Master Degree Project in Economics

The Impact of the Kimberley Process Certification Scheme on Country-Level Competition in the International Rough Diamond Market

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ABSTRACT

The Kimberley Process, a policy to curb conflict diamonds from reaching international markets, has now been implemented for more than ten years. Amidst discussions to change or make additions to the existing conflict diamond policy, as well as rising awareness about other conflict minerals, the creation of future conflict resource related policy appears inevitable. To aid the development of future policy in this industry, this paper studies if the Kimberley Process has had an impact on country level rough diamond competition. Using data compiled from a number of academic and industry sources, we employ a discrete choice oligopoly model to estimate demand and evaluate competition in the rough diamond market while allowing for unobserved product and country characteristics and controlling for endogeneity of price. In this way, we investigate the impacts of the Kimberley Process on competition and estimate own- and cross-price elasticities for top producers. The results suggest that the Kimberley Process has reduced the competitive advantage of autocratic governments and has increased competition among top producing countries.

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1. INTRODUCTION

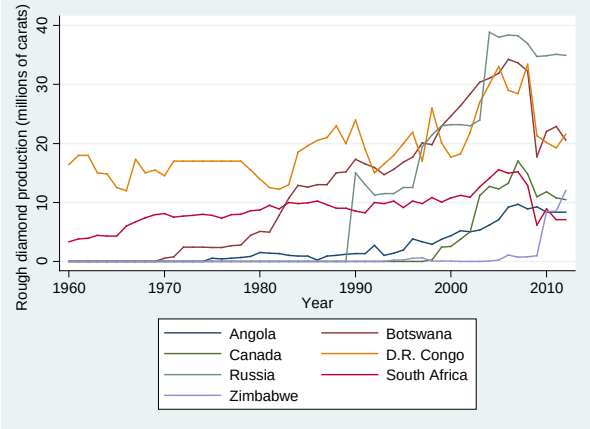
More than ten years have now passed since the implementation of the Kimberley Process Certification Scheme (KPCS), a UN backed policy to curb the flow of "conflict diamonds" from global markets. Though there is general consensus that this policy has made great improvements against conflict in many diamond producing regions of the world, assessment of the policy is under constant review by critics and supporters, with many calling for revisions. At the time of the KPCS's development, no similar such policy had preceded it. Now, ten years down the road and with calls for alterations to the KPCS, it is imperative to gain an understanding of the impact that the Kimberley Process, regardless of its successes or failures, has had on the industry that it is meant to govern, so that future policy can be adopted with such knowledge in mind. As such, this paper addresses how the Kimberley Process has impacted competition at country-levels in the rough diamond industry by analyzing changes in country market shares.

The motivation for pursuing such a study at country level stems from several factors. First of all, though it is endorsed by the United Nations, the KPCS policy is adopted at country levels and thereby imposed on firms acting within a country's borders. Thus, as the drivers of such policy and ultimately the enforcers, auditors and implementers of it, it seems sensible to assess the country level competition impacts rather than firm level. Secondly, in the evolution of the diamond industry, countries have desired and achieved an increased involvement and role in the industry (N. Oppenheimer, personal interview, February 20, 2014). Third, the limited rough diamond data that is available for the otherwise closed diamond industry is at country levels, not firm. Lastly, a glance at country level production over time shows that there has been much variation amongst the top producing countries since the 1960s (Figure 1), while competition at firm level has historically been dominated by De Beers (Spar, 2006) who remains one of the main actors on the scene today.

Over the past 50 years, diamond producing countries have been faced with a steadily increasing global demand for rough diamonds driven by growing global wealth and population, as evidenced by the steady upward trend of global rough diamond production that is targeted to meet such appetite (Figure 2). Within the industry, the ever important supply of rough diamonds has always been dominated by a handful of countries that control a combined majority of the rough diamond market. However, the few countries of importance in controlling the market have evolved over time as their production levels and market shares have varied greatly. This

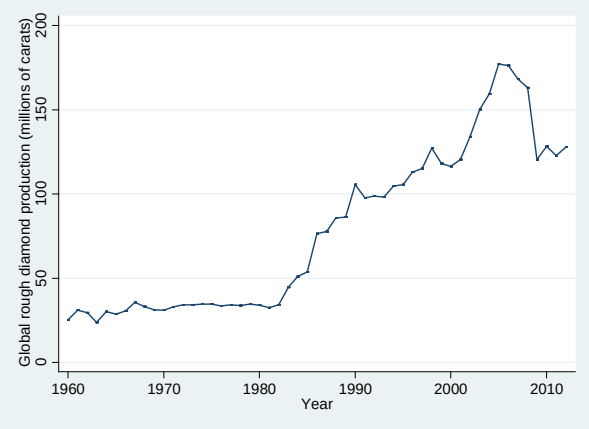
leads to an important question: how do country characteristics shape competition in this industry? For example, what role do country characteristics such as wealth or level of democratization play in evident trends, such as South Africa's downward movement in production versus Russia's growth (Figure 1)? In 2012 the top producing countries in the global supply of rough diamonds included developed countries with high levels of democracy such as Canada, and poor, struggling autocratic countries such as Zimbabwe. This variation creates both the opportunity and need to define how country characteristics such as wealth, population density and level of democracy shape country level competition in the rough diamond market.

Figure 1: Country Level Rough Diamond Production over Time of Top 7 Producers (Millions of carats)



Source: Humphreys (2005), US Geological Survey, KPCS

Figure 2: Global Rough Diamond Production over Time, 1960-2012 (Millions of carats),



Source: Humphreys (2005), US Geological Survey, KPCS

Evolution of the country-level market shares in this industry has not been a product of country characteristics alone, as the aforementioned KPCS policy has developed during recent years in response to the pattern where the discovery of an extractable resource and demand from international markets has led to the financing of conflict. Highlighted by the bloody civil war in Sierra Leone, the problem of conflict diamonds on international diamond markets came into the spotlight in the early 1990s. Encouraged by the international community, the diamond producing African countries met in Kimberley, South Africa to create a process to curtail such behavior, and a few years later, the Kimberley Process Certification Scheme was born and adopted by the United Nations in January of 2003 (United Nations Resolution-1459, 2003). Through a central mechanism of applying certificates through every phase of diamond production and to every rough diamond on the global market, from the moment a rough diamond is extracted from the earth until the time it reaches an end consumer, the Kimberley Process aims to prevent conflict stones, "those used by rebel movements or their allies to finance conflict aimed

at undermining legitimate governments" (KPCS Core Document, 2003), from reaching the rough diamond market.

Though it is generally believed that this policy has made progress in reducing or avoiding conflict in many diamond producing countries, there has been continual evaluation of its effectiveness and calls by many for reform. In December of 2011, an NGO called Global Witness and former endorser of the Kimberley Process Certification Scheme announced the following: "Global Witness has left the Kimberley Process, the international certification scheme established to stop the trade in blood diamonds" citing flaws and loopholes in the policy (Global Witness, 2011), leading to consumers' uncertainty about if their diamonds are financing armed violence or oppressive regimes. The continuing debate on the effectiveness of the KPCS is an important one without a straightforward answer.

Though the effectiveness of such a policy is hard to measure, how such policy impacts the industry in affecting countries' market shares in rough diamond sales is important to understand. It is relevant both in assessing the overall impacts of the KPCS and in the context of future "conflict resource" policy that may target diamonds or other valuable resources that directly or indirectly support conflict. Does the Kimberley Process consolidate the market in some way by creating barriers to entry and restrictive costs on smaller players, thereby boosting market shares of the top producers? Do countries with more democratic governments, for example, Canada as opposed to Zimbabwe, gain a competitive advantage from such a policy? For proponents and critics to debate the effectiveness of such policy or develop new policy for conflict resources in the future, such indirect consequences of the KPCS are imperative to understand.

In light of the several unique features of this industry (such as the great variation in production levels amongst producers, the dominance of a few countries at the top, and the importance of effective policy to curb conflict diamonds), the aim of this paper is to explore if the Kimberley Process has had a significant impact on country-level competition in the international rough diamond market. To address this task, we use a discrete choice oligopoly model for implied demand adapted from that presented in Berry (1994). Using a consolidated panel dataset of annual production data for diamond producing countries from 1960 to 2012, we obtain several interesting results. We find that the level of democracy of a country has a negative and highly significant relationship with market share. Interestingly however, this result

reverses after the Kimberley Process is implemented, at which point moves towards democracy by countries boost their rough diamond market shares, a result which implies that the Kimberley Process is encouraging democracy amongst the top diamond producing countries. The results also suggest that the Kimberley Process has had the general effect whereby top producers have lost market share to the diamond producing countries with small portions of the market, perhaps a sign that major producers will be wary of additional future policy. Subsequently, we use a dataset containing price data which spans the post-Kimberley Process implementation years of 2004 to 2012 to calculate and present own- and cross-price elasticities for the top producing countries in the rough diamond industry. The elasticities suggest that regional differences affect consumer sensitivity to price.

In accomplishing such, this paper is presented in the following manner. First, the industrial organization literature relevant to the applied theory of this paper, as well as a broad overview of diamond relevant economic literature, is presented in section 2. We then present the data and descriptive statistics in sections 3 and 4. The paper proceeds in developing the applied model and discusses its specific merits with regard to the rough diamond industry in section 5. The results are presented in section 6, where we further explore the main findings mentioned above and offer a discussion about what may drive such results. After addressing some of the paper's limitations in section 7, the results are drawn upon to discuss what these insights mean for the rough diamond industry, the Kimberley Process, and future conflict resource policies in section 8.

2. LITERATURE REVIEW

With a lack of literature specific to competition in the diamond industry, in this section we first present a sample of demand related literature, specifically in discrete choice settings, such as is the case in the rough diamond market. Subsequently, we offer developmental and industry related literature, both theoretical and empirical, that is connected to diamond resources and markets.

A wealth of contemporary literature on estimating demand in discrete choice settings is built upon Nobel prize winning work of Daniel McFadden which drew attention to the fact that classical choice theory, when applied in practice, forced any disturbances from predicted choice into an additive error. In real application however, there are important unobserved quality

characteristics of products that shape consumer choices that should not be forced into a utility function's error term (McFadden, 1974). Endogeneity of price, however, is cause for concern, as unobserved quality characteristics are likely correlated with price. If unaccounted for, such endogeneity may lead estimation results to suggest that price has a positive effect on consumer utility (Berry, Levinsohn, & Pakes, 1993; Trajtenberg, 1989). In the progression of such literature, Berry (1994) proposes methodology for inverting market shares based on market level data. Contrary to prior works, such a technique allows for McFadden's unobserved demand variables, as well as for the endogeneity of price to be dealt with through traditional instrumental variable methods (Berry, 1994).

Both theoretical and empirical diamond pertinent literature can more or less be categorized as either developmental or industry related, though far more of these efforts have been in the way of development research. A consequence of very limited data in the realm of diamonds is that there have been particularly few quantitative research papers pertaining to this topic. Though historical records of production data have been gathered, other variables important to industry studies are still unavailable, such as historical rough prices per country and production costs per country, among others.

Amongst the development research, a primary subject related to diamonds has been the tie between diamond wealth and conflict, to which the prominent literature has repeatedly drawn an empirical connection. Lujala, Gleditsch, and Gilmore (2005) use diamond production and conflict data to test numerous hypotheses regarding this link. They draw distinction between lootable diamonds (alluvial mining near the surface) and non-lootable diamonds (primary mining which is highly capital intensive) and find that while there is a significant connection between diamond wealth and civil war onset, the effect is far stronger and far more significant when tested with lootable diamonds versus non-lootable diamonds, proposing that this is part of the explanation for "the contrasting effects of diamond riches in Sierra Leone and Botswana" as Sierra Leone has alluvial deposits and Botswana has primary (Lujala et al., 2005). A theoretical article by Olsson (2006), also supports this theory as he adds that not only are primary mines capital intensive to mine, but they are also easily taxed and controlled by governments.

Humphreys (2005) builds on the literature connecting diamonds and conflict by trying to identify the mechanisms by which the resources indeed create such conflict. Though more broadly about natural resources, including oil reserves and diamond deposits, his results do show

that natural resource wealth, be it from diamonds or otherwise, tends to lead to conflict via weak state structures more so than wealth or state capture mechanisms (Humphreys, 2005), a result which is quite consistent with "resource curse" literature (Karl, 1997; Sachs & Warner, 1997).

Building on Humphreys (2005) and Lujala et al. (2005), Ross (2006) sought to better establish the connection between diamonds and conflict by including value of production rather than volume of production into his regressions. Such was accomplished by using diamond trade journals to extrapolate backwards price estimates for all countries and all years in Humphreys' diamond dataset, thereby enabling him to associate a value to each production figure. Once again, similar results hold and he finds that diamond production is robustly correlated with civil war onset (Ross, 2006). In a testament to the challenges pertaining to diamond data, even after this paper was published the author thereafter decided not to circulate the data with concerns over its quality.

Development economists have also drawn much attention to Botswana in their work, the outlier amongst diamond producing countries in terms of economic growth and resource management. In discerning why Botswana has been an exception, the literature draws common ground in reference to their institutions and governance. Acemoglu, Johnson, and Robinson (2002) point to the fact that Botswana enjoyed institutions beneficial to development long before independence and in fact before colonization as the reason for Botswana's success. Mbayi (2013) discusses the manner in which Botswana's beneficiation efforts, to keep value-adding segments of the industry within its countries borders, has aided growth for the country.

Amongst the diamond industry related literature, an article by Kargbo (2012) presents a model for diamond production within the country of Sierra Leone. He presents diamond production to a be a function of diamond export prices, the price of commodities like coffee and cocoa (which he argues are in a way substitutes for alluvial diamonds since they compete for labor), the openness of the economy, exchange rates, income of industrialized countries, and lastly dummy variables to control for periods of civil war and political instability. Using time series data and employing time series econometric methods, he argues that these variables do have significant impacts on diamond production levels and suggests that for Sierra Leone to boost production, policies should be invoked which curtail corruption and promote transparency (Kargbo, 2012). Though our forthcoming model has a different approach and tackles a different

research question, we draw from Kargbo's model in rationalizing our specification for market share (which is derived from production).

With regard to the Kimberley Process, some academics propose that its effect is to restrict supply, thus aiding the larger, established actors in the industry. Further, it levies costs that create a barrier to entry in the market (Spar, 2006). Olsson (2006) cautions that despite the great improvements against "conflict diamonds" that the Kimberley Process has likely led to, it still fails in many regards that could have developmental impacts; for example, vast countries, such as the Democratic Republic (D.R.) of Congo, being able to control inflows and outflows of smuggled or uncertified stones.

Though he doesn't analyze diamond production, Seitz (2012) uses an event study methodology to gauge the impact on stock prices of the Kimberley Process on different publicly listed segments of the diamond industry; particularly, mining and retail. "After 2004, jewelry companies, a group that in general is much closer to end consumers on the supply chain, felt the effects of KPCS related events much more than mining firms, which appear hardly affected by KPCS related events during this time. This may indicate that the more image driven portion of the market was more sensitive to the perception of consumers surrounding the KPCS and its implementation" (Seitz, 2012). Such results support the cause to further analyze how the Kimberley Process Certification Scheme has changed the landscape within the diamond industry. If retailers are indeed concerned with their image as pertains to the KPCS, as Seitz (2012) suggests, then one may conjecture that retailers might have a higher utility in purchasing their rough diamonds from a more reputable country as well, thus preserving their reputation.

This brief literature review, which we have focused on diamond relevant literature, establishes two things. First, lacking data has been a hindrance to empirical research in this department. In the development sphere, diamond production datasets have been utilized with a focus on the connection between diamonds and conflict. Quantitative research about the diamond industry itself has been even less. To the best of our knowledge, no empirical analysis about the effects of the Kimberley process on competition within the diamond industry has been put forth, let alone about competition in general within this industry. With so little understanding in an industry with such critical developmental consequences, we find all the more motivation to broach this frontier as the policy implications of understanding competition in the diamond industry, and the Kimberley Process's role in such, is of high importance.

3. DATA

Perhaps the primary reason why there is such limited empirical research about diamonds, both within developmental and industrial organization fields, is that there is a lack of quality data available regarding diamond production and diamond pricing statistics. The best of such data has been used for research in the past, particularly within research pertaining to conflict such as the aforementioned works by Humphreys (2005), Ross (2006) and Lujala et al. (2005), but even such data is imperfect. Ideally, one would have an extensive panel that captured more than simply production since aggregating diamond production into one sole output resource is misleading. In actuality, there is immense heterogeneity in quality, as determined by the four Cs which constitute diamond value: clarity, color, carat and cut. Thus, some measure of value of production would certainly be a better measure for such data, but reliable data for this had simply not been disclosed in the past, particularly at the rough diamond level of exchange, where few countries and fewer mining companies have controlled the scene. The data for the subsequent empirical analysis comes from two separate panel datasets which have been compiled from numerous sources.

3.1 Long Run Dataset

It is from the diamond related variable from Humphreys' (2005) data which comprises the foundation of our dataset for the annual analysis used to determine some of the effects attributed to country characteristics and the Kimberley Process on countries' market share. We refer to this variable as *Diamond production*, and it is the volume in carats produced by each country each year. Though we have predominantly sourced this variable from Humphreys' (2005) diamond production numbers (from 1960 to 1999), we have extended his annual data through 2012 using U.S. Geological Survey diamond production estimates as well as Kimberley Process Certification Scheme publicly available production statistics. Using these production variables we have then calculated variables for annual total global production represented by *Global production*. Then, using *Diamond production* and *Global production* we have calculated country market shares for each year, the ratio of a country's own *Diamond production* versus *Global production* during a given observation period, which we call *Country market share*. We have also calculated a variable called *Others market share* which in our baseline specification is the cumulative market share of all countries outside the top seven producers. As this variable

depends on which countries are defined as top producers, it is adjusted for some of the robustness models for which the definition of the top producers is amended. Supplementing these variables we have *Population density* and country *GDP per capita* taken from The World Bank Indicators database. Lastly, we use a measure for a country's *Level of democracy* during a given observation period, sourced from Quality of Government datasets, and originally taken from Marshall, Jagger & Gurr's Polity IV Project (2011). This variable ranges from +10 for strongly democratic governments to -10 for strongly autocratic governments. A variable for capturing effects of the Kimberley Process is created using a dummy variable we call *Kimberley dummy*, equal to 1 for all years since the Kimberley Process went into effect in 2003. Last but not least, the dimensions of our panel are at country level (*Country*) over annual observations (*Year*).

3.2 Price Dataset

The second dataset is used to estimate own- and cross-price elasticities for the top producing countries. This data uses semi-annual observations from 2004 to 2012 for all diamond producing countries and the core of this data is sourced from the Kimberley Process Certification Scheme's publicly available production statistics. Though the Kimberley Process officially began in 2003, public statistics were not available until the year 2004, thus defining the beginning of this price dataset. Production in this dataset is given both in terms of *Volume production* (in carats) and by *Value production* (in US$). Along with these semi-annual production measures, we also have aggregated *Rough diamond prices* given in US$/carat per country-semi-annual-observation. This data is also reported through the Kimberley Process Certification Scheme. Supplementing these variables, similar to the annual dataset, we utilize *Global volume production* and *Global value production*, then creating variables for country market share; however, we now have market share defined by both volume (*Market share by volume*) as well as by value (*Market share by value*). This dataset also contains a variable for others' market share both derived by volume (*Others market share by volume*) and value (*Others market share by value*). Additionally, the price dataset contains a measure of advanced economy countries' GDP per capita (*Advanced economies GDP per capita*) taken from and defined by the World Economic Outlook (WEO)[1] database. The same *Population density*, *GDP per capita*, and

[1] Definition of Advanced Economies as per the World Economic Outlook / IMF found here: https://www.imf.org/external/pubs/ft/weo/2014/01/weodata/groups.htm#ae

Level of democracy measures are used as in the annual dataset. We also include *Oil prices* and *Coal prices* sourced from Data Stream. For *Population density* and *Level of democracy*, data was only available at annual intervals and thus semi-annual approximations were used by averaging the annual observations in order to complete the dataset. Lastly, during the Kimberley Process years, the Kimberley Process public statistics report zero production for Ivory Coast for all years within the production time range. As such, the semi-annual dataset observes 24 countries whereas the annual dataset observes 25.

4. DESCRIPTIVE STATISTICS

4.1 Long Run Dataset

As previously mentioned, Humphreys' (2005) original dataset contains a variable for diamond production which is used to compute country market shares by volume as the fraction of a country's annual diamond production to that year's total global production. Though Humphreys' (2005) original dataset spans from 1960 to 1999, if a country does not produce diamonds, then observations for such countries for such years are reported as missing diamond production values. As this variable is subsequently used in formulating *Country market share*, we have 188 missing values comprising 14.19 percent of the sample, as reported in Table 1. Upon closer inspection of these missing values, they precede the onset of significant production values in most cases and otherwise are missing values after a country's production has already exhausted; there are no intermediate missing values. Therefore, as missing values correspond to zero production, we replace these missing production values as zeroes before proceeding to analyze the variable descriptive statistics.

Table 1: Missing Values from Long Run Panel Dataset (1960-2012)

Variable	Missing	Total	Percent Missing
Country market share	188	1,325	14.19
Others market share (top 7)*	0	1,325	0
Population density (# people/km^2)	0	1,325	0
GDP per capita (US$2005)	128	1,325	9.66
Level of democracy	117	1,325	8.83
Global production (carats)	0	1,325	0

**Top 7 countries by volume are Angola, Botswana, Canada, Democratic Republic of Congo, Russian Federation, South Africa and Zimbabwe as per 2012 Kimberley Statistics. Source: Humphreys (2005), Kimberley Process Certification Scheme, World Bank Development Indicators, Quality of Government Datasets. All market shares are in terms of production volume.*

We also observe that there are missing values for *GDP per capita* and *Level of democracy*. These missing values stem from the fact that these variables were separately gathered from different sources and were not available for all countries for the complete time range of the production variables. Though missing values can lead to bias in the coefficient estimates of a regression, our model which is explained in section 5, only considers the top producing countries and of those countries, only years where production is non-zero. This being the case, most of the missing values do not impact the regressions as they occur during the earlier years of the panel when production values for several of the top producing countries were zero.

Table 2 below presents summary statistics for the variables of interest in the annual panel dataset. Prior to generating this table, the aforementioned assumption to change diamond production missing values to zeroes is made and thus we can see that there are no longer missing observations for *Country market share*. With 25 countries in the panel, the average market share is expectedly 4%. Also important to observe is that the range for *Country market share* is extremely high across the panel with values as low as zero when countries have no production, to as high as 64.9% for the D.R. Congo in 1960. Also important to such a study is the observed variation in the "others" country market shares. We see that *Others market share* has an average value of 26.9% of the market but with substantial variation ranging from 8.8% to 47.3% with a standard deviation of over 11%.

Table 2: Long Run Panel Dataset Summary Statistics (1960-2012)

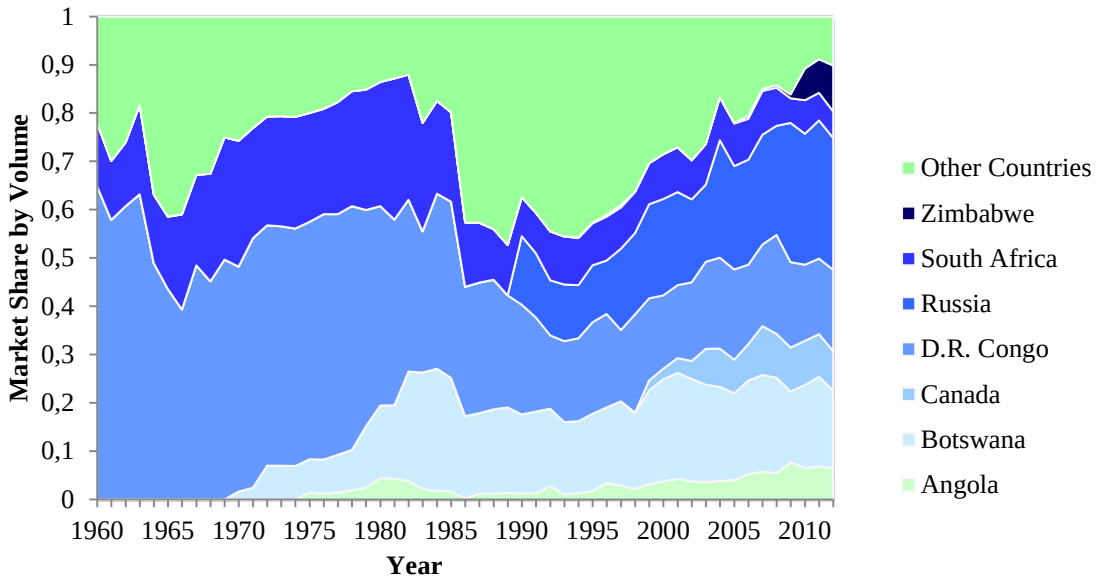
Variable	Obs	Mean	Std. Dev.	Min	Max
Country market share	1,325	0.040	0.092	0.000	0.649
Others market share (top 7)*	1,325	0.269	0.113	0.088	0.473
Population density (# people/km^2)	1,325	38.359	59.515	0.732	415.946
GDP per capita (US$2005)	1,197	3592.976	7088.274	50.042	37304.640
Level of democracy	1,208	0.155	6.840	-9.000	10.000
Global production (carats)	1,325	78,530,000	48,281,000	23,746,000	177,151,000

**Top 7 countries by volume are Angola, Botswana, Canada, Democratic Republic of Congo, Russian Federation, South Africa and Zimbabwe as per 2012 Kimberley Statistics.*
Source: Humphreys (2005), Kimberley Process Certification Scheme, World Bank Development Indicators, Quality of Government Datasets.

As our model looks at the difference in market share between the top producers and "others" in order to determine demand for the top producers, variation such as we see in these values is critical. Such variation is also exhibited in Figure 3. We also highlight the summary statistics for *GDP per capita* and *Level of democracy* both of which exhibit significant variation

over observations with democracy ratings ranging from -9 to 10 with a mean of 0.155 and standard deviation of 6.840. *Global production* ranges from 23.746 million carats to 177.151 million carats, a reflection of the increased global demand over time along with better extraction methods and more mine discoveries.

Figure 3: Evolution of Rough Diamond Production Market Shares by Volume, 1960-2012



Source: Humphreys (2005), US Geological Survey, KPCS

Table 3 exhibits summary statistics divided between Kimberley Process years (2003-2012) and non-Kimberley Process years (1960-2002). Such a depiction of the relevant variable statistics brings us back to the economic question at hand: has the Kimberley Process impacted competition in the rough diamond industry? In looking at the table, we point out two particular observations. First, we notice that *Others market share* has a reduced mean, variance and range after the Kimberley Process is introduced, perhaps a signal that the Kimberley Process is somehow benefiting the top producing countries more so than non-top producing countries. Additionally, we observe that prior to the Kimberley Process the mean level of democracy was at -0.775 amongst diamond producing countries. After the Kimberley Process, the mean of this variable increases to 3.716 while its variance, minimum and maximum remain otherwise the same. Could this be a signal that the Kimberley Process, though its direct intention is to eliminate conflict diamonds, is somehow fostering governments towards democratization? Our results, as presented in section 6.2, suggest that this may be the case.

Table 3: Long Run Summary Statistics before (1960-2002) and after (2003-2012) The Kimberley Process

Variable	Obs	Mean	Std. Dev.	Min	Max
Before Kimberley Process (1960-2002)					
Country market share	1,075	0.040	0.097	0.000	0.649
Others market share (top 7)*	1,075	0.295	0.108	0.120	0.473
Population density (# people/km^2)	1,075	34.195	52.977	0.732	362.138
GDP per capita (US$2005)	947	3302.349	6369.490	50.042	33401.310
Level of democracy	958	-0.775	6.942	-9.000	10.000
Global production (carats)	1,075	62,000,000	36,400,000	23,700,000	134,000,000
After Kimberley Process (2003-2012)					
Country market share	250	0.040	0.070	0.000	0.288
Others market share (top 7)*	250	0.161	0.053	0.088	0.264
Population density (# people/km^2)	250	56.265	79.572	2.406	415.946
GDP per capita (US$2005)	250	4693.870	9255.150	122.722	37304.640
Level of democracy	250	3.716	5.056	-7.000	10.000
Global production (carats)	250	149,000,000	21,500,000	121,000,000	177,000,000

**Top 7 countries by volume are Angola, Botswana, Canada, Democratic Republic of Congo, Russian Federation, South Africa and Zimbabwe as per 2012 Kimberley Statistics.*
Source: Humphreys (2005), Kimberley Process Certification Scheme, World Bank Development Indicators, Quality of Government Datasets.

Lastly, Table 4 shows summary statistics by country which allows for comparison between the top players as well as observing variation within countries. In viewing this table, two variables, *Country market share* and *Level of democracy*, stand out as particularly interesting. We see that over the time period of the sample, only D.R. Congo and South Africa have remained active in the market across the entire period, and consequently, across the entire sample, these two countries also have the highest average production as they are not weighed down by years of zero production. We also see that D.R. Congo has by far the broadest range of market share and also the highest variation. At the other end of the spectrum, Angola's market share, which only peaks at 7.7% has the lowest variation with a standard deviation of 0.02.

The second particularly interesting variable to observe is the *Level of democracy*. Not so surprisingly, D.R. Congo, Zimbabwe and Angola, rich with histories of civil wars and dictatorship, have the highest variation within the data. Russia and South Africa represent the middle ground where things have improved but they were never as autocratic as the aforementioned three in terms of this measurement. Canada and Botswana represent the most stable and democratic governments of the group. In fact, Canada, with its maximum democracy rating across the entire period of observation has no variation at all in the sample, and Botswana,

one of the model political systems and economies in Africa, has only fluctuated between a level of 6 and 8 across the entire time period.

Table 4: Long Run Panel Dataset Summary Statistics by Top Producing Country, 1960-2012

Variable	Country	Obs	Mean	Std. Dev.	Min	Max
Country market share						
	Angola	53	0.022	0.021	0.000	0.077
	Botswana	53	0.127	0.081	0.000	0.253
	Canada	53	0.018	0.033	0.000	0.101
	D.R. Congo	53	0.328	0.158	0.148	0.649
	Russia	53	0.082	0.102	0.000	0.288
	South Africa	53	0.148	0.070	0.051	0.292
	Zimbabwe	53	0.005	0.018	0.000	0.094
Population density (# people/km^2)						
	Angola	53	8.347	3.732	3.983	16.701
	Botswana	53	2.195	0.882	0.925	3.536
	Canada	53	2.905	0.540	1.969	3.836
	D.R. Congo	53	15.249	6.593	6.726	28.983
	Russia	53	8.490	0.511	7.315	9.072
	South Africa	53	27.356	8.809	14.340	42.197
	Zimbabwe	53	23.102	8.592	9.700	35.477
GDP per capita(US$2005)						
	Angola	28	1635.903	543.460	973.814	2685.834
	Botswana	53	2943.192	2007.228	379.654	6683.660
	Canada	53	25160.410	7073.543	12931.420	36182.910
	D.R. Congo	53	301.619	133.471	118.645	484.709
	Russia	24	4944.504	1198.368	3300.036	6834.000
	South Africa	53	4847.271	588.441	3394.926	6003.457
	Zimbabwe	53	586.768	106.589	344.742	732.639
Level of democracy						
	Angola	37	-4.081	2.510	-7	0
	Botswana	46	6.913	0.890	6	8
	Canada	53	10.000	0.000	10	10
	D.R. Congo	53	-3.906	5.531	-9	5
	Russia	21	4.381	1.284	3	6
	South Africa	52	5.981	2.397	4	9
	Zimbabwe	43	-1.163	4.186	-6	4

Source: Humphreys (2005), Kimberley Process Certification Scheme, World Bank Development Indicators, Quality of Government Datasets.

Also interesting is the variation in *GDP per capita* across countries, where Zimbabwe and D.R. Congo have the smallest variance, mean values and maximum values across the

sample. When observing the mean values, we see that Canada has achieved much higher GDP per capita levels than its competitors, with South Africa, Russia and Botswana somewhere in the middle of the group. Observing such drastic differences in these key country characteristics further motivates the importance of understanding how such characteristics affect production, and subsequently, how their effects have changed in the wake of the Kimberley Process.

4.2 Price Dataset

When consolidating the Kimberley Process statistics reports to generate the price dataset, we assume that if a country's production is listed during one year and not in subsequent years, then indeed production is 0 for such years. By drawing this assumption, we see from Appendix B, Table 15 that there are no missing values for all of our pertinent variables.

Table 5: Price Dataset Summary Statistics (2004-2012)

Variable	Obs	Mean	Std. Dev.	Min	Max
Country market share by value	432	0.042	0.071	0.000	0.329
Country market share by volume	432	0.042	0.071	0.000	0.354
Others market share by value (top 5)*	432	0.182	0.018	0.157	0.218
Rough diamond price ($/carat)	432	156.817	244.608	0.000	2039.90
Population Density (# people/km^2)	432	56.452	81.402	2.420	415.946
Global production (carats)	432	74,600,000	12,400,000	51,800,000	92,800,000
GDP per capita (US$2005)	432	4883.488	9439.516	124.908	37304.640
Advanced economies GDP per capita**	432	36442.350	2576.727	31142.170	40177.300
Level of democracy	432	3.909	5.099	-7	10
Oil Price (US$/barrel-Brent Crude)	432	75.752	26.527	31.075	116.950
Coal Price (US$/metric ton)	432	76.578	29.502	42.405	145.735

**Top 5 countries by value are Angola, Botswana, Canada, Russian Federation and South Africa as per 2012 Kimberley Statistics*
***Based on PPP in current international dollar, as per World Economic Outlook/IMF.*
Source: Kimberley Process Certification Scheme, World Bank Development Indicators, Quality of Government Datasets, IMF World Economic Outlook Database, Datastream.

Table 5 reports the summary statistics for the variables within our regressions on price data. The first difference of note when compared with the long run dataset descriptives is that mean market shares are now 4.2% which stems from the fact that within the Kimberley Process years, the Ivory Coast has had zero production according to the Kimberley statistics and therefore, we have 24 countries in our panel rather than the 25 in the long run dataset. We can also see that all of the *Others market share* variables have less variation in the price dataset than the long run dataset due to the shorter observation window. Another interesting observation comes from the *Rough diamond price* which exhibits quite a spread signifying the vast array of

quality of diamonds mined. Though the average price is $156.82 per carat, Lesotho in the second half of 2010 pulled in $2,039.90 for its stones. Similar to the market share variables, *Global production* also displays much less variation in this narrower dataset. As was emphasized in Table 3, it is again evident that the mean of *Level of democracy* is much higher in the post-Kimberley time frame, with a mean value in the price dataset of 3.909 as opposed to 0.155 in the annual dataset.

Table 6: Price Dataset Summary Statistics by Top Producing Country (2004-2012)

Variable	Country	Mean	Std. Dev.	Min	Max
Country market share by value					
	Angola	0.091	0.010	0.077	0.113
	Botswana	0.241	0.043	0.087	0.280
	Canada	0.161	0.030	0.107	0.210
	D.R. Congo	0.031	0.016	0.009	0.056
	Russia	0.220	0.032	0.183	0.329
	South Africa	0.105	0.015	0.075	0.130
	Zimbabwe	0.014	0.019	0	0.051
Rough diamond price (US$/carat)					
	Angola	127.57	19.16	80.79	156.3
	Botswana	107.67	30.43	81	176
	Canada	151.64	46.68	97.14	244.94
	D.R. Congo	12.60	3.97	5.59	18.64
	Russia	69.02	7.50	53.37	84.57
	South Africa	119.42	43.15	76.14	203.13
	Zimbabwe	64.00	48.06	0	179.61

Table contains semi-annual data for 2004 – 2012.
**Top 5 countries by value are Angola, Botswana, Canada, Russian Federation and South Africa as per 2012 KPCS statistics.*
Source: Kimberley Process Certification Scheme, World Bank Development Indicators, Quality of Government Datasets, IMF World Economic Outlook Database, Datastream.

In Table 6, a by-country view of *Country market share by value* and *Rough diamond price* is provided (a complete table of all key variables from the price dataset is included in Appendix B, Table 16). *Rough diamond price* is inherently necessary in order to make estimations of country own- and cross-price elasticities and it is interesting to observe that the mean price varies quite significantly between countries, with D.R. Congo carrying the low mean price at $12.60 per carat and Canada with a high mean price at $151.64. Also, within countries there is noticeably high variation of prices. Though across country variation is likely due to quality differences of the diamonds extracted, within country variation is more likely due to

fluctuations in supply and demand. Also noteworthy, the variation in the *Level of democracy* variable is zero for four of the seven countries observed (Appendix B, Table 16). Such reduced variation in this variable leads to reduced significance in estimations using this dataset and thus the variable is excluded from our price dataset regressions.

5. THEORETICAL FRAMEWORK

In many demand estimation studies, it is often assumed that the market is perfectly competitive. In the diamond market however, where a handful of countries dominate the rough diamond production market, we do not believe that the perfectly competitive market assumption is safe to assume. Additionally, in an industry such as this, where the final consumers are sensitive to where the diamonds have been sourced from, it is logical to believe that many country characteristics which are unobserved by the econometrician help determine which country a diamond retailer will purchase its stones from. Thus, in order to proceed with demand analysis for the diamond market, we adapt Berry's (1994) model for estimating demand for differentiated products on oligopoly markets using inverted market share equations that allow for instrumenting techniques. This framework is applied to the international rough diamond market, with product differentiation occurring at the country level instead of at the firm level, and with a limited number of countries producing the product. We assume that downstream demand for rough diamonds varies across countries due to country-specific characteristics which inherently determine the quality of the diamonds produced within that country. Like Berry (1994), we also assume that prices are endogenously set by countries and are correlated with unobserved demand characteristics, thus requiring instrumentation in specifications where price is included in the model. The versatility of this model enables us to apply it to both our long run dataset, for which price data is unobserved, as well as our price dataset, subsequently allowing for estimation of market share sensitivity to price through country level own- and cross-price elasticities.

5.1 A Discrete-Choice Model for Rough Diamonds

The beauty of Berry's (1994) discrete choice model is that it accounts for price endogeneity while using aggregate demand data where unobserved product characteristics may also drive demand. Berry's (1994) construction proceeds with a simple random coefficients utility function of consumer *i* for product *j*. For our economic application of this model, the

consumers are the diamond retailers which purchase rough diamonds from different countries and the products are the rough diamonds of different countries. Thus, the utility function below is the utility of a diamond retailing firm (analogous to consumer *i*) for a specific country's diamonds (product *j*) at time *t*:

$$u_{ijt} = \boldsymbol{x}'_{\boldsymbol{jt}}\beta - \alpha p_{jt} + \xi_{jt} + \epsilon_{ijt} \equiv \delta_{jt} + \epsilon_{ijt} \qquad (1)$$

In Equation 1 above, we have utility as a function of the following variables and parameters: $\boldsymbol{x}'_{\boldsymbol{jt}}$ which is the vector of observed country characteristics such as level of democracy, GDP per capita and population density at time *t*, p_{jt} which is the price of country *j*'s diamonds at time *t*, ξ_{jt} which is the unobserved (by the econometrician, though observed by the firm) characteristics of country *j's* diamonds at time *t* and δ_{jt} is the mean utility across retailing firms for country *j's* diamonds at time *t*. In the primary long run analysis, price information is unavailable and thus p_{jt} is omitted, however, in the secondary post-KPCS analysis, p_{jt} is observed and included. ξ_{jt}, the unobserved quality characteristics of country *j's* diamonds at time *t*, in this case captures something akin to the utility gained by the firm for buying a specific country's diamonds; for example, maybe they gain more utility by doing business with trusted governments such as Canada, rather than the likes of Zimbabwe or there are other contract incentives which lead one retailing firm to prefer a certain country's diamonds.

Following from Equation 1, we assume that ϵ_{ijt} is independently and identically distributed type I. It follows that the discrete choice probability for which a rational firm will choose to purchase country *j's* diamonds is the probability that such diamonds yield the highest utility for the consuming diamond purchasing firm, as follows:

$$P_{ijt} = P_{ijt}(\beta, \alpha, x_{kt}, \xi_{kt}, k = 1, \dots, J) = \frac{e^{\delta_{jt}}}{\sum_{k=0}^{J} e^{\delta_{kt}}} \qquad (2)$$

When written in the form of the right-hand side of Equation 2, this probability is nothing more than the aggregate market-shares for each product as can be seen below in Equation 3.

$$s_{jt} = \frac{e^{\delta_{jt}}}{\sum_{k=0}^{J} e^{\delta_{kt}}} = \tilde{s}_{jt}(\beta, \alpha, x_{kt}, \xi_{kt}, k = 1, \dots, J) \qquad (3)$$

From Equation 3, we now have a function for predicted market shares as given by $\tilde{s}_{jt}(\beta, \alpha, x_{kt}, \xi_{kt}, k = 1, \dots, J)$ and derived from our utility function given in Equation 1. The

predicted market shares of $\tilde{s}_j(.)$ imply that with observed market shares (which we do observe), we can estimate the coefficients β and α.

We now have an equation for the market share for country *j*, but in order to solve such, we must look at the market share functions for the entire oligopolistic market. If we normalize the mean utility of the outside good to zero, we obtain the following system of equations:

$$\begin{cases} s_{0t} = \frac{1}{1+\sum_{k=1}^{J} e^{\delta_{kt}}} \\ s_{1t} = \frac{e^{\delta_{1t}}}{1+\sum_{k=1}^{J} e^{\delta_{kt}}} \\ \vdots \\ s_{jt} = \frac{e^{\delta_{jt}}}{1+\sum_{k=1}^{J} e^{\delta_{kt}}} \\ \vdots \\ s_{Jt} = \frac{e^{\delta_{Jt}}}{1+\sum_{k=1}^{J} e^{\delta_{kt}}} \end{cases} \tag{4}$$

Berry (1994) takes the log transformation of each equation within the system of equations above which enables him to solve for mean utility as a function of market shares. By performing such, and then differencing the resulting transformations, we obtain the following:

$$\begin{aligned} ln(s_{0t}) &= ln(1) - ln(1 + \textstyle\sum_{k=1}^{J} e^{\delta_{kt}}) \\ ln(s_{jt}) &= \delta_{jt} - ln(1 + \textstyle\sum_{k=1}^{J} e^{\delta_{kt}}) \\ ln(s_{jt}) - ln(s_{0t}) &= \delta_{jt} \end{aligned} \tag{5}$$

From Equation 1, we can define an expression for δ_{jt} such that $\delta_{jt} = \boldsymbol{x}'_{\boldsymbol{jt}}\beta - \alpha p_{jt} + \xi_{jt}$, thus yielding the final form for Berry's (1994) regression and that which we employ in analyzing country level market shares in the rough diamond market:

$$ln(s_{jt}) - ln(s_{0t}) = \boldsymbol{x}'_{\boldsymbol{jt}}\beta - \alpha p_{jt} + \xi_{jt} \tag{6}$$

Equation 6 above is precisely the theoretical approach employed in this paper's analyses, and utilizes the observed differences in market share between countries defined as top producers and those defined as "outsiders" and the effects that country characteristics, the Kimberley Process, and price play on this market share difference. Therefore, the greater the difference, the more demand for country *j*'s diamonds compared to the "outsiders" and, thus an increase in relative demand.

5.2 The Residuals

From the above theoretical framework, the analysis of the aggregate demand yields residuals, ξ_{jt}, which capture the effect on market share of the quality characteristics at time *t* which are unobserved by the econometrician, yet observed by the firm purchasing the rough diamonds. Since these are important determinants of the revealed consumer preferences (revealed by the aggregate market shares we do observe), it is important to study the residual terms after regressions are performed. For each country *j*, ξ_{jt} will reveal unobserved determinants of relative demand for a country's diamonds and thus, comparing the residuals for different countries will shed some light on the relative effects for these unobserved features of demand. This is particularly important when a known measure of diamond quality, such is price, is unobserved and omitted from the model.

5.3 Identification

In the above methodology, traditional estimation techniques can be used to estimate α and β. However, OLS assumptions require that the unobserved characteristics are uncorrelated with the control variables $\boldsymbol{x'_{jt}}$, as well as the price, p_{jt}; that is, $E[\boldsymbol{x'_{jt}}\xi_{jt}] = 0$ and $E[p_{jt}\xi_{jt}] = 0$. The assumption however that $E[p_{jt}\xi_{jt}] = 0$ is very difficult to take for granted and implies that prices are exogenous. It is more likely the case that $E[p_{jt}\xi_{jt}] \neq 0$, since unobserved characteristics will include some type of quality factors and such are likely correlated with price. Additionally, as is often the case when estimating demand, quantity (in this case market share) is determined by price, but price is also a function of quantity, giving rise to endogeneity through reverse causality. In our long run dataset analysis which omits price (due to unavailable price data), price effects are captured by ξ_{jt}; however, in the post-KPCS analysis, price is included in our model and therefore, endogeneity of price can be addressed. By utilizing instruments which affect supply side costs and not demand, typically using cost-shifting variables, we can perform a first stage regression using instruments (and other control variables) on price. Such a technique provides predicted values of price which are effectively purged of endogeneity such that $E[\hat{p}_{jt}\xi_{jt}] = 0$.

5.4 Price Elasticities

From Equation 6, we are further able to deduce own- and cross-price elasticities reflecting how changes in a country's price for its rough diamonds will affect its market shares (own-price elasticities), as well as how changes in other top producers' rough diamond prices will affect one's own market share (cross-price elasticities). Using the predicted coefficient for price, from the analytical expression for difference in log market share, the price elasticities can be calculated as follows:

$$\varepsilon_{jkt} = \begin{cases} \frac{\partial s_{jt}}{\partial p_{jt}} * \frac{p_{jt}}{s_{jt}} = -\hat{\alpha} p_{jt}(1 - s_{jt}) & \text{if } j = k \\ \frac{\partial s_{jt}}{\partial p_{kt}} * \frac{p_{kt}}{s_{jt}} = \hat{\alpha} p_{kt}(s_{kt}) & \text{if } j \neq k \end{cases} \quad (7)$$

By calculating a matrix of price elasticities for the top producing countries, we can observe the relative sensitivity of demand (market share) for each country's diamonds to changes in its own and other's prices.

Though such elasticities still offer valuable insights, they do have some drawbacks. A particular limitation in our case is that since the cross-price elasticities are determined by the term $\hat{\alpha} p_{kt}(s_{kt})$, then the cross-price elasticities of all countries $j \neq k$ with respect to country k will be the same. This arises from an assumed logit functional form underlying the model. For example, the cross-price elasticities of Botswana and Angola with respect to South Africa will be the same since it is solely dependent on South Africa's price and market share in that period.

6. RESULTS

6.1 Methodology for Long Run Dataset

In order to understand the impact of the Kimberley Process on country level competition in the rough diamond market, one can examine how countries' market shares have changed over time for top producing countries. Across a period spanning from 1960 to 2012, this analysis examines seven defined top producing countries' change in market share by volume of rough diamond production relative to those considered not top producers (the "others").

To investigate if there has been a significant impact of the Kimberley Process Certification Scheme on competition in the rough diamond market, we propose the specification below according to the model formalized in Equation 6 of the Theoretical Framework, with

caveat that any information about price is unobserved in this case. Using a within fixed effects estimation, the model can be applied to the long run cross-country panel data from 1960 to 2012, as follows:

$$ln(s_{jt}) - ln(s_{0t}) =$$
$$\beta_0 + \beta_1(Population\ density)_{jt} + \beta_2(GDP\ per\ capita)_{jt} +$$
$$\beta_3(Level\ of\ democracy)_{jt} + \beta_4(Global\ production)_t +$$
$$\beta_5(Kimberley\ dummy)_t + \sum_{j=1}^{J} \gamma_j(Kimberley\ dummy)_t \text{ x } (country)_j +$$
$$\sum_{j=1}^{J} \theta_j(Level\ of\ Democracy)_t \text{ x } (country)_j + \tau_t + \xi_{jt}$$
$$\text{where, } \xi_{jt} = u_j + e_{jt} \qquad (8)$$

The specification thus investigates the difference in log market shares of rough diamonds for country j = 1, … J, and other countries (denoted with subscript *0*) at time *t*. In proposing this economic model, we argue that the included country characteristic variables (*Population density*, *GDP per capita*, and *Level of democracy*) are all important in determining a country's market share. *Population density* is important because within diamond producing countries a densely populated area is likely more difficult to prospect and if diamonds are discovered in an inhabited area, such diamonds are significantly more costly to reach as there are economic, political, and cultural sensitivities to displacing people (Taylor & Mokhawa, 2003). *GDP per capita* is included as wealthier countries may be better prepared to efficiently locate and extract diamonds as well as possess infrastructure that makes an isolated diamond deposit economical to operate as a mine. Lastly, we include a measure for *Level of democracy* as development connections have been drawn between diamonds and political conditions (Acemoglu et al., 2001; Lujala et al., 2005; Humphreys, 2005; Olsson, 2006; Ross, 2005). Kargbo (2012) also determines that political related variables are significant in his proposed model for production of rough diamonds in Sierra Leone. To control for shifts in demand in our model, we include *Global production*, as countries' rough diamond production is aimed to meet demand (B. Bonyongo, personal interview, February 26, 2014; K. Mmopi, personal interview, February 25, 2014) implying that total global production should control well for changes in demand. The *Kimberley dummy* variable is used to capture effects for years for which the KPCS has been implemented, that being 2003 onward. Additionally, in order to capture how the Kimberley Process has impacted

the effects of other deterministic variables of market share, we introduce interaction terms between the *Kimberley dummy* and *Level of Democracy*, as well as between the *Kimberley dummy* and *Country* dummy variables for each of the top producers. Lastly, τ_t are year dummies intended to capture macroeconomic trends. ξ_{jt}, the residual of our regression captures the unobserved (to the econometrician) quality characteristics of each country's diamonds at a given time that impact the country market shares and it is assumed that ξ_{jt} is uncorrelated with the observed product characteristic variables. The unobserved quality characteristics are further decomposed into u_j, a time-invariant country component, and e_{jt}, a time-varying country component of i.i.d. shocks.

6.2 Long Run Dataset Results

The above specification is computed using a fixed effects estimator in order to control for unobserved time and country effects. These results are shown in Table 7, Column 1. Country dummies refer to Botswana as the base case. Due to issues that arise from clustering standard errors when there is a small number of clusters in the data, as well as a small number of observations within each cluster (Donald and Lang, 2007), we choose not to cluster standard errors. With the exception of *Global production*, we find high statistical significance in all variables of interest. *Global production* is retained in the baseline with lack of a better variable available to control for demand shifts. Additionally, because the dependent variable is a measure of relative market shares, it is difficult to interpret the magnitude of coefficients. As such, interpretation of the results focuses on the sign and significance.

Market shares increase with shifts towards democracy under the Kimberley Process

For most of the top producing countries, there is a general and statistically significant effect that, since 1960, decreasing democracy corresponds to increasing market shares of rough diamond production by volume. As the market shares are a one-to-one mapping of the polishing firms' utility functions, this implies that, for whatever reason, a decrease in democracy led to an increase in utility for the purchasing firms. This is evidenced in the results by the sum of the coefficients on *Level of democracy* and the interaction terms between this variable and the *Country* dummies as shown in Table 8, Column 1. Botswana, D.R. Congo, Russia, and Zimbabwe have all historically found increasing market shares during more politically autocratic times. Angola and South Africa have seen a small opposite effect where democratization has

Table 7: Fixed Effects Regressions of Difference in Log Market Shares by Volume

	(1) Top 7 Fixed Effects	(2) Top 6 Fixed Effects	(3) Top 5 by Volume Fixed Effects	(4) Top 5 by Value Fixed Effects
Population density	-0.170***	-0.123***	-0.303***	-0.183***
	(0.0424)	(0.0257)	(0.0950)	(0.0342)
GDP per capita	0.000546***	0.000646***	0.000372**	0.000475***
	(9.88e-05)	(6.10e-05)	(0.000166)	(8.85e-05)
Global production	9.64e-09	1.11e-08**	2.63e-08*	3.40e-08***
	(7.48e-09)	(5.03e-09)	(1.38e-08)	(8.13e-09)
Level of Democracy	-5.846***	-5.935***	-4.171	-6.763***
	(1.733)	(1.060)	(2.515)	(1.198)
Kimberley dummy	-5.886***	-2.659***	-6.589***	-5.103***
	(0.951)	(0.595)	(1.412)	(1.255)
Kimberley dummy x Level of Democracy	4.220***	2.018***	4.095***	2.549***
	(0.647)	(0.468)	(0.863)	(0.932)
Kimberley dummy x Angola	7.533***	4.152***		4.997***
	(1.004)	(0.716)		(1.394)
Kimberley dummy x Canada	-0.684	-0.176	-0.323	0.0404
	(0.480)	(0.305)	(0.640)	(0.409)
Kimberley dummy x D.R. Congo	3.843***	2.461***	4.033***	
	(0.558)	(0.375)	(0.790)	
Kimberley dummy x Russia	1.813***	0.674**	1.810***	0.989*
	(0.443)	(0.289)	(0.566)	(0.500)
Kimberley dummy x South Africa	0.0814	0.183		0.293
	(0.359)	(0.216)		(0.259)
Kimberley dummy x Zimbabwe	9.425***		9.151***	
	(1.274)		(1.687)	
Level of Democracy x Angola	7.191***	7.422***		7.993***
	(1.688)	(1.033)		(1.168)
Level of Democracy x Canada				
Level of Democracy x D.R. Congo	5.763***	5.878***	4.675*	
	(1.681)	(1.028)	(2.412)	
Level of Democracy x Russia	4.325**	4.849***	2.823	5.190***
	(1.776)	(1.073)	(2.478)	(1.229)
Level of Democracy x South Africa	6.798***	6.590***		7.332***
	(1.761)	(1.077)		(1.209)
Level of Democracy x Zimbabwe	4.976***		3.521	
	(1.712)		(2.387)	
Constant	13.45***	-2.241***	12.98***	-3.147***
	(0.753)	(0.469)	(1.274)	(0.495)
Observations	228	212	148	159
R-squared	0.855	0.881	0.797	0.908
Number of Clusters (*Country*)	7	6	5	5

*Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0..1*

The table reports the Fixed Effects estimates on difference in log market shares of rough diamond production by volume between top producers and other countries [$ln(s_{jt}) - ln(s_{0t})$]. Columns represent different sets of top producers. Regressions include year dummies (not shown). Level of Democracy is a standardized index ranging from strong autocracy to strong democracy. Kimberley dummy is a dummy for years including and after 2004, when the Kimberley Process was introduced.

Top 7 countries by volume/value are Angola, Botswana, Canada, Democratic Republic of Congo, Russian Federation, South Africa as per 2012 Kimberley Statistics. Top 6 countries are Top 7 excluding Zimbabwe.

Top 5 countries by value are Angola, Botswana, Canada, Russian Federation and South Africa as per 2012 Kimberley Statistics

Top 5 countries by volume are Botswana, Canada, Democratic Republic of Congo, Russian Federation and Zimbabwe as per 2012 Kimberley Statistics.

corresponded to gaining market share in the rough diamond market. Canada has enjoyed the highest level of democracy since the beginning of its diamond discovery and entry into the rough diamond market. With no variation, it is therefore impossible to estimate how Canada's relative market shares would react to a shift towards autocracy.

Table 8: Marginal Effects of the Kimberley Process and Level of Democracy

	Marginal Effect of Level of Democracy Δ*Level of democracy**		Marginal Effect of KPCS Δ*Kimberley dummy*
	Kimberley dummy = 0	*Kimberley dummy* = 1	*Level of democracy = mean (=0**)*
Angola	1.345	5.565	1.647
Botswana	-5.846	-1.626	-5.886
Canada	-5.846	-1.626	-6.570
D.R. Congo	-0.083	4.137	-2.043
Russia	-1.521	2.699	-4.073
South Africa	0.952	5.172	-5.805
Zimbabwe	-0.870	3.350	3.539

*The table reports marginal effects on the dependent variable $[ln(s_{jt}) - ln(s_{0t})]$ calculated when all other variables are held constant. Column 1 represents the sum of the coefficients on Level of democracy and Level of democracy-Country interaction terms from Table 7 Column 1. Column 2 represents the sum of the coefficients on Level of democracy, Level of democracy-Country interaction terms, and Kimberley dummy-Level of democracy interaction term from Table 7 Column 1. Column 3 represents the sum of the coefficients on Kimberley dummy and Kimberley-Country interaction terms from Table 7 Column 1. *In the regression, the Level of democracy variable is standardized. The marginal effect therefore considers a 1 standard deviation change in Level of democracy. **To examine the marginal effects at the mean Level of democracy, we consider when this standardized variable is equal to 0.*

The results suggest a negative relationship between a country's level of democracy and their market share of rough diamond production by volume, however, this general trend is reversed in the years after 2003 and the introduction of the Kimberley process. This is evidenced by the positive and highly significant coefficient on the interaction term between the *Kimberley dummy* and *Level of democracy*. This coefficient is larger in magnitude than the historically negative impact of democracy on market shares for most top producers (with Botswana and Canada as the exceptions). This marginal impact is reported by country in Table 8, Column 2. This result sheds favorable light on the KPCS for proponents of democracy, as the data suggests that the KPCS has been reversing the competitive advantage given to autocratic countries. Since 2003 and the Kimberley Process, countries no longer find the same size of increasing market shares from moving towards autocracy that was prevalent prior to the KPCS, providing less competition-related incentive for autocratic behavior. This could indicate that the Kimberley Process has had a desirable side effect of "promoting" democracy, whereby diamond production now does less to discourage democracy.

The result that autocracy is less strongly correlated with rising market shares is perhaps driven by the consumer sentiment to feel good about purchasing diamonds from a place they perceive to be treating its citizens fairly, i.e. a country with higher levels of democracy. If such is the case, then it can be interpreted that since the Kimberley Process, downstream firms attain higher utility by purchasing rough diamonds from more democratic countries, perhaps for the sake of maintaining their reputation. Such a result is consistent with the aforementioned findings of Seitz's (2012) event study concluding that the reactions of diamond retail firms' stock prices to KPCS related events imply that diamond retailers are concerned about their image as pertains to conflict diamonds.

An additional mechanism by which such a result could emerge is that for more democratic countries like Botswana and Canada, with higher democracy measures than others, it was an easier and less costly transition to implement and subsequently maintain the Kimberley Process. Interviews within the supply chain in Botswana indicate that the Kimberley Process had not created substantial costs to their production (B. Bonyongo, personal interview, February 26, 2014), evidence that could be in accordance with such a possible mechanism at work.

The Kimberley Process has led to increased market shares for the "other" producers

The general effect of the Kimberley Process has been that the top producers have lost market share. Because of the numerous interaction terms, the marginal effect of the KPCS depends on the *Level of democracy*. Therefore, in order to determine a general effect, we consider this impact when *Level of democracy* (which is standardized in the regressions) is at its mean value, zero. When we sum the net effect on all top producing countries by summing the coefficients of the *Kimberley dummy* and each country's interaction with *Kimberley dummy*, there is a negative overall change which means that market share is shifting to the others. If we assume that these top producers all have a "typical" country's *Level of democracy*, Botswana, Canada, D.R. Congo, Russia, and South Africa have all lost market share since the Kimberley Process was introduced. However, specific to Angola and Zimbabwe this marginal effect indicates that these countries have gained market share in reaction to the Kimberley Process (as seen in Table 8, Column 3). Despite Angola's and Zimbabwe's predicted gains (assuming the mean *Level of democracy*), it seems the Kimberley Process has in some manner aided the smaller producers (the others). Under these assumptions, it appears that the Kimberley Process has had

some kind of effect by which it "fosters competition," a result that contradicts the theorized effects of Spar (2006) that the KPCS would hinder competition.

To gain a better understanding of each country's market share behavior after the introduction of the Kimberley Process, we also examine marginal effects at each country's mean *Level of Democracy* from 2003-2012, as reported in Appendix B, Table 11. The results hold except for D.R. Congo, which now exhibits increasing relative market shares. Angola's, D.R. Congo's, and Zimbabwe's rise in market share could be due to questionable implementation and enforcement of the Kimberley Process within their borders. For example, rough diamonds may be smuggled in from non-Kimberley members and then re-exported under the guise of being conflict-free Kimberley Certified diamonds (Dugger, 2009; Global Witness, 2007). This could help to explain the three countries' seemingly comparative advantage in producing rough diamonds in the post-Kimberley process era. It could also be that these countries have become relatively more open politically. It was only recently, for example, that Angola became open enough for substantial diamond prospecting and exploration to continue within the country (B. Bonyongo, personal interview, February 26, 2014). Despite these three countries having a relative gain in market share, the overall effect when summing the marginal effects of top producing countries under such assumptions is again negative, supporting the suggested result that the KPCS has fostered competition.

Wealthier and less densely populated countries exhibit increased relative market shares

As anticipated, the results suggest that *Population Density* and *GDP per capita* are quite significant in determining country market shares of the rough diamond market. There is a negative relationship between population density and market share of volume, indicating that less densely populated countries may have a comparative advantage in rough production. As previously suggested, this could be due to the fact that diamond prospecting and exploration is likely more expensive in more densely populated areas for several possible reasons.

We also see a highly significant coefficient on *GDP per capita*. The results indicate that an increase in *GDP per capita* relates to an increase in relative market share of the top producers compared to the "others". This implies that more economically developed countries may be better equipped for production with greater investments in infrastructure and technology that plays a role in mining sectors.

Robustness

While the dataset is inclusive of all diamond producing countries across the period, the countries whose market shares we examine are those we now define as the "top 7" producers. This definition is drawn from Kimberley Process Certification Scheme public statistics of rough diamond production for 2012, which gives the top rough diamond producing countries both by volume and by value (Appendix B, Figure 5). In 2012, the countries producing the most carats were Russia, D.R. Congo, Botswana, Zimbabwe, and Canada. The top producing countries by value in 2012 were Botswana, Russia, Canada, Angola, and South Africa. These two subsets are then combined yielding the "top 7" producing countries on which we focus. This selection of countries leaves 18 other countries which have produced diamonds since 1960, and these "others" contain a large enough market share and enough variation over time for the analysis. Since the model looks at the difference in market shares between a top producer and the "others," variation of the others' market share is crucial. The others' market share varies from as small as about 9% in 2011 to as large as about 47% in 1989.

For robustness, we investigate various subsets of the top producers. Such subsets include dropping Zimbabwe (as their production has only substantially come about since the implementation of the Kimberley Process), analyzing the top 5 by volume, and examining the top 5 by value (as seen in Appendix B, Figure 5). Though certain variables' significances do adjust, the general results are consistent with the main results.

An additional robustness check is performed and reported in Table 13 of Appendix B which slightly redefines the *Kimberley dummy*. When the Kimberley Process was adopted, implementation was originally to take effect on January 1, 2003; however, as many participants were not prepared for the rollout, grace periods were issued and extended throughout the first few months of 2003 with complete enforcement beginning May 1, 2003 (DiamandFacts.org). As enforcement of the policy had repeated delays and perhaps there were additional unreported implementation rollout issues throughout 2003, defining the *Kimberley dummy* from 2003 onward is imperfect. In case the effect of the policy is better captured by ignoring the first "official" year due to problems with its rollout, we redefine the *Kimberley dummy* as 2004 and onward. These results are shown in Appendix B, Table 13 and are consistent with the baseline results.

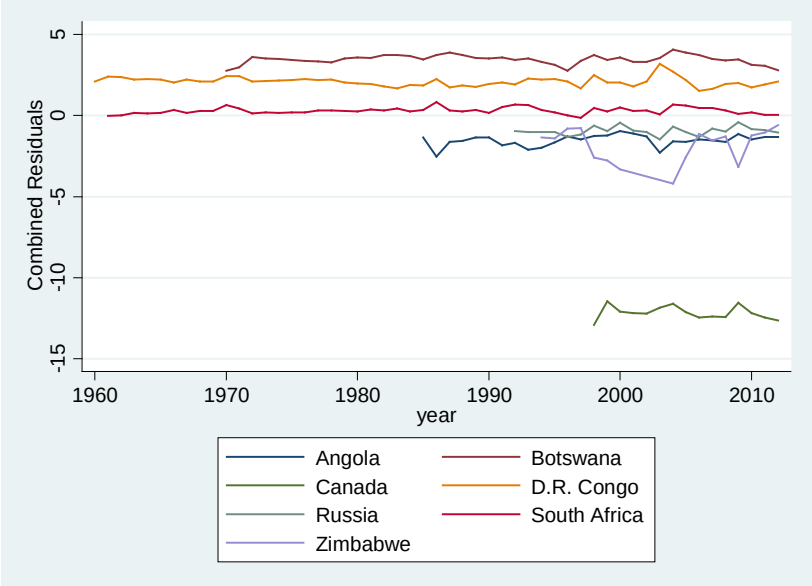
6.3 Residuals of Long Run Analysis

There is still information to be gleaned from the specification that is not contained in the estimated coefficients on the key variables and interaction terms. An analysis of the residuals of the model gives insight into the extent to which unobserved quality characteristics determine the relative market shares of the top rough diamond producing countries. As discussed in the Theoretical Framework (section 5.2), the residuals of the model, ξ_{jt}, capture the effect on relative market share of the unobserved (to the econometrician) quality characteristics of country j at time t which are observed by the firm purchasing the rough diamonds. For each country j, ξ_{jt} will reveal unobserved preferences in relative demand for a country's diamonds.

In our fixed effects regression, after controlling for key country specific variables that vary through time and general time trends, captured by year dummies, we are left with a residual ξ_{jt} that contains a fixed component (u_j) and a time-varying component (e_{jt}). Figure 4 shows the combination of these two components of the residuals ($\xi_{jt} = u_j + e_{jt}$).

Evident is that the fixed component of the residual (u_j) is largest in magnitude for Canada. As we have previously seen, Canada's level of democracy has not varied during the whole period of observation so this effect is not captured by the *Level of democracy* variable in the model, and is largely falling into the fixed component of the residual. Due to this, it may be that the model we have specified does a better job of modeling the relative market shares of the other six countries than it does for Canada.

Figure 4: Combined Residuals by Country from Baseline Fixed Effects Regression



These residuals can also give insight into the characteristics that firms buying the rough diamonds consider when choosing from which country to buy, if we assume that these firms' utility maximizing criteria are also time invariant. Clarity, for example, may be a characteristic of rough diamonds that varies across countries but not across time, and is a quality that firms see as utility increasing in the same way across time. Given this, we might guess that the countries with a higher fixed component of the residuals (u_j) produce higher quality diamonds. If we exclude Canada from this exercise for the reasons mentioned above, then we could read the fixed component of the residuals to mean that Zimbabwe, Angola, and Russia produce lower quality diamonds than Botswana, D.R. Congo, and South Africa, with Botswana producing the highest quality of diamonds of all top producers.

Available price data for rough diamonds from 2004 and onwards (Appendix B, Figure 7) partially supports this claim, with the exception of D.R. Congo which sells rough diamonds at a far lower price than others. In the setting applied to the long run data, price is not included, but instead impacts firm (consumer) utility through the unobserved characteristics, so D.R. Congo may have a higher residual precisely because it sells its rough diamonds at a lower price.

All countries exhibit interesting characteristics when we examine the time-varying error component of the residuals (e_{jt}), shown in Figure 6 of Appendix B. There appears to be a shock to the countries' residuals occurring in 2003, which could coincide with a market reaction to the introduction of the KPCS. The fixed effects regression applies a dummy variable in order to control for shifts in the market after the KPCS, but this does not control for shocks. Additionally, the regression employs year dummies to control for time trends and shocks to the entire market. The time varying residuals, then, should give information about country-specific shocks occurring as a response to the shift induced by the Kimberley Process. D.R. Congo exhibits a positive shock in 2003 while the others display a negative shock. This could indicate that at the introduction of the Kimberley Process, D.R. Congo's rough diamonds gained a temporary increase in perceived quality by rough diamond purchasing firms, perhaps amid a renewed legitimacy of these diamonds in the wake of the KPCS. We see a positive shock in 2004, one year after the policy, for Botswana and Russia, and a notable return to predicted market shares for Zimbabwe in the few years after the introduction of the KPCS. The residuals e_{jt} also identify differing country reactions to the financial crisis of 2008, evidenced by the shock appearing in 2009, most notably by Zimbabwe. Overall, the different top producing countries' relative market

shares respond at different times and in different ways to the new market landscape induced by the Kimberley Process.

There appears to be another more subtle change in market behavior during the mid-90s. e_{jt} appears to have a mean of approximately zero for all countries, but the variance is much larger after around 1995. Table 14 of Appendix B shows that the standard error has nearly doubled since this time. Interestingly, this time frame coincides with growing awareness about conflict diamonds and it seems that since this time, a larger part of relative market shares have been determined by unobserved quality characteristics than before. Given this variance, it seems that the observed country characteristics of the model better explain relative market shares prior to the mid-90s, than after.

6.4 Methodology for Price Dataset

A complementary objective of this paper is to estimate own- and cross-price elasticities for rough diamonds produced by the market leading countries in the wake of the Kimberley Process Certification Scheme's implementation. This can indicate the sensitivity of each country's market share of rough diamond sales to changes in price under the Kimberley Process regime and give additional insight into implied demand and the competition between these top rough diamond producers.

This objective is pursued according to the model explained in the Theoretical Framework (section 5.4). The specification, based on Equation 6 (section 5.1), has now varied slightly from the long run annual regression as the price panel dataset is only looking at the years 2004 to 2012, since the full introduction of the Kimberley Process. This being the case, the dummy variable for Kimberley Process years and interaction terms between this dummy and other variables are no longer included. It should also be pointed out that with a significantly narrower observation period (and number of observations for that matter) in this exercise, some variables now lose the variation desired for estimation. We therefore do not include the *Level of democracy* variable analyzed in the annual data, as now it contains very little variation indicating that changes in political status within countries are often long run trends. Broad sweeps in political status are not evident in the narrower nine year period that we now analyze. However, with the narrower observation window, we now have access to a variable for the GDP per capita of all advanced economies (*Advanced economies GDP per capita*). Given repeated emphasis that demand is driven by global disposable income (N. Oppenheimer, personal interview,

February 20, 2014; B. Bonyongo, personal interview, February 26, 2014), as well as Kargbo's (2012) inclusion of a similar variable in his production model, it is imperative to include such a measure in the baseline specification to better control for demand shifts. In the long run annual analysis, such a measure was unavailable for the given time range.

Another significant difference between the price data analysis and long run analysis is that we now include *Rough diamond price* in the specification. When we do such, we can control for the endogeneity of price as was previously mentioned in the Theoretical Framework (section 5.3). That is, the effects of competition result in a reverse causality problem when attempting to model implied demand as price affects quantity, but quantity also affects price. To deal with this issue, our baseline employs a two stage least squares (TSLS) estimator, rather than the fixed effects estimator used in the long run section. In the first stage, we use instrumental variables on price, ideally purging the endogenous component of price which is affected by supply shifts. To perform this, we use the following cost-shifting instruments in the first stage: *Oil price*, which is the price of crude oil and which is used as a general costs measure since it is a large component of costs, energy and otherwise, regardless of country, and *Coal price*, which is the price of coal and which is used as another gauge of energy input costs for producing countries. Additionally, we use an instrument called *Mean price of others*, which is the mean price of the other top producing countries. The rationalization of using such an instrument is that competition amongst competitors' pricing will affect one's own price, but will not directly affect demand (and thus market share) (Nevo, 2001). Therefore, we argue that these instruments are exogenous and that the correlation between the instruments (Z_{jt}) and the dependent variable $[ln(s_{jt}) - ln(s_{0t})]$ is zero; that is, $corr(Z_{jt}, [ln(s_{jt}) - ln(s_{0t})]) = 0$. In the first stage we regress these instruments and the exogenous variables, as well as country and time dummies, γ_j and τ_t, on price of rough diamonds, and include an i.i.d. error term, $\acute{e}_{jt}$. This leaves us with exogenous predicted values of price to be implemented in the second stage. The resulting baseline specification is as follows:

First Stage:

$$(Rough\ diamond\ price)_{jt} =$$

$$\beta_0 + \beta_1(Population\ density)_{jt} + \beta_2(Global\ production)_{jt} +$$
$$\beta_3(GDP\ per\ capita)_{jt} + \beta_4(Advanced\ economies'GDP\ per\ capita)_t +$$
$$\beta_5(Oil\ price)_t + \beta_6(Coal\ price)_t + \beta_7(Mean\ price\ of\ others)_{jt} + \tau_t + \gamma_j + \acute{e}_{jt}$$

Second Stage:

$$ln(s_{jt}) - ln(s_{0t}) =$$

$$\alpha(Rough\ \widehat{diamond}\ price)_{jt} + \beta_1(Population\ density)_{jt} +$$
$$\beta_2(Global\ production)_{jt} + \beta_3(GDP\ per\ captia)_{jt} +$$
$$\beta_4(Advanced\ economies'\ GDP\ per\ capita)_{jt} + \tau_t + \gamma_j + \xi_{jt} \qquad (9)$$

The difference in log market shares of rough diamond production for country *j* at time *t* can be modeled accordingly. From the results of this specification, α, the coefficient on *Rough diamond price* can be used to calculate own- and cross-price elasticities.

One consequence of the shorter timeframe of the data is that the variable representing the others' market share when considering the top 7 producers has significantly less variation which creates problems for the model and consequently its results. The lack of variation in the others' market share when considering the top 7 can be seen in Appendix B, Figure 8. Because of this, we focus the analysis on the top 5 producing countries by value, which increases the size and variation in the others' market share. We later present the top 5 countries by volume as a robustness check for the baseline and find consistent results.

6.5 Price Dataset Results

The regression results of the baseline specification and robustness checks are shown in Table 9. *Rough diamond price*, *Population density,* and *Advanced economies GDP per capita* all exude significance at the 1% level. Contrary to the results in the annual regression however, *Global production* has increased in significance and *GDP per capita* is now statistically insignificant, likely a result of the much narrower window of observation in this regression.

Table 9: IV Regressions Difference of Log Market Shares by Value

	(1) Top 5 by Value	(2) Top 5 by Volume	(3) Top 7
Panel A: Two Stage Least Squares			
Rough diamond price	-0.00413***	-0.00445**	0.00823***
	(0.00118)	(0.00208)	(0.00221)
Population density	-0.0174***	-0.131***	-0.0522***
	(0.00288)	(0.00768)	(0.00767)
Global production	-5.14e-09**	-1.12e-08**	-6.05e-09
	(2.36e-09)	(4.37e-09)	(5.69e-09)
GDP per capita	2.80e-06	-1.29e-05	-8.04e-06
	(3.64e-06)	(8.06e-06)	(1.05e-05)
Advanced economies GDP per capita	2.42e-05***	4.68e-05***	3.35e-06
	(6.60e-06)	(1.09e-05)	(1.38e-05)
R-squared	0.409	0.819	0.406
Panel B: First-Stage for Rough Diamond Price			
Oil price	-0.819**	-1.223**	-2.035***
	(0.405)	(0.566)	(0.539)
Coal price	0.581*	1.944***	1.844***
	(0.293)	(0.454)	(0.410)
Mean price of others	-2.181***	-1.911***	-1.569***
	(0.289)	(0.291)	(0.226)
Population density	-4.713	-4.662	-4.180
	(3.279)	(3.883)	(3.436)
Global production	8.80e-07*	3.67e-06***	3.38e-06***
	(4.88e-07)	(7.91e-07)	(7.05e-07)
GDP per capita	-0.0201**	0.0107	0.0105
	(0.00951)	(0.00957)	(0.00913)
Advanced economies GDP per capita	0.0102	-0.0208**	-0.0144*
	(0.00662)	(0.00881)	(0.00788)
Constant	8.418	502.5**	506.0**
	(186.9)	(242.7)	(221.1)
R-squared	0.871	0.872	0.831
F-statistic	24.93	24.82	24.11
Observations	90	89	125

*Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*

Panel A states the Two Stage Least Squares estimates on difference in log market shares of rough diamond production by value between top producers and other countries [$ln(s_{jt}) - ln(s_{0t})$], instrumenting for rough diamond price (US$/carat) using Oil Price (US$/barrel-Brent Crude), Coal Price (US$/metric ton), and Mean price of others ($/carat). Population Density (# people/km^2), Global Production (carats), GDP per capita (2005 USD), and Advanced economies GDP per capita (based on PPP in current international dollars) are used as controls. Panel B states the corresponding first stage and includes year and country dummies (not shown in the second stage). Columns represent different sets of top producers. Top 5 countries by value are Angola, Botswana, Canada, Russian Federation and South Africa as per 2012 Kimberley Statistics. Top 5 countries by volume are Botswana, Canada, Democratic Republic of Congo, Russian Federation and Zimbabwe as per 2012 Kimberley Statistics. Top 7 countries by volume/value are Top 5 by volume plus Angola and South Africa as per 2012 Kimberley Statistics. The one fewer observation in Columns 2 and 3 arises from no production by Zimbabwe in the first half of 2004.

The first stage results of the baseline show the statistical significance of the chosen instruments (Table 9, Column 1). Specifically, the instrument *Oil price* is significant at the 5% level, *Coal price* is significant at the 10% level, and lastly, *Mean price of others* is significant at the 1% level. The validity of these instruments is supported by the first stage results, as we observe an F-statistic of 24.93, well above the generally used threshold of an F-statistic greater than 10 for relevant instruments. The resulting coefficient on *Rough diamond price* in the second stage is negative and significant at the 1% level. The effect of implementing the first stage with valid instruments is immediately relevant as we observe that the coefficient on price has transformed from negative in the 2SLS regression (Table 9, Column 1) to a positive coefficient when employing an OLS estimation (Appendix B, Table 17), indicating that without instrumenting, we inflate the coefficient on price. Thus, applying IV techniques using 2SLS appears to provide plausible results for the coefficient on price (which will subsequently yield plausible price elasticities).

Robustness

Results prove robust to analyzing the top 5 countries by volume (rather than value) and those respective market shares by value, as seen in Table 9, Column 2. However, the coefficient on price when analyzing the top 7 countries (the same used in our long run dataset examination) is now positive (Table 9, Column 3), an improbable result suggesting that the higher a country's price, the larger its market share. As discussed, variation of the *Others market share* is an issue when considering the top 7 and so we attribute this result to such.

6.6 Own- and Cross-Price Elasticities for Top Diamond Producing Countries

Given the results of the baseline TSLS price coefficient estimates, we are now in a position to estimate price elasticities, based on Equation 7 in the Theoretical Framework (section 5.4). The elasticities of the top 5 producing countries by value are calculated using the result of the baseline specification (Table 9, Column 1). Specifically, the coefficient on the rough diamond price ($\hat{\alpha}$ = -0.00413) is used, along with rough diamond prices and rough diamond market shares from 2012, the most recent year of observation. One can observe from Table 10 that an increase in country *k*'s price leads to the same increase in market share among all other top producers. As was discussed in the Theoretical Framework (section 5.4), this result stems

from the logit assumption underlying the model. The calculated elasticities for the top producing countries of rough diamonds by value are shown in Table 10.

Table 10: Own- and Cross-price Elasticities for Top 5 Producing Countries by Value

		Country j				
		Angola	Botswana	Canada	Russia	South Africa
Country k	Angola	**-0.478**	0.045	0.045	0.045	0.045
	Botswana	0.138	**-0.450**	0.138	0.138	0.138
	Canada	0.109	0.109	**-0.617**	0.109	0.109
	Russia	0.080	0.080	0.080	**-0.251**	0.080
	South Africa	0.048	0.048	0.048	0.048	**-0.507**

Top 5 Producing Countries by Value based on KPCS public statistics. Price Elasticities are calculated using 2012 observations for country-price and country-market share by value. Bolded values represent own-price elasticities and non-bolded values represent cross-price elasticities.

These elasticities are a result of the chosen instruments on price. Our use of instruments (*Oil price*, *Coal price*, and *Mean price of others*) is intended to account for shifts in price that do not influence demand and are applied in order to remove endogeneity concerns in the second stage regression on relative market shares. Of course there may be better instruments on price, but these instruments are difficult to identify as well as to observe. Such cost-shifting data is limited, especially at cross-country levels. Despite these limitations, the elasticities calculated and reported in Table 10 are an initial attempt at describing this feature of the market, and to the best of our knowledge, offer the first country-level elasticities put forth in any diamond related literature. Any inflation of elasticities that may occur because of poor instruments or quality of data should affect all top producers in a similar way, so that a comparative analysis of the different top producers is still useful in describing the relative elasticities between them. Further research may be able to refine this sort of analysis, as better instruments and data become available.

Consumers seem less sensitive to changes in Russia's price than to other top producers

These elasticities present a large range of sensitivities of rough diamond market shares by value to changes in rough diamond prices among countries. Russia's own-price elasticity is much smaller than that of Angola, Botswana, Canada, and South Africa. If Russia were to increase the price of its rough diamonds by 1% it would lose 0.25% of its market share. Conversely, if Canada were to increase its price by 1% it would lose a much larger percent (nearly 0.62%) of its market share. Russia's lower price elasticity may say something about

competition. Russia's diamonds appear to be underpriced, having a lower price per carat of rough diamonds in 2012 than its competitors. In fact, Angola, Botswana, Canada, and South Africa all have prices above US$125/carat, whereas Russian diamonds are priced much lower, at about US$80/carat in the second half of 2012 (KPCS, 2012). This suggests an average lower quality of Russia's rough diamonds than the other top producers. If this is the case, the price elasticity seems to reflect that Russia's diamonds are not in direct competition with the other top producers and thus their price elasticity is far less sensitive.

The rest of the top producers exhibit own-price elasticities between -0.45% and -0.62%, relatively high in comparison to Russia. These elasticities give evidence that the downstream firms consuming these countries' rough diamonds are more sensitive to changes in prices. If a top producer raises its price, rough diamond purchasing firms will shift their sourcing to less expensive countries. Excluding Russia, this signifies that when all other demand determining variables are held constant, rough diamonds from Angola, Botswana, Canada and South Africa are reasonable substitutes for one another. Russia, with its suggested lower quality rough diamonds, is in this way offering a differentiated product.

Canada appears more price-elastic than African top producers

Why consumers of Canada's diamonds appear highly sensitive to changes in the price of Canadian stones is uncertain. One possibility is that Africa is more and more becoming a commercial center for the rough diamond trade, evidenced by Botswana's growing involvement in downstream segments of the industry (K. Mmopi, personal interview, February 25, 2014; J. Thamage, personal interview, February 27, 2014). Cutting and polishing firms have increasingly invested large amounts of capital in setting up polishing facilities in Botswana's capital. Perhaps, due to transport costs, the purchasers of rough diamonds prefer to buy rough diamonds which are geographically closer to their factories. Therefore, these consumers of Canadian diamonds are more sensitive to price than rough diamonds from countries in the African region, where many of their factories are based.

Cross-price elasticities appear greatest with respect to Botswana

The cross-price elasticities tell us what percentage country *j*'s market share will change in reaction to a 1% increase in country *k*'s price of rough diamonds. The cross-price elasticities with respect to Angola and South Africa have the lowest values, whereas with respect to

Botswana, the cross-elasticities are quite high. Part of the reason why we see the largest cross-price elasticities with respect to Botswana is that the calculation of cross-price elasticities depends on the size of Botswana's market share (recall that cross-price elasticities are determined by $\hat{\alpha} p_{kt}(s_{kt})$). When Botswana, the country with the largest market share by value in the second half of 2012, loses 1% of their market share, it frees up a larger piece of the pie for the others than when any other country loses 1%. This helps to explain why Botswana, with its highest market share, yields high cross-price elasticities, and Angola and South Africa, with their much smaller market shares, result in cross-price elasticities of much smaller magnitude.

7. LIMITATIONS

As with all preceding diamond production related studies, data has remained a challenge to the efforts put forth in this study. Historically, information about the diamond industry remained rather tight to the vest of the actors involved, and while information has become more available through the efforts of the Kimberley Process (for example, the aggregate rough price information has become published annually), reliable past data may never become available. Better estimations could also be made with better access to cost and demand shifting control variables. Unfortunately, many of the diamond producing countries, particularly those coming from poor, struggling regions of the world, either do not have or do not make available such historical data (for example, wage data which could be used as a production cost to instrument on price). With access to more variables on country level diamond quality characteristics, important additional information on the Kimberley Process's impacts to the industry can perhaps be derived.

Another limit to this research stems not directly from poor data in the dataset, but from poor information about what is actually transpiring within the industry. Without knowing the story completely, it is hard to identify potential mechanisms for our results. For example, though many NGOs and critics of the system may identify smuggling of non-Kimberley certified diamonds into the Kimberley certified pipeline, many accusations of such are speculative. While we posit that such may be a cause for Zimbabwe's and Angola's growing market shares since the introduction of the Kimberley Process, lack of information about what is going on within these countries makes the proposed mechanism nothing more than an untestable conjecture.

Another concern in such research is that the nature of the rough diamond industry means that the number of observations for any econometric exercise is relatively small. There is only one market for rough diamonds, the global market, and the geologic conditions which create this resource are so rare and unique that diamonds are currently sourced from only 25 countries. Pending future discoveries in other areas of the world, this means 25 is the maximum in any analysis' country dimension. Likewise, data in the time dimension only dates back to the mid-1900s.

Lastly, we acknowledge a potential source of endogeneity in our model which may be biasing estimates of the coefficient on *GDP per capita* and *Level of Democracy*. There is a large amount of literature describing a negative impact of natural resource wealth on economic growth as well as strength of political institutions, described as the "resource curse" by Sachs and Warner (1997). The consequences of this concept are that diamond production (i.e. country relative market share of rough diamonds) may have impacts on both *GDP per capita* and *Level of democracy*, implying reverse causality. There may be additional endogeneity concerns with *GDP per capita* in countries where diamond wealth contributes to a large fraction of the economy.

As the resource curse suggests a negative relationship between diamond production and *Level of democracy*, this mechanism may impose a downward bias on the coefficients on *Level of democracy* and any interaction terms involving the variable. In the case of *GDP per capita*, endogeneity bias may work in multiple directions and so the direction of the bias is difficult to predict. The resource curse again suggests a negative relationship and such a mechanism would predict that our coefficient for *GDP per capita* is biased downward. On the other hand, when diamond production is a large component of a country's *GDP per capita*, and thus, there is a positive relationship between these variables, our coefficient for *GDP per capita* is likely inflated. It is difficult to say which of these biases dominates.

These endogeneity concerns present a conundrum for the research at hand. Economically, these variables are important country-specific quality characteristics that we want to learn about. For now, variables to measure a country's wealth and political status which are not affected by the level of its diamond production remain elusive. Like those who have preceded us in attempting empirical research pertaining to diamonds, we acknowledge these

limitations of the research and offer our results with such in mind. Perhaps future research will identify suitable instruments to remove endogeneity of such variables.

8. CONCLUSION

This paper has shown that there are indeed statistically significant impacts to country level competition in the rough diamond market due to the implementation of the Kimberley Process Certification Scheme policy. We maintain that these impacts are important for the world to begin to understand, as future policy, be it brand new or revisions of old, designed to deal with the still prevalent ties between natural resources and conflict, is inevitable. Specifically, the data suggests two profound results which can be considered in the shaping of future conflict resource policy:

- First, the Kimberley Process "promotes" more democratic governance by reversing the gain in market share associated with autocratic governance that existed prior.
- Second, the Kimberley Process "fosters competition" as market share has generally shifted from the top producers to the others.

In concluding that the Kimberley Process has reduced the beneficial impacts of an autocratic government in this industry, it is possible that future advances in this policy will face obstacles from less democratic countries. In anticipating this, conflict diamond policymakers may need to somehow incentivize the more autocratic countries to support such policy. Conversely, democratic countries, regardless of diamond production or not, with a foreign policy agenda to promote and spread democracy, should pursue additional conflict diamond policy. Further, it is the democratic diamond producing countries with this type of foreign policy that stand to gain the most of all the democracy proponents, as they can promote a foreign policy agenda as well as reduce an autocratic competitor's competitive advantage in the rough diamond market. By such logic, a diamond producing country like Australia, with its high levels of democracy, should spearhead new policy or at least be a staunch supporter of it.

The parties driving conflict diamond policy should also keep in mind that, according to the results suggested by this paper, the KPCS appears to have led to a shift in market share from top producers to non-top producers. Such a result raises concerns that the most influential

countries in the diamond industry may be disincentivized to initiate or support more policy. One would expect that a country-level policy governing any industry would be pioneered by those countries most involved in the industry, i.e. those with the largest market shares. Countries with small chunks of the market share may not have the persuasive tools or the power to generate such policy across an industry, even if the motivation exists. This may be precisely why revisions and additional conflict diamond policy have not been initiated, despite years of calls for such. If further policy is to be achieved, proponents must find a way to counter this impact.

There may be some instances, however, in which the net effect of the two main results would be unclear. In the case of a more democratically oriented market leader such as Canada, the country's democratic interests would incentivize future conflict resource policy, whereas their relatively large share of the market would discourage such policy reform. In this case, the country's policy agenda is difficult to predict as it is uncertain which of these effects would dominate.

Reformists attempting to introduce new policies will need to find ways to counter the resistance from autocratic governments and top producers, as suggested by this paper's results. Advocates have always touted the importance of educating the end consumer about conflict diamonds as a means of squashing demand for them, but our results imply that educating the final consumer might additionally be important in terms of catalyzing new policy. If the utility of the firms (consumers) buying rough diamonds is threatened by a negative reputation of the product and reduced end consumer demand, then the need for policy to repair consumer confidence may eventually overtake any disincentives to future reform created by the existing KPCS policy. This could possibly instigate the top producers to take on further policy which may not occur otherwise, much in the same way the initial policy came about.

In recent years, conflict minerals have gathered attention as a new source of finance in conflict zones[2]. Gold and other minerals such as cassiterite, wolframite, and coltan which are crucial components in consumer electronics have functioned in black markets much the same way as conflict diamonds. Though there are significant differences between the rough diamond industry and the precious minerals industry, and therefore, policy to guide conflict minerals must

[2] As an indication that conflict mineral policy has come into focus, the Securities and Exchange Commission (SEC) in the United States has recently released requirements for firms to report the use of conflict minerals coming out of D.R. Congo. This has come under legal scrutiny within the US, causing the SEC to revise its guidelines (Leinaweaver, 2014). As of May 2014, the final form of this policy is unclear.

take a different form than the policy governing rough diamonds, the actors involved can consider the results pertaining to rough diamonds found in this paper when developing country-level policy.

For the sake of improved research in this field, future and tangent policies should also focus on enhancing the flow of information within the industry at country levels. As previously discussed, the extent of uncertainty that surrounds many countries, specifically with regard to if they are enforcing the policy properly or smuggling diamonds in and out of their country, makes it impossible to identify the mechanisms which drive the changes in market share. Again we come back to Angola's and Zimbabwe's gain in market share since the Kimberley Process began which is counter to the general trend of those at the top. If speculated smuggling is indeed occurring, it could be driving this result, but if policy is to be shaped around such research, conclusive mechanisms should be studied. Though observing such types of occurrences and subsequently reporting them is a difficult task to resolve, future policy makers may strengthen transparency efforts which will at the least aid in these efforts.

The Kimberley Process has undoubtedly been a step in the right direction in staving off violence funded by conflict diamonds, but it is not the final solution to the problem. With more conflict resource policy inevitable, the initial insights suggested by this paper into the impacts of such policy on competition can provide guidance to those involved in future policy creation.

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APPENDIX A: Key Interviews & Jwaneng Mine Tour

Between the dates of February 20, 2014 and February 28, 2014, we conducted key interviews with several persons of importance to the diamond industry. Discussions regarded features of the industry that affect supply, demand and costs in particular, with focus on Botswana and the development of the industry within its borders. Summaries of the interviews are presented in chronological order below.

Meeting with Nicky Oppenheimer (Former Chairman of De Beers) - Johannesburg, South Africa, February 20, 2014

Discussions with Mr. Oppenheimer took focus on demand and supply side shifters for the industry. From this conversation, it was emphasized that consumers' desire for gem quality stones is driven by the lust for what the diamonds symbolize, for example, wealth and power. Since diamonds serve no other functional purpose, demand is driven entirely by the world's disposable income. Additionally, most of the value production of rough diamond comes from gem quality stones, since technology now exists to supply the industrial diamond demand with synthetically produced diamonds. Interestingly, despite such technologies, gem quality consumers have shown no interest in synthetic diamonds; gem quality consumers want the diamonds produced in nature. On the supply side, we learned that technology does little to drive supply in this industry because diamonds are simply so rare that technology advances don't change the supply side landscape significantly. We also inquired what the significant changes were to the industry over the years to which Mr. Oppenheimer explained that diamond producing countries have increasingly wanted to have more say in the industry itself, of which Botswana is a perfect example. He adds that during his tenure in command of De Beers, this was the biggest challenge he faced – balancing working with governments with the private interests of the mines.

Meeting with Binu Philip (Plant Manager at Laurelton Botswana), Gaborone, Botswana, February 24, 2014

Laurelton Botswana is a diamond cutting and polishing factory for Tiffany, one of the largest diamond retailers in the world. Thus, Mr. Philip's comments come from a more downstream perspective than any of the other people interviewed. In our analysis, a firm like Tiffany is the consumer choosing which country to purchase rough diamonds from.

In our discussions with Mr. Philip, we first discuss the operations of the plant which, as a sight holder to Debswana, has a contract to buy rough diamonds through Debswana's sorting arm called the Diamond Trading Company Botswana (DTC Botswana). After stones are received at the factory, further sorting of the stones is performed where each stone is analyzed in order to maximize its value output which is determined by what is known as the four Cs: color, clarity, carat, and cut (shape). Cutting and polishing of stones then proceeds. It is in these stages of the retail diamond supply chain that most of the value is added.

Mr. Philip adds that some of the challenges faced at the retail purchasing level are that it is difficult to get the right sizes and clarities from DTC in order to meet the Tiffany jewelry standards and that information is rather closed. Expanding on this he explains that the rough diamond phase of the supply chain is highly controlled with few players and with very closed information which makes business planning for retailers difficult. As an example of this he cites that Laurelton only receives estimates of the coming year's supply, not more distant timelines.
As a retailer operating in Botswana, Mr. Philip talked about Botswana's "Diamond Beneficiation" policy (and similar policies in effect in Namibia) which have been established so that the country of origin for the rough diamonds retain more of the value from the resource. One example of this is that under the most current agreements, Laurelton Botswana must polish within Botswana 90% of the Botswana diamonds they purchase. This is intended to generate more jobs and skills for the people of Botswana.

Lastly, regarding the Kimberley Process, Mr. Philip said that the stones Laurelton Botswana receives are Kimberley Certified as soon as they come out of the diamond mine. The polished stones are again certified when they leave Laurelton Botswana's facility, as they are at each phase of the supply chain. Mr. Philip adds that the effectiveness of the Kimberley Process is contingent upon educating the final consumer because as long as there are end consumers for conflict stones, the initiative won't be fully effective.

Meeting with Kago Mmopi (Head of Communications at Diamond Trading Company Botswana), Gaborone, Botswana, February 25, 2014

Mr. Mmopi works for DTCB which sorts the rough diamonds mined by Debswana and distributes it to sight holders. Our conversation focused on the role of DTCB in the supply chain, as well as the Kimberley Process and beneficiation efforts in Botswana.

The rough diamond mines in Botswana are mined to meet expected retail demand based on forecasts. As an example, the crisis of 2008 had a large impact on Debswana production: 34 million carats produced in 2007 and 17.5 million produced in 2008.

The mined stones come to DTC Botswana to serve two purposes – here they are sorted and valued. The Botswana government and De Beers (the partners in Debswana) then negotiate prices for these stones based on the valuations as De Beers will then sell these stones to the contracted sight holders. For this service, DTCB is paid a fee of 4% of the agreed sales price.

As part of the Botswana beneficiation process, DTCB operations used to occur in London, but Botswana in 2006 negotiated the relocation of sorting to Gaborone as part of mining lease negotiations, and in 2008 DTC began its operations in the country. Additionally, as of sales agreement negotiations in September 2011, De Beers has gradually moved all of its global aggregation and sales operations to Botswana, a process completed in October 2013. This means that stones from De Beers' other mine interests outside of Botswana (including Canada, South Africa and Namibia) are now imported here before being sorted, valued and sold generating additional economic value for Botswana and making Botswana ever more relevant in the whole of the diamond industry. Since De Beers' sales operations have moved to Gaborone, more than 200 sight holders fly in every five weeks to complete sales, creating a trickle-down effect in other sectors of the economy. Lastly, Botswana is also trying to establish itself as a sales entity for Debswana's rough diamonds. In doing so, Botswana has created a 100% Botswana-owned diamond sales company called the Okavango Diamond Company which takes and sells a gradually increasing 10 to 15% of Botswana's production from De Beers.

Lastly, Mr. Mmopi addressed our questions about the mechanisms of the Kimberley Process which reiterates the aforementioned that each phase of the supply chain gets a Kimberley Process certification. Each weekly parcel that arrives from Debswana is certified by auditors. He also added that DTCB and Debswana mandate that all sight-holders only source goods that are Kimberley Process certified in all their business or else their purchase contracts will be voided.

Meeting with Balisi Bonyongo (Managing Director at Debswana), Gaborone, Botswana, February 26, 2014

As managing director of Debswana, Mr. Bonyongo oversees the management of all of Debswana's diamond producing mines, and thus is critical in managing supply decisions such as production scales, supply-side investments and operating costs. While we touch upon some demand side and general industry issues with Mr. Bonyongo, the focus of our discussion is about long-term and short-term supply issues for Debswana.

Regarding demand, Mr. Bonyongo reiterates aforementioned calls that disposable income drives demand, but he also adds that since conflict diamonds came to light, consumer sentiment also drives demand. In this sense, the Kimberley Process has enhanced value for the industry as it addresses consumers' desire for conflict free stones. Additionally, diamonds are mined to meet expected demand given current equilibrium prices at the retail level (which are monitored by De Beers' downstream partners).

On the supply side, Mr. Bonyongo strives to have flexible production for Botswana (especially because they do not want to stockpile or have excess supply since the safest storage of the diamonds is in the ground). Since they do not want to stockpile, they maintain a small supply buffer aimed only to satisfy short term volatility.

Regarding longer term supply planning, Mr. Bonyongo informed us that it takes 10 years from discovery to bringing diamonds out of the ground; therefore, investment has to be well planned. For example, Debswana has discovered many small diamond fields around its bigger mines but the need and economics to develop them are not necessarily always there. In Botswana, he estimates that the diamond supply is sufficient to at least supply until 2050.

Regarding the dynamic between supply and demand, the industry predicts that demand will increase in the future while supply remains flat which creates a supply-demand gap in the market and this is what Mr. Bonyongo is trying to manage. In doing so, Debswana has a resource development plan (which is revisited often) to address utilizing the resources (which are the diamonds you have your hands on) and your reserves (which are the diamonds that can be mined) to optimally address the supply-demand gap moving forward. With respect to this supply-demand gap, it is important to understand price elasticities for diamonds, but Mr. Bonyongo points out that price elasticities of rough diamonds have been difficult for even Debswana's economists to understand because diamonds are such a peculiar good.

With regard to technology's relation to supply, Mr. Bonyongo states that technology is not driving supply in terms of discovery, but it is in terms of recovery rate. For example, new tailing treatment facilities are being used to re-process already spent ore at Jwaneng, Letlhakane and Orapa Mines and this resource and technology is producing 1,000,000 carats per year.

With regard to the biggest changes in the rough diamond industry over recent years, Mr. Bonyongo mentions that there has been consolidation in the market in terms of mining companies. BHP Billiton and Rio Tinto have been selling much of their diamond mining operations leaving De Beers and Alrosa as the two dominant major players.

Meeting with Jacob A. R. Thamage (Coordinator Diamond Hub, Ministry of Minerals, Energy and Water Resources, Chairman of the Okavango Diamond Company), Gaborone, Botswana, February 27, 2014

Mr. Thamage is a Botswana government employee dealing directly with the development of the diamond industry. Our conversation with Mr. Thamage therefore dealt with government policy in terms of cultivating the diamond industry and government policy in terms of beneficiation.

The country operates a policy to gently develop minerals with the private sector as the country wants to remain open to attract investment. Under this policy there are five key points: exploring, exploitation, evaluation, create opportunities to be educated within the industry and protect the environment.

To explore, prospecting rights can be applied for and are good for three years, for a maximum 1,000 km^2. After these three years, prospectors have two years to renew the rights but half of the land must be surrendered. If diamonds are discovered, then mining rights must be applied for and are good for a maximum of 25 years but are renewable, as per Botswana's Mines and Minerals Act. Though the government has partnerships with De Beers, they want to convey openness to foreign investment and business and so they want competition in exploration (currently, Alrosa (from Russia) and Falcon Bridges (from Canada) are prospecting in Botswana).

The first acts of beneficiation commenced in 1982 with the start of production at Jwaneng mine under a 50-50 partnership in production between Botswana and De Beers. Another primary area of beneficiation is in sorting and valuation which also first began in 1982 when some sorting procedures began operation within the country. Beneficiation in this area has

continued with the setup of DTC Botswana in Gaborone. The first cutting and polishing began in Gaborone in 1981 and as of February, 2014, there are 21 factories in operation employing approximately 3700 people. Recently, support industries have begun to establish themselves in Botswana as gem certifying institutions such as the Gemological Institute of America and banks that finance diamond transactions have setup offices in Gaborone as well. Generating beneficiation throughout the value addition process is the goal of beneficiation, but in doing so, a major challenge is created by the relatively high labor costs in Botswana compared to competitors such as India, China and Thailand which disincentivizes market actors from moving facilities to Botswana.

In Botswana's efforts to build local knowledge of the diamond market, they have also established the Okavango Delta Company (ODC). In 2011, the ODC initially received 10% of the critical mass of rough and this increases 1% annually up to a maximum of 15%. ODC then issues sales to sight holders. The ODC provides two main functions for Botswana; it provides a price comparison to ensure that Botswana is getting a good price in Debswana-De Beers transactions and it provides knowledge to the country about another element of the industry. To further these efforts, Botswana negotiates agreements to try to incentivize companies to open locally. For example, in 2016, $800 million in sales will be available specifically to sight holders with local factories.

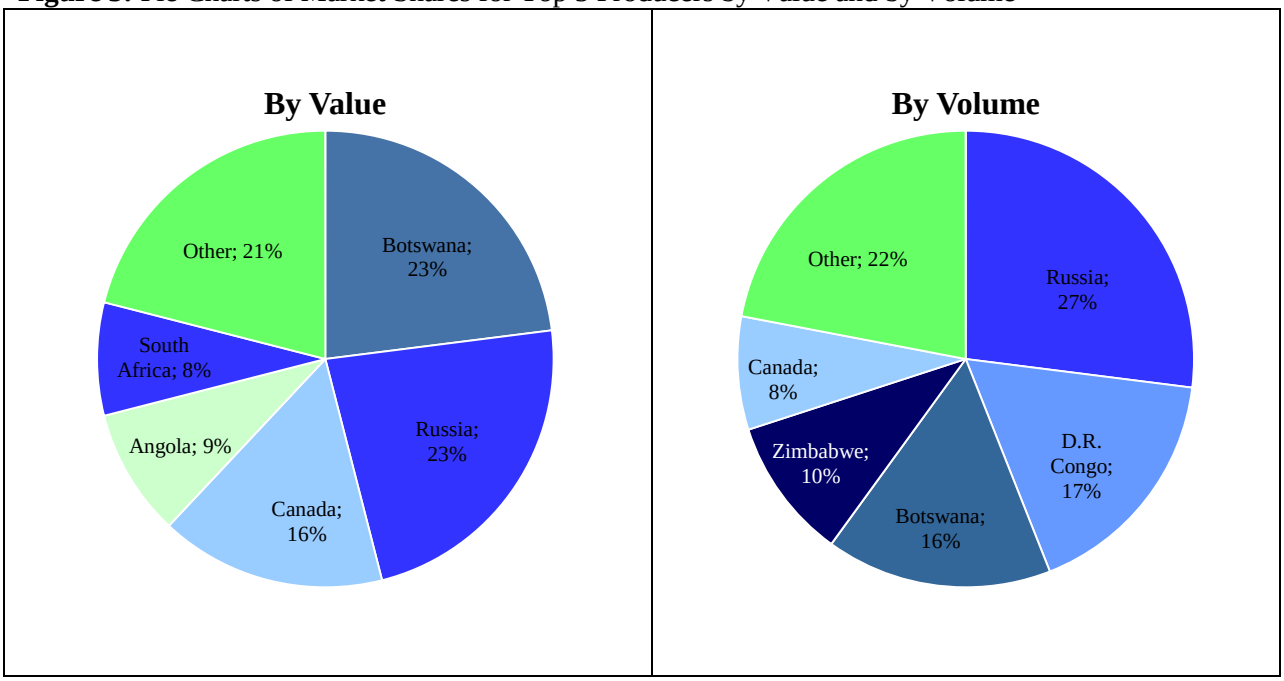
Tour of Jwaneng Mine, February 28, 2014

Touring the world's richest diamond mine, Jwaneng, was not a 'Q & A' opportunity, but it did provide insights into the scale of operations and in witnessing such, made clear some aforementioned supply related comments. The open pit mine (which takes the appearance of a small canyon) is operating constantly - 24 hours a day, 365 days per year. Ore and non-diamond material is constantly being pulled from the pit in massive hauling equipment. At this point in the mine's lifespan, it is becoming more and more expensive to mine diamond containing ore. Most material mined is non-diamond containing in order to gain access to the Kimberlite which is the ore that contains diamonds. To witness the amount of equipment required to run and maintain the mine, as well as the amount of work in excavating and processing to produce a diamond, it seems quite sensible that Debswana would want to only extract rough to satisfy supply. To stockpile would require extensive upfront costs which would not see returns until the

stockpiled stones were sold off. Further, as so much processing is required to extract the stones they are more or less secure in the earth and therefore, there would be significant additional costs to secure stockpiled stones.

APPENDIX B: Tables and Figures

Figure 5: Pie Charts of Market Shares for Top 5 Producers by Value and by Volume



Source: Kimberley Process Public Statistics (2004-2012)

Table 11: Marginal Effects of the KPCS assuming different *Levels of Democracy* Values

	Marginal Effect of KPCS *ΔKimberley dummy*	Marginal Effect of KPCS *ΔKimberley dummy*	Marginal Effect of KPCS *ΔKimberley dummy*
Country	*Level of democracy = mean (=0*)*	*Level of democracy = country mean*	*Level of democracy = country mean during Kimberley*
Angola	1.647	-0.966	0.318
Botswana	-5.886	-1.717	-1.046
Canada	-6.570	-0.496	-0.496
D.R. Congo	-2.043	-4.548	0.514
Russia	-4.073	-1.466	-1.207
South Africa	-5.805	-2.211	-0.348
Zimbabwe	3.539	2.726	2.210

The table reports marginal effects on the dependent variable $[ln(s_{jt}) - ln(s_{0t})]$ *calculated when all other variables are held constant.*
In the long run regression results, the Level of democracy variable is standardized.
Column 1 reports the marginal effects at the mean Level of democracy for all diamond producing countries, equal to 0.
Column 2 reports the marginal effects at the country mean level of democracy for all years of observation.
Column 3 reports the marginal effects at the country mean level of democracy for 2003-2012.
The mean values used in Columns 2 and 3 are reported in Table 12.

Table 12: Mean standardized *Level of Democracy* by Country

Country	Country Mean *Level of democracy (1960-2012)*	Country Mean *Level of democracy (2003 - 2012)*
Angola	-0.619	-0.315
Botswana	0.988	1.147
Canada	1.439	1.439
D.R. Congo	-0.594	0.606
Russia	0.618	0.679
South Africa	0.852	1.293
Zimbabwe	-0.193	-0.315

Level of democracy variable is standardized.

Table 13: Fixed Effects Regressions of Difference in Log Market Shares by Volume

	(1) Top 7 Fixed Effects Kimberley dummy = (2003-2012)	(2) Top 7 Fixed Effects Kimberley dummy = (2004-2012)
Population density	-0.170***	-0.182***
	(0.0424)	(0.0405)
GDP per capita	0.000546***	0.000560***
	(9.88e-05)	(9.17e-05)
Global production	9.64e-09	1.18e-08*
	(7.48e-09)	(6.29e-09)
Level of Democracy	-5.846***	-6.235***
	(1.733)	(1.614)
Kimberley dummy	-5.886***	-8.111***
	(0.951)	(0.993)
Kimberley dummy x Level of Democracy	4.220***	6.081***
	(0.647)	(0.760)
Kimberley dummy x Angola	7.533***	10.32***
	(1.004)	(1.163)
Kimberley dummy x Canada	-0.684	-1.371***
	(0.480)	(0.453)
Kimberley dummy x DR Congo	3.843***	4.564***
	(0.558)	(0.549)
Kimberley dummy x Russia	1.813***	2.784***
	(0.443)	(0.473)
Kimberley dummy x South Africa	0.0814	-0.154
	(0.359)	(0.345)
Kimberley dummy x Zimbabwe	9.425***	12.82***
	(1.274)	(1.456)
Level of Democracy x Angola	7.191***	7.686***
	(1.688)	(1.568)
Level of Democracy x Canada	0	0
	(0)	(0)
Level of Democracy x DR Congo	5.763***	6.255***
	(1.681)	(1.566)
Level of Democracy x Russia	4.325**	4.076**
	(1.776)	(1.632)
Level of Democracy x South Africa	6.798***	7.379***
	(1.761)	(1.649)
Level of Democracy x Zimbabwe	4.976***	3.842**
	(1.712)	(1.646)
Constant	13.45***	-0.448
	(0.753)	(0.708)
Observations	228	228
R-squared	0.855	0.869
Number of Clusters (*Country*)	7	7

*Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0..1. The table reports the Fixed Effects estimates on difference in log market shares of rough diamond production by volume between top producers and other countries* $[ln(s_{jt}) - ln(s_{0t})]$.
Column 1 (Table 8, Column 1) reports results when Kimberley dummy covers years 2003-2012.
Column 2 reports results when Kimberley Dummy covers years from 2004 – 2012.
Regressions include year dummies (not shown). Level of Democracy is a standardized index ranging from strong autocracy to strong democracy. Top 7 countries by volume/value are Angola, Botswana, Canada, Democratic Republic of Congo, Russian Federation, South Africa as per 2012 Kimberley Statistics.

Figure 6: Time-Varying Component of Long Run Dataset Regression Residuals By Country

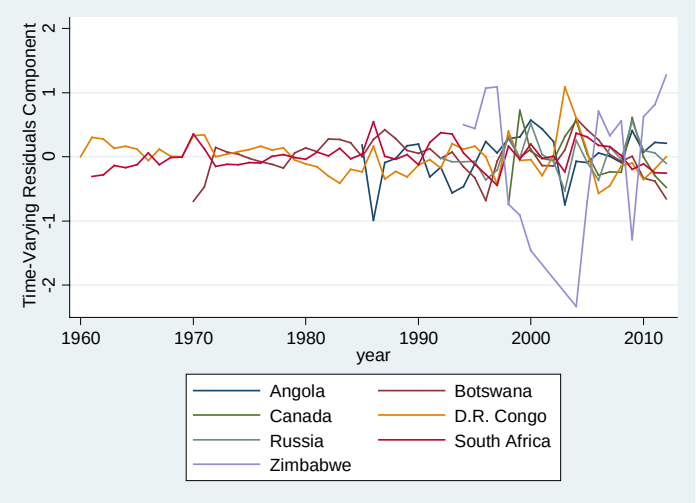


Table 14: Summary Statistics of e_{jt} before and after 1995

Variable	Obs	Mean	Std. Dev.	Min	Max
1960 - 1994					
e_{jt}	108	4.07E-15	0.23444	-0.9864	0.54608
1995 - 2012					
e_{jt}	120	3.26E-15	0.48782	-2.3297	1.2719

e_{jt} is the time-varying error component of the residuals from the baseline Fixed Effects regression performed on the top 7 diamond producing countries by volume. We note that the standard deviation more than doubles since 1995.

Table 15: Missing Values of Price Dataset (2004-2012)

Variable	Missing	Total	Percent Missing
Country market share by value	0	432	0
Country market share by volume	0	432	0
Others market share by value (top 5)*	0	432	0
Rough diamond price (US$/carat)	0	432	0
Population Density (# people/km^2)	0	432	0
Global production (carats)	0	432	0
GDP per capita (US$2005)	0	432	0
Advanced economies GDP per capita**	0	432	0
Level of democracy	0	432	0
Oil Price (US$/barrel-Brent Crude)	0	432	0
Coal Price (US$/metric ton)	0	432	0

**Top 5 countries by volume are Botswana, Canada, Democratic Republic of Congo, Russian Federation and Zimbabwe as per 2012 Kimberley Statistics*

***Based on PPP in current international dollar, as per World Economic Outlook/IMF.*

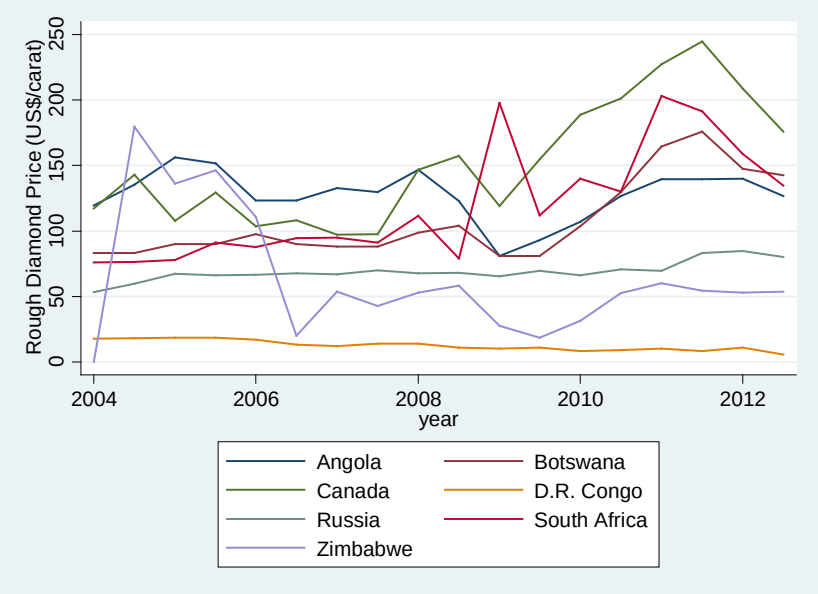
Source: Kimberley Process Certification Scheme, World Bank Development Indicators, Quality of Government Datasets, IMF World Economic Outlook Database, Datastream.

Table 16: Price Dataset Summary Statistics by Country (2004-2012)

Variable	Country	Mean	Std. Dev.	Min	Max
Country market share by value					
	Angola	0.091	0.010	0.077	0.113
	Botswana	0.241	0.043	0.087	0.280
	Canada	0.161	0.030	0.107	0.210
	D.R. Congo	0.031	0.016	0.009	0.056
	Russia	0.220	0.032	0.183	0.329
	South Africa	0.105	0.015	0.075	0.130
	Zimbabwe	0.014	0.019	0	0.051
Country market share by volume					
	Angola	0.058	0.013	0.037	0.087
	Botswana	0.181	0.030	0.076	0.208
	Canada	0.086	0.014	0.065	0.119
	D.R. Congo	0.175	0.031	0.129	0.274
	Russia	0.251	0.038	0.207	0.354
	South Africa	0.074	0.016	0.044	0.097
	Zimbabwe	0.028	0.037	0	0.097
Rough diamond price					
	Angola	127.546	19.164	80.790	156.300
	Botswana	107.666	30.434	81.000	176.000
	Canada	151.639	46.681	97.140	244.940
	D.R. Congo	12.597	3.969	5.590	18.640
	Russia	69.024	7.500	53.370	84.570
	South Africa	119.419	43.148	76.140	203.130
	Zimbabwe	64.000	48.062	0	179.610
Population density					
	Angola	14.598	1.292	12.592	16.701
	Botswana	3.400	0.088	3.253	3.536
	Canada	3.660	0.107	3.501	3.836
	D.R. Congo	25.816	1.935	22.818	28.983
	Russia	8.714	0.044	8.663	8.804
	South Africa	40.160	1.236	38.242	42.197
	Zimbabwe	33.443	0.826	32.786	35.477
GDP per capita					
	Angola	2250.624	444.342	1445.266	2685.834
	Botswana	5892.359	501.385	5083.816	6683.660
	Canada	35392.390	641.973	34044.680	36182.910
	D.R. Congo	1784.273	104.810	1630.488	1943.691
	Russia	6058.094	630.442	4813.538	6834.000
	South Africa	5602.021	330.316	4947.862	6003.457
	Zimbabwe	418.196	43.021	344.742	496.104
Level of democracy					
	Angola	-2	0	-2	-2
	Botswana	8	0	8	8
	Canada	10	0	10	10
	D.R. Congo	4.611	0.719	3	5
	Russia	4.722	0.958	4	6
	South Africa	9	0	9	9
	Zimbabwe	-1.917	2.463	-4	1

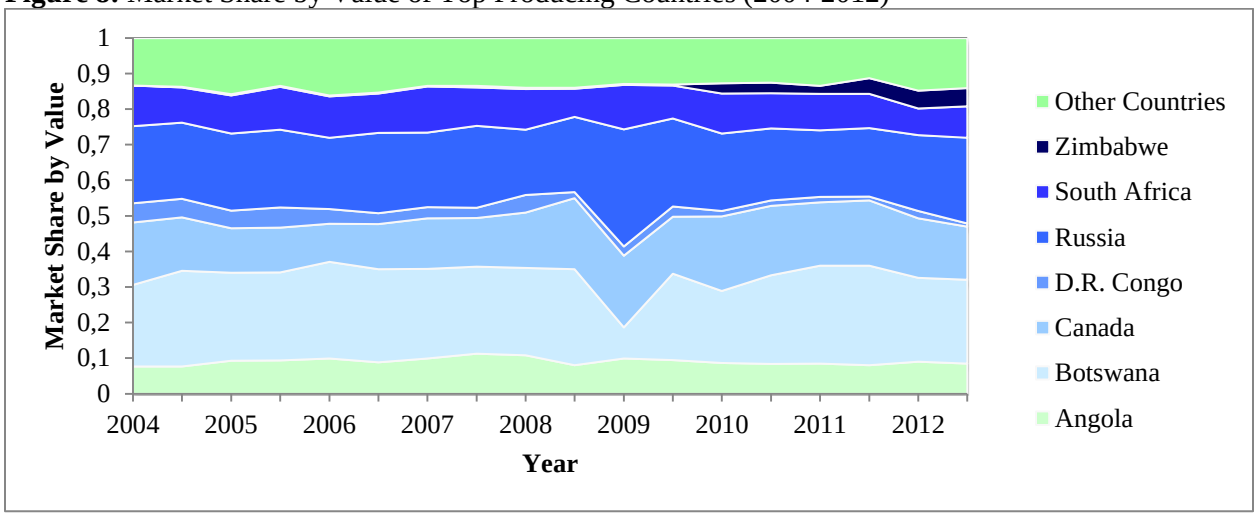
Table 16 contains semi-annual data for 2004 – 2012. Top 5 countries by value are Angola, Botswana, Canada, Russian Federation and South Africa as per 2012 KPCS statistics. Source: Kimberley Process Certification Scheme, World Bank Development Indicators, Quality of Government Datasets, IMF World Economic Outlook Database, Datastream.

Figure 7: Rough Diamond Prices of Top Producing Countries, 2004-2012



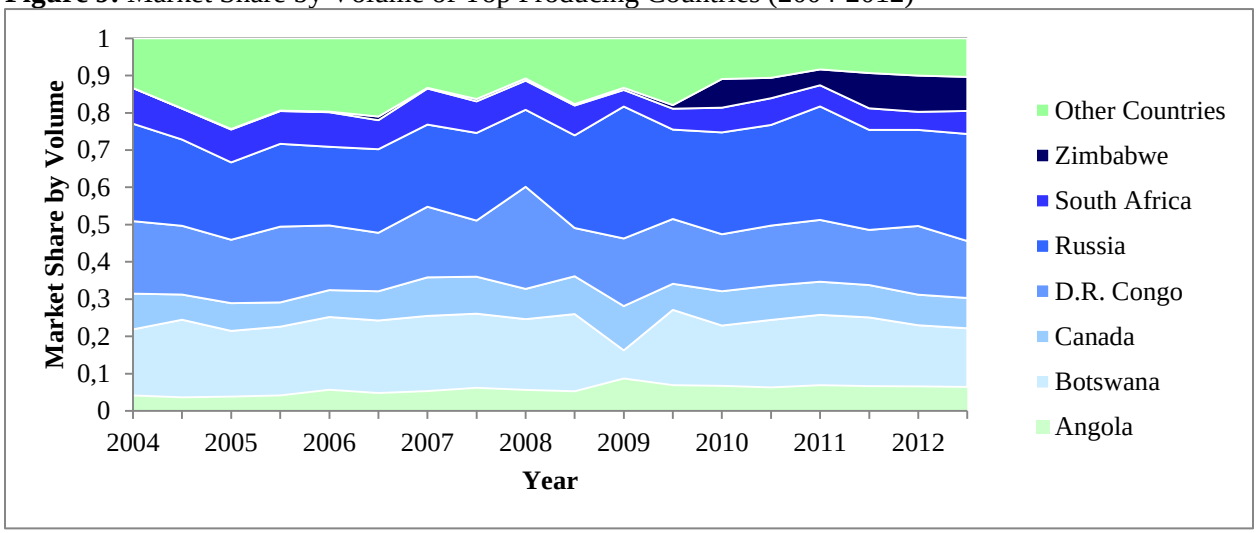
Source: Kimberley Process Public Statistics (2004-2012)

Figure 8: Market Share by Value of Top Producing Countries (2004-2012)



Source: Kimberley Process Public Statistics (2004-2012)

Figure 9: Market Share by Volume of Top Producing Countries (2004-2012)



Source: Kimberley Process Public Statistics (2004-2012)

Table 17: OLS Regression of Difference of Log Market Shares by Value

VARIABLES	**Top 5 by Value**
Rough diamond price	0.00197**
	(0.000933)
Population density	-0.0526
	(0.0351)
Global production	-2.61e-09
	(3.89e-09)
GDP per capita	-0.000109
	(0.000103)
Advanced economies GDP per capita	9.22e-05
	(6.42e-05)
Constant	-2.784
	(1.836)
Observations	90
R-squared	0.864

*Standard errors in parentheses; *** p<0.01, ** p<0.05, * p<0.1*

The table shows Ordinary Least Squares estimates on difference in log market shares of rough diamond production by value between top producers and other countries[$ln(s_{jt}) - ln(s_{0t})$],with Rough diamond price (US$/carat,) as the variable of interest. Population Density (# people/km^2), Global Production (carats), GDP per capita (2005 USD), and Advanced economies GDP per capita (based on PPP in current international dollars) are used as controls.

Top 5 countries by value are Angola, Botswana, Canada, Russian Federation and South Africa as per 2012 Kimberley Statistics.