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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 study how unilateral policies concerning certain conflict raw materials influence prices, illegal mining activities, and welfare. 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 in 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.

1 | INTRODUCTION

Access to precious minerals is essential to various industries in the modern economy (OECD, 2009). Many minerals can be found in resource-rich developing countries with rather weak political institutions. Empirical evidence shows that the presence of natural resources in these countries may trigger and intensify conflicts and rent-seeking behavior (Van der Ploeg, 2011; Nillesen & Bulte, 2014), in particular during commodity price booms (Berman, Couttenier, Rohner, & Thoenig, 2017).

For example, two thirds of the world's coltan, a mineral that is essential for many electrical devices, was extracted in the Democratic Republic of Congo (DRC) and its neighbor Rwanda in 2018 (USGS, 2019b). Furthermore, the DRC hosts important reserves for cobalt, which make up 49% of the global stock (USGS, 2019a), as well as large reserves of tin, tungsten, and gold (Yager, 2015). At the same time, the country faces substantial challenges with armed groups that control a part of the mines and finance ongoing conflicts with revenues raised from these mines (Fearon, 2004). According to field studies of the International Peace Information Service (IPIS), armed actors were present at 56% of

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the artisanal mines in Eastern Congo in the period between 2013 and 2015. The influence of armed forces was particularly pronounced in gold mines, where 80% of artisanal mining takes place. In these mines, almost two of three miners worked under the influence of armed actors (IPIS Research, 2016).

The DRC's adjoining countries have similar problems with illegal extraction of minerals, gold and diamonds within their country borders, and are furthermore affected as smuggling routes for resources from the DRC to downstream markets worldwide (Lopez & Salcedo-Albaran, 2017). Illegal mines run by local militias or organized crime groups are also known for using forced labor and child workers, or to be responsible for other forms of human rights abuses.

The problem with conflict minerals is not confined to the DRC and its neighboring countries: The high-resolution geographical data set of Berman et al. (2017) covers the entire African continent. It shows that the presence of a resource mine raises the probability of a conflict in a given location and a given year to an average of 14% compared to 5% in places without a mine. Other examples for resource conflicts include illegal logging of precious timber from Cambodian rainforests, poaching in South Sudan during the civil war, or the massive extraction of jade in the conflict ridden Kachin region of Myanmar.¹

Public pressure from NGOs and civil society against the use of inputs from conflict regions has 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 countries 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 of the minerals tin, tantalum, tungsten, and gold originating from the DRC or adjoining countries. More recently, similar regulations on conflict minerals have been passed by the European Union (European Commission, 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: 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, one of which is facing 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. We also allow for the possibility of leakage by smuggling minerals across borders and consider additional certification costs per unit of the resource. 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, even if smuggling is possible;
2. the introduction of a certification system further reduces rent-seeking and the number of illegal mines compared to the embargo;
3. the embargo raises consumer welfare compared to the benchmark situation in which consumers are not able to distinguish the origin of the natural resource (“pooling” setting); aggregate income in the South is highest under certification followed by the embargo.

Our paper is related to several theoretical studies on conflicts and rent-seeking in resource abundant countries with weak institutions. Wick and Bulte (2006) and Butler and Gates (2012) employ a contest

success function (as we do) to model the resource conflict and they analyze how the shape of this function determines the intensity of the conflict. In De Luca, Sekeris, and Vargas (2018) an autocratic leader has an incentive to promote fights between ethnic groups for natural resource access. Janus (2012) sets up a two-period model to analyze how exogenous changes of the resource price influence the intensity of a civil conflict. In his model, rebel groups may face a credit constraint that limits the amount of capital invested in the conflict. In such a setting, a temporary decline in the resource price reduces conflict intensity if the credit constraint is binding. With a nonbinding credit constraint, a temporary price decline shifts activities from resource extraction to resource conflicts and raises conflict intensity. Parker and Vadheim (2017) analyze a stationary bandit equilibrium with two resources and assume that rebel groups can either tax resource miners or loot civilians. In their model, a decline in the exogenous price of one resource can shift rebel activities toward the other resource and toward more looting of civilians.

In our paper, we do not distinguish between different forms of illegal activities as in Parker and Vadheim (2017) and we also abstract from intertemporal aspects as in Janus (2012). Instead, we embed resource conflicts into a trade model with a downstream final goods sector to endogenize resource prices. This allows us to determine equilibrium resource prices and to derive how national policies toward resource imports can influence these prices and thereby conflict intensity. By focusing on the incomplete information of consumers and on the resulting price implications, we provide a novel perspective on the effects of national resource policies. In addition, in our framework with two resource exporting and two importing countries, we can account for international repercussions of unilateral policies toward individual conflict countries.

Certification of conflict-free mines bears certain similarities to product quality labels such as for organically produced food. Podhorsky (2013) analyzes product certification in a two-country model with endogenous product quality. In her model, firms of the home country have an advantage compared to foreign firms for quality improvements. This gives the home government a protectionist motive to set the quality standard at a rather high level. Still, foreign consumers benefit from the resulting increase in product quality compared to a setting without a standard. Bonroy and Lemarié (2012) study the effects of labels for genetically modified food on upstream and downstream suppliers. The authors identify conditions under which 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. However, this literature does not consider conflicts for resource access and the effects of policy measures by the importing countries on rent-seeking and illegal mining.

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 assumption builds on results concerning the willingness to pay for “fair trade” products. For example, in experimental auctions realized on Ebay, Hiscox, Broukhim, and Litwin (2011) find that consumers pay a substantial premium for fair trade-labeled goods. Similarly, according to a survey-based study of Campbell, Heinrich, and Schoenmüller (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 if these do not differ in terms of their actual physical properties compared to conventionally produced counterparts: Psychological aversion to being (indirectly) involved in illegal or harmful operations and a willingness to contribute to socially desirable goals may be strong motives. A recent neurological study by Enax, Krapp, Piehl, and Weber (2015) reported that for people who decide for a product labeled as “fair trade” more activities in their ventral striatum could be measured, which is an important brain region for reward processing and motivational salience. In a North–South trade context, Cardebat and Cassagnard (2010) set-up a duopoly model with ethically motivated consumers and analyze how monitoring influences fundamental labor standards.²

In the remainder of the paper, Section 2 introduces the model and derives the baseline equilibrium without government intervention. In Section 3, we introduce a unilateral embargo and a certification policy, and analyze the welfare properties of these measures in Section 4. Section 5 summarizes the paper and concludes. Detailed analytical derivations are provided for the interested reader in a supplementary appendix online.

2 | THE MODEL

To analyze international trade with legal and illegal resources, we set-up a static model with 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. All varieties of M are sold exclusively in the North and can be traded freely between both North countries. 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 that is inelastically supplied.³

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 r . Two types of mines exist in the South, legal (L) mines owned by the state and illegal (I) mines under the control of local rebel groups or militias.

2.1 | Consumer preferences

We consider conscientious consumers who care about the production conditions in the mining sector of the upstream countries. These consumers experience a utility loss if their consumed varieties contain materials from illegal mines. Although buyers of manufactured varieties know whether an industry is affected by illegal mining in general, they cannot verify for a 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 contained in the varieties bought from NW or from NE , respectively.⁴ 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:

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

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. While the consumer cannot observe Θ directly it knows the source country of the individual final goods varieties ω . The function $x(\Theta) \equiv 1 - \mu[1 - \Theta]$ 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. For the sake of simplicity, the working conditions or resource conflicts in the upstream countries are not directly accounted for in the utility specification (1), but instead influence utility only via the share of illegal materials.

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 . Consumers' budget is defined by the income generated on the labor market, and aggregate consumer income of NW and NE together is $2\bar{L}$. Maximization of utility with total expenditures of $2\alpha\bar{L}$ for the manufacturing good M yields the following expenditure level for an individual variety ($\sigma = 1/(1-\rho)$):

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

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

With a nominal wage rate of 1 (due to the normalized productivity in the agricultural sector) and a raw material price of r , production costs in manufacturing are $C(q) = f + rq$. Manufacturing firms set profit maximizing prices at a constant mark-up over marginal costs, that is, $p(\omega) = r(\omega)/\rho$.

2.2 | 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 .⁵ 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 raw materials is given by $\bar{R} \equiv \bar{R}_W + \bar{R}_E$.⁶ The share of legal mines S in SE is determined by a contest between illegally operating extractors on the one hand and local governments (who own the mines) on the other. We assume that both illegal extractors and local governments are only active in the respective jurisdiction of the mine and cannot influence the aggregate resource price by their actions.⁷

At each mine, there is a local group that may try to access the resources extracted there, whereas the local government tries to protect the mine. In the rent-seeking contest for the mine, the group spends a for rent-seeking activities and the owner 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 owner's effort, the more likely it is that the mine will fall into the hands of 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 received by legal or illegal mines is \hat{r}_L or \hat{r}_I . Maximizing the expected income of rent seekers and of the local defenders, respectively

$$I_{rs} = \pi(a, b)\hat{r}_I - a - \gamma F \quad \text{and} \quad I_{ld} = [1 - \pi(a, b)]\hat{r}_L - b$$

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

$$a = \frac{\hat{r}_L (\hat{r}_I)^2}{(\hat{r}_I + \hat{r}_L)^2}, \quad b = \frac{\hat{r}_I (\hat{r}_L)^2}{(\hat{r}_I + \hat{r}_L)^2}, \quad \text{and} \quad \pi = \frac{\hat{r}_I}{\hat{r}_L + \hat{r}_I}. \quad (3)$$

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

$$\tilde{F} = \frac{(\hat{r}_I)^3}{\gamma (\hat{r}_I + \hat{r}_L)^2}. \quad (4)$$

\tilde{F} increases in \hat{r}_I , decreases in \hat{r}_L , and has increasing returns to scale. That is, if prices received by legal and by illegal mines 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

$$S(a, b) = 1 - \pi(a, b)\tilde{F}.$$

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

$$S = 1 - \frac{(\hat{r}_I)^4}{\gamma (\hat{r}_I + \hat{r}_L)^3}. \quad (5)$$

2.3 | Benchmark equilibrium

As benchmark, we consider the case in which the source of raw materials contained in the final product is completely nontransparent 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 and given our assumption of no trading costs, there is no reason for producers to prefer raw materials from a certain source over another. It follows that there is one common world market for resources with one common price, that is, $\hat{r}_L^p = \hat{r}_I^p = r^p$.⁸ For the distribution of illegal materials on final good producers, we assume perfect symmetry: each manufacturing variety ω contains the same share of legal materials given by

$$\Theta^p = \frac{\bar{R}_W + S^p \bar{R}_E}{\bar{R}_W + \bar{R}_E}. \quad (6)$$

To motivate this assumption, consider a setting in which raw materials are collected from the different mines and mixed together in a further processing stage or during storage and shipping as bulk cargo before they finally arrive in the destination of the final producers.

All manufacturing firms charge the same price $p^p = r^p / \rho$ for final varieties, sell the same quantity q^p and earn the same revenue. 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^p in the market. The zero profit condition requires that the revenue is also equal to σf . We can use these relationships to derive the equilibrium number of varieties in the pooling setting:

$$\Omega^p = \frac{2\alpha\bar{L}}{\sigma f}. \quad (7)$$

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

$$q^p = \frac{\bar{R} \sigma f}{2 \alpha \bar{L}}. \quad (8)$$

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

$$p^p = \frac{2 \alpha \bar{L}}{\bar{R}} \quad \text{and} \quad r^p = \frac{2 \alpha \bar{L} \rho}{\bar{R}}. \quad (9)$$

Note that the equilibrium resource price in the pooling situation does not depend on the share of illegal raw materials in the market. This is due to the Dixit–Stiglitz utility according to which expenditures for an individual variety depend on the adjusted price \tilde{p} relative to the aggregate adjusted price index \tilde{P} (see Equation 2). With pooling, individual and aggregate prices are influenced in the same way. The value of aggregate raw material imports of the North is $q^p r^p \Omega^p = 2 \alpha \bar{L} \rho$, which is equal to the value of its agricultural exports.

Equilibrium rent-seeking expenditures are equal for the local government and for rent seekers and can be determined by (3). With $\hat{r}_L = \hat{r}_I = r^p$, this results in a success probability of 1/2 for all mines that are contested:

$$a^p = b^p = \frac{r^p}{4} \quad \text{and} \quad \pi(a^p, b^p) = \frac{1}{2} \quad (10)$$

Considering the critical $\tilde{F}^p = r^p / (4\gamma)$, 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:

$$S^p = 1 - \frac{r^p}{8\gamma} = 1 - \frac{\alpha \rho \bar{L}}{4\gamma \bar{R}}. \quad (11)$$

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.

3 | RESOURCE POLICIES

In this section, we consider two policy options that may help to reduce the degree of uncertainty for consumers with respect to the content of natural resources: First, we introduce a unilateral embargo of *NW* against *SE*. The embargo does not allow *NW* firms to use resources from the conflict country *SE*, whereas products supplied by firms of *NE* are still free to use materials from *SE*. If consumers know the origin of final varieties (i.e., through certificates of origin) and are aware of the policy of country *NW*, the embargo enables them to distinguish between “cleaner” products made in *NW* from those made in *NE*. Second, we study the possibility to certify legal mines from *SE*. In practice, such certification systems can be designed as supply-chain auditing programs, such as the ITSCI (2018) initiative, or by using geological identification methods (as in the “Analytical Fingerprint” project of the BGR, 2018). Certification provides consumers with additional information about the type of raw materials sourced for each individual variety.

3.1 | Embargo

All manufacturing varieties supplied by *NW* contain legal resources from *SW*. If buyers have to pay higher prices for raw materials from *SW* compared to those from *SE*, that is, for $r_W^e > r_E^e$, 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*. We allow for possible leakage by assuming that a certain percentage ϕ of the raw materials from *SE* is smuggled to *NW* ($0 < \phi < 1$). This raises the quantity of raw materials available in *NW* to $\bar{R}_W + \phi\bar{R}_E$ while it reduces the quantity in *NE* to $(1 - \phi)\bar{R}_E$. The respective shares of legal materials used in *NW* and *NE* are given by

$$\Theta_W^e = \frac{\bar{R}_W + \phi S^e \bar{R}_E}{\bar{R}_W + \phi \bar{R}_E} \quad \text{and} \quad \Theta_E^e = S^e. \quad (12)$$

Without smuggling ($\phi = 0$) varieties from *NW* would contain only legal raw materials sourced from *SW* and Θ_W^e would be equal to 1, while for any smuggling rate strictly between 0 and 1 the outcome is $\Theta_E^e < \Theta_W^e < 1$, with $\partial\Theta_W^e/\partial\bar{R}_W > 0$ and $\partial\Theta_W^e/\partial\bar{R}_E < 0$. Due to smuggling, the term Θ_W^e increases in \bar{R}_W and declines in \bar{R}_E . Since consumers draw a higher utility from varieties from *NW*, they are willing to pay a higher price for these than for *NE* varieties, that is, $p_W^e X^e = p_E^e$. The term $X^e \equiv x(\Theta_E^e)/x(\Theta_W^e)$ denotes the valuation of varieties from *NE* relative to those produced in *NW*, which depends, among others, on the share of legal raw materials in the source country *SE* according to (12). Equilibrium resource prices are

$$r_W^e = \frac{2\alpha\bar{L}\rho}{\bar{R}_W + \phi^e \bar{R}_E} \quad \text{and} \quad r_E^e = r_W^e X^e, \quad (13)$$

with $\tilde{\phi}^e = \phi + (1 - \phi)X^e < 1$ as the weight of resources from *SE* compared to those from *SW*. Compared to pooling, the resource price declines in *SE* and increases in *SW*, that is, $r_E^e < r^p < r_W^e$. Since a part of the resources from *SE* is smuggled to *NW*, mine owners in *SE* receive the price $\hat{r}_E^e = \phi r_W^e + (1 - \phi)r_E^e$ for their resources. Inserting from (13) implies $\hat{r}_E^e = \tilde{\phi}^e r_W^e$. This price is lower than the price in the pooling equilibrium.

The share of legal mines in the embargo equilibrium is given by

$$S^e = 1 - \frac{\hat{r}_E^e}{8\gamma}. \quad (14)$$

Since $\hat{r}_E^e < r^p$, fewer mines are contested in *SE* such that the embargo raises the share of legal resources compared to the pooling benchmark, that is, $S^e > S^p$, with

$$S^e = 1 - \frac{\alpha\rho\bar{L}\tilde{\phi}^e}{4\gamma [\bar{R}_W + \tilde{\phi}^e \bar{R}_E]}. \quad (15)$$

We can use Equations (13) and (15) to determine the effects of a change in exogenous parameters on equilibrium resource prices and on illegal mining. For example, an increase in the smuggling rate ϕ raises \hat{r}_E^e such that more mines are contested in *SE*. This results in a lower share of legal mines in *SE*. An improvement in the institutional quality in *SE*, that is, an increase in γ , results in less illegal mining and a higher resource price \hat{r}_E^e . With an increase in the discount term μ , the outcomes are fewer illegal mines and a lower resource price in *SE*.

3.2 | Certification

We now assume that the government in *NW* allows to officially import raw materials from *SE* if these are certified to be of legal origin. The government in *NW* controls the validity of the certificates for raw materials imported from *SE* to *NW*, while the government in *NE* admits all types of raw materials to be used by its firms. Furthermore, it is assumed that certification raises the unit cost for raw materials from *SE* by causing iceberg certification costs $1-g$. That is, we model certification costs as a fraction of the raw material that “melts” during the certification process. With this specification of certification costs we abstract from factor costs of certification or from potential rents earned by certification bodies. The iceberg costs of certification are paid by the legal mines in *SE* that export to the certification country where only the fraction g of each unit sent finally arrives. Firms from *NE* do not buy certified raw materials in this setting as they would have to pay a higher price than for uncertified materials without being able to verify their source to consumers. The aggregate supply of raw materials in *NW* consists of the quantity imported from *SW*, certified raw materials from *SE* and, again, a share ϕ of raw materials smuggled from *SE*. In the following, we only consider an equilibrium situation in which all owners of legal mines in *SE* choose to certify their materials. The aggregate quantity of raw materials available in *NW* is then $\bar{R}_W + [gS^c + (1-S^c)\phi] \bar{R}_E$. Raw material supply in *NE* is given by $(1-\phi)(1-S^c)\bar{R}_E$. For the respective shares of legal raw materials in both countries, we obtain

$$\Theta_W^c = \frac{\bar{R}_W + gS^c\bar{R}_E}{\bar{R}_W + [gS^c + (1-S^c)\phi] \bar{R}_E} \quad \text{and} \quad \Theta_E^c = 0. \quad (16)$$

In equilibrium, firms from *NW* pay the same price for certified raw materials from *SE* as for materials from the no-conflict country *SW*. We denote this price by r_W^c . Owners of the certified legal mines receive a resource price net of certification costs of $\hat{r}_L^c = gr_W^c$. As the valuation for uncertified resources declines to $x(0) = 1 - \mu$, the resource price paid by firms in *NE* is accordingly lower than in *NW*, that is, $r_E^c = r_W^c X^c$, with $X^c = x(0)/x(\Theta_W^c)$. The price that owners of illegal mines in *SE* receive is given by $\hat{r}_I^c = \tilde{\phi}^c r_W^c$, with $\tilde{\phi}^c = \phi + (1-\phi)X^c$. Mine owners in *SE* prefer certified over noncertified exports if and only if $\hat{r}_L^c > \hat{r}_I^c$, or, after inserting, if $g > \tilde{\phi}^c$. We assume in the following that this inequality is satisfied, which is the case if certification is not “too costly,” that is, if g is sufficiently close to 1.⁹ Equilibrium resource prices are given by

$$r_W^c = \frac{2\alpha\bar{L}\rho}{\bar{R}_W + [gS^c + (1-S^c)\tilde{\phi}^c] \bar{R}_E} \quad \text{and} \quad r_E^c = X^c r_W^c. \quad (17)$$

For the share of legal mines in *SE* we obtain the following equation from (5) and with $\hat{r}_L^c = (g/\tilde{\phi}^c)\hat{r}_I^c$:

$$S^c = 1 - \frac{(\tilde{\phi}^c)^3 \hat{r}_I^c}{\gamma [g + \tilde{\phi}^c]^3}. \quad (18)$$

Comparing (18) with (14) reveals that S^c would exceed S^e already for $\hat{r}_I^c = \hat{r}_E^e$.¹⁰ Even if the resource price for illegal materials was unchanged, the number of illegal mines would decline as the local government gets a higher price for legal raw materials and therefore invests more in the rent-seeking contest than the attacking group. In addition, the producer price for resources from illegal mines \hat{r}_I^c is lower with certification compared to the price \hat{r}_E^e with an embargo, that is, $\hat{r}_I^c < \hat{r}_E^e$.¹¹ The reason is that illegal mines in *SE*

can no longer pool with legal mines under certification. This has an additional influence on rent-seeking activities and raises the number of legal mines even further.

For $g > \tilde{\phi}^e$, we also have $\hat{r}_L^c > r_E^e$. That is, certification influences the price for legal raw materials via a supply effect by reducing rent-seeking and thereby lowering the number of conflict mines.

4 | WELFARE ANALYSIS

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

$$V = 2\bar{L}\alpha^\alpha(1-\alpha)^{1-\alpha}\tilde{P}^{-\alpha}. \quad (19)$$

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

$$\tilde{P}^p = \frac{r^p}{\rho x(\Theta^p)} \Omega^{\frac{1}{1-\sigma}}, \quad \tilde{P}^e = \frac{r_W^e}{\rho x(\Theta_W^e)} \Omega^{\frac{1}{1-\sigma}} \quad \text{and} \quad \tilde{P}^c = \frac{r_W^c}{\rho x(\Theta_W^c)} \Omega^{\frac{1}{1-\sigma}}. \quad (20)$$

The aggregate number of varieties Ω is the same in all three settings. A comparison shows that the embargo raises consumer welfare compared to the pooling benchmark, that is, $\tilde{P}^e < \tilde{P}^p$. For sufficiently small certification costs ($g \rightarrow 1$), certification is superior to an embargo from a consumer's point of view, that is, $\tilde{P}^c < \tilde{P}^e$.

Aggregate income in SW equals the resource rent for this country, that is, $V_{SW} = r_W \bar{R}_W$. Both policies, embargo and certification raise the price for resources from SW , that is, $r_W^e > r^p$ and $r_W^c > r^p$, such that income in SW increases.

For country SE aggregate income falls short of the resource rent because a part of the rent is dissipated in the rent-seeking contest. The following expression shows aggregate income in SE (net of rent-seeking costs) in the pooling benchmark and for the embargo:

$$V_{SE}^i = \left[1 - \frac{5\hat{r}^i}{32\gamma} \right] \hat{r}^i \bar{R}_E,$$

where $\hat{r}^i = r^p$ in the benchmark and $\hat{r}^i = \hat{r}_E^e$ with the embargo. From (21), we can conclude that the embargo not necessarily raises aggregate income in SE . It reduces the resource price, which has two effects on income: On the one hand, rent-seeking declines such that a smaller share of the resource rent is dissipated (the square bracket term in (21) declines in \hat{r}_E^e). On the other hand, the resource rent itself declines in country SE .¹²

Aggregate income in SE with certification is given by

$$V_{SE}^c = \left[1 - \frac{(\tilde{\phi}^c)^3 (4g^2 + 2g\tilde{\phi}^c - (\tilde{\phi}^c)^2) \hat{r}_I^c}{2\gamma g(g + \tilde{\phi}^c)^4} \right] \hat{r}_L^c \bar{R}_E \quad (21)$$

For small certification costs, certification is superior to the embargo from the view of country SE : Since $\hat{r}_L^c > \hat{r}_E^e$ for $g > \tilde{\phi}^e$, the resource rent increases compared to the embargo. Moreover, rent dissipation declines (the square bracket term in V_{SE}^c exceeds that in V_{SE}^e).

Taking both countries SE and SW together, aggregate income with certification exceeds aggregate income with the embargo, which in turn exceeds aggregate income in the pooling case: $V_{SE}^p + V_{SW}^p < V_{SW}^e + V_{SE}^e < V_{SW}^c + V_{SE}^c$, with

$$\begin{aligned} V_{SE}^p + V_{SW}^p &= 2\alpha\bar{L}\rho - \frac{5}{32\gamma} (r^p)^2 \bar{R}_E, \\ V_{SW}^e + V_{SE}^e &= 2\alpha\bar{L}\rho - \frac{5}{32\gamma} (\hat{r}_E^e)^2 \bar{R}_E, \quad \text{and} \\ V_{SW}^c + V_{SE}^c &= 2\alpha\bar{L}\rho - \frac{(\tilde{\phi}^c)^4 + 2g^2 (\tilde{\phi}^c)^2 + 2g (\tilde{\phi}^c)^3}{2\gamma (g + \tilde{\phi}^c)^4} (\hat{r}_I^c)^2 \bar{R}_E. \end{aligned} \quad (22)$$

5 | SUMMARY AND CONCLUSION

In this paper, we have analyzed unilateral policies aimed at counteracting resource conflicts and at improving the situation in resource exporting countries. 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. A mandatory certification of legal resources has an even stronger effect on rent-seeking in the resource exporting conflict country which further reduces the share of conflict materials in the world. From the view of the importing countries certification is superior as long as the iceberg certification costs are not too high. Taken together, the exporting countries benefit most from certification, while an embargo also improves their income compared to the benchmark.

Our model can be extended in various directions to provide further insights into the implications of conflict resource policies: First, in addition to the iceberg costs of certification one may explicitly account for fixed certification costs and their implication as barriers to entry for downstream suppliers. Second, the model may incorporate additional forms of illegally extracted rents, such as contraband to neighboring jurisdictions or taxation of the local population.¹³ 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 or 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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DATA AVAILABILITY STATEMENT

Data sharing is not applicable to this article as no new data were created or analyzed in this study.

ENDNOTES

¹ In a broader perspective, natural resources are estimated to play a role in at least 40% of internal conflicts worldwide (UNEP, 2009).

² In a related context, various authors analyze the question whether core labor standards should be linked with international trade policies (see, e.g., Krueger, 1996; Maskus, 1997; Brown, 2001).

- ³ By assuming a given resource supply, we abstract from price effects on resource supply as they would be present in a dynamic Hotelling model of resource extraction or in a setting with endogenous exploration efforts.
- ⁴ Manufacturing varieties are modeled here as credence goods, comparable to settings with nonobservable product quality (see Darby & Karni, 1973). As in Hallak (2006), we specify quality as a utility shifter.
- ⁵ We will determine this share endogenously in our model.
- ⁶ This means, we assume that at each point on the unit interval \bar{R}_E mines exist in country *SE* and similarly \bar{R}_W mines in *SW*.
- ⁷ This simplifying assumption abstracts from considerations of strategically manipulating the aggregate resource price when deciding about contesting or defending a certain mine.
- ⁸ The superscript *p* stands for the pooling equilibrium.
- ⁹ However, additional equilibria may exist in which only a share $\psi < 1$ of mines chooses certification. Such equilibria can be ruled out by assuming $g > \bar{\phi}^c(\psi)$ for all $\psi < 1$. Since $\bar{\phi}^c$ is strictly smaller than 1, a g sufficiently close to 1 exists such that this condition is satisfied.
- ¹⁰ For $\hat{r}_I^c = \hat{r}_E^c, S^c > S^e$ if $\bar{\phi}^c / (g + \bar{\phi}^c) < 1/2$. Since $g > \bar{\phi}^c$, this condition is satisfied.
- ¹¹ For $S^c = S^e = 0$, we have $\hat{r}_I^c = \hat{r}_E^c$. In addition, $\partial \hat{r}_E^c / \partial S^c > 0$ and $\partial \hat{r}_I^c / \partial S^c < 0$, such that $\hat{r}_I^c < \hat{r}_E^c$ for all positive S^e and S^c .
- ¹² Anecdotal evidence for the DRC supports our hypothesis of a declining raw material price in the embargoed country (Carisch, 2012).
- ¹³ See the empirical results on the effects of the Dodd–Frank–Act by Parker and Vadheim (2017) and Stoop, Verpoorten, and van der Windt (2018).

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SUPPORTING INFORMATION

Additional supporting information may be found online in the Supporting Information section.

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