Charles University

Faculty of Social Sciences
Institute of Economic Studies

MASTER'S THESIS

Transition to a Cashless Society: Impact on Economic Activity

Author: **Bc. Aliya Berkimbayeva**

Supervisor: **prof. Ing. et Ing. Lubos Komarek, Ph.D., MSc., MBA**

Academic Year: **2018/2019**

Declaration of Authorship

The author hereby declares that she compiled this thesis independently; using only the listed resources and literature, and the thesis has not been used to obtain a different or the same degree.

The author grants to Charles University permission to reproduce and to distribute copies of this thesis document in whole or in part.

Prague, May 8, 2019

Signature

Acknowledgments

I would like to declare my sincere gratitude to my supervisor prof. Ing. et Ing. Lubos Komarek, Ph.D., MSc., MBA, for the guidance, valuable comments, and time invested during the research and writing of this thesis. I also wish to acknowledge dearest colleagues at Charles University and to thank my family for the support.

A special gratitude belongs to my mother Gulnara Rysmendeyeva for the constant inspiration and encouragement.

This thesis is part of a project that has received funding from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No. 68122.

Abstract

The present study aims to deliberate over a wider perspective on the topic of physical currency, assuming the global conversion to digital payment instruments affecting stakeholders at different scales alters number of aspects. The theoretical section discusses the process of transition to cashless society by identifying transformation stages and the barriers faced to undertake the shift. Subsequently, the links between factors as business environment, globalization, and shadow economy in relation to physical currency in circulation are examined by static and dynamic panel data analyses applying annual panel data for 70 countries for the period from 2013 to 2017. The conclusive inference is formulated based on outputs from the Blundell-Bond (1998) system GMM estimator. The empirical results provide significant evidence on negative relationship between business environment and physical currency in circulation and contrary positive link for shadow economy. Further, the greater impact of business environment on physical money among variables included, implies the promotion of electronic money solutions solely to be not sufficient to transit to cashless economy. We also construct transformation score ranking for the last five years to snap the transit stage among countries included in the study with Singapore and Nordic countries maintaining leading positions.

JEL Classification	C33, E41, E26, F65, G23, G28
Keywords	cashless economy, electronic money, dynamic panel analysis, system GMM estimator

Author's e-mail	aliya.rgs@gmail.com
Supervisor's e-mail	lubos.komarek@cnb.cz

Contents

List of Tables

Acronyms

ANSI American National Standard Institute

BIS Bank for International Settlements

ECB European Central Bank

CEMEA Central Europe, Middle East and Africa

USA United States of America

BTCA Better Than Cash Alliance

G2P Government to Person

P2B Payments to Business

P2P Payment to People

P2G Payments to Government

GSMC Global System for Mobile Communications

GDP Gross Domestic Product

IMF International Monetary Fund

Findex Global Financial Inclusion Database

GPSS Global Payment Systems Survey

GCR Global Competitiveness Report

Master's Thesis Proposal

Author:	Bc. Aliya Berkimbayeva
Supervisor:	prof. Ing. et Ing. Lubos Komarek, Ph.D., MSc., MBA
Defense Planned:	June 2019

Proposed Topic:

Transition to a Cashless Society: Impact on Economic Activity

Motivation:

From barter trading and first coins and banknotes, to checks and cards, humankind is constantly progressing in finding alternatives to the methods of payments. Currently, in the alignment with technologies, the credit card industry has been rapidly growing to the point when cash is not in demand in countries like Sweden.

Economists believe in a great potential of electronic money to positively affect economic growth, decrease share of shadow economies, increase efficiency, and production. According to ECB (2010), safe and reliable payment infrastructure is necessary for the financial market efficiency, consumer confidence, and trade. Electronic payments meet demand of consumers to conduct efficient, cross border transaction in a large volumes, fostering companies to increase number of customers and to provide them with greater options availability, thus supporting economy by competition and lower prices (Deloitte, 2013). Consequently, it enables to increased participation of SMEs in the economies and introduction of new products and services.

Alternative methods of payments have therefore both direct benefits such as increased taxes and employment from larger profits and indirect benefits generated through purchase of intermediate inputs from suppliers and consulting services that are in total added to the economy (Deloitte, 2013). Indirect benefits as a consequence develop ICT infrastructure, logistics, innovations in data management, and other related technologies advancements. According to Moody's Analytics estimation, between 2011 and 2015 increased card penetration contributed USD 296 billion to consumption that accounts for 0.4 percent of consumption growth and 2.6 million increase in employment occupancy (2016). In addition, electronic methods of payments allow for decreased costs in the market, increased speed and security of transactions, and economic interactions. Secure payment methods driving the consumption leading to increased production and jobs and therefore increasing income. The financial institutions progressed rapidly with technological advancements, introducing new services that correlate with increased productivity (Berger 2003). The banking industry receives benefits in efficiency and therefore is able to provide good conditions for lending, therefore stimulating investments (Hasan, 2012). Mieseigha and Ogbodo (2013) concluded that cashless payments are essential for increasing transparency and eliminating cash related fraud. Cash payments are not reported automatically and give an incentive to be used in a shadow economy negatively affecting countries'

economies and societies. As consequence increasing tax evasions, corruption, and unhealthy competition.

For this research, I am going to aggregate direct and indirect benefits of electronic payments on economic activity and social impact. Each of hypotheses formulated will focus on three perspectives: globalization, business environment, and shadow economies.

Hypotheses:

1. Hypothesis #1: Alternative methods of payment through indirect benefits impact to healthier business environment
2. Hypothesis #2: The demand for cash is higher for countries with greater shadow economies
3. Hypothesis #3: The globalization and markets integration are negatively affected if the share of currency circulated is large

Methodology:

The estimation will cover 70 countries for the period from 2013 to 2017 to 350 total observations. The Generalized Method of Moments (GMM) introduced by Hansen (1982) is going to be applied as the main estimation method. The method relaxes parametric assumptions allowing for robustness and comprises of almost all available estimator (Baltagi, 2005; Wooldridge 2007). GMM serves as relevant method, when the issues of endogeneity, causality, and autocorrelation may arise with other traditional estimation methods resulting in biased and inconsistent estimator (Baltagi, 2005; Wooldridge 2007). In order to test and compare results the additional methods of Instrumental Variables and 2SLS will be performed followed by Hausman, Wald and other tests to check the validity.

The dependent variable - cash in circulation as a proxy for demand of cash will include M0 and M1 (deposits held in financial institutions). Electronic payments will consider payment cards, including both credit and debit cards, credit/ debit transfers, number of ATM and POS terminals, and mobile payments. Determinants of business environment include competition, trade, technological and financial development, corruption level, electronic devices penetration, and demand in terms of wealth per adult. Shadow economy represented by taxes, social contributions, rule of law index, unemployment rate. And finally, globalization and integration will be based on KOF Globalization Index that considers economic, social, and political perspective. The data for estimation will be retrieved through various sources: International Monetary Fund, central banks, European Central Bank - Statistical Data Warehouse, World Bank, International Telecommunication Union (UN) and etc.

Expected Contribution:

The paper will consider the impact of electronic methods of payments on three dimensions: business environment, shadow economy, and integration of markets. The academic literature mostly values direct benefit in term of macroeconomic values. However, the thesis considers indirect impacts of electronic payments evolution on economic and social aspects as well. Therefore, the model is more comprehensive and the estimation method differs as well. The result of the paper can be helpful for government offices to promote regulatory aspects of electronic payments, if the conclusion of the paper proves hypotheses in order to reduce shadow economy, provide better conditions for business environment, and benefit from the globalization. Also, private businesses can realize the benefit and further

develop introduction of alternative methods of payments to increase customer base and expand the level of cross border trade.

Outline:

1. Introduction: history and evolution of money and methods of payment, including recent development, and future prospects
2. Motivation: estimation of direct and indirect benefits of non-cash payments to business environment, shadow economy, and integration
3. Literature review: analysis of academic papers related to the topic
4. Data: explanation of variables, its sources, and model specification
5. Methods: discussion of Generalized method of Moments; followed estimator validity
6. Results: analyze and conclude the results of each method, robustness check
7. Conclusion: findings summary and provision of topics for future research

Core Bibliography:

1. Baltagi, B. H. (2005): Econometric Analysis of Panel Data (third ed.) John Wiley & Sons
2. Berger, A. N. (2003): The Economic Effects of Technological Progress: Evidence from the Banking Industry, Journal of Money Credit and Banking, 35, 141-176.
3. Deloitte LLP (2013): The economic impact of online payments. Breaking barriers across Europe. Deloitte
4. ECB (2010): The Payment system. Payments, Securities and Derivatives, and the Role of the Eurosystem.
5. Hasan I., De Renzis T., Schmiedel H. (2013): Retail Payments and the Real Economy. ECB
6. Hasan, I., Schmiedel, H., and Song, L. (2012): Retail Payment and Bank Performance, Journal of Financial Services and Research, 41 (3): 163-195.
7. Humphrey D., B., Pulley L. B. and Vesala J. M., (1995): Cash, Paper, and Electronic Payments: A Cross Country Analysis, Journal of Money, Credit and Banking.
8. Wooldridge, J.M., (2007): Econometric Analysis of Cross Section and Panel Data (second ed.) MIT Press.
9. Zandi Mark, Koropeckyj Sophia, Singh Virenda (2016): The impact of electronic payments on economic growth, Moody's Analytics.
10. Mieseigha EG, Ogbodo UK (2013): An empirical analysis of the benefits of cashless economy on Nigeria' s economic development. J Financ Account 4:11–16

Author **Supervisor**

1 Introduction

Modern economy delineates complex and interconnected structure with increasing global interdependence on number of variety networks, such as transport, energy, communication, and others. The financial networks in terms of payment systems affect stakeholders at different levels and therefore play major role in economic activity both within a country and cross-border activities. Failures in efficient functioning of fund flow would have adverse impact on financial markets and economy. Substantial resilience on efficient exchange of goods and services triggered societies to dynamic search of alternative methods of payments. Over the time, trade settlement mechanism transformed from barter trading and first coins and banknotes, to checks and recent electronic payments. Currently, digital forms of transactions are rapidly transforming the landscape of payment systems offered by both conventional and alternative providers of financial services. The straightforward benefits of cashless transactions that come in form of transparency, efficiency, and financial inclusion uplift the trend of transformations from paper-based money into digital form. Although cash loyalty remains in some societies, the structural shifts are inevitable with financial markets facing major disruptions.

The academic field and related researches are largely focused on the relationship between alternative methods of payments and economic growth solely. Few studies aimed on extending the topic of physical currency by analyzing other altered aspects, yet commonly addressing individual regions and nations. The objective of this thesis is therefore to aim to further broaden the subject of physical cash in circulation, taking into consideration the conversion to digital payment instruments prompt number of areas. The study contributes to the topic by forming an extensive outlook from a global perspective, examining factors as business environment, globalization, and shadow economy in relation to currency in circulation.

This paper begins with the discussion of the payment system organization development figuring the enduring definition of money term and its functions, but it's evolving representing nature throughout the history. It further follows with defining the structure of currently existing payment system, overviewing its main characteristics and differentiating terminologies between cash and non-cash instruments. The major trends in the field occurring triggered by technological advancements are highlighted in the subsequent section. We then delineate and classify

the electronic payment system into five subcategories of cash-based and account-based groups.

The general overview of the payment system from theoretical and terminological viewpoint is followed by Chapter 3, where the main focus of the thesis on transition to cashless society is deliberated. Rooting on literature review, we identify four main stages of transition, including: inception, transitioning, tipping point, and advanced. The driving key forces along with barriers faced to undertake shifts are considered, associated with each stage specifics. We can then infer the initial shifts prompted by the need for transparency and security in transactions, whereas shift to advanced stage is generally pulled by individuals themselves in search for convenience and low costs. The chapter acts as a ground base in forming the transformation stage score to further rank countries included in research. The subsequent Chapter 4 focuses on academic studies and researches conducted in the field related to this thesis, followed by the formulation of hypotheses that are tested in the Chapter 5.

The panel data for 70 countries over the period from 2013 to 2017 is studied using standard panel estimation methods and the Blundell-Bond (1998) system GMM estimator. The Chapter 5 begins with elaboration of the data construction, grounding on the literature perspective of the basic definitions and characteristics of the categories analyzed further in the model that is followed by general pre-estimate stage diagnosis, and theoretical overview of panel data estimators. The outputs derived from the estimators' employment are subjected to consequent testing and comparison to elaborate for the selection of the most appropriate method.

The empirical results of econometrical analysis affirms the presence of negative relationship between *Business Environment* and *Currency in Circulation M0* and contrary positive relationship between *Shadow Economy* and *Currency in Circulation M0*, confirming the first and the second hypotheses. The *Globalization* relation to physical cash is left as subject for further research. The conclusive section in the Chapter 6 provides reviewing deliberation over the empirical results in combination with the reflection retrieved from theoretical and literature sections. The central inference implies the insufficiency of solely electronic money solutions promotion and significance of the business environment for both developing and developed stages of transition to cashless economy to ensure trust and security of the system to allow not only the introduction of alternative payment system but to enhance its active usage.

2 Payment system organization

2.1 Evolution of payment system

In the past when definition of medium of exchange had not yet been defined, the process of bartering – direct exchange of goods and services lied in the basis of trade. The difficulty to satisfy exact matching of supply and demand and challenges to set fair rate of exchange attributed to bartering prompted inefficiencies in the trade. The first definition of money as 'measure and standard of value' and its basic three functions of medium of exchange, measure of value, and store of value were introduced by William Stanley Jevons (1883). As medium of exchange money embodied in different physical forms throughout the history. In the hunting state many ancient nations employed skins or furs of animals, whereas, later in pastoral state money reshaped into cattle adding store of value function (Jevons, 1883). Interestingly, emphasizing the importance of livestock to the age, he further discusses etymology of modern common words, such as *fee*, which comes from Anglo-Saxon *feoh*, meaning cattle; or *capital* originating from the kine known as *capitale* (Jevons, 1883). The agriculture induced employment of produced goods as means of trade; therefore, geographical factor determined the form to which money would transform. Such as olive oil circulated in Mediterranean, wheat and oats in Europe, corn and maize in Central America (Jevons, 1883). In Norway corn was deposited and borrowed in the banks (Jevons, 1883).

In addition to proposition of definition and basic functions of money, Jevson (1883) discussed main properties money should hold following the order of importance: utility and value, portability, indestructibility, homogeneity, divisibility, stability of value, and cognizability. Given that, in order to possess those values the material of money need to correspond certain qualities. Metal was the dominant choice for years later as it hold the properties and functions in comparison to commodities used in the past. China has a long history of utilizing base metals in money creation and recognized as first to introduce coins that met basic functions of state authentication, identicalness, acceptance by tale, and guarantee of symbol of value (Davies, 2005). Non-Chinese coinage invention of modern-type of coinage with guarantee of purity and weight, attributes to Lydia and Ionia, which currently form parts of Turkey (Davies, 2005).

The gradual substitute of coinage related to the development of modern paper form of money. The early advancements took place in China where paper and printing were first invented, five hundred years before the occurrence in Europe (Davies, 2005). Johann Gutenberg developed printing in Europe independently in 1440 with Leonardo da Vinci contribution to process improvements, however bankers learned regarding the banknote printing from travelers like Marco Polo (Davies, 2005). The traveler in turn confronted note issues for the first time emanated by Mongol's Khan who adopted Chinese paper money to achieve currency standardization in Asia (Davies, 2005). The rise of paper money printing in Europe coincides with the fall in China due to world's first inflation followed by value depreciation, decreased trust, and further abundance (Davies, 2005). The first money in paper form in Europe was issued in Sweden by Stockholm's Banco in 1660 to provide an alternative to heavy copper made coins (Riksbank, 2018).

The origin of credit cards takes place in the USA as a result of changing consumer habits after World War II (Batiz-Lazo & Del Angel, 2018). Initially, service sector begun offering loyalty cards with the option to pay off later, however, from 1950 "Diners Club" begun to operate as first credit card company implementing credit based system for "Travel and Entertainment" targeting mobile businessmen audience (Giessmann, 2018). First attempts of large banks to compete with retailers failed due to high initial and operational costs, but in 1970 with large banks venturing into credit cards, the penetration experienced high growth from USD 820 million to USD 9.1 billion over eight years (Batiz-Lazo & Del Angel, 2018). The expansion was exerted by intensive marketing campaigns through mass mailings of credit cards to target middle class families (Giessmann, 2018). Credit cards fostered the views on future societies converting to cashless. Following the idea, the realization of need for standardization initiated the implementation of uniforms in card format by American National Standard Institute (ANSI) that defined details standards applied till nowadays such as font, format, signature location, and measures (Giessmann, 2018).

The idea of digital cash was firstly introduced by cryptographer David Lee Chaum in his research paper in 1983 that he further evolved and enacted in his company DigiCash Inc. in Amsterdam to introduce electronic money and avoid bank intermediation (Seth, 2017). His attempt was condemned to failure, yet number of aims ventured in the market based on his views. In 1997 first mobile payment mechanism was launched by Coca-Cola introducing vending machine connected to mobile phone to undertake the payment transaction through SMS instead of physical money (Seth, 2017). Mobile phones reached banking industry during nineties by Merita Bank of Finland setting a trend of phone banking (Barnes, 2003). However, the major change

in payment methods occurred with the establishment of PayPal in 1998, which until nowadays remains to hold strong position in the market of alternative methods of payments. Recently, the digital wallet industry experiencing a rapid growth with technological giants such as Facebook, Apple, Google, and Amazon intensively competing in offering the wallets on their operational platforms. In addition, currently heated discussions surround the blockchain technology introduced by anonymous individual Satoshi Nakomoto in his paper "Bitcoin: Peer-to-Peer Electronic Cash System". The flow of alternative methods of payments remain substantial around the world including both developing and developed economies with major disruption and transformations to be faced and need to adapt. The brief overview of history of developments in payment mechanisms illustrates the continuous progress and evolution.

2.2 Modern payment system structure

The organization and structure of payment and settlement systems undergoing continuous modifications altering complexity in the process. Bank for International Settlements (BIS) (2003) defines payment system as a set of instruments, banking procedures, and interbank transfer fund systems that ensure circulation of money. The facilitation of fund flows is especially significant with the growth of international trade that increases the volume of cross-border transactions, inducing higher scale of complexity in terms of jurisdiction compliment and risk mitigation. Given that, trusted and secure mechanisms are required for improving the transactions and settlements procedures. According to Hasan (et al., 2013), safe and reliable payment infrastructure is necessary for the financial market efficiency, consumer confidence, and trade. The payment types are classified into three main categories: based on type of payer and payee, such as wholesale payments and retail payments; based on number of payers and payees involved in transaction; based on type of execution in terms of international trade (European Central Bank (ECB), 2010). In order to function correctly, payment system should incorporate three main elements (ECB, 2010):

- *payment instrument*, mean to authorize and submit payment
- *processing*, payment instruction in terms of clearing between banks involved
- *settlement means*, procedure to compensate payee by payer's bank

BIS (2003) defines payment instrument as any instrument that enables fund transferring. It delineates in different forms according to the type of relationship and transaction between the parties (ECB, 2010). Payment instruments classified into five main categories: cash, checks, credit cards, stored value, and accumulating balance (Laudon & Traver, 2014). The instruments generally differentiated on basis of cash and non-cash forms. Cash is legal tender authorized by state to represent value, which involves face-to-face communication between individuals to undertake immediate transfer with no further identification, except large-value transactions (ECB, 2010; Laudon & Traver, 2014). In non-cash instruments the authorization to process payment transfers to individual's bank or other payment service provider.

2.3 Payment method trends

Online banking and e-commerce trigger shift from cash based payments to electronic means, allowing consumers to conduct purchase indifferent from location and time. According to the latest World Payment Report 2018, total volume of non-cash transactions reached to USD 482.6 billion, growing by 10.1 percent during 2015 – 2016 with the substantial drive from Emerging Asia and CEMEA and estimated to grow at compound annual growth rate of 12.7 percent (Capgemini and BNP Paribas, 2018). By the end of 2017, total number of credit, debit, and prepaid cards in circulation worldwide accounted to 20.48 billion (The Nilson Report, 2018). The global leader in non-cash transactions per inhabitant is currently Sweden with 461.5 transaction recorder, followed by the United States of America (USA) and South Korea (Capgemini and BNP Paribas, 2018). Alternative methods of payments are rapidly growing offering non-conventional ways to perform transactions. In Denmark, churches and street performers are now accepting mobile transfers; fast food in China can be purchased by facial recognition technology 'smile to pay' (Bech et al., 2018). Boston Consulting Group (2016) identifies four trends that would influence the digital payments industry, including the ongoing technology revolution, entry of non-traditional players, demanding customer experience, and 'enabling regulations'. The advancements in mobile phones technologies introduced mobile payment services with fast growing mobile payments adoption rate in developing economies, notably in Russia 36.5 percent, India 33.2 percent, China 25.8 percent, and South Africa 15.1 percent (Capgemini and BNP Paribas, 2018).

Payment methods are currently condemned to transformation with the technological advancements and innovations introduced in the market. Nevertheless, cash circulation remain high in majority of countries. Bech (et al., 2018) provide

evidence of increased demand in cash in advanced countries driven by Great Financial Crisis and lower interest rate with exception to Nordics.

2.4 Electronic payment system

Cashless economy does not imply the outright absence of cash transactions, however refers to the system, where cash transfers are kept at minimum level (Paul and Friday, 2012). Cashless payments allow for trade of goods and services through electronic media and non-electronic transfers via checks (Tee & Ong, 2016). Electronic payment is therefore defined as transfer of electronic value from payer to payee through electronic mechanism (Kim et al., 2010). According to Tsiakis and Sthephanides (2005), electronic payment system imitates current payment structure and designs new ways for transaction executions. The continuous growth is currently observed in electronic payment system with new entrants in the market offering advanced improvements and technologies, accounting for 750 million of payment systems worldwide (Treasury Alliance Group, 2018).

Abrazhevich (2004) distinguishing by money representation form and money transfer principle, divides electronic payment system into two groups: electronic cash based system and account based system. Electronic cash based group represents conventional money in form of coins and banknotes, or 'tokens' so that medium of exchange carriers a value, whereas in account based approach, money refers to records in bank accounts, also knowns as 'notational' with authority to store value (Abrazhevich, 2004; Tsiakis & Sthephanides, 2005). Electronic money is then considered as 'mean of settlement rather than a payment instrument', representing monetary value stored either on hardware or software (European Central Bank, 2010). Kim (et al., 2010) further modifies the model in terms of subcategories of each group and proposes five main classifications of electronic payment system, where electronic cash and prepaid cards belonging to the first cash-based group; credit cards, debit cards, and electronic checks to account-based system.

- *Electronic cash* is represented by tokens in electronic forms that can be purchased by individuals from issuers using conventional forms of payment and later resided only on user's account, also referred as 'e-purses' (Abrazhevich, 2004). Electronic cash method of payment includes one organization responsible for the issuance and redemption of cash, where for specific amount of money the unique identification number required (Kim et al., 2010).

- *Prepaid card* is issued by merchant for specific value and purchased by consumer for convenience in store transaction (Kim et al., 2010).

- *Credit card*, the money transfers are maintained by payment service provider that records charges on user's account and later bills customer with the balance of account (Abrazhevich, 2004). The long-term success of expansion of credit card scheme into global payment network attributes to 'critical mass of retail customers and retail merchants', investments in computer technology, and international cooperation and knowledge sharing within financial service industry (Batiz-Lazo and Del Angel, 2018). The developments of the credit card system in the USA in 1960's was driven by need of standardization due to heterogeneity of the systems as a result of high boom in 1950's, middle class demand to ease the procedure, and popularity in cashless society visions (Giessmann, 2018). Visa and MasterCard are nonprofit credit card associations that set standards for banks issuing credit cards that later act as financial intermediaries (Laudon & Traver, 2014). According to the Nilson Report (2018), as of the end of 2017 there was 14.4 billion of credit cards in global circulation. In the USA, individuals generally have more than one credit card with consumers with high credit score to hold on average four accounts and cardholder with low score have average more than two cards (Consumer Financial Protection Bereau, 2017). The capacity to purchase goods and service instantaneously and to pay off the account balance later provides benefit for merchants in terms of increased consumer spending. The merchants, however have to pay high fees for every transaction conducted by consumer with total USD 7 billion in USA (The Nilson Report, 2018). Inability for full authentication places both consumer and merchant side into vulnerable position, creating possibility of fraud and crimes to arise and generating number of issues, including security, administrative, and transaction risks (Laudon & Traver, 2014).

- *Debit Card* is a type of stored value account that created by depositing amount from which transfers or withdrawals take place (Laudon & Traver, 2014). The payment method is maintained by payment service provider, however allows to retain positive balance on account by immediate subtraction when transaction is performed (Abrazhevich, 2004). Debit card instrument combines features of ATM and Internet banking (Kim et al., 2010). Debit and prepaid card purchase

transactions accounted for 55.44 percent of total purchased transactions (The Nilson Report, 2018). The advancements in technologies triggered variations in payment offerings in especially Person-to-Person transactions such as PayPal, which are often referred to store value accounts (Laudon & Traver, 2014)

- *Electronic check* is converted from paper form checks (U.S. Department of Treasury, 2018). The payment type remain to be widespread in some countries, such as the USA, Canada, United Kingdom, however, payment service providers attempt to switch to other instruments.

3 Transition to cashless society

3.1 Transformation stages

There are generally four main stages described that economies experience during transitions from cash payments dominance to non-cash solutions. Thomas (2013) classified each stage as following: inception, transitioning, tipping point, and advanced. The inception stage appears in developing economies with cash based payments accounting for more than ninety percent that results due to lack of available financial infrastructure or social attributes. The second stage represents mixture usage of paper and electronic payments occurring both in developing and developed countries, where in the in developing economies the cashless transactions are mainly driven by growing middle class, and conservatism in developed countries happens in response to cultural aspects. The tipping point classification accounts for range of non-paper transactions from twenty nine to forty five percent, applying to countries with access to required infrastructure for the transition, however the final decision to conduct a change in payment method lies on individuals in the economy and again, socio-cultural attributes. In the advanced stage along with developed infrastructure and high financial inclusion level, the individuals accept and use intensively the alternative method of payments (BFA & Better Than Cash Alliance, 2015; Thomas, 2013)

In order for countries to undertake shifts through each classified stage in efficient manner, considering costs and timing, the coordinated approach needs to be applied. It is also important to note that shifts between each stage are individual to each countries' specifics and thus initial starting point needs to be evaluated. The first shift from inception to transitioning stage occur with large payments made by "governments, large employers, and aid distributors to pay electronically", creating changes in cash flow pattern and need for the development of financial infrastructure (BFA & BTCA, 2015). The advancement in infrastructure is limited to cash withdraw activities in terms of ATMs and bank branches expansion as at this point the small and medium volume transactions are remain paper based.

There are over 100 million low income individuals or 19 percent of adults receiving payments from government in form of wages or social transfers with less than 39 percent of transactions into an account, whereas in high-income economies the share is over 80 percent (Demirgüç-Kunt, 2018). In this way, the probability of shadow economy and corruption is significantly high, placing recipients into vulnerable

position. Digitalization of Government to Person (G2P) payments lowers government costs, improve efficiency and transparency of money transfers, enhances security, increase financial inclusion level, and empower women's role in economy (Klapper & Singer, 2017).

There are number of evidences supporting an argument for decreased government costs in developing countries with such cost appearing from unauthorized payments, bank fees, and interest payments (Aker et al., 2013). Need for efficient methods of payments is especially crucial in case of emergency situations, which was illustrated during Ebola infection, when Liberian government had to instantaneously transfer payments to workers in remote areas (BFA & BTCA, 2015). The ability to trace the payments conducted digitally allows for decreased level of fraud. Bribe incidents in India decreased by 47 percent when social security pensions were transferred digitally; similar result happened in Argentina with the digitalization of social payments under anti-poverty program Plan Jefes (Duryea and Schargrodsky, 2008; Muralidharan et al., 2014). Another important outcome of shifting G2P payments lies in evidence of individuals to further use other financial services, such as savings, deposits, and loans once the bank account is created (Bold et al., 2012). Following distributes saving accounts, 80 percent of households in Nepal kept using the account for deposits of 8 percent of weekly income (Prina, 2015).

The second shift happens with increased opportunities to individuals to transfer or spend money digitally (BFA & BTCA, 2015). The small-medium type of payments are conducted at this stage based on evaluation of available payment methods and decision to transfer in the most efficient manner, including Payments to Business (P2B), Payment to People (P2P), and Payments to Government (P2G). The developments in the Information and Communication Technologies led to rapid innovations in financial services, providing easier access for consumers and businesses to the market who were either not meeting requirements for formal banking accounts or were not be able to take part in electronic system for other reasons. According to World Bank, with 40 percent of adults having bank account, the mobile phones penetration rate is around 90 percent, thus providing a base for increased developments in mobile payments. In 2016 over 100 million new mobile money accounts were created totaling to 0.5 billion of mobile money accounts processing billion dollars a day (Global System for Mobile Communications (GSMC), 2018).

The number of mobile payments methods are especially rapidly increasing in emerging and developing economies. Sub-Saharan Africa has been having the largest share of global mobile money accounts with 49.1 percent in 2017, followed by 34

percent in South Asia, 6.8 percent in Middle East and North Africa with half of P2P transfers to total transfers (GSMC, 2018). M-PESA mobile money service in Kenya represents a successful example of a transition in developing world from unbanked society to financial system through fostering efficient and secure payment system and therefore increasing social welfare by lifting 2 percent of total population out of poverty (Suri & Jack, 2016).

The third shift involves transition from turning point to advanced stage, when small and everyday purchases are done electronically (BFA & BTCA, 2015). At this point, the demand and supply side have easy access at low cost to alternative methods of payments. If first two shifts are mainly driven by the need for secure and transparent payments, the shift to advanced stage is generally pulled by community to enhance convenience and lower costs of transactions.

According to Deloitte (2013), the top reasons for consumers to decide to shop online include ability to compare prices, time saving, accessibility, cheaper products, and wider selection. In turn, electronic methods of payments allow merchant to enter new markets and increase their customer base. In 2017 European e-commerce increased by 11 percent to EUR 534 billion in total turnover and expected to grow by 13 percent to EUR 602 billion in 2018, with the strongest share of 68 percent in Western Europe (Ecommerce Europe, 2018). According to MasterCard (2017), Europeans are actively engaged in online retail with 25 percent of consumers shopping every day and 60 percent shop at least once a month. However, the number of online transactions vary geographically with highest frequency in Asia and North America (KPMG, 2017). The most commonly products purchased online are clothing, footwear, electronics, and tickets (KPMG, 2017; MasterCard, 2017). The main drivers for Europeans to engage in online cross border shopping included appealing offer for 40 percent of respondent, followed by such aspects as better service or terms conditions for 33 percent, and better availability for 32 percent (MasterCard, 2017). Globally, the main motivations for online shopping based on Global Consumer Report (KPMG, 2017) were cost and time savings.

The method of online payment is preferred to cards and online banking for 1 in 3 European shoppers with PC dominance in device preferences and although the market is open for other alternative methods as QR code scanning, mobile banking apps, e-wallets, the expressed interest does not correlate with the actual usage (MasterCard, 2017). The device preference differs in Asian countries with over 19 percent rpefer to purchase through mobile applications, particularly evidenced in China with 26 percent to prefer mobile devices (KPMG, 2017). However, the research

on price difference in online and offline stores conducted in 10 countries based on 56 large retailers concludes that prices are identical for both types at 72 percent, however heterogeneous in country and industry levels (Cavallo, 2018).

3.2 Barriers in shifting

The main challenges to undertake the first shift include investments in payment system infrastructure, regulatory framework to build ecosystem, endurance of reliable digital payment experience, and recipient's education (Klapper and Singer, 2017). It is therefore necessary to assess the initial stage of the country to determine the most convenient method of payment transfer.

World Bank (2010) identifies two decisions to undertake, including the type of delivery instrument and selecting of distributing agency. Payment channel depends on broad country specific factors such as economic, demographic, and policy aspects (Faz and Moser, 2013). Thus, for some developing countries direct bank account deposits are more convenient form of transfer, however to others with lack of developed formal financial infrastructure, the payments to mobile money accounts should be considered. The decision on the distribution agency shall therefore also be based on current available infrastructure to be able to have broader coverage to include both urban and remote areas. Since state or public banks, ATMs, and post offices are mainly available in urban areas, the possibility to receive payments in retail stores in form of presenting electronic cards can be included (World Bank, 2010). In-kind beneficiaries may have not been engaged in financial activities in the past, thus it is necessary to provide education and training at early stage to introduce available financial products and increase the level of financial literacy.

During proceeding between transitioning to turning point stage, several barriers can appear on the way. Electronic payments service suppliers may face obstacles in regulatory issues as licensing requirements, new procedures for new forms of financial services, inadequate infrastructure, and underdeveloped distribution channels among others (World Economic Forum, 2018). In cross border transactions the financial risks in form of currency liquidity and exchange rate can imply additional adverse effect (World Economic Forum, 2018). International Trade Center conducted a global survey for micro, small, and medium-sized enterprises where the insufficient "link between third party e-payment provider and local bank" was the main obstacle for electronic payment, notably more for developing countries (26 percent) than developed countries (16 percent), followed by such reasons as foreign exchange control (20 percent), lack

of e-payment providers (18 percent) and online banking (15 percent), and e-payment knowledge (ITC, 2016).

From the consumers' side, community may remain to the conventional methods mainly due to lack of trust, shortage of financial knowledge, cultural preference on face-to-face interactions, and low internet penetration (World Economic Forum, 2018). Based on the recent study on experience of electronic payment system, the personal perception on security and trust have significant influence on the use of the system with technical protection and past experience as main determinants of security and trust (Oney et al., 2017). The demand on cash is higher for developing countries with low trust in sharing information on credit card while purchasing online (Nielsen, 2016). India presents an example of increased card penetration to be not the only factor for adoption of electronic payments, but trust in security of transactions to play larger role, and thus the developments in digital payment systems are expected to be similar to trajectory in China (Nielsen, 2016). In order to tackle the issue of trust, the major e-commerce player on Chinese market Alibaba created payment system Alipay that boosted the e-commerce level in the country (Boston Consulting Group, 2016). The trust in the financial institution was identified as a primary enabler to engage in electronic payments (EWS, 2018). One third of respondents from the developing countries in Global Connected Commerce Report reported high access costs and unreliable connection to Internet as impediment for online shopping (Nielsen, 2016).

The stage between turning point and advanced mainly based on the decisions of individual to conduct transactions electronically and merchants to offer variety of convenient options. Although at the stage individuals do express willingness to electronic trade and enough skills and knowledge to proceed, there are certain barriers existing for consumers not willing to use new methods of payments or engage in e-commerce at all. The highest concerns for European consumers are fraud and control over payment (MasterCard, 2017). The quantitative survey of 1500 consumers from the USA and 804 businesses in 2016 by Forrester Consulting on usage of digital wallets showed that although individuals express high interest in utilizing new payment technologies, the adoption rate remain slow, thus making the role of merchants crucial in driving adoption level (Forrester Consulting, 2017). The reasons for not embracing new technologies include the concerns for security, lack of understanding the service process, and unawareness of availability of the service are among the top (Forrester Consulting, 2017). In turn, when it comes to merchants side the main issues in introducing the advanced new technologies lie in upgrading costs, integration

challenges with existing systems, and lack of demand to implement new tools from consumers (Forrester Consulting, 2017).

3.3 Electronic payment system adoption

The rate at which economies would be shifting from one stage to another differs and mainly depends on innovation adopters in the society (Hock-Han Tee & Hway-Boon Ong, 2016). There are several frameworks of technology adoption developed that can be applied to explain the process of acceptance of alternative methods of payment. Among them the Unified Theory of Acceptance and the Use of Technology founded by (Venkatesh et al., 2003) aggregates views on several adoption theories and includes aspects of behavioral economy. The identification of adopter categories along with the way how individuals proceed along technology adoption process can be analyzed by the Diffusion Innovation Theory introduced by Roger in 1962 (Valente and Rogers, 1995). Chakravorti and Chaturvedi (2017) noted four key drivers of digitalization, including consumer demand, regulatory environment, infrastructure, and innovation. Although the adoption issue is not the primary topic for this paper, it is however crucial aspect in the transitioning process.

4 Literature review

The academic literature and other related researches associated with the field of studying electronic payments systems are predominantly focused on evaluating its impact on economic growth solely. One of the recent studies conducted by Moody's Analytics examines the topic in the international context, including 70 countries between 2011 and 2015, finding that increased card usage resulted in increase of 2.6 million jobs and additional USD 296 billion increase in global Gross Domestic Product (GDP) with real consumption growth of 2.3 percent out of which 0.01 relates to increase in card penetration (Moody's Analytics, 2016). The estimations in research showed that 1 percent increase in usage of electronic methods of payments increases GDP on average by 0.04 percent or annual consumption by USD 104 billion in dollar amount with larger effect on developed countries rather than emerging economies (Moody's Analytics, 2016). Countries that experienced the largest increase in card penetration had higher benefit to growth. Hasan (et al., 2013) uses similar approach in analyzing the data for European Union member states for the period from 1995 to 2009, confirming the positive effect of electronic methods of payment to economy and trade, so that increase in card payments by EUR 1 million corresponds to the increase of GDP by EUR 6 million or 0.07 percent. Deloitte (2013) estimated economic impact of online payments across 27 European countries of USD 125 billion to GDP with USD 6.6 billion generated by online payment industry through direct, indirect, and induced contributions.

The particular relevance of transition to cashless systems is evident in developing economies. Oyewole (et al., 2013) studying the transition to cashless economy in Nigeria for the period between 2005 and 2012, discovers positive relationship between the electronic payment system and economic growth. The social transfer program Bolsa Familia in Brazil contributed to reduction in squared poverty gap in rural areas by 50 percent and by 8 percent in urban states (Higgins, 2012). The expansion of M-PESA mobile money system in Kenya resulted in consumption growth per capita and brought up 194,000 household from extreme poverty (Suri and Jack, 2016). The case study on digitalization of loan repayments for farmers in Kenya initiated by One Acre Fund non-profit organization, finds positive effect on transparency, convenience, and efficiency; with repayment processing costs decrease by 80 percent and collection time by 46 percent (BTCA, 2017). Prina (2015) randomly distributed saving bank accounts to 1118 females form rural areas in Nepal, who in

turn increased spending by 20 percent on education and 15 percent on meat and fish. Garment factories in Bangladesh reported 85 percent decrease within 2 years in transaction costs when digitalizing wages employees through hybrid solutions of bank account and mobile systems (BTCA, 2017b). In Mexico, study found 30 percent growth in sales followed by installation of point-of-sale (POS) terminals in small retailers.

In this thesis we however aim to extend the perspective on physical cash, assuming the adoption of electronic money solutions to be associated with number of another aspects. As such, the review on the way literature views and uses for testing conventional forms of cash is undertaken. Various studies are available connecting the topics of currency in circulation with digital money. Stix (2004) studying cash disappearance through payment cards applies interesting approach on estimating cash demand by surveying Australian individuals on their purse cash management, finding individuals who frequently conduct payments via cards hold 20% less cash in their wallets. Since in our study the survey conduction is not the initial plan to consider, the proxy for cash demand is required to be viewed in a different perspective. For example, in the research by Rao (et al., 2009) analyzing demand for cash in 11 Asian countries for a quite substantive period from 1970 to 2007, M1 money aggregate is used to account for money demand, arguing it to be a dominant part of money supply in developing economies. Viren (1992) takes different perspective of cash demand denoting it as physical cash and coins excluding cash holdings at the bank, when studying credit card transaction offsetting conventional money in Finland. He further concludes the estimation results with strong, stable relation with one percent increase in credit cards transaction decreasing one percent in currency demand. The decrease in currency demand with the increase in usage of alternative electronic payments, such as credit cards, debit card, and mobile banking is tested in number of studies conducted in different countries Yilmazkuday and Yazgan (2009) for Turkey, Rinaldi (2001) for Belgium, Raj (2017) for India, Bounie (et al., 2016) for France.

The currency demand approach origin generates from the study by (Cagan, 1958), where he considers the determinant factors affecting M2, concluding it include interest rate, income, and tax rate. Grounding on his approach, Tanzi and Vito (1980) applying the intuition in calculation the currency demand in the USA in order to estimate the underground economy in the country from 1930 to 1980. The method was further used in number of other countries and regions. Generally M2 money aggregate is used as dependent variable for the econometrical analysis. One of the recent studies examines 111 countries to calculate the size of shadow economy, discovering range of from 10 to 86 percent of GDP with mean of 17 percent of GDP in OECD countries, 33

percent for upper middle countries, and 38 percent in low income countries (Alm and Embaye, 2013).

The method is therefore remains to be relatively common when measuring shadow economy. The same applies when considering financial innovation in terms of electronic methods of payment impact on informal economy. The research by the EY (2016) in Central and Eastern European countries applying currency demand approach with M1 money aggregate as dependent variable, finds positive significant effect of promotion of alternative method of payments on limiting passive shadow economy with 100 percent increase in value payments leading to shadow economy reduction by 0.6 - 3.7 percent of GDP and government revenue increase by 0.1 - 0.8 percent depending on a country. Mac Géidigh (et al., 2016) applying currency demand approach finds that over the past 145 years the underground economy in the United Kingdom, Norway, Sweden, and the United States is gradually stabilizes pointing on the developments in technology and financial innovations leading to better spending accountability. The extended study with the outlook on global informal economy by Kearney and Visa Inc. (2018) conducted in 60 markets finds that 10 percent increase in digital payments for the five consecutive years could increase global GDP by USD 1.5 trillion by 2021. Among other related studies, major part of it examines developed economies, with very few taking into account developing countries or overviewing in global perspective.

The transition to cashless society chapter in describing transformation stages provided a brief snapshot on usage and trends of digital instruments worldwide. Particularly, individuals in the economies locating at the advanced or tipping point stages are active users in conducting online transactions both inside and outside of the country, valuing ability to have wider selection in terms of variety and prices and to save time (Deloitte, 2013; MasterCard, 2017). The e-commerce market is therefore dynamically develops with 13 percent increase in 2018 in Europe and 18 percent increase globally with total value of USD 2.8 trillion (Digital Commerce, 2018; Ecommerce Europe, 2018). In response to advancements in payment technologies and consequently e-commerce market growth, businesses are able to enter new geographical markets expanding the customer base. There are however limited academic research available on the topic covering relation of trade within and outside of national levels in consideration of currency demand. For the most part, researchers examine the role of non-cashless payments to consumer behavior, perception of money, and future spending. The general finding among them states the increased usage of card payments increase overall consumption due to psychological factors (Khan and Craig-Lees, 2009; Soman, 2001). The relation between trade and digital

money can be found from different perspective, so that Bodas (et al., 2018) estimating retail trade in Spain by assuming credit and debit transactions at POS terminals, discover that those transactions closely replicate the Retail Trade Index movements. The inference can be formulated from the deliberated data that with the trade growth to be related to alternative payment solutions enabling fast and efficient transactions undertaken over nation borders. Thus connecting the world with a greater extend, ensuring competitiveness among market players.

On the basis of elaborating literature review, we formulate following hypotheses:

H1: Alternative methods of payment through indirect benefits impact to healthier business environment

H2: The demand for cash is higher for countries with greater shadow economies

H3: The globalization and markets integration are negatively affected if the share of currency circulated is large

5 Methodology

The methodology chapter of the research paper consists of four sections. First, we review the dataset and details on examined variables. In the following section, analyzed countries for the research are grouped based on classification of transformation stage discussed in the literature section. Later sections discuss the research method and formulate analytical model to test the hypotheses with the further deliberation over estimation results.

5.1 Data

In order to test formulated in Chapter 4 hypotheses, a database of 70 countries was built, covering period between 2013 and 2017. The full list of countries included in the research can be found in Appendix A. The initial set of 212 countries was reduced due to lack of available observations. In order to preserve global outlook for the research, countries are selected to represent diverse regions and income groups defined by the World Bank. The data for the panel set are retrieved from the World Bank, the International Monetary Fund (IMF), BIS, the International Telecommunications Union, World Economic Forum, and KOF Swiss Economic Institute. Missing observations are identified with few exceptions and further updated with data retrieved from government statistical agencies. For more detailed information on the data source see Appendix D.

The dependent variable considered in the estimation of the model is currency in circulation. Currency is generally classified at different levels. Initially the explained variable was intended to be formulated as M1 also referred as narrow money or money base, which is money aggregate that includes physical banknotes and coins, deposits held in financial institutions, and other highly liquid assets that are quickly converted into cash. Nevertheless, with regard of the paper to primarily focus on physical cash, it is decided to exclude other components of M1 money supply in order to result in appropriate outcome reflecting the aim of the study. Narrow money that takes into account only material money is defined as M0 and expresses the amount of money held by public. Assuming electronic money to substitute physical cash, the M0 will be affected in the first place from other levels of money aggregates. Further, M1 money supply level is affected by other factors as monetary supply, hence not demonstrating the link examined in this paper.

The data on the amount of M0 and M1 is retrieved from Thomson Reuters Datastream for nearly half of analyzed countries, with the rest of the data manually derived from the each countries' central bank websites. The second method of the data collection can be viewed as more accurate, providing different classification and terminology for M0 among different countries. Additional aspect considered in formulation of the dependent variable is the transformation of real amounts into the share of physical currency in circulation to total money base. There are several motives to perform this step. Firstly to account for general yearly growth of both levels of narrow money with the development of economics. Secondly to delineate the development of physical money relative to demand deposits and other highly liquid money over the time, and lastly to advocate for cross country differences in characteristics and background. The share of currency in circulation held in public relative to total narrow base is therefore reflects changes in cash demand in the greatest appropriate manner for the study.

The independent variables are classified into four major categories that are further tested in the research, including electronic money solutions, business environment, globalization, and shadow economy. Each mentioned category is represented by number of relevant sub pillars and indicators. From the perspective of eliminating large number of variables, the score for each category and selection of variables are elaborated based on the literature and relevant previous studies.

The score is constructed based on comparison of the economies studied, reflecting the absolute distance to the best performer. The underlying framework for the score calculation is based on the methodology of the Doing Business report by the World Bank. The estimation of the score for each country involves mainly three steps. First, normalizing each indicator to a common unit, followed by identifying the worst and the best performance values. Then, the indicators are rescaled by applying linear transformation. Considering the presence of extreme outliers for some indicators, in order to eliminate its effect on rescaled data they are removed from the calculations. Deriving from the dispersion of the distribution, the outliers were mitigated using 95th percentile or 99th percentile. The economies outperforming the best or the worst performance, assuming the elimination of outliers, are therefore scored as 1 or 0, respectively. The final step calculates score for individual sub pillar and category by aggregating the indicators through either simple equal averaging for some values or weighting each indicator based on the significance of the indicators. Score calculations are based on five decimals and scale from 0 to 1, delineating the worst and the performance accordingly. The information on general structure of categories is presented in the Table 5.1.

Table 5.1: Categories' sub-pillars

Electronic money solutions	Business environment
• Account ownership • Account usage • Access Points	• Competitiveness • Legal framework • Procedural regulations • Financial infrastructure
Shadow economy	**Globalization**
• Social taxes • Unemployment • Rule of Law • Control of Corruption	• Trade Globalization • Interpersonal Globalization • Cultural Globalization

The variables for the electronic money solutions category are selected based on theoretical framework discussed earlier. Referring to the definition of electronic money as a "mean of settlement" and classification of the electronic payment system into cash-based group and account-based group, and assuming the research purpose of this thesis, we consider second group as a target for further study (European Central Bank, 2010; Abrazhevich 2004; Kim et al., 2010). The account-based group by definition include credit cards, debit cards, and electronic checks. In order to elaborate over which instruments to consider subsequently, we refer to the literature and studies conducted earlier. European Central Bank (2010) in the research on electronic retail payment instruments focuses on payment cards, credit transfers, direct debits, and checks. Moody's Analytics (2016) in the research on the impact of electronic payments on economic growth focuses only on the card penetration. The empirical study developed by modeling consumers' demand for checks, cash, and debit cards from Humphrey (et al., 2001), finds significant substitution effect from checks to debit cards and low reverse substitution. The research therefore implies consumers' willingness to transfer from checks to cards with cost increase of checks, but less willingness to revert from cards to checks with increase cost of cards. Considering low level of usage and decreasing popularity in many countries, or no availability in others, check payment method is mitigated from the dataset.

The literature section also discusses and provides the empirical evidence on the significance of required infrastructure to operate with digital money, therefore indicators reflecting the availability of access point, in terms of ATMs and POS terminals, are included in the dataset. EY (2016) includes the ratio of payment terminals to the number of payments cards in the payment cards system variables of the dataset. Humphrey (et al., 2001) in the model mentioned earlier finds no significant substitution effect between ATMs and POS terminals. From the other hand, European

Central Bank (2010) assumes ATMs as a proxy for cash. Referring to the literature section, the ATMs delineate different values to developing economies, where it play as significant underlying factor to actively operate with electronic money, and contrary has opposite effect on developed economies. Given that the analyzed countries for our dataset include low, middle, and high income groups, the ATMs remain to reflect electronic money solution score, with different allocated weigh depending on the income group. It is further mentioned the weight of actual active usage of electronic money, assuming the availability of basic instruments and infrastructure, specifically it concerns developing economies, where debit and credit cards are used only for the purpose of withdrawals. Thus, indicators in the dataset include the formal and informal patterns of digital money usage.

Rooting on the above discussion on earlier studies and conclusive observations of literature background, the electronic money solutions score is therefore constructed based on account ownership, credit and debit cards in circulation, availability of access points, and general usage of the accounts with total of 21 underlying indicators. The data are obtained from Global Financial Inclusion (Findex) Database and Global Payment Systems Survey (GPSS) provided by the World Bank. Both sources represent the most comprehensive data on accounts ownership and further detailed usage, considering the payment methods, saving and borrowing mechanisms among adults worldwide. The data collection for Findex Database is conducted through surveys of over 150,000 adults by national representatives in partnership with Gallup, Inc., and covers more than 140 countries. The GPSS collects the information on the status of payment systems through surveys of national central banks and authorities to depict quantitative and qualitative aspects of payment system worldwide. Table 5.2 summarizes the indicators forming the score for the electronic money solutions category.

Table 5.2: Electronic Money solutions' sub-pillars and indicators

Sub-pillar	Indicator	Source
Account ownership	Account (% age 15+)	Findex, World Bank
Account ownership	Debit card ownership (% age 15+)	Findex, World Bank
Account ownership	Credit card ownership (% age 15+)	Findex, World Bank
Account ownership	Mobile money account (% age 15+)	Findex, World Bank

Access Points	Automated teller machines (ATMs) (per 100,000 adults)	GPSS, World Bank
Access Points	Number of POS terminals (per 100,000 adults)	GPSS, World Bank
Account usage	Made or received digital payments in the past year (% age 15+)	Findex, World Bank
Account usage	Received government payments: into a financial institution account (% age 15+)	Findex, World Bank
Account usage	Used a mobile phone or the internet to access a financial institution account in the past year (%	Findex, World Bank
Account usage	Used a debit or credit card to make a purchase in the past year (% age 15+)	Findex, World Bank
Account usage	Debit card used to make a purchase in the past year (% age 15+)	Findex, World Bank
Account usage	Received wages: into a financial institution account (% age 15+)	Findex, World Bank
Account usage	Paid utility bills: using a financial institution account (% age 15+)	Findex, World Bank
Account usage	Paid utility bills: using a mobile phone (% age 15+)	Findex, World Bank
Account usage	Sent or received domestic remittances: through a financial institution (% age 15+)	Findex, World Bank
Account usage	Sent or received domestic remittances: through a mobile phone (% age 15+)	Findex, World Bank
Account usage	Sent or received domestic remittances: through a money transfer service (% age 15+)	Findex, World Bank
Account usage	Saved at a financial institution (% age 15+)	Findex, World Bank
Account usage	Paid online for internet purchase (% internet purchasers, age 15+)	Findex, World Bank
Account usage	Used the internet to buy something online in the past year(% age 15+)	Findex, World Bank
Account usage	Used the internet to pay bills in the past year (% age 15+)	Findex, World Bank

Findex: Global Financial Inclusion Database, World Bank
GPSS: Global Payment Systems Survey, World Bank

In order to develop the shadow economy category, the definition of the term need to be formulated. According to Schneider (et al., 2002) the shadow economy, also referred to informal, underground, and parallel economy, comprises of both illegal and legal activities that involve monetary and non-monetary transactions leading to tax evasion or avoidance. European Commission defines the non-observed economy as not directly observed values of production activities that would be generally included within the national production accounts, and therefore constituted of following: (1) illegal activities involving willing parties in an economic transaction; (2) underground activities that are not reported to avoid official scrutiny, but not necessarily illegal; (3) informal activities with no records kept (Eurostat, 2018). Schneider (et al., 2002) identifies major causes triggering shadow economy in cost of labor in terms of taxes and social contributions, government regulations, and inefficient governance that lead to intentional disguise from authorities for the following reasons:

- to avoid income or other tax payments;
- to avoid social security payments;
- to avoid meeting legal labor market standards;
- to avoid complying with administrative obligations.

Thiessen (2010) in the research on causes of shadow economy, proposes 7 major categories of influences derived from number of previous empirical studies, including constitution, taxes, administration, quality of justice system, economic institution, social values, and other subjective factors. The literature generally excludes illegal criminal activities, such as robbery, drug dealing and others. Since the criminal activity involves unwilling party, the definition from European Commission can be applied to exclude the criminal indicator from the dataset.

According to the report on shadow economy by the EY (2016), considering the role of unreported cash transactions, informal economy can be classified into two categories: committed shadow economy and passive shadow economy. The first situation occurs when cash payments act as consequence of shadow economy resulting in the increased demand for cash, when both parties are motivated to benefit from avoiding reporting. The passive shadow economy, on the opposite, act as a cause for underground economy triggering its expansion generally by passive parties who are not intending to benefit from unreported transactions. From this perspective, the solutions to limit each type of shadow economy differs. Since cash payments trigger passive shadow economy, actions to reduce it relates to encouragement of digital

payment methods, however other measures need to be applied to limit committed shadow economy. Thus, for this research only passive shadow economy is considered.

Considering the complexity in measuring some of the causes influencing the informal economy, the proxies that assume to delineate certain indicators need to be applied to provide quantitative measures. Consequently, in order to define the score for the model, major determinants of shadow economy are selected to exhibit the categories formed in the research, comprising of social tax, unemployment rate, rule of law, and control of corruption. The data are retrieved from the official statistical data sources along with reports related to qualitative measures, such as the World Bank's Worldwide Governance Indicator. Rule of law index considers the perception of confidence and compliance to rules set in society, its enforcement quality, and probability of criminal and violent activities (Kaufmann et al., 2010). Control for corruption index reflects the perception of degree in usage of public power for private gains, as well as magnitude of elite power in state (Kaufmann et al., 2010). The shadoe economy score elements are presented in the Table 5.3.

Table 5.3: Shadow Economy solutions' sub-pillars and indicators

Sub-pillar	Indicator	Source
Social taxes	Tax revenue (% of GDP)	WDI, World Bank
Unemployment	Unemployment, total (% of total labor force)	WDI, World Bank
Rule of Law	Rule of Law	WGI, World Bank
Control of Corruption	Control of Corruption	WGI, World Bank

WDI: World Development Indicators, World Bank Data
WGI: World Governance Index

The business environment score is mainly based on the Doing Business report by the World Bank that provides quantitative measure of business environment and background across countries. The final score is constructed based on 10 indicators that are widely used in academic studies related to measure business regulations. Adepoju (2017), finds statistically significant impact of the Doing Business indicators on income per capita growth with some countries having direct contribution to economic growth from improvements experienced in the score. Freund and Bolaky (2008) studying the relationship between cross border trade and income per capita, applies the Doing Business indicators to compose business regulation index and observes its

higher relevance to trade liberalization than education, rule of law, and financial development. Calvino (et al., 2016) incorporates the score to provide an evidence on the effect of national policies and frameworks on startup environment. Crafts (2006) include indicators to reviews impact of business regulations using the score on the productivity outcomes through incentives to invest and innovate. Acknowledging wide acceptance and utilization of the Doing Business index to reflect business environment in number of studies, we select relevant indicators for the research to form business environment category to test our hypothesis. Accordingly, three indicators are included: starting a business, trading across borders, and enforcing countries.

In addition, indicators are retrieved from the World Economic Forum's Global Competitiveness Index Report (GCI). GCI is comprised of 3 major sub-indexes and 12 pillars to combine macroeconomic and microeconomic factors of interstate competitiveness in one general index. Regarding it as one of the most comprehensive tool to report national competitiveness level, appropriate indicators are adopted to construct the score. The business environment category is therefore characterized by procedural indicators, competitiveness, legal framework, and financial infrastructure totaling to 10 indicators forming the score that are listed in the Table 5.4.

Table 5.4: Business Environment solutions' sub-pillars and indicators

Sub-pillar	Indicator	Source
Competitiveness	Intensity of local competition	GCR, WEF
Competitiveness	Effectiveness of anti-monopoly policy	GCR, WEF
Legal framework	Intellectual property protection	GCR, WEF
Legal framework	Property rights	GCR, WEF
Legal framework	Efficiency of legal framework in settling disputes	GCR, WEF
Legal framework	Enforcing contracts	DB, World Bank
Procedural regulations	Starting a business	DB, World Bank
Procedural regulations	Trading across borders	DB, World Bank

Financial infrastructure	Ease of access to loans	GCR, WEF
Financial infrastructure	Soundness of banks	GCR, WEF

GCR, WEF: The Global Competitiveness Report, World Economic Forum
DB: Doing Business Index, World Bank

The last category for the analytical model covers globalization. The term commonly refers to economic, social, and political integration of nations, however literature defines it from diverse perspectives. Held and McGrew (1998) define it as transformation process of spatial organization that generate transcontinental networks of interaction and the exercise of power. Waters (2001) sees it as social process in which geographical constraints are reduced on social and cultural arrangements. Ulrich Beck emphasizes the significance of transnational corporations that captured power of political action from state (Kilbourne, 2002). As such, globalization term concerns wide sphere of aspects that need to be reflected when constructing a measure for the concept.

Number of indexes are built grounded on different definitions. Samimi (et al., 2011) reviews commonly used measurements of globalization and categorizes them based on definitions into single index and synthetic index. Single index mainly focuses on de jure and de facto measurements of trade and financial elements of globalization. It therefore concentrates on the level of export, import, capital flow, and restriction on movement of goods and services. Synthetic index on the other hand aims to capture variety of globalization aspects by adopting variables that align with selected definition of the concept (Samimi et al., 2011).

For this study synthetic index is selected to construct globalization dimension for the dataset to consider comprehensive perspective. These indexes include Kearney Foreign Policy Globalization, KOF Globalization Index (KOF), CSGR2 Globalization Index, Maastricht Globalization Index, and Globalization index (G-index). To select appropriate measurement, we refer to the study by Samimi (et al., 2011), where she compares the indexes based on several developed criteria, such as economic, political, social dimensions, as well as general coverage. The review discovers KOF Index to cover the largest number of economies for longer time period and to include the highest number of indicators. Other indexes include some dimensions, but not all as KOF Index does. In addition, each dimension is calculated in more comprehensive manner, considering variety of factor elements. The index was introduced in 2002 by Alex Dreher and later revised several times (Gygli et al., 2019). The underlying definition of globalization applied in index construction can be formulated as process of

diminishing borders that leads to economic, cultural, political, and technological integration.

In order to construct the globalization score three dimensions are selected from the KOF Globalization Index: trade globalization, interpersonal globalization, and cultural globalization, reflecting social, economic, and political factors of globalization. Each of the dimensions are estimated by researches based on number of factors reflecting de facto and de jure attributes. For this model, weighted average of both are considered.

Table 5.5: Globalization solutions' sub-pillars and indicators

Indicator	Source
Trade Globalization	KOF
Interpersonal Globalization	KOF
Cultural Globalization	KOF

KOF: KOF Globalization Index

To take into account initial economic development, several control variables are selected based on previous empirical studies, including GDP per capita, infrastructure, percentage of rural population, and interest rate. The macroeconomic data is retrieved from the WDI, World Bank.

Table 5.6: Summary statistics

Variable	(1) Mean	(2) Std. Dev.	(3) Min.	(4) Max.	(5) N
M0 in % of M1 (M0)	0.388	0.239	0.004	0.980	350
Business Environment (BE)	0.664	0.094	0.426	0.866	350
Globalization (Gl)	0.668	0.169	0.276	0.938	350
Shadow economy (SE)	0.415	0.165	0.044	0.756	350
Electronic money (EM)	0.359	0.181	0.003	0.758	350
Infrastructure (INF)	0.599	0.197	0.153	0.914	350
Interest rate (IR)	0.035	0.056	-0.113	0.415	350
Rural population (RP)	0.318	0.188	0	0.818	350
GDP per capita (GDP)	9.978	0.834	7.734	11.549	350
Education (Educ)	0.534	0.256	0	1.166	350

The general observation of analyzed data shows the relationship between currency circulation and independent variables corresponding with expectations and theoretical framework considered earlier. From the scatter plots that put together all observations, negative relationship is viewed for business environment, globalization, and chiefly for electronic money solutions in relation to physical money. The strongest

relationship among mentioned variables is observed for the business environment. Further, we view the predicted positive relationship between shadow economy and cash in circulation. The graphical representations of interrelationship among variables are available in the Appendix D.

The correlation test between variables at the pre-estimation stage revealed presence of strong correlation among some variables shown in the correlation matrix in the Table 5.7. The strongest correlations appear between *Infrastructure* and *GDP* (0,876) followed by *Globalization* with *GDP* and *Infrastructure* (0,829; 0,833). Overall high correlation of both *Infrastructure* and *GDP* is observed with the rest of variables with the exception to currency in circulation.

Table 5.7: Correlation matrix

	M0	BE	Gl	SE	EM	INF	IR	RP	GDP	Educ
M0	1									
BE	-0.48	1								
Gl	-0.31	0.67	1							
SE	0.43	-0.77	-0.63	1						
EM	-0.40	0.59	0.63	-0.56	1					
INF	-0.39	0.73	0.83	-0.68	0.68	1				
IR	0.23	-0.33	-0.44	0.36	-0.29	-0.38	1			
RP	0.39	-0.58	-0.58	0.51	-0.52	-0.67	0.16	1		
GDP	-0.41	0.77	0.83	-0.69	0.70	0.88	-0.40	-0.75	1	
Educ	-0.22	0.39	0.66	-0.45	0.58	0.68	-0.33	-0.60	0.68	1

The collinearity is not detected when running preliminary regression attempts with no variables being excluded from the model. Additionally the collinearity diagnosis is implemented that reveals high VIF for *Business Environment* and *GDP*. The result of the test is present in Appendix D. The high correlation of *GDP* observed form the correlation matrix with other variables is therefore confirmed by high VIF value and low Tolerance result. The large proportion of variance for *Business Environment* (0.537) and *Shadow Economy* (0.555) is associated with *GDP* that correspond to large Conditional Index (22.447) and small Eigenvalue (0.016). Quite large Conditional Index is found for *Education* (137.401) and very close to zero Eigenvalue (0.0004) with high variance (0.775) associated to *Rural Population*. Considering the outcome of employed tests to the dataset, the *GDP* and *Education* are required to be treated with cautions with being either run in separate regressions or

dropped from the valuation at all in order to avoid misleading results coming from correlation and collinearity effects. For the purpose to check the collinearity excluding doubtful variable, in our case the *GDP,* we run the diagnosis one more time. The Table 5.8 shows the results of implemented test, where we can observe better findings. Assuming that we conclude to exclude the variable from the model estimation. The complete output from the implemented tests can be found in Appendix D.

Table 5.8: Collinearity test - reduced

Variable	Tolerance	VIF	Eigenvalue	Conditional Index
intercept			7,059	1
BE	0.276	3.620	0.980	2.684
Gl	0.343	2.911	0.487	3.805
SE	0.372	2.689	0.143	7.034
EM	0.487	2.055	0.127	7.457
INF	0.897	1.115	0.095	8.641
IR	0.758	1.320	0.072	9.893
RP	0.478	2.094	0.028	15.853
Educ	0.419	2.388	0.009	28.151

Note: Variance Inflation Factor (VIF) measures the inflation in the variances of the estimated coefficients from the existence of collinearities among explanatory variables in the model. VIF value exceeding 10 is an indicator of multicollinearity.

5.2 Transformation stage score

The Chapter 3 of the literature section of the paper identifies and comprehensively discusses four major stages of transitions from the dominance of cash transactions to non-cash payments solutions in economies, considering empirical research results, barriers in shifting, and general statistics. Taking into account, the heterogeneity of the market in terms of economies' readiness in cashless economy transition assuming both economic background and social factors, it is therefore applicable to imply the classification for the estimated model. As defined earlier, Thomas (2013) defined each transition stage as following: inception, transitioning, tipping point, and advanced.

The underlying framework to allocate the countries analyzed for the paper is built on assumptions of the Digital Money Index estimated by Citibank (2015). While

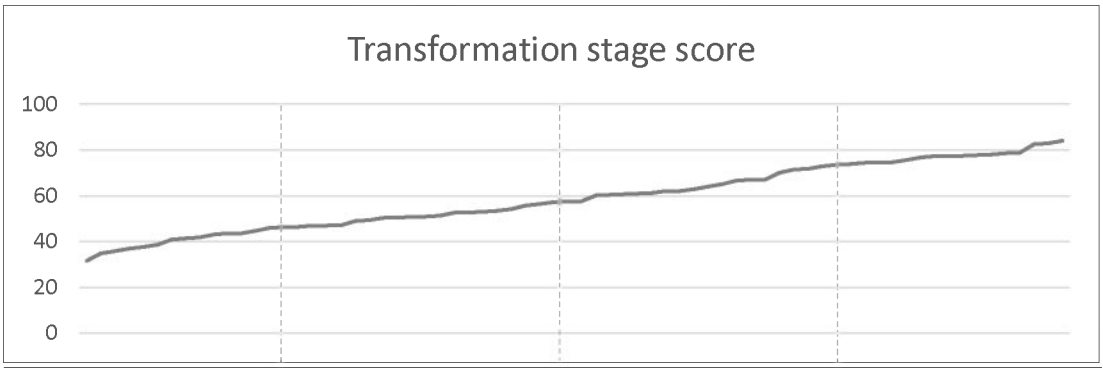
retaining four major building blocks of the index, the sub-pillars and indicators are adjusted. The main pillars therefore include Government and Market Support, Financial and ICT Infrastructure, Electronic Money Solutions, and Social Capital. The first pillar assumes institutional aspects needed to support electronic money market such as innovation, legal, and business environment support. The second pillar considers availability of the basic infrastructure necessary for the operations. Third pillar is based on existing digital money solutions, including payment methods, account usage, and ATM and POS terminals. The last pillar acknowledges the human capital of the country and social relationships, since the levels of trust and education play decisive role in adoption of new technologies. Each dimension consists of number of defining sub-pillars and 64 of total indicators. The estimation method of the score for each pillar follows the procedure applied and discussed previously. Table 5.9 presents the information on pillars and sub pillars used for the transformation stage score calculation. The findings of the underlying framework assigning each country into classified transition stage are summarized in the Table 5.10. The further detailed information on score data and sources are in Appendix B.

Table 5.9: Components of the transformation score

Government and market support	Financial/ tech infrastructure
• Competitiveness • Business environment • Innovation environment • Legal environment • Financial market	• ICT infrastructure • Financial infrastructure
Social capital	**Electronic money solutions**
• Human capital • Social relationships	• Account ownership • Account usage • Access Points

The general picture of the ranking results for the last five years has not differentiated significantly. The economies classified in each stage mainly remained at the same level. The best performer for the last three years is Singapore, followed by Nordic countries and other developed economies. On the other hand, Azerbaijan Argentina, China, and Japan improved their positions for equal or more than 9 ranks since 2013, mainly due to rapid improvements in electronic money solutions.

Table 5.10: Transformation stage score 2017



Inception stage	Transitioning stage	Tipping point stage	Advanced stage
Albania	Croatia	Austria	Singapore
Lebanon	Turkey	France	Finland
India	Greece	United States	Norway
Argentina	Hungary	Israel	Luxembourg
Kenya	Azerbaijan	Korea, Rep.	Australia
Dominican Republic	Georgia	Malaysia	Canada
Indonesia	Kazakhstan	Slovenia	Sweden
Mexico	Serbia	Portugal	Denmark
Peru	Thailand	Saudi Arabia	Switzerland
Philippines	Bulgaria	Czech Republic	Japan
Vietnam	Russian Federation	Latvia	Netherlands
Egypt, Arab Rep.	Armenia	Spain	United Arab Emirates
Tunisia	Brazil	Italy	Germany
Zambia	South Africa	Lithuania	United Kingdom
Bangladesh	Romania	Chile	Ireland
Nigeria	Sri Lanka	Uruguay	Estonia
Zimbabwe	Mongolia	China	Belgium
Pakistan		Poland	

5.3 Estimation methodology

The collected data for the paper consists of two dimensions with the first dimension representing country and the second – time, constructing a panel dataset together. The panel data approach allows to consider time and country dimensions and therefore provides comprehensive analysis of multiple countries throughout the time, outplaying cross-sectional or time-series datasets by considering the heterogeneity at the country level and dynamic effects. In order to derive efficient and consistent estimators, econometric models for panel data are employed and tested.

In order to select appropriate estimator, we firstly analyze static panel data with standard panel econometric estimators, including Pooled Ordinary Least Squares (OLS), Fixed Effects, First Difference, and Random Effects estimators. The basic Pooled OLS method pools all observations from the panel dataset and treats it as cross-sectional data, disregarding cross-sectional differences and its time dimension,

proceeding as simple OLS regression. The estimator is then efficient if variable z_i contains observed constant term for all countries included, otherwise in case z_i is not observed, different approach is required (Greene, 2012; Wooldridge, 2002). The model is formulated in the following form:

$$y_{it} = x'_{it}\beta + z'_i\alpha + \varepsilon_{it} \qquad (5.1)$$
$$i = 1, \dots, N \quad t = 1, \dots, T$$

The consistency and efficiency of the Pooled OLS estimator depends on exogeneity and heterogeneity assumptions. Accounting for heterogeneity presence among countries in our dataset, the estimator can therefore produce inconsistent estimates by violating underlying assumptions. The issue of heterogeneity is possible to be eliminated by the First Difference approach by applying repeated observations over the time allowing to bypass time invariant omitted variables z'_i (Greene, 2012; Wooldridge, 2002). The estimator is the most appropriate for two period panel dataset. The model is formulated in the following form:

$$\Delta y_{it} = \Delta(x'_{it})\beta + \Delta(z'_i)\alpha + \Delta(\varepsilon_{it}) \qquad (5.2)$$
$$i = 1, \dots, N \quad t = 2, \dots, T$$

The underlying assumption of the Fixed Effect method lies in assuming the omitted effects z'_i to be correlated with included variables in the model, implying $E[z'_i\alpha|x_i] \neq 0$ (Greene, 2012; Wooldridge, 2002). The estimator allows the correlation among explanatory variables and considers the existence of cross country differences that can significantly vary. It is the most suitable for the variables that vary over the time. The characteristics of time invariant variables are absorbed in the constant terms, in case of error term correlation, the Random Effects model is preferred. The Within Estimator method of the Fixed Effect estimator is further applied, using deviations from the group means. It therefore proceeds as the Pooled OLS estimator on time-demeaned variables with the time variation applied between each cross-sections. The model is formulated in the following form:

$$y_{it} - \bar{y}_i = (x_{it} - \bar{x}'_i)\beta + \varepsilon_{it} - \bar{\varepsilon}_i \qquad (5.3)$$
$$i = 1, \dots, N \quad t = 1, \dots, T$$

The following Random Effects model is considered when unobserved variation effects among entities z'_i are random and uncorrelated with included variables, implying $E[z'_i\alpha|x_i] = 0$ (Greene, 2012; Wooldridge, 2002). In the scenario where Hausman test result indicates preference on the Random Effects estimator, the output is more efficient than the Fixed Effects estimator with the second one to be assumed

as more consistent. The model includes group-specific random element denoted as u_i and constant mean of the unobserved heterogeneity represented as α. The model is formulated in the following form:

$$y_{it} = x'_{it}\beta + (\alpha + u_i) + \varepsilon_{it} \qquad (5.4)$$
$$i = 1, \dots, N \quad t = 1, \dots, T$$

The following model analyzes dynamic panel dataset that contains dependent variable with one or several lags as independent variable in the regression. The method therefore appropriate in terms of allowing to address for the persistence of currency demand as it evolves over time. Besides it accounts for omitted variable bias and simultaneous effect on each other between dependent and explanatory variables.

In order to overcome the issues related to the standard estimators, researches refer to instrumental variable (IV) estimator proposed by Anderson and Hsiao (1981) or difference Generalized Method of Moments (GMM) developed by Arellano and Bond (1991). In both cases statistical issues can occur. In the first instance, related to weak instruments and elimination of cross-country specifics in the second case. Blundell and Bond (1998) proposed a system GMM to address these problems by using moment conditions both on the equation in the first difference and the equation in the levels to yield consistent estimates of the coefficients. Monte Carlo simulation results find system GMM estimates to have better properties when it comes to bias and root mean squared error than difference GMM estimator even in moderate sample sizes (Rao et al., 2009). It is however argued that system GMM requires larger number of instruments arising to issues. The additional moment conditions also result in more restrictive assumptions for the estimator, including the instruments validity and error term correlation absence. In case the conditions are satisfied, the method results in consistent estimator. Two specification tests are developed to check the validity: the Sargan test or Hansen test and the second order autocorrelation test. The first test of over identifying restrictions considers the overall validity of instruments; the second checks the absence of second order autocorrelation in the residuals.

Caselli (et al., 1996) in the paper on inconsistencies of cross-country empirical studies finds GMM estimator to mitigate the issues of standard panel econometric specifications. Number of researches employ the estimator for related studies. Snellman and Viren (2007) studying the choices of payment means through cash demand analysis use GMM technique for the model. Rao (et al., 2009) applies the method to estimate the currency demand for the panel data of Asian countries.

The Blundell and Bond (1998) system GMM estimator is finally selected for our dynamic panel dataset based on several characteristics described by Roodman (2009). First, it is appropriate for panel data with few time periods and large number of individuals that corresponds to our set with 5 years and 70 countries. Second, dependent variable depend on its realization, which relates to the nature of physical currency in circulation. Third, the independent variables are not strictly exogenous that is potentially possible in our case. Lastly, it assumes liner functional relationship, presence of fixed individual effects related to country specifics, and heteroscedasticity and autocorrelation within countries. Concluding these characteristics to be aligned with the data analyzed and previous related research in the field applying the Blundell and Bond (1998) system GMM estimator, we further employ the method to analyze our dynamic panel dataset. The model is formulated in the following form:

$$y_{it} = x'_{it}\beta + \delta y_{it-1} + z'_i\alpha + \varepsilon_{it} \qquad (5.5)$$
$$i = 1, \dots, N \quad t = 1, \dots, T$$

5.4 Results

In order to retrieve first impression of the dataset, the standard panel econometric estimators are employed, including the Pooled OLS, First Difference, Fixed Effects, and Random Effects estimators with the results presented in the Table 5.11.

Table 5.11: Regression results for pooled OLS, FD, FE and RE estimators

	Dependent variable:			
	currency in circulation (M0)			
	POLS	FD	FE	RE
BE	-0.3774**	0.0527	-0.0595	-0.2070·
	(0.1439)	(0.1398)	(0.1224)	(0.1137)
GI	0.1389*	-0.4558	-0.3320	-0.0086
	(0.0665)	(0.2475)	(0.2033)	(0.1041)
SE	0.0664*	-0.0216	-0.0166	0.0633
	(0.0333)	(0.0954)	(0.0715)	(0.0484)
EM	-0.0571**	0.0079	-0.0089	-0.0188·
	(0.0191)	(0.0150)	(0.0121)	(0.0114)
INF	-0.2583	0.0310	-0.0826	-0.0737
	(0.1741)	(0.1263)	(0.1163)	(0.1136)
IR	0.5166*	-0.5920***	-0.2838	-0.1881
	(0.2209)	(0.1453)	(0.1452)	(0.1425)
RP	0.3016***	2.2734	2.9918***	0.3594*

	(0.0855)	(1.7761)	(0.7313)	(0.1616)
Educ	0.1008	-0.0235	-0.0005	0.0127
	(0.0662)	(0.0581)	(0.0691)	(0.0627)
Const	0.1779	-0.0072		0.2401*
	(0.1022)	(0.0073)		(0.1182)
Observations	350	280	350	350
R^2	0.2991	0.0741	0.0874	0.0886
Adjusted R^2	0.2827	0.0468	-0.1781	0.0671

Source: author's computations
Note: The dependent variable is M0 in % of M1 over the five year period. The p-value is reported at 95% confidence level *p<0.05; **p<0.01; ***p<0.001. Standard errors in parentheses.

The Pooled OLS estimator resulted in statistically significant coefficients at all reasonable levels of the majority of variables applied in the model with the exception to *Infrastructure* and *Education.* It is however not compatible with the other estimators. The coefficients estimated with the First Difference estimator have relatively high standard errors resulting in statistical insignificance. Similar inference is applied when considering the Fixed Effects estimator with only *Rural Population* coefficient being strongly statistically significant. In addition to that first glance factor, the general intuition behind coefficients' relationship to the dependent variable is not aligned. From this perspective the doubtfulness of the First Difference and the Fixed Effects estimators to produce relevant information can be assumed considering the model analyzed in the paper. With regards to the Random Effects estimator, although major coefficients are insignificant with the exception of weak statistical significance of *Business Environment* and *Rural Population,* the general expectations of coefficients' movements do correspond in the similar manner as the Pooled OLS.

The basic observation of the derived results suggests the Pooled OLS and Random Effects estimator to be the most appropriate among standard panel econometric estimators. The interesting finding from both methods is the not correspondence of *Globalization* to the assumption drawn from theoretical viewpoint. The positive coefficient sign in relation to physical currency contradicts to the predicted negative value. The scatter plot discussed earlier in Appendix D and the value from correlation matrix in the Table 5.7 illustrates the negative relationship between *Globalization* and currency in circulation. The issue may arise from the correlation among variables that leads to suppression of globalization by the stronger relation of other independent variables included in the model. Therefore globalization score has no additional power to explain currency in circulation in specified settings.

Nevertheless, the estimators allows to draw general overview of the dynamics of the variables. *Rural Population* and *Business Environment* being statistically significant in both appropriate estimators have the largest impact on physical cash. *Shadow Economy* resulted in almost similar coefficients and the rest variables follow the same sign dynamics.

In order to conclude the final inference regarding the standard panel data estimators, several tests are applied. The F-test allows to make a decision on more efficient estimator between Pooled OLS and Fixed Effects. From this perspective, the hypothesis on unobserved individual effects equality is tested, where the null hypothesis representing the equality and the alternate hypothesis inequality. The test results in the rejection of the null hypothesis, referring the Fixed Effects method producing more efficient estimator than Pooled OLS method. The outcome of the tests is therefore does not correspond with the general observations considered earlier, showing unanticipated results. The reasoning can be attributed to the inconstant individual effects across the countries. Taking into account more relevance of results from the Fixed Effect method, the impact of *Rural Population* on physical cash is the highest followed by *Globalization, Infrastructure, Business Environment,* and *Shadow Economy*. It is interestingly to note the negative sign of Globalization coefficient that is in line with the predictions.

Further, the Breusch-Pagan Lagrange multiplier test is conducted to decide between the Pooled OLS and Random Effects methods. The test allows to detect the effect of unobserved heterogeneity between the countries that is uncorrelated with the explanatory variables. Both estimators are efficient in case heterogeneity is not observed. The test results in rejection of null hypothesis due to the presence of unobserved heterogeneity, thus favoring the Random Effects method over Pooled OLS.

The Pooled OLS method appears to produce less efficient estimator among others, although resulting in major coefficients to be statistically significant. The Hausman test is employed to select between Fixed Effects and Random Effects by comparing estimator that is consistent regardless of the null hypothesis to be true or not and the other estimator that is only consistent when the null hypothesis is true. The test result lead to rejection of null hypothesis so that the Fixed Effects method to produce both consistent and efficient estimator. The tests output is available in the Table 5.12.

Table 5.12: Tests result

	F test for individual effect		Breusch-Pagan Lagrange Multiplier	Hausman test
			chisq	chisq
Tests statistics	41.743	41.743	521.09	16.044
DF	69	272	1	8
p value	2.2e-16	2.2e-16	2.2e-16	0.001279
Alternative hypothesis	significant effects	significant effects	significant effects	one model is inconsistent

The tests output concluded the Fixed Effects estimator to favor over the other panel data estimators considered. Nevertheless, number of factors derived from general examination of regression results such as coefficient dynamics, insignificance of most variables, and low overall fit leads to doubtfulness arise. The reasoning could be attributed to error term assumption. Under Fixed Effects the individual specific effects assume to correlate with independent variables, whereas under Random Effects method not. As such the conducted test may have been affected by the correlation between error and independent variables. The conclusive inference drawn from regressions output, test control, and general intuition prompts to acknowledge the Random Effects estimator to be the most appropriate to analyze the relationship among variables for the model examined in this paper. In order to reflect more on the data, dynamic model is further applied by introducing additional instruments.

The system GMM estimator introduced by Blundell and Bond is employed on the panel dataset to estimate the parameters of dynamic model. System GMM allows to account for correlation occurring in dynamic models between lagged dependent variable and unobserved panel effects. The issue may result in inconsistency when standard models are used. Furthermore, the system GMM estimator assumes to yield consistent, unbiased, and efficient estimator, considering possible endogeneity and heterogeneity. The Blundell and Bond's estimator is also suitable for panel dataset with few time period, which relates to our case with 5 periods. The ground base of the method is based on instrumenting lagged first differences, integrating level equation with first-difference equation into system.

The two step estimator is employed firstly followed by one step estimator. The two step estimator is assumed to be asymptotically efficient, however the issue of over identified instruments can arise with number of instrumented variables approaching to number of entities. The estimator will be therefore examined by Sargan test of over

identification of instruments. The explanatory variables used for the standard panel estimation methods are included in the model. Additionally, the first lags of the variables are added for the purpose to reveal if lags possess more explanatory power. As it was discussed previously, the system GMM is based on instrumenting lagged variables, however, in case explanatory variables are believed to be exogenous, instrumenting is not required. Nevertheless, strict exogeneity of variables in the model cannot be concluded with the assumed exception to *Interest Rate* and *Rural Population*. Thus lag is added to all the independent variables excluding these two. One lag is also applied to the dependent variable *M0*. Preliminary execution of the model with two lag of the dependent variable resulted in issues with autocorrelation and with this are not further considered for the estimation. The output of two step and one step system GMM are presented in Table 5.13.

Table 5.13: System GMM aggregate model

	Dependent variable	
	M0 Two step	M0 One step
l.M0	0.4745	0.3461
	(0.4095)	(0.2599)
l.BE	-0.2047	-0.2861*
	(0.1651)	(0.1667)
l.Gl	0.0374	0.0679
	(0.0868)	(0.0901)
l.SE	0.0309	0.0428
	(0.0412)	(0.0334)
l.EM	-0.0371	-0.0347
	(0.0241)	(0.0229)
l.INF	-0.0158	-0.0553
	(0.2563)	(0.2583)
IR	0.1808	0.0532
	(0.3467)	(0.3729)
RP	0.0602	0.1465
	(0.1630)	(0.1407)
l.Educ	0.0431	0.0478
	(0.0603)	(0.0635)
Const	0.0559	0.0933
	(0.4095)	(0.1066)
N	280	280
AR (1)	-1.6579*	-2.3967*

AR (2)	1.1785	1.5479
Sargan test	8.7813	33.3259
Wald test	149.231***	167.939

Note: The dependent variable is M0 in % of M1 over the five year period. The p-value is reported at 95% confidence level *p<0.05; **p<0.01; ***p<0.001. GMM standard errors in parentheses.

In order to examine the reliability of the results, two specification tests are employed, including Sargan test and autocorrelation. The first one checks on the instruments validity, and the second ensures the absence of the second order autocorrelation in residuals. The null hypothesis of Sargan test states the validity of the instruments and the p-value shall be over 0.05 to be able not to reject the hypothesis. The test output, show the p-value is larger than threshold value implying that Sargan is insignificant and the instruments in the model are valid. When it comes to interpreting the first (AR1) and second order (AR2) correlation, in order to meet estimator requirements, the AR1 should be insignificant, reversely, AR2 to be significant. In the context of specified conditions, the test output for both twostep and one step method satisfy the model.

The estimation output suggest that under Blundell and Bond's system GMM estimator the explanatory variables are not exercising statistically significant influence on the dependent variable. The only weakly significant independent variable from the estimation is *Business Environment*, which is evaluated with one step method. Regardless, the difference between both methods are not significant, resulting in alike outputs. The standard errors for two step method is slightly lower in contrast to the other as it was initially expected. The valuable conclusion that can be drawn from the estimation lies in corresponding dynamics of coefficients to our intuition and the results from the standard panel estimators deliberated earlier. Specifically, the *Business Environment, Electronic Money,* and *Shadow Economy* follow the expectations in signs with first two variables having negative relationship to currency in circulation and the last one with positive relationship. Furthermore, as it was identified in previous models, *Business Environment* impacts *M0* with the greatest extent. The issue with *Globalization* and *Education* yet remain with coefficients signs not aligning with general predictions.

Following the idea to compare several models the 2SLS is applied including the same panel dataset and variables. The exception concerns exclusion of lag of dependent variable *M0* as a regressor but remaining as an instrument instead. The

output is available in the Table 5.14. The general observation shows the method to produce statistically significant coefficients in contrast to the system GMM estimator examined earlier. The statement is even more vivid when second lag of *M0* is instrumented, adding the *BE* to become significant. On the other hand the estimations can be assumed to be slightly inflated when it comes to some variables. The results of Sargan test rejects null hypothesis concluding the validity of instruments used in the model. Hausman tests else rejects null hypothesis of OLS estimates consistency.

Table 5.14: 2SLS aggregate model

	Dependent variable	
	M0 (1)	M0 (2)
l.BE	-0.1812	-0.3725**
	(0.1971)	(0.1455)
l.Gl	0.1557**	0.1363**
	(0.0775)	(0.0675) **
l.SE	0.0691*	0.0666**
	(0.0394)	(0.0334)
l.EM	-0.1404***	-0.0568***
	(0.0361)	(0.0198)
l.INF	-0.4526*	-0.2622
	(0.2478)	(0.1752)
IR	0.5825**	0.5128**
	(0.2399)	(0.2219)
RP	0.3308***	0.3018***
	(0.1023)	(0.0857)
l.Educ	0.2079**	0.1012
	(0.0888)	(0.0664)
Const	0.1512	0.1799*
	(0.1307)	(0.1028)
Observations	280	348
R^2	0.3005	0.2946
Adjusted R^2	0.2798	0.2779
Sargan test	224.045	168.916
Hausman	10.059	

The subsequent action would be addressed to examine each category in a separate manner. The step is motivated to accurately form the final inference by collaborating the outcome analyses together. It is additionally valuable to reflect on each hypothesis later on. The estimation method and variables stay the same with only

excluding variables representing other dimensions. For the purpose to retrieve even more comprehensive outlook, the dimension itself would be considered as dependent variable. As a first step, *Business Environment* is studied. The results of the estimation are found below in Table 5.15.

Table 5.15: System GMM BE model

	Dependent variable	
	M0 Two step	BE Two step
l.M0	0.5217	-0.0288**
	(0.4074)	(0.0140)
l.BE	-0.2163	-0.7375***
	(0.1632)	(0.0714)
l.EM	-0.0352	0.0127**
	(0.0645)	(0.0229)
l.INF	-0.0084	0.0576
	(0.2338)	(0.0592)
IR	0.1762	-0.1263**
	(0.3152)	(0.0500)
RP	0.0503	-0.0747**
	(0.1495)	(0.0318)
l.Educ	0.0393	-0.0016
	(0.0645)	(0.0153)
Const	-0.0083	-0.0016**
	(0.0739)	(0.0246)
N	280	280
AR (1)	-1.6953*	-2.7638***
AR (2)	1.1786	-0.6163
Sargan test	8.8654	20.4239
Wald test	139.118***	2157.61

Note: The p-value is reported at 95% confidence level *p<0.05; **p<0.01; ***p<0.001. GMM standard errors in parentheses.

The estimation concentrated on *Business Environment (BE)* revealed interesting results. The model with currency in circulation as dependent variable remained to have statistically insignificant explanatory variables with generally similar characteristics. From this perspective it can be concluded that other two dimensions are not closely associated with *BE*. On the other hand, the output of the second model with *BE* regarded as dependent variable, has majority statistically significant influence. Although variables such as *Interest Rate* and *Rural Population* have larger impact on

BE, with regard of the research to be particularly focused on cashless trend impact, the main interest is concerned with currency in circulation *M0* and *Electronic Money*. The coefficients of these two variables go along with the expectations. The models are further tested to check the validity of the results by employing Sargan test and autocorrelation tests. The requirements of the system GMM estimator is satisfied with Saragan and AR(2) tests to be statistically insignificant and AR(1) test statistically significant proving the validity and the consistency of the estimator.

The general picture can be therefore formed based on the overall overview of the estimators employed in the study. The *BE* coefficients derived in number of ways yield to analogous values, differencing only slightly between each other. The most significant estimate provided by the 2SLS method and the smallest standard error by Random Effects. Nevertheless, assuming the properties and validity of each estimator, value computed by system GMM appear to be viewed as the most appropriate to interpret for the final inference. Deliberating over that we can state the relationship between *BE* and *M0* to be negative confirmed by several estimators. As such, it can be further formulated that increase in *Business Environment* score leads to decrease in *Currency in circulation M0.* The dimension concluded to delineate the greatest impact on the dependent variable in comparison to the rest. The reverse study of the influencers on *BE* additionally contributed to the reflection on the topic. The *M0* and *Electronic Money* yielded to statistically significant coefficients. The inference is described as increase in *Electronic Money* solutions improve *Business Environment*, and vice versa increase in physical currency *M0* decrease *BE* score. Following final conclusions, we do not reject the first hypothesis that alternative methods of payments impact to a healthier business environment.

Table 5.16: System GMM Gl model

	Dependent variable	
	M0 Two step	Gl Two step
l.M0	0.3429*	-0.0053
	(0.1771)	(0.0041)
l.Gl	-0.0263	0.9901***
	(0.0835)	(0.0135)
l.EM	-0.0538***	0.0004
	(0.0172)	(0.0017)
l.INF	-0.1415	0.0089
	(0.2717)	(0.0136)
IR	0.3891*	-0.0423**
	(0.2293)	(0.0203)

RP	0.1980	-0.0025
	(0.1326)	(0.0080)
l.Educ	0.0803	0.0019
	(0.0494)	(0.0060)***
Const	0.0717	0.0131**
	(0.0847)	(0.0482)
N	280	280
AR (1)	-2.0826*	-2.7638***
AR (2)	1.12984	-0.6163
Sargan test	7.2832	20.4239
Wald test	100.953***	2157.61***

Note: The p-value is reported at 95% confidence level *p<0.05; **p<0.01; ***p<0.001. GMM standard errors in parentheses.

The output of the following models with the focus on the *Globalization (Gl)* identified the presence of the issue in relation to other variables. The coefficient sign change from original aggregate model with all dimensions included can be observed. The analysis of the aggregate model noted the *Gl* estimation result to contradict with predicted expectation and general intuition. As such, it can be viewed more appropriate to consider the dimension in a separate estimation. The additional tests of the model revealed no issues related to autocorrelation and validity of the instruments. When it comes to the interpretation of the results that can be found in Table 5.16, we observe statistically negative relationship between *M0* and *Gl* in both models. The model with *Gl* as dependent variable reveals the impact of the *M0* and *Electronic Money* to *Gl* with the first one having larger impact yet both having insignificant coefficients. The strongest statistically significance is observed for *Education*.

The challenge arises to form final conclusion on the *Globalization* score. Apparently the variable is sensitive to another dimensions included, however, the review of the correlation matrix and the collinearity test have not detected any issue. As assumed earlier, we can suppose that the variable is suppressed by the strongest relation of other dimensions'. The separate estimation is therefore the most related among others for the final interpretation. From this perspective, the *Gl* coefficient proves the negative relationship assumed in formulating the hypothesis, however, in contrast to other dimensions with the least impact. The increase of *Globalization* score leads to decrease in *Currency in circulation M0.* Similarly, increase in *Electronic Money* solutions improves *Globalization* score, and oppositely increase in *M0* decreases it. Nonetheless, the final inference for the variable requires to be considered with a great care, since number of factors appearing such as its sensitivity resulting in

varying results, insignificant coefficients in separate model, and unstable sings. It is safer to assume the reliance of the estimation output to be viewed as questionable and leave as subject for further research.

Table 5.17: System GMM SE model

Dependent variable		
	M0 Two step	SE Two step
l.M0	0.3207*	0.0660**
	(0.1879)	(0.0309)
l.SE	0.0702**	0.3747
	(0.0298)	(0.2745)
l.EM	-0.0443***	-0.0157*
	(0.0154)	0.0090
l.INF	-0.1316	-0.3953***
	(0.2478)	(0.1213)
IR	0.3471	0.0523
	(0.2330)	(0.0534)
RP	0.1507	0.0005
	(0.1307)	(0.7320)
l.Educ	0.0824	-0.0030
	(0.0516)	(0.0228)
Const	0.1873	-0.0040
	(0.1046)	(0.0039)
N	280	210
AR (1)	-2.0949*	0.3319*
AR (2)	1.12765	-1.1264
Sargan test	7.6524	7.3991
Wald test	153.392***	31.7495***

Note: The p-value is reported at 95% confidence level *p<0.05; **p<0.01; ***p<0.001. GMM standard errors in parentheses.

The separate examination of *Shadow Economy (SE)* presented better results in relation to the system GMM estimator having statistically significant *SE* in the model with *M0* as dependent variable. Furthermore, the model where *SE* viewed as explained variable proved the impact of *M0* and *Electronic Money* with statistically significant coefficients. The strongest impact in the model is presented by *Infrastructure*. The additional Sargan and first and second order autocorrelation tests of the model revealed no issues related to autocorrelation and validity of the instruments.

The estimates for *Shadow Economy* yielded to relatively similar values. The most significant coefficient derived by the 2SLS estimator, and standard errors not varying as much. Similarly to the approach assumed in the reflection on *Business Environment* analysis, the system GMM method is the most suitable for further consideration. With the corresponding outputs from different estimators it is yet straightforward to draw a conclusion on the final interpretation. The positive impact of *SE* on *M0* is observed in all employed estimators, so that increase in *Shadow Economy* increases the *Currency in circulation M0.* Accordingly, the results of next model suggests the increase in *Electronic Money* solutions decreasing in *Shadow Economy,* and *Currency in circulation M0* contrary increasing *SE.* The formatted inference can be used to prove second hypothesis of higher cash demand in countries with higher level of shadow economy.

6 Conclusion

The societies have been in a constant vigorous search of efficient payment mechanisms altering transformation from barter trading, first coins and banknotes, to checks and recent electronic payments. The financial markets currently confront with considerable disruptions affecting stakeholders at different scales with digital transactions offered by both conventional and unconventional institutes providing relatively efficient and transparent instruments.

The present study aims to deliberate over a wider perspective on the topic of physical currency. The academic literature and other related previous researches largely concentrated the focus on economic growth strictly or examined other relationships for certain regions and nations. Taking into account the global transformation to the electronic method of payments alters number of aspects, the thesis therefore contributes by analyzing factors as business environment, globalization, and shadow economy in relation to currency in circulation in a global perspective. This enables to analyze the topic in more extensive manner.

The first part of the paper overviews the historical evolution of payment systems and provides description of the current organization in electronic systems. Further, the process of transition to cashless society is discussed with identifying transformation stages and the barriers faced to undertake the shift. The inference on the considered information along with literature review allowed to formulate the hypotheses which are tested and analyzed in later sections. For the purpose to form global viewpoint, the annual panel data is used for the period from 2013 to 2017, covering 70 countries to represent diverse regions and incomes. Additionally, we formed transformation score ranking for the last five years to allow for comprehensive picture on the transit among countries included in research with Singapore and Nordic countries maintaining leading positions.

The econometrical analysis of both static and dynamic panel data estimated by standard panel estimation methods and the Blundell-Bond system GMM technique accordingly, resulted in alike outputs with the second estimator preferred for the formulation of the final inference. The estimation results imply the confirmation of the first and second presented hypotheses, therefore proving *Business Environment* and physical *Currency in Circulation M0* to have negative relationship and contrary *Shadow Economy* and *Currency in Circulation M0* to have positive relationship.

Regression estimates for the formulation of the third hypothesis related to *Globalization* produced mixed results that appeared to be unreliable for forming inference leaving the issue to be a subject of future studies.

When it comes to constructing general outlook in a larger perspective, we can observe *Business Environment* impacting the *M0* with a greater extent among other variables used in the models. From this view, it can be implied that promotion of *Electronic Money* solutions solely is not sufficient to undertake transition to a cashless economy. The theoretical part of the paper deliberates over the topic of transitioning stages and its barriers, where regulatory ecosystem and financial infrastructure are recognized as both challenge and major prerequisite to undertake a shift for the next stage. The aspects are mainly concern emerging and developing economies that generally on the staring stage of cashless journey. On the other hand these two aspects are essential to promote trust and security of the financial system that identified in paper as a major concern for developed countries to shift to the advanced stage of cashless society. The conservatism and reluctance to shift at developed stages mentioned earlier in the paper is concerned with individuals' choice as generally the essential infrastructure is present in the economy and can be thus associated with those individuals to persist lack of trust in security of available system. The issue can be therefore examined in detail in further researches. The regulatory and procedural framework, competitiveness, and financial infrastructure are necessary not only introducing alternative methods of payment, but further active usage of it by individuals in the economy.

The policy implication should therefore account the implementation or advancement of legal and procedural framework in order to assure trust, security, and stability in market to enable the promotion of electronic money ecosystem that could deliver reliable digital experience to individuals. In turn, the active daily usage of electronic system can lead to larger extent conversion to progress the transition to cashless society. As such, among straightforward benefits of efficiency and transparency, the issue of shadow economy can be improved as it is found in the paper. We believe the cashless society is inevitable future for some economies and accepted present in others and therefore needs to be considered with due attention and care with further investigations to be undertaken in the field.

Bibliography

Alm, J., Embaye, A., (2013). "Using Dynamic Panel Methods to Estimate Shadow Economies Around the World." Working Papers.

Abrazhevich, D. (2004): "Electronic payment systems: a user-centered perspective and interaction design." ISBN 978-90-386-1948-4

Adepoju, U. (2017): "Ease of Doing Business and Economic Growth."

Aker, J., Boumnijel, R., McClelland, A., Tierney, N. (2013): "How do Electronic Transfers Compare? Evidence from a Mobile Money Cash Transfer Experiment in Niger."

Alm, J., Embaye, A., (2013). "Using Dynamic Panel Methods to Estimate Shadow Economies Around the World. Working Papers."

Anderson, T.W., Hsiao, C. (1981): "Estimation of Dynamic Models with Error Components." Journal of the American Statistical Association 76 (375). ISSN 01621459. DOI 10.2307/2287517

Arellano, M., Bond, S. (1991): "Some Tests of Specification for Panel Data: Monte Carlo Evidence and an Application to Employment Equations". Review of Economic Studies 58 (2): pp. 277–297.

Bank for International Settlements (2003): "A glossary of terms used in payments and settlement systems."

Barnes, S.J., Corbitt, B.J., Profile, S., Barnes, S.J., Corbitt, B. (2003): "Mobile banking: Concept and potential." International Journal of Mobile Communications pp. 273–288.

Batiz-Lazo, B., Del Angel, G.A. (2018): "The Ascent of Plastic Money: International Adoption of the Bank Credit Card." 1950-1975. BUSINESS HISTORY REVIEW 92 (3): pp. 509–533. ISSN 00076805. DOI 10.1017/S0007680518000752

Bech, M., Faruqui, U., Ougaard, F., Picillo, C. (2018): "Payments are a-changin' but cash still rules."

Better Than Cash Alliance (2017a): "How Digitizing Agricultural Input Payments in Rural Kenya Is Tackling Poverty: The Case of One Acre Fund."

Better Than Cash Alliance (2017b): "Digitizing Wage Payments in Bangladesh's Garment Production Sector."

BFA & Better Than Cash Alliance (2015): "The Journey Towards "Cash Lite."

Blundell, R., Bond, S., (1998). "Initial conditions and moment restrictions in dynamic panel data models." Journal of Econometrics 1(87): pp. 115–143.

Bodas, D., Garcia, J.R., Murillo, J., Pacce, M., Rodrigo, T., Romero, J., Ruiz, P., 2018. Measuring Retail Trade Using Card Transactional Data. BBVA Bank, Economic Research Department. Working Papers 18/03.

Bold, C., Porteous, D., Rotman, S. (2012): "Social Cash Transfers and Financial Inclusion: Evidence from Four Countries." CGAP.

Boston Consulting Group (2016): "Digital Payments 2020."

Bounie, D., Francois, A., Waelbroeck, P., (2016). "Debit card and demand for cash."

Cagan, P., (1958). "The Demand for Currency Relative to the Total Money Supply." Journal of Political Economy 66(4): pp. 303-328.

Calvino, F., Criscuolo, C., Menon, C. (2016): "No Country for Young Firms?" OECD library.
Capgemini, BNP Paribas (2018): "World Payments Report 2018."
Caselli, F., Esquivel, G., Lefort, F. (1996): "Reopening the Convergence Debate: A New Look at Cross-Country Growth Empirics." Journal of Economic Growth 1(3): pp 363–389.
Cavallo, A. (2018): "Are Online and Offline Prices Similar? Evidence from Large Multi-Channel Retailers". American Economic Review 107(1): pp. 283–303.
Chakravorti, B., Chaturvedi, R.S. (2017): "Digital planet 2017. How competitiveness and trust in digital economies vary across the world." The Fletcher School.
Citibank (2015): "Digital money A pathway to an Experience Economy."
Consumer Financial Protection Bereau (2017): "The Consumer Credit Card Market Study, 2017."
Crafts, N. (2006): "Regulation and Productivity Performance." Oxford Review of Economic Policy 22(2): pp. 186–202. ISSN 0266-903X. DOI 10.1093/oxrep/grj012
David H., McGrew A. (1998): "The End of the Old Older? Globalization and the Prospects for World Order." Review of International Studies 219. ISSN 02602105.
Davies, G. (2005): "History of Money.: University of Wales Press.
Deloitte (2013): "The economic impact of online payments: Breaking barriers across Europe."
Demirgüç-Kunt, A. (2018): "The Global Findex database 2017: measuring financial inclusion and the fintech revolution." World Bank. ISBN 978-1-4648-1268-2.
Digital Commerce (2018). Global e-commerce sales grow in 2018.
Duryea, S., Schargrodsky, E. (2008): "Financial Services for the Poor: Savings, Consumption, and Welfare."
Early Warning Services (2018): "Digital Payments Adoption."
Ecommerce Europe (2018): "The European Ecommerce Report 2018."
European Central Bank (2010): "The Payment System: Payments, securities and derivatives, and the role of the Eurosystem." ISBN 978-92-899-0633-3.
Eurostat (2018): "Handbook on the compilation of statistics on illegal economic activities in national accounts and balance of payments." ISBN 978-92-79-76448-6.
EY (2016): "Reducing the Shadow Economy through Electronic Payments."
Faz, X., Moser, T. (2013): "Advancing Financial Inclusion through Use of Market Archetypes." Research Policy 37(9): pp. 1417-1435. ISSN 0048-7333. DOI 10.1016/j.respol.2008.06.003.
Forrester Consulting (2017): "The Intersection Of Payments And Commerce In A Digital World."
Freund, C., Bolaky, B. (2008): "Trade, regulations, and income." Journal of Development Economics 87(2): pp. 309–321. ISSN 0304-3878. DOI 10.1016/j.jdeveco.2007.11.003.
Giessmann, S. (2018): "Money, Credit, and Digital Payment 1971 - 2014: From the Credit Card to Apple Pay." ADMINISTRATION & SOCIETY 50(9): pp. 1259–1279. ISSN 00953997. DOI 10.1177/0095399718794169.
Global System for Mobile Communications (2018): "The Mobile Economy 2018."
Greene, W.H., (2012): "Econometric analysis". Prentice Hall. 7th ed pp. 383-472. ISBN 978-0-13-139538-1.

Gygli, S., Haelg, F., Potrafke, N., Sturm, J.-E. (2019): "The KOF Globalisation Index – revisited." The Review of International Organizations pp. 1-32. ISSN 1559-7431, 1559-744X. DOI 10.1007/s11558-019-09344-2.

Hasan, I., De Renzis T., Schmiedel, H. (2013): "Retail Payments and the Real Economy." European Central Bank. ISSN 1725-2806.

Higgins, S. (2012): "The Impact of Bolsa Família on Poverty: Does Brazil's Conditional Cash Transfer Program Have a Rural Bias?" 23(1): pp. 88–125. DOI 10.7916/D8B27S8K

Hock-Han Tee, Hway-Boon Ong (2016): "Cashless payment and economic growth." Financial Innovation 2(1).

Humphrey, D.B., Kim, M., Vale, B. (2001): "Realizing the Gains from Electronic Payments: Costs, Pricing, and Payment Choice." Journal of Money, Credit and Banking 33(2): pp. 216–234.ISSN 0022-2879. DOI 10.2307/2673882.

International Trade Centre (2016): "Bringing SMEs onto the E-commerce Highway."

Jevons, W.S. (1883): "Money and the mechanism of exchange." Pacific Coast Numismatic Society. Humboldt Publishing Company.

Kaufmann, D., Kraay, A., Mastruzzi, M. (2010): "The Worldwide Governance Indicators: Methodology and Analytical Issues." Social Science Research Network. ID 1682130.

Kearney, A.T., Visa Inc. (2018): "Digital Payments and the Global Informal Economy."

Khan, J., Craig-Lees, M., (2009). "Cashless transactions: perceptions of money in mobile payments."

Kilbourne, W.E. (2002): "What is Globalization?" Journal of Macromarketing 22(2): pp. 182–184. ISSN 0276-1467. DOI 10.1177/0276146702238221.

Kim, C., Tao, W., Shin, N., Kim, K.-S. (2010): "An empirical study of customers' perceptions of security and trust in e-payment systems." Electronic Commerce Research and Applications 9(1): pp. 84–95. ISSN 1567-4223. DOI 10.1016/j.elerap.2009.04.014.

Klapper, L., Singer, D. (2017): "The opportunities and challenges of digitizing government - to - person payments." World Bank Research Observer 32(2): pp. 211–226. ISSN 15646971. DOI 10.1093/wbro/lkx003.

KPMG (2017): "2017 Global Online Consumer Report".

Laudon, K., Traver, C.G. (2014): "E-Commerce: Business, Technology, Society" 10th ed.

Mac Géidigh, D., Schneider, F., Blum, M. (2016): "Grey Matters: Charting the Development of the Shadow Economy." Social Science Research Network.

MasterCard (2017): "Masterindex 2017. Pan-European e-commerce and new payment trends."

Moody's Analytics (2016): "The Impact of Electronic Payments on Economic Growth."

Muralidharan, K., Niehaus, P., Sukhtankar, S. (2014): "Payments Infrastructure and the Performance of Public Programs: Evidence from Biometric Smartcards in India." NBER Working Papers 2. ISSN 08982937.

Nielsen (2016): "Global Connected Commerce Survey."

Oney, E., Guven, G.O., Rizvi, W.H. (2017): "The determinants of electronic payment systems usage from consumers' perspective." Economic Research-Ekonomska Istraživanja 30(1): pp. 394–415. ISSN 1331-677X. DOI 10.1080/1331677X.2017.1305791.

Oyewole, O., Gambo, J., Abba, M., Onuh, M. (2013): "Electronic Payment System and Economic Growth: A Review of Transition to Cashless Economy in Nigeria."

Paul, A., Friday, O. (2012): "Nigeria' s Cashless Economy: The Imperatives." International Journal of Managing Business Studies 2 pp. 31–36.

Prina, S. (2015): "Banking the poor via savings accounts: Evidence from a field experiment." Journal of Development Economics 115 pp. 16–31. ISSN 0304-3878. DOI 10.1016/j.jdeveco.2015.01.004.

Raj, K.D., (2017). "Impact of credit cards and debit cards on currency demand and seigniorage: Evidence from India."

Rao, B., Tamazian, A., Singh, P. (2009): "Demand for Money in the Asian Countries: A Systems GMM Panel Data Approach and Structural Breaks." MPRA Paper 15030. University Library of Munich.

Riksbank (2018): "First banknotes in Europe."

Rinaldi, L., (2001). "Payment Cards and Money Demand in Belgium." International Economics Working Papers Series.

Roodman, D., (2009): "How to do xtabond2: An introduction to difference and system GMM in Stata." Stata Journal 9(1): pp. 86-136.

Samimi, P., Lim, G.C., Buang, A.A. (2011): "Globalization Measurement: Notes on Common Globalization Indexes." Journal of Knowledge Management, Economics and Information Technology 1(7). ISSN 2069-5934.

Schneider, F., Enste, D. (2002): "Hiding in the Shadows: The Growth of the Underground Economy." Economic Issues, International Monetary Fund. ISBN 978-1-58906-096-8.

Seth, R. (2017): "Development of Academic Thought on Cashless Transactions." Journal of Alternative Perspectives in the Social Sciences 8(3): pp. 371–382. ISSN 19441088.

Snellman, H., Viren, M. (2007): "ATM Networks and Cash Usage." Social Science Research Network ID 1018389.

Soman, D., (2001). "Effects of Payment Mechanism on Spending Behavior: The Role of Rehearsal and Immediacy of Payments." Journal of Consumer Research 27(4): pp.460-474. DOI 10.1086/319621.

Stix, H. (2004): "How Do Debit Cards Affect Cash Demand? Survey Data Evidence." Empirica 31 (2-3): pp. 93–115. ISSN 0340-8744, 1573-6911. DOI 10.1007/s10663-004-1079-y.

Suri, T., Jack, W. (2016): "The long-run poverty and gender impacts of mobile money." Science 354(6317): pp. 1288–1292. ISSN 0036-8075, 1095-9203. DOI 10.1126/science.aah5309.

Tanzi, V., (1980). "The Underground Economy in the United States: Annual Estimates, 1930-80." Staff Papers (International Monetary Fund) 30(2): pp. 283-305. DOI 10.2307/3867001.

The Nilson Report (2018): "Card and Mobile Payment Industry Statistics." The Nilson Report Archive of Charts & Graphs.

Thiessen, U. (2010): "The Shadow Economy in International Comparison: Options for Economic Policy Derived from an OECD Panel Analysis." Social Science Research Network ID 1641039.

Thomas, H. (2013): "Measuring Progress Towards a Cashless Society." MasterCard.

Treasury Alliance Group (2018): "Fundamentals of Global Payment Systems and Practices."

Tsiakis, T., Sthephanides, G. (2005): "The concept of security and trust in electronic payments." Computers & Security 24 pp. 10–15. ISSN 0167-4048. DOI 10.1016/j.cose.2004.11.001.

U.S. Department of Treasury (2018): "Electronic Check Processing".

Valente, T.W., Rogers, E.M. (1995): "The Origins and Development of the Diffusion of Innovations Paradigm as an Example of Scientific Growth." Science Communication 16(3): pp. 242–273. ISSN 1075-5470. DOI 10.1177/1075547095016003002.

Venkatesh, V., Morris, M.G., Davis, G.B., Davis, F.D. (2003): "User acceptance of information technology: Toward a unified view." MIS Quarterly: Management Information Systems 27(3): pp. 425–478. ISSN 0276-7783.

Viren, M., (1992). "Financial Innovations and Currency Demand: Some New Evidence." Empirical Economics 17: pp. 451-461. DOI 10.1007/BF01205390

Virén, M., 1992. Financial innovations and currency demand: Some new evidence. Empirical Economics 17, 451–461. https://doi.org/10.1007/BF01205390

Waters, M., (2001): "Globalization." 2nd ed. Routledge, London. ISBN 978-0-415-23853-3 978-0-415-23854-0.

Wooldridge, J.M., 2002. "Econometric analysis of cross section and panel data." MIT Press, pp. 247-291. ISBN 978-0-262-23219-7.

World Bank (2010): "Safety Nets How to Make Payments: key program processes."

World Economic Forum (2018): "Addressing E-Payment Challenges in Global E-Commerce."

Yilmazkuday, H., Yazgan, M.E., (2009). "Effects of credit and debit cards on the currency demand." Applied Economics 41(17): pp. 2115-2123. DOI:10.1080/00036840701222496.

Appendix A: List of countries analyzed

Albania	Estonia	Lithuania	Slovenia
Argentina	Finland	Luxembourg	South Africa
Armenia	France	Malaysia	Spain
Australia	Georgia	Mexico	Sri Lanka
Austria	Germany	Mongolia	Sweden
Azerbaijan	Greece	Netherlands	Switzerland
Bangladesh	Hungary	Nigeria	Thailand
Belgium	India	Norway	Tunisia
Brazil	Indonesia	Pakistan	Turkey
Bulgaria	Ireland	Peru	United Arab Emirates
Canada	Israel	Philippines	United Kingdom
Chile	Italy	Poland	United States
China	Japan	Portugal	Uruguay
Croatia	Kazakhstan	Romania	Vietnam
Czech Republic	Kenya	Russian	Zambia
Denmark	Korea, Rep.	Saudi Arabia	Zimbabwe
Dominican	Latvia	Serbia	
Egypt, Arab	Lebanon	Singapore	

Appendix B: Transformation score indicators

Pillar	*Sub-pillar*	*Indicator*	*Source*
Government support	Competitiveness	Intensity of local competition, 1-7 (best) Value	GCR, WEF
Government support	Competitiveness	Effectiveness of anti-monopoly policy, 1-7 (best) Value	GCR, WEF
Government support	Competitiveness	Extent of market dominance, 1-7 (best) Value	GCR, WEF
Government support	Competitiveness	Imports as a percentage of GDP Value	GCR, WEF
Government support	Business environment	Effect of taxation on incentives to invest, 1-7 (best) Value	GCR, WEF
Government support	Business environment	No. days to start a business Value	EDBI
Government support	Business environment	No. procedures to start a business Value	EDBI
Government support	Innovation environment	Venture capital availability, 1-7 (best) Value	GCR, WEF
Government support	Innovation environment	State of cluster development, 1-7 (best) Value	GCR, WEF
Government support	Innovation environment	Gov't procurement of advanced tech products, 1-7 (best) Value	GCR, WEF
Government support	Legal environment	Intellectual property protection, 1-7 (best) Value	GCR, WEF
Government support	Legal environment	Property rights, 1-7 (best) Value	GCR, WEF
Government support	Legal environment	Efficiency of legal framework in settling disputes, 1-7 (best)	GCR, WEF
Government support	Legal environment	Efficiency of legal framework in challenging regs., 1-7 (best)	GCR, WEF
Government support	Legal environment	Burden of government regulation, 1-7 (best) Value	GCR, WEF

Financial/ Tech infrastructure	Financial market	Ease of access to loans, 1-7 (best) Value	GCR, WEF
Financial/ Tech infrastructure	Financial market	Soundness of banks, 1-7 (best) Value	GCR, WEF
Financial/ Tech infrastructure	ICT infrastructure	Availability of latest technologies, 1-7 (best) Value	GCR, WEF
Financial/ Tech infrastructure	ICT infrastructure	Individuals using Internet, %* Value	GCR, WEF
Financial/ Tech infrastructure	ICT infrastructure	Mobile broadband subscriptions/100 pop. Value	GCR, WEF
Financial/ Tech infrastructure	ICT infrastructure	Fixed broadband Internet subscriptions/100 pop. Value	GCR, WEF
Financial/ Tech infrastructure	ICT infrastructure	Quality of electricity supply, 1-7 (best) Value	GCR, WEF
Financial/ Tech infrastructure	ICT infrastructure	Impact of ICTs on access to basic services, 1-7 (best)	GITR, WEF
Financial/ Tech infrastructure	ICT infrastructure	Households w/ personal computer, % Value	GITR, WEF
Financial/ Tech infrastructure	ICT infrastructure	Households w/ Internet access, %	GCR, WEF
Financial/ Tech infrastructure	ICT infrastructure	Importance of ICTs to gov't vision, 1-7 (best) Value	GITR, WEF
Financial/ Tech infrastructure	ICT infrastructure	Government Online Service Index, 0–1 (best) Value	GITR, WEF
Financial/ Tech infrastructure	ICT infrastructure	Mobile network coverage, % pop. Value	GITR, WEF
Financial/ Tech infrastructure	ICT infrastructure	Prepaid mobile cellular tariffs, PPP USD /min. Value	GITR, WEF
Electronic money solutions	General usage	Account (% age 15+)	Findex, World
Electronic money solutions	General usage	Debit card ownership (% age 15+)	Findex, World
Electronic money solutions	General usage	Credit card ownership (% age 15+)	Findex, World
Electronic money solutions	General usage	Made or received digital payments in the past year (% age	Findex, World

Electronic money solutions	General usage	Mobile money account (% age 15+)	Findex, World
Electronic money solutions	General usage	Received government payments: into a financial institution	Findex, World
Electronic money solutions	General usage	Used a mobile phone or the internet to access a financial	Findex, World
Electronic money solutions	General usage	Used a debit or credit card to make a purchase in the past year	Findex, World
Electronic money solutions	General usage	Debit card used to make a purchase in the past year (% age	Findex, World
Electronic money solutions	General usage	Received wages: into a financial institution account (% age 15+)	Findex, World
Electronic money solutions	General usage	Paid utility bills: using a financial institution account (% age 15+)	Findex, World
Electronic money solutions	General usage	Paid utility bills: using a mobile phone (% age 15+)	Findex, World
Electronic money solutions	General usage	Sent or received domestic remittances: through a financial	Findex, World
Electronic money solutions	General usage	Sent or received domestic remittances: through a mobile	Findex, World
Electronic money solutions	General usage	Sent or received domestic remittances: through a money	Findex, World
Electronic money solutions	General usage	Saved at a financial institution (% age 15+)	Findex, World
Electronic money solutions	General usage	Paid online for internet purchase (% internet purchasers, age 15+)	Findex, World
Electronic money solutions	General usage	Used the internet to buy something online in the past	Findex, World
Electronic money solutions	General usage	Used the internet to pay bills in the past year (% age 15+)	Findex, World
Electronic money solutions	Acess Points	Number of ATMs	IMF
Electronic money solutions	Acess Points	Number of POS terminals	GPSS, World
Electronic money solutions	Acess Points	Total number of branches of PSPs	GPSS, World

Electronic money solutions	Accounts	Number of deposit transaction accounts	GPSS, World
Electronic money solutions	Accounts	Number of debit cards in circulation	GPSS, World
Electronic money solutions	Accounts	Number of credit cards in circulation	GPSS, World
Electronic money solutions	Accounts	Number of e-money accounts	GPSS, World
Social capital	Human Capital	Tertiary education enrollment, gross % Value	World Bank
Social capital	Human Capital	Quality of the education system, 1-7 (best) Value	World Bank
Social capital	Human Capital	Secondary education enrollment, gross % Value	World Bank
Social capital	Social relationships	Public trust in politicians, 1-7 (best) Value	GCR, WEF
Social capital	Social relationships	Ethical behavior of firms, 1-7 (best) Value	GCR, WEF
Social capital	Social relationships	Transparency of government policymaking, 1-7 (best) Value	GCR, WEF

GCR, WEF: The Global Competitiveness Report, World Economic Forum

GITR, WEF: The Global Information Technology Report, World Economic Forum

WDI: World Development Indicators, World Bank Data

Findex: Global Financial Inclusion Database, World Bank

DB: Doing Business Index, World Bank

GPSS: Global Payment Systems Survey, World Bank

Appendix C: Transformation score ranking

Economy	*2017*	*Rank Δ*	*2016*	*Rank Δ*	*2015*	*Rank Δ*	*2014*	*Rank Δ*	*2013*	*Rank Δ 13-17*
Albania	53	*2*	55	*5*	60	*2*	62	*-1*	61	*8*
Argentina	56	*0*	56	*1*	57	*6*	63	*2*	65	*9*
Armenia	47	*4*	51	*4*	55	*3*	58	*-4*	54	*7*
Australia	5	*2*	7	*2*	9	*2*	11	*1*	12	*7*
Austria	18	*-1*	17	*3*	20	*1*	21	*-6*	15	*-3*
Azerbaijan	40	*5*	45	*6*	51	*4*	55	*-2*	53	*13*
Bangladesh	67	*1*	68	*0*	68	*1*	69	*-1*	68	*1*
Belgium	17	*-1*	16	*1*	17	*-7*	10	*-1*	9	*-8*
Brazil	48	*0*	48	*-4*	44	*3*	47	*1*	48	*0*
Bulgaria	45	*-4*	41	*1*	42	*2*	44	*0*	44	*-1*
Canada	6	*-3*	3	*4*	7	*-1*	6	*-2*	4	*-2*
Chile	32	*-3*	29	*0*	29	*1*	30	*4*	34	*2*
China	34	*0*	34	*4*	38	*-1*	37	*6*	43	*9*
Croatia	36	*0*	36	*-3*	33	*-1*	32	*-1*	31	*-5*
Czech	27	*4*	31	*1*	32	*1*	33	*-11*	22	*-5*
Denmark	8	*4*	12	*1*	13	*-1*	12	*-7*	5	*-3*
Dominican	58	*2*	60	*4*	64	*0*	64	*-7*	57	*-1*
Egypt, Arab	64	*1*	65	*1*	66	*0*	66	*-7*	59	*-5*
Estonia	16	*2*	18	*0*	18	*1*	19	*-6*	13	*-3*
Finland	2	*0*	2	*0*	2	*0*	2	*-1*	1	*-1*
France	19	*0*	19	*0*	19	*-1*	18	*-4*	14	*-5*
Georgia	41	*5*	46	*4*	50	*4*	54	*-13*	41	*0*
Germany	13	*2*	15	*0*	15	*1*	16	*-6*	10	*-3*
Greece	38	*0*	38	*2*	40	*2*	42	*-6*	36	*-2*
Hungary	39	*1*	40	*1*	41	*-2*	39	*-7*	32	*-7*
India	55	*3*	58	*1*	59	*-7*	52	*-2*	50	*-5*

Indonesia	59	*-7*	52	*1*	53	*3*	56	*6*	62	*3*
Ireland	15	*-1*	14	*2*	16	*1*	17	*-1*	16	*1*
Israel	21	*0*	21	*3*	24	*0*	24	*1*	25	*4*
Italy	30	*3*	33	*1*	34	*0*	34	*5*	39	*9*
Japan	10	*1*	11	*1*	12	*2*	14	*6*	20	*10*
Kazakhstan	42	*2*	44	*4*	48	*-5*	43	*-6*	37	*-5*
Kenya	57	*-3*	54	*2*	56	*-3*	53	*2*	55	*-2*
Korea, Rep.	22	*0*	22	*-1*	21	*-1*	20	*-3*	17	*-5*
Latvia	28	*0*	28	*0*	28	*-2*	26	*-2*	24	*-4*
Lebanon	54	*5*	59	*-1*	58	*-8*	50	*-1*	49	*-5*
Lithuania	31	*1*	32	*4*	36	*-7*	29	*-2*	27	*-4*
Luxembourg	4	*4*	8	*3*	11	*-6*	5	*1*	6	*2*
Malaysia	23	*1*	24	*3*	27	*0*	27	*1*	28	*5*
Mexico	60	*-3*	57	*-5*	52	*-1*	51	*5*	56	*-4*
Mongolia	52	*-3*	49	*-2*	47	*1*	48	*-3*	45	*-7*
Netherlands	11	*-6*	5	*1*	6	*3*	9	*-1*	8	*-3*
Nigeria	68	*-1*	67	*0*	67	*0*	67	*2*	69	*1*
Norway	3	*1*	4	*-1*	3	*1*	4	*-2*	2	*-1*
Pakistan	70	*0*	70	*0*	70	*-2*	68	*2*	70	*0*
Peru	61	*1*	62	*-8*	54	*3*	57	*3*	60	*-1*
Philippines	62	*2*	64	*-2*	62	*-3*	59	*-1*	58	*-4*
Poland	35	*4*	39	*-9*	30	*1*	31	*4*	35	*0*
Portugal	25	*2*	27	*-4*	23	*0*	23	*-2*	21	*-4*
Romania	50	*3*	53	*-8*	45	*1*	46	*0*	46	*-4*
Russian	46	*-11*	35	*4*	39	*1*	40	*12*	52	*6*
Saudi	26	*-1*	25	*0*	25	*0*	25	*5*	30	*4*
Serbia	43	*-1*	42	*4*	46	*3*	49	*2*	51	*8*
Singapore	1	*0*	1	*0*	1	*2*	3	*4*	7	*6*
Slovenia	24	*-1*	23	*3*	26	*2*	28	*-2*	26	*2*
South Africa	49	*-6*	43	*0*	43	*-8*	35	*3*	38	*-11*
Spain	29	*-3*	26	*-4*	22	*0*	22	*1*	23	*-6*
Sri Lanka	51	*-1*	50	*-1*	49	*-4*	45	*2*	47	*-4*
Sweden	7	*-1*	6	*-2*	4	*-3*	1	*2*	3	*-4*
Switzerland	9	*0*	9	*-4*	5	*2*	7	*22*	29	*20*
Thailand	44	*3*	47	*-10*	37	*4*	41	*-1*	40	*-4*

Tunisia	65	*-4*	61	*0*	61	*0*	61	*2*	63	*-2*
Turkey	37	*0*	37	*-2*	35	*1*	36	*-3*	33	*-4*
United Arab	12	*8*	20	*-10*	10	*3*	13	*5*	18	*6*
United	14	*-1*	13	*-5*	8	*0*	8	*3*	11	*-3*
United	20	*-10*	10	*4*	14	*1*	15	*4*	19	*-1*
Uruguay	33	*-3*	30	*1*	31	*7*	38	*4*	42	*9*
Vietnam	63	*0*	63	*2*	65	*0*	65	*1*	66	*3*
Zambia	66	*0*	66	*-3*	63	*-3*	60	*4*	64	*-2*
Zimbabwe	69	*0*	69	*0*	69	*1*	70	*-3*	67	*-2*

Appendix D: Data and diagnosis

Shadow economy index	
Tax revenue (% of GDP)	World Bank
Unemployment, total (% of total labor force)	World Bank
Rule of Law	WGI, World Bank
Control of Corruption	WGI, World Bank

Electronic money solutions index	
Account (% age 15+)	Findex, World Bank
Debit card ownership (% age 15+)	Findex, World Bank
Credit card ownership (% age 15+)	Findex, World Bank
Made or received digital payments in the past year (% age 15+)	Findex, World Bank
Mobile money account (% age 15+)	Findex, World Bank
Received government payments: into a financial institution account (% age 15+)	Findex, World Bank
Used a mobile phone or the internet to access a financial institution account in the past year (%	Findex, World Bank
Used a debit or credit card to make a purchase in the past year (% age 15+)	Findex, World Bank
Debit card used to make a purchase in the past year (% age 15+)	Findex, World Bank
Received wages: into a financial institution account (% age 15+)	Findex, World Bank
Paid utility bills: using a financial institution account (% age 15+)	Findex, World Bank
Paid utility bills: using a mobile phone (% age 15+)	Findex, World Bank
Sent or received domestic remittances: through a financial institution (% age 15+)	Findex, World Bank

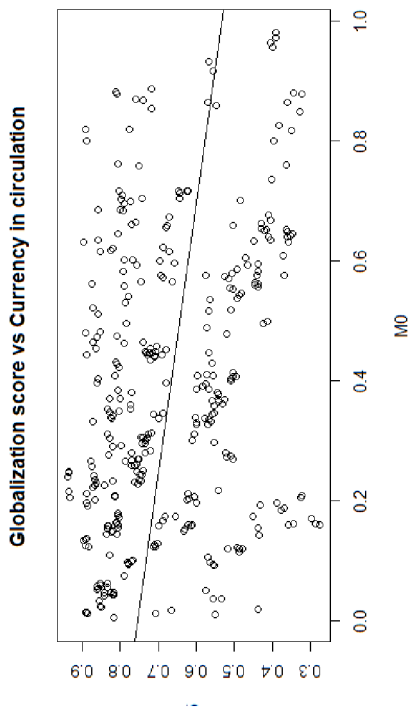
Sent or received domestic remittances: through a mobile phone (% age 15+)	Findex, World Bank
Sent or received domestic remittances: through a money transfer service (% age 15+)	Findex, World Bank
Saved at a financial institution (% age 15+)	Findex, World Bank
Paid online for internet purchase (% internet purchasers, age 15+)	Findex, World Bank
Used the internet to buy something online in the past year(% age 15+)	Findex, World Bank
Used the internet to pay bills in the past year (% age 15+)	Findex, World Bank
Number of ATMs	IMF
Number of POS terminals	GPSS, World Bank; BIS
Total number of branches of PSPs	GPSS, World Bank
Number of deposit transaction accounts	GPSS, World Bank
Number of debit cards in circulation	GPSS, World Bank
Number of credit cards in circulation	GPSS, World Bank
Number of e-money accounts	GPSS, World Bank

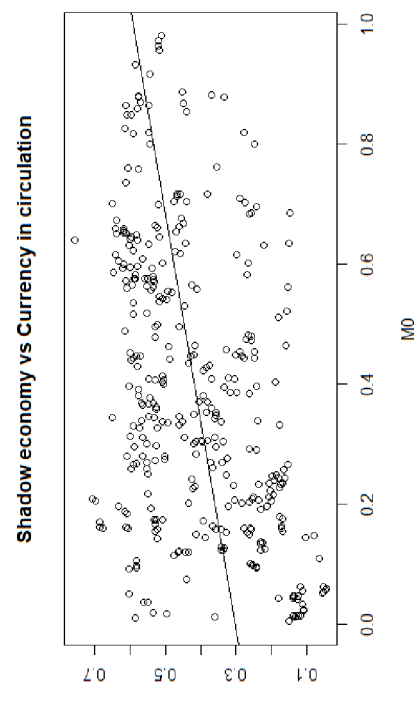
Business environment index

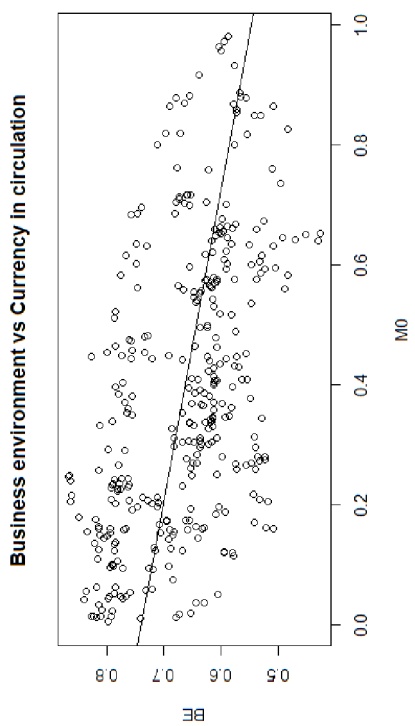
Effect of taxation on incentives to invest, 1-7	GCR, WEF
No. days to start a business	EDBI
No. procedures to start a business	EDBI
Property rights, 1-7 (best)	GCR, WEF
Efficiency of legal framework in settling disputes,	GCR, WEF
Ease of access to loans, 1-7 (best)	GCR, WEF
Soundness of banks, 1-7 (best)	GCR, WEF

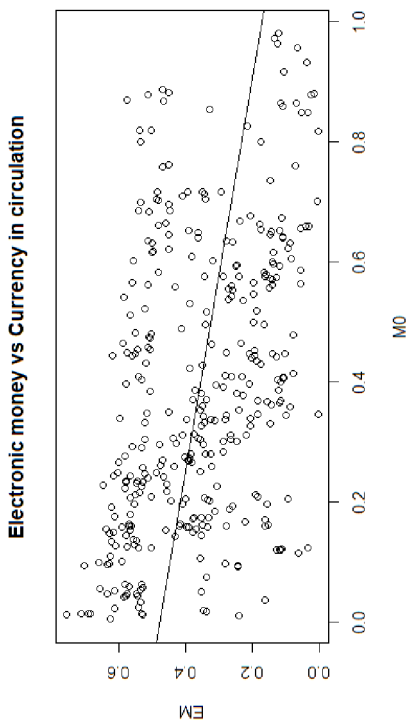
Globalization index

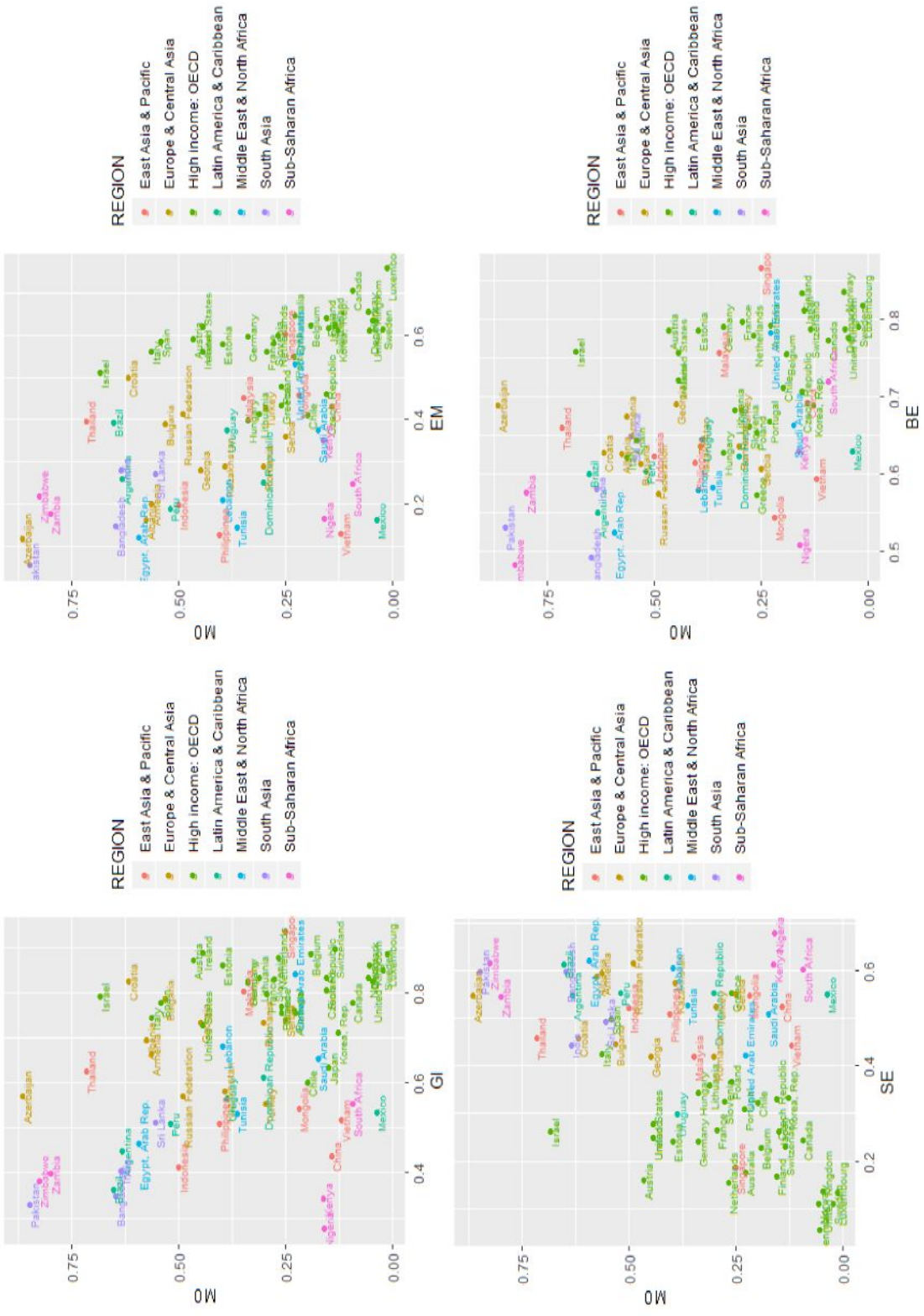
Trade Globalization	KOF Index
Interpersonal Globalization	KOF Index
Cultural Globalization	KOF Index










REGION
East Asia & Pacific
Europe & Central Asia
High income: OECD
Latin America & Caribbean
Middle East & North Africa
South Asia
Sub-Saharan Africa
MO
EM
BE
GI
SE

	Eigenvalue	Condition Index	intercept	BE	GI	SE	EM	Capital	IR	RUR_POP	GDP	Educ
1	8.003	1	0.000	0.000	0.001	0.001	0.002	0.001	0.003	0.001	0.00	0.001
2	1.023	2.797	0.000	0.000	0.009	0.017	0.009	0.001	0.167	0.003	0.00	0.013
3	0.490	4.043	0.000	0.001	0.007	0.008	0.024	0.000	0.655	0.027	0.00	0.007
4	0.143	7.484	0.000	0.019	0.001	0.126	0.108	0.029	0.015	0.150	0.00	0.140
5	0.127	7.940	0.000	0.015	0.001	0.124	0.522	0.004	0.001	0.107	0.00	0.053
6	0.095	9.200	0.000	0.000	0.514	0.004	0.129	0.010	0.112	0.239	0.00	0.008
7	0.072	10.531	0.000	0.012	0.042	0.159	0.022	0.692	0.009	0.049	0.00	0.007
8	0.031	16.087	0.002	0.266	0.202	0.001	0.119	0.004	0.015	0.177	0.01	0.755
9	0.016	22.447	0.009	0.537	0.022	0.555	0.001	0.258	0.000	0.031	0.97	0.005
10	0.000	137.401	0.989	0.149	0.202	0.005	0.064	0.001	0.023	0.216	0.00	0.011

	Eigenvalue	Condition	intercept	BE	GI	SE	EM	INF	IR	RUR_POP	Educ
1	7.059	1	2.19E+02	0.001	0.002	0.001	0.002	0.001	0.004	0.002	0.001
2	0.980	2.684	2.85E+02	0.000	0.009	0.021	0.008	0.001	0.180	0.003	0.016
3	0.487	3.805	1.78E+01	0.001	0.009	0.010	0.026	0.000	0.658	0.034	0.009
4	0.143	7.034	7.11E+01	0.022	0.001	0.121	0.114	0.027	0.015	0.186	0.151
5	0.127	7.457	1.03E+01	0.016	0.001	0.125	0.551	0.004	0.001	0.136	0.053
6	0.095	8.641	4.50E+01	0.000	0.637	0.005	0.134	0.010	0.114	0.301	0.007
7	0.072	9.893	7.01E+00	0.014	0.050	0.155	0.024	0.699	0.009	0.062	0.006
8	0.028	15.853	2.77E+04	0.515	0.289	0.029	0.113	0.005	0.016	0.276	0.682
9	0.009	28.151	9.72E+05	0.432	0.002	0.534	0.027	0.251	0.003	0.001	0.075

Collinearity test for all variables

Variable	Tolerance	VIF	Eigenvalue	Conditional
intercept			8,003	1
BE	0.248	4.029	1.023	2.797
GI	0.266	3.761	0.490	4.043
SE	0.368	2.715	0.143	7.484
EM	0.462	2.164	0.127	7.940
INF	0.890	1.123	0.095	9.200
IR	0.742	1.347	0.072	10.531
RUR_POP	0.361	2.768	0.031	16.087
GDP	0.143	6.983	0.016	22.447
Educ	0.400	2.501	0.000	137.401