Joint Discussion Paper
Series in Economics

by the Universities of

Aachen · Gießen · Göttingen
Kassel · Marburg · Siegen

ISSN 1867-3678

No. 38-2018

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Sourcing from Conflict Regions: Policies to Improve Transparency in International Supply Chains

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Sourcing from Conflict Regions: Policies to Improve Transparency in International Supply Chains

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Abstract

In this paper, we set up a theoretical model to study how unilateral policies aimed at improving transparency for consumers concerning the source of certain raw materials influence prices, illegal mining activities and welfare. The model distinguishes two regions in the world, North and South. Firms in the North import natural resources from the South to produce final consumption goods. In one of the countries, in the South, local groups attempt to access natural resources, which results in rent seeking conflicts with the government and illegal mining. We find that a unilateral embargo against the conflict country as well as certification of legal mines can reduce rent seeking and illegal mining with different welfare consequences in the countries involved.

I. Introduction

Access to precious minerals is essential to various industries in the modern economy (OECD, 2009). Many minerals as well as energy resources such as oil or shale gas can be found in resource-rich developing countries with rather weak political institutions. In these countries, the presence of natural resources may trigger and intensify conflicts and rent-seeking behavior. For example, using a high spatial resolution dataset that covers the entire African continent, Berman et al. (2017) find a substantially stronger effect of the recent commodity price boom on the likelihood of conflict in geographical areas with mining activities compared to those without.[1] Rebel groups and independence movements are flourishing in certain resource-rich regions, such as in Southeast Columbia (FARC), in Kivu, Eastern Congo, or in Mindandao, Southern Philippines (Moro Islamic Liberation Front). They fight for the control of mines against each other and against state forces and can use earnings from illegally exported resources for new weapons, which tends to prolong conflicts (Fearon, 2004).

Public pressure from NGOs and the civil society against the use of inputs from conflict regions have stimulated the implementation of national and international sanctions. A prominent example that started in the early 2000s is the Kimberly Process, a commitment of 54 member states to prevent the inclusion of conflict diamonds in the global supply chain (Kimberly Process, 2018). After the financial crisis, the United States implemented the Dodd-Frank Act, a federal law concerning Wall Street reform, in which section 1502 requires to disclose the use

[1] For surveys of the earlier literature, see Van der Ploeg (2011) and Nillesen and Bulte (2014).

of the minerals tin, tantalum, tungsten, and gold originating from the Democratic Republic of Congo or adjoining countries. More recently, similar regulations on conflict minerals have been passed by the European Union (European Commission, 2016). Energy resources may also be subject to international measures such as embargoes against oil from Syria (e.g., European Council, 2016).

This paper aims to shed light on the consequences of unilateral sanctions on markets for raw materials as well as on downstream industries. It distinguishes two different policies that may be implemented in order to increase market transparency: first, an embargo by a resource importing country against an exporting country in which mines are contested by illegal operators, and second, the implementation of a certification system that enables customers to distinguish legal from illegal mines. These policies are analyzed in a North-South framework with vertically related industries. Two downstream countries in the North import raw materials from two countries in the South, of which one has an internal conflict for raw materials. The downstream countries produce final goods according to a Dixit-Stiglitz framework of monopolistic competition. A Tullock rent-seeking contest maps the situation in the conflict country in the South. In this framework, we investigate the effects of stepwise removing the information asymmetry concerning the source of raw materials on equilibrium prices, industry structure, rent seeking, and welfare. Our main results are the following:

1. A unilateral embargo reduces the price of raw materials sourced from the conflict country while the price for raw materials from the conflict-free country increases. Rent seeking and the supplied quantity of illegal raw materials decline.

2. The embargo raises consumer welfare only if the resource endowment of the conflict free country in the South is sufficiently large compared to that of the conflict country.

3. The introduction of a certification system further reduces rent seeking and the number of illegal mines compared to the embargo.[2] Certification is also superior in terms of consumer welfare.

Our paper is related to several strands of the literature: First, various studies investigate the effects of product labels on the consumers' and the producers' side. For example, Podhorsky (2013) analyzes product certification in a two country model with endogenous product quality. In her model, foreign welfare increases if a certification system is implemented by the home country as foreign consumers benefit from the resulting increase in product quality. Bonroy and Lemarié (2012) study the effects of labels for genetically modified food on upstream and downstream suppliers. The authors identify conditions under which such labels reduce the price of genetically modified inputs. Moreover, our paper relates to studies on vertical product differentiation, such as Gervais (2015), who shows in a Melitz-type model that product quality may influence selection into the export market.

One feature of our model is that consumers are willing to pay an extra premium for product varieties that are produced from conflict-free resources. This is related to the willingness to

[2] In practice, such certification systems can be designed as supply-chain auditing programs, such as the ITSCI (2018) initiative, or as projects aiming at the verification of origin, e.g., by using geological identification methods (as in the "Analytical Fingerprint" project of the BGR, 2018)).

pay for “fair trade” products. For example, in experimental auctions realized on Ebay, Hiscox et al. (2011) find that consumers pay a substantial premium for fair trade labeled goods. Similarly, according to a survey-based study of Campbell et al. (2015) consumers are more willing to accept a price increase if this is justified by commitments to fair trade standards than by higher taxes. There could be various reasons why people prefer ethical products even though they do not differ in terms of their actual quality compared to conventional produced counterparts: Psychological aversion of being (indirectly) involved in illegal or harmful operations and a willingness to contribute to social desirable goals may be strong motives. A recent neurological study by Enax et al. (2015) reported that for people who decide for a product labelled as "fair trade" more activities in their ventral striatum could be measured, which is an important brain region for reward-processing and motivational salience.

Our paper also builds on related theoretical studies on conflicts and rent-seeking in resource abundant countries. Wick and Bulte (2006) and Butler and Gates (2012) analyze how the framework of a resource conflict – in particular, the shape of the contest success function – determines its intensity. In De Luca et al. (2018) conflicts for natural resource access can be influenced by an autocratic leader who may have an incentive to promote such conflicts in order to weaken the political opposition. Janus (2012) considers the implications of liquidity constraints for resource extraction and conflicts. In his model, an import embargo reduces conflict intensity only if a binding credit constraint limits the amount of capital that can be invested in the conflict. Otherwise, an export restriction shifts activities from resource extraction to resource conflicts and thereby raises conflict intensity. Similarly Parker and Vadheim (2017), who assume that rebel groups can either tax resource mines or loot civilians, find that a ban on certain minerals may shift conflicts to other (less affected) types of mines or may increase looting of civilians.

In the remainder of the paper, section II introduces the the model and derives the baseline equilibrium without government intervention. In section III we introduce a unilateral embargo and a certification policy, and analyze the welfare properties of these measures in section IV. Section V summarizes the paper and concludes.

II. The Model

The world according to our model is composed of four countries, two in the ”North” (indexed by NE and NW) and two in the “South” (SE and SW). Both countries in the North supply a continuum of varieties of a manufacturing aggregate M in a standard monopolistic-competition industry and sell M exclusively in the North. Production of manufacturing varieties entails certain raw materials sourced from a continuum of mines in SE and SW distributed over the unit interval. Each mine is endowed with one unit of the resource. Per unit of a manufacturing variety, firms in the North need one unit of raw materials, which they buy on a competitive market for a price of c. Two types of mines exist in the South: Legal (L) mines, which adhere to certain environmental and labor standards, and illegal (I) mines under the control of illegal operators, producing raw materials under poor and unregulated conditions.

Consumer Preferences: We consider conscious consumers who care about of the production conditions in the mining sector of the upstream countries. These consumers experience a utility loss if varieties contain illegally mined materials. Although buyers of manufactured varieties know whether an industry is affected by illegal mining in general, they cannot verify for each single variety whether it contains illegal primary resources or not. To model this setting, we assign a certain quality discount to manufactured varieties that corresponds to the average share of illegally mined resources.[3] The difference to a standard product quality context is the fact that quality is not determined by the physical properties of a good but instead by the conditions under which its ingredients are produced. In particular, we consider a representative consumer with the following utility specification:

$$U = M^{\alpha} A^{1-\alpha} \ , \quad \text{with} \quad M = \left(\int_{\omega \in \Omega} \left[x(\Theta(\omega)) \cdot q(\omega) \right]^{\rho} d\omega \right)^{1/\rho} . \tag{1}$$

A is a freely traded agricultural good (the numéraire), M is the manufacturing aggregate, $q(\omega)$ is the quantity of variety ω, and $\Theta(\omega) \in [0;1]$ stands for the share of legal raw materials contained in this variety. The function $x(\Theta) \equiv 1 - \mu \left[1 - \Theta\right]$ measures the utility impact of Θ, with μ $(0 < \mu < 1)$ representing the marginal effect of increasing the share of illegal raw materials in an individual variety . Each country in the North is endowed with $\bar{L}$ units of labor, which can either be employed in manufacturing or to produce A (with productivity normalized to 1). In manufacturing, each firm needs a fixed labor input of f. Maximization of utility with total expenditures of $2\alpha\bar{L}$ for M yields the following expenditure levels for an individual variety ($\sigma = 1/(1-\rho)$):

$$q(\omega)p(\omega) = 2\alpha\bar{L}\tilde{P}^{\sigma-1}\tilde{p}(\omega)^{1-\sigma} \ , \quad \text{with} \quad \tilde{P} = \left(\int_{\omega \in \Omega} \tilde{p}(\omega)^{1-\sigma} d\omega \right)^{1/(1-\sigma)} \tag{2}$$

as the corresponding price index. The term $\tilde{p}(\omega) = p(\omega)/x\left(\Theta\right)$ represents the adjusted price for variety ω.

With a wage rate of 1 and a raw material price of c, production costs in manufacturing are $C(q) = f + cq$. Manufacturing firms set profit maximizing prices at a constant mark-up over marginal costs, i.e., $p(\omega) = c(\omega)/\rho$.

Illegal Mining: The two countries in the South differ with respect to the distribution of legal and illegal mines. More specifically, illegal mining only occurs in SE whereas country SW does not have this problem. The term S $(0 \leq S \leq 1)$ denotes the share of legal mines in SE.[4] We assume that the total endowment with raw materials is $\bar{R}_W$ in country SW and $\bar{R}_E$ in SE, such that the aggregate worldwide supply of the raw materials is given by $\bar{R} \equiv \bar{R}_W + \bar{R}_E$.[5] The share of legal mines S in SE is determined by a contest between illegally operating extractors on the one hand and the state on the other. At each mine there

[3] Manufacturing varieties are modeled here as credence goods, comparable to settings with non-observable product quality (see Darby and Karni, 1973). As in Hallak (2006), we specify quality as a utility-shifter.

[4] We will determine this share endogenously in our model.

[5] This means, we assume that on each point on the unit interval $\bar{R}_E$ mines exist in country SE and similarly $\bar{R}_W$ mines in SW.

is a local group that may try to get hold of the resources extracted there, whereas the state tries to protect the mine. In the rent seeking contest for the mine, the group spends a for rent seeking activities and the state spends b for protection efforts. Assuming a Tullock (1980) contest success function, each single mine can be seized with probability

$$\pi(a,b) = \frac{a}{a+b} \ .$$

The higher the group's, or the lower the state's effort, the more likely the mine will get hold of by the rent-seekers. In addition to the rent seeking effort, the local group has to spend a fixed cost γF to enter the contest. The term F follows a uniform distribution on $[0;1]$ representing differences between mines with respect to the accessibility for rent-seekers. For example, some mines may be located in a civil war zone and thereby may be more easily accessible for rebel groups than others. The slope term γ can be interpreted as a measure for the general situation in the country (its "institutional quality"), which improves as γ increases. Given the entry costs, we can determine a critical cut-off $\tilde{F}$ below which mines are contested by rent seekers.

Suppose, the price for raw materials is c_L or c_I depending on whether they originate from legal or illegal mines. Maximizing the expected income of rent seekers or the state, respectively

$$I_{rs} = \pi(a,b)c_I - a - \gamma F \quad \text{and} \quad I_s = \left[1 - \pi(a,b)\right] c_L - b$$

yields the following equilibrium rent seeking expenditures and the resulting success probability as functions of the price for legal and illegal resources:

$$a = \frac{c_L \left(c_I\right)^2}{\left(c_I + c_L\right)^2} \ , \quad b = \frac{c_I \left(c_L\right)^2}{\left(c_I + c_L\right)^2} \ , \quad \text{and} \quad \pi = \frac{c_I}{c_L + c_I} \tag{3}$$

Inserting π into I_{rs} and setting $I_{rs} = 0$ produces the critical cut-off:

$$\tilde{F} = \frac{\left(c_I\right)^3}{\gamma \left(c_I + c_L\right)^2} \ . \tag{4}$$

$\tilde{F}$ increases in c_I, declines in c_L, and has increasing returns to scale. That is, if prices of legal and illegal raw materials rise proportionally, more groups engage in rent seeking. With the cut-off $\tilde{F}$ and success probability $\pi(a,b)$, the aggregate share of legal mines in SE is

$$S(a,b) = 1 - \tilde{F} + \tilde{F}\left[1 - \pi(a,b)\right] \ .$$

Inserting (3) and (4) yields the following expression for the endogenous share of legal mines in SE:

$$S = 1 - \frac{\left(c_I\right)^4}{\gamma \left(c_I + c_L\right)^3} \ . \tag{5}$$

Benchmark Equilibrium: As benchmark, we consider the case in which the source of raw materials contained in the final product is completely non-transparent for consumers.

Consumers cannot distinguish legal from illegal mines and also do not know the geographical origin of raw materials used in a certain variety. In this setting of worldwide pooling, there is one common world market for resources with a common price, i.e., $c_L^p = c_I^p = c^p$.[6] For the distribution of illegal materials on final good producers, we assume perfect symmetry: each manufacturing variety contains the same share of illegal materials given by $\Theta^p = (1 + S^p)/2$. All firms charge the same price $p^p = c^p/\rho$, sell the same quantity q^p and make the same revenue r^p. The revenue of an individual firm equals the ratio between total expenditures $2\alpha\bar{L}$ and the mass or "number" of active firms Ω in the market, i.e., $r^p = 2\alpha\bar{L}/\Omega^p$. With the zero profit condition $r^p = \sigma f$, we use this ratio to derive the equilibrium number of varieties in the pooling setting:

$$\Omega^p = \frac{2\alpha\bar{L}}{\sigma f} \ . \tag{6}$$

For the equilibrium quantities of imported raw materials, we set demand equal to supply, $q^p \cdot \Omega^p = \bar{R}$, yielding

$$q^p = \frac{\bar{R}\sigma f}{2\alpha\bar{L}} \ . \tag{7}$$

After inserting into $p^p = \sigma f/q^p$, we obtain for prices

$$p^p = \frac{2\alpha\bar{L}}{\bar{R}} \quad \text{and} \quad c^p = \frac{2\alpha\bar{L}\rho}{\bar{R}} \ . \tag{8}$$

The value of aggregate raw material imports of the North is $q^p c^p \Omega^p = 2\alpha\bar{L}\rho$, which is equal to the value of its agricultural exports.

Equilibrium rent seeking expenditures are equal for the state and for rent seekers, which results in a success probability of 1/2 for all mines that are contested:

$$a^p = b^p = \frac{c^p}{4} \qquad \text{and} \qquad \pi(a^p, b^p) = \frac{1}{2} \tag{9}$$

Considering the critical $\tilde{F}^p = c^p/(4\gamma)$, we find that the aggregate share of legal mines increases in the fixed rent seeking costs γ and decreases in the resource price. We assume that γ is sufficiently large relative to the equilibrium resource price such that an interior solution with $S^p > 0$ exists. Inserting from (5) determines the share of legal mines as a function of the model's parameters:

$$S^p = 1 - \frac{c^p}{8\gamma} = 1 - \frac{\alpha\rho\bar{L}}{4\gamma\bar{R}} \ . \tag{10}$$

These results characterize the market situation without any governmental intervention or transparency initiative. In the following we expand the basic model by two possible downstream policies.

[6] The superscript p stands for the pooling equilibrium.

III. Resource Transparency

In this section, we consider two policy options to raise transparency with respect to natural resources: First, we introduce a unilateral embargo of NW against SE. As a result of the embargo, NE firms rely entirely on resources from legal mines (those from SW), whereas products supplied by firms of country NE still contain illegally mined materials from SE. The embargo serves as a screening device and reduces the degree of consumers' uncertainty, as it discloses the geographical origin of raw materials.

Second, we study the possibility of providing full transparency for consumers by introducing certification of legal mines from SE into the model. For example, it could be possible to distinguish legal (L) from illegal (I) mines in SE by third-party auditing. This auditing provides consumers with full information about the type of the raw materials sourced for each individual variety. For simplicity, we do not consider auditing costs.[7]

Embargo: An embargo by country NW against SE discloses the origin of the resources for consumers: All manufacturing varieties supplied by NW contain legal resources from SW. If raw material prices of SW exceed those of SW, i.e., for $c^e_W > c^e_E$, firms from country NE have no incentive to purchase raw materials from SW as they cannot verify the source of their materials. As a result, firms from NE source raw materials entirely from SE. Since, by assumption, only legal mines exist in SW, the perceived quality is $\Theta^e_W = 1$ for varieties produced in NW. For varieties produced in NE, quality declines to $\Theta^e_E = S^e$, i.e., to the share of illegal mines in SE. Consumers draw a higher utility from varieties from NW and are willing to pay a higher price compared to NE varieties, i.e., $p^e_W \cdot X(S^e) = p^e_E$. Resource prices can be determined as

$$c^e_W = \frac{2\alpha\bar{L}\rho}{\bar{R}_W + x(S^e)\bar{R}_E} \quad \text{and} \quad c^e_E = \frac{2\alpha\bar{L}\rho x(S^e)}{\bar{R}_W + x(S^e)\bar{R}_E} \,. \tag{11}$$

Compared to the pooling equilibrium, the resource price declines in SE and increases in SW, i.e., $c^e_E < c^p < c^e_W$, since $x(S^e) < 1$. The share of legal mines in SE is given by (5) with $c_I = c_L = c^e_E$ and and is higher than in the pooling benchmark ($S^e > S^p$):

$$S^e = 1 - \frac{c^e_E}{8\gamma} = 1 - \frac{\alpha\rho\bar{L}x(S^e)}{4\gamma\left[\bar{R}_W + x(S^e)\bar{R}_E\right]} \,. \tag{12}$$

Figure 1 illustrates the equilibrium price and share of legal mines in country SE. The downward sloping dotted line depicts the share of legal mines S as a function of the price of raw materials supplied by country SE as determined by equation (12). This relationship is the same for the pooling and the embargo setting. The upward sloping dashed curve depicts the resource price c^e_E in country SE, as determined in (A.9) for the embargo case. The price of raw materials from the embargo country SE is lower than in the pooling case (solid horizontal line) and rises with the share of legal mines. The intersection between both curves determines the equilibrium allocation in SE.

[7] As an alternative, we may assume that the audit is financed by the government of NW.

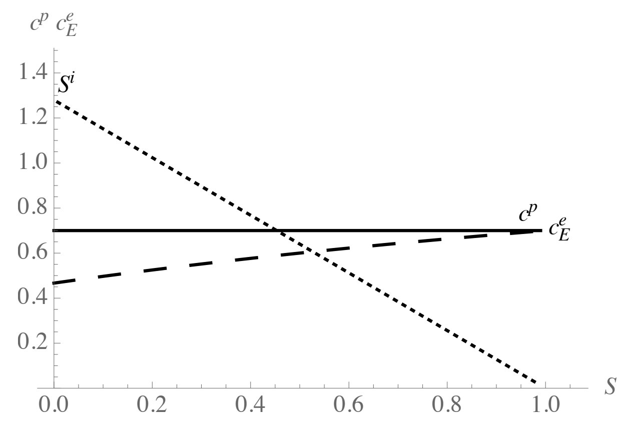

Figure 1: *Equilibrium with Pooling and with Embargo*

We can use figure 1 to determine the effects of a change in exogenous parameters on the equilibrium. For example, an increase in the institutional quality in SE, i.e., an increase in γ, raises the slope of the S_E^e-line and results in less illegal mining and a higher equilibrium resource price in country SE. With an increase in the discount term μ, the c_E^e curve becomes less steep resulting in fewer illegal mines and a lower resource price in SE.

Certification: We now assume that the government in NW allows its domestic firms to use raw materials from SE if these are certified to be of legal origin. As in the embargo case, firms from NE do not buy legal raw materials in this setting as they would have to pay a higher price than for illegal materials without being able to verify their source to consumers. That is, $\Theta_W^c = 1$ and $\Theta_E^c = 0$, and the perceived quality of varieties supplied by firms from NE declines to $x(0) = 1 - \mu$.

The certification scheme raises the price for legal raw materials from SE to the same level as for materials from SW, whereas the price for illegal raw materials is accordingly lower (see appendix for a derivation):

$$c_I^c = \frac{2\alpha\bar{L}\rho\,[1-\mu]}{\bar{R}_W + x(S^c)\bar{R}_E} \quad \text{and} \quad c_L^c = \frac{2\alpha\bar{L}\rho}{\bar{R}_W + x(S^c)\bar{R}_E}\,. \tag{13}$$

From these equations, we can infer $c_I^c < c_E^e$. Not surprisingly, the price for illegal raw materials under certification declines compared to the raw material price from SE under the embargo. With certification, downstream buyers from NE purchase only illegal materials from SE compared to a mix of legal and illegal materials under the embargo. For the share of legal mines in SE we obtain the following equation:

$$S^c = 1 - \frac{[1-\mu]^3\,c_I^c}{[2-\mu]^3\,\gamma} = 1 - \frac{2\alpha\bar{L}\rho\,[1-\mu]^4}{[2-\mu]^3\,\gamma\,[\bar{R}_W + x(S^c)\bar{R}_E]}\,. \tag{14}$$

Comparing (14) with (12) reveals that S^c would exceed S^e already for $c_I^c = c_E^e$. In addition, since the price for illegal raw materials c_I^c declines compared to c_E^e in the embargo case, the share of legal mines increases further. The inequality $S^c > S^e$ also implies $c_L^c < c_W^e$. That is, certification influences the price for legal raw materials via a supply effect by reducing rent seeking and thereby raising the number of conflict mines.

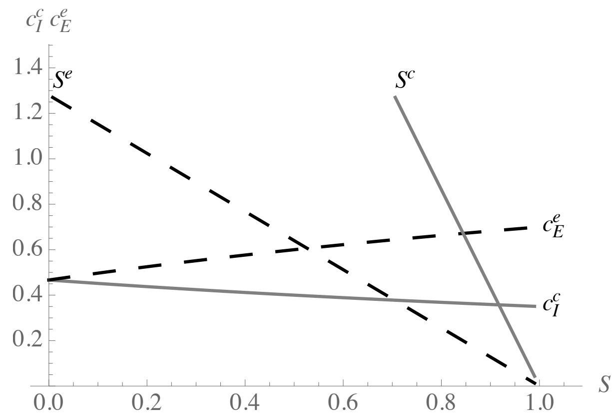

Figure 2: *Equilibrium with Embargo and with Certification*

Figure 2 illustrates the equilibrium for the case of certification in comparison to the embargo equilibrium. The line c_I^c depicts the price of illegal resources as determined by (13), and this line is declining in S^c. For $S^c = S^e = 0$, the resource price would be the same as in the embargo case. For every $S^c > 0$, the price of illegal resources c_I^c is therefore lower than in the embargo case. The downward sloping line S^c depicts the share of legal resources as a function of c_I^c according to (14). This line is steeper than the S^e line of the embargo case, with the same limit at $S^c = S^e = 1$ for $c_E^c = c_I^e = 0$. The intersection between the S^c and c_I^c lines determines the equilibrium.[8]

IV. Welfare Analysis

In this section, we evaluate all three settings in terms of consumer welfare in the North and aggregate income in the South countries. Welfare of the representative consumer in the North (NE or NW) can be written as

$$V = 2\bar{L}\alpha^{\alpha}(1-\alpha)^{1-\alpha}\tilde{P}^{-\alpha} \, . \tag{15}$$

For the three scenarios considered, the utility based price index $\tilde{P}$ is

$$\tilde{P}^p = \frac{c^p}{x(S^p)\rho}\Omega^{\frac{1}{1-\sigma}} \, , \quad \tilde{P}^e = \frac{c_W^e}{\rho}\Omega^{\frac{1}{1-\sigma}} \quad \text{and} \quad \tilde{P}^c = \frac{c_L^c}{\rho}\Omega^{\frac{1}{1-\sigma}} \, . \tag{16}$$

[8]As the c_I^c line is strictly concave, we cannot rule out a priori that there are two intersection points, but we do not further consider this possibility of multiple equilibria here.

The number of varieties Ω is the same in all three settings. Compared to the pooling benchmark, the embargo lowers the price index and thereby raises consumer welfare in the North if and only if $c_W^e < c^p/x(S^p)$, or $\bar{R}_W > x(S^e)\bar{R}_E$ (see appendix). Thus, it could well be that the embargo lowers consumer welfare. This may happen, if resource supply from SW is rather low compared to resource supply from SE such that the embargo raises the price for legal resources from SW above the quality adjusted price in the pooling setting. Certification is superior to the embargo from the view of consumers, as $c_L^c < c_W^e$.

Aggregate resource income in SW, $V_{SW} = \bar{R}_W c_W$, is highest under the embargo, since $c_W^e > c^p$ and $c_W^e > c_L^c$. For income (net of rent seeking efforts) in SE we obtain

$$\begin{aligned}
V_{SE}^p &= \left[1 - \frac{5c^p}{32\gamma}\right] c^p \bar{R}_E \ , \\
V_{SE}^e &= \left[1 - \frac{5c_E^e}{32\gamma}\right] c_E^e \bar{R}_E \quad \text{and} \\
V_{SE}^c &= \left[1 - \frac{\left(5-\mu^2\right)\left(1-\mu\right)^3 c_I^c}{2\gamma\left(2-\mu\right)^4}\right] c_L^c \bar{R}_E \ . \qquad (17)
\end{aligned}$$

Comparing V_{SE}^e with V_{SE}^c, we first note that $c_L^c > c_E^e$. However, in SE, aggregate welfare falls short of the resource rent because of the wasteful rent seeking efforts in the conflict for raw materials. The term in squared brackets in (17) captures this effect. As rent seeking declines, a declining resource price in SE not necessarily reduces aggregate income in the conflict country. Instead, it may be the case that the rent-seeking effect outweighs the declining resource price such that the net income in SE increases with the embargo against this country.[9] Since this term in V_{SE}^c exceeds the one in V_{SE}^e the country SE benefits from certification compared to the embargo. Comparing welfare in SE under embargo and pooling gives an ambiguous result: While the decline in the resource price reduces welfare in SE, rent seeking activities decrease at the same time.

Taking both countries SE and SW together, aggregate income under certification exceeds aggregate income under embargo, which in turn exceeds aggregate income in the pooling case.

$$V_{SE}^p + V_{SW}^p = 2\alpha\bar{L}\rho - \frac{5\left(c^p\right)^2 \bar{R}_E}{32\gamma} < \qquad (18)$$

$$V_{SW}^e + V_{SE}^e = 2\alpha\bar{L}\rho - \frac{5\left(c_E^e\right)^2 \bar{R}_E}{32\gamma} < \qquad (19)$$

$$V_{SW}^c + V_{SE}^c = 2\alpha\bar{L}\rho - \frac{(5-4\mu+\mu^2)(1-\mu)^2\left(c_I^c\right)^2 \bar{R}_E}{2\gamma(2-\mu)^4} \ . \qquad (20)$$

The inequalities follow from $c^p > c_E^e > c_I^c$ and the fact that $(5-4\mu+\mu^2)(1-\mu)^2/(2-\mu)^4 < 5/16$ (see appendix).

[9]Note that this rent dissipation effect differs from the sectoral allocation effect in Torvik (2002), where rent seeking crowds out entrepreneurial activities in a modern sector.

V. Summary and Conclusion

In this paper, we have analyzed unilateral policies aimed at improving transparency about the origin and the legal status of imported natural resources. In our framework, an embargo against a conflict country is comparable to a mandatory disclosure of origin. It lowers the equilibrium price of raw materials from the embargoed country and thereby reduces resource rents and rent seeking activities there. Consumers in the downstream countries benefit from the embargo if and only if the relative supply of resources from the conflict-free country is sufficiently large. Raising transparency further by a mandatory certification of legal resources is superior in terms of consumer welfare in the downstream countries as well as in terms of aggregate income of the resource exporting upstream countries. Compared to an embargo, rent seeking further declines which leads to more “clean products” on the market.

Our model can be extended in various directions to provide further insights into the implications of conflict resource policies: First, instead of assuming costless certification, one may explicitly account for such costs and their implications as barriers to entry for downstream suppliers. Second, the model may incorporate additional forms of illegally extracted rents, such as contraband to neighbouring states or taxation of the local population. This may allow for leakage, which appears to be important empirically.[10] Third, barriers for trading final product varieties between downstream countries may be considered. Unilateral measures to improve transparency would then affect domestic consumers differently compared to those in other downstream countries. Further asymmetries between downstream countries may result from consumer or firm heterogeneity. Promising extensions in this respect would be to distinguish between more and less ethical consumers, more and less productive firms and differences between countries in this regard. Finally, supply of natural resources could also be endogenized, such that policies that influence demand and prices also affect the total quantity of natural resources supplied.

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[10] See the empirical results on the effects of the Dodd-Frank-Act by Parker and Vadheim (2017) and Stoop et al. (2018).

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Appendix: Derivations

Embargo Equilibrium: Maximizing utility

$$M = \left(\int_0^{\Omega_W} q(\omega)^\rho d\omega \ + \int_0^{\Omega_E} [x(S) \cdot q(\upsilon)]^\rho \, d\upsilon \right)^{1/\rho} \tag{A.1}$$

yields the following spending levels for varieties from NW (indexed by ω) and from NE (indexed by υ):

$$q(\omega)p(\omega) = 2\alpha\bar{L}\tilde{P}^{\sigma-1}\tilde{p}(\omega)^{1-\sigma} \qquad \text{and} \qquad q(\upsilon)p(\upsilon) = 2\alpha\bar{L}\tilde{P}^{\sigma-1}\tilde{p}(\upsilon)^{1-\sigma} \ , \tag{A.2}$$

with

$$\tilde{P} = \left(\int_0^{\Omega_W} \tilde{p}(\omega)^{1-\sigma} d\omega + \int_0^{\Omega_E} \tilde{p}(\upsilon)^{1-\sigma} d\upsilon \right)^{1/(1-\sigma)} , \quad \tilde{p}(\omega) = \frac{c_W^e}{\rho} \quad \text{and} \quad \tilde{p}(\upsilon) = \frac{c_E^e}{\rho x(S)}$$

as corresponding price index and profit maximizing prices.

From the zero profit condition and (A.2) we can infer $\tilde{p}(\omega) = \tilde{p}(\upsilon)$, i.e., adjusted prices have to be equal in the world equilibrium. For this to hold, manufacturers have to pay a premium for raw materials from SW:

$$c_E^e = x(S^e) \cdot c_W^e \ . \tag{A.3}$$

Given that quality adjusted prices are equalized, we obtain for quantities from (A.2)

$$q_W^e = x(S) \cdot q_E^e \ . \tag{A.4}$$

With an aggregate number of varieties $\Omega = \Omega_W + \Omega_E$, the price index can be written as

$$\tilde{P}^e = \frac{c_W^e}{\rho} \cdot \Omega^{1/(1-\sigma)} \ . \tag{A.5}$$

The equilibrium aggregate number of varieties can be determined from the free entry condition as

$$\Omega^e = \frac{2\alpha \bar{L}}{\sigma f} \ . \tag{A.6}$$

Inserting into (A.2) yields

$$\Omega^e \cdot q_W^e = \frac{2\alpha \bar{L}\rho}{c_W^e} \quad \text{and} \quad \Omega^e \cdot q_E^e = \frac{2\alpha \bar{L}\rho}{c_E^e} \ . \tag{A.7}$$

Using $\Omega_W^e \cdot q_W^e = \bar{R}_W$, $\Omega_E^e \cdot q_E^e = \bar{R}_E$ and (A.3) yields (A.8) for the number of varieties in both countries and (A.9) for equilibrium resource prices.

$$\Omega_W^e = \frac{\bar{R}_W}{\bar{R}_W + x(S^e)\bar{R}_E} \cdot \Omega^e \ , \quad \Omega_E^e = \frac{x(S^e)\bar{R}_E}{\bar{R}_W + x(S^e)\bar{R}_E} \cdot \Omega^e \ , \tag{A.8}$$

$$c_W^e = \frac{2\alpha \bar{L}\rho}{\bar{R}_W + x(S^e)\bar{R}_E} \quad \text{and} \quad c_E^e = \frac{2\alpha \bar{L}\rho x(S^e)}{\bar{R}_W + x(S^e)\bar{R}_E} \ . \tag{A.9}$$

Certification Equilibrium Firms in NW have the possibility to purchase certified legal minerals from SE or SW. Consumer utility is then

$$M = \left(\int_0^{\Omega_L} q(\omega)^\rho d\omega \ + \int_0^{\Omega_I} [x(0) \cdot q(\upsilon)]^\rho \, d\upsilon \right)^{1/\rho} \ .$$

with varieties made from legal raw materials indexed by ω and varieties using illegally mined resources by υ. Utility maximization leads to a spending pattern of

$$q(\omega)p(\omega) = 2\alpha \bar{L}\tilde{P}^{\sigma-1}\tilde{p}(\omega)^{1-\sigma} \quad \text{and} \quad q(\upsilon)p(\upsilon) = 2\alpha \bar{L}\tilde{P}^{\sigma-1}\tilde{p}(\upsilon)^{1-\sigma} \ ,$$

with corresponding prices

$$\tilde{P} = \left(\int_0^{\Omega_L} \tilde{p}(\omega)^{1-\sigma} d\omega + \int_0^{\Omega_I} \tilde{p}(\upsilon)^{1-\sigma} d\upsilon \right)^{1/(1-\sigma)} \ , \quad \tilde{p}(\omega) = \frac{c_L}{\rho} \quad \text{and} \quad \tilde{p}(\upsilon) = \frac{c_I}{\rho x(0)} \ .$$

Using the zero-profit condition, we again obtain $\tilde{p}(\omega) = \tilde{p}(\upsilon)$ and thus

$$c_I^c = x(0) \cdot c_L^c \quad \text{and} \quad q_L^c = x(0) \cdot q_I^c \ .$$

As in the embargo case, we can derive equilibrium resource prices (A.10) and the equilibrium number of varieties (A.11) from these equations. Hereby we also employ the relationship $x(S^c) = S^c + x(0) \cdot (1 - S^c)$ that follows from the linear specification of $x(\cdot)$.

$$c_L^c = \frac{c_I^c}{1-\mu} \quad \text{and} \quad c_I^c = \frac{2\alpha \bar{L}\rho(1-\mu)}{\bar{R}_W + x(S^c)\bar{R}_E} \ . \tag{A.10}$$

$$\Omega_W^c = \frac{\bar{R}_W + R_L}{\bar{R}_W + x(S^c)\bar{R}_E} \cdot \Omega^c \quad \text{and} \quad \Omega_E^c = \frac{x(0) \cdot R_I}{\bar{R}_W + x(S^c)\bar{R}_E} \cdot \Omega^c \ , \tag{A.11}$$

with $R_L = S^c \cdot \bar{R}_E$, $R_I = (1 - S^c) \cdot \bar{R}_E$ and

$$\Omega^c = \frac{2\alpha\bar{L}}{\sigma f} \ .$$

For the equilibrium price index, we obtain

$$\tilde{P}^c = \frac{c_L^c}{\rho} \cdot \Omega^{1/(1-\sigma)} \ . \tag{A.12}$$

Welfare Effects: With regard to welfare in the North, comparing (8) with (11) reveals that $c_W^e < c^p/x(S^p)$ if $\bar{R}_W + x(S^e)\bar{R}_E > x(\Theta^p)\bar{R}$. Inserting for Θ^p and for $x(\Theta)$ yields the condition $[1 - S^p]\,\bar{R}_W > [1 + S^p - 2S^e]\,\bar{R}_E$, or, after inserting for S^p and S^e, $\bar{R}_W > x(S^e)\bar{R}_E$. If this inequality is satisfied, the embargo raises consumer welfare.

Welfare in SE is equal to resource rents in SE minus the costs of rent-seeking, i.e.,

$$V_{SE} = \left[c_L - \pi(c_L - c_I)\tilde{F} - (a + b)\,\tilde{F} - 0.5\gamma\tilde{F}^2\right] \cdot \bar{R}_E \ .$$

Inserting yields

$$\begin{aligned}
V_{SE}^p &= \left[1 - \frac{5c^p}{32\gamma}\right] c^p \bar{R}_E \ , \\
V_{SE}^e &= \left[1 - \frac{5c_E^e}{32\gamma}\right] c_E^e \bar{R}_E \ , \quad \text{and} \\
V_{SE}^c &= \left[1 - \frac{\left(5 - \mu^2\right)(1 - \mu)^3 c_I^c}{2\gamma\,(2 - \mu)^4}\right] c_L^c \bar{R}_E \ .
\end{aligned}$$

To compare certification with the embargo, we first note that $c_E^e < c_L^c$, $c_I^c < c_E^e$ and $1 - \mu < 1$. Therefore, sufficient for $V_{SE}^c > V_{SE}^e$ is

$$\frac{(5 - \mu^2)(1 - \mu)^2}{(2 - \mu)^4} < \frac{5}{16} \quad \text{or} \quad f(\mu) \equiv 56 - 72\mu + 21\mu^2 > 0 \ . \tag{A.13}$$

The term $f(\mu)$ declines in μ for all $\mu \leq 1$ and and it is positive at $\mu = 1$. Condition (A.13) is satisfied and $V_{SE}^c > V_{SE}^e$.

For aggregate welfare with certification, we obtain from the budget constraint of consumers $2\alpha\bar{L}\rho = \bar{R}_W c_L^c + (1 - S^c)\bar{R}_E c_I^c + S^c\bar{R}_E c_L^c$. Inserting $c_L^c = c_I^c/(1 - \mu)$ and S^c yields

$$V_{SW}^c = c_L^c \bar{R}_W = 2\alpha\bar{L}\rho - \frac{c_I^c \bar{R}_E}{1 - \mu} + \frac{\mu(1 - \mu)^2}{(2 - \mu)^3\gamma}\,(c_I^c)^2\,\bar{R}_E \ .$$

Adding V^c_{SE} leads to

$$\begin{aligned} V^c_{SW} + V^c_{SE} &= 2\alpha\bar{L}\rho - \frac{c^c_I \bar{R}_E}{1-\mu} + \frac{\mu(1-\mu)^2}{(2-\mu)^3\gamma}\left(c^c_I\right)^2 \bar{R}_E + \left[1 - \frac{\left(5-\mu^2\right)(1-\mu)^3 c^c_I}{2\gamma\,(2-\mu)^4}\right]\frac{c^c_I \bar{R}_E}{1-\mu} \\ &= 2\alpha\bar{L}\rho + \frac{\mu(1-\mu)^2\left(c^c_I\right)^2 \bar{R}_E}{(2-\mu)^3\gamma} - \frac{\left(5-\mu^2\right)(1-\mu)^2\left(c^c_I\right)^2 \bar{R}_E}{2\gamma\,(2-\mu)^4} \\ &= 2\alpha\bar{L}\rho - \frac{(5-4\mu+\mu^2)(1-\mu)^2\left(c^c_I\right)^2 \bar{R}_E}{2\gamma(2-\mu)^4}\,. \end{aligned} \tag{A.14}$$

Since $5-4\mu+\mu^2 < 5-\mu^2$, (A.13) also implies $(5-4\mu+\mu^2)(1-\mu)^2/(2-\mu)^4 < 5/16$, i.e., $V^c_{SW} + V^c_{SE} > V^e_{SW} + V^e_{SE}$.