WORLD MARKET PRICE INFLUENCE ON PRODUCERS' PRICES FOR CASH CROPS: PALM OIL TREE IN INDONESIA

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WORLD MARKET PRICE INFLUENCE ON PRODUCERS' PRICES FOR CASH CROPS: PALM OIL TREE IN INDONESIA

Abstract

This work analyzes the impact of crude palm oil (CPO) world price on producer prices for palm oil in Indonesia. For the analysis, a panel data set was implemented using monthly data from 2011 to 2019. The local price used was the average price of 14 Indonesian provinces. The analysis also studied the influence that other variables have on the local price, such as productivity and maturity of the crop. The scenario presented from the results does not look bright for smallholders, despite in this agricultural system they occupy 40% in the production of palm oil. After testing for stationarity and cointegration an Error Correction Model (ECM) was built to assess the transmission of prices for the short and long time period. Using empirical results and theory as support, it was possible to understand better what happens in the upstream chain of this sector. Maturity of land influences negatively producer price and one of the main reasons that explain that is the corruption operating at a high level leading to a situation of state capture at the national and regional level. The presence of few big refineries, that also own plantations and mills, without competing with each other is another issue that does not bring benefit to small producers both independent and under scheme.

1. Introduction

Palm oil has become through years one of the most important crop in Indonesia, due to its versatility to be transformed and used for food, feed, cosmetics, energy, and other industrial uses.

Currently, Indonesia is leading the production and the export of palm oil at global level with 36 million tons of palm oil produced in 2016 against 21 million tons coming from Malaysia. These two countries produce together, globally, around 85% to 90% of the total production (Index Mundi, 2016).

Indonesia other than being the largest producer and exporter (27 million tons exported in 2016) represents also one of the major greenhouse gases emitters right after China and the United States.

Indeed, palm oil plantations have been largely expanded by farmers and agribusiness with a severe cost for the environment and the other crops as palm oil is the most productive and profitable.

The Indonesian palm oil production is mostly used to satisfy the world demand, even if local demand in Indonesia is rising as well. The major importer are China, India, Pakistan, and Malaysia (Business Investment, 2016). Also, a very small amount is imported by Indonesia from India. This chapter will be dedicated to the analysis of the main actors playing in the upstream value chain of this sector, from the cultivation of fresh fruit bunches till the fruit reaches the refinery and they are ready to be exported. Importance will be given also to the environmental cost Indonesia is suffering from the production and export of this crop. Corruption plays a big role in this country concerning the acquisition of land, mainly given to the “business elites” from the government in exchange of political favour.

1.1 Main objectives

The purpose of this work is to analyze the link between the oil palm world price and the producer price in Indonesia to see whether the world market price influence the local price in Indonesia. The use of world monthly data and producer monthly data for 14 Indonesian provinces from 2011 to 2019, will be useful to assess the actors’ behaviors and the influence of their decisions in the Indonesian palm oil sector. Also,

other variables will be added to the long- and short-term regression such as land and productivity. To study the transmission of prices it is necessary to adopt an empirical approach as the theory support is not sufficient. To do that, a panel data set has been developed through which long- and short-term regression will be assessed and it will be possible to develop the Error Correction Model (ECM) used to analyze transmission of prices.

1.2 The main actors in the palm oil sector

The role of the State in the palm oil sector has changed since its beginning: the colonial period governed by the Dutch East Indies undertook the set-up of big plantations in Sumatra. Afterwards, when Indonesia got the independence in 1945, Sukarno, the prime minister nationalized the colonial plantations. He developed a transmigration program to reduce the unemployment rate and decrease the diversities existed in terms of ethnicity, religion and integrate the outer islands. When Suharto became president in 1967, he realized a 5-year plan to reach rice self-sufficiency in Sumatra and Kalimatan but, due to lack of funding, these agricultural lands were converted in palm oil plantation and thanks to many transmigrants participating in the program this crop became a major vector for the development of many rural areas.

Initially these plantations were managed by public companies called *Perusahaan Negara Perkebunan* (PNP); then they were transformed into *Perseroan Terbatas Perkebunan* (PTP), semi-public companies supported by the World Bank. After some time, the Indonesian Government start granting large concession to private companies, called *Perkebunan Besar Swasta* (PBS), considering them as a vehicle to boost the national income and increase Indonesian income. In 1978 the Indonesian government launched the Nucleus Estate and Smallholders (NES) program to reinforce the participation of smallholders in the palm oil sector. This program introduced a contract farming between two parties, the nucleus (called “inti” in Indonesian) that is composed by the plantation companies and it was usually located near an industrial mill, and the smallholders, who run their plots (called “plasma”) that were usually located at the periphery of the nucleus. Smallholders under scheme are provided of technical assistance, input for the cultivation such as fertilizer, seed stock, pesticides etc., (in some cases partly subsidized by the state), and in exchange they have to provide the

supply of fresh fruit bunches to the companies (Cahyadi E.R, 2013). However, the initial costs to sustain from the smallholders is an obstacle for the participation in the program since most of them were unable to burden the cost during the immature phase. Another factor is the reluctance of banks to provide them credit without any collateral. In the 1988 *the Koperasi Kredit Prier Anggota* (KKPA) favoured the creation of cooperatives to intermediate between companies and farmer. The organization of this model, developed to increase and encourage the smallholder's productivity in the palm oil industry did not have the success expected. Despite all the best intentions the lack of regulation together with the missing commitment from the cooperatives towards farmers and an all-pervading corruption weakened the country's economic stability.

In 1998, Indonesia was severely hit by the Asian crisis: the pervading corruption under Suharto's government let companies avoid transparencies in accounting and burden on excessive foreign currency debt. The "laissez faire" era, called by McCarthy (2010), saw the withdrawal of the government from controlling the organization of companies, providing credit and infrastructure to the KKPA scheme so that smallholder could not enter or remain due to a lack of financial services and were subsequently forced to sell their lands. The government also applied a decentralization process that empowered regional and local governments which are therefore less relying on the central one concerning their territory.

The decentralization was supported by two main laws: "Law 22 on Regional Governance" and "Law 25 on Fiscal Balancing" both approved in 1999. This "freedom" within the provinces which were able to manage and transfer land rights, classifying forest between conversion, safeguard, and production, resulted in a differentiation between regions that is still likely to increase depending on specificities related to the local environment.

The expansion of the sector sees now three main actors sharing the agricultural system for palm oil: the government, private companies, and smallholders.

The figure 1.1 below, shows the share of the agricultural system in Indonesia with their respective percentages. Nowadays, state-owned plantations count almost the 7% against the 40% of smallholder's production and the almost 53% of private enterprises.

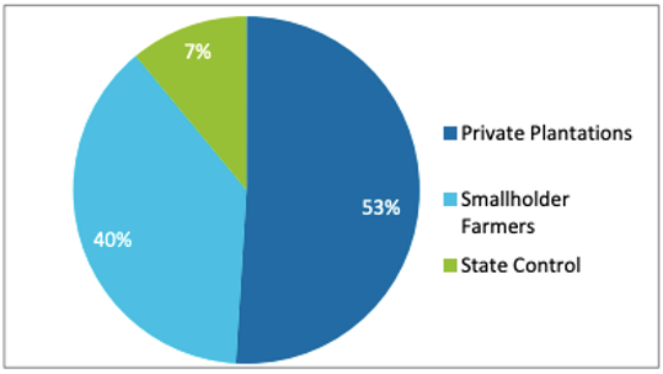

Figure 1.1 Share of agricultural system in Indonesia.
Source: Directorate General of Estate Crops 2016

Private companies have largely invested in palm oil refining capacity and shifted their business downstream in the value chain towards refined products. Indeed, Indonesia has always mainly been exporter for the raw commodity but through years it raised its capacity in producing refined products jumping from 30.7 million tons in 2013 to 45 million tons in 2015 (Business Insider, 2017).

The big share covered from the smallholder's production is the result of pro-poor schemes developed by the government to enhance their participation in new palm oil plantations (Eko Ruddy Cahyadi, 2013). This category is usually classified into two categories, plasma farmers, namely company-assisted farmers, and independent farmers. Independent farmers are free to sell their products and are not constrained by selling the fruit to specific mills differently from smallholders under scheme. Around 500,000 smallholders (one third of palm oil area) are under contractual arrangements (Varkkey H. et al., 2018).

However, it has to be said that talking about smallholders both as homogeneous group both as two-categories group is not fully representative; indeed, this country developed within each province and territory its diversities and specificities that cannot fit or classified in one or two groups uniformly (Jelsma I. et al., 2017). Furthermore, the Ministry of Environment and Forestry does not have yet mapped smallholders nationally so they cannot be distinguished from the land cover map.

That is also why, most of the time, policies are partially inefficient and fail as they do not fully take into consideration the variety of actors they cover. In Jelsma et al. (2017) research, they were able to identify for Riau province seven different typologies of oil

palm smallholders and warned about the inefficient and detrimental one-size-fits-all-solutions usually adopted considering a heterogenous group as a uniform population.
This category, even if accounting for 40% of the cultivated area, faces several difficulties in terms of upgrading and developing sustainable ways of production. The main barriers are represented by limited cash flow and access to finance, poor know-how and access to production inputs, non-compliant land registration documents (lack land registration documents or wrong registration). According to Jelsma et al. (2017) 55% of smallholders do not have land registration or they have a wrong one and this documentation is necessary in order to sell their products certified according to the sustainable standards required.
As the demand for sustainable certified palm oil is expected to increase this large part of non-compliant farmers risk to remain outside of the palm oil market.

1.2 Palm Oil Supply Chain

The mature fresh fruit bunches (FFB) are what are generally harvested at the plantation during a year. The mesocarp, in the outer part, contains Palm Oil (PO), while the kernel is used to produced Palm Kernel Oil (PKO). Production can vary with respect to different characteristics or cultivation practices and the range of production goes from 20 to 25 tons of FFB per hectare (Santosa, 2008).
After harvesting, the fruits need to be brought to the mill and be processed within 24 to 48 hours or will result unusable. The period of maturation of the fruit is a long process. It takes around three years from the initial input to the harvest. Also, the yield gradually increases from 8 tons per hectare per year to 30 tons per hectare per year at the 13^{th} year. This trend continues until the 17^{th} year and after that it will decrease slowly until the end of the palm oil around age of 25.
In Figure 1.2 is represented the process occurring in the mill and the resulting products from Crude and Kernel Palm oil and Kernel Meal. This process starts with the sterilization by steaming of the bunches and the separation from their stalks. Empty bunches are sent to boiling to be used as energy. The fruits are extracted for the oil content that will be purified from water and impurities to obtain Crude Palm oil. The cake coming from the oil extraction are mainly nuts and fibers that after drying are put into a nutcracker and the mixture of kernels and shells is afterwards separated. Before

1980 the process to obtain crude palm oil and kernel were done outside Indonesia since there were no kernel crushing plant or refinery plant in the country. When finally crushing plants and refineries were built after 1980, palm kernel meal and CPKO started to be produced in Indonesia. From the mills, palm oil is also transported by trucks or ships to the refineries in other countries (Malaysia or European countries) to be further processed and sold on the market.

According to Chain Reaction Research (2021) the global production for CPO in 2020/21 is expected to be around 75.6 million metric tons while PKO production around 8.77 million metric tons.

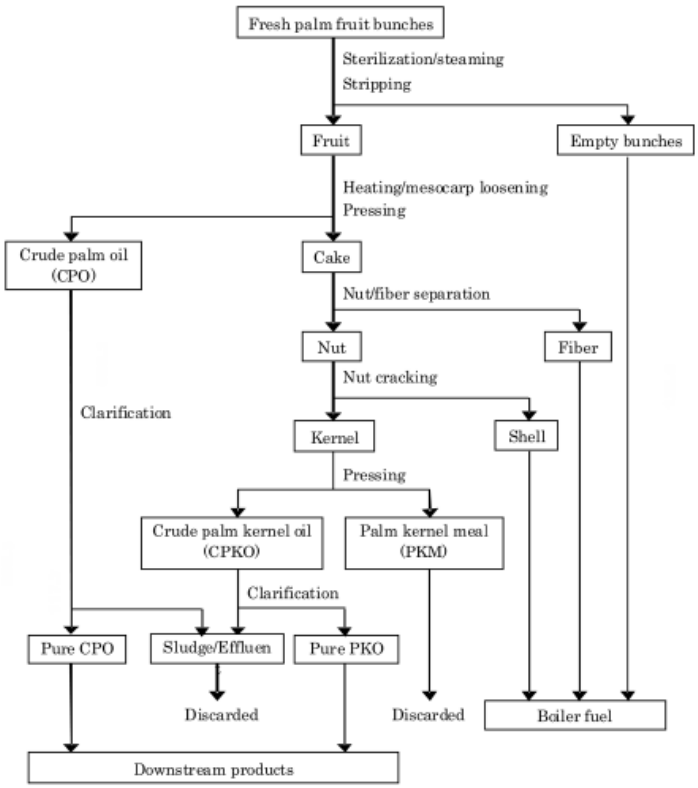

Figure 1.2 Current process operation and products of palm oil mills and kernel crushing plants in Indonesia. Source: Santosa, 2008

The palm oil value chain developed and grew with time, becoming more complex and including different stakeholders. This is also the reason why it is difficult to identify a unique responsible for the environmental and social damages (greenhouse gases emissions, biodiversity loss, deforestation, poverty among small producers, labour rights and social conflicts etc.) the production and consume of this palm oil is causing.

Palm oil is a capital-intensive crop, more than others, and it requires specific inputs and infrastructures. That is why processes like milling, refining, and trading are controlled mainly by big companies since a lot of investments are needed. As it is already mentioned, the process of FFB is critical as they need to reach the mill by 48 hours since the quality decreases after the harvest. This implies expensive and complex organization other than a geographical proximity between plantation and processing structures.

Some private companies have integrated other processes of the supply chain, other than just being big plantations owner. Those activities include operations at mill, refineries, and development of products through which these companies were able to make big profits and play a big role in the palm oil sector. One of these, Wilmar international, distribute palm oil products to more than 50 countries around the world and control 45% of the global production and trade (UNPD, 2020). Other two big refineries and plantation owners are Golden Agri-Resources and Sime Darby. It seems that in the upstream chain the palm oil industry is managed by those few companies that do not even need to compete between each other since they have their plantations and can reach full capacity of production with their own estates. It will be more evident from the econometric results and interpretation why the market does not function properly, and why this scenario is not reassuring for smallholders in Indonesia.

1.3 The expansionist policy in Indonesia

The production of palm oil in Indonesia increased swiftly from 1960s till nowadays. According to FAO (2017) the annual production volume raised from 5 million tons in 1995 to almost 30 million tons in 2014. This is reflected also in the land area covered by palm oil plantations: this crop occupies 4.1% of the Indonesian land area and 17.7% of the agricultural land in 2014.

This situation led to a rapid expansion of the sector but also to a rapid decrease of the suitable land and the usage of peat soils, originally considered as not favorable for palm oil cultivation.

This is also due to the high productivity and profitability of palm oil compared to other crops. Palm oil yields around 3.72 tons of oil per hectare per year, significantly better

than soybean (average of 0.40 t/ha/y), sunflower (0.55 t/ha/y) and rapeseed (0.72 t/ha/y) (Shimizu & Desrochers, 2012).

The rapid increase of the international demand for palm oil brought prices to rise and consequently more and more farmers decided to switch their production into palm oil plantation. Many growers that choose to change their product mix and cultivate palm oil saw their profits increase noticeably.

Indeed, the net present value for planting palm oil can yield per hectare per year between 3835$ and 9630$ compared to the net value for other crops that goes around 1283$ and 1416$ per hectare per year (Prasetyo, 2009).

The fast increase in productivity was a motivation for growers to expand more land: the profits made represented an encouragement for expansion, especially in Sumatra and Kalimatan provinces. Moreover, this was supported by a policy objective to become the largest producer of CPO in the world and surpass Malaysia. As private companies started to develop with the government consent and support, expansion happened rapidly and started to take the place of natural forest and peatlands.

At the beginning of 1990s Indonesia opened its sector to foreign investors as the International Monetary Fund (IMF) suggested for its structural reforms. This made possible for many Malaysian companies to enter in the sector: in 2013 was reported that Malaysian companies detained land banks for an average of 1.8 million hectares, with a presence in terms of palm oil area of 18% (Aidenvironment, 2014; Ministry of Agriculture, 2017).

Currently palm oil area occupies 12.3 million hectares, it contributes to the Indonesian GDP for the 7% annually and employs around 20 million people in a direct and indirect way.

In Riau province, one of the major producers in Indonesia, 85% of palm oil plantation were forest land before. Large agribusinesses are the main responsible for the forest and peatlands loss, and in minor part smallholders. Indonesia, differently from Malaysia has largely favored expansion of land as strategy to boost its production of palm oil. Intensification is intended as an increase in the productivity of land and it is determined by the real value of agricultural output per hectare or yield increase while expansion is the increase in the land used for the cultivation of crops and it can involve the conversion of forest or other land use types (Varkkey H. et al., 2018).

These two different strategies are often complementary, both were used in Indonesia and Malaysia. However, the expansion in Malaysia was reduced to maintain at least half of forest cover in 90s, consequently to the decision of many companies to establish their plantation in Indonesia. Indonesia did not choose this direction and decided instead to focus on expansionist policies to reach market goals and increase its production volume. Even if Indonesia is the largest producer, Malaysia, thanks to its intensification policies, results the best in terms of efficiency, measured in terms of production per hectare and extraction rate. Malaysia national annual yield is 21 tons per hectare of fresh fruit bunches while Indonesia, despite its 12.3 million hectares of land use for plantations (Malaysia 5.2 million hectares of planted area), only 17 tons per hectare of FFB.

Furthermore, smallholders in Indonesia, both company-assisted and independent, receive limited support and are not enough prepared on how to optimize productivity. This also encouraged them to expand in order to earn more. Indeed, as Indonesia have so much land available both high and low productivity support the expansion of land for plantations. In this country the land has always been used in exchange of favors, something also called "patronage transaction" (Varkkey H. et al., 2018).

This phenomenon is common in the Indonesian business world and describe a situation where a person in a high socio-economic-political status uses his/her position to provide for a lower status client resources or other favors (such as rights to concession of lands) in exchange of political support (election support). In this way it is easier to get rid of the difficulties of the administration and procedures needed for the conversion of forest into palm oil plantations. (Setiawan E.N., et al., 2016).

These situations, where big agribusinesses can exert a significant power over land policies at national and country level, can lead to a sort of "state capture", especially for those who are responsible for the forest area and titling like the Ministry of Forestry, the National Land Agency and the regional governments. As example, the moratoriums part of the project "Reducing Emissions through Deforestation and Forest Degradation (REDD+) were found compromised by companies' private interests. The expansion of land is preferred by companies because of the timber that can be harvested and sold before starting the plantations. Cisneros E. et al. (2021) results, showed in their report that the loss of forest increases before mayoral elections

and incentives for palm oil and election inducements are strictly related to each other and drive deforestation in Indonesia.

Several studies confirm that corruption is one of the major causes of deforestation in Indonesia and those scandals often see involved palm oil companies: financing illegally elections, bribes to overlook illegal logging or to allow forest concession.

2. Different market structures

This chapter will present different market organization and structures. This theoretical background will be useful to assess the actors' behaviors and the influence of their decisions in the Indonesian palm oil sector. Each type of market has its peculiarities so that the transmission of prices will result in a less or higher relation.

The equation 2.1 below, show the relation between producer price and world price:

$$\ln Y_t = \ln a + \beta \ln X_t + s_t \qquad (2.1)$$

where Y is the price paid to smallholders and farmers for Fresh Fruit Bunches (FFB) and X is price at which the Crude Palm Oil (CPO) is sold on the world market. Also, s_t is the error term, β is the slope and ln a is the intercept.

2.1 Market in perfect and pure competition

Perfect competition occurs when the market is characterized by a high level of supply and demand. Because of the high competition and the presence of many buyers and sellers the actors are considered "price takers". If we have the following equations:

$$Y = X\ , \qquad (2.2)$$

$$ln\ Y_t = ln\ X_t \qquad (2.3)$$

and we compare the (2.3) with the equation (2.1) one has $\beta = 1$ and $a = 1$.

The five conditions that make possible the existence of a pure and perfect competition are: there are many buyers and sellers, ease of entry and exit, competitors sell similar products, buyers and customers have full information, competitors have similar market share cause they do not compete on price and the marginal revenue is equal to the marginal cost.

2.2 Monopolistic market

A monopolistic market describes a situation where we have one seller and many buyers and is the opposite of a perfect competition where many firms operate.
In this case the firm who has the monopoly can fix its price X and make profit on it.
We have the equation:

$$\pi = argmax(Xq(p) - Yq(p)) \qquad (2.4)$$

where π is the profit, X is the world price, Y is the producer price and $q(p)$ is the production. If the firm wants to make profits the world price needs to be higher than the producer price. In the following equation:

$$X = Y\left(1 + \frac{1}{\mu}\right) \leftrightarrow X = k\,Y \leftrightarrow Y = \frac{1}{k}\,X \qquad (2.5)$$

and $k = \left(1 + \frac{1}{\mu}\right)$ where $\frac{1}{\mu}$ is the difference between price and marginal cost, also called "markup". If k is greater than 1 the firm will make great profits, while if k is equal 1 means there is no markup for the firm. We have:

$$lnY_t = \ln(k^{-1}) + \ln X_t \qquad (2.6)$$

and if we compare (2.6) with (2.1) this means that $\beta = 1$ and s $a = k^{-1}$. In this case since we have $\beta = 1$ both for monopoly and perfect competition it is important once made the regression to check for the parameter a.

2.3 Oligopolistic market

In an oligopolistic situation the market is composed by a small number of firms and a high number of buyers. Those companies can collude, explicitly or tacitly to restrict the output or to fix the price or can compete between each other. A duopoly situation occurs when there are two sellers and those can act both competing or colluding. In

this situation the transmission of price is not perfect, except for the Bertrand duopoly where there is a competition of prices.

2.4 Principal-agent relationship

This particular type of interaction occurs when the merchant (or principal) makes a contract with the producer (or agent) to produce a certain quantity q under payment $\gamma Xq + \delta$. The producer in this case will make an investment to produce this quantity but his effort is not quantifiable as the production will be the result not only of his effort but also the different natural conditions and risks that influence the harvest. Also, the principal can choose to pay the agent a fixed price or can decide to remunerate him according to the quantity produced.

The producer has also other options such as the possibility to exit (exit option) from that market and enter in another one or decide to work in a sector where he is paid more. In this situation, the merchant power depends on the exit option that the producer has. The transmission of price is therefore characterized by β significantly lower than 1 (Parez Mathilde, 2021).

3. Data and Methodology

In this chapter will be introduced and explained different variables used for the analysis and how they were integrated in a panel data set using STATA 17 program.
In the previous chapters has been done an introduction of the palm oil sector in Indonesia focusing on some major and important background situations and events that will be useful to understand and interpret data afterwards. For the study, the analysis is conducted using the logarithm of prices and the other variables used.

Other than world price for palm oil expressed in the local money, the Indonesian rupiah (Rp), others explanatory variables were integrated in the analysis:
-three different types of diversity for the crop (mature, immature, and damaged) expressed in hectares
- productivity (kg/ha)
- haircut price expressed in Rp.

Except the world price all the variables were found for the different 14 Indonesian provinces taken into consideration. The independent variables except the world price are yearly data, from 2011 till 2019.
As already mentioned, a panel data set has been developed for the analysis of the short-term and long-term regression that are used to build the Error Correction Model, a useful tool to assess the transmission mechanism of the world price to producer price for palm oil.

3.1 World CPO price and local price for FFB

For this study were used monthly data from January 2011 till December 2019, both for world price and producer price. Producer prices were extracted from the Indonesian Ministry of Agriculture database.
Moreover, producer price was implemented using the average price of 14 Indonesian provinces and it refers to the local price paid for fresh fruit bunches. The 14 provinces used for the analyses are: Aceh, Sumatera Utara, Sumatera Barat, Riau, Jambi, Sumatera Selatan, Bengkulu, Lampung, Kep. Bangka Belitung, Banten, Kalimantan

Barat, Kalimantan Tengah, Sulawesi Selatan and Sulawesi Barat. Monthly world prices (equal everywhere) refer to the Crude Palm Oil (CPO) sold on the market, and it does not include export costs. World prices were extracted from Index Mundi database.

The figure 3.1 above reports the trend of producer price in Indonesia and world price for Crude palm oil expressed in $/metric tons, for the period studied (Jan 2011-Dec 2019). One can see that the two prices move together during this period of time.

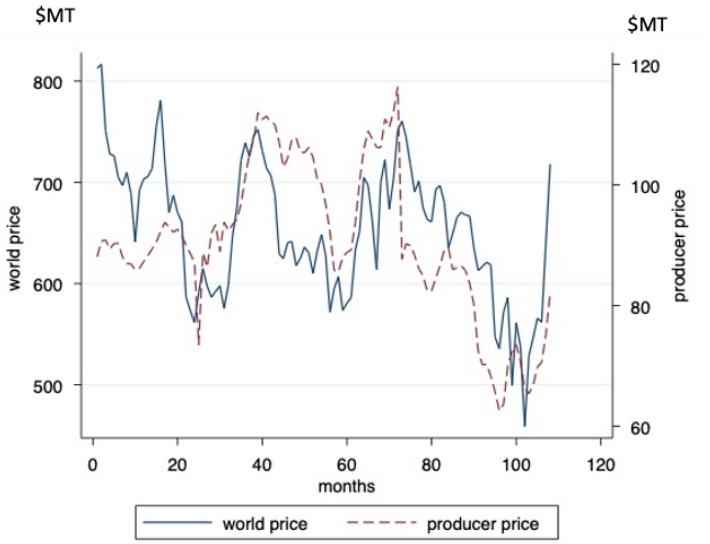

Figure 3.1 Palm oil monthly price from January 2011 to December 2019

3.2 Crop diversities

Data about crop diversities were extracted from the Indonesian Ministry of Agriculture database and are yearly data.

These variables are all expressed in hectares and represent the space of land occupied by each category.

The three stages of the palm oil plant considered in the analysis are: immature, mature, and damaged. The immature plant is the one that have not given results yet, because is still young and not yet old to produce fruits or it will never give flower. The mature plant is the one that has already produced or is producing, even if it is not producing at the moment.

Damaged or Non-productive plants is an old plant, damaged, that does not give adequate results.

3.3 Productivity

Productivity expresses the quantity of production yielded in kilograms per hectare. Even if Indonesia is the largest producer, Malaysia achieves better results in terms of production efficiency. For mature plants Indonesia's productivity is 75% for 12.3 million of hectares involved in palm oil production, against the 86% of Malaysia for 5.2 million of hectares of planted area (Varkkey et al., 2018).
Donough et al. (2011) have identified three common yield gaps: the first is caused by inefficiencies during the management of plantation until maturity stage; the second gap is related to lack of nutrient management in the production stage; the third gap concerns the poor efficiency in managing mature trees. It is important to remark that smallholders and local producers are quite diverse in Indonesia, and they have different level of productivity. Yearly data for this variable were extracted from the Ministry of Agriculture website.

3.4 Exit option

The exit option represents the choice for palm oil farmers to do something else instead of working in a palm oil plantation. Those option can be represented by the haircut price: it is an index of expected wage one can get in a non-qualified job in Indonesia. For this study has been found haircut price for the 14 provinces included, but only for the year 2019. This variable was included in the analysis as in a first place it was retained that the market structure of Indonesia could have been characterized by the principal-agent relation. Data for this explanatory variable were found on Cost of Living Indonesia website.

3.4 Methodology

This paragraph will clarify the methodology used for the analysis of the transmission of world price x_t on producer price y_t. As example of the linear regression where producer price is the dependent variable and the world price the independent variable:

$$y_t = a + \beta x_t + s_t \qquad (5.1)$$

where a is the intercept, $\beta$is the coefficient of the world price and s_t the residual of the regression.

To develop the Error Correction Model, it is important to test the series for stationarity and cointegration. The stationarity tests performed were the Augmented Dickey-Fuller for the world price and the Levin-Lin Chu unit root test for the producer prices.
These tests consider the following hypothesis:

H_0 = all panels contain unit root
H_a = all panels are stationary

If H_0 is rejected than we have stationary series. H_0 will be rejected if we have a p-value less than 5%. If the series are non-stationary, it is possible to make them stationary by performing a first difference process where Δy_t becomes potentially stationary.

In order to continue the analysis, the Pedroni test for cointegration, specific for panel data, was implemented to see if the two variables are cointegrated with each other and to estimate a long-term relationship.
In this case we have the following hypothesis:

H_0 = no cointegration
H_a = all panels are cointegrated

If the p-value results lower than 5% the null hypothesis is rejected, and we have cointegration between the two variables.

An Error Correction Model (ECM) was used to study the transmission from palm oil world prices to the Indonesian producer prices. If these two series are cointegrated it is possible to estimate a long-term relationship.

An ECM includes a short-term dynamic model estimated in first difference and a long-term model.

These models make it possible to integrate, around the long-term relationship, short-term fluctuations of y_t in terms of x_t. The equation (4.1) is an example of ECM:

$$\Delta y_t = \ \propto_0 + \ \gamma_0 \Delta x_t - \ \delta(y_{t-1} - \ \beta \ \cdot x_{t-1}) + u_t \qquad (4.1)$$

The term $\delta(y_{t-1} - \ \beta \ \cdot x_{t-1})$ is the error correction term with δ which is the error correction coefficient.

The coefficient γ_0 provides information on the short-term transmission of world prices and δ on the rate of adjustment to equilibrium. The coefficient β of the long-run equation will indicate the rate of transmission of world prices over the long run while $\propto_0$ is the intercept of the short run regression.

This transmission study is valid for the entire period studied, from 2011 to 2019.

4 Econometric results and discussion

Before building the Error Correction Model stationarity tests have been done to all the variables. In the table 1, below, it is shown two different unit-root tests for world price and producer price. The stationarity tests chosen were the Levin-Lin Chu and Im-Pesaran-Shin unit-root test.

Levin-Lin Chu unit root test for y_t

	Statistic	p-value
Unadjusted t	-7.0595	
Adjusted t*	-1.9690	0.0245

Levin-Lin Chu unit root test for x_t

	Statistic	p-value
Unadjusted t	-9.1447	
Adjusted t*	3.4236	0.997

Table 1 – producer price and world price stationarity test using Levin-Lin Chu unit-root test

In Levin-Lin Chu test for producer price the null hypothesis is rejected as the p-value is less than 5%; that means that the variable is stationary. However, for the world price, it is not possible to reject null hypothesis as the p-value is 0.99 (more than 5%). World price is therefore non-stationary.

Table 2 shows results for Im-Pesaran Shin test. Even in this case results are confirmed, showing producer price as stationary variable and world price as non-stationary. All the other independent variables resulted non-stationary from the results obtained.

In case both variables resulted stationary it would have been implemented the Arellano-Bond methodology, but in the situation of having one variable stationary and the others containing unit-root it has been decided to treat all of them as non-stationary and continue with the cointegration tests.

Im-Pesaran-Shin unit-root test test for y_t t l(2)

	Statistic	p-value
W-t-bar	-2.4639	0.0069

Im-Pesaran-Shin unit-root test test for x_t t l(2)

	Statistic	p-value
W-t-bar	-1.0854	0.1389

Table 2 – producer price and world price stationarity test using Im-Pesaran-Shin unit-root test

To verify if the panels are cointegrated and proceed with the ECM it has been used Pedroni test for cointegration. Table 3 below shows that in all the tests for cointegration, Modified Phillips-Perron, Phillips-Perron and Augmented Dickey-Fuller, the p-value is less than zero and it is possible to reject the null hypothesis and affirm that all panels are cointegrated.

Pedroni test for cointegration

	Statistic	p-value
Modified Phillips-Perron t	-7.4175	0.000
Phillips-Perron t	-8.4656	0.000
Augmented Dickey-Fuller t	-8.0662	0.000

Table 3 – Cointegration results using Pedroni test

After conducting the tests for stationarity and cointegration, next step consists in assessing long run and short-term regression in order to build the Error Correction Model. In table 4 it is represented the long run regression: the world transmission to the producer price is significant (p-value less than 5%) and high, considering that those are monthly data. Indeed, it means that almost 80% of the world price is transmitted to producers in the long period.

Long run regression

	b (se)
World price (x_t)	0.79*** (0.066)
Immature crop	-0.08*** (0.014)
Mature crop	0.10*** (0.01)
productivity	0.39*** (0.04)
Haircut price	-0.07* (0.04)
Cons	-1.56 (1.19)
Observations	1,512
Adj R-squared	0.21

Note: significant effects are indicated with *p<0.1, **p<0.05, ***p<0.01

Table 4 – Long run regression without fixed effect

A long and short run regression using fixed effect were used in order to understand and have a more accurate representation of the situation.

In table 5 it is represented the long-term regression controlling for province fixed effect and a different scenario can be seen:

The transmission from the world to Indonesian producers is 66% per month. Moreover, it is possible to notice how mature land influence negatively (almost -10%) producer prices in the long run. The more land for mature crop expands the more producer prices decrease. This is an unfortunate news for producers in Indonesia, not only for those who manage independently their production but also for farmers under scheme. Indeed, those small farmers are price takers: they do not have bargaining power at all against big refineries and agribusinesses and have to accept the price settled by them. Moreover, the so called “k index” that is the costs deducted from their production, it is not known outside the circle of companies and is always variable.

In the same table it is also possible to notice how productivity and immaturity of the crop do not matter anymore for producers, as they resulted not significant.

Long run regression with fixed effect

	b (se)
World price (x_t)	0.66*** (0.056)
Immature crop	-0.02 (0.016)
Mature crop	-0.09*** (0.02)
productivity	0.02 (0.06)
Haircut price	(omitted)
Cons	4.63***

Note: significant effects are indicated with *p<0.1, **p<0.05, ***p<0.01

Table 5 – Long run regression with fixed effect

Moreover, because the competition might have come from other provinces, the prices of the other provinces was included as an extra regressor. Unfortunately, doing so the estimation lost all the theoretically consistencies.

In order to be sure that there was no endogeneity of the world price due to the market power of Indonesia at global level, the world market price was lagged in the short run regression with and without fixed effect.

Considering the short run regression controlling for province fixed effect, table 6 illustrates the results: 16% of the world price is transmitted to producers in Indonesia monthly. The estimated coefficient of the error correction term is -0.35. This value represents the speed of adjustment, and it means that 35% of the deviations from the equilibrium are corrected in a month.

Short run regression with fixed effect

	b (se)
World price (x_t)	0.18** (0.08)
Immature crop	-0.02 (0.04)
Mature crop	-0.27** (0.11)
Productivity	-0.41* (0.22)
eb L1.	-0.34*** (0.04)
Haircut price	(omitted)
Cons	-0.00
Observations	1,484

Note: significant effects are indicated with *p<0.1, **p<0.05, ***p<0.01

Table 6– Short term regression with fixed effect

The error correction model (ECM) was used to assess the transmission mechanism of world palm oil prices to Indonesian producer prices.

If y_t (producer price) and x_t (world price) are cointegrated it is possible to estimate a long-term relation between these two series. In an ECM we have a variation of producer prices that is modelled by the variation of the prices in a short run relationship, and we have a long run relationship.

(4.1) $$\Delta y_t = \propto_0 + \gamma_0 \Delta x_t - \delta(y_{t-1} - \beta \cdot x_{t-1}) + u_t$$

The equation 4.1 represents the model that includes a short-term dynamic model estimated in first difference and a long-term model. These models make possible to integrate, around the long-term relationship, short-term fluctuations of y_t in terms of x_t. Table 7 illustrates coefficients and their estimations.

Coefficients:	estimation	stand.err	t-value	p-value
α_0	-0.0002	0.004	-0.01	0.995
γ_0	0.163	0.078	2.88	0.04
β	0.661	0.056	11.75	0.000
δ	-0.348	0.019	17.71	0.000

Table 7– Error Correction Model

Using results obtained in table 7 equation (4.1) becomes:

(4.2) $$\Delta y_t = 0.16\,\Delta x_t - 0.35(y_{t-1} - 0.66\,x_{t-1}) + u_t$$

In this case $\propto_0$ was not included as it is not significant therefore it is considered as zero in the equation.

One important thing to verify in order to have a correct ECM is the error correction term δ: it has to be negative (-.348) and significant (***).

The coefficient γ_0 represents the rate transmission of a price shock on the short run; when the world price fluctuates 16% of this variation is directly transmitted to producers in the short term. Even though it seems quite low coefficient is important to remember that those are monthly data and considering the error correction coefficient of almost 35%. Indeed, in a year the transmission from the world to producers will be around 87%.

Table 8 wants to show the share of Indonesian producers on the world market price for CPO. The percentage shows that producers occupy almost 14% of the share over the world price. To understand if this coefficient can be considered high or low percentage would be interesting to assess refineries and mills costs and figure it out the profit they do. According to Chain Reaction Research (2021) and their study on the topic, refineries and especially those who owned plantations make big profits from the production of palm oil while those classified as smallholders make zero profit from

the market. Unfortunately, it is not so easy to understand and assess which are those costs and their amount as they do not reveal so easily this kind of information.
What is sure is that in the upstream chain there are few big industries that control lands, producer price according to their interest, and have power on a big share of production.

Place	Mean (se)
Aceh	0.10 (0.018)
Sumatera Utara	0.19 (0.05)
Sumatera Barat	0.19 (0.048)
Riau	0.14 (0.016)
Jambi	0.14 (0.025)
Sumatera Selatan	0.12 (0.014)
Bengkulu	0.12 (0.02)
Lampung	0.14 (0.019)
Kep. Bangka Belitung	0.18 (0.05)
Banten	0.10 (0.02)
Kalimantan Barat	0.12 (0.018)
Kalimantan Tengah	0.11 (0.019)
Sulawesi Selatan	0.09 (0.01)
Sulawesi Barat	0.12 (0.02)
Total	0.139 (0.041)

Table 8 – Share of producer price over the world market price for Indonesia

5 Conclusions

Based on the results obtained it is possible to draw conclusions and limitation of the work. In a first place the panels were tested for stationarity and cointegration to understand if it was possible to build an Error Correction model to assess the transmission of world price on Indonesian producer prices.
After verified that the panels were all cointegrated it was possible to estimate a long- and short-term relationship between the producer price and the other variables.
Results in these analyses illustrate a very difficult scenario for smallholders in Indonesia.

In the long run results showed the world price influence for the 79% producer prices. In order to have more accurate results, control for province fixed effect was implemented both in long and in the short term. The long run with fixed effect showed a world price coefficient of 66% monthly. In the short run 16% of the CPO world price is transmitted to the producers, monthly.
Moreover, another interesting consequence was how mature crop negatively affect producer prices in the long run (around -9%). Literature explains in several ways how this can happen: corruption, low smallholder's bargaining power against agribusinesses, presence of few refinery companies that control the production without competing between each other.
As already mentioned in the theory part, corruption plays a big role both in terms of land acquisition and in the establishment of the so called "K index". This index is the amount subtracted for the costs of management and it is used from companies to justify the low producer price. These costs, supported also by the government, always vary and the calculation of them is not known outside the group pf company managers.
The issue about land is really ambiguous. This -9% can also be related to the fact that when the land increase this does not benefit so much producer prices, because the land concession are given mainly to the «business elites», so less independent smallholders are required and more smallholders under 'scheme' that do not have so much bargaining power. It was mentioned in the previous chapters how both categories of smallholders depend and suffer on two major constraints: deliver the fruits in 48 hours

and deliver them to a specific mill in case of contract with a company. In case of independent farmers, the mill can even refuse their production if the fruits do not reach a certain quality standard.

Another fact is the control operated by refineries in Indonesia: competition between them is very low as it is possible to notice it from results but also from the literature. Indeed, most of the refineries have their own plantation integrated; that means they can reach full capacity of production with their own estates. In total there are 5 big players in Indonesia. One of these is Wilmar International, which controls around 45% of global palm oil production and trade.

Furthermore, some limitations need to be enlightened: Indonesia's smallholders in the palm oil economy embedded different typologies of farmers that in this study are not considered. In fact, there are so many diversities due to the geography and the different organization of the provinces. Idsert Jelsma et al (2017) for example, have identified in the Riau region 7 different types of smallholders, «seven unique groups».

It is also true that there is confusion around the definitions of smallholders. For example, the directorate of Estate Crop (DJP) and the Indonesian Bureau of Statistics (BPS) consider three typologies of smallholders, while the Ministry of Agriculture makes a distinction based on the size of production.

The results obtained from the analysis made possible to put in light the current market dynamics for the palm oil upstream value chain in Indonesia. The sector is not showing presence of competition, and this is also explained by the literature on the field.

In this scenario it seems smallholders are not getting many advantages: local government should act more in favour of the villagers giving permission to build more independent mills and mills without plantations or developing regulations that can account for the wide variety of actors and issues producers face. Another improvement that could help would be make more transparent regulations over the fixing of prices. This calls also for more study and research in support of the adverse implication concerning certification standards.

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