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Abstract

In 2003, the Kimberley Process Certification Scheme (KPCS) went into force to stop the trade in those diamonds, directly linked to the fueling of armed conflict and activities of rebel movements, also known as conflict diamonds. This article gives empirical evidence on the impact of the KPCS on international trade in rough diamonds. We find that bilateral KPCS participation facilitates access to international markets for rough diamonds and increases trade values. The bilateral trade impact of the KPCS does not depend on the exporters' economic development nor the extent of market access. A more detailed analysis of exporters' heterogeneity in trade values shows that unilaterally KPCS intensifies the trade impediments resulting from armed conflicts and, thereby, reduces the scale of potential conflict diamonds traded internationally. We further offer evidence that the KPCS-induced trade effects apply not only to exporter- or importer-hubs but equally to smaller trade partners. Our analysis gives insights into how agreements setting a particular standard may affect international trade patterns in conflict minerals.

Keywords: International product standards, conflict diamonds, international trade, gravity model.

JEL: F53, Q34, Q37, Q56, L15

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1 Introduction

Diamond production can play an essential role in a country's economic and social development, especially in resource-based economies, as is the case for many low-income countries. Taking the land size into account, Olson (2007) shows that diamond production intensity, measured as annual production in carats divided by land area, is exceptionally high in low-income countries, like Botswana, the Democratic Republic of Congo, Ghana, Sierra Leone, and South Africa.[1] However, this natural resource abundance does not regularly translate into economic development and wealth. Previous literature argues and case study evidence shows that diamond resource abundance can initiate, finance, and possibly prolong armed conflicts (Taylor & Mokhawa 2003, Lujala, Gleditsch & Gilmore 2005, Olson 2006, Olson 2007, Janus 2012, Stoop, Verpoorten & van der Windt 2019). In light of these circumstances, much hope was raised by affected producer countries, international organizations, and customers as the Kimberley Process Certification Scheme (KPCS) went into force in 2003. The KPCS is an international certification scheme established to stop the trade in rough diamonds, directly linked to the fuelling of armed conflict and activities of rebel movements. On December 5^{th}, 2011, international trade in rough diamonds newly gain public attention when Global Witness, a non-governmental organization, announced the withdrawal as an official observer from the KPCS. Charmian Gooch, a founding director of Global Witness, reasoned the move with the inefficiency of the KPCS in hindering the trade of rough diamonds originating from a country's conflict areas.[2]

Despite considerable interest by policymakers and the society in general, little empirical evidence exists, which evaluates the impact of the KPCS. This paper refers to the KPCS' primary task and examines how the certification scheme influences trade in rough diamonds worldwide. To the best of our knowledge, no study exists, which systematically analyzes the impact of the KPCS on international trade in rough diamonds. We investigate the KPCS's impact on the level of the rough diamond trade and the propensity to trade. Thereby, we contribute to the literature on the impact of public and private standards on the international trade in natural resources.[3] Product standards, on the one hand, can increase an industry's competitiveness by giving access to a larger, international market with a single harmonized standard. Access to a larger market allows an increase in production and thereby gives rise to economies of scale (Maertens & Swinnen 2009). Furthermore, through increased product information and comparability, business transaction costs can be reduced. Analyzing the impact of standards in the British industry, Swann, Temple & Shurmer (1996) find that increased adherence to common product standards has a positive effect on the import-volume and export-volume of regulated goods. Using

[1] The annual production in thousand carats per km^2 for the period 1990-1999 is 30.98 (Botswana), 8.41 (Democratic Republic of Congo), 3.02 (Ghana), 3.84 (Sierra Leone), and 8.20 (South Africa).

[2] Press release, Global Witness, 5^{th} December 2011: http://www.globalwitness.org/library/global-witness-leaves-kimberley-process-calls-diamond-trade-be-held-accountable

[3] For a relatively recent review on this topic, see Beghin, Maertens & Swinnen (2015).

a gravity model of international trade, Clougherty & Grajek (2014) show that sharing a common product standard increases a country pairs trade activity. In a recent paper, Borsky, Leiter & Pfaffermayr (2018) find that countries participating in an international agreement on sustainable timber production exhibit a significant and substantial increase in timber trade values ranging from 4 % to 6 %. On the other hand, product standards can restrict the competitiveness of firms by raising compliance costs. Higher variable production costs can affect both: the export volume, as firms are likely to export less due to the presence of trade frictions, as well as the probability to export due to higher production costs, which make it harder for producers to export at all (Czubala, Shepherd & Wilson 2009). Maskus, Otsuki & Wilson (2013), for example, calculate that an increase in the strictness in foreign product standards by 1 % rises variable costs of production by 0.06 %-0.13 %. The size and distribution of a product standard's trade effect remains an empirical question and depends on the size of the affected industry and the specificity and strictness of the standard (Shepherd & Wilson 2013, Melo, Engler, Nahuehual, Cofre & Barrena 2014). The empirical literature on product standard effects on middle- and low-income countries is mixed, with some studies indicating trade barriers (e.g., Hoekman & Nicita 2011, Tran, Wilson & Anders 2012, Ferro, Otsuki & Wilson 2015) while others not finding a statistically significant impact (e.g., Schuster & Maertens 2015, Ehrich & Mangelsdorf 2018). Few find a trade-enhancing effect, such as Disdier, Fontagné & Cadot (2015) for international harmonized product standards.

The KPCS is a voluntary agreement, which pursues two objectives. The KPCS's internal control mechanisms ease and support international cooperation between signatories, leading to lower transaction costs. In this respect, the KPCS works like a regional trade agreement, aiming to reduce trade barriers and, hence, transaction costs between the member countries. However, the KPCS's primary focus is not on reducing trade costs between specific geographic regions but rather on setting a minimum common product standard that internationally traded diamonds have to comply with. Adherence to this common product standard can increase production costs. Whether the trade-enhancing or the cost-increasing effect dominates, i.e., how the KPCS affects international trade flows in rough diamonds, remains an empirical question which we address in this paper.

Diamond production is regularly related to armed conflicts, which potentially affects a producer country's production volume and trade activity. By interacting the KPCS membership with existing conflicts, we control and analyze systematic differences in how the KPCS membership impacts trade for belligerent and non-belligerent exporters, respectively. By doing this, we relate to the literature on the role of conflicts, wars, and violence as potential trade impediments. Blomberg & Hess (2006) were one of the first, who empirically stressed the potential impact of violence and terrorist attacks on international trade flows. Based on a gravity model of trade and panel data of annual observations on 177 countries from 1968 to 1999, their results suggest that the presence of terrorism together with internal and external conflicts is equivalent to a 30 % tariff on trade. Lamotte (2012)

shows that war reduces the volume of belligerent nations' trade to a neutral country by about 41 %. Based on a large dataset and a gravity model, Martin, Mayer & Thoenig (2008) estimate the effect of civil wars on international trade. They show that the effect of a severe civil war on trade is substantial and persistent. We concentrate on a subset of international trade, namely trade in natural resources and here, in particular, rough diamonds trade, and examine if the trade impediment hypothesis of conflicts holds for this subset as well.

Our theoretical model relates to the findings in Anderson & van Wincoop (2003), Anderson & Yotov (2010), and Yotov, Piermartini, Monteiro & Larch (2016), who derive a structural gravity equation to estimate international trade flows. We base our econometric analysis on a dataset covering trade flows in rough diamonds between 50 importing and 25 exporting countries over 20 years (1996-2015). We apply a linear probability model to examine the probability of trading diamonds and the Poisson pseudo maximum likelihood (PPML) estimator, as suggested by Silva & Tenreyro (2006), to estimate the value of imports in rough diamonds.

The results give evidence that the KPCS significantly impacts international trade in rough diamonds. First, we find that the KPCS increases production costs, which leads to a decrease in the exporter's competitiveness in serving non-KPCS importers. However, our results show that in situations where both trading partners have signed the KPCS agreement the trade-enhancing mechanisms of the KPCS dominates. In other words, once the minimum product standard of conflict-free diamonds produced by the exporter matches the demand by the importer, trade in rough diamonds increases. Second, a unilateral KPCS participation intensifies the trade impediments resulting from armed conflicts and, thereby, reduces the scale of potential conflict diamonds traded internationally. However, in situations where the exporting country faces an internal armed conflict, the bilateral KPCS membership is able to overcome trade impediments due to armed conflicts so that the bilateral KPCS participation results in even higher trade values for belligerent exporters. Finally, if we exclude large exporter and importer hubs, i.e., South Africa and the United Kingdom, from the sample, our central conclusions remain valid. This finding assures us that despite the fairly concentrated market for rough diamonds, the KPCS trade impacts we observe also apply to smaller diamond traders and are not specific to the big players.

In an extension of the baseline model, we examine whether the positive trade impact of the KPCS depends on the exporters' market access. Behrens, Lamorgese, Ottaviano & Tabuchi (2007) or Candau, Guepie & Schlick (2019), for example, address the role of hubs for the trade impact of regional trade agreements. This literature points at the possibility that (regional) trade agreements primarily improve trade conditions for well-connected countries at the expense of peripheral regions. This argument of a possible "hub effect" may also apply to the KPCS. While the trade impact of a bilateral KPCS participation does not depend on the exporters' market access, we indeed find evidence

that exporters with proximity to large import markets face lower compliance costs of a unilateral participation in the KPCS than their remote counterparts.

The insights of this study have important policy implications. The use of public and private standards to regulate terms of trade has increased considerably in the last decades. Based on the scientific debate on "standards-as-catalysts" versus "standards-as-barriers" to trade, our study gives evidence that in the case of the KPCS the trade-enhancing benefits, such as lower information asymmetries and lower transaction costs, are sufficiently large to offset the increase in compliance costs and other non-tariff barriers. In the policy discourse, industries in low-income countries are often seen to be particularly affected by the introduction of product standards. First, to meet the standards, these industries have to bear relatively higher costs than their developed counterparts because their governments are often unable to provide the technical and institutional infrastructure. Moreover, they often do not participate in the design and international coordination of these standards, are less informed, and are often unable to anticipate these regulations (Chen, Wilson & Otsuki 2008). This leads product standards to be questioned as a development tool to integrate low-income countries into the world trade system. Worldwide, diamonds are mined predominately in low- and middle-income countries. In this setting, we find that the KPCS has worked as a catalyst, increasing trade in rough diamonds in both margins. Further, we do not find that the KPCS affects low-income countries differently, which suggests that the trade-enhancing benefits of KPCS are sufficiently large to compensate for the disproportional increase in compliance costs.

The remainder of the paper is structured as follows. Section 2 provides information on the KPCS. In Section 3 we present the theoretical model and explain our empirical strategy. Section 4 describes our data and Section 5 discusses our results. Section 6 finally concludes.

2 The Kimberley Process Certification Scheme

On November 5^{th}, 2002, following a two-year-long period of negotiations, 54 governments, the European Union, representing its member states, the worldwide diamond industry, and NGOs representing over 100 civil society groups agreed upon establishing the KPCS for the international trade in rough diamonds. The KPCS became effective on February 13^{th}, 2003, and banned shipments of rough diamonds from or to non-participant countries with 31^{st} August 2003 (Wright 2004). The KPCS is a voluntary agreement, which does not impose legally binding obligations on the participating countries. The agreement could be rather seen as a set of minimum requirements to be implemented by the participating countries to fulfill a common product standard in providing conflict-free diamonds. The participating countries can be divided into two groups: exporters and importers of rough diamonds. With the accession to the agreement, these two country groups agreed to implement specific trade obligations, which ensure that each shipment of rough diamonds

crossing an international border between these member countries consists of conflict-free gems. Further, agreement countries are urged to implement internal controls and publish their annual trade in rough diamonds, increasing the level of transparency, monitoring, and cooperation between them. The KPCS consists of two fundamental principles: First, each member country agreed to stop imports or exports of rough diamonds without a valid Kimberley Process certificate. Second, the signatory countries commit not to trade rough diamonds with non-signatories.

In general, due to its voluntary character, the agreement lacks binding penalty measures. Therefore, it consists mainly of two approaches to strengthen compliance. First, by increasing the transparency ("access to production and trade statistics") and reporting ("introduction of certificate"), non-compliance becomes more publicly known, which can produce international pressure to increase the level of compliance (Borsky & Raschky 2015). Second, failures to comply can lead to the removal of a country's KPCS membership. Exclusion from the group of members implies that the KPCS acts as a trade restriction (Wright 2004) as a nonmember can only trade with other nonmembers. Direct punishment of the non-compliant country should increase compliance and, therefore, work as a credible threat to deter free-riding (Barrett 1997).

Finally, it has to be mentioned that the KPCS is neither a provision to protect the environment, a guarantee for fair and ethical labor practices, nor a regulation, which ensures that the money from the sale of these diamonds will be directed back to the community that it was mined from.

3 Theoretical model and empirical specification

The quality of rough diamonds differs in carat, clarity, and color, which depends on specific geological characteristics at the point of origin. Further, production standards differ between countries. We, therefore, base our theoretical model on rough diamond trade on a gravity model with monopolistic competition among diamond exporters in diamond importer markets as laid out in Anderson & van Wincoop (2003), Anderson & Yotov (2010), and Yotov et al. (2016). Accordingly, we define the trade flows in rough diamonds from country i to j in year t, X_{ijt} as

$$X_{ijt} = \frac{Y_{it}Y_{jt}}{Y_{wt}} \frac{\left(\frac{\tau_{ijt}}{P_{jt}}\right)^{1-\sigma}}{\left(\sum_{h=1}^{J}\left(\frac{\tau_{iht}}{P_{ht}}\right)^{1-\sigma}\frac{Y_{ht}}{Y_{wt}}\right)}. \tag{1}$$

Following Anderson & van Wincoop (2003), the denominator of the second fraction in equation (1) can be defined as $\Pi^{1-\sigma} \equiv \sum_{h=1}^{J}\left(\frac{\tau_{iht}}{P_{ht}}\right)^{1-\sigma}\frac{Y_{ht}}{Y_{wt}}$. Y_{it}, Y_{jt}, and Y_{wt} denote the total value of rough diamond production of country i in year t, total rough diamond expenditures of country j in year t, and global expenditures on rough diamonds in year t, respectively. σ stands for the elasticity of substitution between varieties of rough diamonds

which is constant and uniform across countries with $\sigma \geq 1$. P_{jt} (Π_{it}) represents the inward (outward) multilateral trade resistance term of the importer (exporter). Based on Anderson & Yotov (2010), we interpret P_{jt} as the uniform markup on the world market price for the bundle of rough diamonds that are purchased at the world market; Π_{it} measures the exporter i's ease of market access.

$\tau_{ijt} > 1$ represents iceberg-type trade costs in year t. τ_{ijt} includes bilateral trade cost proxies. A typical proxy for time-variant bilateral trade costs is the existence of regional trade agreements that aim to ease the international exchange of goods and services. Similar to regional trade agreements, we consider the trading partners' KPCS membership as another proxy for trade costs. The fact that diamond production is often related to armed conflicts motivates a closer look at heterogeneity in trade impacts across belligerent and non-belligerent exporters. To allow for heterogeneity in the KPCS trade effects, we interact the common KPCS membership with the exporters' conflict intensity.

As our main interest lies in identifying the KPCS's trade effects, we use in the empirical specification a set of exporter-time, importer-time, and bilateral fixed effects (Yotov et al. 2016). The fixed effects control for country-time specific factors such as the trading partners' market size Y_{it} and Y_{jt} or the multilateral resistance terms Π_{it} and P_{jt} as well as bilateral time-invariant trade cost measures like distance or common border. Hence, aside from the rich set of fixed effects, we include only those proxies for trade costs that vary over country pairs and time, namely, dummies for the existence of a regional trade agreement and a joint KPCS membership, as well as an interaction of the KPCS dummy with the exporters' share of conflict mines over total mines in the exporting country. In the subsequent empirical models, we refer to these time-varying bilateral proxies for trade costs as D_{ijt}.

Re-writing the log-linearized transformation of equation (1) in exponential form and adding a stochastic error term (ϵ_{ijt}) our empirical specification of country j's nominal imports from country i in year t, X_{ijt}, reads as:

$$X_{ijt} = \exp\left(\alpha \mathbf{D_{ijt}} + \xi_{it} + \delta_{jt} + \zeta_{ij}\right) \times \epsilon_{ijt}, \tag{2}$$

with ξ_{it}, δ_{jt}, and ζ_{ij} representing exporter-year, importer-year, and bilateral fixed effects, respectively. As trade data often include zero trade flows and are heteroscedastic, we follow the recommendation of Silva & Tenreyro (2006) and estimate equation (2) by the Poisson pseudo maximum likelihood (PPML) estimator. Standard errors are clustered by trading pairs.

We expect both the existence of a regional trade agreement and bilateral KPCS participation to positively impact the trade value in rough diamonds. These agreements reduce trade barriers and thus serve to facilitate the bilateral exchange of diamonds. Further, we expect the KPCS to have a different trade impact depending on the exporters' conflict incidence. On the one hand, the mutual agreement between KPCS signatories to curb

trade in conflict diamonds could make the trade in rough diamonds more difficult for belligerent KPCS exporters. On the other hand, KPCS participation could also mitigate existing trade barriers and uncertainties in wartime, leading to increased trade values for KPCS-exporters facing armed conflicts within their territories. Depending on which effect dominates, we expect a negative or positive coefficient on the interaction term.

The decision to participate in diamond trading depends on the country i's firms operating profits and their fixed costs of serving the foreign market j in year t. The KPCS influences both the level of profits and the fixed costs. On the one hand, the KPCS acts as a regional trade agreement that reduces trade costs. Lower trade costs influence the extensive and intensive margin. In contrast to a typical trade agreement, the KPCS also acts as a trade club in which only member countries are allowed to trade rough diamonds among themselves. A trade club impacts the choice of potential trading partners and, therefore, mainly affects the extensive margin. Since these two mechanisms work in opposite directions, we do not have a clear expectation on how the KPCS influences the probability of trading. For examining the extensive margin, we apply the following linear probability model using the total sample:

$$P(X_{ijt} > 0) = \beta \mathbf{D_{ijt}} + \eta_{it} + \kappa_{jt} + \lambda_{ij} + \nu_{ijt} \tag{3}$$

with D_{ijt}, η_{it}, κ_{jt}, λ_{ij} representing time-varying bilateral proxies for trade costs, exporter-year, importer-year, and bilateral fixed effects, respectively. ν_{ijt} stands for the stochastic error term, clustered by trading pair. The dependent variable is a dummy which equals 1 in cases with positive import values, i.e., if $X_{ijt} > 0$; it is 0 otherwise. Concerning the heterogeneity of the KPCS's trade effects across belligerent and non-belligerent exporters, KPCS membership may, on the one hand, exacerbate the trade barriers due to conflict, as additional requirements must be met to participate in the international trade of rough diamonds. On the other hand, an existing agreement could reduce uncertainties in times of crisis so that the trade impediments due to armed conflicts are mitigated.

The unilateral impact of the KPCS

In this section, we focus on the observed heterogeneity in trade values across exporters. As we include exporter-year fixed effects when estimating the extensive and intensive margin, we cannot identify the importance of various exporter-year specific determinants for a country's exports in rough diamonds via the gravity equation. Therefore, in the second stage, we use the exporter-year fixed effects, which we derive from the gravity estimation, to analyze the heterogeneity in trade flows across exporting countries on both margins. We either regress $\widehat{\xi_{it}}$ (intensive margin) or $\widehat{\eta_{it}}$ (extensive margin) on exporter (ς_i) and year (χ_t) fixed effects, as well as on a vector of covariates, D_{it}, which explain exporter-year variation in rough diamond trade flows. The respective specification for the intensive

margin reads as:

$$\ln \widehat{\xi_{it}} = \kappa + \gamma D_{it} + \varsigma_i + \chi_t + \varepsilon_{it}. \tag{4}$$

ε_{it} represents the stochastic error term. Analogous to Agnosteva, Anderson & Yotov (2019) and Kinzius, Sandkamp & Yalcin (2018), we bootstrap standard errors in this stage using 200 replications. D_{it} contains yearly information on the exporter i's unilateral KPCS membership status, the share of conflict mines in the exporting country, and its interaction with the exporter's KPCS membership status. To account for yearly changes in the prices of production factors in an exporting country, we include the logarithm of the exporters' GDP/capita. Finally, due to their product characteristic as low-weight and high-value goods, diamonds are prone to potentially illegal smuggling activities, which could influence an exporter's trade activity. To account for the intensity of smuggling activities to exporter i, we include the number of diamond deposits for which the exporting country is the nearest neighbor and the sum of the geographic distance between these mines and the exporting country's closest border.

Unilateral commitments to the certified diamond trade incur additional costs that reduce the exporters' competitiveness so that a unilateral KPCS membership should negatively influence trade values (e.g., Maskus et al. 2013). Following the literature of armed conflicts as trade impediments (e.g., Blomberg & Hess 2006), we expect negative impacts from armed conflicts in the exporting country. Finally, conflict incidence introduces a source of heterogeneity in the trade impacts of a KPCS membership. Based on the agreement's provision, we expect unilateral KPCS participation to exacerbate trade barriers due to conflicts.

We want to emphasize that all bilateral factors of influence no longer play a role in this analysis of heterogeneous trade values. They have already been controlled for by including bilateral fixed effects in the first stage.

4 The data

Our dataset draws information from various sources. Information on international trade flows in rough diamonds is taken from the World Integrated Trade Solutions database, which relies on the UN's commodity trade statistics database.[4] Data on regional trade agreements in force are taken from Baier, Bergstrand, Egger & McLaughlin (2008) and from the WTO's Regional Trade Agreements Information System.[5] The Kimberley process rough diamond statistics provide information in case a country is a signatory country of the KPCS.[6] To distinguish between diamond producers and intermediaries, we rely on the information given in the U.S. Geological Survey, which reports data on the world

[4] http://wits.worldbank.org/wits/
[5] http://rtais.wto.org/UI/PublicMaintainRTAHome.aspx
[6] https://kimberleyprocessstatistics.org/

production of natural diamonds by country and type, which are gemstones and industrial diamonds.[7]

In our empirical analysis, we focus on import flows (reported in 1,000 USD) in rough diamonds referring to three different HS-1996 codes, which are directly drawn from the KPCS agreement text (see Table A1 in the Appendix): diamonds unsorted (710210), industrial diamonds, unworked or simply sawn, cleaved or bruted (710221) and non-industrial diamonds, unworked or simply sawn, cleaved or bruted (710231). As the KPCS does not differentiate between the various types of rough diamonds, we summarize the trade value over the three HS-1996-categories. We only include those exporting countries that have – according to the U.S. Geological Survey – diamonds at their disposal. We do so to ensure that we do not mix up original diamond producers' and intermediaries' trade flows.

These data modifications result in a sample size of 62,300 potential trade flows between 27 exporters and 116 importers. Positive trade flows occur for 4,413 observations (7.1 %) and amount to a total import value of 216,834 million USD. As we include a comprehensive set of fixed effects in our empirical specification, we need to have at least two observations per exporter-year, importer-year, and exporter-importer combination. This constraint considerably reduces the sample size, which leads to our final dataset. Our final dataset consists of 6,687 observations over 20 years (1996-2015) and comprises 25 exporters and 50 importers.[8] For 3,794 (56.7 %) observations, import flows are > 0 with an average value of 56.79 million USD. The total import value now amounts to 215,479 million USD or 99.4 % of the original import value. Hence, only rather small trading partners were excluded due to the reduction of the sample.

From 2003 onwards, 23 out of 25 exporters in our sample are KPCS members. Two exporters, the Republic of Congo and Indonesia, switch their KPCS status from non-member to active membership.[9] The importers' KPCS status is more heterogeneous. Bahrain, Bolivia, Cyprus, Hong Kong, Kazakhstan, and Turkey have not been KPCS members during the whole period or for the majority of years. 2,634 out of the 3,794 positive trade flows are between KPCS members, leaving 1,160 positive trade flows, where either only one or none of the trading partners are members of the agreement.

Table 1 provides descriptive statistics of the variables included in the regression analysis for the total sample and two subgroups, namely observations with zero-trade flows and observations with positive trade flows. For a definition and data source of these variables, see Table A6 in the Appendix. Regarding the KPCS variable, we find that on average, in 71 % (68 %) of the observations, the exporting (importing) country participated in the KPCS. Distinguishing between non-trading and trading country pairs, we find that these proportions are considerably higher for traders than non-traders. If countries do trade with each other, 74 % (70 %) of the exporting (importing) countries agreed on the KPCS;

[7] http://minerals.usgs.gov/minerals/pubs/commodity/diamond/

[8] Please see Tables A2 and A3 in the appendix for a list of included exporters and importers.

[9] Republic of Congo: years 2004-2006; Indonesia: years 2003-2004.

for zero-trade flows, the proportions amount to 67 % (exporters) and 64 % (importers), respectively. Further, in 69 % of positive trade flows, both countries are KPCS members. For non-traders with 63 %, this number is lower. Regarding the conflict variable, Table 1 reveals that the share of conflict mines over total diamond mines in exporting countries is 8 %, almost as high as for non-exporters (9 %).

Table 1: Summary statistics

Variable	Total sample		Imports= 0		Imports> 0	
	Mean	Std.D	Mean	Std.D	Mean	Std.D
Pos Trade	0.57	0.50	0	0	1	0
Imports (Mio USD)	32.22	193.49	0	0	56.79	254.17
KPCS Exp	0.71	0.45	0.67	0.47	0.74	0.44
KPCS Imp	0.68	0.47	0.64	0.48	0.70	0.46
KPCS Both	0.67	0.47	0.63	0.48	0.69	0.46
Conflict mines Exp	0.08	0.21	0.09	0.23	0.08	0.19
KPCS Exp×Conf mines Exp	0.04	0.13	0.03	0.11	0.05	0.15
Number conflict mines Neighbor	2.24	6.45	3.10	7.56	1.58	5.35
Dist conflict mines Neighbor	0.03	0.30	0.05	0.40	0.02	0.20

Notes: Sample size is 6687, 2893 and 3794 for the total, zero-trade and positive trade flows, respectively.

4.1 International trade in rough diamonds

Table 2 provides an overview of the geographical location of exporting and importing countries and the value of diamonds traded in percent of the total import value for two time periods - the period from 1996 until 2002 before the KPCS went into force and the KPCS period from 2003 until 2015. Figures in Table 2 in parentheses refer to the KPCS period.

Overall, the global import value has increased nearly eightfold (from 27 to 188 million USD) in the period after KPCS went into force. Over the whole sample period, Europe is with an import share of 86 % (70 %) the principal importer, primarily importing from Africa (56 % | 39 %), other European countries (13 % | 13 %) and North- and South America (10 % | 12 %). These three continents are also the major exporters, with Africa covering an export share of 66 % (58 %) followed by Europe with 15 % (19 %) and America with 10 % (14 %). The remaining continents are of minor importance for the world trade in rough diamonds. Over time, the importance of Asia and Africa as an importer increased considerably. Whereas, Europe as an importer lost nearly 16 % of its global market share. Concerning exporters, we see a slight decrease in Africa and Oceania's market shares, which is replaced by increased market shares for America, Asia, and Europe.

Tables 3 and 4 provide deeper insights into which countries are the export and import leaders, respectively. South Africa is the largest exporter before and after the KPCS went into force. Its exports cover 30 % and 20 % of the total import value, respectively. South

Table 2: Value of diamonds traded (in % of total import value)

Exporter	*Importer*					
	(1)	(2)	(3)	(4)	(5)	Total
(1) Africa	0.39 (4.13)	7.70 (3.88)	2.65 (10.75)	55.62 (39.10)	0.01 (0.00)	66.37 (57.85)
(2) Americas	0.00 (0.93)	0.46 (0.32)	0.29 (1.07)	9.57 (11.91)	0.00 (0.01)	10.33 (14.24)
(3) Asia	0.01 (0.04)	0.27 (0.06)	0.37 (2.51)	2.73 (3.95)	0.03 (0.00)	3.41 (6.56)
(4) Europe	— (0.16)	0.10 (0.20)	1.52 (5.24)	12.99 (13.14)	— (—)	14.61 (18.73)
(5) Oceania	0.04 (0.06)	0.02 (0.03)	0.06 (0.18)	5.15 (2.34)	0.00 (0.00)	5.28 (2.61)
Total	0.45 (5.32)	8.54 (4.48)	4.89 (19.75)	86.07 (70.43)	0.05 (0.02)	100.00 (100.00)

Notes: Table presents the value of trade in rough diamonds in % of the total observed import value for two time periods: 1996 to 2002 and (2003 to 2015 in parentheses). Figures refer to the sum of imported goods recorded. The total observed import value is 27,071 mill. USD (188,409 mill. USD).

Africa exports are mainly directed to Europe (24 % | 14 %). However, Asia and Africa's importance as import partners for South African rough diamond exports has considerably increased after KPCS went into force. Besides South Africa, Botswana and Angola are major African exporters of rough diamonds. At the same time, the Democratic Republic of Congo lost market shares after the KPCS period. Other major exporting countries of rough diamonds are Russia, Canada, India, and Australia.

Table 3: Value of diamonds traded (in % of import value) for largest exporters

			Continent of importer					
	Rank	Exporter	Africa	Americas	Asia	Europe	Oceania	Total
2003 - 2015	(1)	South Africa	1.01	2.04	3.53	14.06	0.00	20.64
	(2)	Botswana	1.12	0.83	2.61	14.72	0.00	19.27
	(3)	Russia	0.16	0.20	5.24	13.14	—	18.73
	(4)	Canada	0.93	0.25	1.03	11.73	0.01	13.95
	(5)	Angola	0.07	0.38	3.36	2.70	0.00	6.52
	(6)	India	0.02	0.05	2.24	3.48	0.00	5.80
1996 - 2002	(1)	South Africa	0.06	3.89	1.65	23.92	0.01	29.52
	(2)	Russia	0.00	0.10	1.52	12.99	—	14.61
	(3)	Congo, D.R.	0.32	1.36	0.02	11.86	0.00	13.55
	(4)	Canada	0.00	0.09	0.10	8.55	0.00	8.75
	(5)	Botswana	0.00	0.12	0.00	6.67	0.00	6.79
	(6)	Australia	0.04	0.02	0.06	5.15	0.00	5.28

Notes: Empty cells for country-continent pair indicate zero trade flows between exporter and continent of importer.

Concerning rough diamond imports, the United Kingdom and Belgium are the principal importers before and after KPCS went into force. Their import shares in the global rough diamond trade amount to about 46% (38 %) from 1995 until 2002 and 39% (29 %) from 2003 until 2015. Interestingly, comparing the two time periods, the dominance of these two importers in the global rough diamond market reduced from 84 % to 68 % quite considerably in the later period. Both countries receive a large part of their diamond imports from Africa. However, in comparison to the United Kingdom, Belgium has a more globally diversified and less concentrated set of exporting partners, particularly after KPCS went into force. From 1995 until 2002, other large importer countries are in descending order the United States, Israel, Hong Kong, and China. This picture changed a bit after KPCS went into force. Besides the United Kingdom and Belgium, the United Arab Emirates, the United States, India, and Botswana are the major importers of rough diamonds from 2003 until 2015.

Table 4: Value of diamonds traded (in % of import value) for largest importers

			Continent of exporter					
	Rank	Importer	Africa	Americas	Asia	Europe	Oceania	Total
2003 - 2015	(1)	United Kingdom	25.72	9.02	0.15	1.88	1.78	38.54
	(2)	Belgium	12.57	2.83	2.55	10.85	0.54	29.35
	(3)	United Arab Emirates	5.20	0.16	2.12	0.59	0.06	8.15
	(4)	United States	3.81	0.32	0.05	0.19	0.03	4.40
	(5)	India	1.33	0.60	0.02	2.16	0.05	4.16
	(6)	Botswana	2.46	0.79	0.04	0.02	—	3.31
1996 - 2002	(1)	United Kingdom	27.19	4.62	0.05	12.18	2.31	46.34
	(2)	Belgium	28.19	4.95	1.27	0.79	2.78	37.98
	(3)	United States	7.68	0.45	0.08	0.10	0.02	8.33
	(4)	Israel	–	0.27	0.20	1.20	0.01	1.68
	(5)	Hong Kong	0.13	0.00	1.40	0.02	0.04	1.59
	(6)	China	1.44	0.00	0.07	0.00	0.00	1.52

Notes: Empty cells for country-continent pair indicate zero trade flows between importer and continent of exporter.

4.2 Conflict and diamond production

The KPCS's key objective is to limit the international trade in conflict diamonds. Because we do not have information on which mines are owned by rebel movements, we focus on the occurrence of conflicts around diamond mines. To measure the number of diamond deposits, which are located in an active conflict area in a given year, we determine each diamond mine deposit within a country, which is inside of a 100-kilometer buffer around

the spatial location of the conflict incidence.[10] To do this, we draw information from two sources.

First, we use location data of diamond deposits provided by Gilmore, Gleditsch, Lujala & Rød (2005). They give a comprehensive list of all relevant 1,113 diamond sites worldwide, including their geographic coordinates. The dataset represents the state of known and actively used deposits as it was in 2005. As the occurrence of new diamond deposits is rather limited over our sample period, we are confident that it is well suited to approximate the state of diamond production in a country also for the subsequent years.[11]

Second, we use conflict data, which is taken from the UCDP Georeferenced Event Dataset, which was collected by the Uppsala Conflict Data Program (UCDP) at the Department of Peace and Conflict Research, Uppsala University (Sundberg & Melander 2013).[12] The UCDP Georeferenced Event Dataset is covering individual events of organized violence at a sufficiently fine-grained level to be geo-coded down to the level of individual villages.[13] For further processing, we aggregate the data at the year level. To be in line with the KPCS conflict definition, we select only conflicts, which are defined as internal armed force, which occur between one or more internal opposition group(s) and the government of a state and against unorganized civilians.

Table 5 gives an overview of the distribution of diamond mines, which are located in an active conflict area, for each exporting country over the whole sample period. For all exporters, the share of conflict mines as a percentage of the exporter's total number of diamond deposits varies considerably within a country, as shown in the last column of Table 5, which depicts the standard deviation for each exporter. In some countries and years, it reaches up to situations in which all diamond deposits within a country are facing a conflict situation, as this was the case in Angola, Sierra Leone, or the Republic of the Congo.

4.3 Illegal trade in rough diamonds

Our dataset on international trade in rough diamonds is limited to legal trade flows only. However, diamonds are characterized as low-weight and high-value goods prone to po-

[10] We exclude diamond deposits, which are within the 100-kilometer conflict zone but outside of the country boundaries.

[11] However, in a robustness exercise, we extend our definition of relevant diamond mines and include next to diamond mines with known activity, meaning production either commercial or artisan, confirmed discoveries, which accounts for a potential future expansion of production. Using the definition of potentially diamond producing countries given in the PRIO database (see Table A4 in the Appendix) extends the number of diamond producers and subsequently exporting countries from 25 to 50. Table A5 in the Appendix shows the regression results based on this larger sample. The results largely support the results of the main specifications.

[12] https://ucdp.uu.se/downloads/index.html#ged_global. In this study, we use the global version 5.0 of the dataset. Please see Högbladh (2020) for a more detailed description of this dataset.

[13] An event is defined as an incident, in which *"armed force was used by an organized actor against another organized actor, or civilians, resulting in at least one direct death at a specific location and a specific date"* (Högbladh 2020). Further, this dataset focuses on the armed conflict involving consciously conducted and planned political campaigns rather than spontaneous violence.

Table 5: Conflict mines in exporting countries

Exporter	Number of mines		Share of conflict mines		
	Conflict mines	Peace mines	Minimum	Maximum	St.Dev.
Angola	8.3	40.7	0	1.0	0.3
Australia	0	67.0	0	0	0
Brazil	0.3	230.7	0	0.0	0.0
Botswana	0	9.0	0	0	0
Cent. Afr. R.	4.8	21.2	0	0.5	0.2
Canada	0	23.0	0	0	0
China	0	9.0	0	0	0
Cote d'Ivoire	4.6	8.4	0	0.8	0.4
Cameroon	0	1.0	0	0	0
Congo, D.R.	4.8	29.2	0	0.4	0.2
Congo, Rep.	0.1	1.0	0	1.0	0.2
Ghanna	0	20.0	0	0	0
Guinea	9.4	38.6	0	0.9	0.3
Guyana	0.6	91.4	0	0.1	0.0
India	0.8	13.2	0	0.6	0.2
Indonesia	5.1	7.9	0.1	0.8	0.2
Liberia	2.5	29.5	0	0.7	0.2
Lesotho	0	9.0	0	0	0
Namibia	0	22.0	0	0	0
Russia	0	32.0	0	0	0
Sierra Leone	6.7	19.3	0	1.0	0.4
South Africa	1.2	99.8	0	0.2	0.0
Tanzania	0	12.0	0	0	0
Venezuela	22.7	111.3	0	0.3	0.1
Zimbabwe	0.5	5.5	0	0.5	0.2

Notes: Sample size is 6,687. Mean number of mines in conflict area and non-conflict area given for each exporter over the whole sample period (1996-2015).

tentially illegal smuggling activities. Potential smuggling is also an often stated critique on the effectiveness of the KPCS in regulating international trade flows in rough diamonds.[14] Intuitively, the smuggling of diamonds will occur as long as there is a positive price differential between the origin country and the destination country, taking the costs of smuggling into account. In case a country's diamond deposit is situated in a conflict area, selling diamonds over official trade channels is limited. It is even more complicated for KPCS members as the exporter has to certify that the diamonds do not originate from mines owned by rebel movements.

To account for smuggling activities, which could potentially confound our estimate of the KPCS's impact on the trade in rough diamonds, we include two measures. First, the

[14] See, for example, a report by Global Witness (2008) available at https://www.globalwitness.org/en/archive/loupe-holes-illicit-diamonds-kimberley-process.

number of diamond deposits, for which the exporting country is the nearest neighbor, serves as a proxy for the potential smuggling stock. Second, the sum of the geographic distance between these mines and the exporting country's closest border accounts for smuggling costs.

To construct these variables, we proceed as follows. In a first step, we assign each diamond deposit to the nearest neighboring country based on the geodesic length in meters between a diamond deposit and an exporting country's border using WGS84-ellipsoid great circles between each vertex. In a second step, we determine the conflict status for each diamond deposit as described above. Finally, in a third step, we sum up the number of diamond deposits situated in a conflict area, for which the exporting country is its nearest neighbor. This gives us our measure of the potential smuggling stock for each exporting country. Our second measure is the sum of the geodesic distance between the diamond deposits situated in a conflict area and the exporting country. This information serves as our measure of smuggling costs. If smuggling occurs between two countries, we expect the neighboring smuggling stock to have a positive impact, and the smuggling costs a negative impact on a country's trade value in rough diamonds.

Table 6 depicts our measures for the smuggling potential for each exporting country over time. Overall, it can be seen that the smuggling stock and smuggling costs vary considerably between countries as well as within countries over time. Variation in these measures comes from both: the conflict occurrence in countries and the country's spatial proximity to its neighboring diamond deposits.

5 The results

Our empirical results of the first stage are based on the structural gravity model developed in Section 3. To analyze the intensive margin, we use the PPML estimator and focus only on positive trade flows. For examining the extensive margin, we rely on a linear probability model and use the OLS estimator. In both specifications, we control for exporter-year, importer-year, and bilateral fixed effects. The outcome is presented in Columns (1) and (3) of Table 7. In the second stage of our estimation procedure, we examine factors determining the heterogeneity in trade flows across exporters. Therefore, we regress the exporter-fixed effects derived from the first stage on a set of exporter specific variables, which determine the value of exports and the likelihood of entering the market as an exporter. Those results are presented in Columns (2) and (4).

The trade impact of bilateral KPCS participation

We first discuss the estimates of the bilateral determinants of international trade in rough diamonds as depicted in column (1) and column (3) in Table 7. Our results give evidence that the KPCS significantly affects international trade in rough diamonds. We find that in situations where both trading partners have signed the KPCS agreement, i.e., when

Table 6: Number of and distance to conflict mines in neighboring countries

Exporter	1996-2000			2001-2005			2006-2010			2011-2015		
	Number		Distance	Number		Distance	Number		Distance	Number		Distance
Angola	8.1	(0;13)	1,609.8	0	(0;0)	0	4.2	(0;11)	918.1	3.1	(0;13)	615.6
Australia	0	(0;0)	0	0	(0;0)	0	0	(0;0)	0	0	(0;0)	0
Brazil	1.1	(0;5)	265.1	8.6	(5;23)	1,093.3	0.4	(0;2)	60.2	0	(0;0)	0
Botswana	0	(0;0)	0	0.2	(0;1)	18.5	0.8	(0;2)	170.8	0	(0;0)	
Cent. Afr. R.	0	(0;0)	0	0	(0;0)	0	0.4	(0;2)	87.1	0.3	(0;1)	50.2
Canada	0	(0;0)	0	0	(0;0)	0	0	(0;0)	0	0	(0;0)	0
China	0.4	(0;2)	63.2	0.8	(0;2)	128.1	0	(0;0)	0	1.4	(0;2)	230.4
Cote d'Ivoire	2.5	(1;4)	164.6	2.3	(1;5)	128.5	–	–	–	–	–	–
Cameroon	0	(0;0)	0	–	–	–	–	–	–	4.5	(0;9)	282.0
Congo, D.R.	31.7	(21;41)	3,761.5	10.9	(0;33)	1,399.7	2.0	(0;4)	399.9	6.5	(6;8)	1,242.5
Congo, Rep.	0.2	(0;1)	34.8	0	(0;0)	0	0	(0;0)	0	0.5	(0;2)	40.5
Ghanna	0.2	(0;1)	16.1	1.2	(0;2)	135.0	1.2	(0;3)	134.3	0.8	(0;1)	53.0
Guinea	21.0	(19;25)	777.9	16.6	(0;34)	892.3	1.5	(0;8)	176.5	1.9	(0;8)	224.0
Guyana	6.6	(0;25)	1,246.7	20.9	(4;29)	4,065.6	0.2	(0;1)	46.7	0	(0;0)	0
India	0	(0;0)	0	0	(0;0)	0	0	(0;0)	0	–	–	–
Indonesia	0.2	(0;1)	26.5	0	(0;0)	0	0.2	(0;1)	26.5	1.25	(1;2)	132.8
Liberia	22.2	(6;45)	1,138.3	–	–	–	5.8	(0;23)	343.8	9.3	(0;32)	428.5
Lesotho	–	–	–	0	(0;0)	0	1.4	(0;7)	226.7	0	(0;0)	0
Namibia	4	(4;4)	1,503.5	1.1	(0;4)	467.1	0	(0;0)	0	0	(0;0)	0
Russia	0	(0;0)	0	0	(0;0)	0	0	(0;0)	0	0.2	(0;1)	19.5
Sierra Leone	13.6	(3;21)	685.9	12.3	(0;22)	506.6	0.4	(0;1)	16.2	0.3	(0;1)	10.5
South Africa	1.7	(0;9)	49.1	0	(0;0)	0	0	(0;0)	0	0	(0;0)	0
Tanzania	0	(0;0)	0	0	(0;0)	0	0	(0;0)	0	0	(0;0)	0
Venezuela	0.2	(0;1)	25.7	0.4	(0;1)	44.3	–	–	–	–	–	–
Zimbabwe	0	(0;0)	0	0	(0;0)	0	0	(0;0)	0	0	(0;0)	0

Notes: Sample size is 6,687. Minimum and maximum number of conflicts in neighboring countries given in parentheses. Mean distance to neighboring conflict mines given in kilometers.

the supply of and the demand for the standard to provide conflict-free rough diamonds matches, the probability, as well as the intensity of trading rough diamonds, is significantly higher than for countries without such a common standard. On average, the trade value between KPCS signatories increases by 220 % compared to trade flows between country pairs, where at least one trading partner has not signed the agreement.[15] As the trade intensity of countries, which have not signed the agreement is rather small, the percentage difference compared to trade flows between KPCS members turns out to be quite large. Secondly, although a conflict incidence potentially serves as a trade impediment, as it will be shown later in the unilateral exporter specific outcomes, the positive trade-enhancing factors of a KPCS membership, like the increased market transparency and openness, dominate even for exporters facing an internal armed conflict. If the exporter's share of conflict mines increases by one percentage point, import values of KPCS members are 2.07 % higher than for non-belligerent non-members. We do not find a significant effect of this interaction on the extensive margin of trade in rough diamonds.

Finally, the RTA dummy's coefficient indicates that the value of international trade in rough diamonds is significantly lower if both countries have signed a regional trade agreement. This outcome contradicts the argument that regional trade agreements reduce transaction costs between member countries and lead to higher trade values. However, Candau et al. (2019), who study the trade effect of regional trade agreements in Africa, also find no evidence of a positive trade effect of recent regional trade agreements in their empirical analysis. They argue, among others, that first regional trade agreements primarily improve trade conditions for well-connected countries, and second discuss the possibility that specific provisions within an agreement may even reduce trade flows.

The trade impact of unilateral KPCS participation

To gain a deeper understanding of the KPCS's trade impact, we now turn to the results of the unilateral exporter specific determinants of international trade in rough diamonds. The dependent variable in the second stage (i.e., exporter fixed effects) captures exporter specific variation in the value of trade flows (column (2)) and in the probability of exporting (column (4)). Note that all time-invariant bilateral variation in trade flows has been canceled out in the first stage. Consequently, the estimated coefficients in the second stage help explain the exporter specific heterogeneity in the trade value and the probability of exporting.

We find that the unilateral KPCS participation significantly affects an exporter's trade decision and trade value. Being a KPCS-member requires investments to fulfill the KPCS obligations, which increases the exporters' production costs. The higher production costs decrease the exporter's competitiveness in serving non-KPCS importing countries, which results in a lower probability of entering the exporting market and also results in a lower trade value. Second, a conflict in an exporting country serves as a trade impediment and

[15] Percentage change of a dummy variable $= (e^{coefficient} - 1) * 100$.

reduces an exporter's probability to trade. Additionally, we find that the KPCS intensifies the trade impediments resulting from armed conflicts and, thereby, reduces the scale of potential conflict diamonds traded internationally. Our results show that if the exporter's share of conflict mines increases by 1 %, the trade value of rough diamonds reduces by another 2.9 % for KPCS-exporters. We do not find a significant effect of this interaction on the extensive margin of trade.

Besides our results on the main explanatory variables of interest, we find that the trade value increases by 0.03 % for every additional conflict mine in the neighboring countries due to smuggling activities. The coefficient estimate of our smuggling cost measure is negative – as expected – but insignificant. We do not find a significant impact of these two measures on the extensive margin. Finally, GDP/capita positively impacts export values.[16]

The KPCS and diamond trading hubs

South Africa dominates the international trade in rough diamonds as a major exporter and the United Kingdom as a major importer. As shown in Table 3, South Africa accounted for 30 % of the total value of the diamonds trade before the KPCS entered into force. After 2002, the dominant role of South Africa decreased slightly, and South African exports summed up to 21 % of the world's rough diamonds exports. With 46 %, the United Kingdom is the principal importer of rough diamonds from 1995 until 2002. After the KPCS went into force, its importance as a major importing partner decreased to 39 % (see Table 4).

To learn how the value of trade flows and the probability of trading sensitively react to the exclusion of the two major export and import hubs, we estimate our structural gravity model on a subsample excluding either South Africa or the United Kingdom. The regression outcomes from this exercise are shown in Table 8.

The observation in columns (1)-(4) of Table 8 show the estimates when South Africa as the major exporter is excluded from the sample. The results presented in the first four columns of Table 8 largely confirm the conclusions from our main estimates. The exclusion of Great Britain as one of the major importers does not change the observed trade patterns in the main regressions either (see columns (5)-(8) of Table 8). The major difference between the results when excluding Great Britain and our main specification is that, on the bilateral level, regional trade agreements are no longer a significant determinant of the trade value. Regarding the determinants that explain the exporter-specific heterogeneity in trade flows, we find that the exporter's share of conflict mines does not significantly impact the extensive margin. The sign and significance levels of the remaining variables

[16] Applying the PPML estimator on the full sample (including zero trade flows), we find similar results concerning the coefficients' sign, size, and significance level in the first stage. In the second stage, only the coefficient on the exporter's unilateral KPCS membership loses its significance, but the negative tendency remains. The other coefficients support the results of the main regression. Results are available upon request.

Table 7: Regression results

	Intensive margin		*Extensive margin*	
Dep. Variable	$X_{ijt}{}^{(a)}$	$\ln \widehat{\xi_{it}}^{(b)}$	$Pr(X_{ijt}>0)^{(a)}$	$\ln \widehat{\eta_{it}}^{(b)}$
	(1)	(2)	(3)	(4)
KPCS Exp × KPCS Imp	1.164**		0.703***	
	(0.562)		(0.162)	
KPCS Both×Conf mines Exp	2.066***		−0.033	
	(0.798)		(0.180)	
RTA	−0.902***		−0.033	
	(0.341)		(0.038)	
KPCS Exp		−1.265**		−0.593***
		(0.570)		(0.063)
Conf mines Exp		0.213		−0.104*
		(0.443)		(0.058)
KPCS Exp×Conf mines Exp		−2.898***		0.044
		(0.586)		(0.084)
ln(GDP/capita Exp)		2.085***		0.028
		(0.645)		(0.060)
Conf mines Neighb		0.025**		−0.002
		(1.166)		(0.153)
Dist conf mines Neighb		−0.329		−0.017
		(0.679)		(0.092)
Observations	3794	415	6687	415

Notes: ***, **, * indicates the significance level of 1, 5, 10 percent, respectively. $^{(a)}$ first stage estimates; $^{(b)}$ second stage estimates. Dependent variables: Import value in mio USD or dummy indicating positive trade flows (1^{st} stages) and exporter-year fixed effects (2^{nd} stages). Included but not reported: exporter-year, importer-year and exporter-year fixed effects in 1^{st} stages; constant, exporter and year fixed effects in 2^{nd} stages. Clustered (by trading pair) standard errors in 1^{st} stages, bootstrapped standard errors in 2^{nd} stages are given between parentheses.

are the same as in the main regressions. From these results, we conclude that the trade impact of the KPCS does not purely depend on the trading partners' market size but also applies to smaller diamond traders.

The KPCS status and the role of economic development

In the literature, the question regularly arises if standards are either working as catalysts and increase trade flows or as barriers reducing trade flows. Industries in low-income countries are often seen to be in particular affected by the introduction of product standards. As governments are often unable to provide the technical and institutional infrastructure, industries in low-income countries often have to bear relatively higher compliance costs than higher-income countries. Moreover, they often do not participate in the design and international coordination of these standards, are less informed, and are often unable to anticipate these regulations (Chen et al. 2008). On the other hand, product standards al-

Table 8: Excluding exporter and importer hubs

	Excluding South Africa				Excluding United Kingdom			
	Intensive margin		*Extensive margin*		*Intensive margin*		*Extensive margin*	
Dep. Variable	$X_{ijt}{}^{(a)}$	$\ln \widehat{\xi_{it}}^{(b)}$	$Pr(X_{ijt}>0)^{(a)}$	$\ln \widehat{\eta_{it}}^{(b)}$	$X_{ijt}{}^{(a)}$	$\ln \widehat{\xi_{it}}^{(b)}$	$Pr(X_{ijt}>0)^{(a)}$	$\ln \widehat{\eta_{it}}^{(b)}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
KPCS Exp × KPCS Imp	1.118**		0.666***		1.219**		0.695***	
	(0.528)		(0.168)		(0.562)		(0.164)	
KPCS Both×Conf mines Exp	2.465***		0.099		2.071***		−0.032	
	(0.794)		(0.184)		(0.657)		(0.182)	
RTA	−0.645**		−0.035		−0.246		−0.031	
	(0.324)		(0.046)		(0.220)		(0.039)	
KPCS Exp		−1.540***		−0.555***		−1.676***		−0.596***
		(0.542)		(0.062)		(0.607)		(0.062)
Conf mines Exp		0.305		−0.114*		−0.129		−0.061
		(0.452)		(0.060)		(0.477)		(0.058)
KPCS Exp×Conf mines Exp		−3.237***		−0.070		−2.503***		0.027
		(0.652)		(0.087)		(0.668)		(0.084)
ln(GDP/capita Exp)		2.112***		0.035		2.263***		0.085
		(0.675)		(0.061)		(0.564)		(0.057)
Conf mines Neighb		0.030**		−0.001		0.028***		−0.002
		(1.190)		(0.148)		(1.081)		(0.151)
Dist conf mines Neighb		−0.271		−0.012		−0.355		−0.017
		(0.600)		(0.076)		(0.494)		(0.085)
Observations	3312	394	5902	394	3555	412	6297	412

Notes: ***, **, * indicates the significance level of 1, 5, 10 percent, respectively. $^{(a)}$ first stage estimates; $^{(b)}$ second stage estimates. Dependent variables: Import value in mio USD or dummy indicating positive trade flows (1^{st} stages) and exporter-year fixed effects (2^{nd} stages). Included but not reported: exporter-year, importer-year and exporter-year fixed effects in 1^{st} stages; constant, exporter and year fixed effects in 2^{nd} stages. Clustered (by trading pair) standard errors in 1^{st} stages, bootstrapped standard errors in 2^{nd} stages are given between parentheses.

low producers in low-income countries to signal and prove high product quality and enter higher value chains and facilitate access to global markets (Henson & Jaffee 2004, Ehrich & Mangelsdorf 2018). To provide insights if the KPCS differs in its trade impact depending on the income status, we extend our base model as discussed in Section 3. We interact the information on the KPCS membership with a dummy variable that equals one for higher-income and upper-middle-income countries and is zero otherwise. The classification of countries refers to the World Bank's country classification by income.[17]

Our estimated effects are shown in Table 9 in columns (1) – (4). Overall, we do not find statistically significant differences in the trade effect of the KPCS. These findings indicate that although low-income countries potentially have to bear relatively higher compliance costs, these costs are compensated by the benefits of a reduction in information asymmetries and access to the global market. Therefore, KPCS does not lead to a systematic exclusion of lower-income countries from the export market.

The KPCS status and the role of market access

According to Behrens et al. (2007) and Candau et al. (2019), for example, countries with good access to foreign markets are expected to benefit particularly from market integration at the expense of peripheral states. To examine the importance of possible hub effects for the trade impact of the KPCS, we first generate a variable analogous to Candau et al. (2019) that measures the access of exporter i to the markets of importer j by weighting the GDP of the importers by bilateral distance:

$$\lambda_{it} = \sum_{j \neq i}^{N} \frac{GDP_{jt}}{Dist_{ij}} \tag{5}$$

We then interact this variable with the bilateral information about the trading partners' KPCS membership to test whether the KPCS's trade effect depends on the exporter's access to international markets.

Columns (5) – (8) of Table 9 show the results of this extension. The bilateral agreement effect is still positive and highly significant and is slightly higher than in the main regression. However, we do not find that the bilateral trade effect of the KPCS membership depends on the extent of the market access. This finding is true for both the intensive (column (5)) and extensive (column (7)) margins.

Concerning the heterogeneity in trade flows across exporters, we find that KPCS exporters with good market access, i.e., KPCS exporters close to big importer markets, experience significantly larger trade values (column (6)) and a higher probability of exporting (column (8)). Furthermore, the negative impact of an unilateral KPCS participation is still negative and highly significant, and even more pronounced as in the main regression. The positive coefficient of the interaction term, together with the more negative coeffi-

[17] https://datahelpdesk.worldbank.org/knowledgebase/articles/906519

cient of unilateral KPCS membership, suggests that compliance costs are less critical for KPCS-members, the better their access to importer markets. The remaining significant coefficients are identical in sign and significance and similar in size to the main results shown in Table 7.

6 Conclusion

On December 5^{th}, 2011, Global Witness, a non-governmental organization, announced the withdrawal as an official observer from the KPCS due to the agreement's failure to hinder the trade of rough diamonds originating from a country's conflict areas. This paper provides empirical evidence on the impact of the KPCS on the international trade in rough diamonds. Our empirical specification is based on a structural gravity model, which is augmented by indicator variables for the trading partners' KPCS status (signatory vs. non-signatory) and the exporters' share of conflict mines. The KPCS requires member countries to fulfill a specific regulatory standard when trading rough diamonds, which will lead to additional compliance costs and a price increase. However, our results show that the trade-enhancing factors inherent in the KPCS, like increased transparency and common standards, outweigh this additional increase in costs. Consequently, trade between KPCS member countries significantly increases relative to trade between non-KPCS member countries. Trade enhancing effects can be seen in other international product standard agreements as well (e.g., Clougherty & Grajek 2014, Borsky et al. 2018).

We also find evidence that the KPCS effectively reduces the scale of potential conflict diamonds traded internationally. Interestingly, besides this unilateral effect, we find that the bilateral KPCS membership reduces trade impediments of conflicts, which increases the export value for belligerent exporters compared to non-belligerent exporters. These findings suggest that although the KPCS restricts the scale of export of potential conflict diamonds, its trade-enhancing measures allow member countries to trade more intensively with the remaining conflict-free diamond stock than non-member countries.

We note that our analysis is based on official trade data. We are aware that the smuggling of diamonds is a prevalent issue that is hard to capture. However, as long as the diamonds are smuggled from a neighboring country into the country of a diamond-producing exporter, and the exporter, in turn, uses official trade channels, we are confident that our approach captures the main drivers of smuggling activities between countries. Rough diamonds that are not exchanged through official markets at any time are, by definition, not included in our analysis.

In our paper, we focus on the trade effect of the KPCS. A different question would be whether the KPCS influences the conflict incidence of the trading partners. Although itself an important issue for thorough analyses, answering this research question is outside this paper's scope. Another essential path for further research is the collection and analysis of firm-specific information. Effects of product standards are expected to vary widely

Table 9: Extensions – KPCS status & economic development/market access

	Intensive margin		*Extensive margin*		*Intensive margin*		*Extensive margin*	
Dep. Variable	$X_{ijt}{}^{(a)}$	$\ln \widehat{\xi_{it}}^{(b)}$	$Pr(X_{ijt}>0)^{(a)}$	$\ln \widehat{\eta_{it}}^{(b)}$	$X_{ijt}{}^{(a)}$	$\ln \widehat{\xi_{it}}^{(b)}$	$Pr(X_{ijt}>0)^{(a)}$	$\ln \widehat{\eta_{it}}^{(b)}$
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
KPCS Exp × KPCS Imp	1.124**		0.704***		1.399**		0.735***	
	(0.572)		(0.163)		(0.661)		(0.165)	
KPCS Both×Conf mines Exp	2.141***		−0.037		2.169***		−0.045	
	(0.768)		(0.187)		(0.809)		(0.179)	
RTA	−0.902***		−0.033		−0.899***		−0.033	
	(0.341)		(0.038)		(0.341)		(0.038)	
KPCS Both×Rich	0.353		−0.004					
	(0.495)		(0.067)					
KPCS Both×Market access					−0.094		−0.006	
					(0.145)		(0.007)	
KPCS Exp		−1.263**		−0.598***		−1.795***		−0.667***
		(0.564)		(0.062)		(0.569)		(0.065)
Conf mines Exp		0.092		−0.117**		0.047		−0.119**
		(0.449)		(0.059)		(0.452)		(0.058)
KPCS Exp×Conf mines Exp		−2.754***		0.073		−2.785***		0.082
		(0.627)		(0.085)		(0.551)		(0.084)
KPCS Exp×Rich		0.055		0.048*				
		(0.235)		(0.027)				
KPCS Exp×Market access						0.198***		0.015***
						(0.027)		(0.003)
ln(GDP/capita Exp)		1.989***		0.014		1.988***		0.008
		(0.659)		(0.062)		(0.659)		(0.060)
Conf mines Neighb		0.026*		−0.002		0.022*		−0.002
		(1.208)		(0.156)		(1.154)		(0.151)
Dist conf mines Neighb		−0.341		−0.018		−0.351		−0.018
		(0.642)		(0.091)		(0.609)		(0.089)
Observations	3794	415	6687	415	3794	415	6687	415

Notes: ***, **, * indicates the significance level of 1, 5, 10 percent, respectively. $^{(a)}$ first stage estimates; $^{(b)}$ second stage estimates. Dependent variables: Import value in mio USD or dummy indicating positive trade flows (1^{st} stages) and exporter-year fixed effects (2^{nd} stages). Included but not reported: exporter-year, importer-year and exporter-year fixed effects in 1^{st} stages; constant, exporter and year fixed effects in 2^{nd} stages. Clustered (by trading pair) standard errors in 1^{st} stages, bootstrapped standard errors in 2^{nd} stages are given between parentheses.

across firms. Differences in the induced changes in the firms' competitiveness can lead to significant economic effects on a sub-regional level depending on the affected firms' location and property situations (e.g., rebel- vs. state-owned mines).

Finally, we see this work as timely because of the recently introduced EU Conflict Mineral Regulation, which entered into force as of 1^{st} January 2021.[18] The EU Conflict Mineral Regulation applies to tin, tungsten, tantalum, and gold. Although the regulation does not introduce import restrictions and certification requirements, as is the case in the KPCS, European Union importers must establish and comply with supply chain due-diligence obligations, that these minerals are not sourced from "conflict-affected" or "high-risk" countries or areas. This will force producer countries to integrate these standards into their supply contracts and develop a higher degree of transparency and traceability in their input sourcing. Our results give insights, how such measures can affect international trade patterns of conflict minerals.

[18] Regulation (EU) 2017/821, https://eur-lex.europa.eu/legal-content/EN/TXT/?uri=OJ:L:2017:130:TOC

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Appendix

Table A1: Harmonized Commodity Description and Coding System 1996 (HS1996)

Code	Description
71	**PEARLS, STONES, PREC. METALS, IMITATION JEWELRY, COINS**
7102	**Diamonds, worked or not, not mounted or set**
710210	Diamonds Unsorted
710221	Industrial Diamonds, Unworked or simply sawn, cleaved or bruted
710231	Nonindustrial Diamonds, Unworked or simply sawn, cleaved or bruted

Table A2: Exporters (producers) of rough diamonds

Angola	Canada	Cote d'Ivoire	Indonesia	Sierra Leone
Australia	Central Afr. Rep.	Ghana	Liberia	South Africa
Botswana	Congo, Dem.Rep.	Guinea	Lesotho	Tanzania
Brazil	Congo, Rep	Guyana	Namibia	Venezuela
Cameroon	China	India	Russia	Zimbabwe

Table A3: Importers of rough diamonds

Aremnia	China	Ireland	Mexico	Spain
Australia	Croatia	Israel	Namibia	Sri Lanka
Austria	Cyprus	Italy	Netherlands	Switzerland
Bahrain	Czechia	Japan	New Zealand	Thailand
Belgium	Denmark	Kazakhstan	Poland	Turkey
Bolivia	Finland	Korea, Rep.	Romania	Ukraine
Botswana	France	Lebanon	Russia	United Arab Emirates
Brazil	Germany	Luxembourg	Singapore	United Kingdom
Canada	Hong Kong	Malaysia	Slovenia	United States of America
Chile	India	Mauritius	South Africa	Viet Nam

Table A4: Exporters (producers) of rough diamonds based on Gilmore et al. (2005)

Algeria	Korea, Rep.
Angola	Lesotho
Armenia	Liberia
Australia	Malaysia
Belarus	Mali
Bolivia	Mauritania*
Botswana	Mozambique
Brazil	Namibia
Burkina Faso	Nigeria
Cameroon	Norway
Canada	Paraguay*
Central African Rep.	Russian Federation
Chad	Sierra Leone
China	Solomon Islands*
Colombia	South Africa
Congo, Dem. Rep.	Suriname
Congo, Rep.	Swaziland
Cote d'Ivoire	Sweden
Finland	Tanzania
Gabon	Thailand
Ghana	Togo
Greenland*	Ukraine
Guinea	United States
Guyana	Uruguay
India	Venezuela
Indonesia	Zambia
Kazakhstan*	Zimbabwe

Notes: * countries are dropped due to zero positive trade flows in the period of observation.

Table A5: Regression results – Larger set of diamond producers

	Intensive margin			*Extensive margin*	
Dep. Variable	$X_{ijt}{}^{(a)}$	$\ln \widehat{\xi_{it}}^{(b)}$		$Pr(X_{ijt}>0)^{(a)}$	$\ln \widehat{\eta_{it}}^{(b)}$
	(1)	(2)		(3)	(4)
KPCS Exp × KPCS Imp	1.230*		0.432**		
	(0.642)		(0.181)		
KPCS Both×Conf mines Exp	2.561***		0.061		
	(0.835)		(0.147)		
RTA	−0.822**		−0.073**		
	(0.337)		(0.032)		
KPCS Exp		−1.598***		−0.279***	
		(0.453)		(0.056)	
Conf mines Exp		0.054		−0.106**	
		(0.439)		(0.045)	
KPCS Exp×Conf mines Exp		−2.895***		−0.004	
		(1.026)		(0.068)	
ln(GDP/capita Exp)		1.957**		0.064	
		(0.881)		(0.052)	
Conf mines Neighb		0.020		−0.003**	
		(1.258)		(0.135)	
Dist conf mines Neighb		−0.348***		−0.023	
		(0.075)		(0.075)	
Observations	4984	502		9033	502

Notes: ***, **, * indicates the significance level of 1, 5, 10 percent, respectively. $^{(a)}$ first stage estimates; $^{(b)}$ second stage estimates. Dependent variables: Import value in mio USD or dummy indicating positive trade flows (1^{st} stages) and exporter-year fixed effects (2^{nd} stages). Included but not reported: exporter-year, importer-year and exporter-year fixed effects in 1^{st} stages; constant, exporter and year fixed effects in 2^{nd} stages. Clustered (by trading pair) standard errors in 1^{st} stages, bootstrapped standard errors in 2^{nd} stages are given between parentheses.

Table A6: Variable description and sources

Variable	Description	Source
Dependent Variables		
X_{ijt}	Import value (in 1000 US$) of bilateral trade flows in rough diamonds from exporter i to importer j in year t.	WITS/UN Comtrade
$Pr(X_{ijt} > 0)$	Dummy variable = 1 if bilateral trade flow of diamond products from exporter i to importer j in year $t > 0$, 0 otherwise.	
$\ln \widehat{\xi_{it}}$; $\ln \widehat{\eta_{it}}$	Heterogeneity in trade flows across exporters measured via logarithmized exporter-year fixed effects from 1st stage regression (gravity estimation).	
Independent Variables		
KPCS Exp$_{it}$	Dummy variable = 1 if exporter participated in the KPCS in year t, 0 otherwise.	KP rough diamonds statistics
KPCS Imp$_{jt}$	Dummy variable = 1 if importer participated in the KPCS in year t, 0 otherwise.	KP rough diamonds statistics
KPCS Exp$_{it}$×*KPCS Imp*$_{jt}$	*KPCS Both*$_{ijt}$. Dummy variable = 1 if both trading partners participated in the KPCS in year t, 0 otherwise.	KP rough diamonds statistics
KPCS Both$_{ijt}$×*Conf mines Exp*$_{it}$	Interaction with *KPCS Both*$_{ijt}$ and *Conf mines Exp*$_{it}$.	
RTA$_{ijt}$	Dummy variable = 1 if a regional trade agreement between the two trading partners is in force in year t, 0 otherwise.	Baier et al. (2008); WTO
Conf mines Exp$_{it}$	Exporter's share of diamond deposits within a 100 km distance to a conflict incidence in year t over total diamond mines in exporting country.	UCDP Geo Conflict Dataset and Lujala et al. (2005)
KPCS Exp$_{it}$×*Conf mines Exp*$_{it}$	Interaction with *KPCS Exp*$_{it}$ and *Conf mines Exp*$_{it}$.	
ln(GDP/capita Exp)$_{it}$	Exporter's GDP per capita (in logs).	World Bank (WDI)
Conf mines Neighb$_{it}$	Number of diamond deposits within a 100 km distance to a conflict incidence in countries neighboring exporter i in year t.	UCDP Geo Conflict Dataset and Lujala et al. (2005)
Dist conf mines Neighb$_{it}$	Sum of the geodesic distance between the diamond deposits situated in a conflict area and the exporting country i in year t.	UCDP Geo Conflict Dataset and Lujala et al. (2005)

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