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The American University in Cairo

The School of Business

THE STRATEGICAL USE OF BLOCKCHAIN AND INFORMATION TECHNOLOGY IN
FINANCIAL INCLUSION AND SECTORS

A Thesis Submitted to
the Department of Economics

In partial fulfillment of the requirements for
the degree of Master of Arts in Economics

by Mona El-Begawi

under the supervision of

Dr. Mohamed Bouaddi

January 2019

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Abstract

Information Technology, and more specifically Blockchain, has taken over many industries, changing their fundamentals in order to increase productivity and efficiency. The world is now moving into the Fourth Industrial Revolution, which merges the tangible and intangible world in ways previously not known to man, such as biotechnology and other disruptive technologies. Changes happening nowadays have affected the requirements for labor and their productivity, profitability of data in general, and the strategic use of Blockchain and Information Technology (IT); meanwhile, there are fears that occur from simple changes. This paper aims to understand the literature revolving the strategic use of Blockchain and IT in the realm of economics – more specifically financial inclusion and institutions, with the possible extensions it poses. It has also examined Egypt's situation in terms of financial inclusion and institutions within the jurisdiction of mobile phone penetration and usage of internet. All this then boils down into a brief policy recommendation for Egyptian use based on the results obtained.

Section 1: Introduction

As globalization becomes an integral part of the world, new technologies have advanced to its highest peak. Cloud computing took over creating downloadable software that excludes the use of the middle man, moving the world away from the traditional scope. Microsoft, Twitter, Facebook, and many more companies have fully optimized the creation of value with simply using data generated on a day-to-day basis. This form of change in the world revolutionizes the economy to mold itself to fit new capacities in a creative domain.

Our daily transactions and lives have changed to allow for a fourth industrial revolution to overcome problems such as speed and loss of data and its technologies to rampage. According to the World Economic Forum, the fourth industrial revolution is the converging of technological advancements that allows for the integration of the digital, physical, and biological worlds.

Under the fourth industrial revolution, the future of economic progress becomes the future of innovation, productivity, disruption, inequality and inclusive growth, the fusion of technologies, and security and conflict. As a result, terms such as cryptocurrencies, Blockchain, and information technology have become critical forms of the industrial and economic leaps. Blockchain finds its way through the means of Information technology (IT) – a technological mechanism which mainly stores, reclaims, and sends/receives information. Notably, IT includes but is not exclusive to Blockchain.

Blockchain, similar to the umbrella of technologies, stores data in a form of a decentralized public ledger. Information is built into blocks of information that could be changed retrieved and verified every 10 seconds. This technology allows for a transparent and costless manner of data collection and verification, as well as an effortless manner of transaction. Cryptocurrencies, most popularly Bitcoin, and other financial technologies (FinTech) use this form of technology for their transactions to reduce costs and increase security. Governments, such as Dubai, have also introduced this technology to store blocks of information to ensure safety and credibility of their citizens' information. Consequently, Blockchain and IT have affected social, economic and political structures, as well as final products. Notably, the technologies affect sustainable development, financial and monetary systems, and banking and capital markets. Thus, contributing to a wide spectrum of strategies followed by different banks and multinationals to allow for structural change.

To elaborate further on the uses of Blockchain in general, in a session curated by PwC professionals in the American University in Cairo, Blockchain is identified as a trusted mean

of transactions. Trust was identified as three important categories: (1) Identity; (2) Security; and (3) Validity. All three depend heavily on cryptography – a mean of encrypting data through codification – which allows for the single source of truth to appear. Deloitte, as well as PwC, has centered its research to understanding this Distributed Ledger Technology (DLT) and its two types. This DLT is a form of decentralized network that could either be permission-less or permissioned. In other words, it would be privatized with certain keys to create a trusted environment with known participants. On the other hand, the permission-less does not know who the participants fully, which may cause a trustless network that requires an incentive mechanism such as mining for Bitcoins.

To understand the underlying impact of technology on our lives and businesses, we must understand that Blockchain and IT change structures and strategies of our economy that have once been difficult to access, such as banking. The banking and financial sectors have converged with the technologies to create FinTech, an easy and sustainable solution for payments and transactions. Banks, such as CIB and HSBC, use personal online banking to eliminate errors and ease processes, which required long periods of time – allowing people who once resisted banking to be integrated to it. Strategies to reduce difficulties have been at the forefront of the finance world. This allows for technologies to carve their way to increasing financial inclusion of countries.

The use of Blockchain and IT in banks and the financial allows for innovation and financial sectors to find sustainable methods to current difficulties, such as financial inclusion. Issues such as the digital divide, transaction costs, and financial literacy have persisted and slowly decreased in areas of finance and banking due to incorporation of technologies. Currently, there is a gap in understanding the dimensions of how the use of Blockchain as a medium of technology to benefit banks and increase financial inclusion. Using a game theory framework, I attempt to understand through previously known and established strategies the effect of technology and its implications, as well as build a well-rounded policy recommendation to enable/disable technological use based on the outcome of the games. The effects of such have an everlasting impact on the economy through cost reduction, reducing times, and increasing both trust and reputation.

This paper aims, not only to understand the use of Blockchain and information technology on the banking sector but also on financial inclusion in a strategic manner, which could possibly be extended into other subjects within economics such as game theory and microeconomics. The question becomes what is the effect of Blockchain and information technology as a strategy in financial inclusion and sectors as a whole? Section 2 pinpoints the

literature review with respect to the different dimensions of the topic; while Section 3 identifies Egypt as a case study of technological use in financial inclusion and institutions. Section 4 and 5 identify the methodology the results with regards to the Egyptian economy. To specify, the methodology will focus on a pooled panel regression through the Random Effects model. Section 6 then proposes possible extensions in the form of game theory and sensitivity analysis; and finally, section 7 provides a brief policy recommendation and conclusion on the matter.

Section 2: Literature Review

This literature review identifies the strategic viewpoints of a key areas: the fourth industrial revolution, the sharing economy and technological use in the economy, Blockchain and IT and its economic benefits, the use of technologies in financial services and banking, and the use of technologies in financial inclusion. the value-added of this literature review is the possible changes that occur with the use of Blockchain and information technology. The literature review provides a leeway in understanding the possible solutions in the improvement of the use of technologies. As it will be more apparent in the following section, the literature review only explains the underlying theory to be used further in the upcoming sections, using it strategies as the basic assumptions of the model being used.

2.1: The Fourth Industrial Revolution

To start, we must understand the root of what allowed for Blockchain and IT – the fourth industrial revolution – to converge and flourish. The term fourth industrial revolution was first used by Klaus Schwab, the founder and executive chairman of the World Economic Forum during the annual meeting in 2016. Named “Mastering the Fourth Industrial Revolution”, the meeting discusses the dark side of terrorism, the different opportunities, and new governance. The meeting revolved around transparency and inclusiveness, as well as embracing technologies to reshape a better future, as well as the disruptive behavior of technologies. The disruptive behavior of technologies has been a great focus in literature; Alin Stancioiu (2017) discussed the disruptiveness impact on manufacturing processes, as well as technologies and people¹. As a overall strategy, Stancioiu suggested that this disruption would benefit people through a reduction of time and cost, and integration and flexibility of the technology – in the means of Research and Development (R&D), security

¹ Stancioiu, A. (2017). The Fourth Industrial Revolution,, Industry 4.0". *Fiabilitate Si Durabilitate - Fiability & Durability,1*, 74-78.

and transparency. Although the strategies above are sustainable, other authors such as Rabeh Morrar et. al (2017) have also expressed the effects and forms of sustainable strategies.

Morrar et. al (2017) identify the fourth industrial revolution as a sustainable strategy in terms of exponential growth of technical change and socioeconomic impact. As a result, coupling technology with social innovation include strategies like economic rewards, enrich societies, and protect the environment ². Negative and positive consequences have also been examined such as human substitution, loss of jobs, and improvement climate change and inequality.

The fourth industrial revolution shares an insight about the path of economic growth and progress, allowing for other types of economies to blossom and grow as mentioned by Stancioiu. The disruptive pattern and nature of technologies during this revolution, unlike the other revolutions, sanctions the development of the sharing economy and its reaping benefits.

2.2: The Sharing Economy and Technological Use in the Economy

As identified above, the future of economic progress lays under the paradigm shift in the technological changes. This means that the economy is not only shaped by the fourth industrial revolution, but by the identification of the sharing economy. The sharing economy – similar to the primary function of IT – allows for platforms between buyers and sellers to communicate freely and conduct transactions in a decentralized manner. The principal concept is that the transaction costs are decreased and integration is maximized.

The author of “The Sharing Economy: The End of Employment and the Rise of Crowd-Based Capitalism”, Arun Sundararajan (2016) points to the real-life examples of how technologies have changed and progressed in the last decade³. Sundararajan explains the end of ownership and the concepts of sharing as a strategic outcome that allows for the elimination of transaction costs and integration of people into the economy³. These sentiments were also echoed by Michael C. Munger (2016) that further explained the benefits of the sharing technology in the form of rent versus ownership. Agreeing with Morrar et. al, Munger examined the environment and economic impact of the sharing economy and its

² Morrar, R., Arman, H., & Moussa, S. (2017). The Fourth Industrial Revolution (Industry 4.0): A Social Innovation Perspective. *Technology Innovation Management Review*,7(11), 12-20.

³ Sundararajan, A. (2016). *The Sharing Economy: The End of Employment and the Rise of Crowd-Based Capitalism*. The MIT Press.

technological use. He specifies the loss of jobs and environmental benefits of the decrease in transaction costs⁴.

Unlike Munger, Sundararajan provided some policy choices that governments have to enable or disable technological-based companies; additionally, the author has raised awareness to governance issues that cause trouble for companies that work closely with technology. To highlight that issue, in a World Economic Forum white paper with McKinsey & Company, the paper discussed the shortcomings of the leading technologies. It is noted that Blockchain is one of the less advanced technologies existing, however it has a positive impact on the creative economy and economy as a whole as it helps create trust and transparency⁵.

Notably, the sharing and creative economy is not the only economic factor of technological use, J. Stan Metcalfe (2010) attempted to understand the technological use and its disruption in three different forms of capabilities (spatial, temporal, and physical) under the realm of economic theory such as production⁶. As a result, he explored the strategic inventions and patterns of technical knowledge. Nonetheless, Metcalfe was not the only scholar to examine the role of the internet and technologies, Ivana Kursan and Mirela Mihic (2010) assessed the use of technologies in a different perspective. They explored the role technologies play and the general impact they have on market research, and business decision-making processes and outcomes⁷. Kursan and Mihic related the major impact and benefit for such as data and profiling, which is widely used in banking and financial services.

Hyun-Joon Jung et al. (2013) examined the productivity of labor using information created by the ICT sector. The article identified that the use of IT and software contributed to the growth of labor productivity almost twice as much as it was before the introduction of these technologies. Jung et al. also examined technological convergence and its effects on investment in tangible and non-tangible ICT capital; they highlighted in their paper that convergence generally strengthens competitiveness of sectors that use such technologies.

⁴ Munger, M. C. (2016). Tomorrow 3.0: The Sharing Economy. *The Independent Review*,20(3), 391-395.

⁵ Hall, S. & Takahashi, R. (2018). Creative Distruption: The impact of emerging technologies on the creative economy. World Economic Forum & McKinsey & Company.

⁶ Metcalfe, J. S. (2010). Technology and economic theory. *Cambridge Journal of Economics*,34(1), 153-171.

⁷ Kursan, I., & Mihić, M. (1986). Business Intelligence: The Role of the Internet in Marketing Research and Business Decision-Making. *Management Information Systems Research Center*,10(2), 107-119.

This competition has created an increase in ICT-intensive investment goods, as well as a strong spillover effect that allows for a competitive advantage to countries that have been investing and using ICT capital.⁸

While generalizing technological use allows for generic outcomes and recommendations, using an umbrella of technologies or a specific technology will enable a further understanding of the impact of technologies and the better recommendations given the technological status.

2.3: Blockchain and IT with regards to strategy and their economic benefits

IT and Blockchain have become the fastest growing technologies used in the 21st century. Many scholars have attempted to understand their effects, on our daily lives and economies. Since IT includes – but is not exclusive to – Blockchain, scholars have taken an interest in it since the late 1980's. J. Bakos and Michael Treacy (1986), two of the first scholars to write about the strategic aspect of IT, have tried to understand the impact that IT has on three areas: internal capacity, competitive capacity, and business portfolio levels. Using characterization to analyze, Bakos and Treacy identified the drawbacks and merits of IT strategically, adding to it the opportunities of cost reduction and ease in data collection as their main thesis⁹. In the 1990's, Erik Brynjolfsson explored deeply the strategic outcome of IT using firm size. By developing a framework, Brynjolfsson uses information as an asset that affects the organizational structure and compares costs of coordination, transactions, and property rights within technological use¹⁰. As years pass, scholars shifted their focus on the argument of decentralization versus centralization as opposed to the use of IT overall; amongst these scholars was Jens Christensen (2002), who aimed to analytically explain technological strategy and its impact.

Through exploring the strategic use of technology and innovation, Christensen argued that the use of specific technologies could be determined based on strategy-structure,

⁸ Jung, Hyun-Joon, Na, K., & Yoon, C. (2013) The role of ICT in Korea's economic growth: Productivity changes across industries since the 1990s. *Telecommunications Policy*, 37, 292–310

⁹ Treacy, M., & Bakos, J. (1986). Information Technology and Corporate Strategy: A Research Perspective. *MIS Quarterly*, 10(2), 107-119. Retrieved from <http://www.jstor.org/stable/249029>

¹⁰ Brynjolfsson, E. (1994). Information Assets, Technology, and Organization. *Management Science*, 40(12), 1645-1662. Retrieved from <http://www.jstor.org/stable/2632943>

dynamics between companies and the key characteristics¹¹ (which will be further discussed in section 2.4.2). Christensen hinted to the importance of technological development as a strategy; through the development of technology through Research and Development (R&D), entities' strategies move into becoming more technologically advanced in order to be able to compete with upcoming entities. This sentiment was also echoed by Tapani Talonen and Kari Hakkarainen (2018), who had highlighted the steps of a good strategy. Talonen and Hakkarainen argued that the business and competitive strategy is no different than the product and technology development strategy; in other words, that both types of strategies have a great impact on the efficiency and competitive-edge of business. Adding to the points made by Liisa Välikangas and Gary Hamel (2003), they mentioned that revolution, renewal and resilience should be in the three combined strategies: competitive, product-and-platform, and integrated technology and competence¹². The aforementioned authors all aim to highlight that the business and competitive strategy of the use of technologies should be partnered with product and technology development in order to create a comprehensive and efficient strategy that allows for further development and integration technologies.

But as years passed and technologies evolved to revolutionize the economy, scholars have recently have taken on an interest in Blockchain as a form of Information Technology. From these scholars, Melanie Swan (2017) highlighted the four main areas of application for Blockchain as a form of IT: (1) digital asset registries, (2) leapfrog technology for global financial inclusion, (3) personalized economic strategies, and (4) payment channels¹³. Swan emphasized on both the growing challenges such as governance of a decentralized ledger and job loss, and the growing benefits of efficiency. Nonetheless, other scholars, such as Malvika Nair and Daniel Sutter (2018), recognized the benefits of a decentralized ledger, by arguing that a third party allows for the enforcement of contracts, and identification of further problems¹⁴. Adding to Nair and Sutter, Joseph Woodside et. al (2017) also highlighted that the application use of Blockchain in areas such as finance, accounting and marketplace. With triangulation as a mean of analysis, Woodside et. al breakdown the impact of (1) cost, (2)

¹¹ Christensen, J. (2002). Corporate strategy and the management of innovation and technology. *Industrial and Corporate Change*, 11(2), 263-288.

¹² Talonen, T., & Hakkarainen, K. (2008). Strategies for Driving R&D and Technology Development. *Research Technology Management*, 51(5), 54-60. Retrieved from <http://www.jstor.org/stable/24136014>

¹³ Swan, M. (2017). Anticipating the Economic Benefits of Blockchain. *Technology Innovation Management Review*, 7(10), 6-13.

¹⁴ Nair, M., & Sutter, D. (2018). The Blockchain and Increasing Cooperative Efficacy. *The Independent Review*, 22(4), 529-550.

volatility, and (3) labor through the disruptive nature of technologies in the political, social, technical, and economic spheres¹⁵. As a part of the technological sphere of Blockchain, Steve Huckle et. al (2107) discussed the strategic use of Blockchain under the realm of the Internet of Things (IoT) to allow for security and transparency in pee-to-peer automatic payment, and foreign exchange platforms¹⁶.

An interactive session held by PwC – at the American University in Cairo – had also focused on the profitability of Blockchain within certain industries. These industries mainly deal with information; therefore, PwC professionals highlighted that Blockchain could be strategically used to resist fraud, removal of central authority when needed, resistance of cyberattacks, and traceability or immutability and auditability. They elaborated further on the strategic drawbacks as well of the use of Blockchain as it is layers in three different layers: (1) Protocols, which determine the ground rules of the technological use; (2) Network, the type of network used its vital to understand the challenges it may face – whether it is enterprise trusted use or bitcoin use; and (3) Application, which is the monetization process of the three. The third and final layer was highlighted to be the most profitable of the three. Professionals emphasized that Blockchain could be extremely profitable – if and only if – it has been used in the correct manner, in our case used in transactions and identity management that is also translated as information. Challenges of the aforementioned may be scalability due to the slowness of transactions, lack of skills or human resources that help with such a technology, regulation by the government, and interoperability, which is caused by isolation of the technology.

In the following two sections, literature that addresses both technological use in the realm of banking services and financial inclusion will be identified, links will also be made.

2.4: Use of technologies in financial services and banking

The world of technology has not only evolved the economy, but it has evolved the financial world as well. The general strategic and economic points of view will be discussed in terms of the use of IT, followed by the use of Blockchain as a specific example.

¹⁵ Woodside, J., Augustine, F., & Giberson, W. (2017). Blockchain Technology Adoption Status and Strategies. *Journal of International Technology and Information Management*,26(2), 65-93.

¹⁶ Huckle, S., Bhattacharya, R., White, M., & Belief, N. (2016). Internet of Things, Blockchain, and Shared Economy Applications. *Procedia Computer Science*,98, 461-466.

2.4.1: IT and Financial services/Banking

IT and its use in the financial world has been discussed greatly in the past years. Under the theme of decentralization and deregulation, Christopher Holland et. al (1997) argued that competitive forces of information technology, globalization, and deregulation are destabilizing to the banking industry since there are multiple banking markets. As a result, focus strategies were outlined to accommodate the destabilization, with reference to size and type of bank: growing processing business, growing a globally recognizable brand, and business management¹⁷. In 2016, Alistair Milne argued another aspect of competitive policy; she argues that the unknown outcomes of FinTech, transformation of banks and their benefits to customers¹⁸. She identifies that banks should strategically use IT as a form of fraud detection, and decreasing costs of access thus including more people into the economy. Milne also discusses the monopolization and how government regulations could help implement effective competition.

From the 2000's onwards, some authors have focused more on customers and their needs with regards to services provided. For example, Rupa Rege Nitsure in 2004 addressed concerns of the digital divide, which is the divide between rich and poor, in terms of financing¹⁹. Nitsure examined the digital divide, financial exclusion, security, regulation, and inadequate financing Small and Medium Enterprises within the realm of e-banking and earlier stages of financial technology using India as a case-study. Nitsure analyzed the cost reduction of transaction costs as a mechanism to overcome the digital divide, as well as other issues mentioned above. Implementation of technologies to reduce transaction costs positively impacted the digital divide by reducing the bridging the accessibility of technologies for transactional purposes.

Other cases of banking implementation were also examined; Calin Gurau (2005) analyzed situations and determined suitable strategies for the implementation and development of multichannel services. Gurau charts the evolution of banking to include the economy and customer strategy, highlighting that the main challenges both banks and

¹⁷ Holland, C., Lockett, A., & Blackman, I. (1997). The Impact of Globalisation and Information Technology on the Strategy and Profitability of the Banking Industry. *IEEE*, 418-427.

¹⁸ Milne, A. (2016). Competition Policy and the Financial Technology Revolution in Banking. *Digiworld Economic Journal*, 103, 145-161.

¹⁹ Nitsure, R. R. (2003/2004). E-Banking: Challenges and Opportunities. *Economic and Political Weekly*, 38(51/52), 5377-5381. Retrieved from <http://www.jstor.org/stable/4414436>

customers face include competitive pressure, cost reduction, and improved offers²⁰. She argued that, through cost reduction, more people are integrated into the existing systems; meanwhile, competitive pressures are taken into consideration to improve customer experiences and are paired with improved offers for retention of customers and improvement of the overall quality presented. The main challenges that face banks in such a strategy include organizational, external and competitive aspects within finance and banking generally. Organizational challenges come with the inadequate preparation and infrastructure within the sector; external and competitive challenges accompany organization in terms of regulation and market capability to retain technologies. Moving forward, there is a special focus on certain aspects and trends of IT conquering the academic sphere, amongst so is Blockchain and Bitcoin.

2.4.2: Blockchain and Financial services/Banking

Even though I will not be discussing Bitcoin itself, I will be discussing Blockchain as an underlying technology – a distributed public ledger, which could be used as a permissioned or permission-less technology – that allows for transaction verification. Blockchain started in 2009 with the start of Bitcoin as an application; however, literature on both Blockchain and bitcoin were looked at in depth starting 2016. Blockchain is directing known as a disruptive technology that allows for innovation, in this case, financial innovation. Rebecca Lewis et. al (2017) gave an overview about the innovative challenges and merits of the use of Blockchain. They discuss challenges in two broad aspects – technical and business and regulatory – that approach immutability, legal uncertainty, and currency control²¹. Lewis et. al also discuss the improvements of efficiency and security that come alongside the use of Blockchain in banks; such as audit trails, information sharing, trust, and transparency. Other efficiencies that supplement sustainability of Blockchain and financial development have also been discussed by other scholars, such as Luisanna Cocca et. al (2017).

Cocca et. al highlight the economic, operational and service efficiencies of the use of Blockchain as a strategy for tackling well-known financial issues (trust, transparency, etc.)²².

²⁰ Gurău, C. (2005). ICT Strategies for Development: Implementing Multichannel Banking in Romania. *Information Technology for Development*, 11(4), 343-362.

²¹ Lewis, R., McParland, J., & Ranjan, R. (2017). Blockchain and Financial Market Innovation. *Economic Perspectives*, 41(7), 1-18.

²² Cocco, L., Pinna, A., & Marchesi, M. (2017). Banking on Blockchain: Costs Savings Thanks to the Blockchain Technology. *Future Internet*, 9(25), 1-20.

Other scholars, namely William Mougayar and Vitalik Buterin, have opposed such an argument. Mougayar and Buterin have expressed that the strategic difficulties come from regulation, redefining banking, and the process (flow, lead, or leapfrog)²³. Notably, both Cocca et. al and Mougayar and Buterin touch upon the changes caused by Blockchain such as data providers, investments, loans, and further applications; they are also accompanied by Alexis Collomb and Klara Sok, who have identified key applications of Blockchain within financial services. Collomb and Sok identify other difficulties such as integration of capital markets within sectors, but have also attempted to estimate the technology's potential for disruption through applications such as corporate governance, cash management, and treasury²⁴. In their attempt to estimate Blockchain, the authors identified that its FinTech application use: payments and credit information in bank use. Ye Guo and Cheng Liang (2016) explored the strategic viewpoint that helps lower the risk of governance and improve efficiencies for application use in payments and credit information; after developing a framework based on type of users and firms, they reached the conclusion that using “multi-centralized, weakly intermediated” scenarios are most profitable and effective for banks to use²⁵. This means that the most profitable and effective strategy to be used is the one owned by several banks but not essentially used as an intermediary mechanism between consumers and service providers.

Guo and Liang's framework was not the only to understand the growing impact of Blockchain on financial services and banking. Jarunee Wonglimpiyarat (2018) formulated a systematic innovation model that aims to analyze the systematic characteristics of all innovations applied in any industry, track impact of technological development and diffusion, and help detect trends²⁶. This framework assists in understanding the management of technologies and competitive markets as a strategy of which has high systematic innovation. Since Blockchain is still developing in nature, results from Wonglimpiyarat's determined that

²³ Mougayar, W., & Buterin, V. (2016). Blockchain in Financial Services. In *The Business Blockchain: Promise, Practice, and Application of the next Internet Technology*. John Wiley & Sons.

²⁴ Collomb, A., & Sok, K. (2017). Blockchain / Distributed Ledger Technology (DLT): What Impact on the Financial Sector? *Digiworld Economic Journal*, 103, 93-111.

²⁵ Guo, Y., & Liang, C. (2016). Blockchain application and outlook in the banking industry. *Financial Innovation*, 2(24), 1-12. doi:0.1186/s40854-016-0034-9

²⁶ Wonglimpiyarat, J. (2017). FinTech banking industry: A systemic approach. *Foresight*, 19(6), 590-603. Retrieved from <https://doi.org/10.1108/FS-07-2017-0026>.

Blockchain has high systematic innovation and its impact may change by time, as well as coalitions and market size changes.

It should be noted however that the use of Blockchain has progressed from simply currencies, into smart contracts and now into what is called Blockchain 3.0. Blockchain 3.0 focuses on the application use of Blockchain, which has not been verified or tested just yet; this causes a setback for the strategic use of Blockchain within the realm of financial services or banks.

Other academics have also explored aspects within financial markets, namely financial inclusion.

2.5: Use of technologies in financial inclusion

The new age of technology has allowed for the unbanked and those excluded from the formal market to have more trust due to its systematic nature. This section aims to not only to understand why people go unbanked or wish to stay in the informal market; but also, to understand the strategies that both banks and governments can follow to ensure financial inclusion and economic development. This also means that one of the potential uses of Blockchain and IT is to bridge the gap between the rich and poor, or the digital divide, to provide cashless services, and to provide microfinance.

With regards to IT, financial inclusion is seen through the lens of microfinance and development. The World Bank started a project in 2017, named the Financial Inclusion Initiative, that aimed to increase financial inclusion in developing economies through the use of IT and Blockchain, in three countries – Mexico, Egypt, and China. Although the above is mostly highlighted, the literature also looks at the strategic viewpoints of financial inclusion to the economy, banks, and governments.

2.5.1: IT and Financial Inclusion

Robert J. Kauffman and Fredrick J. Riggins have addressed the use of information and communication technologies (ICT) in multiple publications. In their first publication (2012), Kauffman and Riggins argued that the creativity of ICT and its availability to solve multiple socioeconomic issues, specifically the digital divide²⁷. Additionally, they provide a literature review that identify the impact of ICT in microfinance through different mediums, which is highlighted in their second publication.

²⁷ Kauffman, R., & Riggins, F. (2012). Poverty, technology, microfinance and development. *Electronic Commerce Research and Applications*, 11, 447-449.

While in their second publication, Kauffman and Riggins argued that ICT assists with financial inclusion, as it speeds or “sets off” economic development and in return microfinance²⁸. Arguably, they investigate the creation of competitive environments through microfinance institutions in order to bridge the digital divide, and the impact of microfinance on poverty. Results show that the most strategic component is Research and Development (R&D), within behavioral economics and applications to accommodate for those who are excluded. Eduardo Diniz et. al (2012) also discussed the impact through the case study of financial inclusion in the Amazon. The results are threefold; (1) financial inclusion positively affects the socioeconomic development, but negatively affects the indebtedness; (2) Remote ICT access is vital; and (3) financial education is equally important as ICT use²⁹. Similarly, Simplice Asongu and Paul Acha-Anyi argued that the positive correlation of ICT and financial formalization is of an increasing function of financial activity³⁰.

An article published by Jyoti Gogia and Jyoti Agrawal (2016) examined the use of mobile financial services – split into mobile payments, mobile banking and insurance and microfinance services – and its impact on financial inclusion. They argue that mobile financial services (MFS) have opened a gateway for those who have not been able to formally access the financial market through the creation of new channels, instruments and business models. Furthermore, they highlighted that MFS use is not an application use, instead it is a medium to provide financial services that has potential to be used further to conduct transactions, globally. The article is then split into explaining the three types of MFS model executions and the issues surrounding MFS. The three types are (1) bank-led, whereas a bank leads the services of account holders through a simple application; (2) joint venture, which mainly focuses on telecom companies managing open/smart wallet accounts with their corresponding banks; and (3) third-party that means telecom companies collaborate with the independent third parties to create semi-opened wallets. Drawbacks of MFS include lack of awareness regarding MFS usage and applications, educational statuses of users, and

²⁸ Kauffman, R., & Riggins, F. (2012). Information and communication technology and the sustainability of microfinance. *Electronic Commerce Research and Applications*, 11, 450-468.

²⁹ Diniz, E., Birochi, R., & Pozzebon, M. (2012). Triggers and barriers to financial inclusion: The use of ICT-based branchless banking in an Amazon county. *Electronic Commerce Research and Applications*, 11, 484-494.

³⁰ Asongu, S., & Acha-Anyi, P. (2017). ICT, conflicts in financial intermediation and financial access: Evidence of synergy and threshold effects. *Netnomics*, 18, 131-168.

consumer preferences based on age.³¹ It should be noted that Blockchain could be used as a mean of MFS in its upcoming generations.

2.5.2: Blockchain and Financial Inclusion

Meanwhile the above section explains the use of technology and its strategy, this section understands the use of Blockchain in financial inclusion and their strategies, which also includes the MFS as a Blockchain application. Jesse Leigh Maniff and W. Marsh explore the demographics and rationales of the “unbanked” – people who choose not to be within the banking sector – to find solutions to integrate more people within the sector through understanding that the main contributors to the existing problem and understanding the use of Blockchain as a mean for information accessibility and cost reduction of transactions³². According to Nir Kshetri (2017), transparency, trust, reputation, and the enhancement of transaction efficiency allow for financial inclusion and the reduction of poverty³³. Through exemplification of the global south, Kshetri highlights Blockchain as a strategy to reduce fraud and ensure trust between companies, institutions, and peoples through its decentralized access and sustainability. Arguably, some others reflect on one important aspect: financial education. Calum Turvey and Xueping Xiong (2016) empirically found that financial literacy and e-commerce work hand-in-hand; they argue that financial literacy contributes greatly to financial inclusion and trust³⁴.

Similar to the previous section and the above paragraph, scholars have touched upon different, yet important points. Paulo L. dos Santos and Ingrid Harvold Kvangraven (2017) highlighted the importance of going into a cashless and electronic payments to promote financial inclusion through widening the availability of financial and monetary systems³⁵. Notably, the authors claim that payment services – in the form of microcredit – are uncompetitive and require more state interventions. Moreover, dos Santos and Kvangraven

³¹ Gogia, J., & Agrawal, J. (2016). Mobile Financial Services: Technology Initiatives Toward Financial Inclusion. *Productivity* 54 (4), 345-352.

³² Maniff, J. L., & Marsh, W. B. (2017). Banking on Distributed Ledger Technology: Can It Help Banks Address Financial Inclusion? *Federal Reserve Bank of Kansas City*, 53-77.

³³ Kshetri, N. (2017). Potential roles of blockchain in fighting poverty and reducing financial exclusion in the global south. *Journal of Global Information Technology Management*, 1-4. doi:10.1080/1097198X.2017.1391370

³⁴ Turvey, C. G., & Xiong, X. (2017). Financial inclusion, financial education, and e-commerce in rural china. *Agribusiness*, 33, 279-285.

³⁵ Dos Santos, P. L., & Kvangraven, I. H. (2017). Better than Cash, but Beware the Costs: Electronic Payments Systems and Financial Inclusion in Developing Economies. *Development and Change*, 48(2), 205-227.

also claim that payments can contribute to economic development, specially through the widened access to affordable payments, savings, insurance, and so on. On the same note, Michael Chibba discussed the Financial Inclusion – Poverty Reduction under the Millennium Development Goals. Chibba examines the difference between institutional initiatives and banks with regards to financial inclusion; he suggests that a conventional manner of financial services is ineffective when it comes to economic development and so it is of a much faster and effective manner that financial inclusion initiatives are held simultaneously with financial services³⁶.

Section 3: Egypt and its Technological Use, Financial Inclusion, and Financial Sector

3.1: Egypt's technological use

With regards to Egypt's technological use in general, Egypt has a long way ahead of it in order to reach the global standards of technological use. This is primarily due to the lack of technological infrastructure, technological illiteracy, low levels of education, and many more socio-economic factors that decrease the use of technology as a whole. In the upcoming years, Egypt aims to digitize itself in order to accelerate economic development and growth alike. To put things into perspective the following sub-sections aim to highlight some of the drawbacks Egypt faces, statistics, and recommendations for both financial inclusion and institutions.

The Ministry of Communications and Information Technology (MICT) issued a brief with the ICT indicators in 2018, the annual growth rate of mobile internet usage in Egypt grew 23.45%; meanwhile, the subscription in international internet bandwidth also increased in double digits – 67.53%. According to the results of “ICT Access and Use by Households and Individuals Survey for 2017/2018” curated by the MICT, internet penetration and users increased 44.3% in one year (2017 till 2018), translating to 37.9 million users.

Technological use in Egypt is thus at its earliest stages. Notably, multi-nationals such as IBM have advanced the use of Blockchain and information technologies; meanwhile other companies have been advancing the use of information technologies as a whole. Within Egypt, Nestle and Vodafone have been in the lead in using information technology and soon

³⁶ Chibba, M. (2009). Financial Inclusion, Poverty Reduction and the Millennium Development Goals. *European Journal of Development Research*, 21, 213-230.

to implement Blockchain systems for transactional uses within itself or between itself and governments.

3.2: Background on Egypt's financial inclusion

According to the World Bank's *The Little Data Book on Financial Inclusion (2018)*, Egypt compared to the Middle East and North Africa (MENA) region, as well as countries categorized as lower middle-income countries, is doing far worse in financial inclusion. The data excludes 2% of the full Egyptian population in 2018; however, it only noted the working force ages (15 till 64). For the purpose of this paper, five important factors will be examined: (1) Accounts in percentages; (2) financial Institution account in percentages; (3) Mobile money account in percentages; (4) Account by individual characteristics by percentages; and (5) digital payments in the past year in percentages.

Firstly, the accounts in percentage shows the differences between the years 2011, 2014, and 2018. For all the adults in Egypt, there is 32.8% of the total work force population who have accounts in 2018, which is higher than 2014 by 18.7 percentage points. Comparable to the MENA region and the Lower Middle-income countries, Egypt scores 10.7 and 25 percentage points below each respectively, meaning that Egypt has a lower financial inclusion in terms of accounts than the rest of its region and the income bracket it belongs to.

Secondly, the percentage of the financial inclusion accounts for all adults in the work force have risen to 32.1 from 13.7 in 2014 and 9.7 in 2011. Meanwhile, Egypt is still significantly below the percentages for both the MENA region and Lower Middle-income countries. Thirdly, mobile money accounts used by financial institutions add up to only 1.8 percent of adults' usage in Egypt. This number has not significantly changed from 2014 till 2018, specifically as the percentage was 1.1% in 2014.

Fourthly, the percentage of accounts could also be divided into four categories: women, adults belonging to the poorest 40%, adults out of the labor force, and adults living in rural areas. Women only comprise of 27% of those who have accounts, which is also significantly below the rest of the region. Adults who belong to the poorest 40% own 20.3%, those out of the labor force have a percentage of 28.5%, and those living in rural areas have 29%.

Finally, digital payments made in the past year have also been spilt into eight categories; for the purposes of this paper, we shall only take the most relevant to Blockchain and ICT, which are made of received digital payments for the years 2014 and 2018, used an account to receive private sector wages, used an account to receive government wages, used a

mobile phone or internet to access an account, and used a debit or credit card to make a purchase. Digital payments – either made or received by adults in Egypt- increased 14.9 percentage points in four years to reach 22.8% in 2018. Wages received through financial institution accounts from the government are significantly higher at (17.1) than those compared to those the lower middle-income countries and insignificantly less than those of the MENA region; meanwhile, those for the private sector wages scored significantly less than those of the MENA region and the lower middle-income countries.

With regards to digital payments, the use of mobile phones and/or the internet to access an account is fundamental in the technological use to engage peoples into financial inclusion. The percentage of adults who use mobile phones and/or the internet in 2018 is 2.2% compared to 10.4% and 8.3% for the MENA region and Lower Middle-Income countries respectively. Finally, the usage of debit or credit cards to make a purchase scored – also less than the MENA region and Lower Middle-Income countries – 2.2% relative to 10.4 and 8.3%.

The data from the World Bank’s research shows that Egypt is significantly behind not only the lower middle-income countries bracket, but also the MENA region as a whole. (Annex)

In another report for the World Bank – *The Global Findex 2017*, it has been noted that the gap in account between the richest and the poorest is approximately 20 percentage points, which means that the wealthier adults are twice as more likely to have an account. Another observation made had been that there is a gap in account ownership as well due to age differences; they observed that older adults are more likely to own accounts.

Unlike *The Little Data Book on Financial Inclusion (2018)*, *The Global Findex 2017* suggested the digitization of payments in order to engage those who are currently unbanked into becoming banked. It estimated that roughly 90% of the population use or simply have mobile phones, which may facilitate their engagement further with the correct awareness and payment methods. Another pointer was that the digitization of payments may also increase the formal sector of remittances as well exponentially.

In a publication by the Oxford Business Group, it had been highlighted that – as of 2016 – only an estimated percentage of 10 to 14 of the total adult population holds bank accounts; while the Central Bank of Egypt (CBE) had placed the figure to be approximately 32% in 2017. The publication focused on two key areas in which the Egyptian Government is trying to encourage and develop further: regulations and digitization.

Regulation in Egypt has been changing since 2014, when the CBE introduced a new regulation requiring banks to open mini-branches all throughout Egypt and especially in rural areas. The focus of this regulation is to decrease the informal sector that had long hindered the Egyptian economy by underestimating it. There is a twofold approach when it comes to the regulatory changes, which is the focus on Small and Medium Enterprises and on mortgages.

The CBE began a new strategy starting 2016 that helps improve SMEs access to finance. Policies including lowering of interest rate limits and minimum requirements – of 20% - for banks to increase the share of SME loans in their portfolio. The latter had also been accompanied with a new initiative to assist 10 million beneficiaries through funding. The aim of this initiative is to have more than 2 million dollars offered in the form of micro-loans by NGOs, microfinance organizations, and banks directly. Furthermore, digitalization is one of Egypt's main focal points in the upcoming years.³⁷

The aforementioned data only points towards the emergence of SMEs and FinTech companies that do not only work within the realm of MFS and online payments, but also to the evolution of the Egyptian market into fully using the information technologies, including but not exclusive to Blockchain, in a fully utilized manner. This also points towards the underutilization of current technological resources and the lack of proper infrastructure needed in the use of such technologies on a day-to-day basis.

3.3: Background on Egypt's financial sector and its technological use

As of August 2017, Egypt had witnessed a mobile phone penetration of 110% according to AlexBank. However, based on the number of peoples unbanked in Egypt, the number of mobile phone penetration is still relatively much lower than that of the global services. The CBE updated its mobile payment services – during November 2016 – to allow customers to use and access mobile accounts easily; this includes sending and receiving funds as well as remittances. These initiatives aim to limit the wide spread use of and dependency on cash.

This strategy also holds to the private sector. It had been recorded that the percentage of Egypt's payments made electronically are less than 2%. This indicates that Egypt has the potential to profit and expand its financial services. In another publication by the Oxford Business Group, it had been noted that there is a setback and underutilization in the usage of

³⁷ <https://oxfordbusinessgroup.com/analysis/digital-drives-host-government-initiatives-are-raising-financial-inclusion>

technology in financial services. Some suggestions and policy recommendations were incorporated in the text. For instance, the authors highlighted that FinTech is pioneered in developed markets whereas there is a fluidity in international capital and the lack of borders in technological adaptation. The article emphasizes on five important areas in which the government should develop further its banking sector: (1) convergence by moving away from the traditional industries and institutions and towards FinTech start-ups that seek innovative methods of productivity increase and competitiveness; (2) technology tree, a research strategy used to understand the different layers of technologies and their use; (3) Digital services that allow for mobile FinTech and digital security; (4) outsourcing through partnerships to enhance digital offerings; and (5) regulation. For regulation, the authors of the article focused in consumer protection and market stability concerns through the creation of a separate regulator entity endorsed or operated by the government to allow for testing and verification of new products.³⁸ These suggestions made within the article are further improvements for the mobilization of technological use in Egypt. Understanding the reality of the situation is critical in understanding how the independent and dependent variable to be explained further in the following section. The aim of the aforementioned section is to further explain the results and the implications in a sense that could improve the situation through policy recommendations to address the areas in which Egypt lacks.

Section 4: Methodology and Data

4.1: Data collection

The data collected is primarily the value of technological know-how, score of technological know-how, and profit margin of technological use for 14 different banks in Egypt, both private and public banks. The dependent variable is the value of technological know-how, which indicates the monetary value of the technological value in terms of the actual value and added value of assets and software. On the other hand, the dependent variables are profit margins and the score of technological know-how. Profit margins explain the portion of the profits attributable to the technological know-how; whereas, the score of the technological know-how is the index of the technological know-how. The independent variables theoretically affect the value of know-how through understanding the technological know-how through its index scoring and the investment and increase in capital through the

³⁸ <https://oxfordbusinessgroup.com/overview/fintech-revolution-technological-solutions-are-evolving-sector-landscape>

re-investment of profit margins. Notably, Blockchain and IT are the underlying technologies being used in most – if not all – banks and FinTech companies nowadays; therefore, the basic assumption becomes that the technological know-how is in itself the use of Blockchain and information technology by banks and FinTech companies.

The data was collected from the Thomson Reuters Eikon datasets. The number of observations exceed 1800 observations, all within a ten-year time span to include the years in which Blockchain came into existence and has developed progressively. The data also concentrates on the technological know-how rather than technologies themselves due to the fact that banks in Egypt have been excessively focusing on the developing its know-how and advancing to where the world is heading globally through international standards and regulations proposed by international organizations.

There were some setbacks with the data collection; seeing as that Egyptian banks are not required to disclose their technological use by the regulator and that some of the data had been repetitive, most of the independent variables – such as geographical area and its index of the technological know-how – that should have been used were excluded while testing the results due to perfect correlation between one another. This data included the perfect correlation between geographical area as an index and the profit margins of technological know-how.

It should be noted that we are trying to explain the value of technological know-how in terms of the score of technological know-how, and profit margin of technological use for 14 different banks in Egypt, including the Commercial International Bank (CIB), EFG Hermes, Qatar National Bank (QNB), and many more. It should be taken as an example that CIB is developing a department, which focuses on the use of Blockchain as a mean of online payment transactions recorded into the system with minimum costs and transaction times, as well as the elimination of human error.

4.2: Methodology

This section focuses on the theoretical aspects of the methodology that will later on be developed into results concerning 14 Egyptian banks within the technological jurisdictions. The methodology is split into three important tests which have been used and examined further in following section.

4.2.1: Pooled Panel Model

This examines the two-dimensional – cross-sectional – panel data that has been observed in the data collection phase. The original Pooled Panel model is denoted by the following equation:

$$y_{it} = \beta_0 + \beta_1 x_{1it} + \beta_2 x_{2it} + \dots + \beta_k x_{kit} + \varepsilon_{it}$$

The key assumption of this model is that there is no unique attribution of individuals within the data set itself; additionally, there should be no universal effects happening across time.

This model could be used as is or it could be used within the framework of the Fixed and Random Effects models. The Random Effects model is the one used in this research paper and explained below.

4.2.2: Random Effects Model

Random effects test indicates that in panel data there is no fixed effect, meaning that individual effects are allowed within the model. This model helps with the controlling of unobserved heterogeneity coming from time rather than the correlation between the independent variables. The original equation for the Random Effects Model is denoted by the following:

$$y_{it} = \beta_0 + \beta_1 x_{1it} + \beta_2 x_{2it} + \dots + \beta_k x_{kit} + \varepsilon_{it}$$

Unlike the Pooled Panel Model, the error term for the Random Effects model is denoted by the following:

$$\varepsilon_{it} = \lambda_i + u_{it}$$

This model is generally used when if the observations are representative of a sample rather than a whole population, which is our case exactly. We only have a portion of the Egyptian population, which is banked – estimates show it is between 10 to 32 % of the whole population. In the model we presented, there is most likely to be a correlation between the unobserved effects and the explanatory variables. In other words, this may mean that model has some inconsistencies due to omitted variables in the model itself. These could be accounted for in the following test.

4.2.3: Hausman Test

The Hausman Test detects endogenous regressors in the regression model; in other words, this hypothesis testing is used to evaluate the consistency of the Random and Fixed effects. Endogenous variables are those that could be explained by other variables in the system. Since the OLS assumes that there is no correlation between any of the explanatory variables and the error term.

In order to test whether there is no correlation between the regressors and the effects – meaning that Random Effects is consistent – the Hausman test is used. The null hypothesis being that there is no correlation; therefore, there is no difference between the estimators. To carry out the test, we subtract the calculated betas for the random and fixed effects, as well as calculate the covariance corresponding to both:

$$\hat{\beta}_{RE} - \hat{\beta}_{FE} \text{ and its covariance is also calculated}$$

Under the null hypothesis that there is no correlation between the regressors and the effects, we test the following equation

$$W = (\beta_{RE} - \beta_{FE})' \sum^{-1} (\beta_{RE} - \beta_{FE}) \sim X^2(k)$$

If the p-value is more than 0.05, we reject the null hypothesis that there is no correlation, the random effects is inconsistent.

Section 5: Results and Implications

5.1: Pooled Panel Model

The p-values corresponding to both the score of technological know-how and the profit margin from the use of technology in this model are less than 0.05, to be exact both p-values are 0.

This model helps us understand the impact of certain events or policies, and the exogenous nature of the data. Seeing as that there has been extensive change in regulation to encourage technological use in banking sector as a part of financial inclusiveness and for economic development and growth as a whole, both the score and the profit margin of technological know-how have a strong impact on the value of technological know-how in general. In other words, there could be an additional improvement in both the profit margins and the scoring of know-how when the regulations are fully established and put into place. The strong impact comes from the sense that banks have been investing further in Blockchain and IT as means to ease transactions – specifically through reducing of costs and time. This allows for the unbanked to engage more in the banking sector due to an increase in trust, transparency and reputation of technologies used, increasing the number of those using technological means provided by banks to increase from a less than 2% to percentage higher than the 32% of those who have bank accounts in Egypt. This is specific increase is highlighted through the added value and strong impact caused by the profit margins and the scoring of the technological know-how. Furthermore, it should be noted that the profit

margins allow for the increase in capital used in technological know-how, corresponding to an increase in the monetary value of technological know-how – which is simply the value of the independent variable.

This should be further examined to understand whether individual effects or the time affect the impact of either score or profit margins on the value of know-how.

5.2: Random Effects Model

The p-values corresponding to both the score of technological know-how and the profit margin from the use of technology in this model are less than 0.05. This means that both variables have a significant impact on the value of technological know-how. This denotes that the impact of both the score and the profit margin both have a significant impact on the value of technological know-how. Furthermore, this model also denotes that the individual effects of the profit margin and the score of technological than the overall effect of time on the model itself.

Individual observations are taken into consideration in this model; therefore, there should be an analysis of the profit margins generated by technological know-how. As explained above, there is a strong impact caused by profit margins on the value of technological know-how, which is parallel to the extent of the capital pumped into capital for technological use and the investments made by banks. Since the CBE new regulation changes, banks are required to increase their investment in technologies. Therefore, for each of the observations made in the past year, the value of know-how changed according to the changes in the profit margins made and therefore the incremental changes within the investment and capital used.

The following section analyzes the consistency of the aforementioned with its assumptions, as well as the analysis itself, to further understand the situation in which banks in Egypt use of technologies, namely Blockchain and information technology.

5.3: Hausman Test

The p-value is less than 0.05, which indicates that the null hypothesis is not rejected. As explained above, this points towards the consistency and efficiency of the Random Effects Model. Therefore, there is a correlation between the score of technological know-how and the profit margin from the use of technology. Thus, the explanatory variables are indeed correlated making the individual effects explain the model.

In the case of our data sample, the correlation between score of technological know-how and the profit margin from the use of technology to explain the value of technological know-how is understandable in the sense that the profit margin is heavily dependent on the score of technological know-how. This means that the analysis above is consistent with the data and the results alike. In other words, there is an increase in the monetary value of technological know-how due to the impact made by capital and investment increase through the increase in profit margins. Additionally, there is also an added value caused by the scoring of technological use.

5.2: Implications

Due to the lack of data of the Egyptian market and the lack of proper use of Blockchain and IT, this data should be further examined. Blockchain and IT are relatively new technologies in the Egyptian market and are constantly being introduced in many different forms than just banks alone. Lack of information comes stems from the lack of awareness and use of other financial providers that use Blockchain and IT as a method of transactional ease and cost reduction. Banks have other implications relating to the technical fees and use of Blockchain and IT in general. As a reminder, the wording of technology for the purposes of this paper refers directly to Blockchain and IT specifically.

The aforementioned further examination should include an analysis of the operational costs of each of the banks with regards to its technological use. One of the more important implications is the use of technologies is the payments of royalties abroad. Most of the banks observed in the data set are multi-national banks with headquarters abroad. Having headquarters abroad highlights that there are payments made abroad each year in the form of technical assistance, royalties, and management fees. These payments are used for technical assistance for technologies and know-how of the multi-nationals coming from abroad directly into Egypt.

In order to understand the profit margins of the banks in further details, we must assess the operational costs of technological use or know-how as in accordance with the profits. This allows us to full take into consideration the fair-market value of such operational expenses and therefore fully comprehend the effect of the profit margin. Other implications of this model include that the underlying technological systems in which the banks use are not openly known to the public. Banks generally do not announce their underlying technologies for competitive reasons; other reasons may include that systems are under

construction and development. For this exact reason, Blockchain and IT are assumed as the technologies used in accordance to global trends highlighted in the literature review.

The most important implication, however, is the underutilization of banks in Egypt in terms of the technological use and efficiency. This is explained by the Ministry of Communications and Information Technology (MICT) into the following categories: (1) Fear of Financial Transaction Disclosure; (2) Lack of e-payments tools; (3) Fear of Personal Data Disclosure; (4) Lack of Data Security Mechanisms over the Internet; (5) Poor English Language; (6) Unrecognition of Electronic Contracts by Formal Parties; and (7) Ignorance about e-commerce. The MICT identified the seventh category as the one with the highest percentage – the percentage of respondents have highlighted this problem – amounting to 65%. Another important implication is the lack of awareness regarding regulation working towards the digitalization of the private sector; meanwhile, the public sector is doing far better in terms of e-payments and sending and receiving payments through accounts. These correspond to the results obtained by the impact and Egypt's technological use in general. Therefore, they should be determined as the root problems of the lack of use of IT and Blockchain within Egypt and further improved to ensure a well-rounded structure through policy recommendations.

There is plenty of rich resources and literature, which does not contribute directly to my research question; what is the impact of Blockchain and IT on the financial services, specifically banking, and financial inclusion? However, this question could be answered in multiple frameworks, one being a game theory framework, which is suggested as a possible extension below.

Section 6: Possible Extensions

Firstly, we must understand the core of game theory in a strategic framework and the suggested games with their reasoning; secondly, understand the strategies and payoffs that contribute the most to my research question and constructed games. Finally, further extensions to the possibility of game theory use will be offered.

6.1: Possible Extensions: Game Theory

6.1.1: Game Theory and Strategies

Game theory in itself is a mixture of techniques and tools that contribute to the understanding of strategy and equilibriums. Larry Samuelson (2016) highlights such in four main sections of his paper: Classical Game Theory, Equilibrium Refinements, Evolutionary

Game Theory, and Cooperative Game Theory³⁹. We will first examine the possible and different approaches of game theory, then we shall identify possible and suitable games.

6.1.1.1: The four different approaches

The first approach is Classical Game Theory, which looks at the classical viewpoint that games fully describe real-life situations. Within its use in economics, this approach usually includes constraints that undermine the analysis. It also assumes that all players are rational. Games that involve communication, signaling, collusion, and agreements are most commonly used in this framework. The intention is to use classical game theory in cooperation with Evolutionary Game Theory, which will be discussed below.

The second approach is the Equilibrium refinements. This approach explores the Nash Equilibria and a few refinements to it. However, there were many unsuccessful trials for such an approach, which lead to many shortcomings in their analysis. This approach will be disregarded due to the concerns addressed in their shortcomings by scholars.

The third approach is the Instrumental View, which studies interactions. This approach does not provide a precise description of interactions between players, instead it studies it carefully. Even though this approach is the most realistic out of the listed approaches, it complicates models and thus is not the most advised approach. The complication stems from the approximations of defects and cooperation between players, as well as the assumption that players are all rational.

The final approach is Evolutionary Game Theory. This approach looks at game theory in an economic theory realm, and more specifically in two different theories – Individual behavior through maximization and competitive markets. By using dynamic processes, evolutionary game theory looks at the different alternatives players are aware of. Unlike classical game theory, alternatives are based on peoples/firms' previous experiences.

6.2: Games to be Constructed

As stated above, I will be using a mixture of Evolutionary and Classical game theory. This allows me to analyze the use of technologies, specifically Blockchain, within the realm of financial services and financial inclusion. There will be four different games that aim to examine three aspects: whether banks will be willing to use such technologies or not to manipulate people into entering formal financial services, whether governments will allow for such technologies, and whether individuals will enter formal financial services or not.

³⁹ Samuelson, L. (2016). Game Theory in Economics and Beyond. *The Journal of Economic Perspectives*, 30(4), 107-130. <http://www.jstor.org/stable/44028260>

6.2.1: Game One: Gain of Using Blockchain and IT in investing in Financial Inclusion

The first game will be split into two single-player games, that include (1) Government, and (2) Banks. A single shot game to understand whether governments/banks would want to invest in financial inclusion through the use of Blockchain and IT. This game will be a simple backward induction game that also determines the Nash Equilibrium of each of the game. Banks would use strategies such as incorporating mobile and online payment services for the unbanked as an incentive, thus payoffs will be of bank's profitability. While governments would target the most vulnerable through decreasing energy costs for the use of technologies, providing online services for microfinance, and so on. Government's payoffs will be determined by tax revenues.

6.2.2: Game Two: Efficiency of Using Blockchain and IT in investing in Financial Inclusion

The second game focuses on examining the efficiency from the use of technologies through understanding conditions pre- and post- technological use. More importantly, this game will be a comparative analysis to understand the difference in number of transactions, costs of transactions, and profitability for both the government and banks. The game will be two single player games, similarly to the above, with a simple backward induction, and Nash equilibriums.

6.2.3: Game Three: Cooperation versus Competition – Banks

The third game focuses on understanding the different dimensions of financial inclusion, whether it is more beneficial to cooperate or not based on profitability/costs. This game will be between two different well-established banks (to be determined) and their decision whether to cooperate or to compete, using Signaling Bayesian game theory. The banks can signal different approaches for technologies such as product and technology development, marketing, R&D, cost reduction mechanisms, and type of management. The exact signaling strategies will be extracted further from the above literature review.

6.2.4: Game Four: Cooperation versus Competition – Bank and Government

The final game is based on Signaling and Pooling Bayesian to understand the effect of government and its regulation on the banks decision to help with financial inclusion. This game is split into two sub-games: symmetric and asymmetric information. There are three signals for this three-player game (nature as a pseudo player, government, and banks): regulation change and incentive for banks' to be included in financial inclusion, cooperation between the government and banks, and deregulation and disincentive for the use of technologies in financial inclusion. The assumptions of this game could vary due to the use of

e-government and the internet as predictors of socio-demographically, geographically, and economically; other assumptions could include that women are more inclined to use the internet rather than e-government and men do not have certain preferences. It should be noted that with the interference of government in this game, all the uses of Blockchain will be permissioned.

The comparative analysis will be implemented between the symmetric and asymmetric games to understand the value of information as well as its effects on the use of technological use.

6.2.4.1: Game Four – Variation: Cooperation versus Competition – Bank and Other FinTech Company

Signaling and Pooling Bayesian games should also be implemented on the cooperation versus the competition between Banks and other FinTech companies rising. This variation helps us understand the implication of banks working against or with FinTech companies, such implications could include profitability of data, focus on key areas of development rather than everything as a whole, and much more. The assumptions of this game should be kept as the original game presented above. The game should also be played as a symmetric and asymmetric game with a comparative analysis being held at the end to understand the difference between an agreement between both and pure competition.

6.2.4.2: Game Four – Variation: Cooperation versus Competition – Government and other FinTech Company

The aforementioned game could also be varied through a final Signaling and Pooling Bayesian to understand the impact of cooperation between governments and other financial institutions. This game should be played as a three-player game with symmetric information as the government and the FinTech Company should have an agreement that could be placed. The assumptions of this game should be kept as the original game presented above.

6.3: Data collection

Each of the games has a different angle for understanding technological use. As a result, each of the games have a different set of assumptions and strategies, as well as payoffs, and implications and policy recommendations. It is important to understand where, why and how these will be calculated. Accordingly, the rest of this section aims to explain where the aforementioned characteristics of the games will be determined.

6.3.1: Assumptions and Strategies

Using the theories stated in the literature review, such as incorporation of e-payments and different technologies to reduce costs, increase in trust and transparency, and security. For example, an assumption for the third game – cooperation versus competition between banks – could be that there is a certain amount of unbanked peoples due to costs of transactions and accessibility. Banks in this case can strategically implement online banking and Blockchain-based applications for transaction verification and payments. The main theme of most games is to understand the underlying effect of technologies as an oppose to not using them at all. According the strategy is always going to be directed in the same direction; banks will invest in either marketing strategies to ensure their brand name, or R&D for product and technology development to further reduce costs. As for governments, there are two assumptions: the government will have an advantage in information or not. The strategies include, but are not exclusive to, creating regulations and incentives allow for the use of Blockchain and IT in banking to contribute to financial inclusion, deregulation and disincentive of the use of Blockchain and IT, and cooperation with banks to allow of financial inclusion as an initiative.

Assumptions such as technological use allows for more peoples to be included in the formal economy, and governments and banks play with nature (recession or boom) to determine their suitable strategy. More specific assumption should also be included to cater for each of the games proposed above, such as the use of ICT and Blockchain is always profitable in key areas of banking sectors namely transaction use.

6.3.2: Payoffs

As for the payoffs, they differ for all the games. For the first game, the payoffs will be calculated based on the average profitability/tax revenues as more people are included in the economy. For computation, a simple forecast (regression) should also be implemented to understand the impact of how many people will be included based on income, inflation, taxes, subsidies, and other macroeconomic factors.

On the other hand, the second game is much simpler. Banks' payoffs will be either the summation of number of transactions (positive or negative relevant to actuals from banks), relevant transaction costs (also based on actuals from banks), or profits made by well-known and established multi-national banks within Egypt specifically. Profits would be the most ideal; since in the third game, the payoffs would be based on relative profitability of a certain strategy, which will be taken from banking statements and forecasts.

For the final game, forecasts of each of the three signaling strategies will be determined through parametric estimation and characterization used in most of the literature. Some calculations will also be based on the calculations within the characterization literature mentioned above. Banks will have payoffs based on maximization of profits in the three given strategies given the macroeconomic indicators examined in other regressions.

6.4: Another Possible Extension: Sensitivity Analysis

Another possible extension to the game theory and econometric frameworks presented above is a sensitivity analysis that could possibly identify the full impact of regulatory changes on the future of profit margins and value of know-how in terms of technology. Sensitivity analysis focuses on the change of one variable to see the difference or impact it causes on the rest of the variables.

The suggested sensitivity analysis would be the introduction of a regulatory body that purely deals with technological use in financial institutions and markets.

Section 7: Policy Recommendations

In order to form a well-rounded and coherent policy recommendation, one must understand the problems in which countries face. In the case of Egypt, the country lacks the correct labor skills, proper infrastructure, financial and technological literacy, awareness towards e-commerce and mobile payments in general, and proper regulation by the government. These recommendations are proposed in order to improve the use of Blockchain and IT within Egypt through different means that contribute directly to their use by the financial sector and governments alike.

The results have also pointed towards the same issues being mentioned; there is great space for development of technologies within Egypt. Notably, there should be corresponding policies in order to allow for this development. Therefore, the policy recommendation focuses on the improvement of Egypt's abilities to further use Blockchain and information technology rather than the Egypt's use of Blockchain and information technology. Like in any economic field, there should be sustainable growth of industries in healthy methods that allow for further growth rather than establishment with no foundation. The policies mentioned below focus on (1) labor market that allows for the development of the Blockchain and information technology industry, (2) proper technological infrastructure, (3) financial and technological literacy, (4) awareness and incentives, and (5) proper regulation and partnerships/outsourcing. All five policy recommendations are root problems of the lack

of growth within the Egyptian market and when fixed can allow for a boom within the industries of technology.

Firstly, Egypt should match skills with the currently needed skillsets required for the market. Since 2016, Egypt is in the process of digitalization of the government, taking away important aspects of growth from other MENA region countries such as the UAE. By digitizing the government, Egypt cuts down the possibility of corruption, bureaucracy, and improves its efficiency. As highlighted above, the use of Blockchain or Information Technology, not only provides a leeway for the preservation of transactions, but also it preserves the identities of individuals as they please through cryptographically encrypting their data. In order to match the full potential of the government and its aim of digitization, there should be a skillful labor force in order to accompany it. By labor force, there is a specific request for a skillful set in terms of technology included but limited to Blockchain programming, Management Information systems, and User Experience (UX) and User Interface (UI) design. As a recommendation to the Egyptian government, it should be noted that trainings, capacity-building workshops, and government-sponsored fellowships scholarships have an impact on the labor market. Trainings and capacity-building workshops for labor, as well as job-shadowing programmes, could help develop, not only government employees, but also the entire labor force to be more aware of technological use. Government-led fellowships and scholarships to universities abroad or private institutions in subject matters that concern computer science and engineering could also be a mechanism in order to fully optimize the potential of those entering the labor market.

Secondly, the creation of proper technological infrastructure – including the internet of things (IoT), databases, platforms, computing, telecommunications, and smart cities – would have a great impact on the usage and implementation of future technologies. Improvements in internet speed, freedom of searching on the IoT, and the creation of different platforms and databases is crucial for the development of a countries GDP in the technological age. With proper technological infrastructure, there could also be environmental and socio-economic benefits, for example a decrease in pollution, increase in awareness and many more.

Thirdly, combatting financial and technological literacy, as well as literacy in general, helps to alleviate the underutilization of technological resources that are provided and increase the chances of success in newer systems. There is a possibility that e-payments tools are widely available; however, when combined with financial and technological illiteracy, citizens of a country would never be able to comprehend such systems unless they have the

minimum financial and technological literacy required. In Egypt specifically, poor English language scored on the higher spectrum when citizens were asked about their lack of technological and mobile penetration, indicating that there is a general need for educational improvement. However, there are many different solutions such as establishing applications by banks and FinTech companies that deal with the poor English language through changing into the Arabic language, providing instructions in Arabic, and other solutions. As for financial and technological literacy, banks and financial institutions could have tutorials and information sessions during long waiting periods for their customers, additionally they could also incentivize them by adding not barriers to entry in the technological realm such as minimum requirements to establish mobile accounts. Through trainings on Blockchain and information technology, citizens will then understand the key areas in which these technologies try to focus on; (1) trust; (2) reputation; (3) validity; and (4) data security.

Fourthly, there is lack of awareness towards e-commerce and mobile payments on a wider-scope. Lack of awareness in Egypt had scored 65% of the reason for their lack of resource mobilization in terms of e-payments. Unrecognition of electronic contracts by Formal Parties had also scored highly in terms of the lack of resource mobilization in terms of e-payments. Regulatory requirements that pertain to the awareness and marketing of technological solutions should be enforced by the government. Incentives such as tax holidays on salary taxes for those who establish accounts for payroll should also be established in order to lure people into the formal financial market.

Finally, the government should also formulate proper regulation in order to focus on consumer protection and market stability of technologies, especially in the sphere of information technology. A new separate regulatory body should be established to focus on these two main aspects of the technology with a framework that does not allow for any misuse of information – whether consumer or company – and should allow for the testing and verification of new products in the market to ensure its quality standards reach up to the global standards. The regulator should address the fears pertaining to financial transaction and personal data disclosure, as well as the lack of data security mechanisms over the internet in which causes a number of individuals to avoid technological use, especially in the financial sector leading to a larger number of those unbanked or financially excluded from the system.

Furthermore, there should also be a regulator body in order to manage the digital world of finance. This requires that the banking sector and FinTech companies all over the country to be treated equally with the same framework for data security, testing of products, and investment encouragement for this sector to further develop itself. Regulators should also

focus on the convergence towards innovative methods of productivity and increases in competitiveness through the divergence from traditional methods. Building a technological tree to safeguard a pathway for FinTech and banks alike to develop its innovative capacities in the form of healthy competition could allow for outsourcing and partnerships to enhance digital offerings. Outsourcing and partnerships such the ones we see between the Government and multi-national companies such as IBM and Vodafone to implement information systems, Blockchain systems, and other e-payment systems empowers these sectors and the government to improve its quality of work, ease payment and information systems, and ensure the data security of the transactions.

Section 8: Conclusion

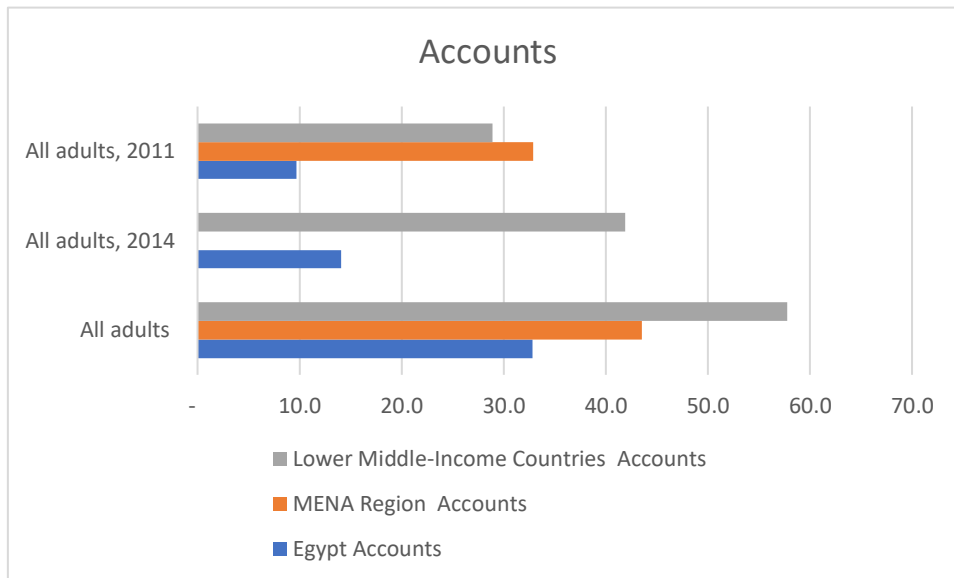
In order to reap the full benefits of Blockchain and information technologies, countries should focus on the sustainable development of its technological sectors in order to avoid regulatory chaos. Benefits including cost reduction and higher efficiency are what should be focused on at the present time; meanwhile, drawbacks such as security and other risks could be easily avoided with the correct regulatory measures in force. Egypt – and the MENA region – should all focus on harboring their available resources, most importantly its labor. The development of smart cities and new regulatory frameworks such as those proposed by the UN and the OECD should guide regulators in the direction the future is heading.

In the case of Egypt, there is a lack of information provided to understand the positive and negative consequences of technological introduction. However, statistics have cleared up some of the underlying questions that have caused results to be vague. The strategic use of Blockchain and information technology is one in which countries should follow with the right measures, the world is moving into a new technological era that encompasses more than just Information Technology and Blockchain, but encompasses Artificial Intelligence and more, which could only be established through the sustainability of our current resources.

Profitability of data and its value in specific can allow nations to utilize its maximum capacity through the use of disruptive technologies, which specifically focus on core issues. Among these core issues are lack of trust, alleviation of the middleman, decrease in human errors and a validation method of information and data alike. In principle, these technologies – if built in the most sustainable method possible – could lead into the growth and development in economies in a manner in which the world is yet to explore.

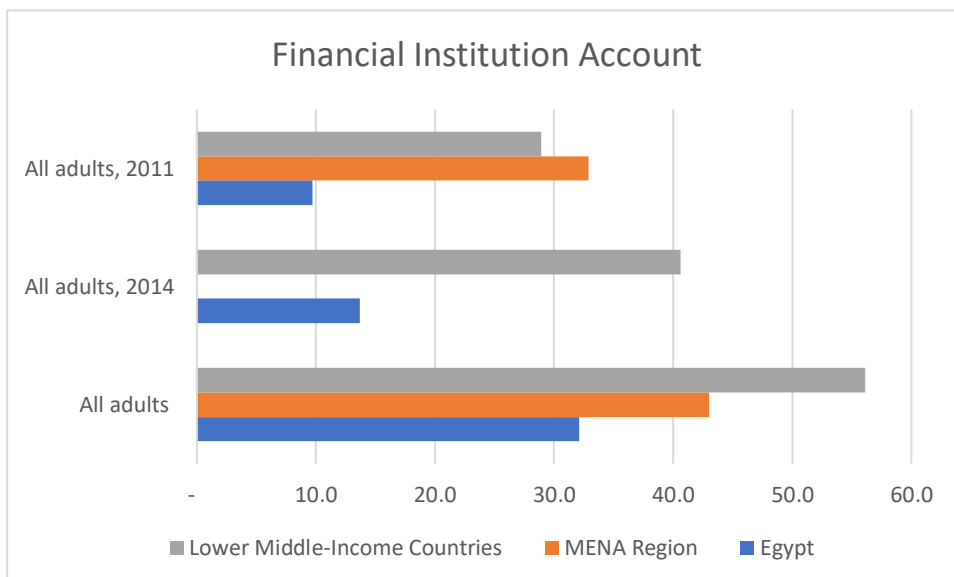
Annex: Graphs and Results

Graph 1



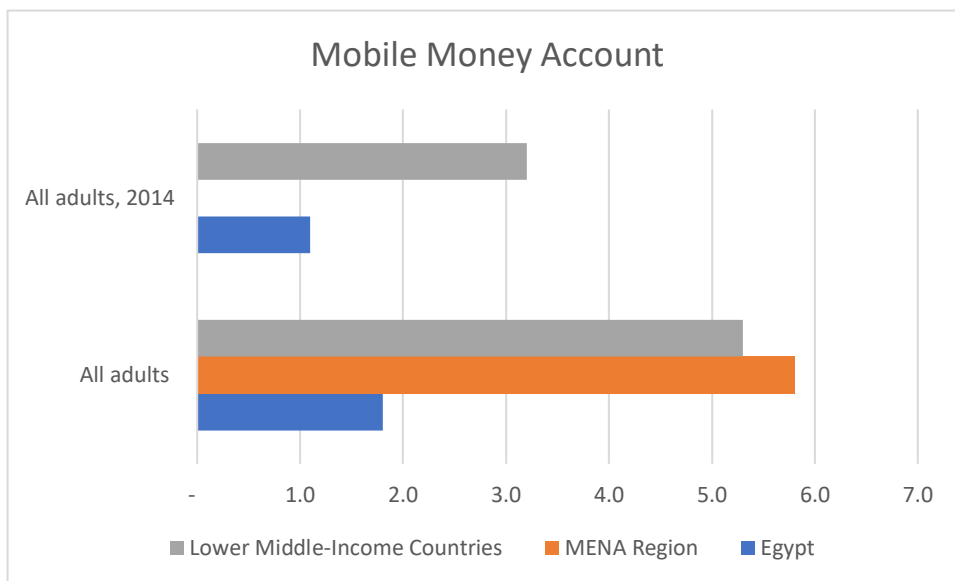
Source: World Bank, *The Little Data Book on Financial Inclusion (2018)*

Graph 2



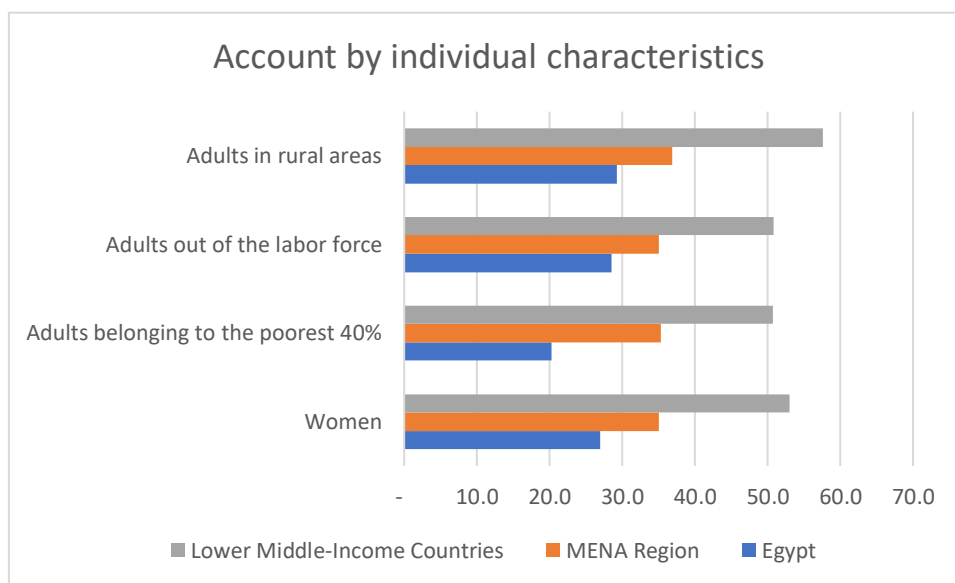
Source: World Bank, *The Little Data Book on Financial Inclusion (2018)*

Graph 3



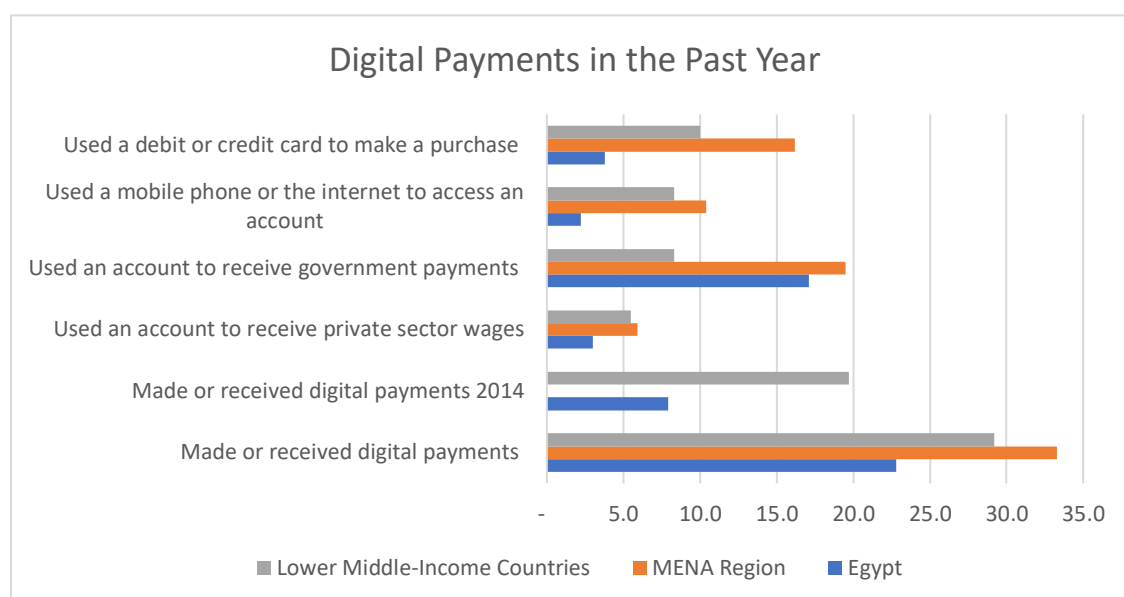
Source: World Bank, *The Little Data Book on Financial Inclusion (2018)*

Graph 4



Source: World Bank, *The Little Data Book on Financial Inclusion (2018)*

Graph 5



Source: World Bank, *The Little Data Book on Financial Inclusion (2018)*

Table 1: Pooled Panel

Dependent Variable: VALUEKNOWHOW

Method: Panel Least Squares

Date: 01/22/19 Time: 14:53

Sample (adjusted): 12/07/2008 12/07/2018

Periods included: 121

Cross-sections included: 12

Total panel (unbalanced) observations: 1349

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-0.251994	0.119300	-2.112277	0.0348
SCOREOFKNOWHOW	0.956905	0.007619	125.6021	0.0000
PROFITMARGIN	0.040345	0.007688	5.247649	0.0000
R-squared	0.993053	Mean dependent var		24.28874
Adjusted R-squared	0.993043	S.D. dependent var		44.68359
S.E. of regression	3.726956	Akaike info criterion		5.471282
Sum squared resid	18696.21	Schwarz criterion		5.482862
Log likelihood	-3687.380	Hannan-Quinn criter.		5.475619
F-statistic	96209.99	Durbin-Watson stat		0.088336
Prob(F-statistic)	0.000000			

Source: Eviews Calculations

Table 2: Random Effects

Dependent Variable: VALUEKNOWHOW
 Method: Panel EGLS (Cross-section random effects)
 Date: 01/22/19 Time: 15:02
 Sample (adjusted): 12/07/2008 12/07/2018
 Periods included: 121
 Cross-sections included: 12
 Total panel (unbalanced) observations: 1349
 Swamy and Arora estimator of component variances
 Cross-section weights (PCSE) standard errors & covariance (d.f. corrected)

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.682762	0.408481	1.671466	0.0949
SCOREOFKNOWHOW	0.973930	0.004082	238.6052	0.0000
PROFITMARGIN	-0.011001	0.005007	-2.197275	0.0282
Effects Specification				
			S.D.	Rho
Cross-section random			1.098738	0.0917
Idiosyncratic random			3.458593	0.9083
Weighted Statistics				
R-squared	0.955063	Mean dependent var		6.804566
Adjusted R-squared	0.954996	S.D. dependent var		16.60126
S.E. of regression	3.530647	Sum squared resid		16778.52
F-statistic	14303.49	Durbin-Watson stat		0.096117
Prob(F-statistic)	0.000000			
Unweighted Statistics				
R-squared	0.991825	Mean dependent var		24.28874
Sum squared resid	22003.23	Durbin-Watson stat		0.073294

Source: Eviews Calculations

Table 3: Hausaman Test

Correlated Random Effects - Hausman Test

Equation: EQ01

Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	58.577379	2	0.0000

Cross-section random effects test comparisons:

Variable	Fixed	Random	Var(Diff.)	Prob.
SCOREOFKNOWHOW	0.959994	0.973930	0.000017	0.0006
PROFITMARGIN	-0.045463	-0.011001	0.000024	0.0000

Cross-section random effects test equation:

Dependent Variable: VALUEKNOWHOW

Method: Panel Least Squares

Date: 01/22/19 Time: 15:00

Sample (adjusted): 12/07/2008 12/07/2018

Periods included: 121

Cross-sections included: 12

Total panel (unbalanced) observations: 1349

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	1.986080	0.249270	7.967574	0.0000
SCOREOFKNOWHOW	0.959994	0.010937	87.77181	0.0000
PROFITMARGIN	-0.045463	0.011537	-3.940681	0.0001

Effects Specification

Cross-section fixed (dummy variables)

R-squared	0.994067	Mean dependent var	24.28874
Adjusted R-squared	0.994009	S.D. dependent var	44.68359
S.E. of regression	3.458593	Akaike info criterion	5.329924
Sum squared resid	15969.09	Schwarz criterion	5.383964
Log likelihood	-3581.034	Hannan-Quinn criter.	5.350163
F-statistic	17205.18	Durbin-Watson stat	0.099866
Prob(F-statistic)	0.000000		

Source: Eviews Calculations

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