2019

Lab Grown Diamond: Stone That Shatters the Century-old Cartel

Ming Feng Wan

ming@cs.toronto.edu

Competition Policy | Dr. Nadia Soboleva

Department of Economics, University of Toronto

12/4/2019

De Beers's century-long sovereignty over diamond has been acknowledged as one of the most noteworthy monopolies in history. Founded in 1888 by British magnate Cecil Rhodes, De Beers leveraged the supply and demand of mined diamond with a series of antitrust practices, which includes cajoling other producers to join the price-fixing cartel and stifling non-cooperative producers. Beginning from the 1990s, De Beers has gradually lost its grip on diamond, but its impact on the diamond market has persisted. The diamond cartel established by De Beers has carried on its antitrust practices, and price of diamond today remains to be unrepresentative of the true value and rarity of diamond (Yu).

In recent years terms such as "lab grown diamond", "lab diamond", and "synthetic diamond" have surfaced in the diamond market. Lab grown diamond has existed for over sixty years with negligible impact on the diamond cartel, as old methods of production are rather costly (Linde, Geyler and Epstein). Over the past few years, however, technological advancement, particularly the development of the Chemical Vapor Deposition (CVD) methodology, has enabled firms to produce lab grown diamonds at a low cost with products that are visually indistinguishable from natural diamond (Shor). In fact, lab diamond is superior in gemstone quality; a natural diamond retailer once attempted to discredit lab diamond for being "simply too perfect looking" (Moquin) while a "real" diamond should have visible flaws. (Of course, such an attempt to discredit lab diamond will not succeed; equipped with advanced CVD machines, lab diamond manufactures can add impurity in production to simulate the flaws of mined diamond). With the surge of lab grown diamond, the diamond market has marked a disruption in supply and demand. In this paper, I delineated the antitrust market for lab grown diamonds and determined that there was price-fixing in the lab grown diamond market. I then

examined the demand change for lab grown diamond and concluded that the continuously increasing demand for lab diamond will most likely trigger a price drop in the diamond market. Finally, I observed De Beers's reaction to the recent surge in lab grown diamond and deduced that it does not seem to have an effective strategy to influence consumer's preference on lab diamond.

Recent surge of lab grown diamond

In 2016 lab grown diamonds accounted for merely one percent of total diamond sales, but Morgan Stanley analysts projected that in the most likely scenario, by 2020 lab diamond could take around 15 percent of the market share of melee diamond, and 7.5 percent of market share of larger diamond (Stanley). In the same year, the International Grown Diamond Association was founded. In 2017, around half of China's diamond output consists of lab diamond (Ge). As of 2019, the share of lab diamond in rough diamond market sale has risen from one percent in 2016 to around two to three percent (Hood). Although "lab diamond" by itself still has not gained as much attention as "diamond" (Figure 1, Figure 2), there is a recent surge of interest in "lab diamond" (Figure 3).

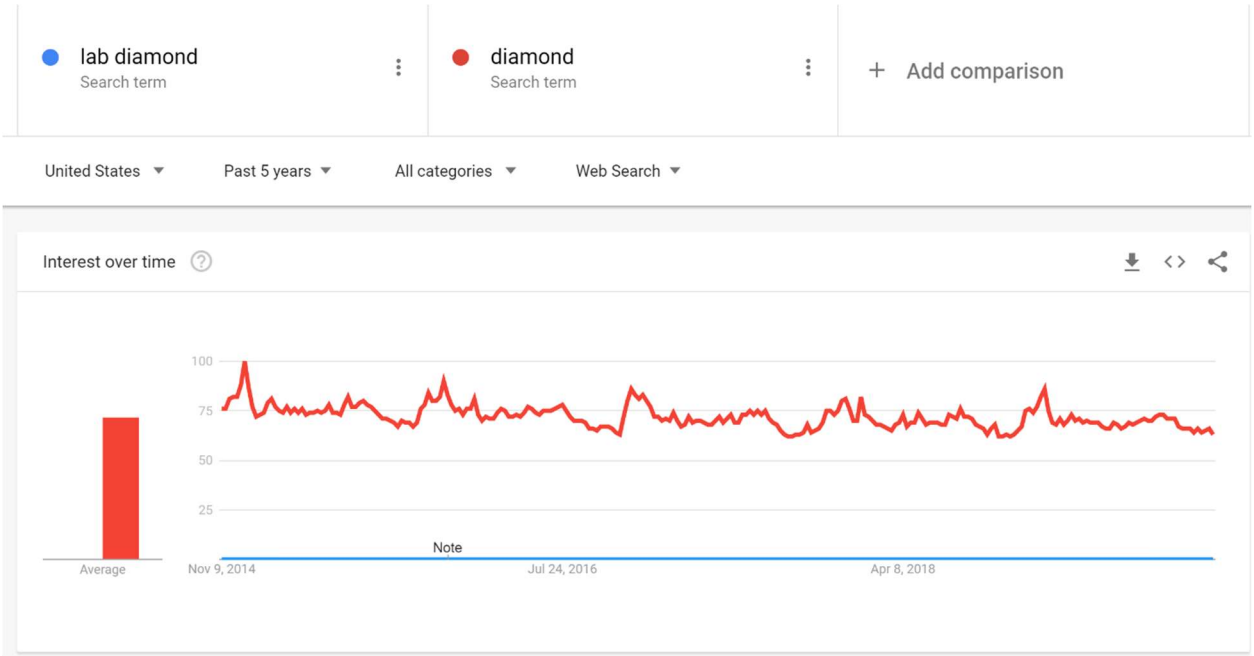

Figure 1: search popularity of lab diamond versus search popularity of diamond in the United States. Source: [Google Trend]

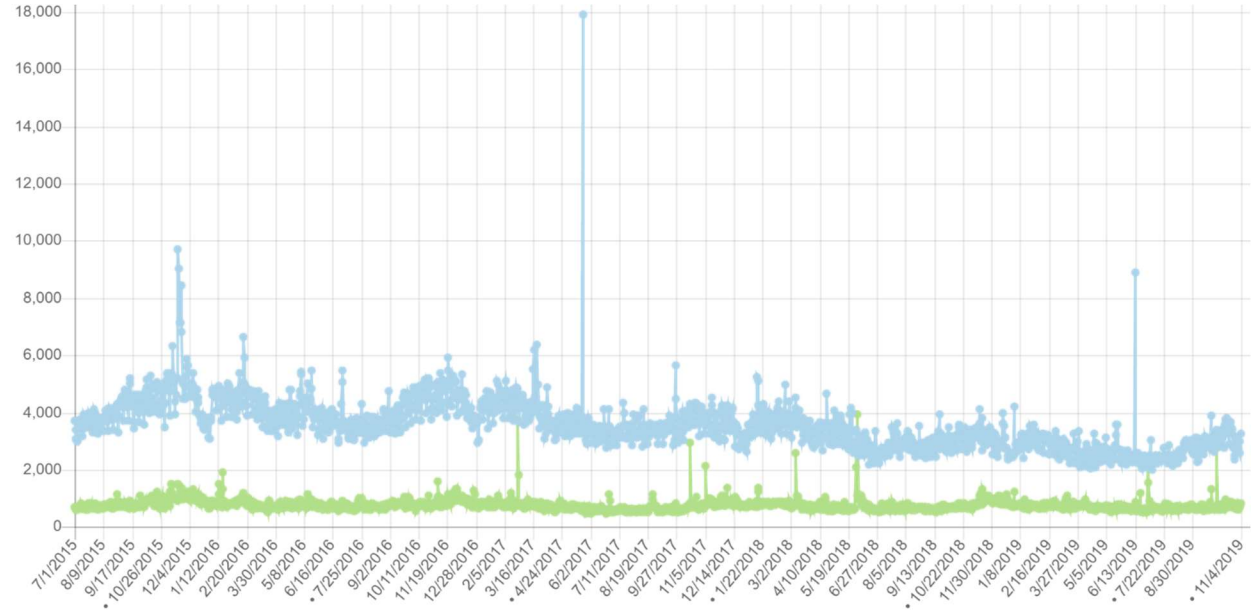

Figure 2: page popurality of diamond versus synthesthic diamond on English Wikipedia. Blue line is for diamond and green line is for synthesthic diamond. Source: [Pageviews Analysis]

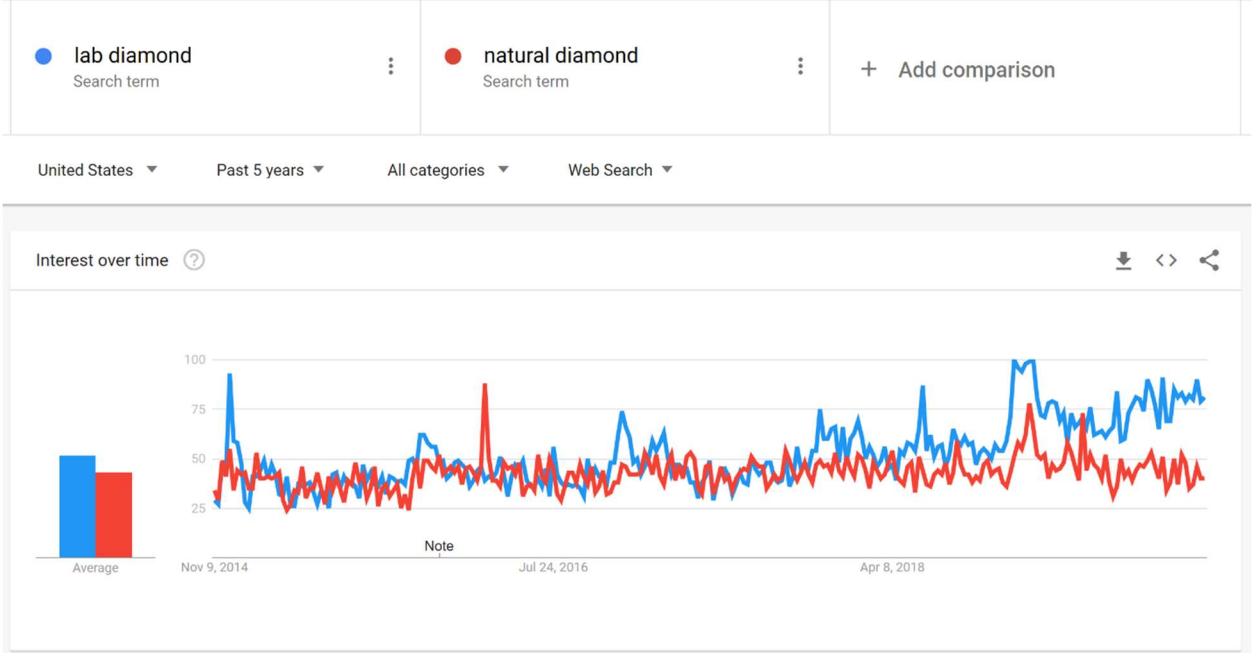

Figure 3: Search popularity of "lab diamond" versus "natural diamond". Source: [Google Trend]

Defining the lab diamond market

In this paper, given the limited amount of data on lab grown diamond firms, the subject of my analysis is the lab grown diamond industry instead of an individual lab diamond firm. The main competitors with lab grown diamond firms are large diamond mining companies such as De Beers and Rio Tinto (Garside).

An antitrust market aims to identify market power. It is defined as a market that consists of a group of products and a region that a hypothetical monopolist will likely impose at least a "small but significant and non-transitory increase in price" ("SSNIP") (Øystein Daljord). The relevant antitrust market of a product is the smallest antitrust market that contains the product. In this paper, given the fact I did not find any evidence for regional differences in diamond pricing, I will not denote a specific region for the market.

To delineate the antitrust market of the lab diamond industry, it is rather important to separate the market of melee diamond apart from the market of larger diamonds. Melee diamonds are defined by GIA as diamonds less than 0.2 carat; they are miniscule and often lack polish. Unlike larger diamond, melee diamond most often serves as a supplementary glow in a piece of jewelry (GIA). Diamond is widely regarded as a luxury good that exhibits the social prestige of its owner. Ownership of melee diamonds, on the other hand, hardly carries any level of social status or prestige. Melee diamond is therefore unlikely to have any characteristics of a luxury good; an owner of natural melee diamonds most likely will not experience a sense of superiority over an owner of lab grown melee diamonds. Consequently, it is safe to assume that consumers are generally neutral between natural melee diamond and lab grown melee diamond. As lab grown melee diamond and natural melee diamond have high interchangeability among consumers, a hypothetical monopolist in the lab grown melee diamond industry will set its price to be on par with the price of natural melee diamond. The relevant antitrust market of lab grown melee diamond is therefore the combination of lab grown melee diamond and natural melee diamond.

For larger diamonds, lab diamond and natural diamond have manifested low product interchangeability and price correlation. In May 2018, De Beers attempted to suffocate the lab diamond firms by entering the lab diamond industry with synthetic diamond products priced at 800 USD per carat, a remarkably low price compared to the price of 6000 USD per carat of natural diamond and price of 4200 USD per carat of lab grown diamond at the time (Onstad and Lewis). De Beers' undercut in price has successfully led to a sixty percent decrease in lab grown diamond price (Reuters). Despite the drastic drop in price of lab diamond, the price of natural

diamond only experienced a slight drop, and natural diamond firms did not experience a massive hit in revenue (Biesheuvel).

Despite the massive hit in price, lab grown diamond firms likely remain to be profitable, on account of the low cost of production that I will elaborate on in the next section. Prior to De Beers's interference, Zimnisky estimated that many of the lab diamond firms have an elevated profit margin of fifty percent (Onstad and Lewis). Hence a hypothetical monopolist in the lab grown diamond industry will most likely impose at least a sixty percent price increase in the absence of price regulation and future competitors. It is safe to assume that for larger diamonds, the relevant antitrust market of lab grown diamond only includes lab grown diamond itself.

Lab grown diamond and mined diamond may become more interchangeable as the production quantity of lab grown diamond gradually move toward the competitive output. The core characteristic of a luxury good is its perceived rarity. As lab diamond and natural diamond are visually indistinguishable, natural diamond may lose its perceived rarity along with the mass production of lab grown diamond. The sheen of social prestige surrounding natural diamond may fade, and natural diamond and lab grown diamond may eventually become perfect substitutes among consumers.

Price fixing in the lab diamond market

As the relevant antitrust market for lab grown diamond is defined, I now seek to explore the possibility of price fixing and collusion in the lab grown diamond industry. I did not find any allegations of price fixing among lab grown diamond firms; after all, the century long antitrust

practices of De Beers have received the most attention. To me, however, there was undoubtfully price fixing among lab diamond firms. In 2018 the estimated cost of production of a high quality polished one carat lab grown diamond is around three hundred to five hundred dollars (Linde, Geyler and Epstein). Before the entry of De Beers in 2018, lab grown diamonds are sold at a price of 4200 dollars per carat (Onstad and Lewis). As I will demonstrate later, the fixed cost for lab grown diamond production was relatively low. Lab diamond firms are unlikely to have any form of high R&D cost, based on two rationales. First, the products produced by the lab diamond firms are close to identical, as the diamond market has a strict gem quality standard. In fact, most lab grown diamond firms put emphasis on the environmental friendliness of lab grown diamond instead of denoting any uniqueness of their own diamond product or production procedure. Second, out of dozens of lab diamond firms, I only discovered two lab diamond firms that patented their own lab diamond production procedure. Therefore, the only explanation for the huge gap in cost of production and market price is the existence of price collusion among lab diamond firms.

Even without the entry of De Beers, the inflated profitability of lab diamond firms was unlikely to persist, as currently the industry itself does not have a high barrier to entry. Barrier to entry is commonly described as the startup cost that prevents a firm from easily entering a market. The vast majority of lab diamond production for ornamental use applies the Chemical Vapor Decomposition (CVD) methodology (Linde, Geyler and Epstein). Under high temperature exerted by a CVD machine, a diamond seed surrounded by “carbon gas” gradually grows into a lab grown diamond in approximately three to four weeks (Brilliant Earth). The main startup cost for lab diamond production would be the purchase of CVD machines. CVD machine, or CVD

diamond machine, is relatively cheap. In fact, CVD diamond machines listed on the e-commerce website Alibaba can have a price as low as 500 USD; the price can even be cheaper if the buyer searches “CVD machine” instead of “CVD diamond machine”. Due to the low barrier to entry, the price of lab diamond will most likely drop to close to the competitive level.

It is hard to determine whether price fixing has remained in the lab diamond market after De Beers’s entry. The price fixing firms in the natural diamond market, on the other hand, are unnerved by the entry of lab diamond into the diamond market.

The change in demand for lab grown diamond

From a pure technological perspective, lab grown diamond and natural diamond are perfectly substitutable. They are not only visually indistinguishable, but also share identical chemical deposition (The Economist). Consumers, however, do not measure interchangeability purely in technical terms. Instead, they tend to place emphasis on the aura of social prestige and ethics surrounding a luminous stone. A May 2016 survey conducted by the MVI stated that 32 percent of respondents of age 21-35 with more than $75K household income regarded lab grown diamonds as “not real diamonds” (MVI, Lab-Grown Diamonds Consumer Research Historical Progression).

The interchangeability of lab diamond and natural diamond among consumers is heavily dependent on the public perception of lab diamond and natural diamond. Over the past decade, there has been significant growth in the consumer acceptance of lab grown diamond. MVI has conducted consumer research on consumer’s attitude toward lab diamond for fifteen years; in 2005, only 33 percent of respondents aged 21-40 in USA were willing to consider lab

diamond as the central stone for engagement rings. In 2016, the number rose to 55 percent within the 21-35 age group, and in 2018, it further increased to 68 percent in the 21-40 age group (MVI, Lab-Grown Diamonds Consumer Research Historical Progression). The diversion ratio quantifies the number of consumers that switch to an alternative product after the price increase of a product. As the public acceptance of lab diamond grows, the diversion ratio of mined diamond increases.

Firms in both lab diamond industry and mined diamond industry attempt to increase their own product demand and decrease diversion ratio by framing their own product as the better choice to influence consumer's preference. Lab diamond firms heavily promote their product imagery as an environmental friendly and conflict-free gemstone carefully cultivated in a high-tech laboratory, while the alterative "natural" diamond is dug out from the earth using environmentally damaging practices and often child labor and slavery; environmental activist and leading actor of the 2006 movie *Blood Diamond* Leonardo DiCaprio personally invests in a lab diamond firm while endorsing its environmental friendliness (Guzman).

The environmental friendliness rhetoric would influence consumers in the United States, a country with more than half of its population concerned about climate change. A recent Yale study presented that within all age groups in the US, more than half of the respondents regard global warming as a personally important issue (Matthew Ballew). Additionally, on English Wikipedia the "environmental impact of mining" page consistently gained around half as much attention as the "mining" page itself (Figure 4), indicating that the population in English speaking regions is relatively concerned about the environmental impact of mining compared to mining itself.

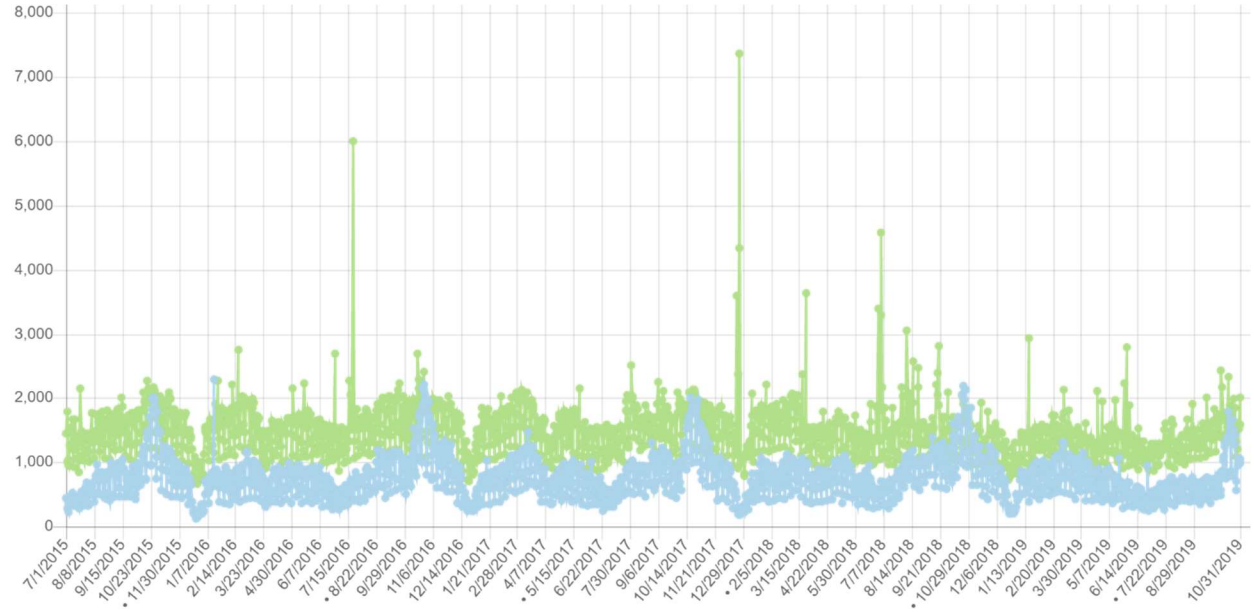

Figure 4: Page popularity of "mining" versus "Environmental impact of mining" on English Wikipedia. Green line: mining, blue line: Environmental impact of mining. Source: [Pageviews Analysis]

Lab diamond firms' emphasis on their product being environmentally friendly and conflict-free may have successfully influenced consumers' preference. A 2016 survey conducted by MVI described that 25 percent of consumers are interested in lab diamond because of its disassociation with destructive mining, and 24 percent is interested in lab diamond because "they are not blood diamonds" (MVI, Lab-Grown Diamonds Consumer Research Historical Progression).

The impact of the demand change on the diamond market is rather complex. Given the previously mentioned consumer survey data, there has been an upward trend among consumers regarding the perceived interchangeability of lab grown diamond and mined diamond. Yet there exists another upward trend for preference of lab grown diamond over mined diamond due to ethical and environmental concerns. In the former trend, given the price

trend of lab grown diamond, the increase in perceived substitutability will undoubtfully lead to a price drop in the diamond market. In the latter trend, the increase in consumer preference for lab grown diamond over mined diamond will cause lab grown diamond and mined diamond to again have separate antitrust market, while the demand for mined diamond will further decrease.

The battle between De Beers and lab grown diamond

De Beers regards the surge of lab grown diamond as a viable threat to the diamond cartel. After all, a diamond may be forever, but a monopoly certainly is not - this former diamond monopoly had witnessed its own market share in rough diamond production shrank from 90 percent (Zimnisky) in the late 1980s to 33 percent in 2013 (De Beers) due to the unstoppable entry of new mined diamond suppliers (Zimnisky). Now the entry of lab diamond can predictably further decrease its share in the rough diamond market, as some consumers have considered or will consider lab grown diamond as an ideal alternative for mined diamond. De Beers made a series of efforts to strangle the budding lab diamond industry, most notably undercutting the lab diamond price (Onstad and Lewis). De Beers may have already been hindered by the emergence of lab diamond; as the demand for lab grown diamond grows (Linde, Geyler and Epstein), in 2019 De Beers's sale slumped, and the company cut price for the first time in years (Biesheuvel). The slump in De Beers's sale can be partially attributed to the fact that millennials are shunning traditional mined diamond and steering toward lab grown diamond (Arnett).

As the market share for lab grown diamond rises, De Beers is fighting back. The “a diamond is forever” slogan coined by De Beers had successfully increased consumer demand for diamond in the 20th century (The Economist). The current surge of lab grown diamond prompted De Beers to embrace a new advertising rhetoric – a diamond is forever, and a diamond is mined.

Diamond mining firms and mined diamond endorsers are portraying mined diamond as a glossy, billion-year-old antique (The Economist). Recently, De Beers commenced to laser-etch the natural origin of mined diamonds to distinguish them from lab grown ones (Reuters). It attempts to ingrain in consumer’s mind that lab diamond is an inferior alterative to its luxurious mined diamond. In De Beer’s own lab diamond business (Lightbox), it only sells cheap low-end jewelry instead of customizable high-end engagement rings. Yet in the antique market, only high-end products can be sold for a considerable sum of money. For instance, exquisite Qing dynasty porcelain is stored in patrolled museums. Regular Qing dynasty porcelain, on the other hand, is worthless. Consequently, such tactics cannot stop the lab grown diamonds from conquering the low-end diamond market.

De Beers also decries synthetic diamonds as “inauthentic” (Sullivan). In 2017, this corporation was reported to have heavy investment in technology that can precisely distinguish mined diamond from lab grown ones (Ge). Yet such effort of De Beers was hindered by FTC’s announcement in 2018 that both lab diamond and natural diamond can be purely labelled as “diamond” (FTC), a decision at which De Beers and other members of Diamond Producers Association cried foul (Sullivan).

It is rather safe to conclude from the analysis above that lab grown diamond will trigger a price shock in the low-end diamond market, since De Beers does not seem to have a valid strategy to influence consumer's perception of substitutability in the low-end diamond market. In general, De Beers's strategy has come out as rather ineffective; despite De Beer's effort, consumer's acceptance for lab grown diamond has continued to spread (MVI, Millennial Consumer Research Lab Grown Diamonds).

Conclusion

It is intriguing to observe how a stone with almost no practical value has sparked a series of business conflicts worldwide. After all, for certain consumers the aura of social prestige surrounding a glossy stone is too shiny to be shunned. In this paper, I first delineated the antitrust market for lab grown diamonds. The main issue for this section is that I was unable to find enough sources for price of melee diamond, and therefore must rely on my own assumptions for consumer's preference. I concluded that the relevant antitrust market for low-end lab grown diamond is the combination of lab grown diamond and mined diamond, while for high-end lab diamond the relevant antitrust market only includes the lab grown diamond itself. I then determined that there was price-fixing in the lab grown diamond market as there exists a huge gap between cost of production and market price. I then examined the demand change for lab grown diamond; there is a lack of data for and research on demand estimation. In fact, only one firm has conducted extensive consumer research on lab diamond. From the available data, I concluded that the continuously increasing demand for lab diamond will most likely trigger a price drop in the diamond market. Finally, I observed De Beers's reaction to the

recent surge in lab grown diamond and deduced that it does not seem to have an effective strategy against the threat of lab grown diamond.

There is a lack of attention on the lab grown diamond industry. As an example, no data on the market share of lab diamond firms is publicly available. For further study in this industry, it is crucial to accrue relevant data and conduct extensive academic research on lab grown diamond markets and firms.

Bibliography

Arnett, George. *Are mined diamonds more environmentally friendly? Not so fast*. 25 June 2019. <https://www.voguebusiness.com/technology/mined-diamonds-environmentally-friendly-debeers-dpa>.

Biesheuvel, Thomas. *De Beers Cuts Diamond Prices by About 5% as Industry Crisis Deepens*. 4 November 2019. <https://www.bloomberg.com/news/articles/2019-11-04/de-beers-cuts-diamond-prices-by-about-5-as-crisis-deepens>.

Brilliant Earth. *How Lab Created Diamonds are Made*. 1 July 2019. <https://www.brilliantearth.com/news/how-lab-created-diamonds-are-made/>.

Can lab-grown diamonds replace the real thing? Dir. The Economist. Perf. The Economist. 2019. Video. <https://www.1843magazine.com/1843/can-labgrown-diamonds-replace-the-real-thing>.

De Beers. "De Beers Analyst Seminar." 2014. <https://www.angloamerican.com/~/media/Files/A/Anglo-American-PLC-V2/presentations/2014pres/de-beers-analyst-seminar-presentation.pdf>.

FTC. *FTC Approves Final Revisions to Jewelry Guides*. 24 July 2018. <https://www.ftc.gov/news-events/press-releases/2018/07/ftc-approves-final-revisions-jewelry-guides>.

Garside, M. *Market share of the leading diamond mining companies worldwide in 2018*. 24 October 2019. <https://www.statista.com/statistics/585450/market-share-of-diamond-supply-worldwide-by-producer/>.

Ge, Celine. *De Beers fights lab-grown diamonds with technology as China's synthetic gems threaten viability of their market*. 2017. <https://www.scmp.com/business/companies/article/2076225/de-beers-fights-fakes-technology-chinas-lab-grown-diamonds>.

GIA. *Melee Diamonds: Tiny Diamonds, Big Impact*. n.d. November 2019. <https://4cs.gia.edu/en-us/blog/melee-diamonds-tiny-diamonds-big-impact/>.

Guzman, Zack. *Leonardo DiCaprio-backed lab-grown diamond company, others welcome FTC warning*. 5 April 2019. <https://ca.finance.yahoo.com/news/leonardo-di-capriobacked-labgrown-diamond-company-others-welcome-ftc-warning-121212828.html>.

Hanbury, Mary. *Millennial attitudes are forcing a massive change in the diamond industry*. 10 May 2018. <https://www.businessinsider.com/millennials-want-cheap-ethical-diamond-engagement-rings-2018-5>.

Hood, Bryan. *Lab-Grown Diamonds Are Now a $280 Million Business*. 22 May 2019. <https://robbreport.com/style/jewelry/lab-grown-diamonds-moment-2851840/>.

Lightbox. *Lightbox*. 2019. 2019. <https://lightboxjewelry.com/>.

Linde, Olya, Oleg Geyler and Ari Epstein. "The Global Diamond Industry 2018: A Resilient Industry Shines Through." 2018. <https://www.bain.com/insights/global-diamond-industry-report-2018/>.

Matthew Ballew, Jennifer Marlon, Seth Rosenthal, Abel Gustafson, John Kotcher, Edward Maibach, Anthony Leiserowitz. *Do younger generations care more about global warming?* 11 June 2019. <https://climatecommunication.yale.edu/publications/do-younger-generations-care-more-about-global-warming/>.

Moquin, Andy. *Lab Created Diamonds VS Real Diamonds – Facts You Need to Know*. 17 May 2018. <https://andrewsjewelers.com/blog/lab-created-diamonds-vs-real-diamonds-facts-you-need-to-know>.

MVI. "Lab-Grown Diamonds Consumer Research Historical Progression." 2019. <https://www.mvimarketing.com/download-report.php?report=37&sent=1>.

—. *Millennial Consumer Research Lab Grown Diamonds*. Austin: MVI Marketing LLC (MVI), 2018.

Onstad, Eric and Barbara Lewis. "Lab-grown diamond prices slide as De Beers fights back." *Reuters* (2018). <https://www.reuters.com/article/us-diamonds-debeers-synthetic-analysis-idUSKCN1OK0MQ>.

Øystein Daljord, Lars Sørgard, Øyvind Thomassen. "The SSNIP test and market definition with the aggregate diversion ratio: A reply to katz and shapiro." *Journal of Competition Law & Economics* (2008): 263–270.

Rapaport. *Rapaport Press Release: Midstream Struggling as Diamond Prices Soften*. 5 June 2019. <https://www.businesswire.com/news/home/20190605005444/en/Rapaport-Press-Release-Midstream-Struggling-Diamond-Prices>.

Reuters. *The 'unsustainable' price of lab-grown diamonds has collapsed 60 per cent, says De Beers, after stunning industry with synthetic stones for jewellery*. 22 Feb 2019. <https://www.scmp.com/news/world/article/2187191/unsustainable-price-lab-grown-diamonds-has-collapsed-60-cent-says-de>.

Shor, Russell. *Is There a Difference Between Natural and Laboratory-Grown Diamonds?* 31 May 2019. <https://www.gia.edu/gia-news-research/difference-between-natural-laboratory-grown-diamonds>.

Stanley, Morgan. *Game of Stones: Disrupting the Diamond Trade*. 12 August 2016. https://www.morganstanley.com/ideas/diamond-market-lab-grown-disruption.

Sullivan, Paul. *A Battle Over Diamonds: Made by Nature or in a Lab?* 9 Feb 2018. <https://www.nytimes.com/2018/02/09/your-money/synthetic-diamond-jewelry.html>.

Yu, William. "De Beers – Rulers of the Diamond Industry." 2006. <https://are.berkeley.edu/~sberto/DeBeersDiamondIndustry.pdf>.

Zimnisky, Paul. *A Diamond Market No Longer Controlled By De Beers*. 6 June 2013. <https://www.kitco.com/ind/Zimnisky/2013-06-06-A-Diamond-Market-No-Longer-Controlled-By-De-Beers.html>.