia	0,488994008	SVN	Europe & Central Asia	High income	Developed
Singapore	0,486136254	SGP	East Asia & Pacific	High income	Developing
Latvia	0,449986972	LVA	Europe & Central Asia	High income	Developed
Myanmar	0,442793157	MMR	East Asia & Pacific	Lower middle income	Developing
Australia	0,43310072	AUS	East Asia & Pacific	High income	Developed
Brazil	0,41710671	BRA	Latin America & Caribbean	Upper middle income	Developing
Sweden	0,415362311	SWE	Europe & Central Asia	High income	Developed
Bulgaria	0,398963187	BGR	Europe & Central Asia	Upper middle income	Developed
Italy	0,39119295	ITA	Europe & Central Asia	High income	Developed
Ireland	0,379519546	IRL	Europe & Central Asia	High income	Developed
Albania	0,370433388	ALB	Europe & Central Asia	Upper middle income	Developed
Russian Federation	0,347968122	RUS	Europe & Central Asia	Upper middle income	Developed
Croatia	0,335263011	HRV	Europe & Central Asia	High income	Developed
Rwanda	0,326852133	RWA	Sub-Saharan Africa	Low income	Developing
United Kingdom	0,314570303	GBR	Europe & Central Asia	High income	Developed
Sri Lanka	0,283774877	LKA	South Asia	Lower middle income	Developing
Morocco	0,279756739	MAR	Middle East & North Africa	Lower middle income	Developing
Bangladesh	0,211376414	BGD	South Asia	Lower middle income	Developing
Portugal	0,199784654	PRT	Europe & Central Asia	High income	Developed
France	0,186863602	FRA	Europe & Central Asia	High income	Developed
Estonia	0,186269179	EST	Europe & Central Asia	High income	Developed
Turkmenistan	0,180430625	TKM	Europe & Central Asia	Upper middle income	Developing
Angola	0,129254278	AGO	Sub-Saharan Africa	Lower middle income	Developing
Cyprus	0,092529261	CYP	Europe & Central Asia	High income	Developed
Nigeria	0,073895445	NGA	Sub-Saharan Africa	Lower middle income	Developing
Papua New Guinea	0,046710415	PNG	East Asia & Pacific	Lower middle income	Developing
Mozambique	-0,085454538	MOZ	Sub-Saharan Africa	Low income	Developing

Country	Correlation	Code	Region	Income.group	Group
Uganda	-0,13307775	UGA	Sub-Saharan Africa	Low income	Developing
Luxembourg	-0,163479393	LUX	Europe & Central Asia	High income	Developed
Austria	-0,185800701	AUT	Europe & Central Asia	High income	Developed
Iraq	-0,192096989	IRQ	Middle East & North Africa	Upper middle income	Developing
Belgium	-0,203176931	BEL	Europe & Central Asia	High income	Developed
Pakistan	-0,367323365	PAK	South Asia	Lower middle income	Developing
Lesotho	-0,414278422	LSO	Sub-Saharan Africa	Lower middle income	Developing
Colombia	-0,418028878	COL	Latin America & Caribbean	Upper middle income	Developing
Malaysia	-0,41907182	MYS	East Asia & Pacific	Upper middle income	Developing
Uzbekistan	-0,431996478	UZB	Europe & Central Asia	Lower middle income	Developing
Argentina	-0,474987641	ARG	Latin America & Caribbean	Upper middle income	Developing
New Zealand	-0,493989291	NZL	East Asia & Pacific	High income	Developed
Jordan	-0,499364846	JOR	Middle East & North Africa	Upper middle income	Developing
Guyana	-0,508711563	GUY	Latin America & Caribbean	Upper middle income	Developing
Guatemala	-0,508711758	GTM	Latin America & Caribbean	Upper middle income	Developing
Dominican Republic	-0,508711826	DOM	Latin America & Caribbean	Upper middle income	Developing
Nicaragua	-0,508711877	NIC	Latin America & Caribbean	Lower middle income	Developing
Panama	-0,508741315	PAN	Latin America & Caribbean	High income	Developing
Paraguay	-0,508783953	PRY	Latin America & Caribbean	Upper middle income	Developing
Kenya	-0,510336566	KEN	Sub-Saharan Africa	Lower middle income	Developing
Senegal	-0,519017333	SEN	Sub-Saharan Africa	Lower middle income	Developing
Spain	-0,527341687	ESP	Europe & Central Asia	High income	Developed
Uruguay	-0,546019308	URY	Latin America & Caribbean	High income	Developing
Gabon	-0,588423829	GAB	Sub-Saharan Africa	Upper middle income	Developing
Algeria	-0,593016087	DZA	Middle East & North Africa	Lower middle income	Developing
Bahrain	-0,631214817	BHR	Middle East & North Africa	High income	Developing
El Salvador	-0,644809765	SLV	Latin America & Caribbean	Lower middle income	Developing
Zimbabwe	-0,647064038	ZWE	Sub-Saharan Africa	Lower middle income	Developing
Greece	-0,651827684	GRC	Europe & Central Asia	High income	Developed
Peru	-0,655083534	PER	Latin America & Caribbean	Upper middle income	Developing
Thailand	-0,710331208	THA	East Asia & Pacific	Upper middle income	Developing
Turkey	-0,741593272	TUR	Europe & Central Asia	Upper middle income	Developing
Guinea	-0,753296759	GIN	Sub-Saharan Africa	Low income	Developing
Kazakhstan	-0,792065055	KAZ	Europe & Central Asia	Upper middle income	Developing

Source: Our calculations.