

Connecting Disparate Data

HOW BLOCKCHAIN CAN
IMPROVE ACCESS TO FINANCE
FOR CARIBBEAN SMES

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Acronyms

- AML** – Anti-Money Laundering
- CC** – Compete Caribbean
- CDB** – Caribbean Development Bank
- CEMLA** – Centre for Latin American Monetary Studies
- CRA** – Credit Reporting Agency
- DLT** – Distributed Ledger Technology
- GDP** – Gross Domestic Product
- IDB** – Inter-American Development Bank
- ICT** – Information and Communications Technology
- IFC** – International Finance Corporation
- IMF** – International Monetary Fund
- KYC** – Know Your Customer
- LAC** – Latin America & the Caribbean
- LACES** – Latin America & Caribbean Enterprise Surveys
- MIF** – Multilateral Investment Fund
- PROTEqIN** – Productivity, Technology, and Innovation
- ROSE** – Rest of Small Economies
- SME** – Small and Medium Enterprise
- TIB** – Traditional Incumbent Bank
- WEF** – World Economic Forum

Executive Summary

This report was commissioned by Compete Caribbean, in conjunction with the Inter-American Development Bank, to investigate how blockchain technology can be employed to overcome barriers and increase access to finance for Caribbean Small and Medium Enterprises (SMEs). Recognising the integral economic role of SMEs throughout the region, the aim of this report is to identify how Caribbean businesses stand to benefit from the accelerating technological advances in finance.

The report synthesises academic literature and regional surveys to highlight the main factors that hinder SMEs from gaining access to traditional financial services, particularly loans and credit from Traditional Incumbent Banks (TIBs). These are: information asymmetry, in which lenders are not provided with sufficient data to accurately ascertain the risk of an applicant; the heavy dependence on collateral by TIBs to hedge risk of default; and the lack of Credit Reporting Agencies (CRAs) and information sharing arrangements in the region. As the Caribbean moves toward information digitisation, one must consider with caution the presiding internet-based sharing and storage of information, which has disproportionately problematic implications for SMEs. It is evident that to address the failures of the Caribbean credit system, a significant dose of innovation is required.

In recent years, financial technology (FinTech) has been rapidly expanding the opportunities available for SMEs to access finance. Such advances are highlighted in the section on alternative lines of credit, such as marketplace lending, angel investing and crowdfunding. Alternative lenders differ from TIBs in their methods of assessing risk, demonstrating a higher degree of flexibility and innovation. Given the dominance of TIBs as the first-choice source of funding, the report aims to promote the creation of a new system by which traditional and alternative lenders alike are better able to assess creditworthiness.

This report identifies alternative data points beyond those currently assessed by TIBs, that are the most effective and efficient indicators of creditworthiness. Three primary categories of information emerge when observing CRA and non-traditional lender considerations: alternative payment data, social data, and psychometrics. Stakeholders have already used these alternative sources to determine whether the

character of the SME or individual reliably merits their services. Incorporating a wider array of data points directly addresses the transparency market failure and associated unfair credit allocation, and has the potential to catalyse the growth of SMEs, TIBs, and the Caribbean as a whole.

The main criteria in assessing the most viable forms of alternative data are: coverage over a large percentage of the population, accuracy, regularity, and predictive capacity of desired outcomes. Alternative financial payment data, such as regular utility bill payments, demonstrate a clear repayment capacity outside of previous banking. The combination of social media and mobile phone data covers all areas of an individual's life including social, financial, and technical data, and indicates repayment capacity through tracking of 'digital footprints'. In the absence of collateral or financial history, psychometric testing is a low-cost way to make more information about the loan applicant available. These variables were selected based on: their consistent popularity across case studies, the availability of the necessary information in the Caribbean context, and their accuracy in informing creditworthiness.

Most importantly, the report sets out the role that blockchain technology can play in devising a new credential management system that will aggregate the aforementioned data points in the most secure, innovative, and cost-effective way. We propose a blockchain-based Self-Sovereign Identification (SSI) system to address the obstacles faced by SMEs in accessing finance. It would intercept the internet's security concerns by providing incorruptible, controllable, and portable credit-worthiness indicators of SMEs for banks and alternative financiers alike. Fundamentally, every incorporated person would hold ultimate authority over their own data, meaning that they have the bargaining power necessary to use that record to maximise their own well-being. The final section of this report highlights the ten defining characteristics of SSI systems, that can be summarised as security, controllability, and portability, separating it from other blockchain solutions (Ferrari, 2017). Finally, an examination of algorithmic, human rights, and regulatory dimensions illustrate why a blockchain-based SSI solution is uniquely positioned to leapfrog the Caribbean economy (Ibid).

This research into the Caribbean has indicated that in order to advance the current credit system, it is necessary to expand the networks of trust and facilitate greater data sharing of the right type of data. The majority of alternative data points recommended are already in existence, and thus must be effectively harnessed and aggregated to maximise their use to concerned parties. The application of a SSI system will require blockchain expertise and start-up capital to introduce the necessary infrastructure. Broader efforts must also be made to further enhance the growing blockchain ecosystem which is already being embraced in many Caribbean countries. Government institutions must be brought in as partners to provide both the adequate regulatory environments for data sharing, as well as to support public education around FinTech, and blockchain technology in particular. The potential users of this system, including SMEs and the community at large, will have to be informed of the value of participating in the initial stages of implementation, and possess full knowledge of their rights and options in granting information for assessment by creditors.

Introduction

During the past decade, economic growth in the Caribbean has stagnated, causing declining productivity and competitiveness. Although small island economies and firms struggle with size-specific issues, such as diseconomies of scale and indivisible fixed costs, the Caribbean's poor performance cannot be attributed to size alone. When compared to the ROSE, countries with populations below three million, it becomes evident that the Caribbean suffers from a particularly unfavourable business environment (Ruprah & Sierra, 2016: 2; IMF, 2013a).

The Caribbean economy is stunted by both exogenous and endogenous factors. Following the global financial crisis of 2008, the trend of de-risking had a detrimental effect on the region, destabilising financial systems, slowing growth, and limiting innovation (Williams, 2017: 8). In the prolonged aftermath, correspondent-banking relationships fell by ten percent in 2016 (FSB, 2017: 2). This has significantly affected economies that are heavily dependent on international trade, such as Belize, Barbados, and St. Lucia (Torbati, 2016). The threat of losing correspondent banking relationships has heightened the risk aversion of Caribbean TIBs, prompting them to withdraw accounts and financial services to customers deemed high risk. Internal policy-driven disadvantages, including high levels of trade protectionism and high costs of labour, electricity and credit, cause most Caribbean countries to rank poorly on the WEF's Global Competitiveness Index (IMF, 2013b: 11).

As SMEs are considered the 'backbone' of the economy, there has been a preoccupation in fostering a more inclusive business climate. International, regional, and local actors widely encourage entrepreneurship. Their initiatives are well-targeted — in the Caribbean, SMEs constitute 69% of the formal sector and contribute over 50% of GDP (Ruprah & Sierra, 2016; CDB, 2016). The majority of SMEs demonstrate high aspirations and potential to scale up and innovate, but face substantial barriers (Dohnert, Crespi & Maffioli, 2017). The LACES and PROTEqIN surveys identify access to finance as the most prominent limitation to firms' productivity (Morris, 2017: 29). Increasing investment in SMEs could translate this potential into growth, greater efficiency, increased competitiveness and economic diversification.

While there are several channels to access finance in the Caribbean, for formal sector growth and innovation, TIBs are considered the most reliable source of loans

(Holden & Howell, 2009: 6). However, SMEs are subject to high interest rates to compensate for their perceived riskiness, owing to both their inability to provide reliable financial information and assets, and the weak legal enforcement mechanisms in cases of default (Ibid:14; Mohan, et al., 2017: 19; Morris, 2017: 31). To this end, new and innovative ways for assessing creditworthiness are being explored around the world. In particular, three primary categories of information have seen positive results: alternative payment data, social data, and psychometrics. Using one or a combination of these components, credit scores are being calculated and provided to banks, helping them to decrease borrowers' portfolio risk and to increase their loan portfolios, thus making the financial environment more inclusive. Currently, the disaggregated way in which these alternative data are available complicates the process of determining creditworthiness.

With these new avenues of assessing creditworthiness, SMEs' macroeconomic prosperity is increasingly subject to their ability to protect their data, as it is the very instrument that leverages their access to credit. LAC's internet user population is growing more quickly than any other in the world, with 147 million users in 2013 (Anon., 2014). An increased incidence of cybercrime brings into question whether the internet is even equipped to share and store sensitive information. 77% of cyber attackers explicitly prey on SMEs as they are "easier targets" (65% have no data security in place), "low risk, high return" ventures, outdated in their data protection systems, and unaware of the real risk posed by hackers (Anon., 2016). The present internet-based system has problematic implications for Caribbean SME access to credit.

SME access to finance stands to improve drastically with accelerating technological advances in the financial services industry. Over the past decade, FinTech has successfully created faster capital markets, economic growth, and formalisation. Blockchain, a type of DLT, is an unprecedented platform to transparently record and store incorruptible information. It cannot be emphasised enough that the distributed nature of blockchain is advantageous beyond the user-to-user verification process. It lends itself to greater resistance to attacks, as there is no one repository of information, and greater resilience of personhood, as attribute information from different providers can be synthesised. Even if providers were to log information on different blockchains, superimposed layers can establish interoperability for seamless data integration. An additional advantage of the user-to-viewer sharing

process is that of zero-knowledge technology. This means that a lender can have full confidence in whether or not a user meets a specific lending criterion, without having seen any personal details that support how they meet the condition. Blockchain's compatibility with data minimisation protocol means increased user privacy, addressing regulatory and human rights concerns. Most revolutionarily, blockchain has the potential to back a SSI system. A SSI system grants entrepreneurs complete control over their identity, so that they may disclose, with maximum privacy, alternative information that accurately demonstrates creditworthiness.

Just as the internet communicates information, blockchain communicates value. Newcomers to the technology may associate it with Bitcoin, a type of cryptocurrency. While most blockchains today are associated with mining a digital currency, Blockchain 1.0 records cryptocurrency exchanges while Blockchain 2.0 and 3.0 record all other value exchanges that can be digitised, economic and social transactions respectively. Our proposed SSI system will run on Blockchain 2.0 and 3.0, of which there are several leading platforms. A common misperception of blockchain is that it is a glorified database, but it is operationally different and superior for security purposes. It is a distributed peer-to-peer platform, meaning transactions are never stored in a centralised reserve. Its distributed nature does not compromise privacy. Blockchains can be any combination of characteristics between permissioned or permissionless (with respect to users) and public or private (with respect to viewers). Transactions added to the blockchain are hashed into an algorithm before being launched for crowd-sourced verification. In this way, entities called miners, who verify transactions through a financially-incentivised consensus process, interact with encrypted information rather than human-readable content (See [Appendix 2](#) regarding energy consumption concerns). Once validated and digitally signed, transactions are grouped into blocks. The blocks are linked into a chain by algorithms called cryptographic hash functions. These hash functions feed forward, one into another, but cannot be undone. Thus, they are tamper-proof and incorruptible. In other words, to add information to a blockchain, asset features are distributed, timestamped, validated, and situated within history. Blockchain is able to operate so uniquely because of digital signatures, hashes, and consensus protocols (Campos 2018).

Methodology

The scope of the project is limited to the 13 territories ([Appendix 3](#)) as identified by CC, but elements could be extrapolated to other regions of the world. The paper is grounded in regional primary surveys that expose underlying problems in the Caribbean business environment, and is supported by academic literature, international organisations' reports, and private sector white papers. To supplement and update the findings, interviews were conducted with practitioners and academics in the field.

First, this report parses out key issues within access to finance. It also identifies universally-held problems with data security on the internet, that, given the lack of a legacy internet-based finance system, the region has the opportunity to overcome and circumvent.

Second, the report identifies three categories of information that various companies are already using to accurately indicate a firm's ability and willingness to pay. These three categories emerged from a comprehensive literature review and were affirmed through conversations with practitioners. Today's FinTech companies aggregate thousands of data points and assess them through algorithmic calculations and machine learning. Thus, the variables we present have been selected based on three factors: their consistent popularity across case studies, their accuracy in informing creditworthiness, and the availability of the required information in the Caribbean context. Due to the limited use of e-commerce in the territories observed, this data point was omitted from our research.

Finally, we propose the use of blockchain technology, partly inspired by the recent upsurge in popularity in the Caribbean, but mostly owing to its unique characteristics of transparency, security, and privacy. Due to the nascent nature of blockchain technology, many use cases are still in the inception or pilot phases, therefore the discussions around its application in the Caribbean remain speculative. Based on white paper and websites examinations of a wide range of blockchain solutions, we recommend a SSI system as the foundation for the incorporation of non-traditional data in loan application decisions.

One limitation of the study was the restricted access to information on CC's 13 territories, which many regional groupings, such as LAC, tend to exclude. Nonetheless, the literature on LAC is encouraging as there is a similar focus on increasing lines of credit specifically to SMEs in comparison to other regions. The heterogeneity of the Caribbean region also means that greater context-specific research is required to fully understand the nuances of SME profiles and the ease of implementing such technologies in each of the territories with regards to infrastructure and regulatory environments.

Key Problems in Access to Finance for Formal SMEs

Asymmetric Information

Literature on SMEs' access to finance has long pinned down asymmetric information as the culprit behind the finance gap (Diamond, 1984: 394). Several factors hinder lenders from ascertaining a small firm's ability and willingness to pay, as identified by Moro et al. (2014: 526), primarily: a firm's apprehension to disclose information due their desire to maintain control; disclosure requirements that vary according to the type of finance; differing accounting standards and taxation strategies; and the limited predictive capacity of retrospective public information available. Less information available on a borrower translates into a higher risk for the lender. Thus, TIBs either deny credit, or exaggerate the cost of finance through elevated interest rates to hedge themselves against risk. SMEs, in their vast majority, cannot afford such loan spreads (Ketterer, 2017). The ramifications of imperfect information reverberate beyond individual SMEs: missed economic opportunities stunt national economic growth. Reducing information asymmetry would have substantial multiplier effects: banks would lower defaults, worthy entrepreneurs would access finance more easily, and business growth would provide macroeconomic stability (Moro et al., 2014: 526).

Heavy Dependence on Collateral

Collateral is "an asset that serves as security against counterparty risk" (Anderson & Joeveer, 2014: 50). In the context of asymmetric information and moral hazard, collateral requirements bring the interests of the borrower in line with those of banks (Godlewski & Weill, 2011). Collateral is also viewed as a sorting device, wherein low-risk borrowers are more likely to take a loan against collateral, while high-risk borrowers, knowing they are more likely to default, are reluctant to offer collateral against borrowing (Cowling, 2012).

Concerns have been raised in several theoretical papers that highlight “unfair credit allocations” (Coco & Pignataro, 2013) related to the use of collateral as a determinant for accessing secured loans (Anderson & Joeveer, 2014; Coco, 2000; Coco & Pignataro, 2014; Besanko & Thakor, 1987). For example, if collateral requirements are inversely related to interest rates, low-risk borrowers are led to select contracts with low interest rates and high collateral requirements, and high-risk borrowers opt for the inverse (Besanko & Thakor, 1987: 672). As a result, low-risk borrowers who do not have sufficient collateral become credit-rationed and are unable to access secured loans. This results in an inequitable distribution of credit, in which poor, good-quality entrepreneurs are excluded from the market. The structural inefficiency present in the collateral system inhibits SMEs from accessing the necessary resources to catalyse their growth.

Another body of work critically examines the relationship between wealth and entrepreneurial ability. Entrepreneurial abilities are not dependent on wealth, but rather on academic and job-related aspects of human capital (Cowling et al., 2003). Thus, capable entrepreneurs who have inadequate assets struggle to fulfil their potential, while financial institutions lose the opportunity to grow their customer base by excluding viable borrowers who otherwise may have even become life-long clients. It is evident that the present dependence on collateral is a poor crutch in the absence of a robust alternative system. This market failure has particularly detrimental effects in emerging economies and must be tackled if economic growth in the Caribbean is to accelerate.

Women entrepreneurs face greater difficulties in accessing finance than men, in addition to the challenges described above (Ghosh, et al., 2017; GPFI, IFC, 2011; Ahmad & Arif, 2015; Richardson, et al., 2004). Access to finance has notably been identified as the major constraint that explains why in emerging markets, women’s enterprises experience significantly lower average growth rates than those run by men (Ahmad & Arif, 2015: 635). This disparity has been linked to firm size, as women’s businesses tend to be from smaller and slower-growing sectors – as opposed to gaps in actual gender performance (Bardasi, et al., 2011). Loan officers’

perceptions of women entrepreneurs as presenting a slow or low return on loans, or as less likely to succeed, represent substantial barriers to finance (Veena, et al., 2012; Richardson, et al., 2004). Alternatively, some female entrepreneurs are less likely to seek a loan than their male counterparts (Bardasi, et al., 2011). Unfortunately, even when they are able to receive a loan, the amount can be insufficient (Ghosh, et al., 2017: 2). These institutionalised inequalities at the macro- and household- levels encumber women entrepreneurs' ability to gain access to finance (Mayoux, 2001: 52). This is another market failure that is largely impeding the pathway to success for the Caribbean's emerging economies.

The regulatory frameworks in the Caribbean for private property pose major challenges for the use of collateral, compared to most industrial countries (Holden & Howell, 2009). In particular, besides the use of fixed property for collateral, the use of moveable property as collateral is in most cases impossible. On a similar note, the legal bodies that can pledge collateral are also limited. Additionally, the Companies Acts, which operates across many Caribbean countries, requires that "companies pledge their entire asset base to one lender... making it costly for borrowers to switch lenders" (Ibid: 16), thus disincentivising bank competition. Such regulations represent an additional obstacle to the general problems associated with collateral.

Lack of Credit Reporting Systems

Credit reporting plays an essential role in reducing information asymmetries and circumventing collateral requirements. CRAs can be public (credit registries) or private but publicly regulated (credit bureaus). They collect, file, and distribute information voluntarily supplied by their members, and operate on the principle of reciprocity; lenders who provide data are granted access to the CRA's files (Jappelli & Pagano, 1993: 1693). Information sharing is essential to build trust and is a pre-requisite for an advanced credit system. There is great incentive to create CRAs where lenders are confronted by large numbers of customers on whom they have no previous information, characteristic of less developed countries (Ibid: 1714). Transparent credit information can raise the portfolio quality of loan

applicants, deter negligent borrower behaviour, and ultimately lower the cost of credit. The most advanced information-sharing arrangements include both positive and negative borrower data, including all repayment history, not only defaults. The potential of CRAs to improve access to finance is considerable. According to IFC studies on 5,000 firms in 51 countries, the percentage of firms complaining of constraints in obtaining finance declined from 49% to 27% after credit bureaus began operations in their regions (World Bank Group, 2010).

An efficient and inclusive credit reporting system, instead of relying exclusively on pledged physical collateral, would allow lenders to base credit decisions on “reputational collateral”, to the advantage of people with a strong borrowing history but few physical assets who would otherwise be unable to access loans from TIBs (Ibid, 2010).

Limited progress has been made in the Caribbean within the last decade. In 2010, both Jamaica and Guyana passed credit reporting legislation. However, according to the World Bank Doing Business data in 2017, 0% of the adult populations of Antigua and Barbuda, the Bahamas, Barbados, Belize, Grenada, St. Lucia, St. Vincent and the Grenadines, and Suriname are covered by credit bureaus (World Bank, 2017). Amongst the Compete Caribbean members, only Guyana, Jamaica and Trinidad and Tobago (52%, 24% and 75% respectively) have coverage of credit bureaus (Ibid). Ramos (2009) indicates that several factors inhibit the presence of CRAs in the region, primarily:

- The high start-up costs may be difficult to justify if the country’s population is small.
- Banks and credit unions within a country may not have a strong tradition of structured information sharing.
- Many countries may lack the necessary software infrastructure to support such a system.
- While regional cooperation could leverage economies of scale, the heterogeneity of legal frameworks impedes files sharing across borders.

In order to establish an efficient credit reporting system throughout the Caribbean, the IFC recommends the following factors for success: building awareness in the community, establishing an appropriate legal and regulatory framework, gathering support from market participants, ensuring commercial viability, training regulators, and identifying appropriate operators (including technology solutions and software), and housing a wide spectrum of data that is relevant, accurate, complete, and updated regularly (World Bank Group, 2010).

Despite the indisputable importance of CRAs, their internet-based means of collecting and sharing information makes their data stores vulnerable to attack. Scandals such as Equifax's data compromise of 148 million people (collectively costing consumers \$4.1 billion), or Yahoo's hacked 3 billion users, indicate the need for more secure data sharing methods (Sovrin Foundation, 2018). Given that the Caribbean does not have a legacy infrastructure of CRAs, it is advised to critically evaluate, and even circumvent, the insecure foundation upon which they have run.

Present Data Insecurity on the Internet

SMEs are simultaneously the most vulnerable and unprepared when it comes to data breaches (Steven, 2017), both at the compromise points of CRAs and their own information stores. This issue is particularly worth consideration as LAC boasts the fastest growing internet user population in the world (Anon., 2014). Cybercrime is on the rise, and there is a need for a coordinated data-store system to assess creditworthiness. The general trajectory of information communication between lenders and borrowers has been to digitise it on the internet. Problematically, however, insecurity is by-default designed into how the internet works.

SME Vulnerability to Cybercrime

The SME's stable financial health and ability to repay and access future loans is in large part contingent upon data security. Data breaches cause "reputational damage, loss of trust and long-term loss of customers", to the extent that a breach would discourage "nearly two out of three (64%) consumers... from using an SME again" (Experian 2016). Paradoxically, not

only do SMEs underestimate direct costs by over 40%, but the vast majority of SMEs (three of four) do not even consider data breaches to be a threat (Ibid). The 2017 results of the Hiscox Cyber Readiness Report estimate that cybercrime and data breaches drain \$450 billion on the global economy every year (Sovrin Foundation, 2018). SMEs only stand to lose with the increasingly frequent data breaches.

Internet Insecurity by Design

Data breaches can be attributed to the centralisation of digital control – a feature of standard databases and internet-based activity, but not blockchain-based systems. The standard verification method (to prove that entities are who they say they are) has been a protocol called Public Key Infrastructure (PKI), that includes a set of rules on certificates called X.509 (Allen, et al., 2015). In PKI, each internet entity has a key pair that are algorithmically related: the public key (used to encrypt information) can unlock the corresponding private key (used to digitally sign information) (Microsoft, n.d.). To check that a connection is secure between two internet entities, a third party called a Certificate Authority (CA) moderates the exchange of public keys. The originator encrypts the information using the CA's public key, before sending it to the CA. The CA can “sign” the information using their private key and generate a new certificate. The CA has verified that the identity of both the originator and the information recipient.

As it stands, only a few CAs arbitrate all of the world's clicks and digital communications – in fact, most “IT Services user-facing services” are verified by only two companies (GlobalSign & Comodo) (Oxford, 2017). While only several hundred Certificate Authorities (CAs) exist to verify that a connection is secure (Sovrin Foundation, 2018), their ranks are in no way comparable to the vastness of the internet and the gravity of their responsibility they uphold. However, browsers would not be able to handle any more CAs (Ibid). By design default, the power to deem whether or not an entity can be trusted is highly concentrated.

Given that hackers need only target a single body, inherently, any communication on the internet is vulnerable to man-in-the-middle (MITM)

attacks (Allen, et. al, 2015). Corrupt entities can maliciously leech information or lure users into scams by duping CAs with false certificates. Likewise, CAs could make a mistake or go out of business. Corruptibility and fallibility intersects with all piecemeal fractions of an individual's online identity. Usernames, otherwise called namespaces, are merely "administrative constructions" that are not even owned by the websites they occupy (Searls, 2012). Rather, "digital identities are owned by CAs, domain registrars, and individual sites, and then rented to users or revoked at any time" (Allen et al. 2015). The SME thus is exposed to threats from many angles but has no way to effectively manage (or know) what information is sourced. The internet's structure is unsecure, liable to attacks, and from a user control perspective, morally unsound. It is time for a new model of identity control.

Lines of Credit

Banks as a Line of Credit

Despite the universal problems that SMEs face in accessing finance, banks are still the most popular source of formal credit, primarily due to their prestige and the lack of public knowledge regarding alternative forms of finance (OECD, 2015). Problems in accessing finance are exacerbated with weak legal and financial institutions that dissuade firms from accessing formal bank finance (Beck & Demirguc-Kunt, 2006; Beck, et al., 2008). When excluded from the formal system they often turn to predatory informal lenders, such as payday lenders. To help fill the financing gap, many banks have also tried alternative means of debt finance such as leasing, factoring and trade finance. Such tools have been successful in certain sectors and regions (Beck & Cull, 2014) but are reliant on established enterprises with assets and liquidity. To this end, banks in emerging markets have intensified their involvement in SME lending with the creation of new technologies, business models and risk management systems (de la Torre, et al., 2010). However, these new technologies have created many of the problems that SMEs face in borrowing. There is fear that the “new normal” will be one of credit scarcity for businesses if banks persist with their archaic tools (OECD, 2015: 18).

Alternative Lines of Credit

It is estimated that half of all SMEs have unmet credit needs – to the cumulative note of 2 trillion USD (SMEFinanceForum, 2017: 2). The disconnect between TIBs and SMEs, in large part due to the lack of CRAs, leaves many firms disenfranchised from the financial system. In pursuit of funding unattainable from TIBs, SMEs can access finance through personal relationships, investors, or alternative lenders.

Equity finance is not appropriate for the majority of SMEs, though it can be a popular form of funding for start-ups and service-based enterprises. This line of credit relies on professional private investors to provide seed or venture funding with stakeholder buy-in. Such funding uniquely nurtures high risk enterprises through investor expertise. Angel investment initiatives

have been popular in Jamaica, with a number of programs such as, First Angels Jamaica, Alpha Angels and the World Bank and Caribbean Export-backed LINK-Caribbean (Divakaran, et al., 2016; InfoDev, 2016). However, equity funding is the least favourable route for SMEs as many owners lack experience in negotiating fair terms and have a general opinion that equity investors are greedy (Kent Baker, et al, 2017). The trend is mirrored in LAC according to LACES (2010), as equity or sale of stock investment only makes up 4.5% of financing sources.

Alternative finance can be defined as channels of finance that emerge outside of the regulated banking system (Wardrop, et al., 2016). Online alternative finance has emerged as a solution to the market failure of TIBs and credit unions to serve the financial demands of the underbanked community. It can encompass both debt and equity finance but lacks many of the regulations and standards applied to traditional financing. In 2015, the online alternative finance market continued its rapid growth across the Americas, generating a total market volume of \$36.49 billion (Ibid: 24). Most online alternative finance methods are investor-led and can be referred to as marketplace lending (MPL), which encompasses a variety of lending technologies, including crowdfunding and peer-to-peer. This form of lending tends to be unsecured and will usually rely on a number of investors online. In LAC, 70% of the overall online alternative finance market was attributed to business finance (Ibid: 44). This endorsement by businesses emphasises the structural issues that prevent growth of SMEs in the traditional system. Alternative lenders such as CariLend and Term Finance are already addressing the concerns of underserved credit consumers in the Caribbean.

Due to the lack of hard information available to alternative lenders, investors have had to engage in a certain degree of innovation to assess credit risk and provide loans to SMEs previously rejected by banks through a frictionless online platform. Alternative lenders, unlike TIBs, are not loaning the money of unknowing depositors and can be more flexible with their requirements. However, not wanting to be left behind, banks have partnered up with alternative lending platforms. Santander UK and Funding Circle

have partnered to mutually refer applicants to each other's platforms (Dunkley, 2016). A number of collaborations with TIBs have occurred in different regions and are an encouraging sign that banks are open to these competitors in the financial space. Despite their increase in global popularity, MPLs come with risks, such as online fraud, user data privacy, and unprofitability of businesses (Ventura, et al., 2015). Moreover, the alternative lines of credit in the Caribbean have been unable to meet the loan demands of SMEs. The uncertainty of formal protections and regulations in this space mean that TIBs are still considered a first-choice destination for SMEs (Alibhai, et al., 2017).

Alternative Data

Given the disparate hard financial data available, the incorporation of alternative data that informs creditworthiness can provide a more nuanced view of potential borrowers, mirroring the holistic relationship between lender and borrower that is characteristic of relationship banks. Three primary categories of information emerge when observing CRA and non-traditional lender considerations: alternative payment data, social data, and psychometrics. Taken on their own or in unique combinations, stakeholders have already used these alternative sources to determine whether the character of the SME or individual reliably merits their services. Incorporating alternative indicators of creditworthiness directly addresses the transparency market failure and associated insurmountable pre-loan requirements, to the catalytic growth of SMEs, TIBs, and the Caribbean region as a whole.

Many lenders have already begun to use alternative data to evaluate thin-file or no-file consumers. According to a 2015 survey of 317 lenders, 87% used alternative data, or any information that is not captured by a traditional credit score, including property, tax, and deed records, checking and debit account, and payday lending information (TransUnion, 2016). Their incorporation of such data reveals broader problems: nearly three-quarters cited increasing difficulty finding and acquiring new customers, competition with lower lending rates of other companies, and consumers with acceptable credit scores becoming saturated with offers (Ibid).

There are several criteria that must be met when evaluating the usefulness and applicability of alternative sources of data (Carroll & Rehmani, 2017:9). A new data source will ideally:

- Have broad and consistent coverage
- Contain detailed data elements about an individual (such as on-time and late payments over a significant time series)
- Be accurate and frequently updated
- Have a system for ongoing data verification and management
- Contain information relevant to the behaviour being predicted
- Be additive to the predictive accuracy of traditional CRA data
- Comply with existing regulations for consumer credit

Alternative Payment Data

One of the most promising data sets stems from non-traditional financial services that incur payment obligations not typically reported in the standardised way. Examples include regular bill payments from telecommunications, utilities and rental properties, and even alternative lending payments (e.g., payday, instalment loan, rent-to-own). Such sources demonstrate a clear repayment capacity outside of previous banking.

As aforementioned, the world's major CRAs have already begun incorporating this type of data. Experian (2014) studied how the positive payment history data from energy-utility companies would impact the thickness of the consumer's credit file (measured by the number of trades on file). Findings showed that the inclusion of positive energy-utility trade lines led to 20% of thin-file consumers in the study's sample population migrating to the thick-file category, while thick files, representing consumers with five or more trade lines on file, increased from 55% to 64% of the sample population. Consumers previously absent from the Experian credit database were able to leverage the existence of this alternative data trade line to begin building credit history. The ability for many consumers to build a more robust credit file and migrate to a better risk segment simply by regularly paying their energy bill on time shows that there is an opportunity, and even a responsibility, for energy companies to help their consumers build credit history. The TransUnion Credit report system in Trinidad has already begun incorporating payment records from the national electricity retailer. Given that in most Caribbean islands there is only one, often state-owned, electricity provider, data sharing coordination to this end should be relatively streamlined.

Experian was also the first major CRA to incorporate positive rental payment data, through RentBureau, a data arrangement which allows rental payments to be systematically recorded and made available to financial services firms. In an Experian study simulating rent reporting, 11% of subsidised housing residents did not have a credit file, but all transitioned to the thin-file category once rental trade lines were incorporated, and 23% of

thin-file residents moved to the thick-file category (Experian, 2015: 2). Though rental payment can demonstrate a consistent pattern of relatively large payments, this market is far less concentrated than utilities. Given that landlords represent a wider pool of stakeholders, this would increase coordination costs and make data collection less feasible.

Credit scores are not without implication, however, and their accuracy and use must be considered. There is a risk that the credit invisible may be better off without a credit score that can expose them to deepening forms of economic or financial disenfranchisement (Aitken, 2017: 289). Thus, beyond thin to thick file conversions, the information must be up-to-date and confidential.

Data access is key in the use of non-financial payment streams (Ibid: 283). Paying for data is usually the simplest way to gain access, but this is not always ideal insofar as it increases costs. Furthermore, payment information is owned by entities that are not allowed or incentivised to share it, even with their customers' consent (Baer, Goland, & Schiff, 2013).

Accounting Certificates

Accounting certificates are another form of alternative data that indicate financial savviness. The pressing need to improve financial education has been widely acknowledged and has manifested in LAC through CEMLA's annual Conference on Economic and Financial Education in Latin America and the Caribbean. SMEs suffer from low levels of financial literacy, which affects their ability to decide on appropriate sources of funding, respond to the due diligence requirements, negotiate the terms and structuring of the financing, and manage accounts (Atkinson, 2017). There is an opportunity for an organisation like Compete Caribbean to issue standardised online financial literacy courses that would result in certification that could be added to an individual's or SME's credit profile.

Mobile and Social Data

Increased global ICT usage offers an explosion of data for extrapolation. When combined, the internet, social media platforms and mobile phones

leave 'digital footprints' that blueprint the behaviour patterns of individuals (Kumar & Muhota, 2012). The combination of data covers all areas of an individual's life including social, financial, and technical patterns. It can present itself in the form of airtime top-up payments, information on outgoing and incoming calls and texts, mobile internet usage, e-payments and transactions through mobile wallets, and value-added services such as text-message subscriptions or downloads.

Prepaid mobiles and phone history are effective sources of real-time financial information about an individual's spending habits. Information on the regularity and amount of credit paid for can be used to determine the financial stability of an individual. Assumptions about employment type can also be made from such information. For example, an individual that tops up a large amount once a week suggests regular salaried work, whereas small but frequent amounts indicates a flexible, possibly informal, worker (Scharwatt, et al., 2014). Phone call information, such as, how often a user makes, rather than receives, calls, the length of the conversation, and the time of day that calls are made, can all be effective predictors of creditworthiness (McEvoy, n.d.). Mobile phone activity is already being collected by networks and operators at a relatively low cost and provides a rich history of both financial and non-financial information that credit bureaus, or financial institutions, cannot access (Bjorkegren & Grissen, 2018: 3). The success of M-Pesa propelled the use of mobile money payments and transfers into the spotlight, opening up another data channel that predicts repayment behaviours (Hieminga, Land & Nijboer, 2016). Much of this information looks at the frequency of activities and from that determines your reliability or ability to repay loans. Mobile information requires collaboration with telecoms operators and mobile money platforms.

Social data can provide an even richer dataset on a borrower. It includes both social media information, such as existing relationships and size of networks, and other online information, such as websites visited, downloaded apps, locations visited and chat history (Ibid, 2016). Historically, lending has relied heavily on social networks, attestation and trust as a form of assessing creditworthiness. In academic literature, this is

referred to as social capital which relies on trust, norms, and networks to improve the efficiency of societal activities like providing local credit or ensuing governance of a locality (Putnam, 1993). Lin, Prabhala and Viswanathan (2013) find that friendships increase the likelihood of an individual successfully accessing credit and having a lower default rate. However, this is not just related to the number of friends one has, but the quality of friends. Based on the idea of homophily, individuals tend to interact with similar people (Wei, et al. 2016). Therefore, there is the assumption that if you are connected with individuals who are low-risk and have successfully repaid loans or not defaulted, then you are also more likely to repay. Some studies claim that such metrics can improve repayment predictions by 18% (Tan & Phan, 2016). Social data is therefore a useful tool for credit scoring as it provides and verifies important information about the borrower that tends to be unobservable by traditional financial institutions (Ibid, 2016). However, such information is useful only when there is a high and frequent amount of internet and social media users in a country to supply such information.

While most FinTech platforms do not transparently weight their social data points, they advertise proven success compared to traditional lenders, evidenced through higher repayment rates and more borrowers. One mobile FinTech is TALA (2018), which provides financial services, such as credit scores and micro-loans. By accessing a number of data points on their mobile device, permissioned by the borrower, the company examines daily travel patterns, the regularity of calls to family, and the number of individuals that the borrower is communicating with on a daily basis, according to their data such information can increase the repayment rate of a borrower by 4% , 5% and 9% respectively (Siroya, 2016). Lenddo, a leading company using non-traditional data for credit scoring, uses machine learning to analyse data points from social media platforms to form a digital personality to credit score. Through their 'LenddoScore' credit scoring, they have been able to reduce the number of defaults by 12% (Lenddo, 2018).

While this new data may be useful in providing greater access to credit to

previously "unworthy" individuals and can solve the issue of information asymmetry, it has certain limitations:

- Internet coverage and usage of mobile phones and social media must be substantial to provide rich and useful data on borrowers. Some information is reliant on smartphones, which are still not as widespread as regular "dummy" phones.
- Gaining access to many diverse data sets can be difficult and requires a number of stakeholders, including telecommunication companies and social media giants that may not have an incentive to share certain data about their users (Baer, et al., 2013).
- FinTech tends to be dominated by a few key players, with natural monopolies stifling competition, as seen in Kenya with M-Pesa (Hieminga, Lande & Njiboer, 2016).
- Data collection can be used for biased screening-out of applicants based on gender, race, or age (PYMNTS, 2015; Franics, Blumenstock & Robinson, 2017).

While alternative data can be empowering for individuals and businesses, it also increases the risk of exploitation of private information (Ibid). Without strong enforcement or protections in place by lenders and users of this data, then individuals providing such data cannot be sure that this information is secure.

Psychometrics

Psychometrics is the field in psychology in which testing, measurement, assessment, and related activities occur (NCME, 2017). In determining the quality of a test, reliability and validity are two of the most important aspects. The former refers to "the extent to which the test is effectively measuring anything at all" while the latter denotes "the extent to which the test is measuring what it is purported to measure" (Rust & Golombok, 2009: 162).

Today, the use of such tests has expanded significantly into the arena of lending, where the corresponding results increasingly play a role in determining creditworthiness. In addition to psychometric answers about attitudes, beliefs, integrity, and performance, how loan applicants interact

with the psychometrics tool (metadata) is collected. A credit score is ultimately produced, identifying a person's ability as well as willingness to repay a loan. Thus, the loan applicant's default behaviour is claimed to be illuminated.

In the absence of collateral or financial history to determine whether a borrower will repay a loan, psychometric testing is a low-cost way to make more information about the loan applicant available (MIF, 2015). Moreover, psychometric results can supplement information from an entrepreneur's available credit history, lowering banks' portfolio risk. Additionally, banks can open access to credit for millions of underbanked entrepreneurs without increasing their portfolio risk.

Other commentators on the application of psychometrics to determine creditworthiness caution its use. First, psychometric testing methods may benefit better-educated, technology-proficient loan applicants over people with less privileged backgrounds. Second, applicants may provide answers to psychometric questions they believe will create ideal results, eschewing their credit score. Third, for applicants who test badly, there is a risk of that information being used against them, and this may occur even a few years after they completed that test.

Given the novelty of psychometric testing as a credit scoring tool, few companies currently offer the product. Rival firms CreditInfo and Entrepreneurial Finance Lab (EFL Global, hereon, EFL) are two key examples. Both companies primarily use the five-factor model – the predominant personality model in the field of psychology (Klinger, et al., 2013: 23) – to underpin their psychometric tests. This “Big Five” personality structure (Costa & McCrae, 1992, in Klinger, et al., 2013: 6) considers the following factors: neuroticism (perceived degree of self-esteem), extraversion (perceived degree of self-confidence, sociability, and drive), openness to experience (perceived degree of creativity and intellectual interest), agreeableness (perceived degree of belief in cooperation), and conscientiousness (perceived degree of leadership and organisation) (McCrae & John, 1992). This model has been found to be strongly

correlated with becoming an entrepreneur (Seibert & Zhao (2006) in Klinger et al., 2013: 19) and with entrepreneurial business survival (Ciavarella et al. (2004) in Klinger et al., 2013: 19). However, exactly which elements of the model are used, or thoroughly tested for, in the psychometric tests is not disclosed.

Since its foundation in 2006, EFL has formalised partnerships across South America, Africa, and Asia, with several publications on the progress of its work. One of the most comprehensive papers was released by the IDB in 2015, assessing the strengths and weaknesses of EFL's psychometrics testing tool for potential borrowers of a commercial bank, the fifth largest in Peru (EFL Global, 2018a). For unbanked entrepreneurs, the EFL tool was found to have the potential effect of improving their portfolio risk, thus opening up access to credit. The psychometrics tool clearly has potential to increase financial inclusion, and ultimately help commercial banks to grow their customer base. For example, a year after adopting the EFL psychometrics tool, Peru's Banco Financiero experienced a 16% increase in its micro loans (EFL Global, 2018a) and Guatemala's G&T's client base increased by 53% (EFL Global, 2018b).

In the Caribbean, the use of psychometrics is still in its early stages, but initial results have proved positive. In particular, Haiti saw the tool being tested in 2013, a project carried out by MIF, the IDB, and SogeSol (FOMIN Member of the IDB Group, 2013). In 2016, Scotiabank Jamaica and the MIF combined psychometric testing with a business and credit-risk rating model they had previously used for micro- and small businesses, with the aim of enhancing their credit-scoring assessment methods (Leslie & Beecher, 2016). These examples indicate the high and exciting potential that psychometric testing has for building risk profiles of SMEs.

The Role of Blockchain

Despite their illustrative potential, alternative payment information, social data, and psychometrics have yet to fully transform mainstream loan conversations. Their vulnerability to manipulation and overall disjointedness results in their supplementary status within TIBs. To have sufficient leverage in credit applications, this information needs to be verified and aggregated at the forefront of information requests. Blockchain is uniquely positioned to overcome the challenges of credit access. In particular, a SSI is the best blockchain application to address obstacles.

A SSI system is a digital identity landscape where every incorporated human being holds ultimate and autonomous authority over all of their own data. SSI systems are the first and only system, currently, that address the three-part need of SMEs to 1) showcase alternative data indicating creditworthiness in 2) a non-corruptible, controllable, and portable manner that necessarily 3) empowers the business owners in the context of an increasing need for data security and digital autonomy. We propose a SSI system that begins with the incorporation of the alternative data above. Beyond its access to credit roots, it would lay the foundation for all future blockchain use cases in development (Ferrarini, 2017).

The SSI is the next step in granting user control (Allen, 2016; See [Appendix 4](#)). Revolutionarily, it is the first model to separate who confirms the information from what is being confirmed (the verification and data layers) (Voshmgir, 2018). A blockchain-based SSI no longer needs trusted third-parties (TTPs) to verify information, nor is information ever housed in a centralised CA repository.

Ten Defining Characteristics of Self-Sovereign Identity

The discussions and initiatives around SSI have conceptually evolved and converged into ten tenants (Allen, 2016; Voshmgir, 2018). Together, they make up the bedrock of a decentralised digital identity landscape based on blockchain, that re-assigns the locus of control to the individual.

1. **“Existence: Users must have an independent existence.”**
Users are more than their digital identity.

2. **“Control: Users must control their identities.”**
As approved by truth mechanisms (algorithms), the user is the presiding and final purveyor of their identity, which they can choose to hide or broadcast. Others’ claims exist but are peripheral unless the individual chooses otherwise.
3. **“Access: Users must have access to their own data.”**
There are no doorkeepers patrolling data access; users are aware of all placed claims on themselves; while they can choose to verify claims or not, they cannot necessarily alter logged claims; they can retrieve any claim themselves. Users access their own data, but their access to the select data of others’ is contingent upon permission from the requested party.
4. **“Transparency: Systems and algorithms must be transparent.”**
Algorithms are understandable, open-source, and agnostic. The network management procedures and updates are clear.
5. **“Persistence: Identities must be long-lived.”**
Digital identities should last as long as the user desires. If forever is not possible, then digital identities should last as long as that identity system does.
6. **“Portability: Information and services about identity must be transportable.”**
Identity should not be consolidated by few TTPs as is currently the practice with internet-based databases. Prevalent schemes may change, users may migrate to other platforms, or the TTP may phase out of operation.
7. **“Interoperability: Identities should be as widely usable as possible.”**
Blockchain needs an agnostic protocol so that users and developers may freely choose and fluidly change systems (Allen, et al. 2015 P11) in a competitively developing international marketplace. The Decentralised Identity Foundation is in the early stages of creating a "Universal Resolver" that sits on top of the many different identifier layers, like the Bitcoin blockchain, Sovrin, Ethereum, and IPFS (Sabadello, 2017).
8. **“Consent: Users must agree to the use of their identity.”**
The user must consent to claims if they are to become valid; only the user can consent to share data.
9. **“Minimisation: Disclosure of claims must be minimised.”**
Selective disclosure, range proofs, and other zero-knowledge (ZK) techniques exponentially enhance privacy. The individual releases only what

is required. Correlativity is acknowledged, but notwithstanding, blockchain offers unprecedented potential in privacy.

10. **“Protection: The rights of users must be protected.”**

If contradicting, user freedoms are valued over network wants. To protect users above all, algorithms should be “censorship-resistant and force-resilient and ... run in a decentralised manner” (Allen, 2016).

Figure 1: Visualising the SSI System: Access to Finance Use Case

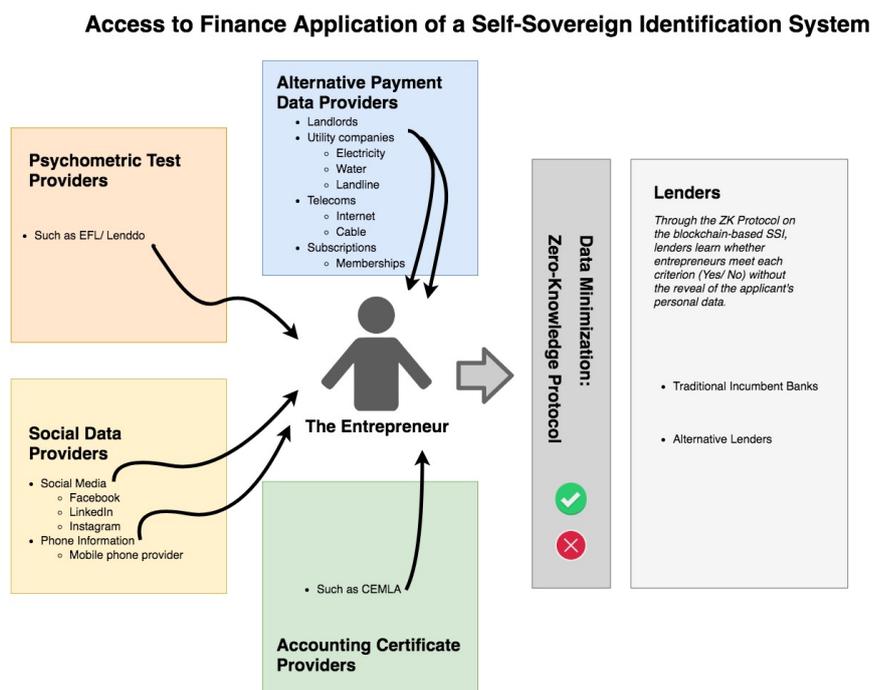


Figure 2: SSI Supports the Integrity of Digital Identity

A blockchain-based Self-Sovereign Identification system best supports the integrity of digital identities along technological, regulatory, and human rights dimensions.

Dimension of Digital Identity	Standard Credit Registry Using the Internet	Blockchain-based CRM System	Blockchain-based SSI system
Technology: Cryptographic Integrity	X Corruptible	✓ Secure	✓ Secure
Regulation: Responses to Cyber Attacks	X Major scandals have evoked such regulation	[Depends] may be compatible with existing legislation, but does not anticipate global trends	✓ Anticipates GDPR and global legislation trends
Human Rights: User Autonomy	X Inaccessible; no control	X Cannot be expanded for other use cases; no control	✓ Can be expanded for other use cases; controllable

Cryptography Perspective

Blockchain solves the aforementioned corruptibility problems inherent to the current CA system. It reduces risk for organisations and individuals by ensuring that the data is "accurate, up to date, revocable, and cannot be lost, stolen, or used illegally" (Sherriff, 2017). As the Sovrin Foundation so aptly puts it, "blockchains replace trust in humans with trust in mathematics" (Sovrin Foundation, 2018). It does so through three cryptographic steps:

1. The issuer of the transaction digitally signs the transaction.
2. A digital hash, or function, links the transaction to the previous one in the chain. Hashes "map data of an arbitrary size to a fixed size", and their output cannot be reverted into a previous state (Campos, 2018).
3. The consensus algorithm governs how the transaction is validated and added to the blockchain. The most common consensus algorithm, Proof of Work (PoW) financially incentivises miners in the peer-to-peer network to participate (Ibid).

"The result is a cryptographic ledger of immutable records that makes it very difficult, if not almost impossible, to change past transactions or maliciously control future ones" (Sovrin Foundation, 2018).

When the transaction issuer signs the transaction, they do not need a CA to verify their identity, as necessitated under the current PKI protocol (Ibid). Instead, individuals can be owners of their own key pair. They can keep their private key securely with them, but self-store their public key on the blockchain. This means that every public key can have a permanent address called a decentralised identifier (DID). The implication of having a personal address - unlike namespaces, domain names, and IP addresses that are impermanent and outside of the individual's control-- is that "anyone with a DID should be able to digitally issue and sign verifiable claims and other documents" (Ibid). Moving to a decentralised PKI (DPKI) "is the same progression that occurred in moving from "islands of networking" (local area networks) into the global Internet" (Ibid).

DPKI has been lauded over the PKI system for its decentralisation, interoperability, integrity, and process for key recovery (Abraham, 2017). It is evident that blockchains, especially when incorporating DPKI, offer revolutionary advantages over standard databases for security and widening participation.

Regulatory Perspective

The world has reached a critical juncture for data privacy. Current events have perturbed all stakeholders into action. A blockchain-based SSI would embrace and anticipate current and upcoming legislation, harness time and money for the private sector, and address civil society concerns.

Regulatory Concerns of the State

Passed in April 2016 by the European Parliament and due to go into effect in May 2017, the General Data Protection Regulation aims to tighten personal data security and squarely reassigns data rights to the individual (ID2020; Abraham, 2017). It includes a penalty of up to 4% pre-tax revenues for non-compliant firms, to a cap of 20 million euros (GDPR & Beyond, 2017). The gravity of the penalty can be best seen in juxtaposition to the previous Data Protection Act of 1998-- the GDPR maximum fine is 40 times greater (Sherriff, 2017). Aside from indicating a globally-felt tide of government scrutiny on data use and abuse, GDPR will have an effect in the Caribbean, though exactly how is unclear. GDPR “will affect firms both inside and outside of the EU. In fact, any company dealing with EU businesses’, residents’, or citizens’ data will have to comply with the GDPR” (GDPR & Beyond, 2017). Luckily, a SSI system prioritises consent, pseudonymisation, data portability, and data protection by design and default in a way that is advanced even beyond GDPR requirements (Abraham, 2017). While blockchain prides itself on immutability, if that property is to be moderated by Sovrin’s suggestion to store some identity information “off ledger”, a blockchain-based SSI still over-complies with GDPR mandates (Reed, et al., 2017).

Regulatory Concerns of the Private Sector

KYC stems from the lack of a trusted and verified identity, and causes massive “cost, friction, and inefficiency” (Sherriff, 2017). Information ‘pulled from the shelves’ is not trusted at all, and the second organisation duplicates efforts and time during their own vetting process. It is reported that some firms spent up to \$500 million on KYC compliance (Sovrin Foundation, 2018). Meanwhile, AML initiatives need greater efficiency in their processes. SSI would allow banks to transfer KYC work within a jurisdiction, saving money and time (Preukschat, 2018). SSI can reduce tedious bureaucracy over days of processing to a series of clicks over seconds (Sovrin Foundation, 2018).

Regulatory Concerns of Civil Society

As increasing masses of data are harvested about each individual, consumers are actively demanding and reclaiming privacy rights (Allen, 2016; ID2020). Recent CRA scandals and most recently, Cambridge Analytica's breach of what could be almost 90 million FaceBook users, have shaken the public into radical reconsiderations of what privacy does and should mean (Kelly, 2018). In a blockchain-based SSI, the centre of identity control is completely inverted - in the future, Facebook may be the one to pay its users to post their content.

Human Rights Perspective

From a human rights perspective, the lack of autonomy over one's own identity unfairly prohibits the marginalised from accessing basic services. The multiple refugee crises continue to see influxes of people who lack any recognised identity. The UN's Universal Declaration of Human Rights already acknowledges sovereignty and privacy as fundamental rights, but there remains a painful gap between aspiration and infrastructure (Voshmgir, 2018). The SSI would grant control, access, and empowerment to the marginalised by re-assigning the identity locus of control (See [Appendix 5](#)).

Recommendations

This research into the Caribbean has indicated that in order to advance the current credit system, it is necessary to expand the networks of trust and facilitate greater data sharing of the right type of data. Lending institutions must overcome their absolute risk aversion by observing the value of a broader wealth of data that informs a borrower's ability to repay, which in turn mitigates risk.

Therefore, the blockchain-based SSI system, a new information sharing platform, that is accessible and highly secure, is suggested for the region. This credit risk management system will be able to fill the void of credit bureaus in the region and address the shortcomings of current practice in assessing narrow data points. Building this system on a blockchain gives it the possibility of being interoperable and portable throughout the region, as well as having the function to adapt over time for other use cases.

Based on our findings the following data should be considered for the new credential management system:

- Utility payments have promising potential as sources of alternative data, since the majority of business owners will have a history of electricity, phone and internet bill payments. Both online and physical payments can be recorded and verified. Given the high market concentration in each country, where one electricity retailer, telecommunications company, and internet provider serve the majority of the population, this minimises the numbers of stakeholders that need to be incentivised to participate in data sharing.
- Mobile and social data can provide great benefit in developing markets with high unbanked populations with no credit bureau presence. Their use is particularly feasible given the high mobile and internet penetration rates throughout the Caribbean. In most Caribbean countries, since there are often fewer than three mobile phone providers, and some regional giants, like Digicel, this simplifies coordination and sharing of data that is likely already being collected.

- Psychometric testing is well suited to markets with many underbanked credit seekers with widespread internet access, such as the Caribbean.

To collate such data three groups of stakeholders must be incentivised to participate:

- **The users (borrowers):** SMEs that hope to access finance through this type of information cannot be averse to transparency in their own financial undertakings. In the absence of a well-established credit history, borrowers must try to leverage their activities that demonstrate timely repayment behaviour. The incentive to do so would obviously be the opportunity of obtaining a credit line. Any data released pertaining to the user will be approved, encrypted, owned and controlled by the user, to share with a lender at their own discretion. The opt-in nature of this arrangement means that data providers cannot share a customer's information without their consent. Users will be fully knowledgeable of what information is being recorded, shared and assessed. Users can overcome their transparency aversion in knowing that their data is highly encrypted and secured on a decentralised database.
- **Data providers:** CRAs have traditionally been able to collect data by brokering mutually beneficial information sharing relationships, either based on reciprocity or financial gain. The current keepers of the proposed alternative data points can be paid to release the information, or find it valuable for their own operations to have this new credential management system in place. Furthermore, an appropriate legal and regulatory framework that allows for the release of information upon request by the customer or trusted third party, as well as an adequate, but not restricted data protection mechanism is recommended.
- **Lending institutions:** lenders will inevitably go through a trial period of extending credit to previously thin-file customers that can now provide verified alternative data. Once convinced of the success of such practices by other lending institutions, but also from their own initial experiences, lenders, including TIBs, are likely to become active participants, seeing value in the alternative data in helping expand customer base and reduce risk.

The success of such an innovative system will require horizontal initiatives that foster an environment of awareness and active participation:

- Government institutions should support the establishment of an innovation hub that enables testing grounds of multiple applications for blockchain technology across islands.
- Partnerships should be explored with the several SSI systems emerging, such as Sovrin and Selfkey (See [Appendix 6](#); Abraham, 2017). Though none explicitly make access to finance as an epicentre from which to expand, it will be wise to enter in conversation to investigate whether they are open to prioritising the use case of access to finance for SMEs in the Caribbean for their entrance into the region.
- Further conversations with blockchain-based non-SSI access to finance companies could provide insight on partnership creation strategies, though they do not offer the foundational SSI advantage of user autonomy (See [Appendix 7](#)).
- Financial literacy is still a hindrance to the commercial viability of SMEs and there is an opportunity for an organisation to issue standardised online financial literacy courses that would result in certification that could be added to a SME's credit profile.
- Educating the community and building awareness of the availability and viability of alternative information assessments and FinTech.

Conclusion

Caribbean firms consistently lag behind the ROSE benchmark, performing worse in sales, employment, efficiency, and the level of total factor productivity (IDB, 2016: 16). In fact, between 2010 and 2013, the Caribbean growth rate fell to an average of 0.8% while ROSE grew by 3.6% (IMF, 2015, in IDB, 2016: 7).

The particularly unfriendly business environment is largely to blame, characterised by a general lack of transparency, heavy reliance on collateral, and near absence of CRAs. Concurrently, SMEs disproportionately suffer from the increase in cybercrime in parallel with expanding internet usage. The current TIB access-to-finance model systematically excludes many creditworthy individuals, and security issues threaten to inhibit the ability of already-credited SMEs to repay secured loans and access future funds. The present business environment and looming risk of cybercrime disadvantage SMEs, TIBs, and Caribbean economies.

This report has investigated alternative data that has gradually been brought into consideration by some lenders and CRAs. Meanwhile, as evidenced by the insecurity of present databases, regulatory movements sweeping governments, private sectors, and civil society around the world, and the increasingly important role of digital identity, a revolutionary new system is needed to assess creditworthiness.

Blockchain has the potential to combine dimensions of digital identity like never before, not only aggregating alternative information, but doing so in a way that maximises frictionless transactions, security, and individual autonomy. Creating a SSI system on the blockchain would democratise economic participation, anticipate future regulatory standards, and lay the foundation for all future use cases for blockchain in development.

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Appendix

Appendix 1: Terms of Reference



Inter-American Development Bank (IDB)
'Hythe' Welches, Maxwell Main Road, Christ Church, Barbados
BB17068

Organization: Compete Caribbean (IDB, DFID and CDB)

Compete Caribbean is a private sector development program that provides technical assistance grants and investment funding to support productive development policies, business climate reforms, clustering initiatives and Small and Medium Size Enterprise (SME) development activities in the Caribbean region. The program, jointly funded by the Inter-American Development Bank (IDB) and the United Kingdom Department for International Development (DFID), supports projects in 13 Caribbean countries. Projects in the OECS countries are implemented in partnership with the Caribbean Development Bank.

Project Title: Blockchain for Small and Medium Enterprise (SME) development in the Caribbean: Access to finance

Background: The growth in productivity of the Caribbean private sector has been falling behind that of the Rest Of Small Economies of the world over the past three decades. Compete Caribbean uses diverse instruments to help SMEs (which represent 69% of Caribbean firms) become more productive and innovative while fostering inclusive and sustainable development. However, SMEs face huge cost and financial barriers that inhibit their ability to innovate, upgrade, and scale up. Commercial banks play an important role in helping to address this problem, but portfolio risks associated with the lack of collateral and financial history hamper their actions to extend credit to potential borrowers. Given the potential that blockchain technology offers to achieve these goals, especially in the Caribbean given the emergence of local expertise and fintech companies such as Bitt.com, the program is seeking advice and latest research findings on how blockchain technologies can be used in the Caribbean to increase credit flows to enterprises across the region.

Question: How can blockchain technology be used to overcome barriers and enhance access to finance for Caribbean SMEs?

Objective: The research findings could help Compete Caribbean and its partners understand the opportunities for catalytic and sustainable impact in the region. Students should first establish the barriers that SMEs face in accessing credit and current lines of credit in the region. Next, the students should find what alternative data is currently being used to circumvent traditional incumbent bank lending procedures and how to incorporate this into a blockchain solution. This alternative information, if applicable to the regional context, can then be used as a proxy for traditional financial data regularly requested by lending institutions. Understanding how blockchain can address the related concerns, and justifying those claims, will be pivotal in determining if the technology has a unique use case for SMEs and access to finance in the Caribbean. The research findings should lead to

recommendations about what should be done, and how and why to optimize the impact on the Caribbean economy and people.

Methodology: The students will have to conduct desk research and become familiar with the following topics: access to finance, blockchain uses, and information privacy. The expertise developed will have to be applied to the Caribbean context. To better understand the evolving financial technology landscape, interviews will have to be conducted with various stakeholders and experts in the fields of research.

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Appendix 2: Limitation of Blockchain: High Energy Consumption

Blockchain technology has been flagged as having serious repercussions on the climate and greenhouse gas emissions, by greatly increasing carbon emissions through its energy consumption. This is largely a result of blockchain's use of the proof-of-work consensus protocol, which is currently the mechanism that gives it its unique security and infallibility characteristics. In this system, blocks are generated when data entered into the distributed ledgers is scrutinised (i.e. mined) by miners who compete for financially convertible tokens. Essentially the more electricity a miner burns, the more hashes for mining are produced, and the greater his/her chances become of earning tokens. Incentives can be huge; a miner of the cryptocurrency bitcoin can win 12.5 tokens – possibly worth over USD\$100,000 (Hern, 2018). Consequently, the demand for coal power has increased (Begum, 2017). For perspective, one transaction on Ethereum can power the equivalent of 2.5 households for one day.

Solutions to the blockchain's high levels of energy consumption are being explored to take on the challenge of reducing its greenhouse gas emissions (Flipo & Berne, 2017). One alternative system on the rise is that of the proof-of-stake algorithm (Lilic, 2017). In this scenario, coin owners, as opposed to miners, create blocks. Thus, without the need for the intensive production of hashes, energy requirements would be much lower (Digiconomist, 2018a). Currently, several versions of the proof-of-stake system exist. Ethereum aims to shift to the proof-of-stake system, Casper, although this has yet to be realised (Lilic, 2017).

	Bitcoin	Ethereum
Current estimated annual electricity consumption (TWh)	58.96	16.86
Country closest to Bitcoin in terms of electricity consumption	Colombia	Lebanon
Electricity consumed per transaction (KWh)	913	74
Number of U.S. households that could be powered by Bitcoin	5,459,147	1,561,035
Number of U.S. households powered for 1 day by the electricity consumed for a single transaction	30.87	2.5
Bitcoin's electricity consumption as a percentage of the world's electricity consumption	0.26%	0.08%
Annual carbon footprint (kt of CO2)	28,890	N/A
Carbon footprint per transaction (kg of CO2)	447.61	N/A

Bitcoin and Ethereum Network Statistics (Digiconomist, 2018a) (Digiconomist, 2018b)

Appendix 3: Compete Caribbean Territory List

Compete Caribbean implements projects in the following 13 territories (Anon., 2017)

- Antigua & Barbuda
 - The Bahamas
 - Barbados
 - Belize
 - Dominica
 - Grenada
 - Guyana
 - Jamaica
 - Saint Kitts & Nevis
 - Saint Lucia
 - Saint Vincent & the Grenadines
 - Suriname
 - Trinidad & Tobago
-

Appendix 4: Evolution of Digital Identity

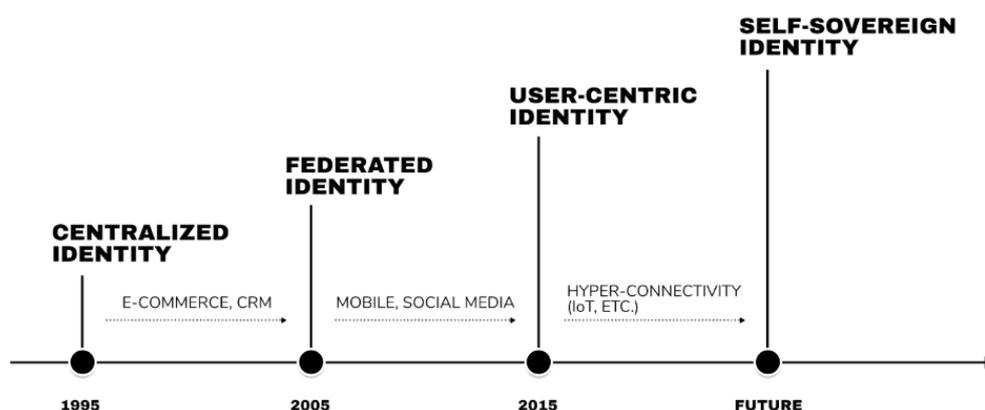
While most of the internet is still centralised, movements toward federated and user-centric modifications acknowledge the corruptibility and failure risk associated with housing information with CAs and other TTPs.

A Federated Identity means that several, federated authorities control the user's experience, and the individuals use the same username and password for multiple platforms. Microsoft Passport (now Windows Hello), released in 1999, was an early example of federated identity, where the user could sign into Microsoft apps, websites, and devices using one account. Since Microsoft was central to the Federation, they created the oligarchical Liberty Alliance in 2001 (Allen 2016)

A User-Centric Identity is where there is "individual or administrative control across multiple authorities without requiring a federation" (Allen 2016). The User-Centric identity, which originally developed out of the desire to improve a superficial experience rather than autonomy, is where the credentials from one website can be used to automatically sign into others, without an account on the home website. For example, FaceBook Connect lends users to ability to intercommunicate on other websites through the "sign in with FaceBook" option.

Finally, Self-Sovereign Identity is a radical departure from previous attempts to lasso control of digital communication. The individual controls their own identity "across any number of authorities" (Allen 2016). The concept and word SSI emerged in the 2010s and has been gaining recognition.

Key Evolution of Digital Identities Chart



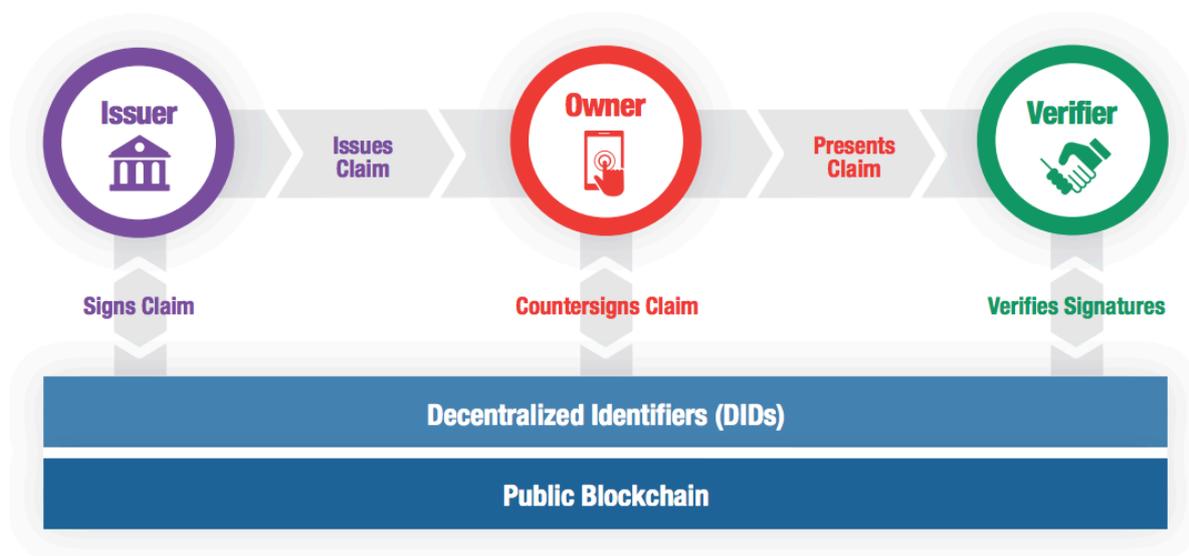
Appendix 5: The Importance of Autonomous Digital Identity Control

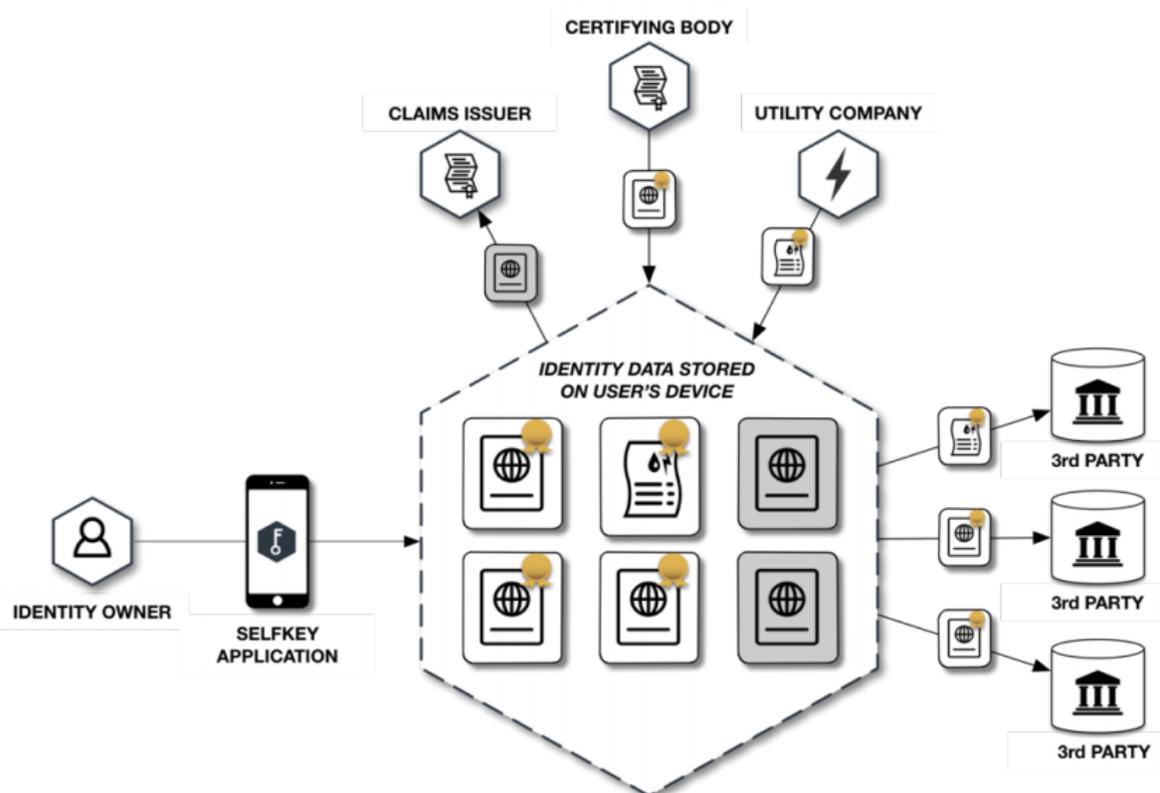
While proponents of SSI embrace the principles of egalitarianism and democracy, there is no consensus that pinpoints its definition. Rather than wrangle a singular meaning of identity, it is more useful to foundationally understand the identity landscape. Identity can be conceptualised as unidirectional or relational. A unidirectional identity may be a personal identity, or how an individual sees themselves. It may be self-declared and socially conceived by others, or, it may be imposed by a higher authority. Meanwhile, relational identities are defined by transactions, reputation vouching, attestations of functional attributes, or a combination (Morris 2018; Preukschat 2018). It is important to remember that a SSI system allows the individual to govern relational identities, rather than unidirectional. This is because the SSI information requires both the attestation of an external party (or parties) and the individual.

To put one's identity on blockchain as a part of an SSI system means that the individual has the bargaining power necessary to use that record as they wish, to maximise their own well-being. Not only does a blockchain-based SSI address access to finance for SMEs in the Caribbean, but it also sets the infrastructure for other use cases, like access to better insurance packages.

Appendix 6: Examples of Other SSI systems

Sovrin White Paper





Appendix 7: Examples of Other Blockchain-Based Access to Finance Projects

Different combinations of alternative data have been integrated into blockchain platforms to produce innovative and secure credit risk management. For example, with Bloom, powered by Ethereum and IPFS (Leimgruber, et al., 2018), the user establishes a Bloom ID by gaining attestation about his/her identity and/or ability to act responsibly with credit, from official organisations and/or peers. The Bloom IQ then records the user's financial history and thereon records current financial information. Finally, a Bloom Score is created using an algorithm created by Bloom, which combines data from the two previous elements. This ultimately is provided to lenders, but only with permission from the user. Bloom is currently in its early stages and has not yet been launched. Alternatively, PayPie, powered by its own PayPie platform (PPP), caters specifically to SMEs, who opt to connect their accounting software to the PPP. The result is a score based on live financial transactions, which can be provided to banks without the permission of the SME. PayPie has not yet begun operations. While both companies guarantee the security of data they gather and the scores they produce, a foreseeable challenge for them would be to raise trust and credibility with TIBs specifically with regard to the design of their algorithms.

PayPie may also be faced with a barrier convincing SMEs to permit full access to their accounts.

In March this year, the Royal Bank of Canada's (RBC) patent application for a credit-scoring platform built on a blockchain was officially released (Clay, 2018). The early released information reveals a CRM system which employs smart contracts to arise with borrowers, based on a RBC algorithmic score. The score would consider both financial history and data from a wider range of sources, and greater transparency will apparently be provided to users as to how their credit score is calculated. User permission would not be necessary here, given that the bank would be creating its own credit scoring system.

