ADOPTION READINESS IN SERVICE INNOVATION:

THE CASE OF DIGITAL MONEY

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ABSTRACT

One challenge for firms seeking to develop new services is to understand the conditions likely to affect rates of adoption. Understanding relative degrees of "adoption readiness" provides innovators with information to choose market segments and indicates opportunities to influence adoption environments. This paper considers these issues through the case of digital money, a service innovation some claim to have the potential to provide major economic and social benefits. However, there is little research into the adoption readiness of countries upon which firms can base their new service development decisions. Defined as "currency exchange by electronic means", we conceptualize digital money as a socio-technical system, and propose a Digital Money Readiness Index. This composite index integrates institutional, financial, technological, economic, industrial and social attributes to measure adoption readiness. We identify four stages of readiness and systematically analyze the factors that drive under or over adoption of digital money technologies.

Key words: Service innovation, digital money, adoption readiness, composite index, cashlessness

1.0 INTRODUCTION

Perhaps the most influential service innovations shaping history, money has driven wealth creation and socio-economic development. Innovation in the technologies of money has the potential to provide major economic and social benefits. Dodgson, Gann, Wladawsky-Berger, and George (2012) argue that the reduction of time lost in making transactions, or waiting for receipt or confirmation of payments, will improve productivity by removing the "friction" in transactions. Others have emphasized potential social and economic benefits of mobile payments such as M-PESA in developing nations (Jack & Suri, 2011; Morawczynski, 2014). Digital money innovation also offers the possibility of "dis-intermediating" financial systems through removing the requirements for intermediaries to facilitate transactions (Dodgson et al., 2012). The development and adoption of digital money poses a range of questions for innovation studies and for management scholars (Dodgson, Gann, Wladawsky-Berger, Sultan, & George, 2015).

A challenge for firms and governments seeking to develop and regulate new service innovations such as digital money is to understand the conditions of adoption in different markets. However, comparisons of service innovation adoption across markets is difficult, as social, economic, political and cultural factors complicate such comparisons (Cooper, 1998; Rogers, 2003). Research comparing service innovations across markets has generally considered firm level new service development rather than national level adoption (see for instance Thakur & Hale, 2013; Yen, Wang, Wei, Hsu, & Chiu, 2012). Digital money adoption probably represents an extreme polar case (Yin, 1984), as the flow of money influences, and is influenced by, a wide range of social and institutional conditions including economic policy, security, ethics, and morality (Eagleton & Williams, 2011; Simmel, 1990). At the country level, all countries have adopted some aspects of digital money, be it credit cards, mobile payments, or e-banking funds transfers. However levels of adoption vary; for instance, in the European context, Snellman, Vesala, and Humphrey (2001) found a trend towards the adoption of card-based digital money, but countries themselves are at significantly different stages of the process. Furthermore, not all countries adopt the same service innovations; and those that have adopted the same technologies will not have necessarily implemented them in the same way. For

instance, in the developed world, the focus of digital money adoption has been on NFC (near field communication) and stored value cards (such as the Oyster card for the London Underground). In contrast in less developed countries the focus has been on mobile payments, such as M-PESA in Kenya. In some countries credit cards are used for the majority of day-to-day transactions, while in others they are often used as flexible financial safety nets (Mann, 2006). This difficulty in comparison is compounded as new digital money technologies are developed and implemented.

An alternative approach would be to measure the level of cashlessness within an economy, based on the intuition that increasing digitization will result in a cashless society (Snellman et al., 2001; Wolman, 2013). However, appealing this notion is, empirically it appears that the use of cash is not necessarily decreasing, even within advanced economies. For instance, Evans, Webster, Colgan, and Murray (2013) demonstrate that the overall real spending in cash is increasing due to economic growth, and that the actual extinction of cash is many generations away. Similarly, Freedman (2000) concludes that it is "extremely unlikely that electronic money will replace bank notes … that are offered by central banks in the foreseeable future" (p 211). Furthermore, those attempts to measure cashlessness have focused on consumer spending, and hence only captures part of the digital money services in use (see for instance Dave & Baxter, 2013; Thomas, Jain, & Angus, 2013). As a consequence, measures of cashlessness only partially capture the adoption of digital money within an economy.

The purpose of this paper is to measure the country level factors likely to affect the adoption of digital money innovations. Rather than focus on the stages of diffusion of a particular service innovation, we instead focus on the characteristics of the environment which influence adoption. Put differently, our goal is to measure the digital money *readiness* of a country. By readiness we mean the level of development of the country with respect to the institutional, financial, technological, and economic factors that underpin digital money.[2] For instance, there is a minimum level of financial regulation and information and communication technology (ICT) infrastructure required to launch

[2] This is not the first attempt to consider the readiness of a country for the adoption of digital money. Previous efforts comprise the MasterCard Cashlessness Readiness Index, focusing on reduction in the amount of cash in an economy (Thomas, et al., 2013) and the Market Platform Dynamics Cash-at-Risk Index (Evans, et al., 2013), both developed by commercial parties.

new digital money services. Moreover, different innovation, business and political environments will influence the ability and the willingness of merchants to utilize and consumers to adopt services. We devise a composite index that integrates a selection of institutional, financial, technological, economic, industrial and social attributes to measure how ready a country is to adopt a service innovation. Composite indices such as these are increasingly recognized as useful tools in policy analysis, public communication and corporate strategy (OECD, 2007).

Indexes such as these are needed as they provide a sophisticated yet easy to understand means of comparing countries. Simpler measures of cashlessness only provide a measure of the symptom of increasing use of digital money, and an imperfect measure at that, due to their focus on consumer spending. Furthermore, given the complexity, quantity, interrelatedness, and (the now) constant evolution of digital money innovations, approaches such as investigating the time and space pattern of adoption of particular innovations are impractical for the coverage of the family of digital money innovations over a large numbers of countries.[3] This is particularly salient when the goal is to create a yearly index so that both headline and more granular trends over time can be analyzed. A further benefit of developing an index rather using measures of cashlessness or direct measurement, is that an index permits the development of policy recommendations. For innovators, an index provides an indication as to the likelihood of success of a particular digital money technology in a country, as well as suggesting the characteristics of digital money innovations that could be introduced into a country. For policy makers, an index suggests actions that they can undertake to assist a country in transitioning from one readiness stage to another.

We first contribute through a Digital Money Readiness Index, a composite index that provides a granular and transparent country-level view of the factors that hinder and help a country's readiness score. Although our index has been developed to understand adoption readiness for digital money, it has implications for understanding adoption readiness of new service innovations more generally (Cooper, 1998; Rogers, 2003). As such our index begins to provide a systematic approach for considering the environment within which service innovations are adopted. We also contribute

[3] However, this type of time and space analysis would be very useful for a study of a single digital money innovation. We thank an anonymous reviewer for pointing this out.

through a detailed examination of how countries over or under adopt digital money innovations relative to their index value; put differently, we examine the relationship between cashlessness and readiness. In particular, we determine which factors drive under or over adoption. We also contribute through a comprehensive theoretical conceptualization of digital money and broadening of academic audience. Our socio-technical systemic model of digital money leverages the insights of Geels (2004), comprising of the institutional environment, enabling infrastructure, and supply and demand conditions, should provide the basis for further theoretical and empirical work.

The paper is structured as follows. In the next section, we provide a theoretical outline of the digital money system, detailing its interdependent components. We explain our method of index construction and the techniques of normalization, dealing with outliers, ranking calculation and clustering. We review country rankings and groupings, before analyzing our index with measures of cashlessness in society. We systematically identify why some countries over- or under-adopt relative to their index value. We conclude with a discussion of general lessons from development of an adoption readiness index for new service innovations.

2.0 DIGITAL MONEY SOCIO-TECHNICAL SYSTEM

Money is a service that has a number of purposes in society: it is a unit of account which enables the measurement and recording of value; it is a means of storing value for convenient future use; and it is a mechanism of value exchange (Bohannan, 1959; Dodd, 1994; Simmel, 1990). Beginning with barter, barter was soon replaced by service tokens, better known as money, which acted as proxies for value (Westland, 2002). Thus for those societies close to oceans, sea shells served as proxies of value; in other places special stones or tea bricks were used, and later innovations included pieces of metal, such as gold and silver, shaped into coins (Kelly, 1997). The subsequent development of printing led to innovations such as bank notes; later still the development of telecommunications, beginning with the telegraph, allowed value exchanges through information technology. Today, the technologies of money provide a range of different services so that value is exchanged in a variety of ways, ranging from paper and metal coins, through short text messages on mobile phones, near field communication (NFC), to the transfer of data over the internet. Beyond

value exchanges of existing currencies, such as the US dollar or British pound, innovations in the unit of account and means of storing value such as crypto-currencies, e.g. Bitcoin, have been introduced, which itself is continually being enhanced. These new electronic means of value exchange have been variously called electronic money (Singh, 1999), electronic cash (Westland, 2002), e-money (Mbiti & Weil, 2013), and mobile money (Erling, 2013). Each of these labels considers the same phenomenon from different perspectives. For instance, "mobile money" applies to electronic means of exchange through mobile phones, "electronic cash" to stored-value services, and "electronic money" to the general digitization of currency flows, including direct transfer and credit cards.

For the purposes of this paper, we take an encompassing view, and collectively call these electronic technologies of value exchange *digital money*: "currency exchange by electronic means". Thus within our scope are all non-cash and non-paper value exchange transactions such as credit/debit/charge cards and direct transfer, as well as all value exchange transactions via electronic channels such as Electronic Funds at Point of Sale (EFTPOS) and prepaid cards. Also within our scope are new exchange intermediaries such as PayPal and M-PESA, as well as stores of value that can be used for transactions, such as Oystercard, MetroCard, and EZY-Pass. In addition, we include the emerging crypto-currencies and their mechanisms of value exchange.

From its earliest conceptualizations, scholars have discussed money and services of value exchange as a system (Eagleton & Williams, 2011). Indeed, the modern monetary regime is generally called the "monetary system" (Dodd, 1994; Mbiti & Weil, 2013; Rogers, 2006; Woodford, 2000). Previous research into mobile money and payments takes a technological systemic approach (Kent, 2012; Mbiti & Weil, 2013; Rochet & Tirole, 2002), as does research into crypto-currencies (Eslami & Talebi, 2011; Juang, 2007). Some scholars have integrated both the technical and broader performance aspects of systems, detailing relevant technical characteristics of a digital money system, such as identifiability of transactions, scalability and consistency, and interoperability, as well as more traditional concerns such as vulnerability, reliability and durability and cost (Misra, Javalgi, & Scherer, 2004). Other scholars have adopted the notion of "ecosystem" (see for instance Erling, 2013; Kemp, 2013; Kent, 2012), considering the digital money system to be a network of participants in which value is co-created amongst multiple co-specialized participants (Autio & Thomas, 2014). For

instance, Kemp (2013) identifies six interdependent market participants in a digital money ecosystem: card schemes, mobile operators, retailers, device suppliers, service providers, as well as trusted service providers that manage the range of contractual and technical connections between the participants. Although Kemp specifically considers mobile payments, his identification of multiple market participants who are mutually dependent on each other, who interact through platforms, demonstrates the systemic nature of digital money generally.

This systemic approach is given salience by the fact that digital money is underpinned by platform technologies that coordinate multi-sided markets and are influenced by network effects (Evans, Hagiu, & Schmalensee, 2006; Rochet & Tirole, 2002, 2006; Thomas, Autio, & Gann, 2014). Network effects occur when the use of a good or service by one user has an influence on the value of that product to other people. These network effects have important implications for the adoption of new currencies and of digital money technologies, as well as competition between different currencies and monetary technologies. For instance, positive network effects can result in rapid adoption of a currency or technology as increasing supply leads to increased demand. Put differently, consumers must be able to easily obtain digital money as well as have plenty of opportunities to spend it (Kelly, 1997). Similarly, network effects can result in complex competitive dynamics involving interchange, compatibility and standardization (Katz & Shapiro, 1994). Multi-sided markets occur when there are multiple distinct user groups or markets that provide each other with network benefits, and are coordinated through platforms (Rochet & Tirole, 2006). Indeed, the seminal paper that modelled multisided markets studied the effects of the no-surcharge and interchange fees in the credit card providers market (Rochet & Tirole, 2002). The multisided nature of digital money often results in difficulties in adoption, known as the "chicken and the egg problem", as both the merchant and the consumer must have the means with which to transact (Caillaud & Jullien, 2003).

Moreover, Kemp (2013) identifies the importance of regulation in governing the interactions within the monetary system, as they drive the effective functioning of platform-based multisided markets (Evans et al., 2006; Tiwana, Konysnski, & Bush, 2010) and ecosystems (Gulati, Puranam, & Tushman, 2012; Wareham, Fox, & Cano Giner, 2014). Regulatory concerns relate to both the ability of the central bank to oversee the monetary system (Freedman, 2000; Lee & Longe-Akindemowo,

1999; Rogers, 2006), as well as privacy and security concerns (Kelly, 1997; Roberds, 1998). These regulations can both support as well as hinder digital money adoption. For instance, in 2000 the European Union (EU) passed its First E-Money Directive which was meant to enable the supply of digital money in the EU member states by creating legal certainty, avoid hampering technological innovation, preserve a level playing field, and ensure the stability and soundness of digital money (Halpin & Moore, 2009). The importance of regulation is underlined by the many difficulties that this Directive caused, which in fact slowed the development and adoption of digital money in the EU (Courtneidge, 2012).

Given these characteristics and the social embeddedness of money within society, we consider money as a socio-technical system (Geels, 2004; Geels & Schot, 2007). Socio-technical systems have substantial inertia, driven by path-dependence and lock-in (Arthur, 1994; David, 1985). This inertia is driven by rules and regulatory regimes that provide stability though guiding perceptions and actions, mutual dependence between actors driven by their embeddedness in the system, and also complementarities between technical components that make radical systemic change difficult (Dosi, 1982; Geels, 2004). This means that innovation and change is often incremental within a given socio-technical system (Geels & Kemp, 2007).

[Insert Figure 1 about here]

The digital money socio-technical system in any particular country has four main components: the institutional environment, the enabling infrastructure, supply and demand (see Figure 1). These four components integrate the technology, regulation, user practices, markets, cultural meaning, infrastructure, production, and supply networks that comprise the digital money socio-technical system (Geels, 2004). It incorporates supply and demand conditions as important factors which drive system performance, which also capture well the multi-sided relationships that typify the relationship between consumers and merchants in digital money contexts. In particular, the provider's supply of digital money can hasten the pace of adoption of digital money, as can the demand driven by the motivations of the user (Singh, 1999). Similarly, the focus on relating and supporting industries aligns with their importance in digital money contexts – both from the perspective of the underlying technological regime (Dosi, 1982; Kim, 2003) that enables digital money, and the regulatory context

that digital money operates within. The consideration of the role of the institutional environment, specifically the actions of government, ensures that its influence on supply and demand conditions, as well as the provision, quality and accessibility of the enabling infrastructure, are addressed.

2.1 Institutional environment

The institutional environment comprises the national regulation, policy, economic, innovation and entrepreneurial characteristics within which digital money needs to operate. Key to any socio-technical system is trust (Geels, 2004) – commanding confidence in money and payments is vital given the natural inertia that typifies money systems (Cohen, 2000). This requirement for trust becomes pressing due to the intangibility of digital money. Thus one institutional requirement for digital money is the legal framework and regulatory effectiveness that builds confidence in innovative technologies of money. To engender confidence in digital money, an adequate level of regulation and law abidance is required in relation to contract enforcement and property rights. Indeed, merchants, consumers and other financial intermediaries need to ensure that their digital money cannot be easily appropriated by others (Kelly, 1997). Furthermore, the move to digital money can open new opportunities for fraud which consumers, merchants, intermediaries and banks want to be protected against (Roberds, 1998). Relatedly, the legal environment needs to ensure privacy and security, as consumers wish to keep the value of their consumption private, and merchants and intermediaries wish to ensure they capture an appropriate record of their sale (Kelly, 1997).

Beyond the legal environment, economic factors also influence digital money adoption rates. For instance, those countries that have competitive markets are well positioned to ensure that there is effective trade between organizations (Williamson, 1975), and hence an institutional environment conducive to digital money technologies and services. This healthy market competition drives business productivity by ensuring that the most efficient firms are those that thrive (Smith, 1994), further providing the conditions for the adoption. In consequence, a competitive market is likely to encourage regulators, government, organizations and consumers alike to adopt digital money, so that the institutional environment assists in overcoming the natural inertia of monetary change. In contrast, in those economies with uncompetitive markets or which are unfriendly to business, there will be little

appreciation of, or need for, digital money by producers or consumers, hence little likelihood of overcoming inertia.

Another national institutional characteristic that influences the readiness of a country is the innovation and entrepreneurial environment. Innovation and entrepreneurship has been at the core of many historical productivity gains, transforming production processes, and opening a wider range of new possibilities in terms of product and service innovation (Dodgson, Gann, & Salter, 2008). Thus the nature and rate of innovation and entrepreneurial startups within an economy will influence the economic environment within which digital money will be provided and consumed, including the types of digital money innovations offered. For instance, innovative and entrepreneurial economies may develop a greater variety of innovative digital money technologies, which may assist in overcoming the natural inertia of monetary change. However, in those economies that are not considered innovative or entrepreneurial, there is less likelihood that digital money innovations will emerge that overcome inertia.

2.2 Enabling infrastructure

The enabling infrastructure comprises the information and communication technology development and financial regulatory characteristics that underpins the deployment and operation of digital money technologies and services. This includes the provision, availability and affordability of information and communication technologies within a country. For instance, levels of mobile network coverage and broadband provision influence readiness to adopt – when mobile network coverage is good, but broadband provision poor, digital money technologies based upon mobile devices may be readily adopted. Similarly, if access to the internet, smartphones or mobile telephony is costly in relation to the average wage, then the infrastructure becomes less available for both companies and individuals to access. This reduces the readiness of a country for digital money adoption. An economy also needs a population with the skills to be able to use these technologies; if the population is not educated on how to use ICTs, then not only will the adoption of digital money be hindered through low consumer adoption, but there will be less skilled staff able to support the provision of digital

money solutions. In consequence, the development of the ICT infrastructure is an important enabling characteristic for digital money.

The financial regulatory characteristics within an economy also influence digital money adoption. Different regulatory regimes reflect differing trade-offs between the efficiency of the financial system and the amount of risk assumed by the public sector (Lee & Longe-Akindemowo, 1999). Most digital money regulation has been directed at reducing systemic risk and increasing the efficiency of the provision of payments services (Singh, 1999). These regulations affect the performance of a digital money system, in their efforts to head off the potential systemic risk issues that would occur with the collapse of an electronic payment system (Dodd, 1994; Lee & Longe-Akindemowo, 1999). The financial regulation within a country is related to the level of development of the overall financial market development. Thus the differing availability and affordability of financial services, the function of equity market, soundness of banks, access to loans and venture capital dynamics within any digital money system will influence the types, scope and enforcement of regulations that are in place. However, regulations can also have the effect of limiting newer participants into the digital money system, restricting activity to banks and other established financial intermediaries.

2.3 Supply conditions

Supply conditions consist of the specialized resources that produce the artefacts required for the performance of the digital money socio-technical system, which are often specific to an industry (Geels, 2004). For instance, the sensors required for payment on transit systems, such as motorways, are often quite different to those in retail environments. Empirically, scholars have found that the levels of adoption of digital money depends crucially on the provision and diffusion of digital money infrastructure, such as card payment terminals (Snellman et al., 2001).

Supply conditions are best considered from the perspective of the industries that have the potential to implement digital money, and best reap the benefits from services innovation. For retail industry, the rise of the internet and the move of commerce to the internet has resulted in increasing provision of digital money solutions to improve efficiency (Panurach, 1996). The increasing levels of

government services online has also lead to increasing provision of digital money solutions, as government seeks to improve service delivery, capture tax revenues, and reduce fraud and the cost of benefit disbursements. The telecommunications industry itself has led to increasing provision of digital money solutions, with many operating system manufacturers (such as Apple and Android) launching digital money solutions. Other industries which are driving the provision of digital money solutions include the transport industry, such as those services automating payment in metro systems and on toll-roads. Here the provision of digital money enables costs reductions in toll and fare collection, as well as improved insight into the behaviors of consumers.

2.4 Demand conditions

Demand conditions comprise the propensity to adopt digital money of consumers and business, and most closely relates to the application domain of Geels (2004) and extant studies of innovation diffusion (Rogers, 2003). The ability to substitute one mechanism of currency exchange depends importantly on the consumers, both individuals and businesses, whose use of digital money is influenced by social, cultural and technological factors (Snellman et al., 2001). As such the demand conditions drives digital money readiness, as businesses and consumers pressure suppliers to innovate faster and to create more advanced offerings.

At a broad level, the propensity to adopt is influenced by the rate at which technology diffuses through an economy (Rogers, 2003). To function as an adequate substitute for existing payment mechanisms, digital money must have widespread acceptance and fit seamlessly in its users daily activities (Singh, 1999). In particular, the perceived usefulness and ease-of-use have a significant positive effect on likelihood of adoption of digital money, especially in stored-value cards (Singh, 1999), while the perceived cost alone does not reduce the likelihood of adoption (Tu, Hsin, & Chiu, 2011). As digital money is a collection of emerging technological forms of currency exchange, the readiness of a country for digital money will be influenced by the rate at which both businesses and individuals accept technological change. For instance, the levels of “newness” and hence perceived riskiness of digital money may lead to slower adoption. Focusing on digital money adoption amongst consumers in Taiwan, some scholars have suggested that the perceived risk of the new technologies

lowers the likelihood of adoption (Tu et al., 2011). However emphasizing that cultural and social factors are important in assessing the propensity to adopt, others scholars have found that in Indonesia risk and security do not reduce the likelihood of adoption (Miliani, Purwanegara, & Indriani, 2013).

In summary, we have outlined the four main components of the digital money socio-technical system building upon the insights of Geels (2004). Taking these four components as the pillars of the composite index, we select a range of indicators which measure progress along each pillar. This allows us to rank countries and using cluster analysis, identify four stages of readiness. We now describe our index construction method.

3.0 INDEX CONSTRUCTION METHOD

Our definition of digital money implies that the measurement of the readiness for the adoption of digital money is not a simple task. Indeed, the existence of multiple interacting components that are expressed through different technologies means that digital money adoption readiness is not a clearly defined object of study. Instead, digital money readiness is a multi-dimensional construct which cannot be captured by a single variable. Such multi-dimensional constructs are generally measured by composite indices (OECD, 2007). Composite indices are constructed when the goal is to measure something that none of the individual components alone does a good job of measuring (Trochim & Donnelly, 2008).

A composite index is a score – a numerical value – that necessitates a calculation to create the final ranking. To construct a composite index and derive a quantitative score for a multi-dimensional construct, a set of rules is essential to combine the two or more variables to reflect the more general construct (Trochim & Donnelly, 2008). The different variables being combined are often measured in different ways and on different scales. Techniques such as normalization and controlling for outliers are therefore required to ensure that indicators can be meaningfully combined. We also further analyze the ranking using clustering, to determine if there are groups of countries within the ranking of countries. We first detail our constituent dimensions and indicators which operationalize our framework, and then detail our normalization, dealing with outliers, ranking calculation, and clustering techniques.

3.1 Dimensions and Indicators

Building upon the four components (hereafter pillars) of the digital money system – institutional environment, enabling infrastructure, supply and demand – we have identified a number of dimensions within each pillar. A dimension is a logical grouping of specific indicators that together represent a single aspect of the pillar. For instance, indicators that measure venture capital availability, and business startup procedures, time and cost are collected into a single dimension called Entrepreneurship Environment.

To select each indicator, the authors reviewed a wide selection of existing single and composite indices, such as those from World Bank, World Economic Forum, International Monetary Fund, International Telecommunications Union, United Nations, and other organizations that publish such country-level data. For those organizations that released their own composite indices, we disaggregated these to derive their source indicators. These individual source level indicators were then reviewed in the context of digital money to ensure that they were related to the adoption of digital money. Where possible, the indicators that were updated yearly were selected, as were those with a good coverage of the target countries. In total, more than 2600 indicators were reviewed from more than 50 different sources, resulting in a short list of 207 indicators.[4] This shortlist was then methodically reviewed with a selection of senior banking executives who specialized in financial digital strategy using a semi-structured Delphi approach to maintain consistency and to minimize bias (Dalkey & Helmer, 1963). The draft list of dimensions and indicators was then presented at a number of workshops and symposia in 2014 and early 2015 which were composed of an industry wide selection financial digital strategy experts. This feedback was collated and reviewed with the same senior banking executives. This resulted in the final list of dimensions and indicators (see Table 1).[5]

[Insert Table 1 around here]

Institutional Environment. Within the Institutional Environment pillar, five dimensions capture the national institutional characteristics within which digital money needs to operate. The

[4] The full list of indicators and their review is available from the corresponding author upon request.
[5] A detailed overview, including sources and description of the underlying data is available from the corresponding author upon request. It has not been included here due to space constraints.

legal framework dimension considers the stability, fairness and operation of the national legal framework. Consisting of four indicators it covers property rights (including IPRs), judicial independence and legal enforcement procedures. The regulatory effectiveness dimension, consisting of four indicators, considers the government regulatory burden, efficiency of regulations, and anti-monopoly effectiveness. The competitive environment dimension consists of four indicators which reflect the level and nature of competition within a national economy, such as contractual observance, industrial counterfeiting, and respect for trade secrets. The innovation environment dimension considers how well an economy innovates, with four indicators covering national R&D and patent output. The entrepreneurship environment dimension, consisting of five indicators, considers the conditions for new business creation in the economy, such as the ease of setting up a business, tax incentives and venture capital availability.

Enabling Infrastructure. The Enabling Infrastructure pillar consists of four dimensions, two reflecting the importance of ICT in digital money, and two reflecting the importance of financial markets and regulation. These represent the economic infrastructure which enables the digital money deployment and operation. The ICT infrastructure dimension, consisting of five indicators, considers the level of development of the telecommunications and information infrastructure, such as mobile network coverage, ICT investment, and the robustness of the telecommunications network. The ICT affordability dimensions considers the affordability of telecommunications and information goods through three indicators. The financial markets dimension, consisting of three indicators, considers the level of development of the financial markets, such as availability and affordability of financial services, as well as the concentration of banking services (known as a Z-score). The financial regulation dimension considers the extent and nature of financial regulation within the economy, with four indicators covering investment and financial freedom, securities regulation and credit information.

Supply (Solution Provision). The Supply Pillar consists of three dimensions which cover the industries which drive the supply of digital money within an economy. The retail dimension considers the development of payments and digital money solutions within the retail industry within an economy. The four indicators here cover the penetration of e-commerce, credit card usage and Point-

of-Sale terminal penetrations. The telecommunications dimension, consisting of three indicators, considers the number of mobile phone subscriptions (as a percentage of the population) as well as the mobile bill payment penetration and the number of mobile money initiatives. The government dimension, consisting of four indicators, considers the development of e-Government within the economy, such as level of online services and how integrated ICT into the government vision.

Demand (Propensity to Adopt). The Demand Pillar consists of three dimensions that capture the demand for digital money driven by the propensity to adopt within an economy. The consumer dimension, consisting of three indicators, considers the characteristics of consumers in adopting new technologies, such as literacy, user sophistication and social network usage. The business dimension considers the characteristics of businesses in adopting new technologies, with five indicators covering level of internet use, innovation capacity, and technology adoption. The ICT penetration dimension, consisting of three indicators, considers the extent to which ICT is used within an economy, such as individual internet usage, broadband subscriptions and the availability of new technologies.

[Insert Table 2 around here]

Table 2 presents the correlations between the indicators grouped by pillar. There are moderate to high correlations (both positive and negative) of all dimensions and indicators. Mobile money has a negative correlation, as most mobile money initiatives are in developing economies, which on average score lower than other indicators. This suggest that all those indicators are measuring a similar underlying phenomenon, catching slightly different perspectives of that phenomenon. Some level of correlation is required if there is to be explanatory power in the combination of the indicators (OECD, 2007). If there was poor or no correlation between these indicators, it is unlikely that they would be able to be combined to suggest a progression of different readiness states.

3.2 Index methodology

Normalization. There were three stages of normalization. The first stage of normalization applied to the indicators, as each has different scales and magnitudes. The second stage of normalization applied to the dimensions, as not all dimensions had the same number of indicators resulting in different magnitudes. The third stage of normalization applied to the pillars, as not all

pillars had the same number of dimensions, resulting in differing magnitudes. For each of the three stages, we transform the indicator, dimension or pillar into z-scores, where each indicator, dimension or pillar has its mean set to zero and a variance of 1.

Outliers. Index building is based upon a benchmarking principle, and the selection of the proper benchmark considerably influences the index scores and hence the ranking of the countries. However within some data sets there are outliers that can skew the results so as to create benchmarks that are inappropriate (Szerb, Acs, Autio, Ortega-Argiles, & Komlosi, 2013). We have taken a capping approach at the indicator level, where the outliers are capped at particular values. No capping was undertaken at the dimension or pillar level z-scores. Although this limits the outlier values, the value of the cap remains within the analysis. Following Szerb et al. (2013), we have capped outliers at the 95% percentile.

Ranking calculation. The ranking is obtained as an average of the pillar scores for each country. This means that every country that scores above zero is above the average of the sample of countries, while every country with negative scores is below the average of the sample countries. The greater their absolute score the further a country is from the average. As a consequence our ranking is a relative ranking where countries are positioned in relation to each other. This implies that adding or removing countries from the sample will modify the score of all the countries (but not the order of the ranking).

This ranking is the first and maybe the more visible outcome of the index, as it lists countries in their order of readiness for digital money. However, there is another outcome of the index that should prove more relevant for innovators and policy makers. We can also distinguish groups of countries that have achieved similar level of maturity. Doing so allows us to look at difference between groups to establish a description of the current level of maturity in each group, highlighting the main differences between groups.

Clustering. The natural methodology to group countries within the ranking is clustering. Although many algorithms can be used to cluster countries, we have applied k-means clustering (Hartigan & Wong, 1979; MacQueen, 1967). To cluster the results, we utilize the index scores of each

country. Countries are grouped by proximity: within a cluster, the average distance between countries are smaller than the distances at the boundaries of each cluster.

This allows us to distinguish four groups of countries with regard to their performance on the index. At the two extremities, there are countries that score high on each pillar (Cluster 4), and incipient countries that score low on all pillars (Cluster 1). In the middle, there are two clusters that are close together: one cluster that does well on some of the indicators but in which on aggregate countries scores are below average (Cluster 2), and a second cluster (Cluster 3) that is above average on aggregate but are trailing behind Cluster 4 on some indicators. Clusters 2 and 3 are characterized by differences in their institutional environment, and supply and demand conditions. Thus countries within Cluster 2 are slightly below average on pillar 1, 3 and 4, and Cluster 3 countries are slightly above average on those same pillars.

Robustness. For robustness, we have compared the index with two similar readiness measures, the MasterCard Cashlessness Readiness score (Thomas et al., 2013) and the Market Platform Dynamics Cash-at-Risk score (Evans et al., 2013). The MasterCard Cashlessness Readiness score, indexed to a scale of 1-100, does not provide any detail as to the actual indicators used in their calculation, only noting they use factors "found to be correlated to consumer cash usage" (p. 6). They group these into four broad categories of "nearly equal weighting" (p. 6), namely access to financial services, macro-economic and cultural factors, merchant scale and competition, and technology and infrastructure. Although the specific data sources[6] and methodology are unknown, and the score only focused on consumer spending, the MasterCard score does cover 33 countries. In contrast, the Platform Dynamics Cash-at-Risk Score does provide more information about its source data, listing 34 different indicators grouped into seven categories of economy, government, merchants, consumers, banks, payment networks and innovators. However, despite covering government and business factors as well as consumer as does our Index, the Market Platform Dynamics score does not detail the methodology used to generate their number,[7] only covering

[6] Some detail is provided, such as "whether people use bank accounts and electronic payment products" and "measures of quality of infrastructure" for example.

[7] The Cash-at-Risk score appears to be a sum of the value of each of the source indicators.

10 developed countries.

As these scores have less extensive coverage than our index, we limit the comparison to the countries that feature in their studies. There is a strong correlation with the MasterCard Cashlessness Readiness score (0.85), as well as quite a strong correlation (0.82) with the Market Platform Dynamics Cash-at-Risk score. Taken together, these correlations suggest that our Digital Money Readiness Index is congruent with similar thinking for readiness for cashlessness.

4.0 DIGITAL MONEY READINESS RESULTS

Table 3 shows the digital money readiness ranking for 2014, with the countries grouped by cluster.

[Insert Table 3 around here]

As can be seen in Table 3, and as described above, the clustering analysis identified four groups of countries. We have named these clusters the Incipient, Emergent, In-Transition and Materially Ready stages. In the Incipient stage, countries are often characterized by a lack of affordable (and basic) ICT infrastructure and expensive and/or limited financial services. For countries in the Emerging Stage, the basic ICT infrastructure and financial services are in place, and the relevant regulation is on the books. Here the challenges tend to be one or more of the following: the presence and size of the informal economy; (perceived) lack of enforcement of existing regulation, both for consumers and corporates; lack of ICT ubiquity and affordability; and consumer preference for cash. For countries in the In-Transition stage, the challenges of the Incipient and Emerging stages have been largely resolved. Often, these countries have successfully deployed accelerators such as social disbursements. However, they still may need to make investments to drive digital money supply, such as digital payments for transit or the seeding of e-commerce initiatives. Sometimes, it may be a matter of lowering restrictions on financial investments so that a healthy system of private enterprises can take root. Finally, countries in the Materially Ready stage are characterized by ubiquitous ICT diffusion coupled with familiarity of digital solutions. They also exhibit a market friendly business and regulatory environment that facilitates private sector investment and innovation in digitally enabled solutions.

Progression from Incipient, through Emerging and In-Transition countries is incremental – the scores for countries in each of the cluster increase gradually until there is a sharp increase for Materially Ready countries. This incremental development is also driven through incremental improvement in all four pillars. However, countries in the Materially Ready cluster have a markedly higher index score than those in the previous clusters. The main differences here seem to arise from differences on pillar 4, Demand, and to a lesser extent on pillar 1, the Institutional Environment. This suggests that in some cases, the main differences between materially ready countries and the most advanced in-transition countries lies in the difference in propensity of businesses and individuals to adopt new technologies. Therefore, it is likely that the differences can be accounted for by cultural factors. In a lesser extent, it also seems that in-transition countries score lower on institutional environment. It is possible that the same cultural argument apply here with institutions that are slightly less favorable to adoption of new technologies or have more circumspect approach to markets.

These readiness stages provide a useful perspective to interpret the results of the index. The index provides insight to innovators on the likelihood of the successful adoption of digital money technologies in a particular country. For instance, it is unlikely that digital money technologies are likely to be adopted in Incipient countries due to their poor performance on all indicators. In contrast, there is an increasing likelihood of new service innovation adoption in countries in the other stages. Although the index does not provide guidance as to the particular innovations or technologies that are likely to be adopted, it does begin to suggest the attributes of an innovation that would have a greater likelihood of adoption. For instance, the level of development of the financial and technological infrastructure will limit the scope of digital money solutions possible and therefore the opportunity for adoption. This is not to say that digital money technologies cannot be provided in countries that score low on financial and technological infrastructure, but that those solutions could be limited in scope and very likely to be incompatible with exchange on the global market (such as M-PESA in Kenya).

5.0 RELATIONSHIP TO CASHLESSNESS

Given that many of these technological innovations in electronic monetary exchange have been occurring since the 1950s between organizations, and the credit card enabled digital money transactions to consumers, the increasing use of digital money has often been considered alongside the reduction of cash within economies. The rise of debit and credit cards, and the concomitant reduction in cash and checks, has often been seen as indicative of the move to a cashless society (see for instance Snellman et al., 2001). Indeed, since the advent of credit cards and electronic funds transfer, some commentators have been predicting not whether cash would disappear, but when (Evans et al., 2013; Wolman, 2013).

As such it is of interest to see how levels of digital money readiness relate to levels of cashlessness in an economy. We have correlated our index with two measures of cashlessness: the Citi Cash Intensity Ranking and the MasterCard Cashless Index. The former is measured by dividing the consumer spending using credit, debit, charge or prepaid cards by the total consumer expenditure. Although this lacks such data on new exchange intermediaries such as PayPal, M-PESA, etc. (which impacts countries like Kenya) and on "stores of value" (such as Oyster card, which may impact the ranking of countries like the UK and Singapore) in the numerator, this simple measure captures the proportion of non-cash utilized in consumer exchanges in an economy. The latter measure focuses on consumer payments, measuring non-cash payments as a share of the total value of consumer payments (Thomas et al., 2013). Figure 2 presents the scatterplots of these comparisons.

[Insert Figure 2 around here]

The correlation with Citi Cashless Intensity Ranking is 0.70, and it is 0.85 with the MasterCard Cashless Index. These correlations between our index and measures of cashlessness go some way to indicate that there is a relationship between readiness and adoption. They also indirectly provide a robustness check.

This imperfect correlation also points to one advantage of our methodology over a coarser approach: using multiple indicators allows insight into the factors that drive digital money adoption. On both correlations there are outliers both above and below the trend line, suggesting that countries

adopt less (more) digital money innovations than their readiness score suggests. We now analyze these outliers to illustrate the manner in which the index can be used to consider the factors that drive adoption. In the table below, we investigate the relationship between the pillars and cashlessness.

[Insert Table 4 around here]

Table 4 presents a regression analysis of the cashlessness outliers, considering all countries above the confidence interval (the grey zone) as "positive outliers", and those countries below the confidence interval as "negative outliers". In the Citi Cashless Intensity Ranking regression, positive outliers have a significantly lower than average score on Pillar 1 (Institutional Environment). For the MasterCard Cashlessness Index, as there are no significant results, we cannot identify systematic differences. These results make intuitive sense for countries which have low index scores, for example, Argentina and Venezuela. Both have low Pillar 1 scores relative to their index score and countries ranked similarly. Both also have active government encouragement of digital money adoption, primarily to improve tax collection, but without the concomitant institutional development the index suggests should be present with increased levels of digital money adoption. Of note is Kuwait, which has a very low score on Pillar 1 in relation to its index score and similarly ranked countries, but which has deep penetration of credit cards (and hence a high cashless intensity). For all three countries, these factors are partially reflected in their strong Pillar 3 (Supply) and Pillar 4 (Demand) scores relative to their index score and similarly ranked countries. Similarly, the positive outlier countries Australia and Denmark have worse Pillar 1 scores than their index score and similarly ranked countries. Here, both had very early and widespread adoption of EFTPOS technologies, leading to decreased cash usage, echoed in their superior Pillar (Supply) scores relative to their index score and similarly ranked countries. Canada is more interesting – although its Pillar 1 and Pillar 2 scores are what would be expected by their position in the index, its poor Pillar 3 and Pillar 4 scores reduce their overall index score despite their high digital money adoption. These results suggest that the countries that are positive outliers have probably reached the limit of their digital money adoption, given their current levels of readiness.

The negative outliers have a significantly higher than average score on Pillar 1 (Institutional Environment) in the Citi Cashless Intensity Ranking. For the MasterCard Cashlessness Index,

although there are no significant results, the size of the values themselves suggests they are more likely to have a higher score than average on Pillar 1. This effect is clearly observed in Japan and Germany, who have higher Pillar 1 scores than their index score and similarly ranked countries would suggest. This is due to the fact that there is a cultural preference for cash in Germany, as well as a proliferation of infrastructure for handling cash, leading to increased inertia. This is reflected in their poor Pillar 3 and Pillar 4 scores relative to their index score and similarly ranked countries. In the case of Japan, there is a cultural bias against liabilities (and hence credit products), which results in a preference for cash. Furthermore, Japan has high interchange rates on credit cards which also reduces the usage of card within the economy. This is reflected in the poor score for Pillar 3. This analysis suggests that Germany and Japan are in a much better position to adopt digital money than other countries with lower cash intensity.

Taken together, this analysis suggests that it is not the institutional or regulatory environment that results in over or under adoption, although these are of course necessary, but the cultural, social and political factors reflected through supply and demand conditions. This provides additional support for our index design, as well as underlining the complex interplay of technology, regulation, user practices, markets, cultural meaning, and infrastructure in digital money contexts.

6.0 CONCLUSIONS AND FUTURE DIRECTIONS

This study develops an adoption readiness index for new service development, using the empirical example of digital money. We developed a perspective of digital money as a socio-technical system, identifying four interdependent components: the institutional environment, enabling infrastructure, supply and demand conditions. We then detailed the methodology used to construct the Digital Money Readiness Index. Comprising of four pillars, it represents the level of readiness of a country for digital money adoption. We presented the ranking of the countries, noting that there are four different stages of digital money maturity. We analyzed our index against existing measures of cashlessness, showing that in general increasing levels of digital money readiness correlate with

increased levels of cashlessness. We also systematically analyzed the factors that lead countries to have higher or lower cashlessness scores than their index score would suggest.

We contribute in a variety of ways. First, the methods developed to create the index have implications for understanding adoption readiness of new service innovations more generally (Cooper, 1998; Rogers, 2003). The index begins to provide a systematic approach for considering the environment within which service innovations might be adopted. For instance, the identification of the four interdependent components highlight the complex interaction between technology, regulation, user practices, markets, cultural meaning, infrastructure, production, and supply networks that influence the adoption of new service innovations. Furthermore, the structure and methodology of the index provides a template for the development of other indices that can measure adoption readiness for other new service innovations.

Second, we have begun to widen the discussion of the technologies of money to a broader academic audience. To date, the most detailed academic attention on money, and to a lesser extent digital money, has come from anthropology (Maurer, 2006; Parry & Bloch, 1989), sociology (Dodd, 1994; Simmel, 1990), and history (Eagleton & Williams, 2011; Ferguson, 2012). Other academic attention has either focused on regulatory (Freedman, 2000; Rogers, 2006) or technical (Eslami & Talebi, 2011; Juang, 2007) aspects, or on the social benefits of particular digital money technologies (Jack & Suri, 2011; Morawczynski, 2014). This plethora of differing perspectives, although informative and insightful, does not currently constitute a coherent theoretical basis for research into digital money. Given the radical innovations happening in the technologies of value exchange as ICTs continue to diffuse across the global economy, and the potential for major economic and social benefits, commencing a rigorous and wide ranging program of research into the phenomenon and its benefits is an urgent priority.

We also contribute through the provision of a comprehensive definition of digital money. This definition – currency exchange by electronic means – encompasses both the wide variety of existing digital means of exchange, as well as those future technologies that are undoubtedly to come. Our broader definition should enable a more systematic and coherent approach to understanding innovation in the technologies of money, a topic sorely under-researched to date. Our socio-technical

system model of digital money, comprising of the institutional environment, enabling infrastructure, and supply and demand conditions, should provide the basis for further theoretical and empirical work. For instance, this definition could enable the application of insights from innovation studies, which has investigated how the characteristics of successful technologies are rarely determined on technological grounds alone but instead are socially and institutionally constructed (Kaplan & Tripsas, 2008; Murmann & Frenken, 2006; Tushman & Murmann, 1998).

The index has implications for innovators who wish to introduce new technologies of money, as well as policy makers. For innovators, the index provides an indication as to the likelihood of success of a particular digital money technology in a country, as well as suggesting the characteristics of a digital money innovation that could be introduced into a country. For policymakers, the index provides the basis for broad policy specifications so as to increase the readiness for digital money adoption. Specifically, each readiness stage serves as the basis to outline what is required for a transition from one stage to the next. For example, the index suggests that a policy focus on improving the financial and technological infrastructure is likely to lead to a transition between the Incipient and Emerging stages. In contrast, for a transition from the Emergent to the In-Transition stage, the index suggests that policy focus should move to the improvement of supply and demand conditions. To move from In-Transition to Materially Ready, the index suggests that enabling financial and technological infrastructure should be significantly improved. However, we are barely scratching the surface of the insights and innovator actions and policy maker interventions that should be possible from analyses using the index.

A future direction of research is to investigate whether the claimed economic and social benefits of innovations in digital money technology and services are indeed present. This index begins to provide a measure of the systemic readiness of a country to adopt digital money, and hence benefit from it. Furthermore, our empirical linking of cashlessness and digital money readiness also provides a theoretical basis for considering the levels of cashlessness in a society as a proxy for digital money adoption. However, despite what commentators have argued, unlike other aspects of the post-industrial economy, the link between digital money readiness, subsequent adoption, and socio-economic benefits is not clear-cut. While increasing digitization in an economy can be theoretically

and intuitively linked to gross domestic product (GDP) growth, unemployment and consumer wellbeing (see for instance Katz & Koutroumpis, 2013), causal links between digital money and such coarse grained measures of socio-economic progress are not as intuitive. Instead, future research may need to focus on such socio-economic issues as the informal economy, financial inclusion, and criminality. Furthermore, given that one of the claims is that digital money increases the "flow of money" (Dodgson et al., 2012), tracking changes in monetary velocity over time with either digital money readiness or cashlessness may provide evidence of such an increase.

Another direction of research is the consideration of security and privacy and the role of regulation, and how these are addressed in different countries. From a security perspective, the increasing digitization of the technologies of money opens up a new range of concerns, with digital technologies potentially perceived to be more at risk for "hacking" and large scale fraud. However, security is one of the main potential benefits of the transition to digital money as well. Indeed, the technology can enable better control on flows of money and easier identification of fraud. There is a need to understand the security challenges that exist and how they can be mitigated, as well as the trade-offs and how they can be leveraged. Considering privacy, digital money will result in the creation of vast amounts of data that could be more invasive of individual privacy than existing technologies, potentially requiring new approaches. On the other hand, the data that digital money generates can be used to confirm the identity of individuals and firms. There is a need to understand and develop privacy rules that are protective of individuals and businesses but also allows individuals, firms and governments to use the data to prove identity and create insight enabling them to refine their operations and deliver better services to citizens and customers. From a regulatory perspective, the rise of crypto-currencies has the potential to change the dynamics of currency flows within an economy making existing regulations at best obsolete, at worst a systemic risk. As such there is a need to explore the impacts of these technological innovations on monetary thought, monetary policy, and the types of policy interventions that are required.

We hope that this paper inspires researchers to develop indices of adoption readiness for other new service innovations, and begin to investigate innovation in, and the impacts of, the technologies of money.

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TABLE 1 – Dimension, Indicator and Source Overview

Pillar	Dimension	Indicator	Source	Year
Institutional Environment	Legal Framework	IPR Protection	World Economic Forum, Executive Opinion Survey	2014
		Efficiency of Challenging Regulations	World Economic Forum, Executive Opinion Survey	2014
		Independence of Judiciary	Cingranelli Richards Human Rights Dataset	2011
		Property Rights	Heritage Foundation, Index of Economic Freedom	2014
	Regulatory Effectiveness	Contract Enforcement Procedures	World Bank and International Finance Corporation, Ease of Doing Business Index	2013
		Government Regulatory Burden	World Economic Forum, Global Competitiveness Survey	2014
		Monetary Freedom	Heritage Foundation, Index of Economic Freedom	2014
		Anti-monopoly Policy Effectiveness	World Economic Forum, Executive Opinion Survey	2014
	Competitive Environment	Market dominance	World Economic Forum, Executive Opinion Survey	2014
		Local Competitive Intensity	World Economic Forum, Global Competitiveness Survey	2014
		Industrial Counterfeiting	Institutional Profiles Database	2012
		Trade Secrets and Copyright	Institutional Profiles Database	2012
	Innovation Environment	PCT Patent Applications	Organization for Economic Co-operation and Development	2013
		Cluster development	World Economic Forum, Executive Opinion Survey	2014
		R&D Technicians	United Nations Educational, Scientific, and Cultural Organization	2013
		Government Advanced Technology Procurement	World Economic Forum, Executive Opinion Survey	2014
	Entrepreneurship Environment	Business Start-up Procedures	World Bank and International Finance Corporation, Ease of Doing Business Index	2013
		Effect of Taxation on Incentives to Invest	World Economic Forum, Executive Opinion Survey	2014
		Venture Capital Availability	World Economic Forum, Executive Opinion Survey	2014
		Start-up time	World Bank and International Finance Corporation, Ease of Doing Business Index	2013
		Start-up Cost	World Bank and International Finance Corporation, Ease of Doing Business Index	2013
Enabling Infrastructure	ICT Infrastructure	Mobile Network Coverage	ITU Telecommunications Database	2014
		International Internet Bandwidth	ITU Telecommunications Database	2014

		Telecommunication Service Investment	ITU Telecommunications Database	2014
		Fixed Telephone Faults	ITU Telecommunications Database	2014
		Fixed-Telephone Fault Clearance	ITU Telecommunications Database	2014
	ICR Affordability	Mobile Cellular Tariffs	World Economic Forum, Global Information Technology Report	2014
		Fixed Broadband Internet Tariffs	World Economic Forum, Global Information Technology Report	2014
		Internet and Telephony Sectors Competition Index	World Economic Forum, Global Information Technology Report	2014
	Financial Markets	Financial Services Availability	World Economic Forum, Executive Opinion Survey	2014
		Financial Services Affordability	World Economic Forum, Executive Opinion Survey	2014
		Bank Z-score	Bankscope	2011
	Financial Regulation	Investment Freedom	Heritage Foundation Index of Economic Freedom	2014
		Financial Freedom	Heritage Foundation Index of Economic Freedom	2014
		Securities Exchanges Regulation	World Economic Forum, Executive Opinion Survey	2014
		Credit Depth of Information	World Bank, Global Financial Inclusion Database	2011
Supply	Retail	E-Commerce Penetration	Euromonitor, E-Commerce Report	2014
		Organized retail	Euromonitor International, World Retail Data and Statistics	2014
		Credit Card Penetration	World Bank, Global Financial Inclusion Database	2011
		Point-of-Sale Terminals Penetration	World Bank, Global Financial Inclusion Database	2011
	Government	Online Services Index	E-Government Development Index	2014
		Government ICT Vision	World Economic Forum, Executive Opinion Survey	2014
		Government ICT Promotion	World Economic Forum, Executive Opinion Survey	2014
		Government ePayment Penetration	World Bank, Global Financial Inclusion Database	2011
	Telecommunications	Mobile-Cellular Telephone Subscriptions	ITU Telecommunications Database	2014
		Mobile Money Initiatives	GMSA, Mobile Money Tracker	2014
		Mobile Bill Payment Penetration	ITU Telecommunications Database	2014
Demand	Consumer	Adult Literacy	United Nations Education, Science and Culture Organization	2014
		Buyer Sophistication	World Economic Forum, Executive Opinion Survey	2014
		Virtual Social Network Usage	World Economic Forum, Executive Opinion Survey	2014

Business	B2B Internet Use	World Economic Forum, Executive Opinion Survey	2014
	B2C Internet Use	World Economic Forum, Executive Opinion Survey	2014
	Innovation Capacity	World Economic Forum, Executive Opinion Survey	2014
	Extent of marketing	World Economic Forum, Executive Opinion Survey	2014
	Technology Absorption	World Economic Forum, Executive Opinion Survey	2014
ICT Penetration	Latest Technology Availability	World Economic Forum, Executive Opinion Survey	2014
	Individual Internet Usage	ITU Telecommunications Database	2014
	Wireless-Broadband Subscriptions	ITU Telecommunications Database	2014

TABLE 2 – Indicator Correlations by Pillar

PILLAR 1

	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
1. Independence of Judiciary	0.00	1.00	-1.18	1.20																				
2. Business Start-up Procedures	0.00	1.00	-5.73	0.90	0.19																			
3. Contract Enforcement Procedures	0.00	1.00	-2.40	2.47	0.50	0.18																		
4. Start-up Cost	0.00	1.00	-5.74	0.63	0.44	0.29	0.32																	
5. Start-up time	0.00	1.00	-3.02	1.81	0.35	0.62	0.41	0.24																
6. Anti-monopoly Policy Effectiveness	0.00	1.00	-3.09	1.97	0.49	0.44	0.38	0.45	0.39															
7. Cluster Development	0.00	1.00	-2.13	2.06	0.38	0.33	0.27	0.39	0.22	0.79														
8. Efficiency of Challenging Regulations	0.00	1.00	-2.56	2.27	0.39	0.36	0.31	0.39	0.35	0.84	0.76													
9. Market Dominance	0.00	1.00	-2.19	2.46	0.35	0.29	0.34	0.38	0.27	0.80	0.83	0.66												
10. Advanced Technology Procurement	0.00	1.00	-2.60	3.34	0.10	0.35	0.14	0.23	0.22	0.68	0.66	0.67	0.52											
11. Government Regulatory Burden	0.00	1.00	-2.52	2.66	-0.01	0.36	0.14	0.11	0.26	0.58	0.51	0.72	0.42	0.77										
12. IPR Protection	0.00	1.00	-2.08	1.97	0.61	0.40	0.48	0.45	0.47	0.85	0.79	0.87	0.77	0.63	0.55									
13. Competitive Intensity	0.00	1.00	-3.80	1.95	0.42	0.49	0.35	0.47	0.36	0.79	0.68	0.59	0.69	0.51	0.37	0.66								
14. Effect of Taxation on Incentives to Invest	0.00	1.00	-2.06	3.11	0.10	0.17	0.10	0.26	0.19	0.50	0.49	0.72	0.40	0.66	0.81	0.57	0.36							
15. Venture Capital Availability	0.00	1.00	-1.81	2.50	0.25	0.23	0.25	0.32	0.23	0.69	0.72	0.81	0.57	0.75	0.67	0.75	0.45	0.69						
16. Monetary Freedom	0.00	1.00	-3.83	1.74	0.41	0.45	0.34	0.28	0.49	0.53	0.44	0.52	0.42	0.39	0.36	0.57	0.57	0.26	0.42					
17. Property Rights	0.00	1.00	-1.79	1.79	0.78	0.36	0.51	0.46	0.49	0.72	0.66	0.71	0.62	0.42	0.34	0.85	0.62	0.38	0.57	0.62				
18. Industrial Counterfeiting	0.00	1.00	-2.08	1.34	0.64	0.29	0.49	0.40	0.37	0.50	0.52	0.49	0.55	0.22	0.10	0.71	0.46	0.10	0.44	0.50	0.75			
19. Trade Secrets and Copyright	0.00	1.00	-2.26	1.30	0.55	0.21	0.43	0.49	0.34	0.51	0.55	0.47	0.53	0.20	0.09	0.66	0.51	0.22	0.44	0.43	0.71	0.71		
20. PCT Patent Applications	0.00	1.00	-0.25	6.93	0.04	0.01	0.08	0.12	-0.11	0.14	0.17	0.04	0.13	0.19	0.06	0.09	0.20	0.03	0.16	0.06	0.01	0.02	-0.05	
21. R&D Technicians	0.00	1.00	-0.86	3.26	0.62	0.18	0.43	0.36	0.30	0.43	0.43	0.26	0.53	0.05	-0.07	0.52	0.40	-0.10	0.19	0.33	0.63	0.60	0.60	0.14

PILLAR 2

	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10	11	12	13	14
1. Credit Depth of Information	0.00	1.00	-2.76	1.09														
2. Financial Services Affordability	0.00	1.00	-1.75	2.00	0.41													
3. Financial Services Availability	0.00	1.00	-2.51	2.00	0.46	0.94												
4. Securities Exchanges Regulation	0.00	1.00	-3.08	2.06	0.40	0.83	0.88											
5. Bank Z-score	0.00	1.00	-1.91	2.99	0.20	0.07	0.08	0.06										
6. Fixed Broadband Internet Tariffs	0.00	1.00	-3.44	1.28	0.38	0.24	0.27	0.16	0.13									
7. International Internet Bandwidth	0.00	1.00	-0.41	8.39	0.12	0.43	0.41	0.37	-0.07	0.13								
8. Mobile Cellular Tariffs	0.00	1.00	-3.32	1.35	-0.03	0.12	0.11	0.13	0.14	0.15	0.12							
9. Mobile Network Coverage	0.00	1.00	-4.83	0.50	0.42	0.43	0.50	0.55	0.08	0.32	0.17	0.14						
10. Internet and Telephony Sectors Competition Index	0.00	1.00	-4.12	0.73	0.25	0.23	0.32	0.26	0.06	0.27	0.22	-0.11	0.27					
11. Financial Freedom	0.00	1.00	-2.57	1.97	0.39	0.66	0.71	0.63	0.02	0.11	0.44	-0.06	0.39	0.42				
12. Investment Freedom	0.00	1.00	-2.74	1.34	0.27	0.48	0.56	0.51	0.09	0.09	0.37	-0.18	0.37	0.45	0.83			
13. Telecommunication Service Investment	0.00	1.00	-7.76	0.34	0.06	0.16	0.14	0.07	0.11	0.23	0.09	0.12	0.13	0.12	0.11	0.07		
14. Fixed Telephone Faults	0.00	1.00	-5.75	1.04	0.09	0.23	0.25	0.23	-0.06	-0.04	0.13	0.02	0.09	-0.01	0.10	0.07	-0.03	
15. Fixed-Telephone Fault Clearance	0.00	1.00	-4.31	1.02	0.34	0.33	0.35	0.26	0.17	0.35	0.27	-0.05	0.39	0.56	0.45	0.41	0.21	0.05

PILLAR 3

	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10
1. Mobile Money Initiatives	-0.00	1.00	-0.64	5.35										
2. Organized retail	-0.00	1.00	-2.08	2.21	-0.49									
3. Point-of-Sale Terminals Penetration	-0.00	1.00	-0.99	2.61	-0.47	0.59								
4. Online Services Index	-0.00	1.00	-2.01	1.86	-0.40	0.36	0.65							
5. Government ePayment Penetration	-0.00	1.00	-0.94	2.53	-0.43	0.55	0.68	0.60						
6. Credit Card Penetration	0.00	1.00	-0.99	2.68	-0.50	0.53	0.76	0.70	0.81					
7. Mobile Bill Payment Penetration	0.00	1.00	-1.00	3.60	-0.17	0.05	0.09	0.14	0.13	0.22				
8. Government ICT Promotion	0.00	1.00	-1.99	2.54	-0.04	0.06	0.27	0.45	0.33	0.38	0.30			
9. Government ICT Vision	-0.00	1.00	-1.92	2.47	-0.09	0.08	0.31	0.49	0.35	0.40	0.33	0.94		
10. Mobile-Cellular Telephone Subscriptions	-0.00	1.00	-2.46	3.23	-0.39	0.24	0.28	0.38	0.22	0.31	0.14	0.20	0.21	
11. E-Commerce Penetration	0.00	1.00	-0.89	4.61	-0.39	0.47	0.52	0.51	0.60	0.60	0.01	0.29	0.28	0.25

PILLAR 4

	Mean	S.D.	Min	Max	1	2	3	4	5	6	7	8	9	10
1. Buyer Sophistication	0.00	1.00	-2.54	2.47										
2. Innovation Capacity	0.00	1.00	-1.72	2.22	0.82									
3. Extent of marketing	0.00	1.00	-2.41	2.12	0.86	0.90								
4. Adult Literacy	0.00	1.00	-3.28	0.76	0.57	0.49	0.65							
5. Latest Technology Availability	0.00	1.00	-2.46	1.60	0.76	0.80	0.89	0.58						
6. B2B Internet Use	0.00	1.00	-2.86	1.68	0.71	0.78	0.85	0.63	0.88					
7. B2C Internet Use	0.00	1.00	-2.51	1.84	0.74	0.79	0.88	0.73	0.81	0.91				
8. Technology Absorption	0.00	1.00	-2.39	1.84	0.78	0.85	0.89	0.53	0.95	0.89	0.81			
9. Virtual Social Network Usage	0.00	1.00	-3.18	1.52	0.64	0.64	0.78	0.68	0.80	0.80	0.81	0.77		
10. Individuals Internet Usage	0.00	1.00	-1.57	1.67	0.64	0.65	0.76	0.74	0.77	0.78	0.85	0.70	0.75	
11. Active Mobile-Broadband Subscriptions	0.00	1.00	-1.06	2.89	0.57	0.64	0.66	0.56	0.69	0.69	0.72	0.67	0.63	0.77

TABLE 3 – Index Results

Country	Overall		Cluster	Pillar 1		Pillar 2		Pillar 3		Pillar 4	
	Rank	Score		Rank	Score	Rank	Score	Rank	Score	Rank	Score
Finland	1	1.17	Materially Ready	7	1.04	5	0.80	1	1.44	3	1.45
Singapore	2	1.10	Materially Ready	1	1.31	2	0.92	6	0.98	9	1.23
Sweden	3	1.04	Materially Ready	11	1.00	4	0.81	9	0.83	1	1.55
United States	4	1.02	Materially Ready	6	1.08	7	0.73	8	0.86	4	1.45
Norway	5	1.00	Materially Ready	15	0.91	6	0.75	3	1.05	7	1.34
Hong Kong	6	1.00	Materially Ready	4	1.13	1	1.35	22	0.44	11	1.12
UK	7	0.99	Materially Ready	12	0.97	14	0.55	2	1.06	5	1.43
Netherlands	8	0.92	Materially Ready	2	1.21	15	0.55	16	0.66	8	1.28
Switzerland	9	0.89	Materially Ready	3	1.17	8	0.73	26	0.33	6	1.36
Japan	10	0.89	Materially Ready	5	1.08	26	0.33	13	0.70	2	1.47
Denmark	11	0.82	Materially Ready	21	0.64	12	0.62	5	1.01	17	1.02
Qatar	12	0.79	Materially Ready	8	1.02	23	0.34	15	0.68	10	1.14
Germany	13	0.78	Materially Ready	9	1.02	13	0.60	21	0.47	15	1.05
New Zealand	14	0.75	Materially Ready	14	0.93	30	0.26	11	0.77	12	1.07
Austria	15	0.74	Materially Ready	17	0.81	10	0.67	20	0.50	18	1.01
Canada	16	0.72	Materially Ready	16	0.84	9	0.69	19	0.51	22	0.89
Australia	17	0.71	Materially Ready	22	0.64	16	0.49	12	0.73	16	1.03
UAE	18	0.71	Materially Ready	18	0.79	35	0.22	10	0.79	13	1.06
Malaysia	19	0.65	Materially Ready	10	1.00	11	0.64	29	0.22	24	0.77
Ireland	20	0.64	Materially Ready	13	0.94	37	0.20	18	0.56	21	0.90
South Korea	21	0.60	Materially Ready	26	0.29	51	0.08	4	1.02	14	1.06
Israel	22	0.60	Materially Ready	27	0.29	20	0.37	7	0.86	19	0.90
France	23	0.58	Materially Ready	20	0.65	21	0.35	17	0.58	23	0.79
Belgium	24	0.58	Materially Ready	19	0.76	19	0.37	27	0.33	20	0.90
Saudi Arabia	25	0.35	In-transition	32	0.14	41	0.13	14	0.69	26	0.46
Panama	26	0.34	In-transition	31	0.19	3	0.83	40	-0.02	30	0.39
Chile	27	0.32	In-transition	23	0.39	18	0.39	35	0.10	28	0.44
Portugal	28	0.29	In-transition	29	0.23	39	0.17	23	0.37	27	0.45
Czech Rep.	29	0.28	In-transition	28	0.25	25	0.33	38	0.02	25	0.54
Spain	30	0.27	In-transition	35	0.01	22	0.35	24	0.35	29	0.40
South Africa	31	0.18	In-transition	24	0.39	45	0.11	42	-0.04	32	0.32
Turkey	32	0.10	In-transition	34	0.03	50	0.10	31	0.19	37	0.13
Slovenia	33	0.07	In-transition	30	0.20	56	-0.14	34	0.11	36	0.15
Costa Rica	34	0.06	In-transition	36	0.01	40	0.16	52	-0.24	31	0.36
Poland	35	0.01	In-transition	33	0.06	24	0.34	50	-0.20	47	-0.12
Indonesia	36	0.00	In-transition	38	0.00	43	0.12	54	-0.25	35	0.19
Croatia	37	-0.01	In-transition	60	-0.31	17	0.41	39	-0.01	46	-0.10
Italy	38	-0.02	In-transition	45	-0.12	48	0.10	43	-0.06	39	0.03
Brazil	39	-0.02	In-transition	79	-0.60	33	0.25	37	0.09	34	0.21
China	40	-0.03	In-transition	25	0.38	66	-0.24	45	-0.13	43	-0.08
Philippines	41	-0.04	In-transition	56	-0.24	31	0.26	67	-0.38	33	0.24
Thailand	42	-0.07	In-transition	46	-0.13	27	0.31	73	-0.41	41	0.00

Country	Overall		Cluster	Pillar 1		Pillar 2		Pillar 3		Pillar 4	
	Rank	Score		Rank	Score	Rank	Score	Rank	Score	Rank	Score
Kazakhstan	43	-0.07	In-transition	55	-0.21	60	-0.16	33	0.12	40	0.02
Hungary	44	-0.07	In-transition	40	-0.07	46	0.11	51	-0.20	44	-0.09
Kenya	45	-0.08	In-transition	53	-0.20	54	-0.08	30	0.20	53	-0.20
Mexico	46	-0.09	In-transition	52	-0.20	44	0.11	41	-0.03	52	-0.19
Colombia	47	-0.10	In-transition	44	-0.12	47	0.10	44	-0.07	56	-0.26
Dominican Rep.	48	-0.11	In-transition	58	-0.25	38	0.19	57	-0.27	42	-0.08
India	49	-0.12	In-transition	65	-0.38	49	0.10	28	0.25	61	-0.39
Romania	50	-0.12	In-transition	43	-0.10	53	0.01	49	-0.19	51	-0.18
Guatemala	51	-0.14	In-transition	49	-0.18	29	0.26	76	-0.45	49	-0.14
El Salvador	52	-0.14	In-transition	39	-0.03	28	0.27	66	-0.38	62	-0.39
Kuwait	53	-0.16	In-transition	73	-0.54	65	-0.22	32	0.14	38	0.03
Jamaica	54	-0.18	In-transition	47	-0.14	59	-0.15	53	-0.24	48	-0.14
Trinidad	55	-0.18	In-transition	57	-0.24	57	-0.14	47	-0.15	50	-0.15
Morocco	56	-0.19	In-transition	42	-0.09	32	0.25	55	-0.25	71	-0.63
Sri Lanka	57	-0.19	In-transition	48	-0.14	52	0.03	71	-0.40	54	-0.20
Russia	58	-0.22	Emerging	67	-0.41	61	-0.17	48	-0.17	45	-0.09
Mongolia	59	-0.22	Emerging	64	-0.38	58	-0.14	36	0.09	63	-0.42
Peru	60	-0.23	Emerging	63	-0.34	34	0.22	74	-0.43	59	-0.32
Namibia	61	-0.27	Emerging	50	-0.19	68	-0.31	63	-0.30	58	-0.26
Botswana	62	-0.30	Emerging	37	0.01	72	-0.45	46	-0.14	69	-0.59
Greece	63	-0.31	Emerging	61	-0.33	70	-0.35	56	-0.26	55	-0.23
Ghana	64	-0.33	Emerging	51	-0.19	62	-0.19	60	-0.30	70	-0.60
Nigeria	65	-0.36	Emerging	80	-0.61	74	-0.58	25	0.34	68	-0.54
Honduras	66	-0.37	Emerging	69	-0.49	36	0.20	86	-0.65	65	-0.48
Senegal	67	-0.37	Emerging	54	-0.20	69	-0.32	68	-0.38	66	-0.53
Viet Nam	68	-0.39	Emerging	71	-0.51	64	-0.21	64	-0.34	64	-0.45
Ukraine	69	-0.43	Emerging	72	-0.54	67	-0.25	79	-0.51	60	-0.36
Egypt	70	-0.43	Emerging	74	-0.57	42	0.12	83	-0.59	72	-0.63
Zambia	71	-0.44	Emerging	41	-0.08	80	-0.80	62	-0.30	67	-0.53
Pakistan	72	-0.52	Emerging	81	-0.62	55	-0.10	82	-0.55	74	-0.76
Tunisia	73	-0.53	Emerging	62	-0.34	73	-0.48	78	-0.49	75	-0.78
Cote d'Ivoire	74	-0.55	Emerging	59	-0.28	77	-0.63	72	-0.41	76	-0.83
Uganda	75	-0.58	Emerging	75	-0.57	63	-0.21	65	-0.37	81	-1.15
Argentina	76	-0.60	Emerging	87	-1.15	79	-0.68	58	-0.28	57	-0.26
Bangladesh	77	-0.64	Emerging	83	-0.70	71	-0.39	59	-0.29	80	-1.15
Cameroon	78	-0.74	Incipient	68	-0.48	86	-1.07	77	-0.49	77	-0.87
Gabon	79	-0.76	Incipient	82	-0.62	84	-0.96	61	-0.30	79	-1.13
Tanzania	80	-0.77	Incipient	78	-0.59	81	-0.89	70	-0.39	82	-1.17
Mali	81	-0.84	Incipient	70	-0.50	87	-1.10	80	-0.52	83	-1.20
Mozambique	82	-0.84	Incipient	66	-0.40	85	-1.00	88	-0.70	85	-1.22
Nepal	83	-0.85	Incipient	77	-0.59	76	-0.63	90	-0.94	84	-1.21
Venezuela	84	-0.88	Incipient	90	-1.76	75	-0.62	75	-0.45	73	-0.67
Iran	85	-0.89	Incipient	86	-0.95	82	-0.91	81	-0.53	78	-1.12
Algeria	86	-0.93	Incipient	84	-0.80	78	-0.65	87	-0.69	87	-1.54

Country	Overall		Cluster	Pillar 1		Pillar 2		Pillar 3		Pillar 4	
	Rank	Score		Rank	Score	Rank	Score	Rank	Score	Rank	Score
Burkina Faso	87	-0.98	Incipient	76	-0.58	83	-0.93	85	-0.62	89	-1.75
Ethiopia	88	-1.08	Incipient	85	-0.82	88	-1.12	84	-0.60	88	-1.73
Angola	89	-1.17	Incipient	89	-1.54	89	-1.23	69	-0.38	86	-1.46
Chad	90	-1.45	Incipient	88	-1.37	90	-1.27	89	-0.87	90	-2.25

TABLE 4 – Regression on Cashlessness Outliers

	Citi Cashless Intensity Positive Outliers	Citi Cashless Intensity Negative Outliers	MasterCard Cashless Positive Outliers	MasterCard Cashless Negative Outliers
(Intercept)	-3.158***	-0.853	-1.840**	-1.647*
	(0.938)	(0.543)	(0.647)	(0.645)
Pillar 1	-6.093**	5.650*	-0.269	4.901·
	(2.283)	(2.454)	(1.711)	(2.731)
Pillar 2	4.326	-1.685	0.264	-0.112
	(2.693)	(2.285)	(2.326)	(2.557)
Pillar 3	1.209	-3.346	-0.335	-4.705·
	(1.681)	(2.366)	(1.761)	(2.818)
Pillar 4	3.350	-1.433	0.652	-0.584
	(2.331)	(2.101)	(2.083)	(2.163)
AIC	44.868	47.035	48.312	40.358
BIC	53.789	55.956	57.233	49.279
Log Likelihood	-17.434	-18.518	-19.156	-15.179
Deviance	34.868	37.035	38.312	30.358
Num. obs.	44	44	25	25

***p < 0.001, **p < 0.01, *p < 0.05, ·p < 0.1

FIGURE 1 – Digital Money Ecosystem

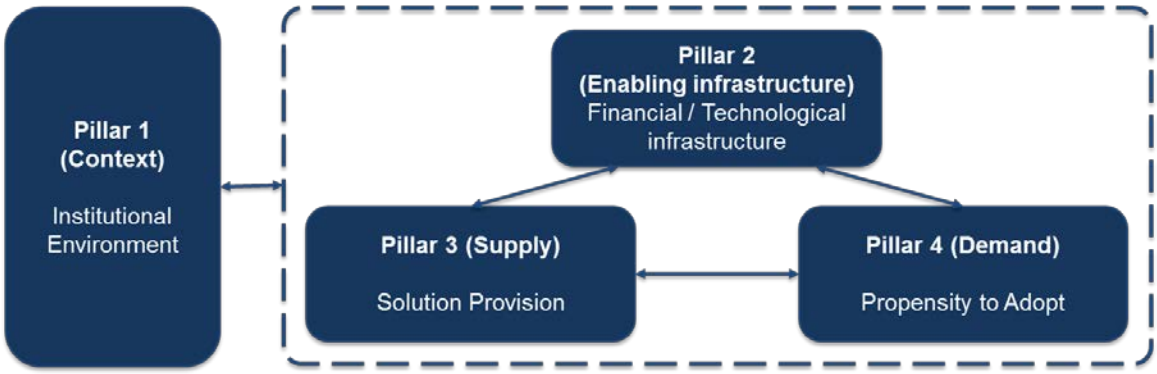

FIGURE 2 – Correlation of Digital Money Readiness Index with Cashless Intensity and MasterCard Cashlessness Index