



Empowering Growth By Enabling Investment

## Whitepaper, version 1.1

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At Topl, our goal is to build the financial infrastructure necessary to bring low-cost capital to developing countries. The barriers that hinder investment into these emerging and frontier markets not only deprive many regions of the capital necessary for an economy to thrive but also block investors from accessing premier opportunities. To break down these barriers and enable low-friction investments anywhere in the world, Topl is creating a blockchain protocol to source, execute, and track these investments and their outcomes.

This whitepaper is the first complete elucidation of the Topl concept, and will cover the motivations behind the project, an overview of its economic and technical design, and a roadmap for future work.



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# Our Goal

I

*To facilitate lower-cost, lower-risk investment into emerging & frontier markets.*

Today, 13% of the world's population (1 billion people) live in countries where the average GDP per capita is less than 10% of the OECD average, with another 31% (2.2 billion people) residing in countries with average GDP per capita less than 25% of the OECD average [1]. In addition to indicating substantial global inequality, this GDP differential represents arguably the largest growth opportunity for the global economy over the coming century. Increasing GDP per capita in every undeveloped and developing country to just 25% of the OECD average (roughly \$10,000 USD on a PPP basis) would total more than \$32 trillion USD in economic growth.

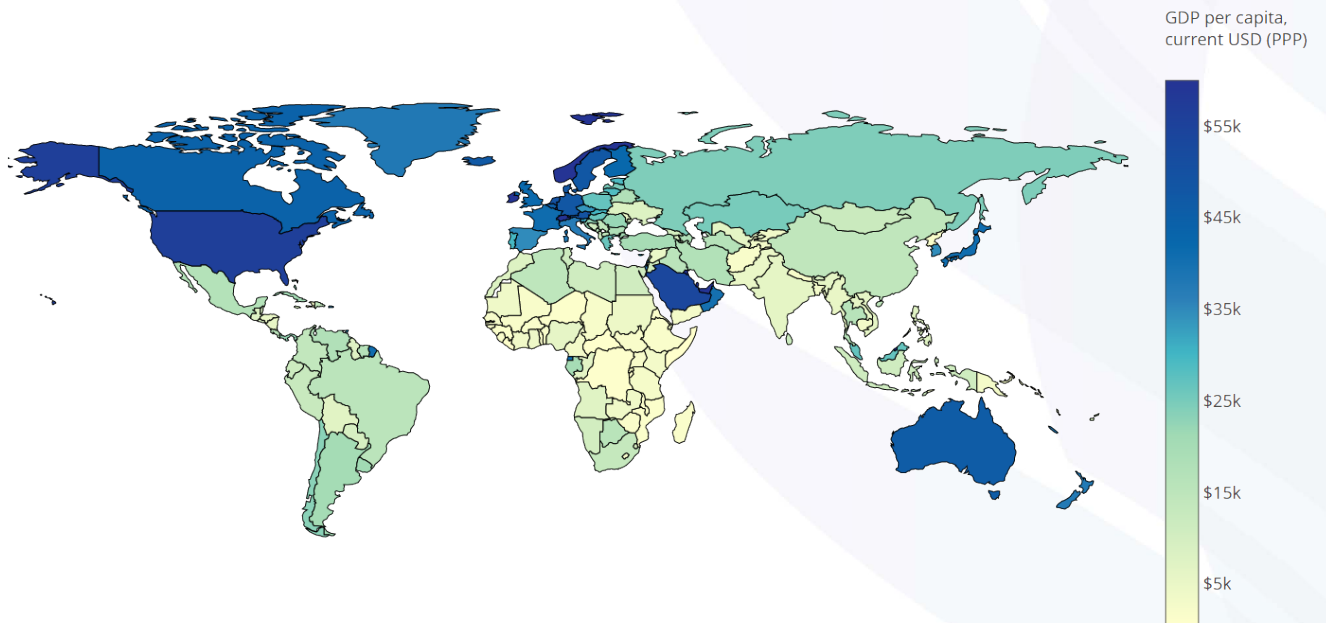


Figure 1.1: GDP per capita (PPP) by country (source World Bank)

Key in unlocking this economic growth is the availability of low-cost capital for businesses. Unfortunately, the average prime lending rate in E&F countries is four times higher than that of the US or other advanced economies, with the annual rate in some countries surpassing 20% or even 30% [2]. The significance of this fact has little to do with fairness and much more to do with the impact that excessive interest rates have on businesses, individuals, and an entire economy. When the cost of capital is high, businesses are reluctant to invest in innovation or expansion. The results of this are fewer jobs and less economic growth.

We believe that supply and demand are at the core of this problem. In many parts of the world, there is insufficient investment capital available to serve a region's economic potential. For this reason, we've designed the Topl protocol to facilitate foreign investment-originating from cash rich economies—into developing economies. By bringing low-cost, easily accessible capital to emerging and frontier (E&F) markets, Topl hopes to play a crucial role in the greatest economic growth opportunity of the 21st century.

# Current Landscape

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## II

Foreign investors can currently invest in E&F market companies in three ways—through stocks and corporate bonds, using a microlending platform, or directly.

### 2.1 Stock and Bond Markets

To see that E&F market debt and equity instruments have become popular investments, we need look no further than to the fact that since 1990 the total value of E&F stocks and bonds has increased from less than \$1 trillion USD to more than \$15 trillion USD [3]. While stocks and bonds issued by companies in E&F markets are undoubtedly popular, there is good reason to believe that such investments are far from optimal for either developing economies or investors. First, publicly listing a stock or issuing bonds on international debt markets is an extremely expensive and complicated process, as illustrated by data showing the size of average issuances easily exceeding \$100 million USD. Being accessible to only large and already established companies, stock and bond markets are severely limited in their ability to serve a growing economy primarily composed of young enterprises. Second, the structure and demands of stocks and bonds as a source of capital are fundamentally ill-suited for application to developing economies (more on this in Section 3.1).

### 2.2 Microlending

The modern concept of microfinance originated in the 1980's with Nobel laureate Muhammad Yunus and Grameen Bank [4]. Yunus's original model, which relied on a bank-like institution to provide small loans (around \$100) to empower individuals, has been extended by groups such as Kiva and My4C to allow for foreign individuals to invest from the convenience of their own home. While the goal of microlending, to empower the world's poor through investments of a thousand dollars or less, is certainly praiseworthy, the actual results leave much to be desired for both investors and the those receiving loans. First, due to small loan sizes, operating costs for microfinance institutions are extremely high, with every \$100 of loans outstanding resulting in

\$14 of operating expenses [5]. Unsurprisingly, the direct results of these high operating costs are decreased profitability for institutions, leading many of them to depend on substantial subsidies, and near-zero returns for investors. Second, numerous studies often fail to discover a significant relationship between microfinance and lasting economic growth or poverty reduction [6].

### **2.3 Direct Investment**

Lastly, foreign investors have the option of investing directly into private companies in developing countries. While conceptually the simplest approach, direct investment carries practical considerations that put it out of reach for the vast majority of investors. When we consider that to make such an investment one would need to remotely locate and vet a potential investment target, rely on legal structures with which he is likely unfamiliar, retain local counsel, and remit money through often volatile currency markets, it comes as no surprise that this remains an unpopular strategy for all but the most risk tolerant and experienced E&F market investors.

# Costs and Risks for E&F Market Investment

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## III

Having mapped out currently available options for investors looking to open positions in developing countries and the shortcomings of each, we move from these failures to the fundamental costs and risks associated with such investing. Drawing extensively from published research, we identify four essential concerns for would-be E&F market investors:

- ill-suited investment structures;
- a lack of reliable information;
- legal uncertainty and limitations regarding contract enforcement;
- foreign currency exchange.

It is our goal to understand as fully as possible these core problems with the current investment landscape for developing economies. By doing so and addressing these risks and costs in the very design of the Topl protocol, instead of simply demanding higher returns to compensate for higher risk and cost, we believe Topl can simultaneously improve the landscape for businesses and investors. However, before moving to how the Topl protocol overcomes these issues, we must first understand them.

### 3.1 Ill-Suited Investment Schemes

As discussed in Section 2.1, traditional investment is largely confined to equity and debt financing. Issuing stock, obtaining a loan, or selling bonds constitute the best traveled paths to raise capital. While these strategies are undoubtedly standard practice, there are critical problems with both standard debt and equity when applied to developing economies.

In short, equity financing relies on extended time horizons for extracting sufficient returns and liquid markets in which investors can reliably buy and sell at market rate. While this is not a problem in developed markets, developing economies face a higher likelihood of political or social turmoil, making long-term bets undesirable. Additionally, illiquid and fragmented E&F markets call into question an investor's ability to reliably offload assets at will.

Turning to debt financing, we are faced with the obvious fact that loans and bonds must be repaid. Therefore, debt places a strain on the profitability of a business while repaying its creditors. When interest rates are high, as is usually the case for companies in developing economies, this burden may be too large to bear, resulting in companies choosing to forgo seeking capital through debt or defaulting.<sup>1</sup>

<sup>1</sup> A more thorough examination of equity and debt financing in E&F markets can be found in Appendix A.

In light of the shortcomings of traditional equity and debt financing, Topl makes use of an alternative financing structure for capital deployed through its investment protocol. Topl investments take the form of project-specific revenue-sharing agreements, a detailed explanation of which can be found in Part IV.

### **3.2 Lack of Accessible and Reliable Information**

Due diligence, the exhaustive investigation of a potential investment target, is among the most important steps in the investment process. Before committing capital to a company or project, an investor must gather as much information on the business as possible. For domestic investments, information – even on private companies – can be gathered readily through a number of channels, including professional or personal networks and relationships, financial records, and discussions with vendors and customers.

Although these options exist for investors looking at companies in developing countries, there are concerns with both the accessibility and reliability of the information in such scenarios. To understand this problem, we turn to similar reasoning used when discussing the feasibility of direct investment (Section ref:direct). An investor's ability to collect and verify information for a potential investment is dependent upon their ability to locate and engage relevant parties. Predictably, this ability is severely hampered by key factors unique to E&F investment, including geographic and social distance and unfamiliar business and regulatory environments.

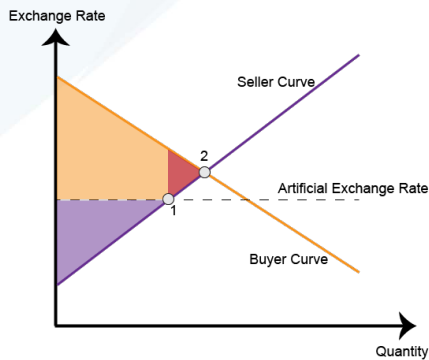
### **3.3 Legal and Regulatory Environment**

As already discussed, dealing in E&F markets exposes an investor to foreign legal structures with which they often do not have intimate familiarity with or counsel for. Even if the threat of dealing with arbitration or trial proceedings in foreign court is not a substantial enough concern for potential investors, they still must deal with relatively immature legal and regulatory frameworks that are often less friendly than those found in developing countries.

It is not difficult to uncover this disappointing relationship between a country's level of economic development and key aspects of its regulatory and legal environment. Data from the World



Bank [7], World Justice Project [8], and the Heritage Foundation [9] overwhelmingly show that developing countries are often less friendly towards businesses and investors across many key metrics including contract enforcement, regulatory burden, investor protection, legal efficiency, and corruption.



**Figure 3.1:** Artificial currency exchange rates, common in developing economies [10], can result in large losses for foreign investors. When a disequilibrium is created by an artificial exchange rate, the price to buy the currency (2) is higher than what it can be sold for (1).

### 3.4 Foreign Currency Exposure

Lastly, when speaking with anyone who has invested directly in a developing country, the difficulty of moving money across borders is likely to be one of the first headaches mentioned. Between fees, delays, and, most significantly, market disequilibriums, a foreign investor can have their returns entirely eroded.

While exchange fees can be reduced by increased competition and price swings can either be beneficial or detrimental, the loss caused by artificial exchange rates requires a more dramatic solution. To address this issue, the Topl protocol makes use of a value-stable cryptocurrency, the Poly, as medium of exchange and unit of account. We will further discuss the Poly, its properties, and its role in the larger system in Section 5.7.

# Topl Investment Process

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## IV

The Topl investment protocol was designed to address the concerns just discussed in the preceding section. Here, we will walk through the investment process of the Topl protocol.

All Topl investments involve three distinct parties—an Investor or Investor Group; the company receiving investment, known as a Producer; and a Hub, responsible for serving as an intermediary and facilitator and generally selected for its geographic proximity to the Producer. In the proceeding sections, we'll walk through three potential investments that could be carried out with the Topl protocol.

### 4.1 Commodity Production

In its first form, the Topl protocol was designed specifically to support investment in commodity production [11]. Despite expansion to cover additional investments types (Sections 4.2 and 4.3), investment in commodity production remains a key use case. The close tie between the Topl protocol and investment in commodity production stems from the use of commodity assets—such as grains, metals, chemicals, minerals, and natural gas—as reserves for Topl's value-stable cryptocurrency (Sections 5.6 and 5.7). As a way of introducing the application of the Topl protocol to commodity production, we illustrate how a Producer would go about funding the production of 30k bushels of corn over the next 3 years. This process may proceed as follows:

<sup>1</sup> All investment calculations in this paper are approximate and meant merely to illustrate general mechanics. For present purposes, the value of 1 Poly is set to be roughly 10 USD.

1. The Producer calculates that they need a 5k Poly investment<sup>1</sup> to purchase fertilizer, new machinery, and higher-yield seed.
2. Producer publishes this investment request through the Topl protocol, making basic information about the proposed investment, including the amount sought, available to all potential Investors in the Topl ecosystem.
3. An interested Investor contacts the Producer through the Topl protocol to begin negotiations over the specifics of an

investment.

<sup>2</sup> The use of a Hub to take delivery of the produced commodity comes from the desire to pool logistical expense across the protocol as a whole. By removing the burden of selling from each individual Producer while simultaneously moving the commodity up in the supply chain, Producer costs are reduced and a better price can be obtained.

<sup>3</sup> When taking delivery of a commodity, Hubs issue tokens that can be redeemed for that particular asset. These tokens can be exchanged on internal markets for Polys or tokens for other assets—or for fiat currency through external markets.

4. Based on the reputation of the Producer (Section 5.4) and broader investment climate, the Investor and Producer agree that at the end of each year of the contract revenue will be divided equally, 50%-50% between Producer and Investor. Additionally, they agree that 50% of the investment will be provided in the first year, with 25% being provided in each year 2 and 3 pending successful production in the year prior.
5. The arrangement enters into force when the Investor funds the proposed contract via an escrow account administered by the participating Hub. Once the escrow account is funded, the Hub dispenses 2500 Polys to the Producer, as stated in the contract.
6. At the end of the first year, the Producer delivers 8000 bushels of corn to the Hub.<sup>2</sup> Upon verifying delivery and quality, the Hub issues 4000 corn tokens<sup>3</sup> to each the Producer and Investor and releases 1250 Polys from escrow to the Producer.
7. At the end of year 2, the Producer delivers 10k bushels to the Hub. Again, after verification, the Hub dispenses 5000 corn tokens to each the Producer and Investor and releases the final installment of 1250 Polys to the Producer.
8. Completion of the contract is marked by a final delivery of 12k bushels of corn to the Hub and the subsequent final payout of 6000 corn tokens to each the Producer and Investor.
9. Finally, the Top1 protocol updates the Producer's reputation score to reflect the successful completion of the contract.

## 4.2 Utility Production

Traditionally, utilities such as water and electricity have been treated as fundamentally different from commodities like grains, metals, and fuels. Although they meet the core criterion for being a commodity, fungibility—one kW-h is equivalent to any other kW-h and clean water is clean water—they are not easily stored or traded. The reason is that utilities, unlike other fungible assets are, generally speaking, produced on demand and immediately consumed. However, if we treat production capacity as an asset with ownership that can easily be transferred, then we can apply a similar investment procedure as outlined for more traditional commodities.

To illustrate this process, let's consider a Producer looking to build an onshore windfarm capable of producing 50,000 MW-h an-

nually, with an operational life of 20 years. Steps involved in this process are as follows:

1. The Producer calculates that they need an investment of 5 million Polys to cover the cost of the turbines as well as operational expenses over their 20 year lifespan.
2. Producer publishes this investment request through the Topl protocol, making basic information about the proposed investment, including the amount sought, available to all potential Investors in the Topl ecosystem.
3. An interested group of Investors contacts the Producer through the Topl protocol to begin negotiations over the specifics of an investment.
4. Based on the reputation of the Producer and broader investment climate, the group of Investors and Producer agree to the following terms. During the first 5 years of operation, 75% of revenue will be collected by the Investor group; during years 6 through 10, 50% of revenue will be collected by the Investor group; during years 11 through 15, 25% of revenue will be collected by the Investor group; and during the final 5 years, all revenue will be collected by the Producer. Additionally, they agree that 80% of the investment will be provided up front, with 2% coming prior to each of the first 10 years of operation.
5. The arrangement enters into force when the Investor group funds the proposed contract via an escrow account administered by the participating Hub. Once the escrow account is funded, the Hub dispenses 4 million Polys to the Producer.
6. Producer completes purchase, installation, and testing of wind turbines, ensuring that the farm will meet the agreed upon production. The windfarm is then connected directly to the Topl protocol to allow for direct collection of Polys in exchange for electricity.
7. With the start of electricity production, the Hub dispenses 37,500 MW-h tokens to the Investor group and 12,500 MW-h tokens to the Producer in exchange for all revenue to be collected in the first year of production. The Hub will also dispense 100,000 Polys to the Producer in accordance with the contract.
8. At the beginning of each subsequent year, the Hub dispenses Polys to the Producer according the agreed upon contract. Additionally, the Hub dispenses MW-h tokens to the Investor group and Producer, taking into account the revenue

sharing agreement as well as any prior or anticipated changes in electricity production. During this time, the Producer will ensure proper upkeep and maintenance of production.

9. At the end of year 20 of operation, the contract is considered to be completed, and full ownership and control of the windfarm reverts to the Producer.
10. Finally, the Topl protocol updates the Producer's reputation score to reflect the successful completion of the contract.

### **4.3 Infrastructure, Real Estate, and Revenue Creation**

In addition to supporting the production of commodities and utilities, the Topl protocol can be used to support investments into more general businesses, specifying only that such investments are structured to produce revenue. This extends the protocol's coverage to include infrastructure construction, the development of income producing real estate, and the general provision of goods and services. The key distinction in the case of these investments compared to those involving commodity or utility production is that these latter investments are serviced entirely in Polys and do not involve delivery of goods to a Hub or asset tokens.

To illustrate how this may work, let us consider the following:

1. A Producer is interested in building and operating a hospital. They establish that they require an investment of 1 million Polys.
2. The Producer publishes this investment request through the Topl protocol, making basic information about the proposed investment, including the amount sought, available to all potential Investors in the Topl ecosystem.
3. An interested Investor contacts the Producer through the Topl protocol to begin negotiations over the specifics of an investment.
4. Based on the reputation of the Producer and broader investment climate, the Investor and Producer agree to the following terms. In each of the first 10 years of operation, the Producer will pay 100,000 Polys to the Investor. Then in each of the next 10 years, the Investor will receive, in Polys, 10% of operating profits from the hospital.
5. The arrangement enters into force when the Investor funds the proposed contract via an escrow account administered

by the participating Hub. Once the escrow account is funded, the Hub dispenses 1 million Polys to the Producer.

6. After each of the first ten years of the hospital's operation, the Producer pays 100,000 Polys to the Investor.
7. During each of the subsequent 10 years, the Producer pays out 10% of the hospital's operating profits to the Investor.
8. At the end of year 20 of operation, the contract is considered to be completed, and full ownership and control of the hospital reverts to the Producer.
9. Finally, the TopI protocol updates the Producer's reputation score to reflect the successful completion of the contract.

# Topl Protocol, Components

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## V

<sup>1</sup> We will focus here only on conceptual motivations for each component of the Topl protocol. A more detailed discussion of these aspects of the protocol will be available in our yellowpaper [23], currently under development.

In order to enable the investment procedures described in Part IV as well as address the problems with E&F markets described in Part III, the Topl protocol is carefully engineered, incorporating several key pieces of conceptual and technical machinery.<sup>1</sup>

### 5.1 Blockchain Network

The Topl protocol operates on top of Topl’s own blockchain network. The decision to build a blockchain network stems from Topl’s need for decentralization and its need for high fidelity in information and reliability.

Our motivation for choosing a decentralized network architecture comes from our desire to ensure that the Topl protocol is not reliant on or constrained by any particular national jurisdiction. Because we seek to design and build a global investment protocol, it is prudent to maintain neutrality and independence from national interests and influence—something likely impossible with traditional business and centralized network structures. By designing the Topl protocol on top of a decentralized network architecture, Topl’s network infrastructure lacks any single potential point of control or failure. In addition to ensuring that Topl’s network architecture is decentralized, we also must guarantee that information transmitted and stored by the Topl protocol remains correct and secure. To satisfy these requirements simultaneously, we turn to the cryptography, hashed data structures, and distributed messaging and consensus mechanisms of the blockchain.

### 5.2 Smart Contract Templating

The model investment processes described in Part IV made use of contracts that existed as part of the Topl protocol. The use of smart contracts, executed and fulfilled in a manner defined by the Topl protocol, stands as Topl’s solution to issues of contract enforceability and poorly formed or understood legal frameworks (Section 3.3). In the Topl protocol, smart contracts:

- Define the allocation of any Polys or commodity tokens that

- result from a contract between an Investor and Producer;
- Rely on only verification by at least two of the three involved parties—Investor, Producer, and Hub— before programmatically releasing any funds that may have been conditional;
- Are fixed in their structure and allow the parties only to define specified variables, including duration, production schedule, allocation of proceeds, and the asset to be produced.

### 5.3 Dynamic Access Controls

The Topl protocol utilizes a combination signature scheme to reconcile the complex and often opposing demands for both privacy as well as public and direct disclosure required for an investment protocol. This design provides Investors sufficient privacy while also maintaining the ability for Producers to provide appropriate disclosures to their future prospective Investors.

We use *traceable ring signatures* with  $k$ -times anonymity as described in work by Fujisaki and Suzuki [12] to allow Investors to engage in a contract without exposing their identity. The linkability property of the signatures allows verifying parties to ensure that contract transactions initiated by an Investor are only valid if that Investor is the one that was involved in the creation of the contract. Then because future prospective Investors will likely demand information about past investment dealings from the Producers with whom they would like to enter into an engagement, we implement a *designated verifier proxy signature scheme with delegation by warrant*. This signature scheme grants the Producer the ability to reveal the identities of their past Investors in such a way that only a designated prospective Investor can verify.

### 5.4 Divine

We discussed in Section 3.2 the difficulties encountered by potential investors interested in developing economies when performing due diligence and obtaining reliable information about potential targets. Due to the obvious importance of accurately determining the risk profile of all Producers engaged with the Topl protocol, the development of a suitable system for risk assessment has been a major thrust of our work.

To this end, we developed Divine, which to our knowledge is the first reputation system designed for use in E&F capital markets [13]. Divine derives its strength as a tool for risk assessment through its use of both contract outcomes and prediction markets. This allows the system to incorporate both objective information about the past behavior of a Producer as well as any new analysis and information that may influence future performance.



## 5.5 Arbids

Critical to the function of any consensus based system, such as a blockchain or a prediction market, is a mechanism by which the system can determine the amount of relative weight to assign to each participant. For the Topl protocol, this is accomplished through use of Arbit tokens. These tokens have a place in both Topl's blockchain consensus and prediction markets.

First, for Topl's proof-of-stake blockchain network, we must be able to select how to determine which transactions are and are not valid. At time of writing, we anticipate implementing a proof-of-stake system through which transactions are approved by a leader, who is elected by use of a probabilistic (randomized) algorithm, weighted by the Arbit holdings of each potential leader.<sup>2</sup> Second, the prediction markets to be used in Divine must weight different positions taken by market participants. This weighting will again be accomplished with Arbids—the more Arbids assigned to a particular position, the more influence that position will have on the aggregated market.

<sup>2</sup> A much simplified implementation of such a system may function as follows. There are three potential leaders, A, B, and C, to decide on the next set of accepted transactions. A has 15 Arbids, B has 50 Arbids, and C has 35 Arbids. Therefore, A has a 15% chance of being randomly elected, B has a 50% chance, and C has a 35% chance.

## 5.6 Tokenized Commodity Assets

The model investments outlined in Sections 4.1 and 4.2 relied on the creation and transfer of tokens for specific commodities. Our motivations for this unconventional setup are twofold. First, by shifting the process of selling the commodity from the Producer to a Hub, we can increase returns for the entire system. Second, these tokens serve as a reserve and backing for Topl's value-stable cryptocurrency, the Poly.

Between the time any commodity is produced and ultimately consumed, it moves through various steps in the supply and distribution chain, increasing in price at each step as every party extracts a cut. By allowing our Hubs to acquire commodities in exchange for issuing asset tokens, the system as a whole is capable of producing more value since Hubs can sell at higher prices than an individual Producer would be able to. In addition to enabling for more value to be produced by the Topl system, the commodity asset tokens are critical to Topl's value-stable cryptocurrency, the Poly.

## 5.7 Polys

The function of the Poly in our system, like that of asset tokens, is twofold, to circumvent artificial exchange rates that result in substantial and irrecoverable losses for participants (Section 3.4) and to serve as a stable store of value and unit of account. This first function is easily accomplished by the nature of the Poly being a non-national cryptocurrency and therefore immune from artificial

exchange rates imposed on fiat currency pairs.

The Poly fulfills its second function by nature of being backed by commodity assets. As we have discussed previously [14] [15], a sufficiently broad basket of commodities — especially one that manages to include utilities — will serve as a reliable store of long term value. The Poly is constructed as a commodity basket in this manner by the process of its issuance and redemption. The Topl Foundation, whose exact role and structure will be detailed in future work, will issue and redeem Polys in exchange for certain commodity (and currency) tokens at a ratio that is continuously dictated by the free market and needs of the protocol.

# Debt and Equity for E&F Investment

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## APPENDIX A

Looking first at equity, we note that such investments yield returns in two manners: by paying dividends and through price appreciation. As an equity investor, one can either collect an annual dividend check or sell the stock at a higher price in the future to achieve a return. The first strategy requires an extended investment horizon, the second necessitates being able to find another buyer for the stock you hold.

On average, E&F and developed market stocks pay out between 1% and 4% of their share price in annual dividends. Therefore, to fully recoup an investment through dividend payments alone, you would have to wait at least 25 years. This is typically not an issue for investors operating in stable economic, political, and social climates where risks are well-known and can be appropriately priced into the value of a stock.

However, E&F countries often do not have stable economic, political, or social climates. Over longer time horizons, such environments present investors with “unknown unknowns” or Knightian Uncertainty, which can be best understood as the uncertainty that comes from knowing neither the likelihood of an event or what such an event might even be [16]. In light of this Knightian Uncertainty, investors are prone to being overly cautious as there is little way of knowing the risks being faced. The result of such behavior is E&F equity pricing that does not accurately reflect the fundamentals of an enterprise and thus creates a suboptimal and inefficient market detrimental to both sides.

Since a reliance on dividend payouts will not result in efficient capital allocation in E&F equities, perhaps the correct approach is to value these stocks with the expectation of selling in the future. In developed markets, this is a straightforward matter; the expected investment return is simply the selling price minus the purchasing price. If you think a stock will go up by 10%, you expect a 10% return on your investment. Hidden in this expectation however is the assumption that a buyer can be found at the necessary moment for an appropriate price. In other words, we are assuming the market is sufficiently liquid. Perhaps unsurprisingly, E&F markets are rarely as liquid as developed markets for which there is much greater availability of capital. When dealing with an illiquid market, our assumption of being able to find a buyer

for our stock whenever we want must be abandoned. Now when calculating an expected return for a stock that has appreciated 10% in value investors must subtract the cost that comes from possibly selling at a less than ideal moment or at a price different from fair market value.

The consequence of having to throw out this liquidity assumption is once again E&F equity pricing that inaccurately reflects the fundamentals of the enterprise being invested in [17]. Therefore, we can conclude that by both available methods of evaluating return, E&F equities are not valued solely on the merits and risks of the enterprise invested in but are in large part influenced by shortcomings in the E&F markets themselves. The overall effect of this is, as already mentioned, an inefficient and suboptimal equity market that is detrimental to the interests of investors and investees.

Luckily in the case of debt, the situation is less complicated (though regrettably no more encouraging). A cursory overview of a fictional company will more than suffice to illustrate the key problem in deploying debt financing in E&F markets. Consider two identical textile producers, Company A and Company B. Both companies record \$5MM in annual earnings on revenue of \$20MM for a net margin of 25%. To expand and open new manufacturing plants, each business is seeking a 10-year bank loan but would like to retain a net margin of at least 10%. Company A, based in the US, is offered funds at a 5% interest rate while Company B, based in Nigeria, is offered funds at a 20% interest rate.

Based on these rates and our profitability constraint (put in place to act as a safety net), Company A can take a loan \$20MM, twice as much as the \$10MM loan that Company B can take.

The issue revealed by the above scenario lies in the impact of interest rates on the ability of company to safely raise debt to finance growth. The high interest rates found in E&F markets have one of two possible effects:

- Companies are less likely to use debt to fund growth strategies and therefore economic growth is negatively impacted;
- Companies borrow as they would if they faced lower interest rates and face a higher probability of default driven by larger interest payments.

# Stable Coins

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## APPENDIX B

There are currently a number of proposals for and implementations of stable cryptocurrencies, or stable coins. Broadly speaking, every stable coin is defined by two properties: the asset or assets to which its value is pegged and the mechanism by which this link is accomplished.

### **Asset Pegs**

Stable coins are most often pegged to either gold or fiat currency. Either of these approaches has substantial merit depending upon the specific purpose of the cryptocurrency. Pegs to fiat currencies like the US dollar are ideal for cryptocurrencies intended for use in everyday e-commerce or micropayments because their value will mirror the normal currency for such transactions and come with no mental burden for users. On the other hand, stable coins pegged to a single fiat currency may not be ideal for large cross-border transactions or as a long-term store of value. Two pegs have been so far been proposed for solutions to these use cases, a peg to a precious metal like gold and a peg to the supra-national pseudo-currency of the International Monetary Fund, the SDR.<sup>1</sup>

<sup>1</sup> SDR stands for Special Drawing Right and was created by the International Monetary Fund to serve as an international unit of account and reserve for member nations. It can be thought of as a basket of different reserve currencies, currently composed of the US dollar, Euro, Chinese yuan, British pound, Japanese yen.

Given that Poly is intended to be used as an instrument of global trade and investment, it would make sense to compare its basket peg against gold and the SDR. First, let's consider the Poly in comparison to gold. Although gold has long been considered an excellent store of value, its ability to function in such a manner is entirely accidental.

In order for an asset such as gold to be a successful store of value, two conditions must be met. First, the supply of the asset must not grow faster than the economy at large and its relative worth should not decrease in comparison to other assets. It should not be hard to see that gold does not necessarily hold these properties across time. It's quite easy to imagine the discovery of substantial gold deposits that flood the market or a gradual shift in preference from gold to some other precious metal. On the other hand, the basket of commodities, goods, and currencies backing the Poly is representative of a sufficiently large swatch of the aggregated economy as to be immune from such concerns. Look-

ing now at the second proposed peg for a stable cryptocurrency, the SDR, we encounter what is known as the Triffin Dilemma. The Triffin Dilemma, first suggested in the 1960's by economist Robert Triffin, notes a problem with using a national currency as a global reserve and unit of account. The issue that Triffin discovered is that there are occasions where the monetary needs of the nation that happens to issue the global reserve currency conflict with the needs of the global economy. Because the SDR is simply a basket of several national currencies, the Triffin Dilemma is as much a concern for its use as a unit of reserve and account as for the USD. In comparison, only a small fraction of the Poly's value is derived from currency holdings; therefore, its exposure to the Triffin Dilemma is substantially mitigated.

## Linking Mechanisms

The second property of any stable coin is how it achieves its intended peg. As can be seen in Table B.1, two strategies dominate, actual ownership of the pegged asset and usage of financial derivatives. Once again both these strategies have their own merits depending upon the intended use of the stable coin.

	Asset Peg	Linking Mechanism
StabL Tokens [18]	Fiat currency	Derivative instruments
Tether [19]	USD	Bank deposits
BitUSD [20]	USD	Derivative instruments
Dai [21]	IMF SDR	Derivative instruments
Digix Gold [22]	Gold	Stored bullion
Poly	Variable basket	Distributed asset ownership

**Table B.1:** The asset peg and linking mechanism of various stable coins

The use of derivative contracts such as options, futures, and collateralized debt obligations is favored by many because of the decentralized nature of such systems and their ability to mirror the price of an asset without requiring ownership. Although the lower overhead of the derivative approach likely makes it ideal for small amounts of value, we have substantial concerns about the robustness of these systems in the face of major economic stressors and believe that their proponents may rely excessively on assumptions of continuous rationality in financial markets.<sup>2</sup>

In light of these concerns, we believe that the best approach to achieving a peg for the Poly is to rely on the actual ownership of the assets comprising its basket.

<sup>2</sup> These concerns will be fully explored in future work.

# References

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- [1] World Bank, “World Development Indicators,” 2017. [Online]. Available: <http://databank.worldbank.org>.
- [2] International Monetary Fund, “International Financial Statistics,” 2017. [Online]. Available: <http://www.imf.org/en/Data>.
- [3] Brookings Institution, “Corporate Debt in Emerging Economies: A Threat of Financial Stability?,” 2015.
- [4] “The Nobel Prize 2006,” Nobel Media, [Online]. Available: [www.nobelprize.org](http://www.nobelprize.org).
- [5] R. Cull, A. Demirguc-Kunt and J. Morduch, “The Microfinance Business Model: Enduring Subsidy and Modest Profit,” Policy Research Working Paper, vol. 7786, 2016.
- [6] A. Banerjee, D. Karlan and J. Zinman, “Six Randomized Evaluations of Microcredit: Introduction and Further Steps,” American Economic Journal: Applied Economics, vol. 7, no. 1, pp. 1-21, 2015.
- [7] World Bank, “Doing Business,” 2017. [Online]. Available: <http://www.doingbusiness.org/>.
- [8] World Justice Project, “Rule of Law Index,” 2016. [Online]. Available: <https://worldjusticeproject.org/ourwork/wjp-rule-law-index>.
- [9] Heritage Foundation, “Index of Economic Freedom,” 2017. [Online]. Available: <http://www.heritage.org/index/>.
- [10] International Monetary Fund, “Annual Report on Exchange Arrangements and Exchange Restrictions,” 2016.
- [11] Topl, “The Blockchain and Global Investment - Eubank Conference 2016,” April 2016. [Online].
- [12] E. Fujisaki and K. Suzuki, “Traceable Ring Signature,” Lecture Notes in Computer Science, Public Key Cryptography, vol. 4450, 2007.

- [13] M. Kindy II, "Divine: A Blockchain Reputation System For Determining Good Market Actors," Jun 2017. [Online]. Available: <https://medium.com/topl-blog>.
- [14] C. Georgen, "A Proposal for Natural Money," April 2017. [Online]. Available: <https://medium.com/topl-blog>.
- [15] C. Georgen, "Friedman, the Blockchain, and the Coming Monetary Revolution," June 2017. [Online]. Available: <https://medium.com/topl-blog>.
- [16] P. Dizikes, "Explained: Knightian uncertainty," MIT News, 2 June 2010.
- [17] J. Hund and D. Lesmond, "Liquidity and Credit Risk in Emerging Debt Markets," SSRN, 2008.
- [18] H. Charlanes, "StabL Bringing Stable Tokens and Derivative Products to the Ethereum Blockchain," February 2017. [Online]. Available: <https://medium.com/stabl-blog>.
- [19] Tether, "Tether: Fiat currencies on the Bitcoin blockchain," [Online]. Available: <https://tether.to/wpcontent/uploads/2016/06/TetherWhitePaper.pdf>.
- [20] D. Larimer and F. Schuh, "Bitshares 2.0: General Overview," [Online]. Available: [http://docs.bitshares.eu/\\_downloads/bitshares-general.pdf](http://docs.bitshares.eu/_downloads/bitshares-general.pdf).
- [21] R. Christensen, N. Mushegian, D. Brockman, K. Rowe, A. Milenius and R. Zurrer, "The Dai Stablecoin System," [Online]. Available: <https://github.com/makerdao/docs/blob/master/Dai.md>.
- [22] A. Eufemio, K. Chng and S. Djie, "Digixs Whitepaper: The Gold Standard in CryptoAssets," January 2016. [Online]. Available: <https://dgx.io/whitepaper.pdf>.
- [23] M. Kindy II and Z. Huang, "Topl: A Blockchain Protocol for Remote Investments Via Production, Storage, & Redemption of Tokenisable Assets," [Online]. Available: <https://github.com/Topl/yellowpaper>.