BITCARAT
OVERVIEW

The Broad Outlines
of Tomorrow

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Table of Contents

BitCarat (Digital Renaissance in Diamond Markets)

Abstract

By combining the insights from the field of academic finance with the boundless potential of blockchain we have created a robust infrastructure that offers the diamond trading and financing functionality far more efficient and comprehensive than what is available in the entire diamond industry today.

BitCarat platform is a scientific and technological foundation for a diamond marketplace with efficient price formation and deep liquidity. It is a blockchain-enabled effort to erase economic frictions that have defined every major flaw in an otherwise sound mechanism of the diamond industry.

Background and Motivation

Historically, diamond prices are known to demonstrate remarkable return performance, especially, on a risk-adjusted basis. Diamond returns are also known to be weakly correlated with the returns of conventional asset classes. Adding to the potential investment demand, strong fundamentals of the diamond industry lend strong support in favor of positive long term dynamics of diamond prices. These properties alone provide solid rationale for including precious gems in professionally managed asset portfolios.

And yet, investment demand for diamonds accounts only for 5% of diamonds sold. The remaining 95% are accounted for by retail demand for polished diamonds and jewellery. What factors could account for this apparent contradiction?

As it turns out, the vast majority of answers to this question is hidden deep inside the opaque market structure of the diamond industry. This industry is plagued with inefficiencies that, using the economics jargon, are generally referred to as market frictions.

In what follows, using a set of basic economic concepts underpinning contemporary financial theory, we will tell a thrilling, yet tragic tale about the market for diamonds. We will defend a claim that, while varying widely in terms of ubiquity and significance, all economic frictions hampering the evolution of diamond markets can be traced back to:

a. a set of unique material properties that make diamonds non-fungible[1];

b. the way they interact in determining diamond's price;

[1] Fungibility is a property of an asset that refers to value equivalence between any two units of it. In other words, any two units of a fungible asset have identical value and are mutually interchangeable.

c. the way the resulting absence of fungibility hampers general diamond market liquidity;

d. the critical importance of liquidity for contemporary economic systems.

Our tale, however, is not simply an account of impressively far-reaching and devastating consequences the interplay of (a)-(d) above had on the diamond industry. The purpose of such account is to provide the background required to appreciate the elegance of our solution; it simply sets the scene for something bigger.

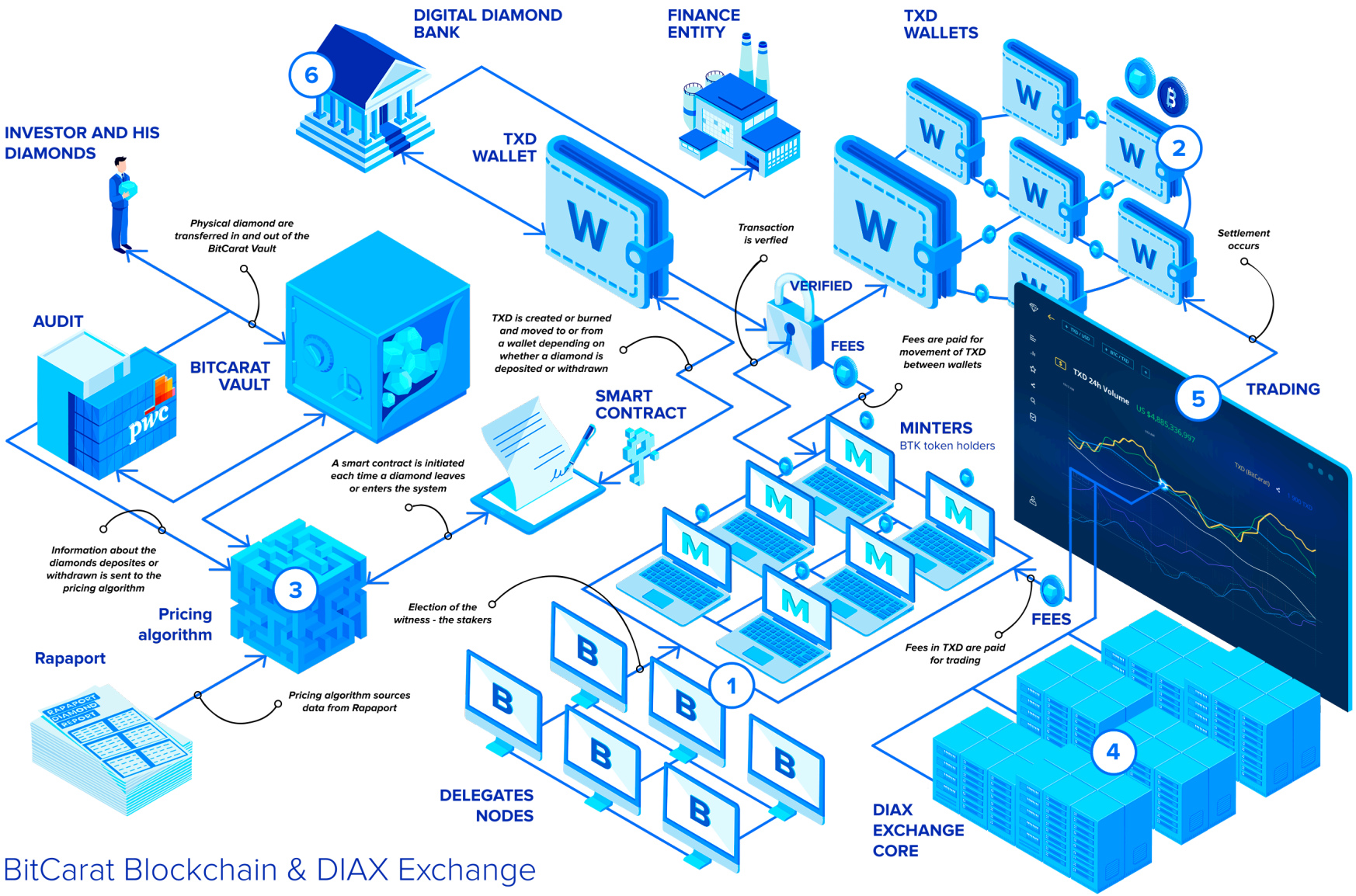
The BitCarat System

The blockchain revolution has provided us with the toolbox to liberate our financial system from market frictions and by implication from those who in the name of fighting these frictions designed a system where full control over many belongs to a chosen few. The blockchain is a story about salvation.

Likewise, our story is a narrative about an imperfect world and someone who is destined to save it, a Hero with answers to questions doomed as imponderable by the common wisdom. The 'Hero' in our tale is 'BitCarat', a blockchain-powered set of facilities that comprise a foundation for the brighter future of diamond markets; the future where liquidity and price efficiency are not abstract textbook definitions with no relevance for the diamond industry, but, instead, are its inherent features with direct implications for both, the present mechanics and future evolution.

Put in more concrete terms, BitCarat ecosystem is comprised of the following elements:

1. BitCarat, a custom blockchain with a dual currency monetary system and DPOS (Delegated Proof Of Stake) consensus protocol;
2. Two coins: price-stable coin backed by a portfolio of physical diamonds, and a staking coin fueling the economics of security of our blockchain;
3. The diamond pricing formula utilizing ML (Machine Learning) techniques that underpins the coin issuance and redemption mechanism;
4. Private-blockchain-powered hybrid exchange, DIAX (Diamond-powered Digital Asset eXchange). In developing DIAX, we have been guided by the idea of providing an orderly, fair and transparent diamond marketplace. Ultra low-latency high-throughput matching engine and advanced supporting infrastructure is the technological stack we provide to power the first liquid diamond marketplace;



BitCarat Blockchain & DIAX Exchange

5. DIAX Futures, the first-in-breed platform for providing deep liquidity to and hosting trades in diamond futures with arbitrary specification of physical properties of the underlying gem;

6. Digital diamond bank that provides lending and margin trading services leveraging obvious benefits of a stable coin as a collateral unit;

The entire BitCarat ecosystem is a product of interaction of these elements whereby each and every of them serves a unique, clearly defined, purpose and yet complements others. Linking other elements of BitCarat, two coins are powering the economics of the ecosystem. Essentially, BitCarat can be viewed as an integrated financial microsystem comprised of institutions that offer a comprehensive set of fundamental financial services. The foundation for this system is a cryptographic coin that serves as a universal and definitive solution to the ancient problem of diamond fungibility: the root of all the dreadest problems in diamond markets.

The BitCarat Value

BitCarat is a project that positions itself as the core infrastructure for the reborn diamond industry. Digital, liquid and transparent, the emerging landscape of diamond trading will have an expanded list of participants. The value BitCarat creates will accrue directly and indirectly to everyone: BitCarat is not simply a milestone that sets in motion the transition to a new paradigm, it is the new paradigm itself.

The Classic Diamond Industry

As we will illustrate in detail later in the text, the value of BitCarat for the diamond industry is immense:

a. DIAX is the first truly liquid secondary market for polished diamonds;

b. DIAX encompasses the universal diamond limit order book: unthinkable today, any diamond can be melted into a massive diamond liquidity pool;

c. DIAX Futures platform offers the first liquid marketplace for diamond derivatives

with an arbitrary specificatione[2] of underlying diamond characteristics;

d. Finally, DTX, the stable diamond-backed coin and simultaneously the first universal unit of diamond value exposes the diamond industry to two completely new markets: that of professional asset managers and that of crypto traders.

Professional Asset Managers

The value proposition of BitCarat to professional asset managers is quite simple:

a. BitCarat system erases the frictions that have historically set diamonds at a disadvantage to other commodities, such as gold, silver or oil;

b. Basically, BitCarat is designed to provide institutional traders with an orderly access to an entirely new asset class with outstanding properties from a portfolio management perspective;

c. Most importantly, BitCarat enables deep diamond liquidity.

The World of Crypto

Crypto traders, blockchain enthusiasts, ICO investors and those otherwise familiar with the crypto space will also benefit from the launch of BitCarat:

a. DTX, the diamond-backed stable coin, will provide an efficient safe haven asset in times of extreme volatility;

b. A blockchain with eventually free transactions. Importantly, this feature comes without compromising security;

c. Finally, the diamond bank's lending facility is a tool that would allow for efficient shorting of the crypto market along with margin trading.

[2] We will elaborate on the importance of flexibility of contract specification below.

Having diverse value proposition for a wide range of participants of the diamond trading process, we aspire to see BitCarat as a symbol of the limitless potential of the digital age technologies to revolutionize the established industrial landscape.

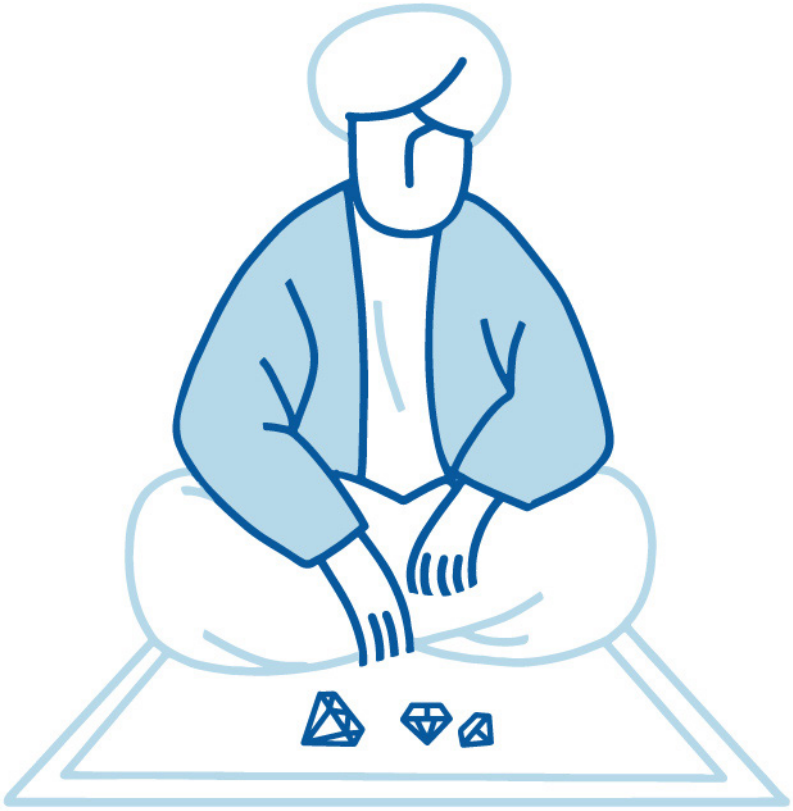
Conclusion

As a concluding remark to this introductory chapter, we, as a BitCarat team, would like to share our vision of the future of economics as a science and, more broadly, of the evolution of the global financial system as a whole.

XXth century was the time when economic science has made a dramatic leap forward: the analysis of departures from the state of perfect markets has emerged as a convenient framework for analyzing a broad range of phenomena, beginning at micro and ending at macro level. Today, leveraging the immense advancements in financial technologies, we can start working backwards systematically erasing frictions on our way to more efficient markets.

At BitCarat we embrace the belief that today the ideal of frictionless markets is slowly leaving the domain of utopias and emerges as an attainable goal. In this context, distributed ledgers offer the essential toolbox: it's raw and deeply underdeveloped and yet, it is just enough to make the first step.

BitCarat is one such step.



BEFORE
BITCARAT

Dark Ages
of Diamond Trading

Diamonds as an Asset Class

Today, an exposure to the price of the precious gem underlying the diamond industry is certainly not an expected characteristic of a professionally managed portfolio. Only around 5% of all diamonds sold over the last decade can be attributed to the investment demand [19].

Why diamonds?

This absence of investors' demand for diamonds as a potential asset class is an odd state of affairs provided the attractive characteristics diamonds have from the perspective of a professional investor:

1. **Safe haven asset:** diamonds are a safe haven asset: their value exhibits steady growth through time and is less strongly influenced by the general economic conditions. Low price correlation with other asset classes makes diamonds an attractive instrument for hedging[3] and strongly benefits thin-margin companies in the mid-stream of the value chain [29], [30]. In 2014, diamonds have enjoyed 1.6x lower volatility than gold [29]. White diamonds generated 10% annualized returns above inflation for the period from 2003 until 2010 and in turn outperformed the broad stock market [34][4]. Indeed, consider that 3-carat and 5-carat diamonds have gained 145% and 171% in the period from 1999 to 2011 respectively[5]. During the same period, S&P 500 index has gained approximately 4.7%.

2. **Exceptional performance:** Over the long-run diamond returns exhibit exceptional performance as compared to other asset classes, especially on a risk adjusted basis. The demand-supply gap for mined diamonds is already significant and is expected to grow in the coming decades. It is estimated that the demand-supply gap will reach a staggering value of 278 million carats by 2050[6] (around 41 billion

[3] For example, diamonds have been found to be a strong hedge for gold investors [31], [32].

[4] Also, investing in physical diamonds are known to provide higher returns than investing in diamond indices [33].

[5] As indicated by the Rapaport Diamond Trade Index [41].

[6] The economics of diamond mining partially accounts for this phenomenon: increasing difficulty of mining deep-underground diamonds explains deterioration of production margins making certain mining operations uneconomical to sustain. At the same time, India and China enjoy a gradual shift from low to mid-income economies. Therefore, the consumption of luxurious goods, such as diamond jewellery, becomes more attainable to the general population driving up the demand for diamonds. Taking into consideration the scale of Chinese and Indian economies, many are inclined to perceive the East as the land where the golden era of diamonds will emerge.

US dollars at today's prices).

3. **Value-weight efficiency:** Diamonds are characterized with extreme ratios of dollar value per unit of weight: the price of 1-gram gemstone (5 ct.) can be above that of 100 kilograms of silver or 1.5 kilograms of gold[7].

At first glance, diamonds present a lucrative investment opportunity. This, however, is obviously contradicted by the lack of popularity of diamonds as an investment vehicle. Why would anyone burdened (or blessed) with the task of managing wealth remain ignorant to this 'brilliant' asset class with so many attractive properties? As it turns out, providing a comprehensive answer to this question is not exactly a trivial task.

Investing in Diamonds: a Bad Luck Primer

On the surface lies an apparent lack of financial instruments that offer pure exposure to the price of physical diamonds. One of the few options available is to invest in specialized asset management firms that have physical units of diamonds backing the value of their shares. The funds of this nature, however, are rare, expensive, offer a limited exposure to the performance of the general diamond market (e.g. only to rare diamonds [41]) and frequently fail due to the lack of demand and/or inability to unwind positions efficiently. Actively managed commodity funds offer little to no avail: this market is dominated by producers of more traditional commodities (such as gold, silver, or gas). This invalidates altogether the dream of investing in diamonds and diamonds alone using these vehicles. Same applies to the idea of using share prices of diamond mining companies as a proxy for the performance of the general diamond market: there is too much 'noise' when attempting to use stocks prices of these companies as a proxy for diamond investing [3].

The paragraph above is somewhat illuminating as to why diamonds lack demand as an asset class, however, it does not provide any answers to an obvious question: why would anyone bother investing in proxy assets, instead of investing directly into the core underlying of all the diamond markets - the physical gemstones themselves?

An elaborate answer to this question requires a good understanding of an obscure domain underpinning the vast body of contemporary financial theory: the economics of liquidity.

In what follows, we will show that this odd state of the markets for diamonds is the result

[7] Note the exponential nature of price - weight relationship characterizing diamonds. a 5-gram diamond will cost an entire fortune.

of a plexus of market imperfections that set diamonds at a significant disadvantage when compared to other established asset classes.

Fungibility

The millenia-lasting inability of the mankind to organize a liquid marketplace for diamonds is largely explained by the fact that these precious gems are not fungible. This fancy jargon means that the basic units of diamonds lack mutual value equivalence in exchange (i.e., the value of one carat[8] of one diamond can be by an order of magnitude higher than that of another)[9]. It merits a note that a lion's share of the remainder of this vast paper will revolve around this basic property of diamonds and its surprisingly dare and far reaching implications for the diamond industry as a whole.

First things first: there are two parts to a story of why carats are utterly and hopelessly non-fungible:

a. why are carats as the basic units of diamonds not fungible;

b. are there any fundamental reasons why carat, a unit of weight, is used as the unit that needs to account for value; and,

c. finally, given that carats are not fungible and there is nothing that can be done to change this, can we propose a legit substitute for carat in its capacity of the basic unit of diamond value?

Fungibility of Carats

First things first: there are two parts to the story of why carats are utterly and hopelessly non-fungible:

a. It is physically impossible to make one diamond out of several. The reverse process, while possible in principle, inevitably results in a massive loss of value for any

[8] Carat is internationally recognized diamond's unit of weight (≅0.2 grams). That is the closest we get to defining 'a unit' of diamonds.

[9] In fact, one cannot attribute the lack of fungibility to diamonds. Diamond is an asset, while fungibility is in the end a property of both, an asset and its unit. For example, dollar as an asset and units of dollar banknotes are not fungible: 3 fifty-dollar banknotes are not equivalent in value to 3 one-dollar banknotes.

polished gem[10]: one diamond is more valuable than two smaller ones with same combined weight, all else equal. As a general rule, diamond price is exponentially increasing with its weight. There are three implications of this that are critically important for our future discussion: (i) the unique physical properties of diamonds are largely reflected in the intricacies of their pricing: e.g. exponential weight-price relationship as a result of the inability to create larger stones out of smaller ones; (ii) the lack of 'within-fungibility'[11]: price is increasing exponentially with the weight; thus, any difference in the weight even between two otherwise exactly identical diamonds introduces a potentially significant wedge between their standardized per carat values; (iii) creating a homogeneous 'mass' of diamonds with the aim of standardizing their prices (e.g. gold bullion) is not economically viable;

b. The famous 4C of the diamond industry (Color, Clarity, Cut, Carats), refers to a set of qualities that for a broad range of gems explain the vast majority of price variation. The metrics used to quantify these pricing dimensions are sophisticated and extremely precise. In other words, there are numerous factors except weight that have a profound influence on the gem's price. The important implications are: (i) as opposed to traded commodities, such as gold, there is no universal diamond price per unit of weight; (ii) the lack of 'between-fungibility'[12]: carats are likely non-fungible even for diamonds with an equivalent weight, (iii) a paradox: being neither complements, nor substitutes, different diamonds share pricing dimensions and thus can be priced relative to each other.

Within the 'carat paradigm', the interaction between (a) and (b) makes diamonds inherently illiquid as a tradable asset. The subtle link between fungibility and liquidity will be explained in the next chapter. Before proceeding to it, let us elaborate a bit more on the notion of fungibility.

[10] Sometimes, a large raw diamond with improper shape would be broken in several in order to be able to properly polish the resulting smaller gems.

[11] In what follows, we adopt a perspective that two diamonds with different characteristics necessarily make up two different assets within the same asset class. 'Within fungibility' is a property of equivalence of unit value for those assets that share all the characteristics, but one (in the example, all, but carat weight) that serves as the basis for standardization (i.e., equivalence of per carat value of 5 against 3 carat stones). Carats are not within-fungible.

[12] Expanding on the distinction introduced above, the 'between-fungibility' assumes ceteris paribus on the weight, the base for standardization. In other words, if we take two gems with widely different characteristics, but identical weight, would carats of these stones be value equivalent?

Diamond-Carat Fungibility

Now, as we have discussed the fungibility (or lack thereof) of diamonds as assets with carats as basic units, we can extend our analysis to question the applicability of carats as legitimate basic units of diamond value.

A step outside of textbook conventions can make one wonder, why fungibility is considered to be the quality of an asset and not of its basic unit. For example, the symbol of absolute fungibility, the US dollar is fungible if dollars as monetary units are chosen as the basic unit: one unit of USD is exactly equal in value to any other; furthermore, a stack of 100 one-dollar bills is exactly twice as valuable as 2 fifty-dollar bills. Unsurprisingly, USD is fungible. However, should we choose units of banknotes, the fungibility is gone: the exchange value of one fifty-dollar bill is obviously not equivalent to that of a ten-dollar bill.

Thus, in what follows we will refer to fungibility as a property of an asset-unit pair instead of a property of an asset per se. For example, diamond-carat is a non-fungible pair; the same applies to the pair of dollar; on the contrary, dollar-dollar is a fungible pair.

The US dollar example was a simple thought experiment: of course no one would ever consider using units of physical notes as units of value. In this case, the choice of unit is simple. Considering other asset classes, however, the choice of a basic value unit can become surprisingly non-trivial. For example, carat is an internationally recognized unit of weight used, among others, in the diamond industry. Its similarity with units of weight of other commodities that do actually represent homogeneous units of value is illusory: 30 Oz. bar of gold is indeed twice as expensive as a 15 Oz. bar[13]. The discussion above clearly illustrates that the same is necessarily not true for diamonds: it is the economic implausibility of homogenizing diamonds combined with the exponential weight-price relationship that accounts for this state of affairs.

Fungibility is an economic property: it is not simply the interchangeability of units of an asset; instead, it is the value equivalence of these units. It follows that the use of units of weight as a substitute for the units of value is only justified when for a given asset these concepts are interchangeable. In the case of gold, it is justified; in the case of diamonds, it is not. Thus, we conclude that a statement that gold is fungible while diamonds are not is misguided. Instead, using our novel jargon introduced earlier, we can only say that gold-ounce pair is fungible while diamond-carat pair is not.

[13] Assuming the same purity.

It follows that if we cannot circumvent the lack of diamond-carat fungibility and we cannot break the conceptual link between fungibility and liquidity, our only option going forward, towards a liquid market for diamonds, is to propose a different basic unit for diamonds; a unit that would accurately represent the value dimension and by implication would make up a fungible pair with diamonds. We leave the further discussion of this topic for the second part of this paper where we introduce the theoretical foundations of BitCarat. At this point, the major takeaway from our discussion is that diamonds could in fact be fungible if we can create a synthetic homogeneous unit of their value.

Summary

So far, we have discussed diamonds' financial properties that in a parallel universe of liquid diamonds would make them the best friends of each and every professional investor. We have also discussed the physical properties of diamonds that make them (or rather their units) non-fungible and highlighted the link between fungibility and liquidity. But what really stands behind the abstract concept of liquidity and what does the deficit thereof mean for diamonds?

Liquidity

> *The word liquidity has so many facets that is often counter-productive to use it without further and closer definition.*
>
> **Charles Goodhart [44]**

In general terms, liquidity refers to the extent markets allow to unwind (or accumulate) a position at little to no cost and within reasonable time frame. In layman terms, it can be simply defined as the 'ease' of selling or buying an asset. In order to understand the exact channels through which issues with fungibility mutate into liquidity problems, take a look at the example below.

The Link Between Fungible and Liquid

Consider the US dollar: one unit of USD is exactly equal in value to any other; furthermore, a stack of 100 one-dollar bills is exactly twice as valuable as 2 fifty-dollar bills. Unsurprisingly, USD is fungible. Fungible assets, such as USD is both, effective and efficient in the capacity of liquidity on either side of an arbitrary order book: one can go and sell 30 BTCs receiving an exact USD value equivalent for every price level-volume pair taken off the book. In such setup, there is no point of creating two BTC/USD pairs on the same exchange: instead, liquidity can be concentrated in one book making it more attractive as a trading venue. Some 100 carats, unfortunately, won't do the trick: each of them has different value and in fact represents a distinct asset[14] (within the same class). In other words, one cannot simply come and sell 30 BTCs worth of carats. The differential in carat values across diamonds can be significant leading to no better solution than treating every diamond as a separate asset. In such setup, liquidity is scattered across a large number of books resulting in wide spreads, high trading costs and suboptimal execution. At the logical extreme, this setup turns into an auction. If these thought experiments appear too general or somewhat exaggerated, consider the following example: the price matrix offered by Rapaport, an entity that hosts one of the most liquid online diamond marketplaces, consists of over 1400 entries and even this has been achieved by grouping multiple grades together. We will provide a more comprehensive account of this below.

Understanding the importance of liquidity is paramount to appreciating the general state and most aching problems of contemporary diamond markets.

The Importance of Liquidity

Understanding the vast and far reaching consequences of lack of liquidity is the best way to appreciate its importance.

Lack of liquidity is liable to result in less efficient market characterized with abrupt price movements; it will also result in a general inability to get an order executed at the expected (top-of-the-book) price, instead the effective execution price will be less (sometimes much less) favorable; the width of spreads is yet another measure of liquidity: defining the

[14] Even worse, carats cannot be effectively purchased as the physical delivery is only possible for an entire gem, not a part of it.

percentage cost of executing two simultaneous trades in opposing directions[15], the spread is one of the major determinants of the effective cost of a trade.

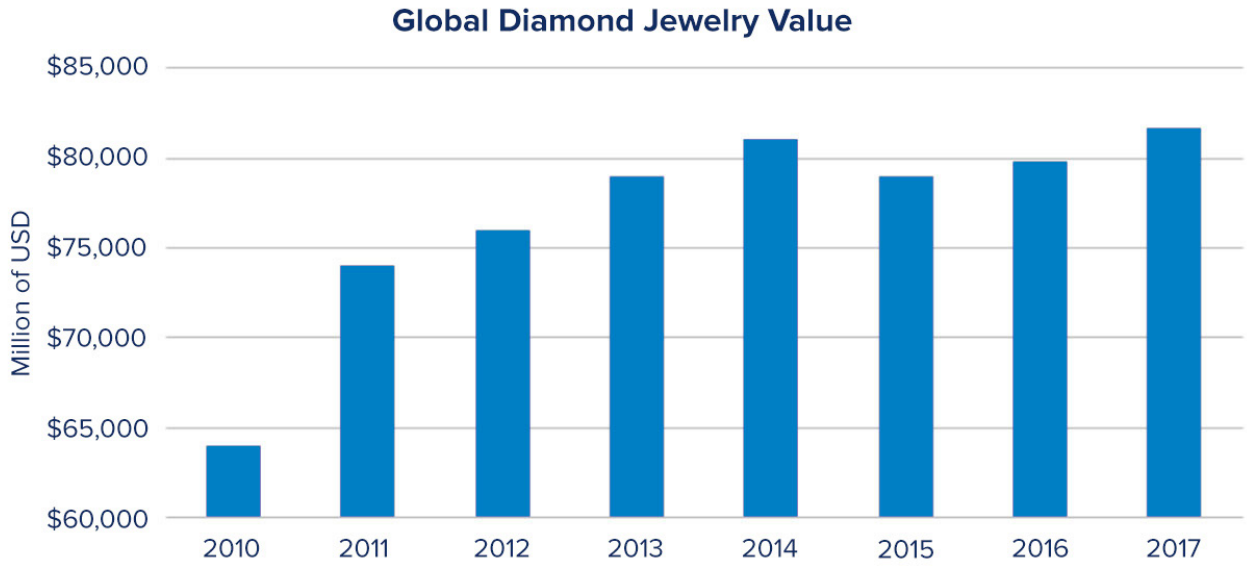
From a theoretical perspective trading only makes sense if the expected profit is at least higher than the immediate and anticipated future costs of trading. Market liquidity is one of (if not the) most important determinant of these costs. From practical perspective, the dimension of liquidity risks is critical: the immediate availability of the capital when it is most needed can be the key to company survival. The cost and time it takes to free-up the capital critically depends upon the depth of market liquidity.

In short, market liquidity is among the most important concepts in trading practice and financial (as well as economic) theory.

Given the natural lack of fungibility of the underlying asset, the state of liquidity in diamond markets can be expected to be grim. And it is; in fact, it is much worse than that.

Liquidity in Diamond Markets

The diamond market is an example of the so-called one-sided market, a liquidity corner case with an extreme cost of trading. While enjoying relatively stable supply, the diamond markets are known to lack stable providers of the buy-side liquidity. In other words, the global diamond order book is half empty on the bid-side: in order to sell diamonds, one needs to pay a massive spread.



[15] i.e. a buy and a sell market orders.

The enormous demand for diamond jewelry, on the retail side, this fuels an extensive network of notorious pawn shops that comprises the secondary market for retail diamonds[16]. If a regular client opts to sell a recently purchased piece of jewelry, at the very best, one will be looking at around 40% discount of the original price. Of course, the access of retail traders to electronic venues where they can buy and sell diamonds at somewhat better prices is largely limited [39]. These two factors alone render investing into diamonds completely infeasible for the entire non-corporate population.

On the institutional side, the picture is not much brighter, the depth of books and spreads on the dedicated diamond trading venues are far worse than what is common on markets for other commodities [26]. In order to provide a real world illustration of what 'far worse' entails, consider that one of the concerns facing fund managers when they evaluate diamonds as a potential investment, is that selling diamonds on RapNet means an average discount of 30% off RapNet best ask price. This is worth highlighting: we are looking at an average spread of 30% charged by one of the most liquid diamond trading platforms. This implies that with an average annual growth rate of diamond prices of around 4% (about what it was in the period 2010-2016), it would take a little less than 7 years to simply recover the cost of spread. Note, that throughout these years, capital invested in diamonds is locked up and is not accessible at any cost below 30% of its market value[17].

Liquidity, is an important consideration for asset managers and other major institutions: not being able to unwind a position at a reasonable cost within an adequate time frame is extremely risky as it ties up the capital that can be required elsewhere at a very short notice [21], [22], [23], [24], [25]. This largely explains why diamonds rarely become a part of an investment portfolio despite a range of attractive properties.

In light of the statistics presented above, it is rather intriguing to take a look at the structure of diamond trading: what kind of entities are capable of surviving and thriving in this toxic environment and what are the views of industry incumbents on the liquidity problem?

[16] It's remarkable that among the few things to match the quality of the terms prevailing in this market, is the quality of reputation that pawn shops and similar establishments have.

[17] Some studies find that re-selling price discount reaches often 80 to 90% of the retail purchase price [40].

Diamond Trading Today

Throughout the history of mankind, the conundrum of designing a system that would allow for abundant liquidity in a market for a non-fungible asset has remained unresolved. Speaking of diamonds, this is not to imply, that no structural improvements have taken place, however. Today diamond trading is an autonomously evolving world with own rules and unique culture [27], [28].

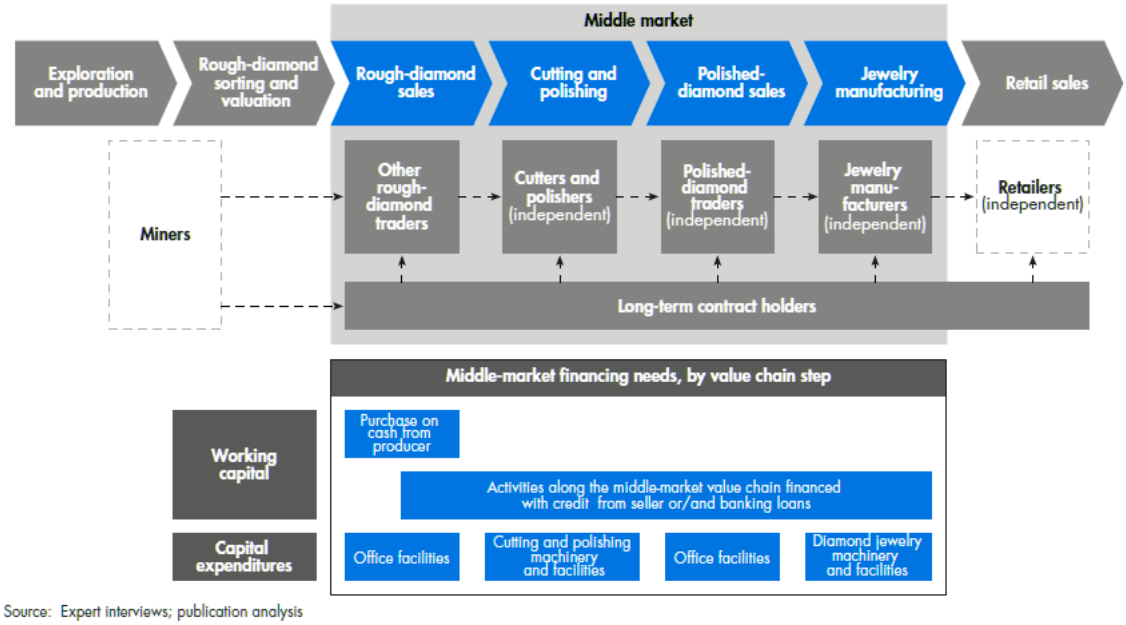
Spot Market

While 'own rules' and 'unique culture' are undoubtedly valuable attributes, the discussion above illustrates starkly that attributes that are actually important for a marketplace are those of fungibility and liquidity and as far as these latter attributes are concerned the progress has not exactly been that breathtaking for diamond markets.

Organization of Diamond Marketplaces

There have been attempts to organize centralized diamond trading facilities. An inquiring reader might wonder how the liquidity issue was resolved (or at least tackled).

Figure 3.1.1: Middle-market players' needs vary, depending on their position along the value chain



Source: Expert interviews; publication analysis

Let's take RapNet, a global dealer market maintained by Rapaport, as an example. Their solution is to screen a set of diamonds using a standardized procedure selecting only those with similar characteristics. These diamonds are then sorted in accordance with their characteristics, each group is priced on a weekly basis by Rapaport itself. The resulting price matrix has two characteristics that are probably the best illustrations of the state of liquidity in diamond trading: (i) there are over 1400 entries in the matrix: 1400 micro-marketplaces with an own price, own liquidity pool. The inability of these markets to cross-settle implies fragmented liquidity; (ii) An eloquent answer to the silent question of how is it possible to make markets (or manage liquidity in any other way) on so many marketplaces is that RapNet price matrix only offers ask prices: frankly, there are no markets: it can be considered a wholesale diamond store. In fact, while not depicted on the RapNet price matrix, the bids are available for large institutional sellers: these bids go with an average 30% discount of the ask price.

Lacking elegance and cost-efficiency since 1970s, sadly, today, this model still powers most of the operational platforms for trading diamonds. There are, however, notable exceptions to this rule.

Alternative Solutions

For example, SDiX (Singapore Diamond Investment Exchange) is a Singapore-based high-frequency diamond trading exchange. From the first glance, there must be something fundamentally different about this exchange: they are an electronic exchange platform with the promise of changing the diamond trading forever making it as easy as trading gold.

Standardization, fungibility, liquidity are all shining in every piece of text that one can find on the website. But what is their solution that no one else has thought of before? Well, it is a standardized set of diamonds that SDiX calls Diamond Bullion©. Sounds familiar? Same applies to baskets that SDiX offers: it is still the same idea of gemstones with particular characteristics that are bundled together and traded on a spot market forming a vehicle similar to an Exchange Traded Funds (ETFs). The novelty of this design is that it allows a set of diamond portfolios to be traded on a continuous matching basis in actual electronic order books. The problem with it is that fundamental problem of fragmented liquidity persists: once again, these are separate order books for every contract specification. This basically implies that their liquidity can't be combined.

So, while having the scent of novelty and indeed representing a meaningful breakthrough

on the exchange technology side, SDiX's diamond liquidity idea is just not different enough from what we have seen elsewhere. Yet, as of today, SDiX is the single most advanced option there is for trading diamonds as commodities. They also pioneer the application of blockchain technology to tracing diamonds' and keeping records.

Futures Market

Another problem with having poor liquidity, is the inability to establish a properly functioning market for derivative products, such as futures or options, with the illiquid asset as the underlying. These instruments comprise an essential toolbox that allows for effective risk management and brings a relief of certainty to every entity forming the industrial landscape. Their absence, on the other hand, leaves entities along the entire value chain exposed and further repels risk-cautious institutional capital.

Industry Landscape: the Diamond Value Chain

This problem exists and proliferates in the diamond industry. The diamond value chain consists of 4 major segments:

a. Upstream stage or the rough diamond production is characterized with double digit production margins, largely sourced from Russian producers (Russia's market share, in ct., grew from 22% in 2005 to 32% in 2016), and is dominated by 2 major players - Alrosa and De Beers (in total 68% market share [43]);

b. Rough diamond imports and exports;

c. Mid-market stage consisting of cutting and polishing activities where rough stones are given their unique shape and shine is dominated by Indian firms who account for more than 93% of the entire polishing market[18]. This segment of the diamond value chain is known for the lowest margins[19]; finally;

d. Downstream stage or the retail jewelry production and sale - somewhat higher margins and geographical dispersion of the core markets.

[18] A remarkable property of this middle segment of the diamond supply chain is that Indian manufacturers consistently squeez the market shares of their competitors for at least last 4 years.

[19] If profitable at all, the businesses in the diamond mid-market are characterized with average production margins below 2%.

It follows from (a) to (c) above that we can identify three narrower commodities representing the product stages in the diamond value chain. Of course, each of these comes with a set of industry agents naturally exposed to their prices:

1. Rough diamond prices - the fall in these threatens the margins of diamond mining companies and brings relief to the cutting and polishing segment. If the prices rise instead, many polishing firms start working at a loss while diamond producing behemoths enjoy even more lucrative margins. Long-term contracts and auctions account for 65% and 30% of all the upstream sales making rough diamond producers' cash flows relatively insensitive to the price fluctuations [42]. Yet, one should also bear in mind the inventory value gains and losses: companies in all the segments of the diamond value chain are known to hold large stocks of diamonds.

2. Polished diamond prices - the fall in these can have devastating consequences for the cutting and polishing segment with its thin margins while making jewelry production more profitable. The opposite is also possible as well. A significant difference between the upstream and the mid-market stages is that up to 90% of all the mid-market sales are done using one-time agreements [42]. Given this observation, it is easy to see that mid-market segment is exposed from both sides, upstream and downstream. In other words, both, rough diamond and polished diamond prices can have a direct and significant impact on the segment's profitability. And yet, given the spot-price-based nature of downstream deals, these are the polished diamond price dynamics that determines the faith of firms in mid-market sector. Indeed, long-term price-fixing contracts are designed to eliminate the price risk for both, producers and polishing firms. Given that over 80% of all the polishing firms are located in India, it is no surprise that Indian-based ICEX was the first one to launch futures after so many years of silence. Also, the long-term nature of the rough diamond delivery contract along with uncertain diamond demand frequently results in local mid-market deficits/surpluses: these would be avoided altogether had the liquid secondary market for diamonds existed; finally,

3. A change in price of the ready jewelry due to, say, a change in either the preferences or general economic climate, will affect the margins of the jewelry producers and retailers. This, in turn, will send shockwaves down the entire value chain. Being the closest to the end consumer, the downstream segment of the diamond market is the mechanism for incorporating the effect of the general economic forces, both macro and micro, into the diamond prices. The deals prevailing in this segment

are normally one-time agreements, thus, there is significant price exposure of the participants to the prices of polished diamonds. Much larger margins (anything in the range of 3% to 11% depending on the size) that characterize favorably the downstream firms provide for a larger space to maneuver as compared to mid-market polishing firms [42].

As a micro-conclusion from the discussion above, we can state that the price of polished diamonds is a significant risk factor for the firms comprising the diamond supply chain. The downstream segment is relatively less affected by the diamond prices, given relatively large production margins and a one-sided nature of their exposure. The actual victims, of course, populate the mid-market segment: the race for efficiency has lowered the margins significantly leaving these firms weakened and undercapitalized to cover the potential costs.

Brief History of Diamond Futures

In 1972 the West Coast Commodity Exchange (currently defunct) became the first institution to pioneer offering diamond futures. Within mere couple of weeks, the markets closed as speculators went all-in long while dealers and traders took massive short positions erasing the margins of everyone reckless enough to have a levered long exposure.

Later in the beginning of the 1980s diamond futures were launched by the Chicago Mercantile Exchange, the London Commodity Exchange, and New York Commodity Exchange (by this time pricing of diamonds has greatly improved). The contracts were designed in a fairly complex way in order to be traded and delivered sustainably. Nonetheless, an attempt to commoditize diamonds was made and many diamond investment companies were created with the intention to invest in diamonds and draw retail investment public into the market by offering shares. Despite, a vivid start and rapid development, this initiative similarly ended in tears with a sudden meteoric decline of diamond prices (of up to 80% in the highest grade categories) that caused most of the recently established companies in this business to go underwater. The cartel of the largest diamond producers which is known for being a de facto monopoly with disproportionate market power is believed by many to have caused this deadly market turmoil. One of the possible rationales for such course of actions could have been the adverse view of the activity surrounding the introduction of futures that would potentially open a liquid secondary market for diamond derivatives. This, in turn would deprive the dominant industry forces of a share of their massive market power.

Finally, in the late 1980s all attempts to present the investment public with futures were

ceased as the supply of diamonds was largely monopolized (in the hands of De Beers). There was no incentive by large producers and dealers to cut in their tremendous market shares built since the 1800s and spread profits in order to strive towards perfectly competitive and complete markets.

Nonetheless, De Beers market share fell from 90% in 1980s to only 60% in late 1990s and currently stays at 38% followed by Alrosa.

In the eyes of the crowd it is merely a truism that history frequently repeats itself looping through similar causal links and delivering an outcome that general public never expects a priori, yet reactive public opinion deems trivial post factum. We should consider carefully the lessons of the past: so far the experience with introducing diamond futures was anything, but inspiring. We believe, however, that today the issue of introducing the diamond futures could have a fundamentally different nature.

Diamond Futures Today

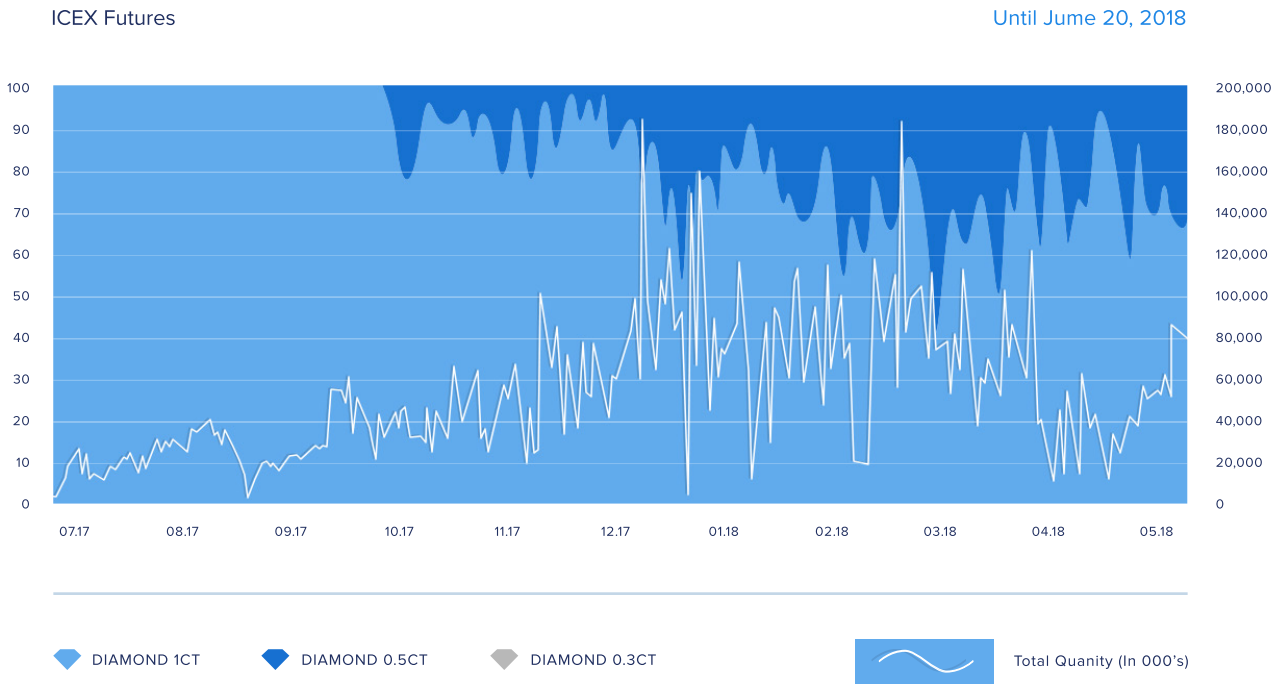
The natural and most effective hedge against supply chain disruptions is to buy a set of institutions capable of running the entire production cycle: from mine to necklace. Such firms, however, haven't been built on a required scale. Not having even one fully vertically integrated firm, the diamond industry would benefit massively from the introduction of hedging instruments, such as futures. The obvious demand for such solution motivated the introduction of diamond futures in 1970's. Unfortunately, this initiative was soon to end in tears with the new market crashing and completely disappearing soon thereafter. The blame is commonly attributed to the monopolistic nature of the diamonds market [37].

Almost half a century later, in August, 2017, ICEX (Indian Commodity Exchange) reintroduced diamond futures and, as shown in the figure below, saw large increase in demand over the following months[20]. As expected, however, the delivery of the underlying asset proved challenging [12]. The futures that are currently available have poor terms, low liquidity and highly inflexible contract design. The futures are only available for the most commonly used (and therefore liquid) diamonds; the gem eligibility criteria is tightly specified: stones allowed must have between 0.3 and 1 carat weight and possess a particular set of characteristics. The fragmentation of diamond futures is of course mirroring the state of affairs in the underlying

[20] This sharp rise in the demand of futures at ICEX is not unexpected as over 93% of all diamond polishing takes place in India and locking up prices of polished diamonds is extremely important for the businesses in that part of the supply chain.

market and is by design confined to a limited number of use cases, leaving a large part of the market uncovered [38].

Futures Volume Dynamics



The futures are traded in 1 carat (100 cents), 0.5 carat (50 cents) and 0.3 carat (30 cents) contracts: their delivery is conditional upon trader accumulating a position in these diamonds (the electronic diamond units, E-units) first. By expanding on smaller carat weights, ICEX increases it's reach and suitability as a platform for hedging. Yet, the fact remains that only the diamonds with very strict parameters are allowed onto the platform: settling the trade with diamonds of worse than specified quality is not possible, while for delivering better quality diamonds, one won't get any premium.

Conclusion

What is our take on this story about futures? The major detail to keep in mind is that derivative financial instruments indeed derive their value from the price of the underlying: there is no market for diamond futures without the market for diamonds. Hence, the rigid contract design, clumsy physical settlement and a limited range of gems offered.

So far, we have discussed all the aspects of the way diamond market operated in the inefficient world of yesterday. Now, we take a brief look on the blockchain projects that are

slowly entering the diamond space and try to explore what are their ideas and aspirations.

Applications of Blockchain

The blockchain technology has found a number of applications in the diamonds industry. Broadly speaking, there are three major directions that are being actively explored already today. Note that this overview is not intended to be comprehensive: there might be other projects and/or research areas aiming at 'disrupting' the diamond industry and of course only 'in the most fundamental way'. If so, we regret that these sparks of future revolution went unnoticed by us.

Tracing of Diamonds

Blockchain is used as an immutable ledger storing data about the origin and subsequent path of diamonds. The major rationale behind developing such systems is to be able to prove ethical and authentic origin of any gem. It goes without saying that tracing also offers marketing benefits of being able to sell the gemstone along with its 'exciting story'. The major problem of tracing projects is the underlying technology.

Recently, IBM along with Berkshire Hathaway and Richiline Group teamed up to create blockchain that will track the origin of all types of jewelry – showing that they are ethically sourced. The idea is to track not only diamonds but also precious metals through certain points of the supply chain before they turn into finished goods.

In addition, De Beers are creating blockchain to track precious gemstones each and every time they change hands – from the moment they are dug from the ground until the moment they are in the hands of the final customer. Other firms have also partnered up including Diacore, Diarough, Rosy Blue, KGK Group, and Venus Jewel. The project called Tracr will be available to everyone in the industry ensuring end-to-end tracking of a diamond throughout the entire value chain [15-17].

Stable Coins

Stable coins are a hot topic in the blockchain space - anchored to some real world assets, these coins are promoted as safe havens offering the exit route when crypto gets wild. In this set-up the blockchain is used to issue cryptographic tokens that are supposed to be backed in some fixed ratio by a stock of actual physical diamonds. Storing the diamonds in a secure

Vault and establishing a transparent and regular audit schedule with a well-known audit firm, theoretically, should be sufficient per se to maintain the peg. Providing a transparent, accessible and efficient arbitrage mechanism is a 'next-gen' requirement that would also ensure price consistency between the available trading platforms.

Given relative price stability of diamonds, a diamond-backed stable coin would in principle serve as a partial remedy some of the fundamental issues that make 'classic' cryptocurrencies ill-suited in their capacity of store of value and medium of exchange. D1 is one project adopting and extending this idea. The diamonds are represented by ERC20 tokens on the Ethereum blockchain. One of the main drivers of the fundamental value of their protocol is their close cooperation with KGK Group and Kristall Smolensk (diamond polishers) as well as their strategic partnerships with trusted storage and logistics solutions [18].

Infrastructural Projects

Infrastructural projects are those with somewhat broader aspirations; those that set the bar high. When compared to industry peers, the ideas underlying these projects are more intricate and less modest: their goal is to change the diamond industry by synthetically replicating some of its components. Adding, modifying and digitizing these new pieces of diamond market infrastructure, these projects attempt to fix some of the perceived imperfections of diamond markets as we know them. The use of blockchain is case-specific.

Properly grasping the concepts of these projects requires a deep-dive into the particularities: business model, technology, organization, team etc. These details are best explained in the respective whitepapers and can be freely accessed from the web. We will constrain ourselves to a general overview and a short discussion[21].

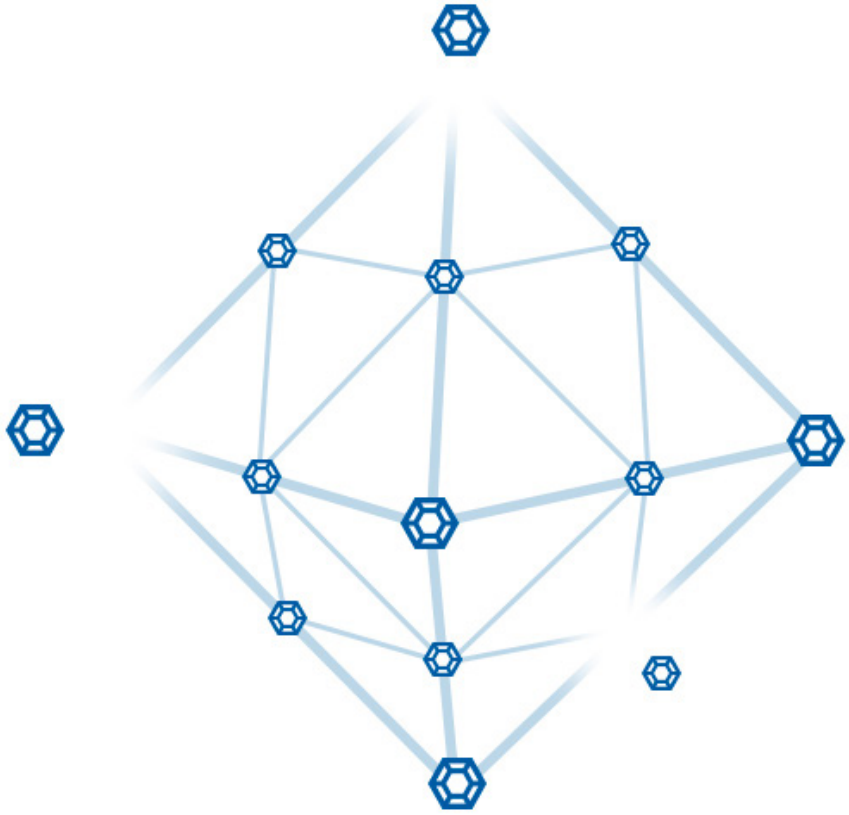
The first project we will discuss is Carats.io. Similar to D1, they embrace the idea of offering price-stable trading instrument to crypto traders tired of double digit daily volatility: a coin backed by physical diamonds. They, however, go further than just creating a stable coin.

They claim that by tokenizing diamonds they deliver the so-coveted by the industry divisibility – create fungible asset that represents diamonds [19]. As we shall see later, however, fungibility alone is at best only a half of the liquidity recipe: it is one of those necessary, but not sufficient conditions.

[21] Later, we will detail the mechanics of CEDEX.

The second project that falls under the 'infrastructural' barrier, CEDEX, also takes a holistic approach to providing liquidity to the diamond industry – aiming for a decentralized exchange for tokenized diamonds with a 'well-balanced' two-sided order book where the entire functionality is fueled by a native currency. In many respects, this project is similar to Carats.io; however, it is more comprehensive, having additional useful features like short selling and lending [20]. 'The exchange', however, is not a trivial concept to define. CEDEX offers something that can rather be termed a 'decentralized marketplace'. Similar to Carats.io, CEDEX is not precisely a market with the full set of mechanisms for price discovery: their pricing relies upon prices in other 'traditional' diamond exchanges. In addition, stones traded on CEDEX are 'packed' into smart contracts on an individual basis. While indeed allowing for fungibility, the decentralized peer-to-peer marketplace built on CEDEX platform cannot serve as a global market that will serve a global price discovery. Being a decentralized exchange, CEDEX's two-sided diamond market suffers from all the inherent limitations of the blockchain technology when used as an order book exchange protocol. Slow and expensive, decentralized exchange protocols cannot compete with their centralized counterparts in terms of liquidity and efficiency.

Sharing the aspirations and ideals that drove projects in this cohort, BitCarat, taken as a single integrated entity, can be best characterized as 'infrastructural'. In what follows we will frequently resort to comparing BitCarat to other projects within this category to illustrate the motivation behind some of the system design choices.



DIGITAL RENAISSANCE

in The Diamond Markets

General Overview

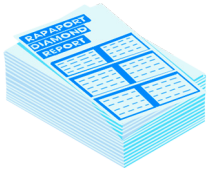
The best way to start explaining what BitCarat really is, is to provide a quote from the starting pages of this document:

> *"The BitCarat platform is a scientific and technological foundation for a diamond marketplace with efficient price formation and deep liquidity. It is a blockchain-enabled effort to erase economic frictions that have defined every major flaw in an otherwise sound mechanism of the diamond industry."*

BitCarat is set to transform trading in diamonds by leveraging the blockchain technological stack to transform physical diamonds into cryptographic tokens with unique properties. These tokens are more than just fungible digital substitutes for diamonds: within the BitCarat trading platform, DIAX, they allow to meld the liquidity of a wide range of diamonds within one central limit order book. In essence, this set-up allows for an efficient price to emerge and is therefore unique in contemporary diamond industry.

At the highest level, the essential components comprising the BitCarat ecosystem are:

1. Consensus protocol and two coins that underpin a custom blockchain;



2. Economic model capable of producing a fungible unit of value for diamonds;

3. Machine learning algorithm for pricing diamonds;

4. Bleeding edge modular low-latency exchange technology for spot trading;

5. Similarly advanced platform allowing for trading in derivatives;

6. Physical depository: a secure Vault allowing for safe storage of diamonds;

7. Digital diamond bank: a regulated institution that can take deposits, give loans and invest;

8. An extant network of partners, clients and service providers that service this massive infrastructure.

Interconnected and complementary nature of these entities provides for an integrated system where each part is essential and is linked to every other. One way to think of the high-level design of BitCarat is that it is a small economy with an independent set of financial institutions and a basic monetary system. This analogy is here for a reason: designed this way, BitCarat can use its facilities to systematically replace all ineffective institutions of the diamond industry, thus setting it free from many economic frictions.

BitCarat Blockchain

We will begin by introducing our blockchain – BitCarat: it is based on DPOS (Delegated Proof-of-Stake) consensus protocol and, hence, requires no “physical” mining: its integrity is ensured by a set of staking nodes. These nodes are called ‘witness-nodes’. They are chosen by voting. Every block, one witness is randomly chosen out of the pool of elected ‘witness-nodes’ to “mine” (or mint) a block and are rewarded with transaction fees.

There are two coins that fuel the inner mechanics of BitCarat:

a. Staking coin (BTK) that entitles holders to a share of total fees and is utilized in internal governance of the protocol.

b. Stable coin (TXD) that acts as a transactional medium, is backed by diamonds and serves as a unit of diamond value;

The fees are paid with TXD (transactional currency) to all the holders of BTK. A small fraction of the fees is distributed between the nodes owning more than 0.05% of total supply. The share of every node participating in the distribution is proportional to its relative stake in BTK coins. The remaining larger part of the fees for every block goes to the witness who signed it.

We break down the evolution of BitCarat into periods that we call ‘eras’. Each era manifests its emergence with an altered set of consensus rules:

a. The first era will be characterized with several trusted nodes acting as both, delegates and witnesses. The fees are paid for both, on-chain transactions and exchange trades. During this era, the stability of the system is tested. A large bug bounty will be initiated.

b. The second era will begin with decentralizing witness and delegate selection process. The structure of fees and the rules of their distribution will remain the same.

c. The third era will hopefully emerge when protocol will be sufficiently mature while volume of trades at DIAX will become satisfactory. We hope the community will vote out on-chain transaction fees with the intention to make BitCarat suitable for (micro-) payment applications.

WThe bi-currency design of the overall monetary system is motivated by our desire to be able to set different economic incentives for agents deriving their utility from:

a. using a coin with price characteristics of a diamond (transactional, trading, hedging motives, etc.);

b. maintaining the security of the protocol and participating in the governance of the ecosystem.

BTK Coin

The entire supply of BTK is issued throughout the ICO. All unsold tokens are burnt. There is no additional issuance of BTK. It is used to elect witness-nodes and delegate-nodes and entitles a holder to receive a part of minting fees. These tokens are used for minting purposes only: their non-speculative value depends on the number of transactions – the general activity of the network.

The BTK coin supply is capped at 100,000,000 units. A part of these will be offered during the private presale, a fraction during the crowdsale, a share will also remain with the founders. All the tokens that remain unsold by the end of the crowdsale will be burned.

Witness-Nodes are similar to miners in POW (Proof-of-Work) systems	**Delegate-nodes** represent a set of nodes responsible for maintaining the system:
a. They approve the blocks with transactions;	a. 'Delegate-nodes' are elected similarly to witness-nodes, but only the nodes with above 5% BTK stake are eligible
b. The number of witness-nodes is limited;	b. Delegate-nodes can propose changes in the consensus protocol, including the fees, block size, etc.
c. Anybody can become a witness, the voting is done by the holders of the staking coin;	c. Once a change is proposed, the actual voting takes place across the entire ecosystem: each unit of BTK is one vote. The voting power is, therefore, proportional to the stake in BTK

Witness-Nodes are similar to miners in POW (Proof-of-Work) systems	**Delegate-nodes** represent a set of nodes responsible for maintaining the system:
d. The voting process is continuous;	
e. The voting power is proportional to the stake in BTK coins;	
f. Any malicious behavior by a witness-node will result in him/her being voted out, assuming that 2/3s of all the voting nodes are honest;	
g. For their work, witness-nodes are rewarded with fees paid in TXD.	

TXD Coin

The BitCarat blockchain records and secures a ledger of transactions made with the second coin – TXD – the finest particle of the BitCarat system. TXD are used for all the purposes other than voting or staking.

TXD, the stable coin is issued and burnt when a diamond or a set thereof is deposited or withdrawn from the Vault:

a. When diamonds are deposited to the Vault, their quality (and value) is priced against those that are currently in the Vault. The price of TXD along with the value of diamond deposit (that is backed by the value of the entire Vault) determines the amount of new coins issued. This amount is calculated using our pricing algorithm and is chosen such that the price of TXD on the exchange remains unchanged;

b. When diamonds are withdrawn from the Vault, the tokens are not burnt immediately; rather, they are placed in an escrow that burns the tokens if the actual physical diamonds successfully reach the client, otherwise the coins are returned;

The process of issuing and burning the stable coins is centralized and relies on a set of trusted node(s) performing the pricing and maintaining the depository. Only the trusted

nodes can issue and burn tokens. The work of these nodes is overseen and audited on a regular basis. Qualified partners and large BTK stakers have to regularly approve the deposit/withdrawal activities. The prudency, consistency and compliance are periodically evaluated by the qualified external auditor.

When issued, TXD coins perform the following two functions:

a. As a unit of diamond value fueling liquidity on the DIAX exchange (see below)
    - TXD is traded on DIAX against a wide range of assets
    - The fees on DIAX are all paid in the stable coin
    - The fees distributed represent a fraction of the total fees paid on DIAX

b. As a transferable unit of value on BitCarat
    - The fees for on-chain transactions are paid in TXD
    - The fees are proportional to the network computing resources required to run the operation

The rules for distributing the fees are:

a. A large share of the fees (80%) collected for trading on DIAX and performing on-chain transactions are summed and distributed among the witness-nodes. The share of total fees received is proportional to the number of blocks minted during a given period;

b. All active nodes (BTK holders who at least participated in voting) are entitled for a smaller share (20%) of the total fees. The amount received is proportional to the stake.

Before describing other elements of BitCarat system, the most important function of TXD needs to be explained more elaborately. This function, in fact, to a large extent defines the entire purpose of this coin; the purpose of becoming the new industry standard as the unit of value. Designed to possess all the desirable characteristics of a homogeneous unit of value, TXD will make up a fungible pair with diamonds. This is the first fundamental step in designing a system sufficiently flexible to host a liquid diamond marketplace.

Economic Model

As noted above, one of the major impediments on the path to making diamonds more liquid is their inherent heterogeneity: a randomly picked carat is more likely than not to differ from another random carat. Hence, the price of these two should also differ prohibiting their treatment as just units of the same asset: as far as pricing is concerned, these two diamonds are different assets and thus cannot both deepen the same liquidity pool. Scattered liquidity cannot facilitate efficient price discovery and seamless execution.

A portfolio of standardized diamonds that provide common pricing benchmark combined with the concept of a cryptographic token that can serve as a frictionless unit of denomination comprise the core of the BitCarat's economic model. It is the mechanism that holds the potential of bringing liquid orderbook and efficient price discovery to the diamonds markets.

Solving the Fungibility Puzzle

The major idea is that even if we cannot seamlessly price and trade against each other diamonds with different characteristics, we can always price different diamonds against a set of reference gems, thus receiving a relative price. If, in turn their price can be indexed at least once from some commonly used system of reference, then the puzzle is solved. To illustrate, if we don't know the price of an asset X, but do know that X is 20% cheaper than an asset Y that, in turn, costs $10, $8 seems like a reasonable approximation for the price of X. In this case, two assets, X and Y combined can be priced at $18. Their average price,thus, is $9. This latter claim is somewhat intriguing: average price is simply the sum of individual prices of X and Y standardized to a single unit of value, in this case 'an asset'. We shall keep this 'unit of value' in mind. Let's introduce some notation to be able to operate outside of the X,Y asset universe. If, in turn their price can be indexed at least once from some commonly used system of reference, then the puzzle is solved. To illustrate, if we don't know the price of an asset X, but do know that X is 20% cheaper than an asset Y that, in turn, costs $10, $8 seems like a reasonable approximation for the price of X. In this case, two assets, X and Y combined can be priced at $18. Their average price is thus $9. This latter claim is somewhat intriguing: average price is simply the sum of individual prices of X and Y standardized to a single unit of value, in this case 'an asset'. We shall keep this 'unit of value' in mind. Let's introduce some notation to be able to operate outside of the X,Y asset universe. Let,

i be the notation for a specific asset - e.g. X, Y, Z or other.

j be a particular group of assets from i - X and Y, Y and Z, X and Y and Z and etc.

t be a predefined fixed time step - e.g. a day.

$p^{V}_{i,j,t}$ bbe the value of asset i that belongs to group j at some time t in some imaginary units of value V;

$p^{USD}_{i,j,t}$ be the value of asset i that belongs to group j at some time t in USD;

$w^{Q}_{i,j,t}$ be the volume of that asset as measured in some arbitrary *homogeneous* units Q;

$\pi^{V}_{j,t}$ be the combined value of all the assets in group j at some time t in some value units V; never used

$\overline{p}^{V}_{j,t}$ be the average unit value of all the assets comprising group j, once again in units V;

$\varepsilon^{V}_{i,j,t}$ be a random variable with no history of observations and, thus, undefined behavior;

$\sum \wr_{i,j,t} \ \forall \ i \in j$ be some information set that defines relative value for any i within any group j;

We also introduce a couple of definitions that will be of great benefit for conciseness in the discussion that follows:

Cross-Sectional: between the units for a given time;

Inter-temporal: between the time periods for the given unit(s);

Range: a multidimensional space of similar diamond characteristics; ‘similar’ - allowing for linear approximation of the prices for other gems belonging to a given group with an acceptable standard error;

Within-Range: refers to anything that holds for diamonds from the same range;

Between-Range: refers to anything that holds for diamonds from a different range;

Also a number of important assumptions have to be kept in mind throughout the larger part the text that follows. These assumptions are required to simplify the model, however, in this context, they can be applied without the loss of generality

1. The first assumption that is made is that everyone trading on the DIAX acts rationally and views the future as all others trading against or alongside that person. That is, there is a consensus among traders of what the future will be

2. Secondly, at any point in time price differentials that emerge between diamonds are arbitraged immediately or in other words there is a constant efficient equilibrium price.

3. Given the assumptions made the diamond pricing formula is perfectly accurate in time and across all types of diamonds on DIAX.

4. The equilibrium price of the diamond used as a 'reference' diamond is perfectly accurate and in equilibrium at the time of the price discovery.

Let's assume that the some amount of asset Y has a dollar equivalent value:

(i) $$p^{V}_{i=Y} * w^{Q}_{i=Y} = p^{USD}_{i=Y}$$

Now, let's assume that the same does not hold for asset X, so that its value in USD is unknown:

(ii) $$p^{V}_{i=X} * w^{Q}_{i=X} = p^{USD}_{i=Y}$$

For the sake of simplicity we assume that for all assets the considered amount equals one:

(iii) $$w^{Q}_{i,j,t} = 1, \forall i$$

The problem of finding the $p^{USD}_{i=Y}$ value is to be solved by matching the X and Y values using all available information about their relative properties, which could be written as::

(iv) $$p^{V}_{i=X,j,t} = f(\sum \aleph_{i,j,t}, p^{V}_{i=Y,j,t}) = a * p^{V}_{i=Y,j,t}$$

In other words, we do know that the information set $\sum \aleph_{i,j,t}$ allows us to estimate relative values of assets knowing their features (e.g., in its simplest form it can be imagined as a linear regression prediction). The outcome of the function $f(\cdots)$ in the eq uation (iii) is a scalar constant a that represents the relative value of asset X in units of asset Y. It follows that:

(v) $$p^{USD}_{i=X} = a * p^{USD}_{i=Y}$$

In other words, for two assets X and Y we can find the desired dollar equivalent value $p_{i=X}^{USD}$ if we know the relationship between assets' values $p_{i=X}^{V}$, $p_{i=Y}^{V}$ and the $p_{i=Y}^{USD}$ value. Then we can easily calculate their combined value as well as their average unit value:

(vi) $$\pi_{j,t}^{USD} = p_{i=X}^{USD} + p_{i=Y}^{USD} \text{ for } X, Y \subset j$$

(vii) $$\overline{p}_{j,t}^{USD} = \left(p_{i=X}^{USD} + p_{i=Y}^{USD}\right)/n = p_{i=Y}^{USD}(1+a)/n = \frac{\pi_{j,t}^{USD}}{n}$$

Note that the effect of the assumption (iii) is negligible, since it's really easy to repeat all these steps for other amounts of asset, which can simply be non-equal to one.

Now, assume yet another asset, Z that also does not have a clearly discernible dollar value, but based on some characteristics can be priced at 40% of the value of Y. Beyond simple: Z's price is 40% of Y, 50% of X and about 22.2% of X and Y combined or equivalently, 44.4% of their 'unit' or average value. Any of these fractions is easy to compute and will result in the expected $4 value assigned to asset Z. The new combined value of our portfolio (now of 3 assets) is $22, while the 'unit' average value is $7.33.This extension illustrates that in the presence of more than 2 assets, any new asset can be 'priced' against any of the quantities obtained before. Likewise, we can extend our portfolio to include the new asset and we can update the 'unit value' or our average price.

Using our formal representation of the numerical examples, we can generalize these remarkable properties to include an arbitrary amount of assets, let it be *n*:

(viii) $$p_{i,j,t}^{USD} \mid (p_{i=Y,j,t}^{V},\ p_{i=Y,j,t}^{USD}) = p_{i,j,t}^{USD} = a_{i,j,t} \cdot p_{i=Y,j,t}^{USD}$$

Note that the conditional notation on the left side of the equation points at the necessary data, which may still limited by only one asset's dollar value $p_{i=Y}^{USD}$ and its relative value $p_{i=Y}^{V}$

(ix) $$\pi_{j,t}^{USD} \mid (p_{i=Y,j,t}^{V},\ p_{i=Y,j,t}^{USD}) = \sum_{i=1}^{I}\left(p_{i,j,t}^{USD}\right) = p_{i=Y,j,t}^{USD} \cdot \left(1 + \sum_{i=1}^{I}\left(a_{i,j,t}\right)\right)$$

It is convenient to denote needed values in this way, so we will stick to it in further equations.

(x) $$\overline{p}_{j,t}^{USD} \mid (p_{i=Y,j,t}^{V}, p_{i=Y,j,t}^{USD}) = \frac{\pi_{j,t}^{USD}}{n} = p_{i=Y,j,t}^{USD} \cdot \left(1 + \sum_{i=1}^{I}\left(a_{i,j,t}\right)\right)/n$$

Equations (viii) through (x) establish that for a given time period, we can basically price any group of illiquid assets, provided that (a) the assets within this group can be priced against each other, (b) there is at least one liquid (i.e. that has a market price) asset within the group.

Moving forward, let's assume that we have a portfolio that includes three assets, X, Y and Z. All the properties of these assets are as before. The USD value of this portfolio ($\pi_{j,t}^{USD}$) is $22, the average portfolio unit value is $7.33 ($\overline{p}_{j,t}^{USD}$). What is this 'unit value'? What does it represent? Assume that there are 50 people willing to buy a share: to get a balanced exposure to assets X, Y and Z. Further assume that the majority of these people have less than $7.33 to spare, so they cannot afford themselves an entire unit. As a solution, we could break down the portfolio value unit into thousands or even million smaller shares, each with 1/n exposure. This is a quite basic ETF set-up, so we will skip too deep of an elaboration. In our case, say, we want 100 times more granular exposures. Then, our new 'unit value' would be $0.0733 and there will be 300 such units, all absolutely homogeneous.

Now let's note *b* as the quantity target. Similarly to (x), and assuming *b* is the desired number of tokens to be allocated, we can formally write:

(xi) $$\overline{p}_{j,t}^{USD,Coin} \left| \left(p_{i=Y,j,t}^{V}, p_{i=Y,j,t}^{USD} \right) = \frac{\pi_{j,t}^{USD}}{b} = \left(p_{i=Y,j,t}^{USD} * \left(1 + \sum_{i=1}^{I} \left(a_{i,j,t} \right) \right) \right) / b \right.$$

At this point, it is already quite apparent that this 'unit value' or is exactly the idea of the TXD coin. The assets are diamonds that are sufficiently within-range similar and between-range comparable . In this way, following two basic assumptions – that (a) diamonds can always be priced accurately against each other (in relative terms only) and that (b) there is at least one diamond in the portfolio implies that it has an up-to-date dollar valuation – we arrived at a model that seemingly allows us to generate a basic diamond unit of value. Each of such units is exactly equivalent in value to any other unit. It is also 'diamond-agnostic': a wide range of diamonds can be priced and turned into these coins without violating the unit-value equivalence condition. We are, however, yet quite far from an ideal case and even still distant from something that would just work. There is a number of reasons. We will tackle them one-by-one.

Deposits and Withdrawals

First off, we still haven't exactly explained what happens to our coin when new assets are

being added to the portfolio. Consider yet again our simple example: there are 300 coins that represent value equivalent units ($0.0733 per coin) of a portfolio consisting of 3 different assets only one of which can actually be priced directly. Assume there is a new asset W that is added: it cannot be priced directly, but we know that it is 50% more valuable than Y, so it is $15 or 104.6% more expensive than our average unit. Should we allow for token price to increase accordingly? Or would that be misguided given the nature of the task at hand? In our set-up the increase in the portfolio would basically mean that someone has deposited his or her diamonds on the DIAX platform and is expecting to get compensated by an equivalent amount of coins. Therefore, allowing the price increase to absorb the increase in the portfolio value would transfer all the wealth of the newcomer to the existing token holders, which is obviously undesirable.

The alternative becomes quite obvious if one considers expression (xi) above. In particular: $\overline{p}_{j,t}^{USD,Coin} = \left(\pi_{j,t}^{USD}\right) / b$.

The addition of new asset automatically increases $\pi_{j,t}^{USD}$ by the value of the added asset. The resulting increase either feeds directly into the coin price, $\overline{p}_{j,t}^{USD,Coin}$ or can be absorbed by increasing the quantity parameter *b*. We have marked the former option as unsuitable. On the other hand, the latter one seems to fit the BitCarat business model perfectly. It follows that the formula for calculating the percent increase in the token supply (Δb) required to offset the increase in the average asset price $\left(\Delta \pi_{j,t}^{USD}\right)$ is::

(xii) $$\Delta b = \Delta \pi_{j,t}^{USD}$$

Computing (xii) for our small numerical example, we get $\Delta b \approx 0.682$. Therefore, the supply of TXD has to be increased by 68.2% or to 504.6. Taking the expression (xi) above, we can calculate the new TXD price to be $0.0733 or virtually unchanged.

Thus, this condition is an alternative way of saying that the amount of new coins issued has to be such, that the price of the coin is unaffected.

Diamond Heterogeneity

Secondly, we have not considered the range of values of diamond gemological parameters that qualifies a diamond to be included in the portfolio. In fact, in our model, there are 4 types of baskets of different diamonds that are included in the initial portfolio. The weight of

each basket is determined by its relative liquidity as measured by the average volume traded. The reason for this is illustrated in expression (iv) above: $p^{V}_{i=X,j,t} = f(\sum \aleph_{i,j,t}, p^{V}_{i=Y,j,t})$. Indeed, the $\aleph_{i,j,t}$ set of parameters is defined only within a given group j. The implicit assumption is that there is a width parameter included in the parameter set that determines the boundaries of the range of this set. In other words, there are diamonds that are sufficiently similar to be priced against one another. The gemstones outside of these boundaries cannot be accurately priced against the basket portfolio j. We call it between-range pricing boundaries. Accurate between-range pricing (i.e. using a unit outside the range to price a unit within it) is, thus, not possible. The reason for this will become evident when we discuss the pricing methodology[22].

As a result, we create four different 'clusters' of diamond characteristics and make individual price estimations for every cluster. Then, we collapse their liquidity into one book. Formally, we can write the equation (ix) for any of the clusters j as following:

xiii. $$\pi^{USD}_{j,t} | (p^{V}_{i=Y,j,t}, p^{USD}_{i=Y,j,t}) = \sum_{i=1}^{I} \left(p^{USD}_{i,j,t} \right) = p^{USD}_{i=Y,j,t} \cdot \left(1 + \sum_{i=1}^{I} \left(a_{i,j,t} \right) \right), \quad \forall j \, ;$$

Now we can sum up the aggregate dollar equivalents for all ranges together while each range has at least one assets already priced in USD, which allows us to find values of all assets in the cluster, as it was shown above:

(xiv) $$\pi^{USD}_{t} | (\exists \; p^{V}_{i,j,t}, p^{USD}_{i,j,t} : i = i, j = j, \forall j) = \sum_{j=1}^{J} \sum_{i=1}^{I} \left(p^{USD}_{i,j,t} \right)$$

Note that existential quantification in this equation is meant to stress this exact requirement: the existence of aggregate group USD equivalent value is conditional upon the existence of a USD equivalent value for at least one diamond for every range (group).

(xv) $$\pi^{USD}_{t} | (\exists \; p^{V}_{i,j,t}, p^{USD}_{i,j,t} : i = i, j = j, \forall j) = \sum_{j=1}^{J} \left(p^{USD}_{i=Y,j,t} \cdot \left(1 + \sum_{i=1}^{I} \left(a_{i,j,t} \right) \right) \right)$$

Now similarly to equation (xi) we would like to split π^{USD}_{t} into *b* pieces, so that the price of the coin reflects both within-range and between-range relative values.

[22] The multidimensional space of diamond price against its important physical properties is non-linear: if large differences exist between diamond characteristics, the fitted price values estimated using one range of diamond characteristics can be far off for a different range. In order to remove this effect, we need a set of comparable gems: those that are sufficiently similar, so that their price differences can be linearly approximated. In short, there needs to be a sufficient number of data points with sufficiently similar characteristics to allow for small residual pricing error.

An attentive reader could already notice that we have found within-range relative values by defining an information set $\aleph$, which described relations between all the assets, as shown in equation (iv). We stressed the necessity of this step since it's quite common not to know $p^{USD}_{i,j,t}$.

Fortunately we do not have this problem with the between-range relative values. Starting from the moment of computing $\pi^{USD}_{j,t}$ for all related groups j in equation (ix) we can easily establish the relation between $\pi^{USD}_{j,t}$ and $\pi^{V}_{j,t}$ for each cluster, still relying on the $f(\Sigma \aleph_{i,j,t}, p^{V}_{i=Y,j,t})$ from equation (iv), following results from equation (vi) and equation (ix). This allows us to find comparative values sj of each group j to the aggregate value in the following way:

(xvi) $$s_{j,t} \mid \left(\exists\ \pi^{V}_{j,t} : j = j,\ \forall j \right) = \pi^{V}_{j=J,t} \Big/ \sum_{j=1}^{J} \pi^{V}_{j,t} = \pi^{V}_{j=J,t} \Big/ \pi^{V}_{t}$$

Here we denote $s_{j,t}$ similarly to $a_{i,j,t}$ as a relation of cluster j value $\pi^{V}_{j,t}$ to the aggregate value.

It gives us a groundbreaking insight on the core of the heterogeneity problem: after solving a fungibility puzzle and finding a way of calculating within-range relative values, we find that previously less transparent between-range relative value problem is solved automatically, since we do not need any extra information apart from earlier requirements.

Now it's obvious that the USD value of the total portfolio at a given time is equal to a sum of all individual diamonds within and between ranges, where within-range relations are covered by previously explained $a_{i,j,t}$ and between-range relations are described by $s_{j,t}$ parameters.

The 'unit value' for all ranges satisfying the conditions above is consequently calculated as:

(xvii) $$\overline{p}^{USD,Coin}_{t} \mid (\exists\ p^{V}_{i,j,t}, p^{USD}_{i,j,t} : i = i, j = j, \forall j) = \frac{\pi^{USD}_{t}}{b} = p^{USD}_{i=Y,j,t} \cdot \sum_{j=1}^{J} \left(s_{j,t} \cdot \left(1 + \sum_{i=1}^{I} \left(a_{i,j,t} \right) \right) \right) / b$$

TIt's worth noting that from this moment due to accounting of all clusters' relative values we do have no need in reference dollar value equivalents for all clusters, since we can use only $p^{USD}_{i=Y,j,t}$ and its respective relations to other assets $a_{i,j,t}$ and other clusters relative values $s_{j,t}$.

These expressions basically demonstrate how easy it is to handle completely different stones using BitCarat model. Notwithstanding their inherent differences, these gems are destined to fall within the same order book.

Exogeneous Price Shocks

Thirdly, we have not considered the effects of variable shocks on the price of TXD. So far, we only know that depositing or withdrawing new stones to or from the DIAX platform results in the quantity parameter *b* absorbing the change in valuation. In what follows, we will present a comprehensive account of the factors that instead of the quantity of TXD are impacting directly their price.

Let's firstly consider the cross-sectional and time-series effects of changing within-range variables (i.e. those variables that affect the relative pricing of individual diamonds within a given group, but not between the other groups).

Within-Range, Cross-Sectional Shocks are those that affect the diamonds within a given group *j* , the variation between the *i*=1...*I*. The Cross-Sectional means that we are not considering the intertemporal variation.

As it is evident from the second equation in (xvi) there are two sources of variation in the within-range cross-sectional component of TXD price: (a) the variation of relative prices of all the diamonds comprising a given group, (b) the price variation of the 'reference' diamond that serves as a benchmark for pricing. Consider the following:

(xviii) $$\sum_{i=1}^{I}\left(a_{i,j,t}\right)=\sum_{i=1}^{I}\left(p^{V}_{i\neq Y,j,t}/p^{V}_{i=Y,j,t}\right)$$

The above expression clearly demonstrates that we can think of the factors $a_{i,j,t}$ as of all the value ratios between all the gems comprising a portfolio j and the reference stone used for pricing. The market-driven inter-temporal emergence of discrepancies between the relative values of gems is absorbed in theory by the TXD token price. Should the gems overrepresented in our portfolio grow in value relative to those that are relatively few, the price of TXD theoretical value will increase; should the opposite happen, it will fall. TXD, thus, is fully functional as an efficient price of diamond assuming homogeneous pricing and rational agents.

The second part of possible within-range cross-sectional variation is the $p^{V}_{i=Y,j,t}$ price. In fact, there is no need in having $p^{V}_{i=Y,j,t}$ as our pricing unit after the first portfolio in every group is comprised. Instead, the portfolio value less the value of the priced asset ($\pi^{V}_{i\neq X,j,t}$) can be

used: this will result in decreased volatility and more consistent pricing. The value ratio parameter will be defined as $a_{i,j,t} = p^V_{i=X,j,t}/\pi^V_{i\neq X,j,t}$.

Between-Range are those sources of variation that affect entire *j* groups introducing a wedge between the groups of diamonds comprising the portfolio. Our coin mechanism allows for these disturbances: the theoretical value of TXD always reflects the state of the underlying portfolio and the diamond market along with it. The same applies to the time-series variation in either, the value ratios ($a_{i,j,t}$) or the units used for valuation ($\pi^V_{i\neq X,j,t}$).

The question, thus, is all about the speed of convergence of an instantaneous TXD price formed by the market to the theoretical equilibrium value. The question of speed in the end boils down to the analysis of the arbitrage mechanisms available.

Prometheus Unbound

Now, we have approached the critical point in our discussion: so far, we have used formulas to determine the price of the TXD token. There are several critical notes we have to take in this respect:

a. In these formulas we compute the theoretical price of TXD. This price is an abstract reference, something like an equilibrium value in theoretical economics that is not even supposed to be ever sustained;

b. This theoretical price makes various assumptions that have been discussed above;

c. Most importantly, as it is evident from the formulas, being the dependent variable, price of TXD is 'determined' exogenously. In other words, we assume that there is a market outside that can price accurately the diamond units that we use in valuation and in constructing our portfolios.

This latter point is particularly essential as it is the final step that is required to appreciate the main BitCarat idea. Indeed, all other projects in the space with similar aspirations are partnering up with other diamond trading venues *in order to take the price feed from there*. We are determined to take a fundamentally different approach to *our goal of creating an efficient diamond market*.

If one thinks of it, what is the main societal value of having efficient markets? Well, that they generate efficient prices. In our view, DIAX is this sacred place for diamond market; it is the critical infrastructure for diamond price formation.

The TXD coin in this case becomes the universal pricing unit that reflects the changes in market sentiment. By offering an open order book where the price of TXD is allowed to fluctuate freely, we unchain diamond trading. The fundamental changes we introduce are best explained with the formulas. Recall the way TXD was priced in expressions (xv) and (xvii) above. We reproduce them for convenience:

(xix) $$\pi_t^{USD} | (\exists\ p_{i,j,t}^{V}, p_{i,j,t}^{USD} : i = i, j = j, \forall j) = \sum_{j=1}^{J} \left(p_{i=Y,j,t}^{USD} \cdot \left(1 + \sum_{i=1}^{I} \left(a_{i,j,t} \right) \right) \right);$$

(xx) $$\overline{p}_t^{USD,Coin} | (\exists\ p_{i,j,t}^{V}, p_{i,j,t}^{USD} : i = i, j = j, \forall j) = \frac{\pi_t^{USD}}{b} = p_{i=Y,j,t}^{USD} \cdot \sum_{j=1}^{J} \left(s_{j,t} \cdot \left(1 + \sum_{i=1}^{I} \left(a_{i,j,t} \right) \right) \right) / b$$

What expression (xix) tells us, is that the portfolio underlying the TXD coin needs prices from elsewhere to be priced. Expression (xx) adds that these same prices are the foundation for pricing the TXD.

These are the formulas that will be used in the beginning of the BitCarat project timeline in order to assess the value of the newly deposited and withdrawn diamonds and to construct our initial portfolio. Later, when DIAX will see sufficient liquidity and vivid trading, the pricing of diamonds that are to be deposited or withdrawn will become:

(xxi) $$p_{i=X,t}^{USD} = \frac{b\overline{p}_t^{USD,Coin}}{\sum_{j=1}^{J} s_{j,t} \cdot \left(1 + \sum_{i=1}^{I} \left(a_{i,j,t} \right) \right)}$$

Using equation (xx) above, it is trivial to show that the portfolio value can now be calculated as:

(xxii) $$\pi_t^{USD} = b\overline{p}_t^{USD,Coin}$$

Even better, the token price of a diamond would be:

(xxiii) $$p_{i=X,t}^{Coin} = \frac{b}{\sum_{j=1}^{J} s_{j,t} \cdot \left(1 + \sum_{i=1}^{I} \left(a_{i,j,t} \right) \right)}$$

This small step from mathematical viewpoint is a huge step for the diamond industry. The nature of these rearrangements is actually very similar to the math underlying the implied volatility concept in option pricing. Volatility is by far the most obscure variable in the Black-Scholes pricing formula, the most common way to determine the value of certain derivative

contracts. Quantifying volatility is an extremely non-trivial task given the fact that wise men of academia are yet to reach consensus on what volatility is, precisely. The price of an option, on the other hand is very easy to define and trivial to observe empirically: one just needs to open a trading terminal. This state of affairs has led to a phenomenon when people were using the price of an option contract to calculate the volatility, the volatility implied by the option price. This tail-wags-the-dog kind of situation is similar to what we have done with TXD coin: we know for a fact the theoretical determinants of the price of TXD. We see the price of TXD on the market. Thus, this price can be used to infer the market consensus on any of the theoretical determinants of it, assuming other such determinants are known. And guess what?

As equation (xxi) above shows, the price of any diamond is exactly one such determinant.

TXD Price Efficiency

Let us elaborate on this essential statement: (i) the DIAX technology and TXD design allow for a liquid diamond marketplace with a freely floating price; (ii) it is trivial to list all the determinants of the TXD theoretical price[23]; and, (iii) it is even simpler to observe the current spot TXD price; (iv) assuming that all the other components of the TXD price are trivial to compute *for every diamond*, the price of TXD gives us an implied price of any diamond; (v) in this way, our system design indeed creates a somewhat odd, yet working market mechanism.

Theoretically, in order to prove this, the only thing that remains is showing that the true price of any diamond cannot systematically deviate from the one calculated in equation (xxi). If this is the case and the *market for TXD is efficient*, we can conclude that we have designed a facility that allows to combine the liquidity from hundreds of books for different diamonds that exist today into a single book creating an immensely more efficient market.

It's important to know the face of your enemy: consider the following scenario of a biased diamond price:

(xxiv) $$p^{USD}_{i=X,t} > \frac{\overline{bp}^{USD,Coin}_{t}}{\sum_{j=1}^{J} s_{j,t} \cdot \left(1+\sum_{i=1}^{I}\left(a_{i,j,t}\right)\right)}$$

Before proceeding, it's vital to imagine a situation when this would be the case. Assuming an efficient market for TXD, we suggest that it cannot be over or underpriced against any of its

[23] Here, we are assuming, the diamond pricing technique is fair and accurate.

components. Hence, cannot be the source of this deviation. It follows that if (xxiv) holds, then the source of distortion must hide somewhere in $a_{i,j,t}$. Why could this be the case? Recall, that we have assumed that we use an ML-based algorithm to determine every $a_{i,j,t}$. It follows that if there is a systematic error in the algorithm itself caused by e.g. ill-specified pricing equation or biased data we can end-up with (xxiv) holding true for an extended period of time, invalidating our efficient price claim. In other words, using a model, irrespective of its sophistication, for pricing the deposits to and withdrawals from the BitCarat Vault necessarily brings its every potential flaw into the price of TXD. The model becomes the single point of failure and a possible source of market frictions. Are there any alternatives to using an algorithm to price deposits and withdrawals?

TXD Public Auctions

Auctions - over 2500 years ago auctions were commonplace, they were quite popular in the Roman Empire, today they are highly varied and are widely apply in particular when talking about high value items, bids for government/municipal projects, commodities in bulk and other highly illiquid or unique assets. There are many different types of auctions all of which thoroughly analyzed by academics in the field of auction theory and practitioners. We will use rather basic auction types below for withdrawals and deposits.

Auctions for Withdrawals

When one wishes to make a withdrawal, he or she places a starting bid and the desired quantity and a regular English auction procedure is enacted. The highest bid wins the auction. The minimal bid is set at 50% of the original quantity. Aggregate bid volume should not exceed 50% of the entire stock of diamonds in the Vault. A bid wins if no higher bid has been submitted for a period of 12 minutes. Lots are allocated on a price-volume priority basis. If the initial volume is not fulfilled with the highest bid order, lower bid volume is fulfilled. Anyone with the DIAX account can place a bid. The total order size for any new bid cannot exceed the total amount of equity on the account. When the final price is determined, respective amount of TXD is placed into a multisig wallet. These coins are burnt when diamonds are physically delivered, verified and accepted.

Auctions for Deposits

When new diamonds are deposited a reverse auction is initiated. In this auction design

roles are swapped: sellers are forced to underbid each other to offer most lucrative terms to a given buyer. The purpose of such design is to achieve a downward price pressure while not limiting the freedom of a seller to accept or decline a particular deal. The winner is the lowest bid. Minimal bet is 10% of the amount auctioned by the first bidder. Betting proceeds with USD: the price of TXD to USD is fixed when bidding is announced. Given the variety of ways in which one can acquire the diamonds to deposit, the bidding patterns will be unpredictable.

Buyers are submitting their reserve prices blindly before the beginning of the bidding process. Finally, when the bidding is over, all the selling bids that have crossed a given reserve price get a fill on the time-price priority basis.When the winning bidder is determined, new tokens are generated and transferred to him, while USD equivalent is sent to the depositor. Diamonds remain with BitCarat in the Vault.

Optimal Price Discovery

Price discovery process begins with arbitrary buy and sell orders interacting within a public order book. Executed orders reflect the changes in supply and demand and inadvertently result in the change in the price of an asset. But what can explain the constant emergence of these orders: what do they reflect?

General

BIf we assume that a *significant* fraction of the entire trading volume in an arbitrary liquid asset *cannot be* entirely initiated and controlled by individuals who are not guided by any rationale but blind emotions when making trading decisions, it appears quite plausible that on average executed orders do convey new information to the market[24]. This brings us to one of the simplest answers to the question voiced above: the orders are merely the *reflections* of the emerging and colluding *information* flows enacted by the profit driven individuals. They are the electronic medium that connects the world of subjective beliefs and changing opinions of market participants with the mathematically certain objective reality of a single price. Once executed, an order becomes public: it becomes a part of the new asset price. In short, while not revealing the information directly, by trading on it, market participants reveal its essence.

[24] Consequently ‘noise’ trading for all intents and purposes can safely be assumed to average out to zero over long time spans.

An asset market cannot effectively serve its purposes if the price discovery process is impaired. Information is 'the blood' of price discovery: it's orderly and careful dissemination and subsequent non-discriminatory assimilation are essential for fair and orderly trading. Technological challenges are no less trivial: for example, the institutional design of the market has to allow for a quick incorporation of all the available information into the price of a traded asset. On a conceptual level, it is easy to see that the extent of price efficiency is closely related to the quality and speed of price discovery: theoretically, hasty and orderly assimilation of the newly available information into the price process is a particular case of price discovery.

Calibrating the Procedure for Deposits and Withdrawals

We have established that apart from casual deposits and withdrawals that happen in non-volatile periods, deposits and withdrawals in the BitCarat system have flexible design that allows them to facilitate price discovery, hence, market efficiency. The question is how to set up the pricing of diamonds deposited and withdrawn. These prices determine how much TXD is issued or burnt. These mechanical changes in supply are mechanisms for self-regulation. We have offered two possible ways to set up the procedure: ML pricing algorithm and Public Auction. The criteria that can be used to evaluate these options in a meaningful manner are not trivial to establish. In order to do so, we need to dive deeper into the concept of market efficiency.

As one can guess, market efficiency is quite far from being an unambiguous term: for decades, precisely defining and quantifying it has been an insoluble riddle for some of the humanity's brightest minds.

The most extreme form of market efficiency (the so-called, strong-form efficiency) is characterized with asset prices that at all times incorporate all the available information, both, public (publicly available) and private (a.k.a. insider information). In layman terms this refers to a situation where every piece of information that is available to the market as a whole or to a limited subset of actors comprising it is instantaneously priced in, leaving no room for consistent excess returns.

Based on this distinction, we can make the first step. We can break the price innovations into two broad categories: (i) those originating from the information accessible from public sources (public information), and (ii) those that emerge as a result of information edge available to a group of people (private/insider information). This distinction is quite subtle:

there are many ways to define insider information. In the discussion that follows, we define insider information-based innovations as the ones that result from few entities capitalizing on the information that is only known to a very limited group and cannot be acquired or deduced from public sources. On the contrary, public information-based innovation is a massive price action whereby many individuals and entities are trying to squeeze out profits from important information that has been disseminated evenly and simultaneously.

In an efficient market, any innovation in the available information set is reflected in the price. Also, the speed of adjustment should be high. These are our first criteria for evaluating the two designs. It is also an important question if the system favors some traders over others. When there is arbitrage, there is also someone who has provided for a lucrative trading opportunity. In the BitCarat case we will favor the system that allows the TXD holders to profit (or minimize the losses resulting) from price discrepancies.

I. Public information-based price innovation, ML-algorithm design:

a. Price Increase: let's assume that, unexpected by the public, an importance piece of information regarding diamonds hits the market. This information suggests that a mine that comprised 80% of the total world supply of a particular type of diamonds that is represented in the BitCarat Vault has suspended operations as a result of a catastrophic flood. Given that there is no data in the model that would suggest such turn of events, the pricing of withdrawals has not changed: TXD is highly undervalued. In such situation, the price can either adjust through the TXD market or through withdrawals. The former option is highly beneficial for TXD holders: the price adjusts directly on the market; the adjustment process is smooth and frictionless. On the contrary, a rush to withdrawals depraves the TXD book from liquidity exporting the price discovery off-book. However, a direct withdrawal at prices that have not reflected anyhow the news is much more profitable: instead of a portfolio where only one asset is mispriced (as is the case with TXD), one purchases directly that asset. The withdrawal at old prices basically allows the arbitrageur to completely absorb the price increase (subject to capital limitations). Assuming the next withdrawal is already priced adequately and the model has fully adjusted, we return to where we have started.

Outcomes: (i) price adjustment through withdrawals is optimal until the model adjusts; (ii) price adjustment is entirely at the expense of TXD holders: arbitrageur takes profit proportional to his available capital; (iii) the price adjusts after 1 transaction;

b. Price Decrease: now we assume that there was a particular type of diamonds that suddenly depreciated: e.g. a mine has been discovered containing massive quantities of this particular diamond. TXD is heavily overpriced now. As before, there are two ways to capitalize on this development: selling TXD directly or depositing overpriced diamonds and selling the TXD. While having several advantages over (a), the price decrease scenario is far from optimal. During the first transaction, the pricing algorithm has not yet adjusted to the change in market conditions. The underpriced diamonds are deposited with BitCarat and rewarded with the excessive amount of TXD. Thereafter, these TXD are dumped on the market unless the price has adjusted already. If it did, the arbitrageur gains proportionally to the weight of the mispriced diamond in the overall portfolio. If it did not, the profit of the arbitrageur is the loss of those who happened to be the counterparty to this last trade.

Outcomes: (i) the arbitrageur reaps the profits from the TXD holders; (ii) the price adjusts partially through deposits and partially through the TXD market, (iii) the price adjusts after the first transaction or faster.

II. Public information-based price innovation, auction design:

a. Price Increase: here we analyze same assumption as in (I.a.) above. Given that the information is public, we assume that its dissemination is even across the trading public while assimilation is almost instant. With the auction-based design of the BitCarat Vault system the choice between arbitraging via withdrawing and trading on the spot TXD market is less clear-cut. In order to see why, consider what happens when at least two investors are trying to withdraw an underpriced diamond from the Vault. In an ascending classic British auction, the highest bid gets the allocation. This means that even two investors will try to squeeze the other one by betting more. The price at which one would stop is the price which equals one's estimate of the 'true' price as at this point there is no arbitrage opportunity anymore. If we assume an entire crowd trying to withdraw, it is clear that they will inevitably drive the price up until the point where no arbitrage opportunities remain. On the spot market, however, 'arbitrage' is perfectly possible if one is just quick enough to react on the news: simply buy more TXD. More liquidity is provided by those who would otherwise end-up withdrawing. If no arbitrage is possible through withdrawals simply because of an incredibly competitive nature of bidding, the only way to do it is the spot.

Outcomes: (i) an arbitrageur can only profit from participating in the spot market and is not guaranteed that; (ii) the price adjusts almost instantly and predominantly via spot trading;

b. Price Decrease: again, borrowing the example from above, we attempt to devise an optimal arbitrage strategy to capitalize on the price discrepancy between the TXD coin and the diamonds comprising it. This is the least trivial case to work with: the deposits mechanics with a public auction market and centralized TXD issuance is an odd concept. As explained above, we opt for a reverse auction design. This means that depositors have to bid against each other to offer the most lucrative price. Bidders need to hold USD balances of at least 10% of the offer of the first depositor in order to be eligible. The price of TXD to USD is fixed at the moment when bidding is initiated. The lowest price that sellers would bid is the price at which they make no profit from the arbitrage transaction. After the lowest bid is determined buyers are free to take as large part of the depositors' resulting bidding landscape as they wish. When the bidding is over, USD is transferred to the depositors, tokens are issued to the buyers, and diamonds are moved to the Vault. This design really allows for a simple deposit/withdrawal mechanics in case of no significant price action. At the same time during the moments when arbitrage opportunities exist, this design makes it far more attractive to do so via the public book. Adding shorting would make it even simpler.

Outcomes: (i) depositing arbitrageurs sometimes get profit: this comes at the expense of not careful bidders; (ii) the price adjustment is quick: deposits are hardly preferable over direct spot market trading;

As it is evident from the discussion above, having model in place to decide for the market is a suboptimal choice. As a supplement to this chapter, we also have a short illustration of what happens if the pricing algorithm employed suffers from a bug that remains unnoticed for an extended time period.

The Importance of Price Discovery

The single most important purpose of a market as a social institute is to serve as the infrastructure allowing economic agents to reach consensus on the value of various assets. Such consensus is a prerequisite for orderly trading and exchange. Scalable and orderly

exchange is the foundation for efficient capital allocation, specialization and, ultimately, technological progress. Indeed, markets are a fundamental core element of evolution.

It is easy to conclude that all the impressive and far reaching benefits of having established markets totally depend upon constantly maintaining smooth mechanisms for reaching value consensus. The consensus value denominated in some fiat currency is better known as the equilibrium price, while the process of reaching it is called price discovery

Supplement

Permanent Pricing Error:

First of all, let's introduce an error component:

(i) $$p_{i=X,t}^{USD,TRUE} = \frac{b\overline{p}_t^{USD,Coin}}{\left(1+\sum_{i=1}^{I}\left(a_{i,t}^{TRUE}\right)\right)},$$

(ii) $$p_{i=X,t}^{USD} = \frac{b\overline{p}_t^{USD,Coin}}{\left(1+\sum_{i=1}^{I-1}\left(a_{i,t}\right)+\left(a_{i=I,t}+\varepsilon_{i=I,t}\right)\right)},\ \varepsilon_{i,t} = 0\ \forall\ i\neq I,t$$

(iii) $$\sum_{i=1}^{I}\left(a_{i,t}^{TRUE}\right) - \sum_{i=1}^{I}\left(a_{i,t}\right) = \varepsilon_{i=I,t}$$

(iv) $$p_{i=X,t}^{USD,TRUE} - p_{i=X,t}^{USD} \gg 0$$

Assume that due to some bug in our system or a poor quality of pricing data, our algorithm always significantly underprices some particular type of diamonds. Assume also that all other diamonds are priced accurately. A careful diamond trader notices this pricing anomaly. For an asset with more than one spot trading venue, one normally has two options to capitalize on an asset being underpriced on one of these venues: (a) buy the asset on the 'underpriced' venue and wait for the price to converge, then sell there (b) buy the asset on the 'underpriced' venue and sell it immediately on a different venue. As it is evident from (xxv), the permanent nature of $\varepsilon_{i=I,t}$ excludes the former option. Thus, the only way for a trader to profit from this market inefficiency is to: (a) buy TXD on DIAX, (b) withdraw the mispriced diamonds from DIAX; (c) sell the mispriced diamonds on the other trading venue. Mind that it still our model that determines the amount of TXD to be burnt when withdrawing diamonds. Therefore, assuming there are no biases in prices of other diamonds, when arbitrageurs withdraw all the underpriced diamonds, the TXD price normalizes.

It is immaterial if we assume presence or absence of initial TXD balances for the arbitrageur, albeit in the former case price adjustment mechanics is more intuitive. Assuming just the efficient TXD market and transparent nature of token balances, burning tokens becomes an effective channel for price convergence. This convergence, however, comes at a cost to some.

In investing, profit of one trader is always a loss of another. In our case, the profit of an arbitrageur is provided for by someone who deposited the diamonds earlier and received an inadequate TXD equivalent. Now, let's assume that our algorithm overprices the diamonds instead, i.e.:

$$\text{(v)} \qquad p_{i=X,t}^{USD,TRUE} - p_{i=X,t}^{USD} \ll 0$$

There are several reasons why this case is far more intriguing. This arbitrage opportunity can be exploited as follows: (a) buy the diamond that is overpriced on DIAX on a different trading venue, (b) deposit it on DIAX receiving TXD; (c) sell the TXD for USD on the respective market. The profit of the arbitrageur is the loss of those who happened to be the counterparty of this last trade.

Now the price of TXD becomes biased: the bias is proportional to the weight of the mispriced diamond in the overall portfolio. The problem, however, is that the perpetual nature of the pricing bias would preclude no one from repeating steps (a) to (c) again. This will continue until the price of the diamond on the other venue incorporates the pricing bias. In the process, all the holders of TXD who happened to deposit a correctly priced diamond or bought TXD on the open market, before the price on the other venue has totally adjusted, take the loss. This amount will depend upon the magnitude of mispricing and relative liquidity on the two venues. If we assume that the other trading venue is disproportionately more liquid than DIAX, the TXD supply will inflate until the amount of profit from arbitrage reaches the size of transaction costs incurred. This is quite an unfortunate scenario for every holder of TXD.

Private and Public Information

The discussion above revolves around an unlikely scenario of a permanent error in the pricing model. It is a part of a broader issue of price discovery within the BitCarat system. Using a model, irrespective of its sophistication, for pricing the deposits to and withdrawals from the BitCarat Vault necessarily brings every potential flaw it has into the price of TXD. Furthermore, it promotes using deposits and withdrawals as arbitrage tools favoring them

over spot transactions in TXD. This results in more transactions happening outside of the public order book and impedes the transparency of price formation. Is there an alternative to using an algorithm to determine the value of deposits and withdrawals? An alternative solution would be to use public auctions.

In what follows, we proceed with explaining the technological 'skeleton' of DIAX, an exchange that hosts the trading and related infrastructure required for everything described above.

Diamond Asset Exchange

This section is intended to give a general overview of DIAX, the Diamond Asset eXchange. It is a high-throughput ultra-low-latency trading facility with the state-of-art infrastructure and interface (customizable UI along with a flexible API).

General Overview

The purpose of DIAX is to create a trading environment where diamonds just like traditional financial instruments can be exchanged seamlessly on a liquid market, with narrow spreads and low commissions (i.e., DIAX's primary purpose is to host trades in TXD and derivatives thereof. TXD is offered for trade against various digital assets and currencies). Being highly sophisticated from technological perspective, DIAX infrastructure is explained more in-detail in the appendices supporting this document.

Hybrid Exchange

DIAX is one of the core pieces of infrastructure powering the BitCarat ecosystem. The TXD economics that has been elaborately described above is entirely hosted on DIAX. It represents a hybrid semi-decentralized exchange. BitCarat blockchain is what accounts for this dual status: deeply integrated with DIAX, this distributed ledger provides for an unprecedented transparency of TXD transactions in a manner that does not contradict the highly stringent user data privacy requirements normally associated with diamond trading. There are several types of nodes that make up the wallet infrastructure:

a. Senior Trusted Nodes: these are the nodes run and maintained by BitCarat's major partners including diamond trading firms, regulators and auditors who oversee the TXD creation and burning in response to deposits and withdrawals of physical diamonds;

b. BTK Holder Wallets: all the holders of BTK balances are automatically assigned with a wallet integrated into the DIAX infrastructure. The TXD mining rewards from both, the fees paid for BitCarat blockchain transactions and those resulting from DIAX trading activity are distributed to DIAX BTK wallets. It is an obligation of the agent owning the BTK balance to pass the KYC (Know-Your-Customer) procedure to enable the withdrawals of either, TXD or BTK from these wallets;

c. TXD Holder Wallets: 'normal' wallets that enable the owner of the private key to make transactions in TXD. These wallets are generated automatically when one registers a trading account with DIAX and passes the KYC. Note, that unlike (b), TXD Holder Wallet can be created outside of DIAX and used to store TXD coin balances as is the case with most of the public blockchains.

The following properties emerge as the product of interaction of the centralized exchange and wallet infrastructure, and the decentralized settlement process:

a. Any execution (the actual change of ownership of two assets being exchanged) is recorded in a private blockchain and is anchored to the BitCarat main chain;

b. The fees paid for trading on DIAX are accumulated and thereafter partially distributed among the BTK nodes;

c. The validity of the fee figure can be verified by observing the trade data from the private chain: only an executed trade is charged with a fee;

d. The futures platform works independently: only the TXD settlement at maturity of a contract or a margin call event is recorded on a private blockchain as a set of transactions.

Core Exchange Technology Overview

The platform high level architecture consists of multiple interconnected yet autonomously performing modules. DIAX Core is the 'naked' API modular exchange infrastructure that hosts matching units and supporting systems. We have chosen the modular architecture as it facilitates flexibility, scalability, maintainability and resilience against various exogenous factors that can adversely influence system performance. From the infrastructural perspective, DIAX is comprised of the following key components:

1. **DIAX Core** is the low-latency multi-asset-class trading platform that encompasses

the core functionality of the DIAX trading facility. It is deployed in a proprietary data center: the actual execution and settlement rests with the Core and partnering financial intermediaries. The key elements comprising the Core are introduced briefly below:

a. A client access layer that supports binary as well as FIX protocols for order routing and Binary MD Gate, FAST MD Gate for market data feed as well as risk management gateway with advanced pre and post trade controls,

b. A validation layer that hosts the risk management module that contains pre and post trade controls as well as configurable custom controls to be specified by the client,

c. A smart order routing/matching layer contains the core of the exchange functionality. This layer includes the multicore highly scalable Matching Unit. Note that the Matching Unit is DIAX's proprietary technology that today supports trading on a number of national stock and derivative exchanges in Europe and Asia. The second component is the Smart Order Router that ensures optimal execution contingent upon liquidity, latency and other factors on alternative connected trading venues (if there are any). Finally, this layer also includes the Best Execution module, a smart logic middleware that assures consistency between the Matching Unit and the Smart Order Router.

d. An External Access Layer provides connectivity for collocated and otherwise connected platforms. It also includes the functionality for connecting to various external data sources.

e. The final module is the Normalized Data Warehouse that represents an integrated storage solution.

The order book mechanics of DIAX is entirely off-chain; it offers continuous price/time priority matching on all the markets that it hosts.

2. **DIAX Diamond Broker** is a brokerage unit that's located in DIAX data center and provides DMA services sourcing the quotes from the DIAX Matching Unit. There are two ways to get exposure to our trading facilities.

a. direct collocation in our state-of-art datacenter that hosts the matching unit; and,

b. onboarding with our broker that acts as a DMA (Direct Market Access) and liquidity provider for our OTC (Other-The-Counter) trading desk.

The former option is designed for 'picosecond cautious' institutional traders: the cost of hardware and datacenter space is prohibitive for the majority of non-institutional clients. The latter option is specifically designed to suit the convenience of retail investors: modular and customizable, our UI can scale and adjust to suit the needs of anyone, professional or otherwise.

DIAX Fee Structure

Executing any type of order on DIAX will cost a small commission, a trading fee that is common in traditional exchange space as well as in crypto. These commissions will be aggregated on a monthly basis into a pool that constitutes a part of a normal exchange income. In our system, a part of these fees will be distributed as a reward to the miners who collectively protect the integrity of the blockchain.

In order to better explain our economic model, a formal specification, we felt, is in order. Beforehand, however, let us introduce some notations:

i is the step in the fees' discount ladder from 1 to 5;

j is the indicator for a trader on the platform;

t is the specific time indicator (e.g. day);

x is equal to 0 if the particular fee is paid in the native currency and 1 when paid in the token;

o is equal to 0 if the particular fee is paid in the case when the order is considered taker's and 1 otherwise;

Fees and Distribution

Now, the percent trading fees are denoted as $f_{i,j,t,x,o} = f(V_{i,j,t,x,o})$ and are a decreasing function of the volume traded by an agent. In other words, in DIAX we adopt a standard ladder fee schedule that is common on today's cryptocurrency trading platforms.

The total dollar fees paid are denoted as $F_{i,j,t,x,o}$ and are calculated as:

$F_{i,j,t,x,o} = f_{i,j,t,x,o} * V_{i,j,t,x,o}$. Summing $F_{i,j,t,x,o}$ over traders, order types, and other relevant dimensions, we arrive at a total fee revenue of DIAX for a given time:

$TC_{t=T} = \sum_{i=1}^{I} \sum_{j=1}^{J} \sum_{x=1}^{2} \sum_{o=1}^{2} F_{i,j,t=T,x,o}$. This number serves as the reference point determining the fees that are paid to the miners. A share of the exchange revenue is set aside and split between the holders of BitCarat tokens who participated in mining:

$M_{t=T} = \alpha * TC_{t=T}$ where alpha is the parameter determining miners share. Once allocated, the fees are being distributed among miners in TXD tokens in proportion with the number of mined blocks over this time period:

$M^{A}_{j,t=T} = M_{t=T} * B_{j,t=T} / \sum_{j=1}^{J} B_{t=T}$. In designing the BitCarat ecosystem this way we were driven primarily by the desire to create a ledger with free transactions. Miners, however, should always be rewarded and to cover up for the possibility that there hasn't been a sufficient volume on DIAX to reward them for the efforts, we also introduce a latent blockchain transaction fee:

$M^{B}_{j,t=T} = f(\vartheta, \tau, \delta, B_{j,t=T} / \sum_{j=1}^{J} B_{t=T})$, where the mining reward of an agent is a function of the number of transactions (τ), urgency (ϑ), difficulty mark-up (δ) and the number of blocks mined by a miner $(B_{j,t=T} / \sum_{j=1}^{J} B_{t=T})$. The particular functional form is to be determined later down the roadmap. In any respect, $M^{A}_{j,t=T}, \geq M^{B}_{j,t=T}$ is the condition when miners are rewarded with the transaction fee. If it doesn't hold, miners are rewarded with the TXD tokens from the founders' pool in the amount equivalent to $M^{B}_{j,t=T}$. Technologically, this distribution becomes possible as all the miners have an account with DIAX that is used for distribution in either case.

In short, the feature of having zero transaction fees is elusive: miners are compensated from the trading fees paid on the exchange. Yet, it is important to highlight that TXD is the only price-stable cryptographic token that enjoys zero fees without having its security compromised. While not constituting anything significant at the first glance, the combination of these two qualities renders TXD and BitCarat an obvious candidate for various payment applications.

Additional Features

The core of BitCarat, DIAX encompasses a truly broad range of capabilities and features. One of these is the ability to offer traders the borrowing, lending as well as shorting functionalities.

1. Nowadays in crypto being able to take a short position on the market as a whole

or a part thereof is hardly possible without taking a heavy exposure to the risk of fraud along the way. It goes without saying that taking a significant short position on crypto is even less trivial. Through its DIAX platform BitCarat offers lending with a variety of assets accepted as collateral.

2. Being able to short is contingent upon being able to borrow: by posting a collateral and passing a set of compliance and technical checks, sophisticated traders can opt to short BTC or any other traded asset that one deems appropriate.

3. With time, as the diamond spot market gets more active and liquid, DIAX will also accommodate futures contracts. In times of uncertainty, many players of the diamond space will find it convenient to hedge away any exposure to the price of diamonds. Those, with vertically integrated business model will still enjoy the decreased cash flow variance and more effective risk management.

DIAX Exchange: Summary

In designing the DIAX technology, we have been driven primarily by the desire to create an institutional-grade product that would be comparable in its performance characteristics to the best-of-breed exchange technologies hosting the trading activity in traditional asset classes. This setup will allow for a swift integration of the traditional trading infrastructure of the trading desk of any bank, fund or a prop-shop. Flexible UI will support the needs of less tech-savvy retail investors just as good as it will suit professional ‘manual’ day-traders.

Equipped with the scalable and modular exchange platform that has been designed for the use of the major global financial institutions, we can test and deploy any spot financial product or a derivative thereof. In the beginning, however, we plan to launch only a limited number of asset pairs: TXD/USD, TXD/CHF, and TXD/BTC. As soon as we will be comfortable with the behavior of every pair, we will add more.

A variety of different diamonds comprising homogeneous liquidity within the same orderbook, will likely foster the growth of our user base – institutional and retail alike.

Digital Diamond Bank

Once built, BitCarat will offer banking services in TXD - both in terms of peer-to-peer manner and in the traditional way - as a financial intermediary. Ever since the abolishment of the gold standard under the Roosevelt administration in early 1930s no major legal tender used for medium of exchange, store of value, and unit of account has ever been backed by an asset of value. Leaving the discussion of fiat money in their capacity to possess the three aforementioned characteristics, in this paragraph we will focus on the way digital money backed by real assets present novel ways of financial intermediation.

Traditional Banking Services

BitCarat will act as a financial intermediary where lending services will be provided to its clients. TXD can be deposited in the bank in exchange for interest. Loans, too, will be made available in TXD will be made available through the bank's lending facilities against which periodic interest payments will have to be made. Since TXD is entirely backed by diamonds the bank's clients will be able to make their periodic repayments (both interest and annuity) in available diamonds. Deposits can also be made in diamonds and if the client so chooses the interest can also be paid in diamonds. The bank will present its clients with a number of loan options including but not limited to:

a. Secured Loans;

b. Unsecured Loans;

c. Demand Loans;

d. Roll-over Loans;

e. Revolving Credit;

f. Lines of Credit;

g. Balloon Loans (Bonds).

While in this case BitCarat is the financial intermediary we will also provide the infrastructure for an autonomous lending market.

Peer-To-Peer Lending Services

In this type of banking all the aforementioned types of loans will be done without the interference of a third party. The first way of peer-to-peer banking will occur in a limit order book fashion where TXD and diamonds will be offered for lending and borrowing by the participants in that market. Interest rates on the loans are determined by the demand/supply mechanics of the markets. It will be possible to use the margin requirements set by default by the BitCarat or customize them.

What is more, the clients will be able to create custom borrowing/lending between themselves in an auction type fashion where one will be able to browse all different types of contracts offered anonymously - contract fulfilment will be left entirely up to the parties forming the contract.

In addition, the clients will be able to choose to whom to lend or from whom to borrow by observing their status - e.g. institutional or retail client, their repayment history, frequency of borrowing and lending, average borrowing size, id of the user from whom the loan was taken, and other in a trustless way - all of this will be recorded on the blockchain.

Moreover, participants in these markets will be able to create a type of “trust” where capital is accumulated from multiple parties all willing and able to be partners and form their own bank - they will govern a bank in a transparent manner and build reputation and expand. Borrowing and lending on the peer-to-peer markets and investing in other “trusts” will also be possible. In this way, we allow for the creation of a system of self-regulated peer-to-peer lending markets which erase all market frictions present in the world of traditional financial intermediation through transparency and maximizing self-interest.

In summary, cryptocurrency market suffers from the absence of a wide array of financial instruments and tools readily available in other, more established markets. The reasons for this unfortunate state of affairs are many and varied. Among the major impediments are:

a. complexities and costs involved in determining and acquiring the required licenses;

b. extreme parameters that normally characterize the asset price processes in markets for cryptocurrencies;

c. lack of developed financial institutions that routinely facilitate many complex transactional arrangements in traditional financial markets. Virtual absence of these

becomes especially critical in extreme market conditions, which are a feature rather than a bug in crypto. While public blockchains and traditional banking infrastructure can be called ‘polar’ technologies (the former is basically designed to liberate the society from the need to use the former), their main functions can nevertheless be combined. The BitCarat Digital Bank utilizes the blockchain technology as the underlying infrastructure with:

1. Fungible units of account as account balances;
2. Transactional logic as the means to reallocate these balances;
3. Conditional transactional logic as the means to add clauses to the reallocation process.

Product Summary

At this point, we have discussed all the major parts comprising the BitCarat ecosystem. Being modular and broad, the system as well as the rationale behind it merit a brief overview..

1. BitCarat consists of:
    a. BitCarat, a stand-alone DPOS-based blockchain that hosts two tokens, a security staking token, BTK that is rewarded with transaction fee rewards and a transactional diamond-backed price-stable token, TXD. The latter can be used as a zero-fee medium of exchange or as a trading token with the aim of bringing a new paradigm to the diamonds markets turning this today illiquid and retail-oriented luxurious good into an institution-demanded asset class.c
    b. A trading platform that is intended to host the trades in the TXD-based markets. Capable of enduring equity market-style loads of millions of transactions per second at extremely low latencies, DIAX is an institutional exchange platform. Equipped with its rich functionality and flexible modular design, BitCarat will scale on the way: when TXD spot markets will enjoy sufficient liquidity and vivid trading, we will introduce futures contracts. As soon as the regulatory environment becomes favorable and stable, BitCarat will make its first major moves towards becoming a diamond-backed bank and introduce lending and short-selling.

c. The trading fees collected during a given period of time serve as the mining reward for the active holders of BitCarat tokens.

d. A diamond Vault with an industry-grade security system and a set of rigorous internal controls that ensure the safety of the physical diamonds.

e. A proprietary pricing algorithm based on the bleeding edge developments in the area of geology, chemistry and applied statistics that allows us to price any standard gem with remarkable accuracy.

2. We aim to:

a. Be able to fundamentally change diamond trading: introducing a fungible token along with a pricing model that provides the basis for tokenization, we finalize the outlines of approaching changes by setting up the professional trading platform to host the major acts of the new world evolving.

b. Making it safer for financial institutions to short crypto and allowing qualified clients to borrow any currency against an appropriate collateral.

c. Becoming a global player in the payment industry: the ability to make instant zero-fee p2p transactions with a token serving as a stable store of value, BitCarat is technologically well-fit to become a part of the emerging landscape of the world of borderless payments.

Team

Aleksandr Malkov - Founder and Chief Executive Officer: Aleksandr is co-founder and CEO of Arbi (legal and escrow services for ICOs), member of the Top 100 Blockchain Legal Advisors in CIS, member of Expert Council on Digital Economy in the Duma State of the Russian Federation.

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Sergey Goncharenko, PhD - Chief Strategy Officer: Having obtained his PhD in Economics in 1995 from the National University of Science and Technology (MISiS) in Russia, Sergey is currently a professor in the university. He specializes in developing sustainable methodologies for optimizing the strategies for the management of mining companies at various stages of their technological life cycle.

Linked In: https://www.linkedin.com/in/sergey-goncharenko-880483165/

Marina Panfilova - Chief Marketing Officer: Previously Head of Strategic Planning for SPN Ogilvy, specializing in marketing analysis and strategy planning for large scale Russian and international companies, innovative & hybrid projects for more than 11 years.

Studied Marketing Analytics at the St-Petersburg University of Engineering & Economics, Economics & Management at Universite de Pierre Mendes, Grenoble.

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Yuriy Kirichenko, PhD - Chief Technical Officer: Yurii has obtained his PhD in technologies for complex mechanization of open mineral deposits in 2001 and specialized further in the field of hydromechanized development and is currently professor at the National University of Science and Technology. He has published over 200 scientific papers, has issued 11 patents, and written multiple chapters of two books all in the field of mining engineering. He has obtained numerous prizes in his field of specialization including that of the International Soros Science Education Program in 2001.

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Alexey Puchkov, PhD - Chief Financial Officer: Aleksey is currently a PhD candidate in Economics and head of the Mining MBA program as well as docent at the Faculty of Finance and Credit at the National University of Science and Technology.

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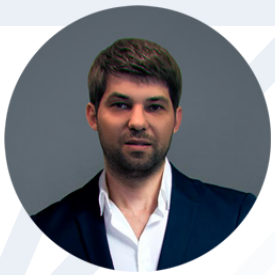

Dmitry Tretyakov - Chief Business Development Officer: With over 8 years of experience in investment banking Dmitry began his career as the Moscow National Investment Bank as the Head of Institutional Clients Relations which he held for over three years before moving to Konrast Bank. For five years he was a SEVP and played a key role in the communications of the bank with its largest institutional partners. Currently, he is on the board of directors and a founding member of a fund that focuses on strategic partnerships, acquisitions, and large scale investments in innovative digital technologies in the payments sector.

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Dmitry Sukhov - Head of Research & Development: Having graduated the Moscow State Mining University and obtained MBA with specialization in mining companies management Dmitry is currently the Head of Research & Development at Severalmaz - a Russian mining company, wholly owned subsidiary of Alrosa. Before beginning his career at Severalmaz he was for nearly five years a researcher at the Institute of Diamonds and Precious Metals in Russia where he studied, among others, the the structure and evolution of real-structural complexes of the lithosphere of cratons and orogenic belts. He contributed greatly to the body of knowledge in geology, mineralogy and forecasting of diamond deposits depletion, precious metals and other minerals.

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Alexey Dimitrienko - Director of Blockchain Development: Graduated Industrial Software Engineering from the Moscow Power Engineering Institute with “Honors” and since then worked on developing innovative solutions in the field of payment systems for Russian SMEs. Since 2010 he has began investigating the use of blockchain technologies in the payments industry by working on projects related to scaling existing solutions for the demand of Russian online stores.

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Advisory

Alexey Blagirev - Fintech Advisor: A top expert on data, one of the first people to held the position of Chief Data Officer in Russia. For more than 10 years, he has been involved in rolling out cutting-edge technology solutions for major companies, such as Societe Generale, PwC, Samsung, Marriott and Alfa Bank. Currently, he is Project Lead R3 for Corda CIS, promoting Corda and R3 and developing local sales desk for R3 membership.

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Partners

ALROSA

FINNOWEX

Deloitte.

MISIS
National University of
Science and Technology

ADAMANT & GRAND

AmaZix

DISTRIBUTED LAB
Blockchain Experts

Roadmap

August 1, 2018	Formation of Swiss Company	A company is established and incorporated in Switzerland
August 15, 2018	Application for Licenses	Application for Swiss Self Regulated. Organization (SRO) license.
September 8, 2018	Beginning of ICO	The ICO will begin with a private sale round.
November 5, 2018	Swiss SRO	An SRO (Self Regulated Organization) Switzerland-issued license for operating a cryptocurrency exchange is obtained. It allows the launching of an exchange where cryptocurrencies, the BTK and TXD tokens can be traded against USD and other fiat in a regulated setting, temporarily.
December 1, 2018	Applying for SDL	Application for a SDL (Securities Dealer License) where the trading of cryptocurrencies against fiat is possible and permanent. This license also allows for the launching and trading of leveraged products as well as trading of exchange traded funds.
January 2, 2019	End of ICO & Listing	The ICO will constitute 3 sale stages with different discount on each level. Listing on exchanges.
February 1, 2019	Swiss Banking License	Application for a Swiss banking license.

March 1, 2019	Exchange MVP 2.0	Deposit, withdrawal, trading of diamond tokens also available.
April 1, 2019	Blockchain MVP 1.0	The first era will be characterized with several trusted nodes acting as both, delegates and witnesses. The fees are paid for both, on-chain transactions and exchange trades. During this era, the stability of the system is tested. A large bug bounty will be initiated.
August 1, 2019	Blockchain MVP 2.0	The second era will begin with decentralizing witness and delegate selection process. The structure of fees and the rules of their distribution will remain the same.
September 1, 2019	Obtaining SDL	Obtaining the Securities Dealer License in Switzerland.
October 1, 2019	Institutional Futures	Launching 0.3; 0.5; and 1.0 CT diamond futures to institutional investors. Settled in cash or diamond tokens.
November 1, 2019	Blockchain Finalized	The third era will emerge when protocol will be sufficiently mature while volume of trades at DIAX will become satisfactory. We hope the community will vote out on-chain transaction fees with the intention to make BitCarat suitable for (micro-) payment applications.
December 1, 2019	Retail Futures	Launching all types of futures also to retail investors. Settled in cash or diamond tokens.

February 1, 2019	Margin trading and shorting instruments & Finalized Exchange	Organizing margin trading and shorting instruments facility. The exchange is not fully functional and it's capabilities are utilized.
May 1, 2019	Bank	Establish a bank that will be able to receive deposits and give out loans.
July 1, 2019	Investment Fund	Establish an investment fund that will form portfolios that invest directly in diamonds as underlying assets rather than companies or other funds.
November 1, 2019	Venture Capital Organization	A fund that provides capital to start-ups in the diamond industry to promote competition and stimulate growth.

INVESTING IN BITCARAT

Fundraising, Business Model and Investor Relations

Business Model

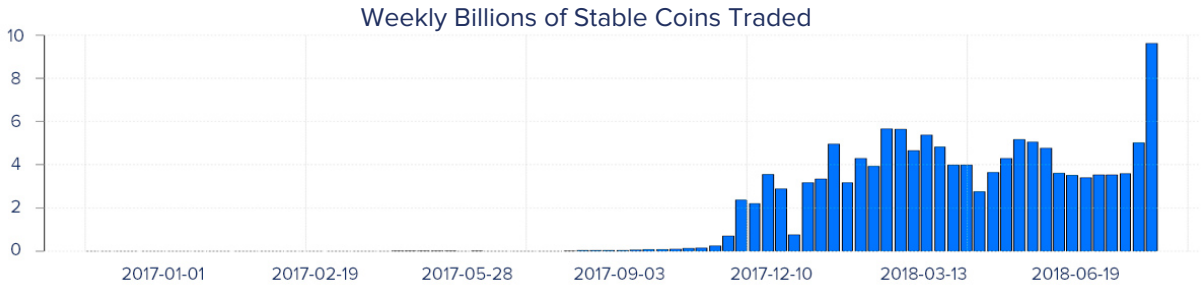
Here we will highlight a number of important concepts that the majority of conventional business outline once they decide to go through a traditional crowdfunding campaign. Attention will be paid to the markets the BitCarat project focuses on by introducing DIAX and the stablecoin. In particular, each of the target markets will be described in broad outlines and further elaboration will follow on how they are tapped.

What is more detail projected monthly income statements from January 2019 until June 2020 will be supplied based on the market research conducted earlier. We will present a brief of these statements and the actual models can be provided upon request.

Markets

The markets which we target can be broken down into three major subgroups.

1. **Cryptocurrency Trading and Investing**. Historically, the volatility of the assets comprising the cryptocurrency market has been by an order of magnitude higher than that normally witnessed in conventional asset classes. This justified the emergence of 'stablecoins', being digital by nature and inheriting light regulatory treatment, these assets offer 'traditional' risk-return profiles making them invaluable for any exchange that cannot afford millions in compliance budgets. Stable Coins are cryptocurrencies that have their price pegged to an underlying 'real-world' asset. At the same time, while offering the performance of a real-world asset, stablecoins are regulated as digital currencies. The combined market capitalization of these coins is around $2.8 bil. The lion's share of these impressive figure (around $2.6 bil.) is Tether. Tether is USD backed stablecoin issued for each US$1.00 deposited in the system. Considering daily trading volume, Tether's dominance is even more pronounced: $2.37 bil out of around $2.4 bil total.



While the applications of stable coins will be many and varied they can currently be summarized around the following three points

a. Convenient exit tools - in times of adverse market conditions, stablecoins are 'local safe havens'.

b. Economically viable cryptocurrency-based transfer and payment protocols - local price stability of an asset that is used for making payments or transferring funds is essentia.

c. A stable collateral - the volatility of the collateral itself obviously magnifies the risk of any levered position.

The current stablecoins trends are largely defined as follows:

a. Explosive and sustained growth in stablecoin traded volumes;

b. On average, over 40% of entire daily stablecoin trading volumes are concentrated in one traded pair: BTC/USDT; over 95% is attributed to USDT pairs

c. Regulation inexorably penetrates the crypto space.

To elaborate, (a) and (b) imply that today, the entire growing stablecoin demand is driven by solely the 'exit tool' rationale. Point (c), in turn, makes painstakingly obvious that increases in stablecoin demand fueled by the exit tool motief is unsustainable: regulated trading venues do not need Tether; they can safely list USD thereby drastically reducing the AML compliance risks.

Before we move to comparing the theoretical and practical applications of stable coins and their future in the digital economy, it is worthwhile to summarize the controversies currently surrounding them.

1. Tether - unaudited, endlessly created cryptocurrency backed by fiat
2. The demand for Tether grows exponentially
3. Tether is used largely at unregulated exchanges
4. There are no fundamental factors supporting this astronomic rise
5. New stable coins are issued all the time
6. Their full potential is barely yet realized

7. The regulatory burden is becoming heavier and heavier with regard to cryptocurrency trading venues and the use of stable coins is likely to disappear once regulations becomes conclusive

Theory: Stable Coins as a Foundation for the Digital Economy	**Practice: Lack of imagination and grave AML concerns**
i. Today, stablecoins are used predominantly as a tool for providing unregulated trading venues with a way to list fiat-denominated pairs.	i. They are cryptocurrencies, thus, are decentralized and offer superior transparency, erasing margin markups of the now obsolete intermediaries. All of this, at a fraction of a unit transaction cost;
ii. Today, the market is virtually monopolized by Tether that accounts for over 95% of average daily stablecoin trading volume. Most of the alternatives are bleak copies of Tether with a premise of better transparency and few if any technological and conceptual improvements.	ii. They allow for the creation of entirely new asset classes: hybrid assets with arbitrary properties and risk/return profiles;
iii. Given the lack of regulatory certainty and any law enforcement in the crypto space, the anonymity features of stablecoins render them obvious candidates for money laundering applications, whilst the inherent inability to provably ensure the issuance consistency make these digital asset a usual suspect in all kinds of price manipulation and outright fraud scandals.	iii. Most importantly, however, stable prices and decentralized nature allow these digital assets to power arbitrary institutional arrangements: e.g. transactional protocols for distributed banking systems. So, in fact, similar to the way legal frameworks supported the legacy financial systems with their rich institutional framework, the protocol that underpins stablecoins is the core infrastructure that provides for the emergence of the new breed of financial and social institutions, the distributed intermediaries a.k.a. DAOs.
iv. The rapid emergence of regulated cryptocurrency exchanges constantly deflates the value of stablecoins as safe haven assets. When compared to USDT, a simple USD offers improved user experience, drastically reduced security and compliance risks and improved transparency.	iv. Also, today, on the unregulated cryptocurrency exchange landscape, stablecoins are utterly effective in providing for USD denominated trading pairs while evading money transmitter regulations.
• **Summary**: today, stablecoins are utterly simplistic constructs that aim to provide an increasingly redundant service to a shrinking subdomain of exchanges that will sooner or later be forced to either adapt to a stricter regulatory landscape or extinct. The irony here is that exactly those exchanges that will embrace regulation will have a fundamentally better alternative to stablecoins (in their safe haven asset capacity) - their underlyings.	• **Summary**: the potential of what is known as stablecoins is multifaceted and evolutionary to say the least. To put it concisely, stablecoin protocols are a prerequisite for the co-existence of financial disintermediation and financial institutions. They are the foundation for the digital economy.

Brief Summary

A. Over $131.2 billion volume has been traded in stable coins since the beginning of 2018 which or over $20 billion each month. Stablecoin volumes are at their ATH, but what really drives this explosive action?

B. There is a clear set of justifications for the existence of stablecoins: excessive volatility is equally destructive for trading cryptocurrencies as it is prohibitive for using them as a transactional medium.

C. Ultimately, these are the protocols most similar to today's stablecoins that will become the foundation for the digital economy.

D. In practice, in the absence of properly functioning decentralized exchanges, spreading regulatory oversight and lack of vivid imagination and/or aspirations in tokenomics of the stablecoin projects that are in existence today, the popularity and adoption of stablecoins remains contained. Their technical and conceptual features are poorly understood by the general public. Consequentially, their value and potential remain underpriced.

E. There are few shady stable coins: the lion's share of all the volume is accounted for by the BTC/USDT pair. Tether dominates the market holding an over 95% average daily volume share.

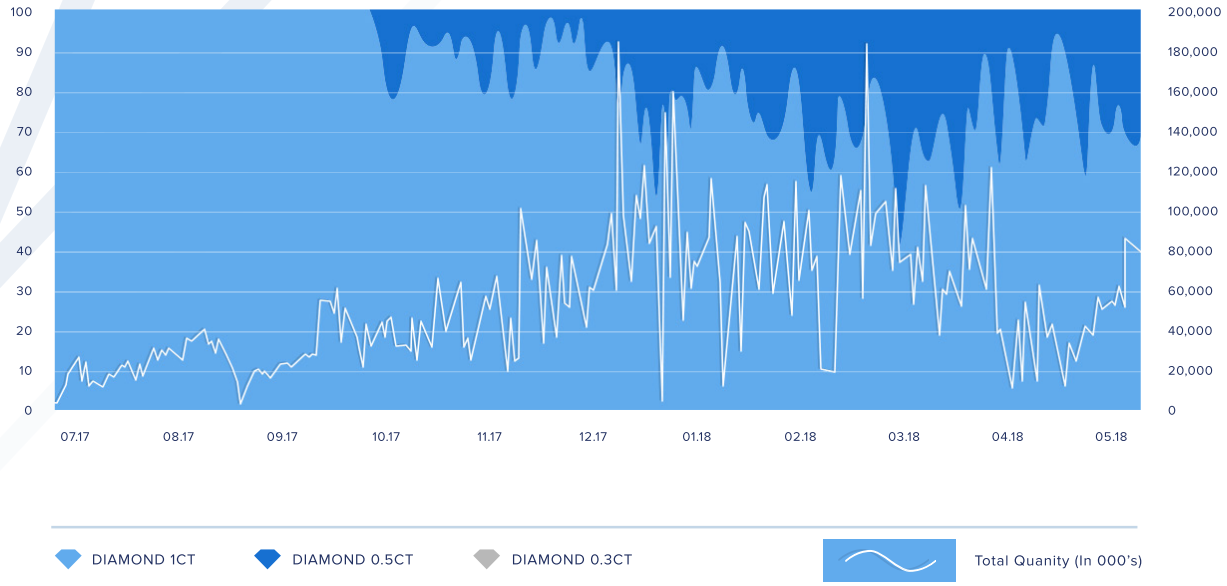
F. The competition is weak: most of the top-stablecoin projects, the 'Tether-killers' lack a better value proposition than that their coin is more transparent than Tether.

G. Instead of embracing a wide range of opportunities that stablecoins offer, today everybody tries to carve a small piece of a constantly shrinking market for stablecoins as safe haven assets. These projects miss out on the opportunity to capitalize the ability to see a broader picture: BitCarat has a fundamentally different proposal along the same 'stablecoin lines'.

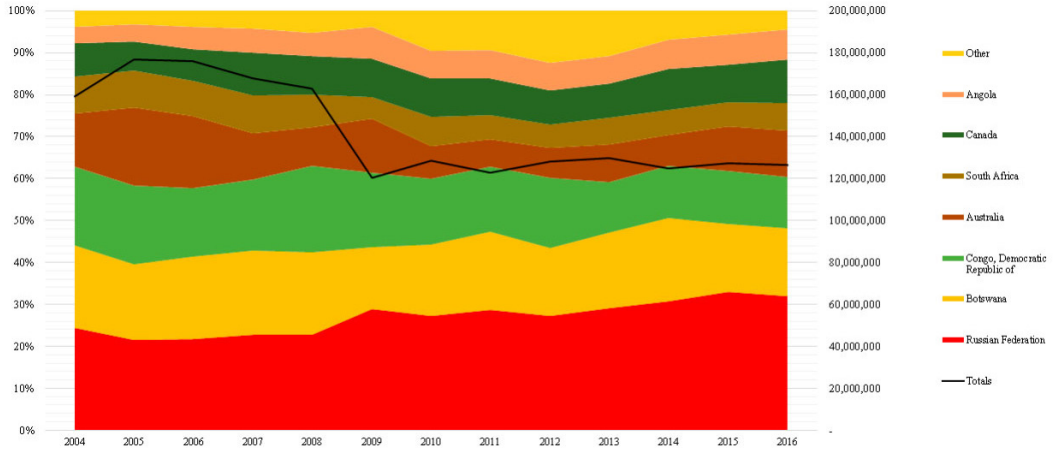
2. The Businesses In the Diamonds Industry.

Diamond-backed futures have been introduced as a tool to hedge business risks for diamond companies [12]. As shown before these futures are largely restricted to 0.3, 0.5, and 1.0 CT diamonds and the majority of the volume traded (over 80%) is concentrated in the 1.0 CT contracts.

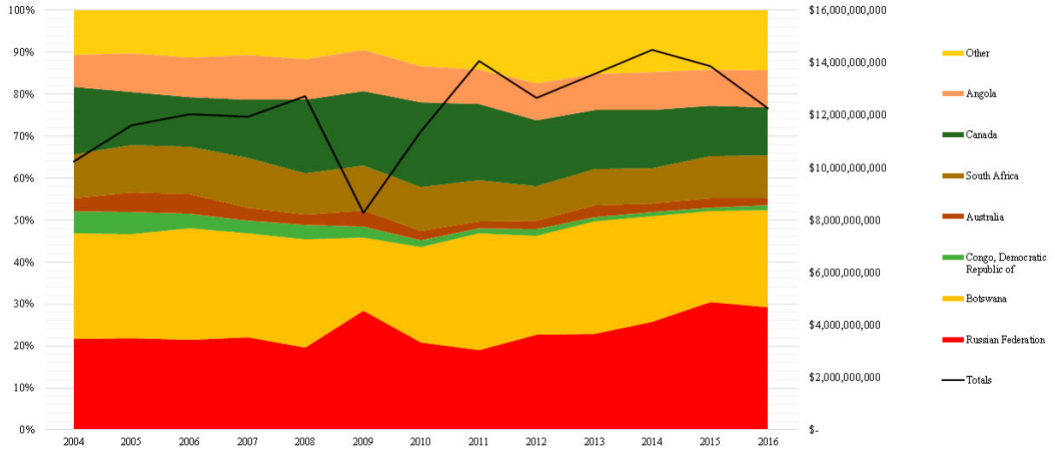
Future Volume Dynamics



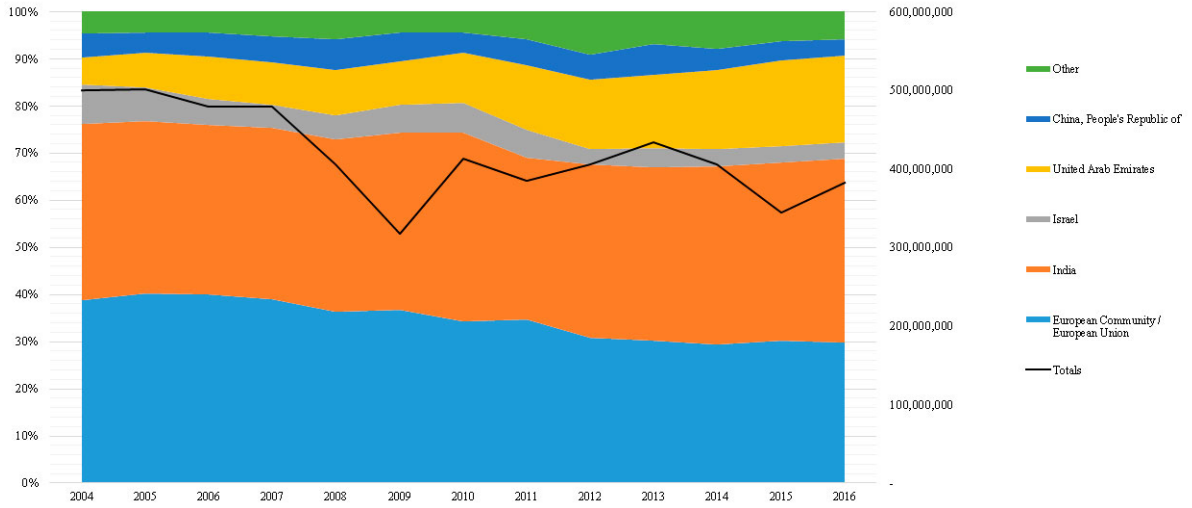
Largest producers of Rough Diamonds in Carats



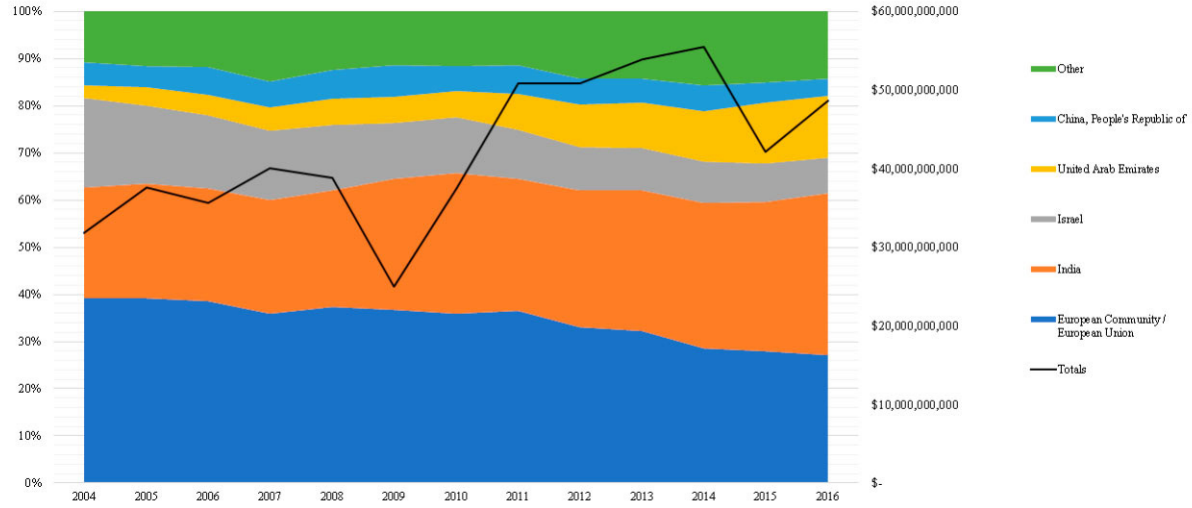
Largest producers of Rough Diamonds in USD



Largest importers of Rough Diamonds in Carats



Largest importers of Rough Diamonds in USD



However, the liquidity of the futures hardly reflects the actual volume of the rough diamond market. In fact one can conclude that they are barely being utilized as tools for hedging by businesses.

1. The market for production of rough diamonds is over $12 billion or 120 million carats on yearly basis

2. Every year nearly $50 billion worth of rough diamonds are imported of which over 30% by India which translates in 400 million carats of which 50% are imported by India

3. Each month over $150 million worth of futures in polished diamonds are being

trade

This discrepancy can be largely attributed to the fact that the flexibility of the hedging contract is severely limited. In addition, the limited access to these hedging contracts (only on ICEX) is another feature of the market structure which serves as a deterring factor when it comes to smaller businesses hedging risks outside of India.

3. **Diamonds as an Investment Vehicle.**

Polished diamonds have been found to be excellent investment tool due to their price change properties [6], [7], [8], [9], [10], [11], [33]. Nonetheless, no public data is available with regard to asset managers focusing on diamonds as an investment vehicle. Therefore, estimating the size of this market for BitCarat is challenging.

However to illustrate the points made in scientific journals, an extremely brief and basic analysis has been conducted from a asset management perspective[25].

We pick a number of “investment choices” - we will refer to these investments by their numbers in this list - e.g. 1-3 means the first three from this list:

1. SPDR S&P 500 Trust ETF (SPY);
2. iShares STOXX Europe 600 (DE) (EXSA.DE);
3. (Shanghai) SSE Composite Index (000001.SS);
4. SPDR Gold Shares (GLD);
5. Teucrium Corn ETF (CORN);
6. Morgan Stanley Emerging Markets Fund, Inc. (MSF);
7. CBOE Volatility Index (^VIX);
8. Spot 1CT Diamond Price (ICEX quoted).

The data frequency is daily and is downloaded from Yahoo! Finance for the period January 1, 2009 until July 18, 2018.

[25] Bear in mind that it is assumed that the reader possesses basic knowledge of finance.

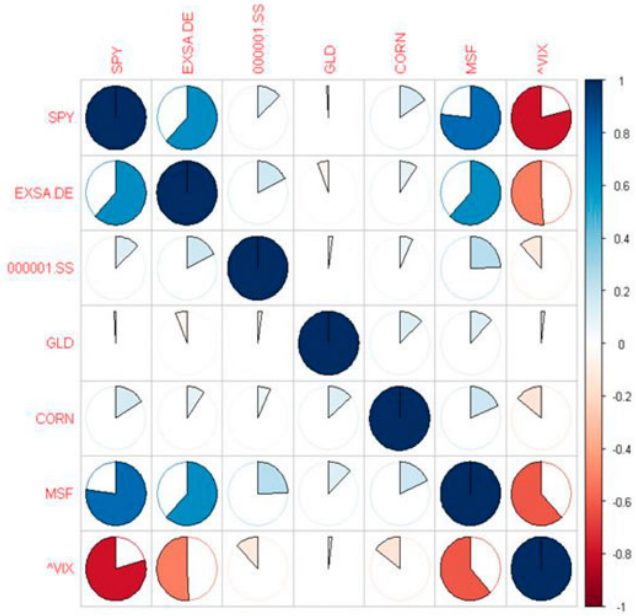
The brief analysis will be conducted in the following manner:

1. Demonstrate the correlations between assets 1 to 7 for the period January 1, 2009 - August 27, 2017 (the latter date is when the ICEX futures were launched).
2. Conduct portfolio optimization.
3. Extract the weights from the Markowitz portfolio.
4. Demonstrate correlations for the period August 28, 2017 until July 18, 2018.
5. Create multiple portfolios for the period August 28, 2017 until July 18, 2018.
6. Show results and provide summary
7. Conduct quantitative risk analysis (for brevity this part will be excluded and can be provided on request)

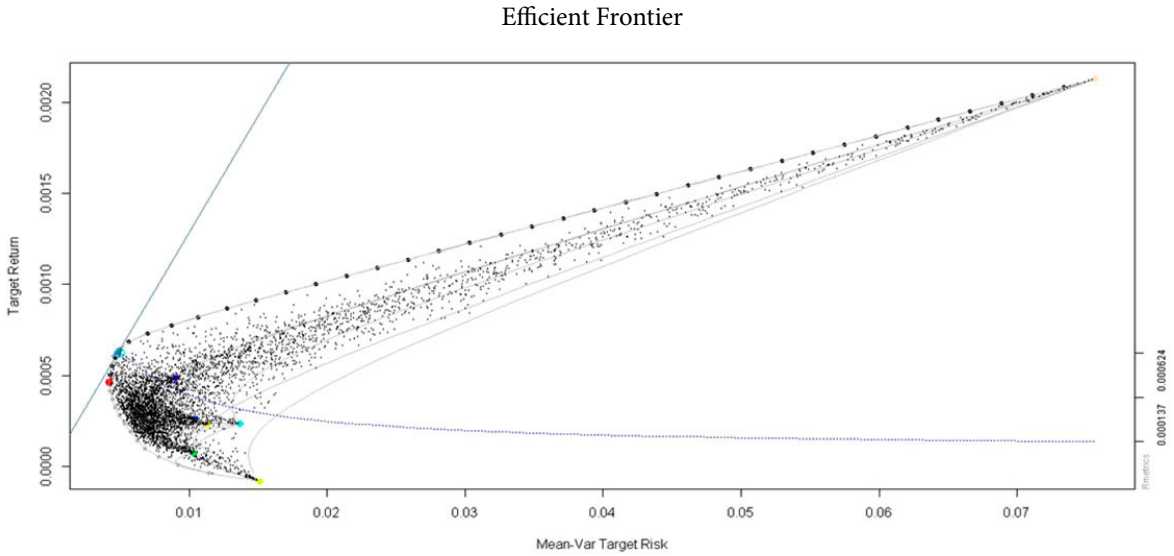
In total 7 portfolios are created[26]:

1. **EW** - Equally weighted portfolio of possible investments 1-7.
2. **SPY** - 100% of all funds are allocated to SPDR S&P 500 Trust ETF (SPY)
3. **Markowitz** - the weights extracted from the Markowitz portfolio optimization for the period January 1, 2009 - August 27, 2017 are then used in creating a portfolio from August 28, 2017 until July 18, 2018.
4. **CT1** - 100% of all funds are allocated to Spot 1CT Diamond Price (ICEX quoted)
5. **MarkowitzCT1_0.1** - is the Markowitz portfolio rebalanced in such a way that possible investment 8 (Spot 1CT Diamond Price (ICEX quoted)) is 10% of the portfolio.
6. **MarkowitzCT1_0.2** - is the Markowitz portfolio rebalanced in such a way that possible investment 8 (Spot 1CT Diamond Price (ICEX quoted)) is 20% of the portfolio.
7. **MkwzNoComCT1** - this is the Markowitz portfolio, however, possible investments 4 and 5 (SPDR Gold Shares (GLD) and Teucrium Corn ETF (CORN)) are excluded and replaced by possible investment 8 (Spot 1CT Diamond Price (ICEX quoted) - this is our chosen portfolio.

[26] Trading costs are ignored, portfolios are rebalanced weekly.

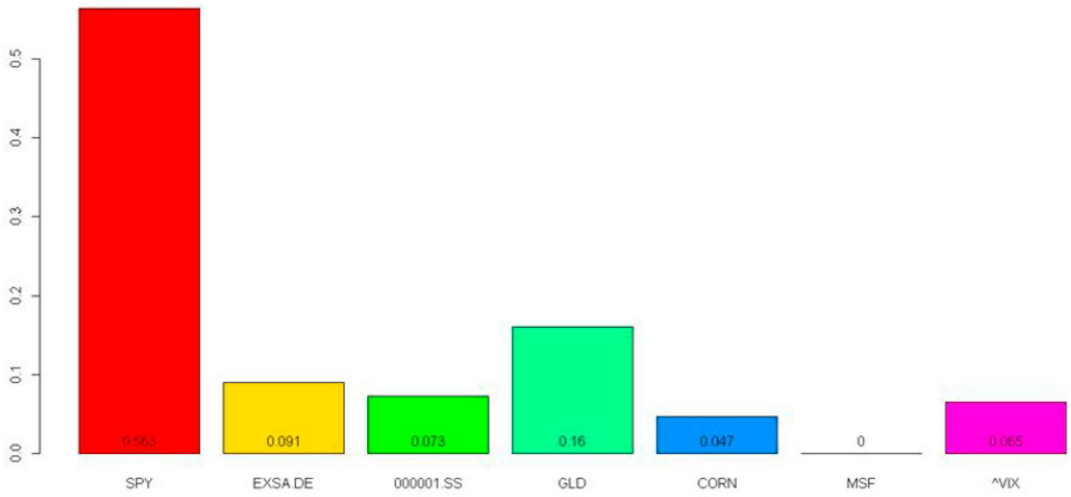


Correlations for the possible investments 1 to 7, January 1, 2009 - August 27, 2017.

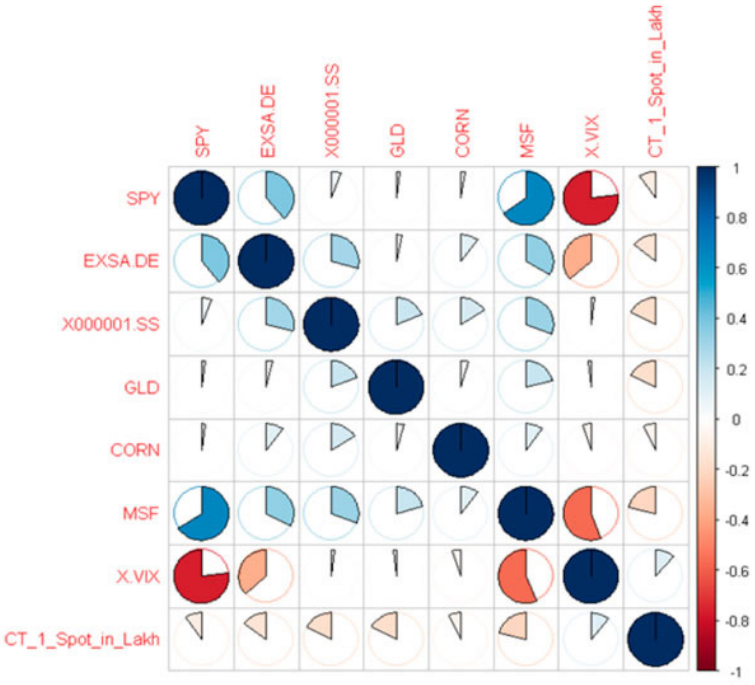


Efficient frontier for possible investments 1 to 7 for the period January 1, 2009 - August 27, 2017, on daily basis.

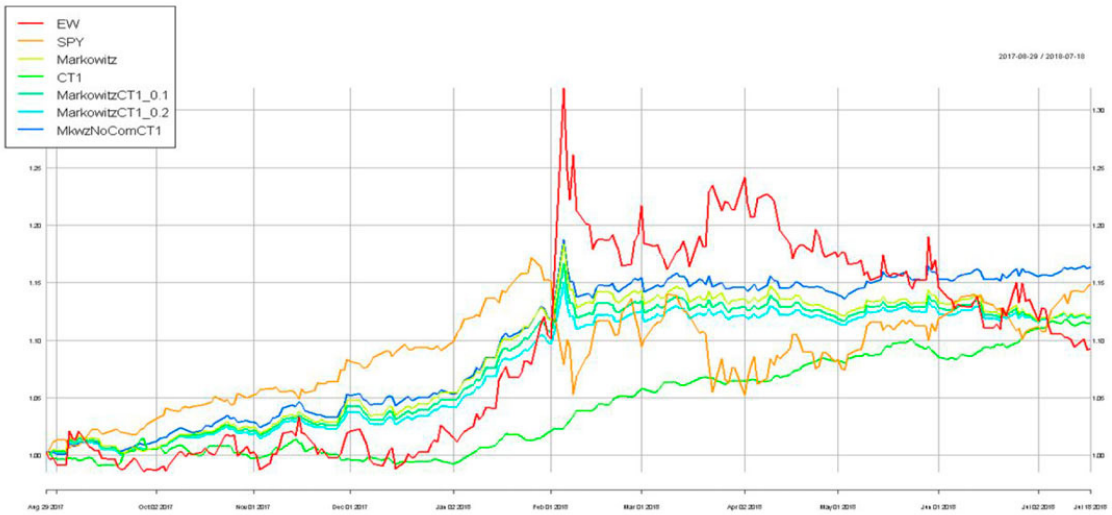
Markowitz Portfolio



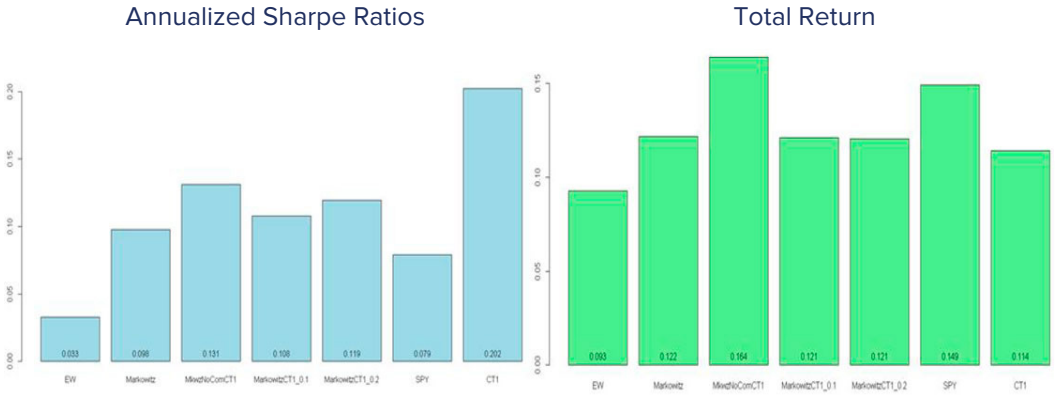
Markowitz portfolio weights extracted from the optimization for possible investments 1 to 7 for the period January 1, 2009 - August 27, 2017, on daily basis.



Correlations for the possible investments 1 to 8, August 28, 2017 until July 18, 2018.



Multiple portfolios - August 28, 2017 - July 18, 2018



Multiple Portfolios Summary - August 28, 2017 - July 18, 2018

1. Adding polished diamonds or their derivatives greatly improve the performance of the portfolio on both raw return and risk adjusted basis.
2. From risk-management standpoint the metrics show that the portfolio becomes more robust to market-wide shocks.
3. In addition, investing in in diamonds instead of commodities and precious metals as a hedge against large volatility swings is more favorable when it comes to both pure returns and in terms of risk-adjusted performance metrics.
4. With regard to risk management - VaR and spectral risk measures show that the chosen portfolio (nr. 7) is “safer” as compared to pure Markowitz portfolio.

Summary

Overall, diamonds as an asset class can be used in a large variety of ways by asset managers not only to hedge risks but to boost the performance - be it raw or risk adjusted of a diversified portfolio – either passively or actively managed.

Financial Projections for the BitCarat Project

1. BitCarat is a blockchain-focused FinTech company with roots in electronic exchanges embracing stocks, commodities and derivatives trading;
2. We deliver mature technological stack and a conservative compliance framework in order to create the first liquid marketplace for diamonds;
3. We solve the long-standing problem of fungibility in the diamonds industry. This allows for commoditizing diamonds, and turning these precious gems into an alternative asset class;
4. Our team has over a century of combined experience in actual diamond business as well as long-standing presence in leading academic establishments;
5. Our partners' list includes the giants of the diamond industry, such as Alrosa as well as some of the leading players on the emerging digital currency landscape.

The financial projects will be made in terms of income statements on monthly basis where the expenses and revenues are broken down into their components. We have made a number of assumptions without which these projections would be difficult to arrive at using solely public data.

Expenses

a. Staff & Salaries: Staff expenses rise over time as the headcount of the company grows. The company begins with a C-suite of six people and staff of nine. In 18 months this number grows to a total of 31 people of which still six are on executive roles, however the development team grows by nearly 60%. The salaries of the staff (excluding C-suite) increase by 5.25% each half year while executive bonuses ranging from 200% to 500% of a month's salary are awarded again half-yearly. Analytics that come up with unique business proposals are awarded 750% of a

month's salary which is reviewed at the end of each year.

b. Advertising & Commercial: These include costs for promoting the operations of the exchange both in the cryptocurrency space and in the diamonds trading industry. Each half a year they are cut by 50% as the company becomes more and more popular and advertising becomes less and less vital part of the revenue growth.

c. Exchange Software Development: The exchange development will cost a cumulative of $2.5 million which is paid in 12 equal parts over the course of a year. Afterwards only minor monthly expenses for maintenance and development will be incurred.

d. Market Making: We assume that we will expend $1.5 million in the first months of operations and subsequently each month we will spend $750,000 on market making in order to provide depth to the order books at all times to promote trading by institutional and retail investors alike.

e. Legal: The legal expenses include those of obtaining licenses in Switzerland and for litigation reserve. The Swiss licenses are estimated in the amount of $2.25 million paid in the course of 18 months while litigation reserves are $10,000 per month and should cover any unexpected litigation expenses.

f. Blockchain Development: While in-house developers will work on the blockchain infrastructure outside developers will also be hired and is expected to pay $150,000 (excluding down-payments) each quarter for five quarters in order to develop and integrate the blockchain fully.

g. Offices & Other: Two 100 sqm offices will be leased in Netherlands and Saint Petersburg respectively which amount to $5,400 per month. Further expansion will be considered after the first 18 months. Other expenses include utilities, employee documentation preparations, unexpected expenses and so forth and are estimated to amount to 0.25% of total expenses and rise at the rate of 2% each month.

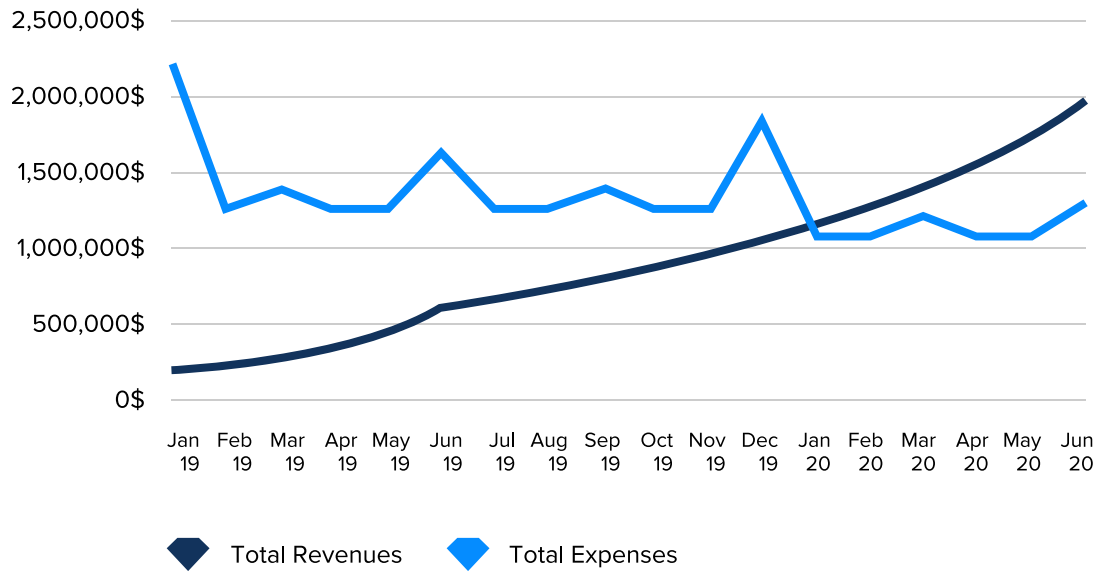
Revenues

a. Stablecoin Trading: We assume taker fee of 0.085% while the maker fees will be 0% both of which match industry standards and even challenge them. We analyze the stable coins market (e.g. USDT, TUSD, and others) - their short and long-term price dynamics and after multiple data filtering we arrive at 53.3% monthly volume growth rate for the first 6 months and about 11% monthly growth rate after that. The total volume traded per month is over $2 billion by the 18th month of operations

which by industry standards is relatively modest.

b. Futures Trading: Here we look at the growth rates of the volume traded of the three types of futures at ICEX - ranging from 1 CT to 0.3 CT. We find that although the dollar volume is low it's growth rates are staggering at over 80% per month for the first six months followed by 18% per month afterwards. The trading volume reaches $86 million in the 18th month which as compared to the daily average of $5 million at ICEX is considerate estimate.

Beyond these points there will be interest on the side of funds and retails for diamond tokens. On the one side sits the hedging opportunity while on the other the liquidity. Both of which, as noted, in the text above make it extremely attractive for institutional and retail investors alike.



The breakeven point occurs in January 2020 given that we begin the project in January 2019 and the cumulative net income (retained earnings) from that point until and including June 2019 is $9.110 million and expected to grow at the same steady monthly pace of about 130% per month until the end of 2020.

Making projections beyond that point, in our opinion, is unprofessional and would at the very least mislead our potential investors as the cryptocurrency market is extremely volatile not only in terms of prices but also in terms of regulation, adoption, and especially when amalgamated with the diamonds market.

Fundraising: Financing the Future

Motivation for a Security Token Offering (STO)

Once a token's value is determined based on the performance of an external asset that token is then classified automatically as security token and all related regulation also subsequently applies. The STO structure provides all of the future and global BitCarat investors - be them institutional or retail - with a fully legitimate way of securing funding for the project as compared to an ICO. The distribution of BTK (the security token) assures that it's holders are entitled to the residual cash flows of the exchange (that is part of the fees) along with the blockchain transactions' fees. In this setting, the BTK clearly qualifies as a security token and will be treated as such.

STO Structure

Two types of tokens will be distributed to the public and private investors – the "stable coin" TXD as well as the "staking coin" BTK.

STO Distribution

The total supply of the BTK is set at 100,000,000 while that of TXD is unlimited. The team reserves 40% if BTK (40,000,000) for project development, advisory and team incentive schemes, market making, listing, and other promotional activities of the project.

The distribution is broken down into three phases as illustrated in the tables below:

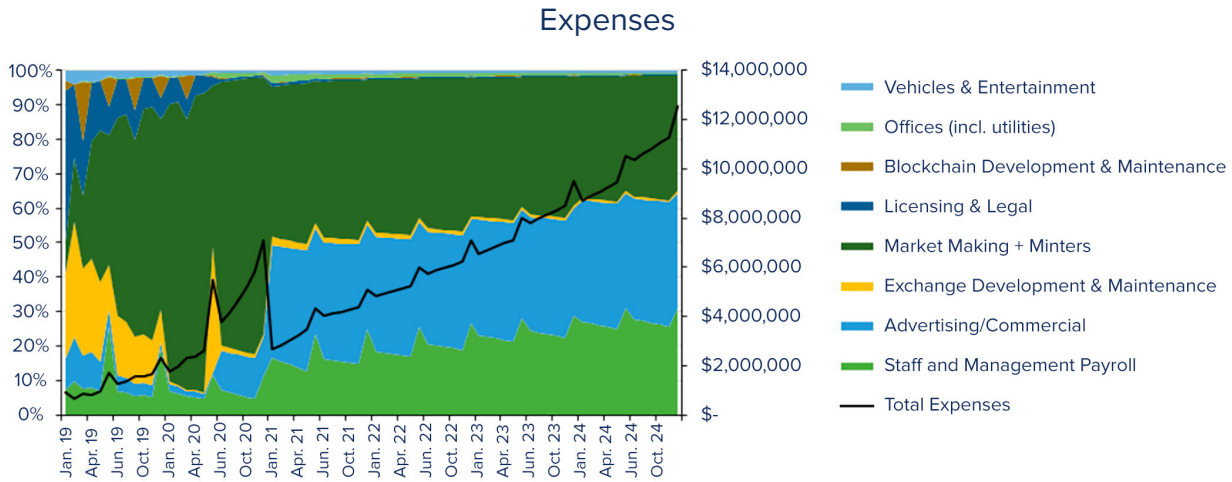
	Start		End	
STO Phase	Date	Time GMT+0	Date	Time GMT+0
Phase I	Nov. 1, 2018	4:00:00 PM	Dec. 1, 2018	4:00:00 PM
SPhase II	Dec. 2, 2018	4:00:00 PM	Dec. 17, 2018	4:00:00 PM
SPhase III	Dec. 18, 2018	4:00:00 PM	Jan. 2, 2018	4:00:00 PM

STO Phase	BTK Distributed	In Percent	Price	Discount	Raise	TXD Distributed % of Raise	Worth of TXD Distributed
Phase I	15,000,000	25%	$ 1.04	50%	$1 5,625,000	20%	$ 3,125,000
Phase II	18,000,000	30%	$ 1.56	25%	$ 28,125,000	5%	$ 1,406,250
Phase III	27,000,000	45%	$ 2.08	0%	$ 56,250,000	5%	$ 2,812,500
Total	60,000,000	100%			$ 100,000,000		$ 7,343,750

Each phase begin at 4:00PM GMT+0 and at the 1st day of each new month starting September and ending November of 2018. The first rounds lasts 30 days, the second 31 days, and the last 18. The amount of tokens distributed in each phase increases while the discount falls from 50% in Phase I. The hard cap of the project is US$100,000,000 while the soft cap is US$15,000,000. All unsold tokens will be burned.

In addition to the conventional, nonetheless quite large discounts the BitCarat STO will give as a bonus also TXD - that is, part of the raised sum will be used to purchase and store physical diamonds. These distributions are conditional on reaching the soft cap. To make this point clearer, 20% of the raised funds during Phase I will be used to buy diamonds and distribute (airdrop) to the investors proportionate amount of TXD. The TXD will be readily convertible to physical diamonds that BitCarat will deliver to their respective holders.

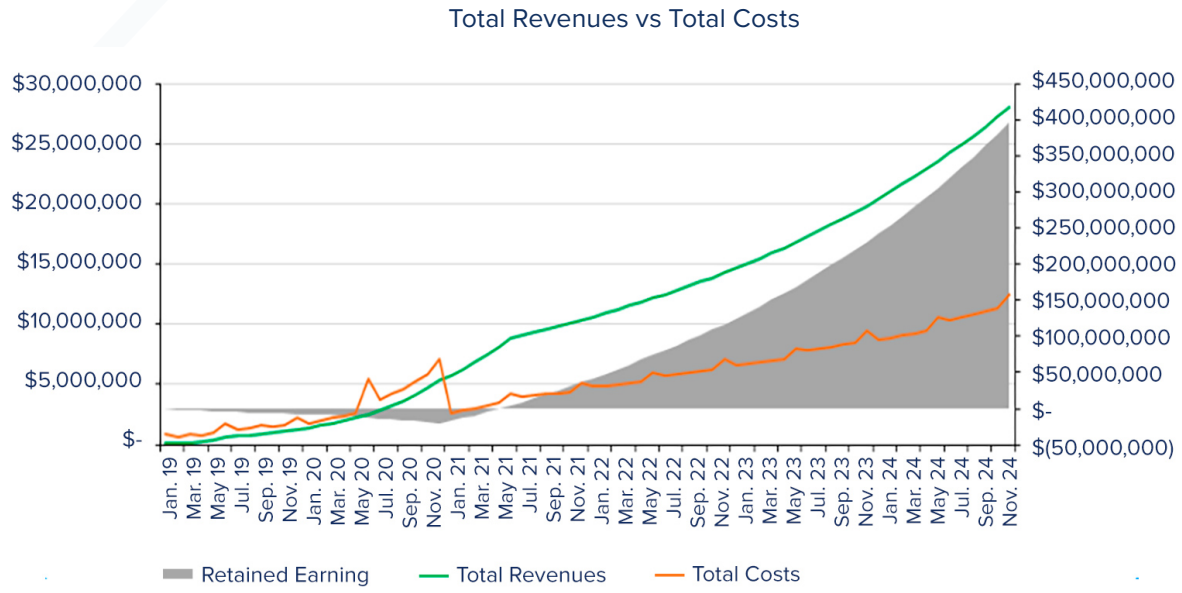
STO Funding Allocation



The funding will be allocated across eight general cost components:

1. **Exchange Development & Maintenance** – These costs comprise the development of the exchange system alongside its support components, colocation, and the maintenance of each. The total capital expenditure amounts to a little over $5,000,000 with yearly recurring costs of about $700,000.
2. **Market Making & Minter's Fees** – Providing depth of order books and narrow spreads is essential for the establishment of a market of entirely new asset class aimed for institutional participation. Therefore, 10% of monthly revenues are allocated each month for market making. Minters' Fees are as % of total monthly revenues and fall each year as follows: 2019: 90%, 2020: 90%, 2021: 10%, 2022: 10%, 2023: 8%, 2024:5%.
3. **Staff and Management Payroll** – The payroll is based on a C-suite of six people and a starting operational level staff of nine which later grows to 445 – 203 of which support and 102 marketing and the rest risk management, administration, analytics, business development and IT. At the end of each June and December salaries of the operational level employees are indexed by 10% and the management receives bonus which is between seven and nine times the monthly salary depending on KPIs.
4. **Advertising & Promotions** – Before June 2020 these expenses will consists solely of articles, PR, and some SEO. After that, each month 15% of the revenue will be spend on heavy advertising and customer acquisition techniques.
5. **Licensing & Legal** – The application for and obtaining of Swiss MTF could take over a year and will cost upward of $2,000,000. In addition, monthly litigation reserves are made in total of $25,000 to cover any unexpected legal fees.
6. **Blockchain Development & Maintenance** – Blockchain development is expected to cost no more than $750,000 with monthly maintenance fees of $5,000.
7. **Offices (incl. utilities)** – Offices in Russia, Netherlands, Hong Kong, and Switzerland will be opened over time as the headcount grows towards the targeted over 450 by end of 2014.
8. **Vehicles & Entertainment** – Corporate vehicles will be leased as well as events organized to keep up the company morale as it expands.

9. **Depreciation, Amortization, Interest Expenses, Tax** – None will be incurred as loans are not taken and cars and offices are leased while intellectual property would take time to be developed and it is difficult to estimate as of this moment its value. Taxable rate is also ignored as it is yet not known the tax efficiency with which the company will operate.



Compliance

Compliance with the multifaceted applicable regulation is one of, if not the most important aspect when speaking about acquisition of market share of well-established markets with 'sturdy' barriers to entry. In particular, providing a venue for both institutional and retail participants, where the stablecoin along with the staking coin are traded in a fair and transparent setting is the milestone which marks all future developments of the BitCarat project. Furthemore, as noted on multiple occasions earlier, trading of financial derivatives (where the underlying is the stablecoin) as well as banking services are both features that BitCarat will offer. In the the contemporary world of rapidly developing digital economy having all of these features fully functional and available on a global scale to retail and professional investors can be considered at best a stiff challenge.

In this section we will describe how the BitCarat team tackles these issues in manner that is appealing even to the strictest of regulatory bodies by also going over the applicable regulation of the Cayman Islands.

Applicable Regulation

Trading Venue for Stablecoins (TXD)

"Securities Investment Business" is regulated as described in the terms of the Cayman Islands Securities and Investment Business Law (SIBL). Most investment managers and investment advisors fall within the definition of an "Excluded Person" for purposes of SIBL and will not, as a result, be subject to regulation in terms thereof. Excluded Persons will however need to register with the Cayman Islands Monetary Authority (CIMA), registration with which gives rise to no further regulatory obligations than the payment of a prescribed annual fee to CIMA. However, depending on the nature and extent of the Investment Manager's activities, further registration and/or licensing may be required in terms of CIMA which may exclude eligibility to register in the Special Economic Zones (although this is viewed as very unlikely). The Cayman Enterprise City (CEC) Order, 2011, sets out the qualifying criteria for the establishment of an SEZ company within CEC's Commodities and Derivatives Park as follows:

The activities of Cayman Commodities & Derivatives Park are regulated in accordance with *the Special Economic Zones Law (Law 22 of 2011) (2017 Revision) and the Special Economic Zones (Cayman Enterprise City) (Amendment) Order, 2015*.

Therefore, according to these regulation acts: Cayman Commodities & Derivatives Park designed to create a centralized global commodity and derivatives market in Cayman, with the intention of being the first dedicated commodities and derivatives center in the Americas' time zone. Division: 64 - (Group 649) other financial service activities, except insurance and pension funding activities. This group includes financial service activities other than those conducted by monetary institutions, and is modified to include other financial services activities (but only those relating directly or indirectly to commodities, derivatives, futures and options, howsoever and wheresoever settled; commodities fund management; or proprietary trading for own account, including facilitating and supporting such businesses). This group excludes insurance and pension funding activities. The qualifying criteria are broad enough to include the activities of most investment managers and advisers who deal with commodities and derivatives.

Summary

In the light of the aforementioned, as the BitCarat project aims to establish a scientific and

technological foundation for a diamond marketplace with efficient price formation and deep liquidity, it is necessary to be conformant with the overall regulation of commodities and derivatives investment management in the Cayman Islands.

Trading Venue for Cryptocurrencies (BTK)

While there has still been no legislation passed for cryptocurrencies, the Cayman Islands Monetary Authority has created a working group with members from government and the private sector that has made certain recommendations for government's consideration, existing legislation in the Cayman Islands can be applicable.

In particular, the Securities Investment Business Law (2015 Revision) and the Mutual Funds Law (2015 Revision) can be applicable given the wide definitions of Security and Money Services Business. The Anti-Money Laundering (AML) regime consists of laws and regulations that should be considered duly when conducting a Security Token Offering due to AML's wide application and the likelihood that compliance will be required. Some of the AML Legislation includes the Proceeds of Crimes Law (2018 Revision), the Anti-Money Laundering Regulations, 2018 and the Guidance Notes on the Prevention and Detection of Money Laundering and Terrorist Financing regulations.

Summary

As mentioned earlier, the Cayman Islands Monetary Authority (CIMA) has not expressed its position regarding the legal status of cryptocurrency and its circulation. At the same time, using cryptocurrency as a means of payment, the Money Services Law (MSL) can be applied. In compliance with the law, legal entities are required to obtain a license from CIMA for the implementation of activities to provide monetary services.

Appropriate Licensing

Trading of TXD and BTK and Margin Trading

Money Services Law (2010 Revision) provides for the licensing of all money services businesses and for the regulation of such businesses by the Monetary Authority. The ongoing supervision of money services businesses falls under the remit of the Banking Supervision Division.

Electronic Transactions Law (2003 Revision) is a law to establish the legal principles applicable to the conduct of electronic commerce and the processing, verification and attribution of electronic records; to provide for the approval, registration and liabilities of service providers; to establish a system for the regulation of processors of personal data; and for incidental and connected purposes. The law enacted by the legislature of the Cayman Islands.

The combination of having this licensing in place allows for the onboarding of retail and institutional clients when considering the trading of TXD and BTK against fiat and cryptocurrencies. In addition, margin trading facilities can be established and accessed upon being compliant with the provisions of the ETL.

Banking Services

The features that the Digital Diamond Bank offers will be made widely available by being fully compliant with the laws laid down in the Monetary Authority Law (MAL) and the Banks and Trust Companies Law (BTCL).

The Monetary Authority Law and the Banks and Trust Companies Law give the Cayman Islands Monetary Authority ("CIMA" or "Authority") the responsibility for licensing and regulating banking and trust business in the Cayman Islands. The Banks and Trust Companies Law provides the legal framework for the operation of banks and trust companies in the Cayman Islands. The Development Bank Law governs the operation of the sole development bank in the Cayman Islands. All applications for licensing under the Bank and Trust Companies Law are sent to, reviewed by and approved or rejected by CIMA.

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