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The natural resource curse
the role of markets and preferences on conflict occurrenc

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The natural resource curse: the role of markets and preferences on conflict occurrence.

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Abstract

The resource curse describes a situation wherein countries that have a large endowment of natural resources suffer from poor economic and social-welfare performance and do not achieve sustainable economic growth and development. Due to the important revenues these resources generate and their volatility; corruption and mismanagement is encouraged, and governments in place fail or lack the political will to invest in the well-being of their population. As such, the resources do not directly cause poverty, but the institutions (or lack thereof) that govern the conditions of their exploitation do. Rent-seeking behaviours appear as a direct consequence of the doing of these institutions, that they are incapable of preventing, or themselves choose to adopt. If we consider rent appropriation as a contest between agents who are willing to resort to violence, then repression is a form of such efforts to capture the contestable rents for the group of individuals at the head of government. In fact, where states do not rely on their citizens for generating revenue (relying instead on resource rents), violations of personal integrity rights appear to be more likely (DeMeritt and Young 2013). In short, the resource curse occurs as a result of poor governance and wealth distribution structures. As rival groups compete for natural resources, conflicts occur.

Colin H. Kahl identifies two pathways whereby this process unfolds (Kahl 2006). The first one is State failure: the population growth, environmental degradation and resource inequality weaken the capacity of the State, as well as its legitimacy and cohesion, which in turn incentivises rebellion and violence. The second is State exploitation. In this configuration, unlike the previous one, political leaders themselves profit from population pressures and resource scarcities through violence. There is a clearly documented link between resource dependency of developing countries and bad governance, characterized by short-sighted and sub-optimal policies from the perspective of public interest (Barma, Kaiser, Le, Vinuela 2012).

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Literature review

The natural resource curse describes the process by which a country's development will be undermined or even prevented by the resources it possesses. The country with a high dependence on natural resources will suffer from macroeconomic and political instability (Frynas, Wood, and Hinks 2017). This phenomenon seems to overwhelmingly affect the poor countries, or less developed countries (LDCs). Historically, resource abundance has been strongly and positively linked to industrial development for the now rich countries. Beginning in the 1950s and 1960s, however, the literature on developing countries began to argue the opposite. For these countries, wealth in natural resources seemed to hinder economic growth. Thus, the term “resource curse” was born. Despite some debate among economists regarding the actual existing of such a relation (Di John 2011; Lederman and Maloney 2007), a plethora of studies have found a strong causal link between resource abundance and poverty. Among those was the very influential Sachs and Warner study from 1995 which showed that on average mineral exporting countries grew slower than the non-mineral exporting countries. Although there are some differences in opinion as to what kind of natural resource are concerned by the resource curse, it is widely agreed that minerals, gas and oil are the main culprits (as empirical evidence is most robust for them). Agricultural resources, on the other hand, are far less regarded as resulting in the resource curse (Ross 2015). The reason for this is because agricultural products are produced and not extracted (unlike minerals), and because they are far less correlated with unfavourable outcomes.

It is possible to consider agricultural products as natural resources under certain conditions. As Ross (2015) points out, there are three components to the definition of natural resources: the type (agricultural/mineral, produced/extracted), the salient quality of the resource (quantity of production, value of production, rents generated through this production, and the value of exports) and the method used to normalise these values (as a fraction of GDP, of total exports, of government revenues). There have been studies on non-mineral products, like forest products (Price 2003; Harwell et al. 2011) or other types of commodities. In this paper, I will propose to look at an agricultural commodity and present arguments for why it makes for a good case study to apply the model.

The concept of resource curse is at the crossroads between political sciences and economics as natural resources affect both political stability and economic growth. In the political science field, natural resources have often been linked to conflict and civil war (Fearon and Laitin 2003; Weinstein 2007; Dreher and Kreibaum 2016). Natural resources have also been found to affect

the democratic transition and human rights, the distribution of public goods, gender inequality, foreign aid, international conflict, and other sectors. Resource wealth can be seen as having the three following political effects (Ross 2015)[1]: strengthen authoritarian regimes; lead to heightened corruption; and trigger violent conflict in low- and middle-income countries.

In economic research, the resource curse takes many forms, with widely varying effects in terms of trade volatility, revenue volatility, economic diversification, human capital formation, long term levels of income and employment, currency appreciation, among others.

Frynas, Wood and Hinks (2017) find that there are three main aspects to the resource curse. The first one is the so-called Dutch disease, where following the discovery of untapped reserves of natural resources a country's currency exchange rate will strongly appreciate due to the export of the valuable resource. This will in turn reduce the country's ability to export non-resource products such as agricultural or manufacturing goods and lead to a contraction of the tradable sector as a whole. By focusing on a single (or a few) grabbable resources, a country can harm its long-term growth. The natural resource sector can draw capital and labour from other non-resource sectors and hamper their development. This idea is present in the model of Dickson, Mackenzie and Sekeris because, although microeconomic, all individuals to make a decision about how to allocate their time and effort. The more time they decide to dedicate to appropriation, the less time they will dedicate to the productive activity. This is in line with Dal Bó and Dal Bó's Heckscher-Ohlin trade model with an appropriative sector which competes with the other sectors for scarce labour and generates revenue by predating the productive sectors. Harding and Venables (2013) found[2] that 1$ of resource revenue decreased non-resource exports by 0,74$ and increased imports by 0,23$. The negative effect of natural resources on the tradable sector may explain the difficulty resource rich countries encounter to diversify their economy. The second aspect of the resource curse mentioned by Frynas, Wood and Hinks is the political effects the resource revenues have on the country's institutions and governance. Simply put, the government's reliance on these revenues will encourage it to focus its efforts and resources to capturing rents and staying in power, rather than improving the lives of its citizens. This translates into higher levels of corruption than in non-resource rich countries. An important literature has supported the idea that resource wealth fuels corruption. Kolstad and Søreide (2009) identify two forms of corruption: rent-seeking and patronage. Patronage is the process through which governments pay off their supporters to stay in power. Therefore, resource abundance helps autocratic regimes to stay in place. The third form taken by the resource curse is conflict. With a higher tolerance to

[1] Although Ross argues that based on the evidence, only petroleum can really be found to have all three effects.

[2] Based on evidence collected from 41 resource-exporting countries during the period 1970–2006.

violence and a lower opportunity cost of resorting to it, extractive activities don't require the same level of human cooperation as other activities do to function properly. As a result, individuals and groups (such as rebel groups, terrorists or revolutionaries) are incentivised to hoard these resources revenues.

A 2011 study from the journal of Comparative Political Studies (Kurtz and Brooks 2011) found that the developmental consequences of resource wealth are strongly conditioned by the country's human capital formation, and by international factors. In this sense, resource abundance can either be a "curse" or a "blessing". I would add that it also depends on the resource in question and its appropriability. In fact, some studies have suggested that the effects of the resource curse are subject to contingencies, such as the type of regime (since democracies are less prone to these effects), and the type of resource (Bhattacharya and Hodler 2010; Ross 2015; Boschini, Pettersson and Roine 2007). There is ample empirical evidence to support the claim that the presence of natural resources significantly increases the probability of violent conflict. Of course, in order for this to be true, the conflicts need to take place in or around the areas where the resources are found[3] (Lujala 2010).

It would be impossible to do an exhaustive review of the literature on the resource curse given the very large number of articles published in recent decades. Instead, I will mention the two conventional effects of the resource curse which are key concepts in this paper: rapacity and opportunity cost.

These two effects combined constitute the basis for understanding the occurrence of conflicts within an appropriation vs production setting. The rapacity effect hypothesis, as described by Dube and Vargas (2008), suggests that an increase in prices will encourage violent competition for grabbable commodities. More valuable rents will incentivize agents to invest effort in appropriating the wealth. Microeconomic studies have focused on different types of resources, from coca (Angrist and Kugler 2005) to minerals (Berman, Couttenier, Rohner and Thoenig 2017), and of course oil (Dube and Vargas 2013). The opportunity cost represents what the individual will miss out on when choosing one alternative over another. The opportunity cost effect suggests that a less profitable use of productive resources translates into a lower opportunity cost of whichever alternative income-generating activity and increases wealth-appropriation incentives. A lower opportunity cost can also be the result of higher resource rents. On the contrary, higher wages in the productive sector may reduce the labour supplied to appropriation activities. The most well-known trigger for the opportunity cost effect are exogenous price shocks in international commodity markets. Negative economic shocks,

[3] This was a determining factor in selecting a case study for this model. An initial country considered was Angola. However, in the case of Angolan oil, a substantial part of the extracted petroleum comes from offshore platforms instead of onshore wells, which makes it harder to link to conflicts.

especially negative international demand shocks, have been shown to cause violent conflict (Miguel, Satyanath and Sergenti 2004; Berman and Couttenier 2015). Jia proposed a historical analysis of the opportunity cost effect through the study of the impact of weather shocks on peasant revolts in imperial China, and the introduction of the sweet potato crop (Jia 2014). Jia shows that weather shocks such as droughts, by destroying crops, reduced opportunity costs for peasants to revolt, and how revolt probability in drought years was more than twice the average.

As the authors explain most of the existing literature on resources and conflict has concentrated on resources that are marketable and for which markets exist. Although these two effects seem to make a link between the amount of contestable resources and the value of the alternative uses of effort and conflict, some authors claim scarcity constitute a central driver of violent conflict (Homer-Dixon 1999, Kahl 2006), especially in a context of the depletion of a resource stock with ill-defined property rights (Diamond 2005).

In their paper, the authors also consider non-marketable goods such as political rights. The existing literature doesn't encompass the historic examples of political rights. Yet, they can be considered a limited and grabbable resource for which individuals compete. However, unlike examples mentioned above, the opportunity cost and rapacity cost cannot explain the historical strive of middle-classes towards civil rights. In fact, political rights have been claimed in many instances (such as those listed by the authors) by middle classes whose income had grown. If the opportunity cost hypothesis held true in these instances, an increase in their income would discourage middle classes from engaging in appropriation activities (such as protesting and demonstrating). This would suggest that economic development appears to generate new social forces standing for more democratic rights (Lipset 1959). In countries with strong state repression, democratic demands will be repressed, and elites will continue to appropriate wealth. Wealth in this context must be understood as the contested resources that are public goods and political rights. Dictatorships and other undemocratic regimes can be seen as markets where public goods (electricity, access to quality infrastructure, education, health…) and political rights (to vote, to choose the policies implemented in the country) are contested resources for which different groups of individuals fight. The lack of these resources means that individuals have an unequal access to these resources and that the appropriation of these resources by one group (the elite) is to the detriment of the others.

Given the lack of literature on the subject, and the more complex nature of political conflict compared to resource conflicts, it is unclear whether economic development brings democracy or the other way around. The example of the servile wars, the most prominent slave rebellions in the Roman Republic, were caused by the poor working conditions and the lack of food and

clothing. More recently, the main causes of the Arab Spring movements were unemployment, misery, high cost of living. Many historical examples show the disenfranchised groups have often sought more equitable conditions and competed for political rights.

Following this literature review, I will now analyse the model and identify its main characteristics.

The theoretical framework

The interest of this model in relation to others already formulated is that it makes it possible to understand the action of agents in relation to an annuity activity, both in relation to the abundance or scarcity of a resource, but also in relation to its price and how it is set, and above all to study the evolution of the agent's behaviour when he has the choice between an annuity and a productive income (which makes it possible to study a change in opportunity costs).

The setting

The setting of the model is an economy where agents consume both a contestable good and a non-contestable good and have preferences that can exhibit diminishing marginal utility over both goods, as well as interactions between them. In this 2-good market, agents invest their time endowment into either appropriating the contestable resource or producing the non-contestable good. Rent appropriation is modelled as a contest where the share of the contestable resource is based on an individual's effort relative to total outlays. To model this contest, a Tullock contest success function is used. A contest can be described as a situation in which individuals compete against each other to appropriate an economic rent. CSFs are used to model tournaments, conflicts, and rent-seeking. Rent-seeking literature originated with Tullock (1980). A CSF provides each player's probability of winning as a function of all players' efforts. Formally, player i's probability of winning is $p_i(x_i, x_j) = \frac{x_i^r}{x_i^r + x_j^r}$. Where x_i and x_j are the efforts of players i and j. Therefore, the probability of player i of winning equal to his effort over the efforts of all players. In this case, all agents are modelled to be symmetric, meaning that their utility curves, productivity and time endowments are identical. As the authors explain in their previous paper (Dickson, MacKenzie and Sekeris 2018) in which they use share contests to look at contests for public funds, share contests can capture lots of economic scenarios, but are seldom employed in the literature, which tends to focus more on winner-take-all functions. However, where the contest functions have been studied, the payoff functions have been linear or quasi-linear. The main issue with these payoff functions being an unchanging marginal rate

of substitution between the participant's effort and the allocation share whatever the size of the latter. "In many applications, such as with rent seeking over public funds, it may appear unrealistic to assume a constant marginal rate of substitution…".

Predictions

The authors make three main propositions which can be summarised as follows:

- When prices are set locally, the curvature of the agent's preferences over the contestable and produced goods, as well as their complementarity/substitutability will determine whether conflict increases or decreases in the resource size (propositions 1 and 2).
- When prices are exogenously determined, the results are those shown in empirical studies so far (proposition 3).

The two pivotal factors of this model are therefore the nature of the market (exogenous or endogenous), and the agents' preferences (as per propositions 1 and 2). The innovation of this model as argued by the authors is the possibility that resource scarcities (rather than abundance) may be the driver of increased conflict. This is because as the stock of the resource becomes scarce, the marginal utility of the resource increases. Further depletion of the resource stock will incentivize agents to devote more time and effort to appropriate the scarcer resource. This prediction lacks some empirical verification.

As per proposition 2, the literature, especially micro-econometric studies mentioned by the authors (Angrist and Kugler 2008; Dube and Vargas 2013; Maystadt et al. 2014; Berman, Rohner and Thoenig 2017) all clearly observe a positive relationship between price shocks and localized violence in geographical areas where the price of the resource is determined exogenously.

Finally, in the case of an absence of markets, such as for political rights and civil liberties, which are not tradable on the market, the authors propose the reading that positive shocks on income-generating activities can induce individuals to devote more time to expanding their political rights. This suggestion relies on the idea that political revolutions are made by the middle class. This is discussed substantially in literature, most notably by Lipset in his 1959 article. This hypothesis will be more difficult to confirm as Acemoglu disproved the link between democracy and income per capita. Despite the empirical challenges, this model manages to create a framework to study resources for which no market exists. In fact, the approach regarding the market structure is an innovation compared with empirical literature which has remained silent on the matter and implicitly considered cases with exogenously given prices.

The Model

With, N = number of agents,

r = contestable good,

y = non-contestable good,

R = total amount of r,

$e^i > 0$ units of time available to agent i.

$x^i \in [0; e^i]$ the number of units of time allocated to appropriating the contestable good,

$l^i = e^i - x^i$ the remainder of time (used to appropriating the non-contestable good).

As discussed above, we have a Tullock share contest, meaning that the payoff of agent i is function of his own effort (x^i) and of the efforts of all other agents (X^{-i}).

$$\pi^i(x^i, \mathrm{X}^{-i}) = \begin{cases} \dfrac{x^i}{x^i + \mathrm{X}^{-i}} & \text{if } x^i + \mathrm{X}^{-i} > 0 \text{ or} \\ \dfrac{1}{n} & \text{otherwise,} \end{cases}$$

X^{-i} is given by $\sum_{j \in N \setminus \{i\}} x^j$, which can be read as the summation of the efforts of all the agents N with the exception of agent i's.

Therefore, the quantity of scarce resource appropriated by agent i is given by:

$\hat{r}^i = \pi^i(x^i, X^{-i}) \cdot R$

And the quantity of non-contestable good that agent i produces is given by:

$\hat{y}^i = \alpha(e - x^i)$

To visualize the choices made by the individual in terms of allocation of time we must first consider a (y^i,r^i)-space. To determine the production possibilities frontier (PPF) we must express r^i in terms of y^i. The resource constraint gives us $l^i + x^i = e$ and the production function implies that $y^i = \alpha l^i <=> l^i = \frac{y^i}{\alpha}$

We can rewrite the resource constraint as follows: $x^i = e - \frac{\hat{y}^i}{\alpha}$

Which gives us the PPF: $\hat{r}^i = \frac{e - \frac{\hat{y}^i}{\alpha}}{\left(e - \frac{\hat{y}^i}{\alpha}\right) + X^{-i}} R$

Each point on this concave curve gives us a combination of the contested and non-contested good that an individual can acquire through the contest. Moving along the curve means giving up on one good in order to acquire more of the other. Therefore, the absolute value of the slope is the **marginal rate of transformation**, meaning the number of units or amount of r^i that must be forgone in order to attain one unit of y^i.

The main goal of this paper is to build a model based on microeconomic theory in order to observe, understand and make predictions about individuals' choices between acting as rent seekers and engaging in productive activities.

These events are sufficiently fine-grained to be geo-coded down to the level of individual villages, with temporal durations disaggregated to single, individual days

The assumption in this framework is that there is a constant return to scale, or $F(aK, aL) = aF(K, L)$.

An agent $i \in N$ will acquire a bundle $(r^i, y^i) \in \mathbb{R}_+^2$ which will give him a level of utility $u^i(r^i, y^i)$.

Assumption: all agents are symmetric, meaning that they behave the same way.

Thus, $e^i = e, u^i(r^i, y^i) = u(.,.)$ and $\alpha^i = \alpha$ for all $i \in N$.

The amount of resource received by an agent is governed by a **Tullock share contest**:

If two players x^i and x^j compete over the appropriation of a resource, then the share of resource received by player x^i is given by $\frac{x^i}{x^i+x^j}$.

Quantity of resources allocated to agent i:

$l^i + x^i = e$ the resource constraint,

$\hat{y}^i = \alpha l^i$ the production function,

Such that $l^i = \dfrac{\hat{y}^i}{\alpha}$

And $x^i = e - \dfrac{\hat{y}^i}{\alpha}$

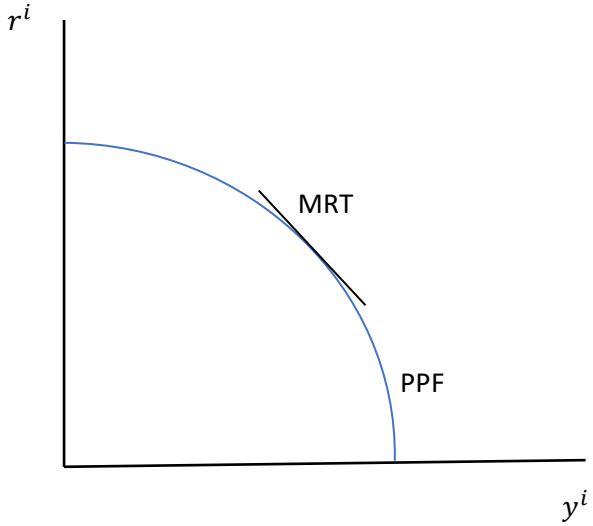
We have $\pi^i\left(x^i, X^{-i}\right) = \dfrac{x^i}{x^i + X^{-i}}$ $as\ x^i + X^{-i} > 0$

We know that $\hat{r}^i = \pi^i\left(x^i, X^{-i}\right) \cdot R$ $and\ X^{-i} = \sum_{j \in N \setminus \{i\}} x^j$

then, $\hat{r}^i = \dfrac{e - \dfrac{\hat{y}^i}{\alpha}}{e - \dfrac{\hat{y}^i}{\alpha} + \sum_{j \in N \setminus \{i\}} x^j} \cdot R$

Thus, $\hat{r}^i$ represents agent i's Production Possibilities Frontier, meaning the expression of resource r in terms of y. Graphically we can represent this as the curve in Figure 1. The absolute value of the slope represents the Marginal Rate of Transformation.

Figure 1: Production Possibilities Frontier in (y^i, r^i)-space



It is obtained by differentiating the PPF, since $r = f(y)$. MRT= $\frac{dr}{dy} = -f'(y)$.

This derivation is of the form $\left(\frac{u}{v}\right)' = \frac{u'v - uv'}{v^2}$.

With, $u = \left(e - \frac{\hat{y}^i}{\alpha}\right);\ u' = -\frac{1}{\alpha};\ v = \left(e - \frac{\hat{y}^i}{\alpha} + X^{-i}\right);\ v' = -\frac{1}{\alpha}$

$$f'(y) = \frac{-\frac{1}{\alpha} \cdot \left(e - \frac{\hat{y}}{\alpha} + X^{-i}\right) - (e - \frac{\hat{y}^i}{\alpha}) \cdot (-\frac{1}{\alpha})}{(e - \frac{\hat{y}^i}{\alpha} + X^{-i})^2} \cdot R$$

$$f'(y) = \frac{\cancel{e - \frac{\hat{y}}{\alpha}} + X^{-i} - \cancel{(e - \frac{\hat{y}^i}{\alpha})}}{(e - \frac{\hat{y}^i}{\alpha} + X^{-i})^2} \cdot \frac{R}{\alpha}$$

$$f'(y) = \frac{X^{-i}}{(e - \frac{\hat{y}^i}{\alpha} + X^{-i})^2} \cdot \frac{R}{\alpha}$$

We have the PPF: $\hat{r}^i = \frac{e - \frac{\hat{y}^i}{\alpha}}{e - \frac{\hat{y}^i}{\alpha} + X^{-i}} \cdot R$, the resource constraint: $l^i + x^i = e^i$,

The MRT: $\frac{X^{-i}}{(e - \frac{\hat{y}^i}{\alpha} + X^{-i})^2} \cdot \frac{R}{\alpha}$, the production functions: $x^i = e - \frac{\hat{y}^i}{\alpha}$

$$y^i = \alpha \cdot l^i$$

Equilibrium with endogenous price formation

The price of the contested good is ϕ and the price of the non-contested good is normalized to 1. We have seen the amount of contestable resource that an individual receives is given by $\frac{x^i}{x^i + X^{-i}} R$, and the amount of non-contestable resource he receives is given by $y^i = \alpha[e - x^i]$. Therefore, the individual's budget is given by $\alpha\left[e - x^i\right] + \phi \frac{x^i}{x^i + X^{-i}} R$.

Following the transaction on the market, the individual's allocation of the contested and non-contested good are respectively denoted as $\tilde{r}^i$ and $\tilde{y}^i$. Since the value of the obtained bundle must be inferior or equal to the budget, it follows the individuals have to solve the following maximisation problem:

$$\max_{x^i, \tilde{r}^i, \tilde{y}^i} u\left(\tilde{r}^i, \tilde{y}^i\right) s.t. \begin{cases} \tilde{y}^i + \phi \tilde{r}^i \leq \alpha\left[e - x^i\right] + \phi \dfrac{x^i}{x^i + X^{-i}} R \\ \sum_{j \in N} \tilde{r}^j(\phi) = R \end{cases}$$

The outcome of this contest will determine what point on his PPF the individual reaches. He can then trade either one of the two goods of his bundle on the market to maximise his utility. This trade is subject to his budget constraint of course. However, since prices are determined endogenously and the rate of exchange between the contested and non-contested good is not fixed, this budget constraint is subject to a complex function. The solution to this issue is to consider that we have a contest with symmetric agents. Since the market clears locally, then it must be the case that all individuals are on the PPF, meaning that the marginal rate of substitution and marginal rate of transformation will be equal.

In a symmetric equilibrium, we have: $\tilde{r}^i = \frac{R}{n}$, $\tilde{y}^i = \alpha(e - x^*)$, $X^{-i} = (n-1)x^*$

Therefore, we have,

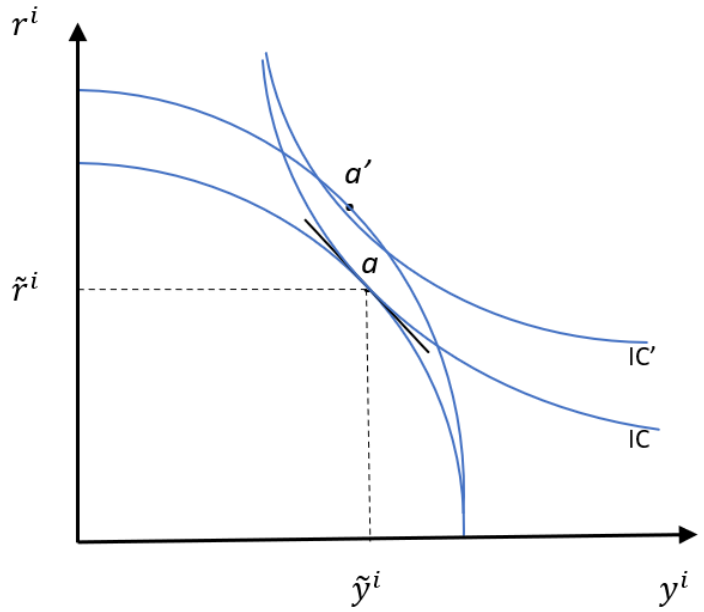
$$\begin{aligned} MRS^i\left(\frac{R}{n}, \alpha(e - x^*)\right) &= \frac{(n-1)x^*}{\left(e - \dfrac{\alpha(e - x^*)}{\alpha} + (n-1)x^*\right)^2} \cdot \frac{R}{\alpha} \\ &= \frac{(n-1)x^*}{(x^* + (n-1)x^*)^2} \cdot \frac{R}{\alpha} \\ &= \frac{(n-1)x^*}{x^{*^2} + 2x^*(n-1)x^* + (n-1)^2 x^{*^2}} \cdot \frac{R}{\alpha} \\ &= \frac{(n-1)}{x^* + 2(n-1)x^* + (n-1)^2 x^*} \cdot \frac{R}{\alpha} \end{aligned}$$

$$= \frac{n-1}{x^*(1+2(n-1)+(n-1)^2)} \cdot \frac{R}{\alpha}$$
$$= \frac{n-1}{n^2} \cdot \frac{R}{\alpha \cdot x^*}$$

We can use this expression to determine the how the optimal allocation of the contested and non-contested good change as the total amount of the contested good changes.

Now let's consider an increase in R in the setting with endogenous price formation. We can use the optimality condition to study the effects of the change in R while the contest effort remains constant. The partial derivative of the MRS with respect to R is $\frac{1}{n}$, so the MRS changes by $\frac{1}{n} MRS_r^i = \frac{1}{R} r^i MRS_r^i$ (using the optimality condition). The partial derivative of the MRT with respect to R equals $\frac{n-1}{n^2} \cdot \frac{1}{\alpha \cdot x^*} = \frac{1}{R} MRS^i$ (again with the optimality condition).

Figure 2: Effect of a change in R on the MRS and MRT



We measure the R – elasticity of the marginal rate of substitution and of the marginal rate of transformation, measuring the responsiveness of both to changes in R.

In the first case, such as in Figure 2, the MRT increases faster than the MRS, meaning that there is an increase in appropriation time and a decrease a production time (optimal consumption moves from *a* to *a'*). If the MRS increases marginally more than the MRT, meaning that it is more elastic to changes in R than the MRT, it then follows that an increase in R results in a decrease in appropriation time x^i.

Proposition 2 echoes proposition 1. In fact, proposition 1 consists in an increase in quantity of the contested resource R, which can lead to 2 cases, either the marginal rate of substitution is elastic between the 2 goods, in which case the contested good would be relatively less interesting and agents would devote more of their time to productive activities; or the marginal rate of substitution is inelastic, in which case agents will increase the time dedicated to appropriating the contested good monotonically to the increase in its quantity.

Proposition 2 works the same way, except that instead of increasing the quantity of R, we consider an increase in the productivity parameter, α. Likewise, if the MRS changes by less than the MRT, meaning the marginal rate of substitution of r to y is inelastic to changes in quantity of y^i, increasing α will lead to a substitution of appropriation time for production time. The originality of this model is the coexistence of two alternate scenarios.

Equilibrium with exogenous price formation

The situation with exogenous prices assumes that "goods can flow in and out of the local economy in which the contest takes place and that actions in the local economy have no influence on the relative price of the contested good". The intuition is simpler as prices are given. The agent's optimisation problem is the following:

$$\max_{\tilde{r}^i, \tilde{y}^i, x^i} u\left(\tilde{r}^i, \tilde{y}^i\right) = s.t. \bar{\phi}\tilde{r}^i + \tilde{y}^i \leq \bar{\phi}\frac{x^i}{x^i + X^{-i}}R + \alpha(e - x^i)$$

Since prices won't be determined by agents' actions, they will all attempt to maximise their utility through a market allocation subject to a linear budget constraint given by the allocation of the contest. It then follows that each agent will seek to maximise their available budget. First Order Conditions then allow us to conclude unambiguously that an increase in R will give rise to an increase in appropriation efforts.

With an understanding of the theoretical framework and based on my literature review, I will now approach the question of empirical testing by identifying and analysing a case of conflict to assess how it fits the theoretical frame, and formulate preliminary conclusions on the model and its limitations.

An approach to empirical testing

In this section, I will attempt to set the stage for an empirical test of the model's predictions. Based on an identification methodology and using the most accurate and up to date data sources, I will propose a case study that meets the model's conditions and fits its theoretical framework. I will also highlight, through a case study, the problems with the empirical study of the model's assumptions and propose ways to overcome them.

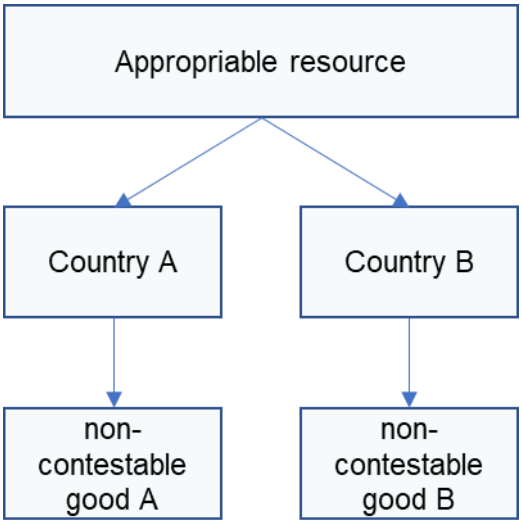
Methodology

The goal of this project is to confront the model to a real-life example of the resource curse, and to better understand the impact of environmental depletion and of Malthusian pressures on conflict. As pointed out by Dickson, Mackenzie and Sekeris (2018), many scholars stand in stark opposition on the question of the actual driver of resource conflict, namely which of scarcity or abundance drive violent conflict. The two challenges put forward by the authors is the identification of robust datasets and the limits of empirical testing due to the issue of ecological fallacy.

Identifying a case study

The next step is to find at least one resource where both economic frameworks can be studied (endogenous and exogenous). One of the challenges is to find settings where prices are determined endogenously, meaning where the resources are consumed locally. Another concern for applicability is the level of observation. The model could as well be applicable to an infra-state level setting as to the world market. In order to realistically apply the model to a setting, I only considered those countries for which natural resources represented an important enough part of their GDP.

Figure 3: Identification matrix for endogenous and exogenous settings



I will be following this step-by-step process, such as represented by the matrix in Figure 3.

1. Find in databases countries with extensive conflict data (fine-grained and disaggregated at the smallest administrative level).
2. Filter these countries according to their production of valuable resources in order to identify two as follows:
    a. Country A (or region A in country A) that produces enough of the valuable resource so that it can be considered big enough to influence the price on the world (or national) market.
    b. Country B (or a smaller region B in country A) that produces the same resource but to a much smaller extent, so that the price determination of the resource does not depend on B's output.

This will make it possible to have a case study with endogenous prices and a case study with exogenous prices. The preferred scale will obviously depend on the results of this research. The third configuration, i.e. the absence of a market, will not be considered for the reasons expressed hereunder.

Ecological fallacy and the issue of cross-country analyses

The issue here is that of ecological fallacy. The expression attributed to Hanan C. Selvin (1958) describes a fallacy in the interpretation of statistical data due to inferences made about an individual based on aggregate data for a group. As explained by the authors, the difficulty arises in a cross-country setting. Since the agents don't act in the same market and under the same conditions, the assumption that all agents are symmetric $e^i = e, u^i(.,.) = u(.,.)$ and $\alpha^i =$

α for all $i \in N$ cannot hold. Already with a micro-empirical setting, the increase in the price of a natural resource is likely to have a differential effect on the propensity to take up arms across geographical regions depending on local specificities. This holds true and is even reinforced when working in a cross-country setting. The difficulty is also that there are many unobservable variables. In fact, "the country-heterogeneity may therefore mask opposing mechanisms taking place across countries, eventually yielding ambiguous econometric results" (Dickson, MacKenzie and Sekeris 2018).

One issue that arises in particular is linked to the diminishing marginal utility over both goods and the assumptions made on the MRT and MRS. Depending on the country, or the region, the agents' MRS may differ widely. This in turn will affect the time allocation for the appropriation activity (consistent with Proposition 1).

The absence of market

Finally, there is also an issue with the case where there is no market to observe. As mentioned in the literature review, the difficulty of the third setting, which relies on Lipset's modernization hypothesis, is that while the authors make the case that the equilibrium will be exactly the same as in the case with endogenous markets, these is no possibility to empirically verify the hypothesis and literature so far, as well as historical examples provide mixed support to this theory. Acemoglu (2008) in particular demonstrated the absence of correlation between initial economic development and democratization. On the contrary, oligarchic societies tend to achieve greater efficiency.

Data

To test the implications of the model, I will need to combine conflict data with data on output, production, prices and export, all of which serve the same function of providing information on the value and quantity produced of both the contested and non-contested resources (see box 1).

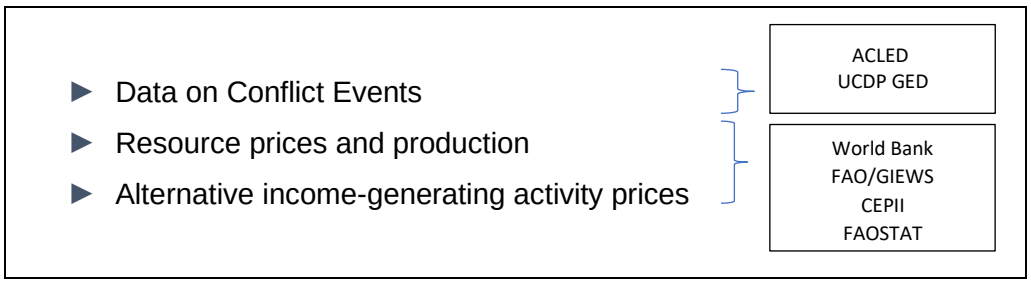
Useful data requires geographical and temporal disaggregation of conflict events. It was obtained from two main sources. The first one is the Uppsala Conflict Data Program Georeferenced Events Dataset (UCDP GED). It is a very disaggregated dataset that covers individual events of organized violence (phenomena of lethal violence occurring at a given time and place). Each individual conflict listed is assigned a date, location, duration and type code. This allows for a village-level geocoding with temporal durations specified in number of individual days. In particular, I used the following dataset: the Sundberg, Ralph, Kristine Eck and Joakim Kreutz (2012) Introducing the UCDP Non-State Conflict Dataset. This conflict-year

dataset contains information on communal and organized armed conflict where none of the parties is the government of a state.

The second source of conflict data is the Armed Conflict Location & Event Data Project (ACLED) database. It is a disaggregated database referencing the dates, actors, locations, fatalities, and types of all reported political violence and protest events.

Adopting the same criteria as Adhvaryu et al. in their paper *Resources, Conflict, and Economic Development in Africa* (2018), I chose to study territorial conflicts and to exclude riots, protests or non-violent events. As for Adhvaryu et al., while choosing to disregard certain types of conflicts lowers the number of observed conflicts substantially, it also ensures that I focus on the interactions most relevant to the model setup. One clarification must be added here, however, since in order to test all the hypotheses of the model, it would be necessary to observe the three market structures described, i.e. a market with endogenous prices, one with exogenous prices, and a case with no market. In this last case, it would be necessary to include in the scope of this paper riots and protests, which are the main ways of claiming political rights. However, as mentioned earlier, the case of an absence of market will not be considered here.

Box 1: Necessary datasets



Case study: Vanilla

One difficulty in identifying endogenous markets when looking into the resource curse is the fact that natural resource markets are global and resource exporters are generally assumed to be price-takers. Even in the case of oil, where OPEC is considered to have some ability to affect global prices, empirical evidence doesn't seem to indicate that it is the case (Barsky and Kilian 2004; Hamilton 2008). Based on the data obtained and following the research methodology above, I will be discussing the case of vanilla, and its production in different settings. Vanilla is one of the most volatile commodities on the global market.

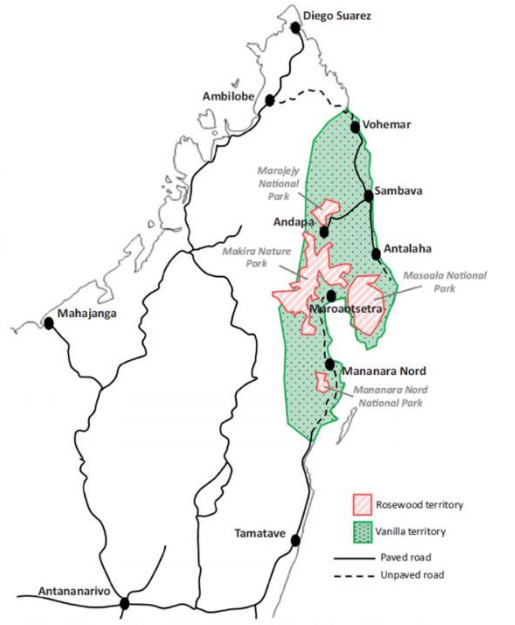
An endogenous setting: Madagascar

The endogenous market I identified is Madagascar. This island has evolved in ecological isolation since its separation from the Indian subcontinent 88 million years ago, which has allowed the development of a very particular fauna and flora. 75% of the species are endemic there. This is not the case for vanilla, which originated in Mexico. However, vanilla lives in the undergrowth of tropical rainforests and its cultivation has spread to various tropical regions of the world. Two countries, Madagascar and Indonesia, provide the bulk of the world's supply.

Researchers have described Madagascar's economy as a kleptocracy, an economy of plunder where one clan's control of a resource will lead to conflicts with other rival clans. Corrupt elites fight for their individual wealth, creating instability that harms everyone and impoverishes the country as a whole. And it is precisely this very high level of poverty that makes it all the more attractive to extract precious resources, and thus strengthens the economy of plunder, in a kind of vicious circle.

Figures 4 & 5: Communities with vanilla in top 5 crops (4); The vanilla and rosewood territories of north-eastern Madagascar (5)

Source: Kaila and Boone 2020



Source: Zhu 2018

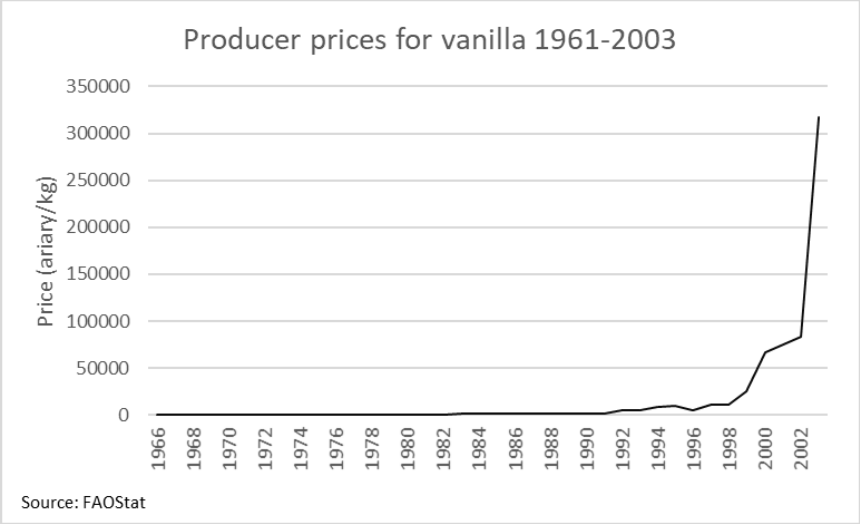
The contested resource

Vanilla production is concentrated in Madagascar's tropical North-East, especially in the Sava region, whose name is an acronym formed after its four districts: Sambava, Antalaha, Vohemar and Andapa (Figures 4 and 5).

The price of this raw commodity is determined in regional markets where growers negotiate and sell their production to the buyers, usually representatives of exporters and international flavouring companies. A per-kilogram price for the crop is agreed upon. These isolated producers have come to dominate world supply. In fact, Madagascar was already producing around 30% of the world's supply by the 1980's, but prices where then fixed by the Government. Price-setting was abandoned in the mid-1990's under pressure from the World Bank. Since then, vanilla prices have increased considerably (see Figure 6). Predictability and a steady price increase of 2 to 3 percent a year (Rain 2004) gave way to intense speculation and acute shifts in local supply and global demand that prompted booms and busts in Madagascar's vanilla market. This boom-and-bust phenomenon, due to the scarcity-based market structure, as well as to the integration into the global economy and price liberalisation, also concerned the other major cash crops in the region, namely coffee, cloves, pepper and cocoa. There are two reasons Madagascar came to dominate world vanilla production: quality

and price. Quality of the product first. Although this has tended to be less true in recent years as farmers trying to satisfy demand started picking the beans earlier than normally would, meaning the beans had less flavour than the mature ones. When vanilla importers fear a poor-quality harvest, they try and secure the available beans early, driving demand and prices upward. This creates a perverse incentive for growers who feel pressured to pick the beans to early, resulting in beans of lesser quality, as anticipated. The second reason is price. Vanilla production is very labour-intensive (none of the planting, pollinating, cultivating, and curing activities have been mechanised), and labour in Madagascar is very cheap: Madagascar's legal minimum wage for agricultural workers is 0,12$ per hour[4].

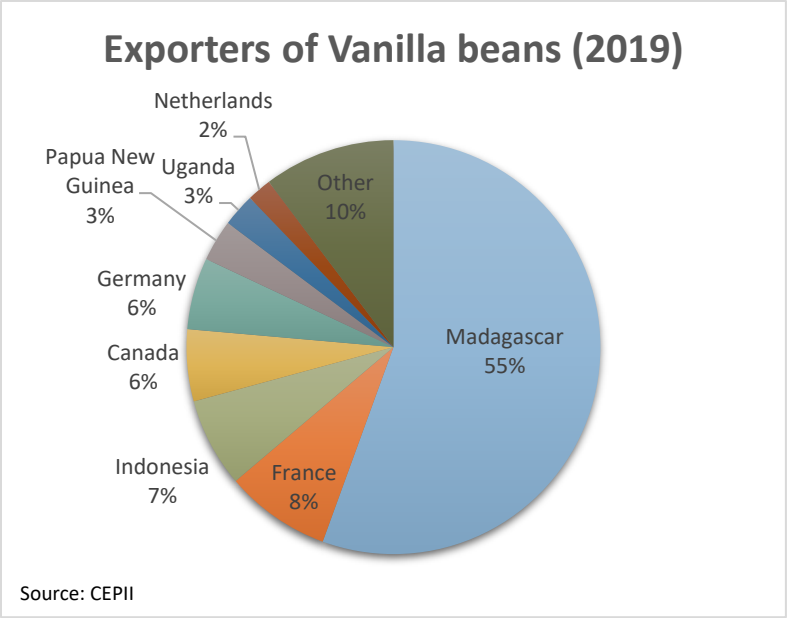
Figure 6: Producer prices for Vanilla 1961-2003



Madagascar is responsible for around 60% of the production of vanilla in the world, as illustrated in Figure 7. The importance of Madagascar's production for world supply is best shown by the supply shocks associated with natural disasters. Following the three successive cyclones and the tropical storm that devastated the northeast and central eastern coast of Madagascar in February, March and April 2000, about 155,000 hectares of cereals and 33,000 hectares of export crops were lost. The sudden drop in vanilla bean exports resulted in a sharp rise in its price on the world market for the next few years, as can be seen in Figure 8. By 2006, prices were back to a low point. The price surge of the previous years led the food industry to turn away from natural vanilla in favour of synthetic alternatives. In addition to the decrease in demand, supply increased, with the arrival of new producers, who had begun to produce the orchid when prices were at their highest, and whose first harvests were reaching maturity.

[4] Madagascar, Social Security Programs Throughout the World, Africa, ISSA, 2009. https://www.ssa.gov/policy/docs/progdesc/ssptw/2008-2009/africa/madagascar.html

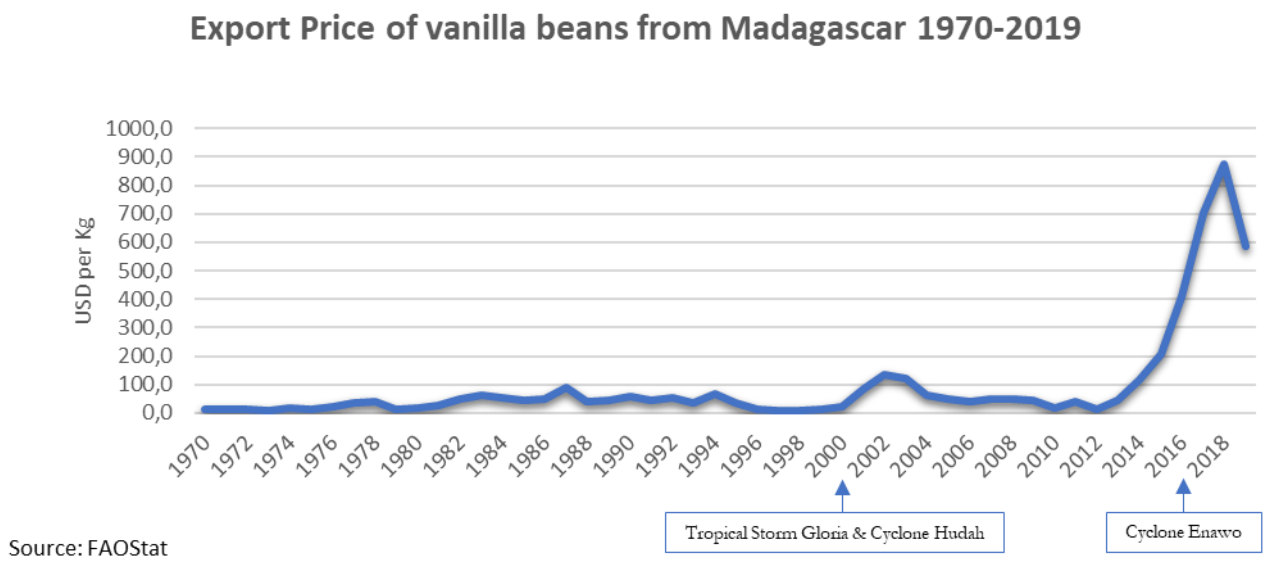
Figure 7: Main exporters of vanilla beans in 2019



The early harvesting done by the farmers in an attempt to prevent thefts means the vanilla beans aren't mature and have lower vanillin levels, the compound where the aroma comes from. Despite the dwindling quality, prices continued to increase as global demand remained insatiable. Between 2013 and 2018, the price of the bean had soared by nearly 2000%, from around $44 per kilogram in 2013 to $875 in 2018. The mix of high demand, poor quality and low production risks jeopardizing this sector. The second price spike observed in Figure 8, which culminated in the all-time high of 2018, seems to have a different origin. This time the increase in world price was due to an increase in demand, especially from the food industry, which is the main buyer of vanilla. Starting 2015, several of the largest groups of the sector decided to substitute natural vanilla for imitation flavouring in order to meet consumer demands.

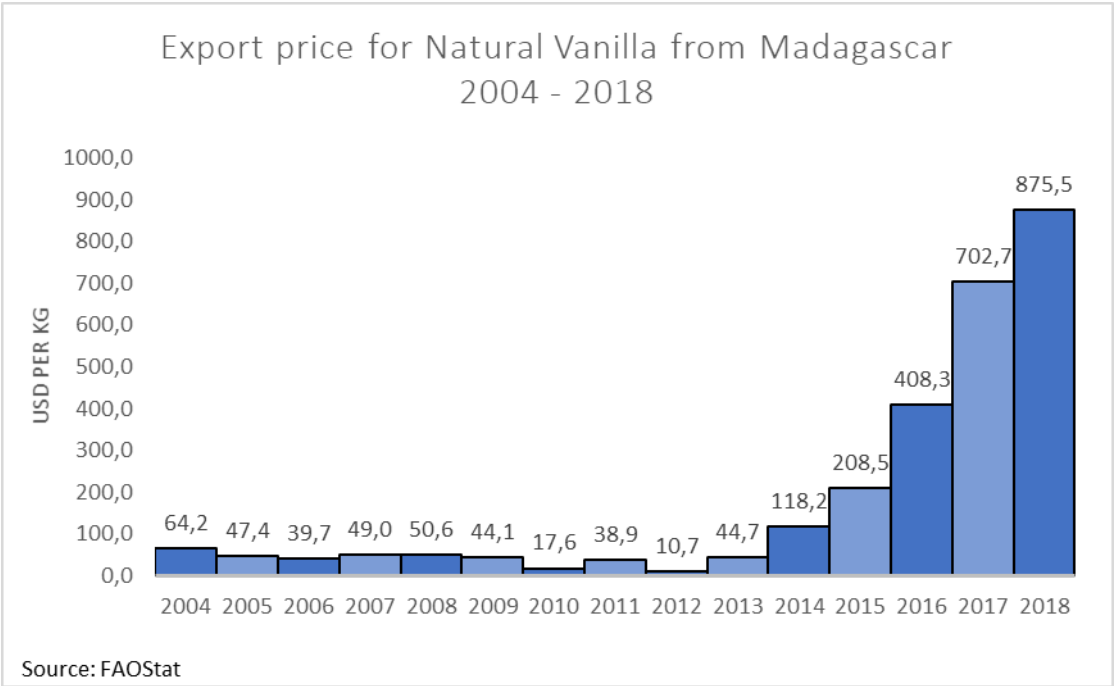
The strong influence of the demand on world prices constitutes one of the main obstacles to empirically test the predictions of the model, namely that when prices are endogenously determined, resource abundance should reduce conflict. It appears that in the global market for primary commodities or natural resources, extraction is dictated by the developed countries, despite several less-developed countries having a quasi-monopole on the production of certain primary commodities.

Figure 8: Export price of vanilla beans from Madagascar 1970-2019



Source: FAOStat

Figure 9: Export price for natural vanilla from Madagascar 2004-2018



Source: FAOStat

The appropriation effort choice

Within the framework of this model, where individuals choose how much time to allocate to production (l^i) or to appropriating the contestable good (x^i), the vanilla growers are treated as agents deciding how much of their production (time) will be destined to growing and harvesting vanilla, and how much will be allocated to growing other types of crops. While both the contestable good r and the non-contestable good y are crops in this setting (see below), the distinction lies in the fact that vanilla constitutes a cash crop, or profit crop, since it is grown to

sell for profit, whereas crop y is a subsistence crop. In fact, "vanilla growers and driers have little idea how consumers use the spice, and they certainly do not use it themselves" (Zhu 2018).

It should be noted that since vanilla production also represents a labour-intensive activity according to the constant returns to scale production function $y^i = \alpha^i l^i$, meaning there exists a productivity parameter α, such that the quantity $\hat{r}^i$ allocated to agent i will no longer be solely determined by the time he and other agents allocate to the contest. This constitutes the biggest difference between vanilla and other, more "grabbable" natural resources. However, the hand-pollination process hasn't change since its discovery in 1841, and vanilla bean production has remained essentially the same since then. In fact, "vanilla, as one of the most labour-intensive cash crops, lacks economies of scale, so its cultivation continues on small family plots throughout the countryside. Growers still use basic techniques introduced by the colonial regime, planting vine by vine with basic shovels and pollinating flower by flower with no more than a splinter delicately bending the anther" (Zhu 2018). This allows us to normalise α to 1, leaving us with the original $\hat{r}^i = \frac{x^i}{x^i + X^{-i}} R$. In addition, this allows us to partially deal with the issue of ecological fallacy mentioned previously.

The non-contestable good y

In determining the non-contestable resource y, we first need to look more closely at the structure of Madagascar's rural economy.

Most rural households in Madagascar earn their living primarily from agricultural activities. Although non-agricultural activities are also practiced, they are less common and do not involve all households. Rice is Madagascar's main staple and most obvious choice for an alternative non-contestable produced good. It is cultivated in all situations and all regions and is intimately linked to the Malagasy cultural and daily life. The rice sector has been studied extensively, and the work of Dabat et al. (2000) has shown the large number of actors who work and live from rice. A significant portion of rural households' income comes from rice growing. In fact, it was estimated that in 2001, 86% of all rural households engaged in some rice growing[5] (Minten, 2003). Other crops include maize, cassava, potatoes, sweet potatoes, peanuts, beans, vegetables, fruits, and more, and there is a strong regional specialization. While rice is the most common crop, maize and cassava are more important in the south and cash crops dominate in the eastern part of the country. The coexistence of surplus and deficit regions and the distinctly different consumption structure of urban agglomerations generate a significant

[5] And some 21% also grew some other crops as cash crops.

volume of interregional trade. Accounting for the import requirements (see table 1), we can assume that the Malagasy rice market is endogenous, as the good is almost entirely produced and consumed by the individuals inside the market.

Table 1: Rice supply/demand balance

Rice supply and utilisation data	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**	**2019**	**2020**
Domestic Availability (000 tonnes)	3 206	3 191	2 830	2 782	2632	2 599	2646	-	-	-	2 613
Utilization (000 tonnes)	3 264	3 314	3 130	3 032	3132	2 899	2966	-	-	-	3 103
Import Requirements (000 tonnes)	58	123	300	250	500	300	320	-	-	-	490
Per Caput Consumption (kg/year)	125	129	125	120	118	107	107	-	-	-	99

Source: FAO/GIEWS Country Cereal Balance System (CCBS) data

As reported in the 2018 Supply and Market Outlook report for Madagascar from the Famine Early Warning Systems Network[6], high prices of cash crops, especially vanilla, have been reported to affect planted area of food crops. This means that farmers, just like thieves, have a time-allocation choice to make. The vanilla growers, who also produce food crops, must decide whether to dedicate their time and land to producing vanilla or to producing other crops.

$$e^i(Total\ production\ time) = l^i(Rice\ producing) + x^i(Vanilla\ producing)$$

A small step away from the initial Tullock share contest where all agents are identical, the market for vanilla can be seen as having two types of agents: vigilante farmers and thieves.

Crop theft has been shown to increase with transitory poverty (Fafchamps and Minten 2004) and is mainly the usage if the rural poor as a risk coping strategy. As such, this form of crime does appear to respond to economic incentives, unlike others such as homicide or cattle theft. These findings are consistent with the opportunity effect channel such as identified by the authors and systematically established by empirical literature (Miguel, Satyanath and Sergenti 2004) and allow us to consider the main drivers of conflict to be negative shocks on agricultural income or other forms of production income, and positive international demand shocks.

6 https://reliefweb.int/sites/reliefweb.int/files/resources/Madagascar%20Supply%20and%20Market%20Report_Jan%202018_final_0.pdf

Preliminary findings

As a very first step towards empirical testing, I will now compare the authors' propositions with my initial results. As we can see from Figures 11 and 12, in the medium term both conflicts and vanilla exports have followed a positive trend. For Madagascar, an encouraging result would be a negative correlation between the amount of vanilla produced and the number of conflicts.

I use the following two equations to perform a simple regression analysis:

$$Con_t = \alpha + \beta ProductionWeight + \varepsilon_t$$

and

$$Con_t = \alpha + \beta ProductionWeight_{t-1} + \varepsilon_t$$

Where the dependent variable Con_t stands for the number of conflicts which occurred in the country in time t, $\beta ProductionWeight$ is the net weight of vanilla produced in the country in time t, $ProductionWeight_{t-1}$ is the net weight of vanilla produced in the country in time $t-1$, and ε_t is the standard term of error.

Using non-lagged annual variables, the sample correlation coefficient between the two variables $ProductionWeight$ and Con gives us $r_{ProductionWeightCon}$ = 0,647335. This result points to a high degree of positive correlation between the production of vanilla and the number of conflicts (as illustrated in Figure 10). Contrary to the predictions for the endogenous market, when production increases, so does conflict. Results vary considerably according to the chosen time unit. The creation of lagged variables allows us to take into account the fact that conflicts are the consequence of the previous period's production. Despite this, the results of the regressions indicate only an extremely small coefficient, and do not exclude the null hypothesis.

The results are even less conclusive when the preferred unit of time is the month. The lack of a clear relationship between the two variables is more visible graphically, as shown in Figure 13. One proposed solution is to filter the data to keep only localized conflicts in vanilla-producing regions (see above). Unfortunately, the other problem that arises is that of lack of data (Figure 14). This is due to the few conflicts recorded in these regions at that time.

Figure 10: Vanilla production and conflict occurrence

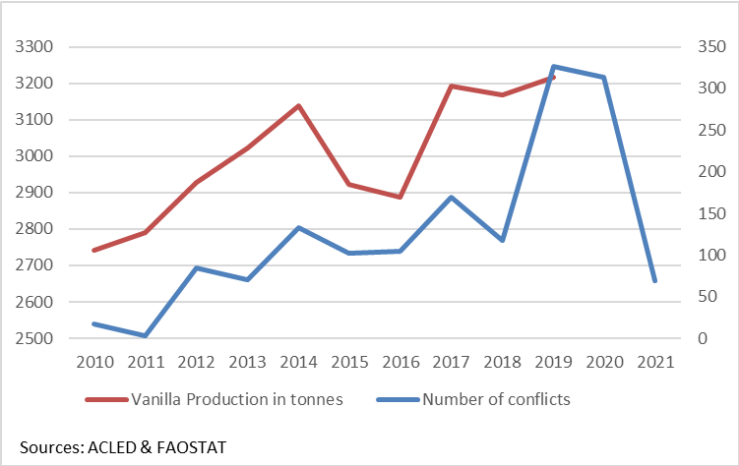


Figure 11: Madagascar's exports of vanilla 2012-2020

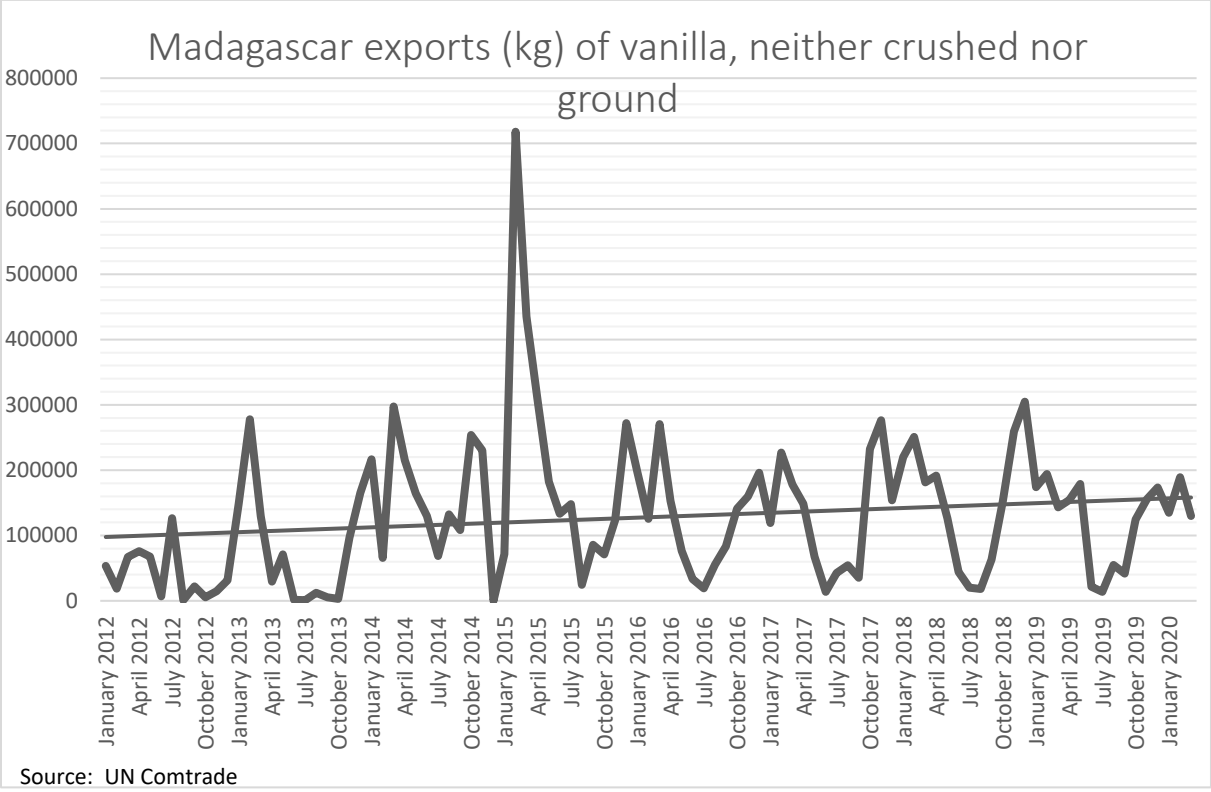
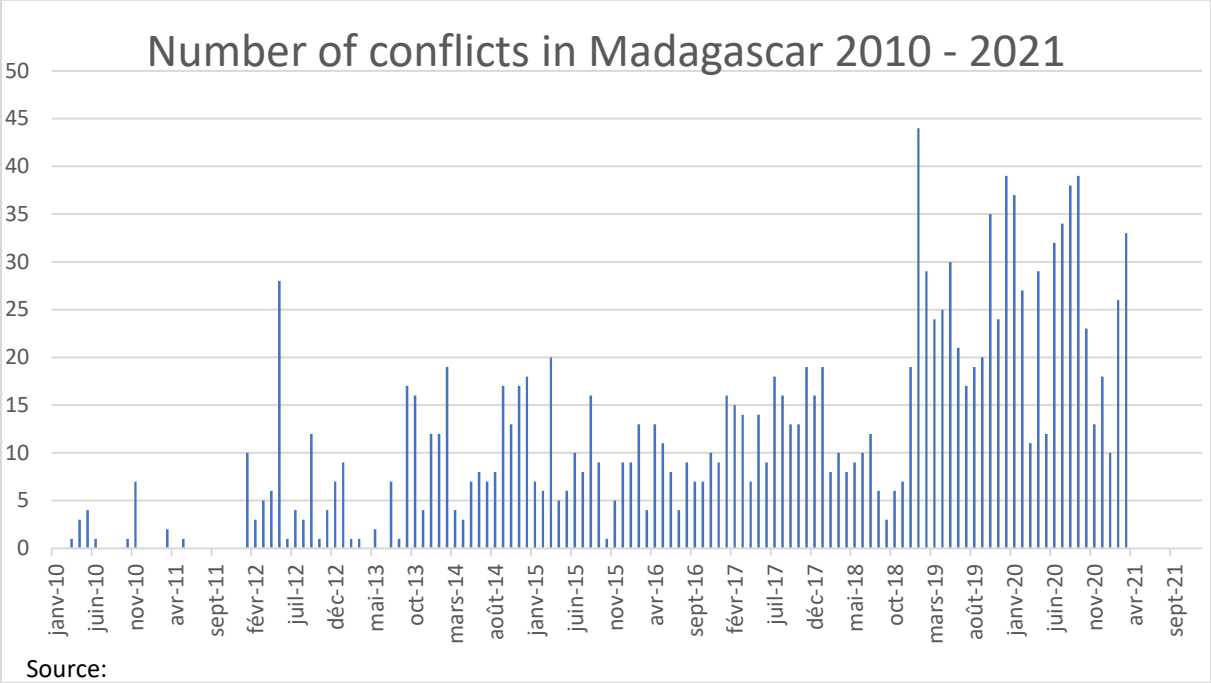
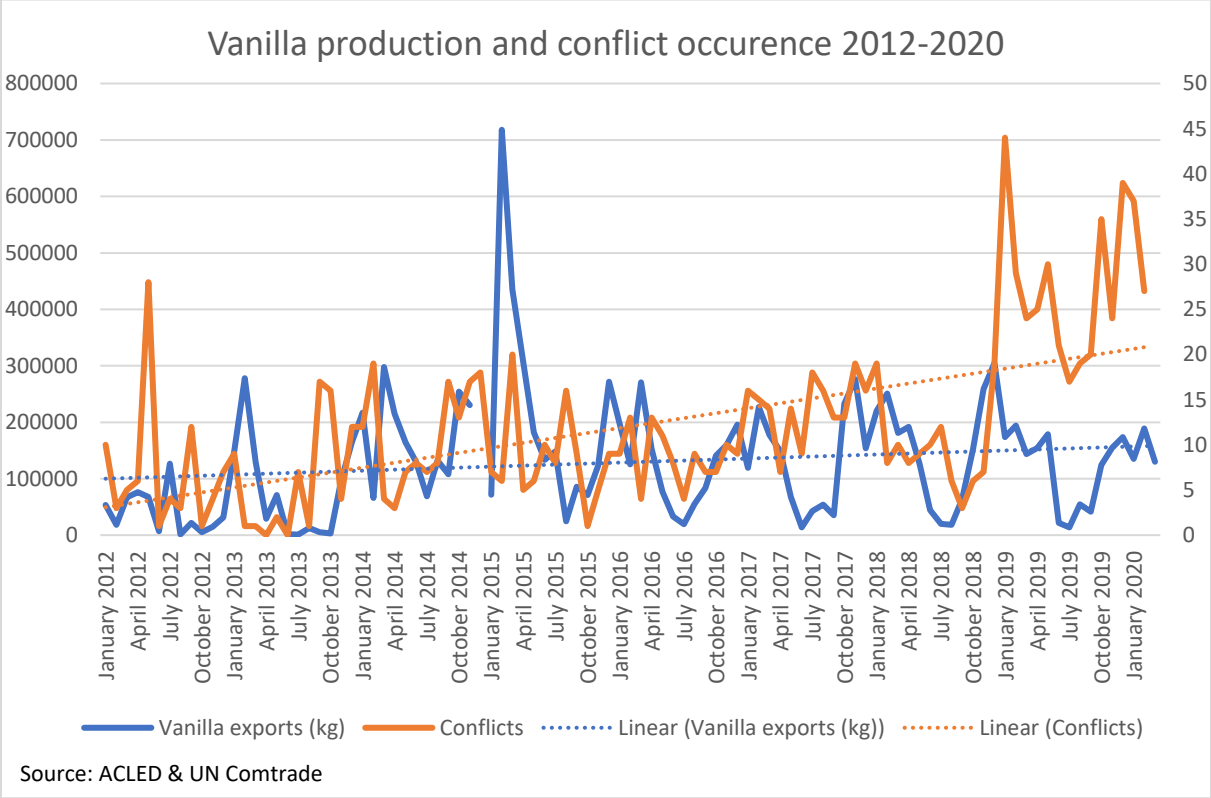


Figure 12: Number of conflicts in Madagascar 2010-2021



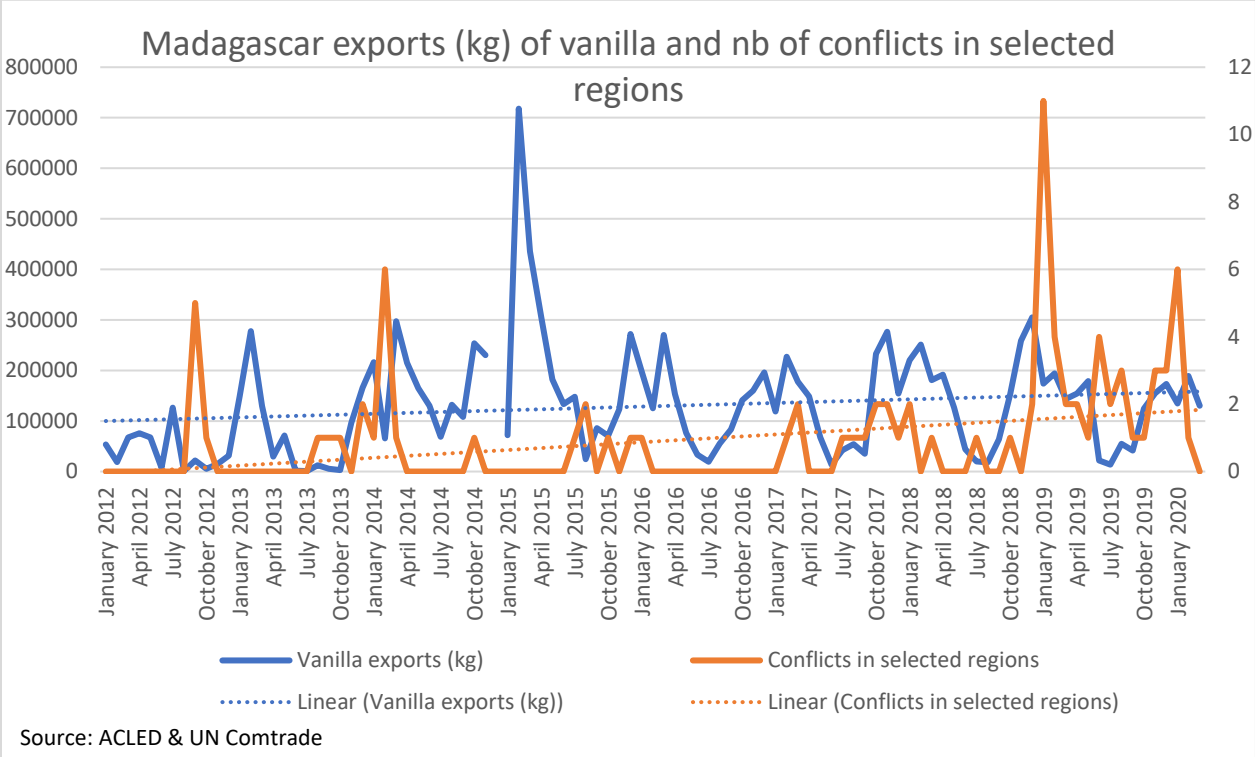
Source:

Figure 13: Trends in exports and conflict in Madagascar 2012-2020



Source: ACLED & UN Comtrade

Figure 14: Trends in exports and conflicts in selected regions of Madagascar

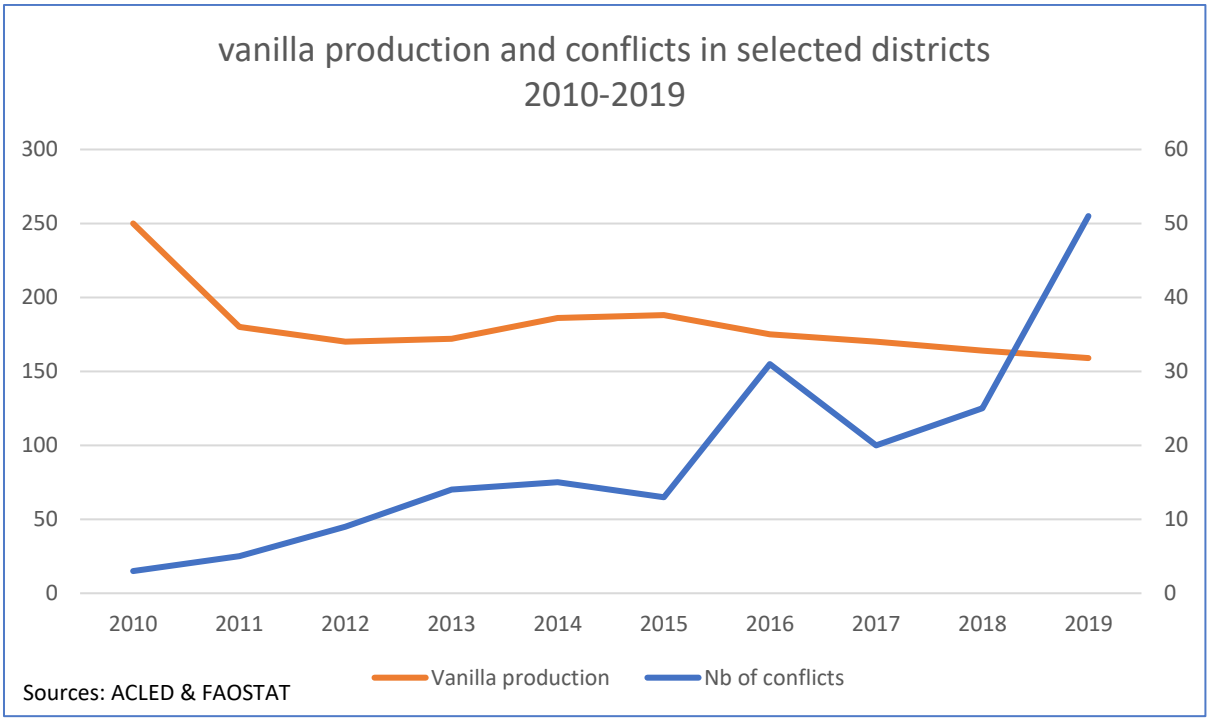


Source: ACLED & UN Comtrade

An exogenous setting: Uganda

Given the recent cyclones which have considerably reduced Madagascar's capacity to produce vanilla, the country may lose its supremacy on the market. Other countries have emerged as alternative producers. This is the case of Uganda, where vanilla growers have been trying to grow their importance as suppliers of the world market. Production efforts have however not proven to be effective on the level of production and Uganda remains one of the smaller producers of vanilla. As such, the vanilla market in Uganda can be considered exogenous as the value of R is set. As per proposition 3, the expected result would be that and increase in the production of vanilla would lead to an increase in conflicts. However, as we can see on Figure 15, for the selected producing districts (Districts where vanilla is grown at commercial levels include Kayunga, Mukono, Mpigi, Jinja, Kamuli, Buikwe, Bundibugyo, Luweero and Kasese), while conflicts have increased over the past ten years, the production of vanilla has actually decreased.

Figure 15: Vanilla production and conflicts in selected districts 2010-2019



Preliminary remarks

The reality behind the natural resource markets

Proposition 1 states that when prices are endogenously determined, resource scarcities may be the driver of conflict, rather than abundance. However, as observed with the example of Madagascar, foreign demand seems to be the real driver of price formation. Even though Madagascar accounts for 60% of world production (which varies from year to year), it is world demand that drives the price. The influence of production is only really felt when there is a negative production shock, for example during cyclone-type events that destroy a large part of production. The same is true for other resources such as minerals, and I think that this is one of the limits of cross-country compared to micro-empirical, as is underlined in the paper by the concept of ecological error. Although it is too early to conclude with certainty, the reason for the results obtained is either that the vanilla market cannot in fact be considered as endogenous and therefore that propositions 1 and 2 do not apply to it. Or that these results disprove the predictions of the model and that its theoretical framework is not applicable to certain natural resources. This would however mean that the framework is not that of a generalised resource curse.

The issue of data

The UCDP GED and ACLED are the two leading conflict events datasets, with their strengths and weaknesses. While the creation of these datasets is a positive development, several caveats have been raised regarding the collect, coding and quality of the data (Eck 2012). The main issue remains that of missing data (especially with the microlevel approach). In fact, while fighting and violent events tend to be well-reported in the media, non-violent events such as thefts, which are the most relevant in our case, are rarely reported in the news. Moreover, these types of local conflicts, in remote areas, are seldom reported to the police and the reporting may not take place or be discouraged by the level of corruption. In fact, corruption is so widespread in rural areas when it comes to extracting natural resources, that it is impossible to know for certain the amount of vanilla that has been stolen. Rosewood and sapphire are subject to the same illegal exploitation. Theft is so widespread that importers often have a hard time tracking the vanilla back to individual farmers (Lind 2017). Local authorities (the gendarmerie) have also been accused by local populations of turning a blind eye to these thefts and of buying the stolen vanilla. When it comes to reporting the thefts, the corruption and lack of resources often make the authorities another issue to deal with for famers rather than a way of obtaining justice and redress (Lind 2017). Moreover, vanilla being an important source of foreign cash with little regulation, is mixed with and used to disguise illegal rosewood trafficking as many of the middlemen involved in the export of the cash crop are also rosewood traders (Sharife and Maintikely 2018).

Overall, Madagascar still “grapples with systemic corruption, a weak rule of law and porous borders with an abundance of natural resources, which has in turn given rise to various organised criminal networks dealing in illicit trade” (Rahman 2021). All the more reasons why quality data is very hard to obtain.

Conclusion

In this paper, I focused on identifying the characteristics that makes vanilla a valid resource, and Madagascar and Uganda valid case studies for the theoretical framework developed by Dickson, MacKenzie and Sekeris, all the while identifying the underlying problems with applying the model in a cross-country study. The preliminary remarks and conclusions formulated in this paper are based on personal research and data accessed online through available datasets. The very basic empirical method suggested to test the hypotheses is limited both by its simplicity, which does not account for both observable and unobservable variables and from a lack of data. I surmise that while Madagascar and Uganda are good case studies for investigating the model’s hypotheses, there are several obstacles that necessitates to either

obtain data from a different source (collection on the ground through surveys and investigations) or to find a way to work around the limited data on conflicts, as accurate government statistics on crime rates are not available. Further investigation into the intrinsic relation between conflict and the production and price of grabbable resources remains necessary.

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