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by

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ESSAYS ON

ETHICS, RELIGION AND FINANCE

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to Ali Kheireddine (August 25, 2013)

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"سوق المسلمين كمسجدهم [...]"[1]

علي بن أبي طالب

[The Muslims' market is similar to their mosque]

Ali b. Abi Talib

[1] Al-Kafi 5:155

Chapter 1

General introduction

My thesis consists of three chapters, thus three papers studying different questions related to ethics, religion and finance.

The topic of ethics is getting more attention in economical and financial research and practice. Ethical standards are the root principles of Islamic Finance (IF). Financial contracts in IF reflect an Islamic philosophy based on justice and morals, where the main pillars are the reliance on profit-and-loss sharing structure and proscription of usury. However, this doesn't necessarily mean that the application of these financial contracts in practice maintains the goal. Apart from the philosophy of foundations, IF is considered to have an ESG friendly scheme especially towards the social component. The structure of IF contracts is based on social justice and the stream of investments is mandatory to follow Shariah rules that prohibit harm to the environment and mankind. The ethical and social background of IF is the main motivation behind this thesis. I try to answer three main questions in three chapters covering effect of IF on tangible economic growth, adaptation of Islamic bonds in blockchain and honesty level of religious people in conducting financial transactions.

Chapter One

In the first chapter, we measure the effect of change in Islamic Banking assets on the economic growth of countries. Islamic Finance experienced a tremendous increase in size from USD 386 Billion in 2006 to USD 1.9 Trillion in 2016. The global financial crisis offered Islamic Banks (IBs) an opportunity to show their resilience being a relatively safe alternative investment. IBs wre better capitalized, had higher asset quality and lower disintermediation than

conventional banks (CBs) during the last financial crisis. Islamic banks, as expected, mainly exist in countries with Muslim majority population, however this concept is developing in other countries as well. The interest in Islamic finance increased in European countries accordingly. Currently, more than twenty banks in the UK and eight banks in the EU (France, Switzerland and Germany) offer Islamic financial services.

We measure the effect of growth in Islamic Banking assets on economic performance in a sample of 32 developed and developing countries based on data spanning from 2000 to 2017. The findings show that, although Islamic banks are considered a small part of the total financial sector, they still are positively correlated with economic growth even with the control imposed on the financial structure, macroeconomic factors and other variables. The outcome is robust across different econometric specifications like pooling OLS, fixed effects and panel data with over-identified GMM. The results are confirmed on two different indicators of Islamic banking and were held for different periods.

Empirical findings confirm theoretical expectations that although Islamic banking still represents a relatively small part of the financial system, it is growing, generating an economic boost and ensuring a stable banking industry. At the empirical level, this chapter confirms results of previous studies like Imam and Kpodar (2016), Ali and Azmi (2017), and Boukhatem and Ben Moussa (2018), but it also highlights the shortcomings of existing studies, which fail to address potential endogeneity problems. Furthermore, the results in this study are more powerful as they are robust under various conditions. First, Islamic banking indicators were measured by two variables, the percentage of total assets with respect to the whole banking sector and the number of institutions as an alternative variable. Second, different econometric estimators (pooling OLS, fixed effects and over-identified panel GMM) revealed significant connections. Third, results are coincided upon using new data sources for banks, different from what has had been used in literature.

Chapter Two

The second chapter introduces a novel, exploratory analysis of sukuk or Islamic Bonds tokenization based on a case study. Sukuk is a financial instrument that provides returns similar to conventional bonds. It has served to cater to the capital requirements of big corporations and governments, while circumventing interest to adhere to the Shariah law. Sukuk can be touted

as Shariah-compliant bonds that rank amongst the most successful and the fastest growing financial instrument in the Islamic economy. The sukuk research area is marked by a dearth of quantitative literature, compared to qualitative academic works. This chapter seeks to fill this existing gap.

The funding needs of small and medium enterprises remains largely unmet through sukuk on account of the high costs involved, among other reasons. Sukuk has immense potential to fund startups and small and medium enterprises (SMEs). However, sukuk issuance remains confined to large corporations and governments, with the primary target market being large investment funds. The smallest issue is still limited to millions with capital needs of SMEs and startups in the IF domain remaining largely unmet through sukuk. The employment of sukuk for funding SMEs can help to expand the Islamic economy and increase the user base.

The evolution of modern technologies poses a threat to the finance industry and consequently to IF. Blockchain is one of the main inevitable disruptions. IF needs to adapt to such disruptive trends, otherwise there is a high risk of losing an existing client base. Blockchain threat is in fact an opportunity for the sector to reinvent the established methodologies by incorporating novel technologies to progress ahead of the financial technology startups.

As we show in this chapter, blockchains can aid to lower the cost incurred through the tokenization of sukuk. We highlight some of the key challenges involved in the issuance of sukuk and discuss their solutions using blockchain. We also provide a taxonomy of blockchain applications in finance, with a particular focus on Islamic finance. The chapter reviews different blockchain architectures to assess their viability for tokenization. We conduct a novel case study on sukuk tokenization by implementing a basic smart contract for Sukuk al-Murabaha on Ethereum. We program the necessary conditions like payment frequency, registering investors, automating the periodic payments to the investors while getting the deferred payment amount from the purchaser of the Murabaha asset. The chapter concludes by a conceptual analysis of feasibility concerns, based on a comparison of the conducted cost-benefit analysis of conventional sukuk issuance with tokenization.

Chapter Three

The third chapter is an experimental study tackling the effect of religion on fraud when

there are monetary incentives. Previous research shows the willingness of clients to work with Islamic banks, promoted as ethical banks, despite their services being more expensive compared to conventional banks because of their social responsibility and transparency. Moreover, Islamic banks abide by a parallel regulatory system, legal and religious, which creates additional complications and opens the door for clients to take advantage. The need of the mutual trust relationship in this ethical financial contract motivated me to research the effect of religion on fraud.

I conduct a dice-under-the-cup experiment on two samples of 581 volunteers to measure honesty in Lebanon among religious and non-religious individuals. Payoffs ranged between 1 and 6 US Dollars. This amount is not trivial, as six Dollars correspond to 17.8% of the monthly minimum wage in Lebanon during the experimental period due to the economic crisis. The experiment was repeated to analyse the priming effect of reminding participants with their religious teachings before conducting the experiment.

I then carry out a mind-game experiment on two samples of 470 volunteer participants to further analyze the honesty differences between the religious and non-religious. I repeat the experiment to analyze the self-reputation effect on honesty. In the second sample, participants carried out the same mind-game experiment as individuals in the first sample, but in a room with no-one else present. There was only a table with the instructions, a dice, the questionnaire and the money. I expect participants with greater self-reputation concerns to cheat more in this experiment. The remaining honesty behavior should reflect intrinsic values.

Overall, the findings of the dice-under-the cup experiment show that the religious cheat less on average than the non-religious. In the first experiment, 6.9% of the non-religious maximize their income by selecting 6 as their outcome, and 9.8% lie partially by picking number five; their average reported dice score is 4.4. The religious in this experiment cheat less, with an average figure of 3.7 (which is very close the fair-dice score of 3.5), 2.4% partial liars and 2.4% income maximizers. In the second experiment, the religious are honest and report an average outcome corresponding to the fair dice. However, 16% of the non-religious are income maximizers and 8% partial liars. This may reflect the priming effect of the religion question reminding participants of their internal beliefs before they take their decisions. This religious priming effect in similar experiments has not been tested in the literature to my knowledge.

The findings of the mind game confirm that the religious cheat less, even when there is no chance of being caught and when they have no self image to lose. In the first experiment, 9.8% of the religious and 19.5% of the non-religious cheat in order to receive the additional 5 USD. Controlling for the self-reputation effect, 15.2% of the religious and 32.5% of the non-religious lie to maximize their income. The mind game explains part of the honesty behavior in the dice-under-the-cup experiment by worries about being caught cheating and self-reputation, with the non-religious giving more weight to these concerns.

Chapter 2

Islamic Banking and Economic Growth

2.1 Introduction

Islamic finance is one of the fastest growing segments in global financial services. It has become important in many markets and too big to ignore in others. Total assets of Islamic Banks (IBs) increased from USD 386 Billion in 2006 Mohieldin (2012) to USD 1.9 Trillion in 2016 Board (2017).

The global financial crisis offered IBs an opportunity to show their resilience being a relatively safe alternative investment. IBs were better capitalized, had higher asset quality and lower disintermediation than conventional banks (CBs) during the last financial crisis Beck et al. (2013). There is a strong evidence that IBs were more cost efficient than CBs during the crisis Dridi and Hasan (2010). As a consequence of the GFC, new IBs inaugurated their business, some CBs have converted into Islamic, and several multinational banks have established Islamic windows. Islamic banks, as expected, mainly exist in countries with Muslim majority population, however this business is developing in other countries as well. The interest in Islamic finance increased in European countries accordingly. Currently, more than twenty banks in UK and eight banks in EU (France, Switzerland and Germany) offer Islamic financial services. The industry is expected to grow in the EU after the "Brexit" Masiukiewicz (2017).

Some of the work introduced IBs as an alternative financial intermediation system able to attain the role of conventional banks (CBs) with more security Al-Bahar (1999); Iqbal and Mirakhor (2012). Others argue that they both complement each other by balancing debt-based and asset-based financing Ali and Azmi (2017); Imam et al. (2010). Islamic finance is not only

limited on commercial services, but it includes as well investment banks, insurance companies, and leasing services. The expansion of new financial products, such as equities, Sukuk (Islamic bonds) and Takaful (Islamic Insurance), has also extended the range of facilities available.

There is mounting evidence that the financial sector performance enhances economic development ever since Schumpeter (1911). A well-established banking system supports mobilize savings, enables capital allocation to high return projects, monitor investments wisely, and allows for diversification of risk. However, do these findings of the relationship between financial sector and economic growth apply for Islamic banking? Following Levine and Zervos (1998) and Beck et al. (2000), this chapter analyzes the effect of Islamic Banking on economic growth in an attempt to explore this emerging banking system.

Empirical findings needs to confirm theoretical expectations that although Islamic Banking still represents a relatively very small share of the financial system, yet it is growing generating an economy boost and insuring a stable banking industry. This is because they are less prone to financial markets shocks, closer to tangible economic activities and attracts savings and investments of devout Muslims thus enhancing economic cycle.

Iran and Sudan are the only countries that applied Islamic Banking solely. Yazdan and Sadr (2012) use time series methods to evaluate the aftermath of this change on the economy of Iran. Although, Iran had an endogenous shock, from 0% to 100% of Islamic Banking system after the crisis, but it is hardly to consider this case as a model to study. Mainly economic sanctions, political closeness and missing data are factors that complicates any empirical work to study the impact of financial system conversion on economic development.

This chapter complements previous literature by evaluating the impact of the size of Islamic banking on the development of economy using a panel data of 32 countries between 2000 and 2017. The results show that bigger portion of IBs' total assets is positively associated with better economic performance even after controlling for various determinants, including the level of financial depth, macroeconomic factors and oil prices. The results are robust across different econometric estimators including pooling OLS, fixed effect and GMM.

The chapter consists of six sections. In the next section, a background on literature review covers how Islamic banking developed, their distinguished features, and how conventional and

Islamic banking systems have been connected to economic growth. The third section presents the data, the fourth section explains the methodology, the fifth section shows the empirical results, and finally the sixth section concludes.

2.2 Background

2.2.1 Islamic Banking Development

The main elements of an IB, mainly the prohibition of Riba (interest) and other Shariah requirements exist since the religion itself, but they were formalized in the IB modern system in 1960s in Egypt. Imam et al. (2010) argue that the contemporary model of Islamic banking is stimulated by two main reasons. First, to attract the savings of devout Muslims who would never participate in prohibited transactions. Second, to finance agricultural and industrial projects in a profit-loss sharing context. Only two countries, Iran and Sudan, have applied Islamic banking as an exclusive financial intermediation in 1980 and 1991, respectively, while the majority of other Muslim countries have both CB and IB.

The increasing trend of IBs in these countries is unarguable. For instance, Ernst and Young "World Islamic banking Competitiveness report" revealed that the Gulf Cooperation Council (GCC) region experienced a 16% increase in the participation of Islamic banking assets between 2010 and 2014. By 2015, IBs acquires 34% of banking assets in the GCC. The report also expects a 17% annual growth rate for IBs total assets thus overshadowing the conventional banking in some countries.

In general, the size of IBs in datasets is still underestimated. Databases specialized in banking sector (e.g. Bankscope) define banks to be either Islamic or conventional. However, many CBs currently have Islamic windows but do not disclose this business separately. Hence, Islamic banking assets in conventional banks are considered conventional in main databases.

On a global level, this industry still does not comprise more than 1% of total banking assets worldwide according Credit Swiss Global Wealth Databook in 2013. However, it is growing fast and is expected to attract more investors especially from non-Muslim countries because of its characteristics.

2.2.2 Banking Performance and Economic Growth

The relationship between economic growth and financial development has been of interest of researchers ever since, but the evidence is mixed. Schumpeter (1911) highlights the impact of the banking sector on productivity growth and technological innovations. Since then, financial economists study financial performance, besides physical and human capital, as a main indicator of GDP per capita. For example, Caves (1974) and Shaw (1973) investigate the significance of banking performance for long-term economic growth through the impact of financial development on technological changes. Bencivenga and Smith (1991), Levine (2005) and Greenwood and Sanchez (2010) find evidence for a positive influence of financial systems on economic growth through assembling savings and efficient allocation of resources. Greenwood and Jovanovic (1990), Saint-Paul (1992) and Xu (2000) argue that better financial performance leads to higher return investments through risk sharing. Bencivenga et al. (1995) and Esso (2010) indicate that the banking sector has more positive impact on economic growth in more developed countries.Beck et al. (2000) and Bordo and Meissner (2006) argue that countries with a more efficient financial systems are more resilient in crises and are less exposed to economic disturbances.

In contrast, Robinson (1952), Kuznets (1955), Lucas and Robert (1988), Stern (1989), Chandavarkar (1992), Stiglitz (1993), Singh and Weisse (1998) dispute that financial intermediation performance has an important effect on economic growth. According to them, the relationship is overstressed in the literature. Empirically, Ben Naceur and Ghazouani (2007) find negative impact of banking development on GDP per capita using a panel data with GMM estimators on 11 countries. This surprising result may be linked to underdeveloped financial systems in the MENA countries. Petkovski and Kjosevski (2014) also find a negative relationship between financial indicators and economic growth. They measure credit to the private sector and interest margin in 16 economies.

Other Authors study this relationship using different econometric techniques, mainly cross-sectional, time series, panel data, and firm level analysis. King and Levine (1993) use cross-sectional analysis on 77 countries between 1960 and 1989. They test the influence of financial system indicators, specifically credit to private sector and liquid liability on the change of GDP.

The outcome is that better banking indicators results in higher economic growth. Beck et al. (2000) use dynamic panel techniques on a sample of 72 countries between 1960 and 1995 to prove that banks exert a substantial positive impact on GDP growth. Levine and Zervos (1998) examine the impact of banking sector development, measured by credit to private sector, on GDP growth. They use panel data with GMM estimator on 42 countries between 1976 and 1993 to show a significant positive correlation. Cole and Wu (2008) observe 18 countries between 1973 and 2001 using dynamic panel data to find a strong positive effect of profitable banks on GDP growth. In addition, Hasan et al. (2009), Zhang et al. (2012) and Bittencourt (2012) use panel data time series to prove a positive relationship between banking performance and GDP per capita.

2.2.3 Islamic Banking and Economic Growth in Theory

Connecting Islamic banking to economic growth has been discussed recently in the literature. Theoretically, IBs and CBs share the main characteristics of financial intermediation. They allocate resources Levine (2005), delegate monitoring Diamond (1984), mobilize savings Levine and Zervos (1998), and facilitate intermediations. Both business models follow the capital structure model of Modigliani and Miller (1958). Accordingly, it is expected that IBs will influence economic growth in the same direction as CBs. Interestingly; there are some features for IBs that gives an advantage for a better economic development. However, it might still be early for IBs' distinct structures to create an impact on macroeconomic level because the industry is still emerging and not yet fully mature Imam and Kpodar (2016).

Islamic banking theorists promote this business as asset-based and profit sharing rather than equity-based and fixed interest Iqbal and Mirakhor (1987). Islamic banks follow the concept of profit sharing and loss bearing because work as a partner of the client on a specific project and share profits and losses on pre-agreed proportions. This originates from the Islamic philosophy, which is based on justice, that no one can have a profit from other's loss. In this case, the incentives of both sides is allied for more monitoring. In principle, this feature means that borrowers can approach the Islamic Bank without guarantee/collateral. This is not accessible in conventional banks. The risk-sharing model insure an agreement on the profits/losses without recourse to collaterals. Despite introducing new risks, this rises investments. Easterly and Levine (2001) explain that productivity development has an important role in economic growth.

Another advantage for IBs is to pool savings from devoted Muslims who are unwilling to participate in financial transactions prohibited by Islam. Religious value is the primary factor for selecting IBs among clients in Muslim majority countries Ahmad et al. (2011); Al-Ajmi et al. (2009); Amin (2008); Idris and Naziman (2011). Hence, IBs allocate more resources and mobilize higher savings by including new segment of population to financial market. In this sense, IBs augment new funds to the financial system regardless of their business model or their benefit to the economy.

Scholars have discussed extensively different reasons on characteristics that make an IB less vulnerable to risk than a CB Asutay and Turkistani (2015); Čihák and Hesse (2010); Errico and Sundararajan (2002); Iqbal and Llewellyn (2002); Venardos (2010). First, according to Smolo and Mirakhor (2010), IBs do not possess balance sheet mismatches, as short-term deposit finance short-term trading, and long-term deposits are used for long term investments. Second, IBs can pass through a negative shock on the asset side (Murabaha loss) to the investment depositors (Mudaraba provisions). In other words, the risk-sharing provisions afford additional security to the bank. Thus, better capitalization combined with higher liquidity reserves have helped IBs to perform better than CBs in the GFC. Third, Čihák and Hesse (2010) stressed that IBs tend to be more conservative and less risk taking. They have to provide stable and competitive return to investors. Fourth, investors have additional inducements to exercise close oversight over bank management since they are sharing in the risks. Fifth, IBs typically hold reserves comparatively in larger proportion of their assets than CBs. Sixth, derivatives and toxic assets are prohibited. These reasons make IBs better poised than CBs to absorb external shocks as investors absorb part of the financing losses Iqbal (1997).

Finally, the common element of Islamic teachings is to create an economy of justice, moral social order and to fight poverty. The accentuation on relating income with real economy and not with money speculation or debt interest is for this purpose. Thus, IB system should be in principle grounded on moral standards which rejects all kinds of financing that are hurtful to the society. All these advantages of IBs contributes to economy development. This is measured in countries that experienced a significant increase in Islamic banking assets.

These differences lead to an expectation that IBs should have a positive impact on economic growth or even a better impact than conventional banks. The objective of this chapter is to

show how does the influence on economic growth change as IBs takeover additional part of the financial system.

2.2.4 IBs and Economic Growth in Empirical Studies

Johnson (2013) use 2SLS regressions on sixteen IBs between 1960 and 2006. She finds no significant correlation between IB and GDP per capita. Her results do not cover the post crisis period when the main growth of IBs occurred. However, Daly et al. (2016) use OLS to study a sample of 120 IBs and CBs between 2005 and 2012. Their analysis reveals that the development of interest-free banks supports economic growth. Boukhatem and Ben Moussa (2018) build a panel data of thirteen countries in MENA from 2000 till 2014. They measure the effect of IB loans on GDP per capita and find significant evidence that IB loans boost economic performance. Their data reveals that underdeveloped institutional frameworks curb this impact. Yazdan and Sadr (2012) find a bidirectional correlation between IB development economic growth both in the short and long run in Iran and Indonesia using quarterly data between 2000 and 2010. Mohagheghniya et al. (2014) assume an Autoregressive Distributed Lag and VAR approach to conclude a significant positive effect of IB financing on the GDP of Iran between 2000 and 2010.Imam and Kpodar (2016) use fixed effects and System GMM to show a positive impact of IBs on economic growth in low and middle-income countries between 1990 and 2010. Most recently, Ali and Azmi (2017) use a sample of 21 countries in the period of 2007–2013 to show that, even though IBs are relatively smaller in scale than CBs, they are conducive to economic growth but do not influence economic volatility.

In similar studies, Gheeraert and Weill (2015) evaluate the influence of IB credits on macroeconomic efficiency using the stochastic frontier approach in a sample of 70 countries between 2000 and 2005. Tabash and Dhankar (2014) analyze the relationship between IB performance and economic growth in the United Arab Emirates and Qatar. Using time series data from 1990 to 2010, they find that IB credits contribute to higher investments in the long run.

Therefore, authors have used various empirical techniques including cross sectional time series to reveal the relationship between Islamic Banking and economic growth. However, none of the literature examined the effect of the portion of IBs assets in the financial market on the GDP. Moreover, this is the first study that comprehend a period of time with the financial crisis

being the median. Finally, this chapter uses static and dynamic GMM to robust the results in addition to the standard fixed effects model.

2.3 Data

2.3.1 Data and Measurement

The objective of this chapter is to measure empirically the effect of Islamic banking on economic growth. A panel of 32 countries is constructed with data on banks spanning the period 2000 to 2017. Sixteen countries have a strictly positive percentage of Islamic banks in at least two years of the covered period. The other sixteen countries (the control group) have zero IB percentage. Five countries of each category are considered developed while eleven are developing according to the World Economic Outlook 2016 issued by IMF. The sample size is constrained by data availability. Only listed banks are studied, and only banks with 100% Islamic financial services are considered IB. Conventional banks with Islamic windows are considered CB due to lack of data on these windows.

The Compustat Global database is used to construct the dataset. The total number of observations is 21,056 covering all listed banks in the 32 countries over 18 years. The banks are then classified into IB or CB based on their legal description provided in the database. A summation for total assets and number of banks is then performed to build a country-year panel data with 575 observations. The percentage of Islamic banking equals the total assets of IBs over the total assets of the whole banking sector in each country.

Relying on the literature, a standard economic growth model is used, with a set of variables measuring Islamic banking development, and controlling for broad financial performance, macroeconomic factors, and other control variables. The data sources for the variables are available in Table 2.2. The basic model is:

$$Y_1 = \alpha_0 + X'\beta_0 + Y_2'\gamma_0 + U \tag{2.1}$$

Y_1, the dependent variable, is the measurement of economic growth through real GDP per

capita (in logarithm). This was also used in similar studies by Abida et al. (2015); Abu-Badr and Abu-Qarn (2008); Herwartz and Walle (2014).

X refers to the Islamic banking variables. This is measured mainly by the percentage of total assets of IBs over the total assets of all banks (IBper). This variable indicates the size of the Islamic banking sector. Imam and Kpodar (2016) instead have used amount of loans extended by IBs to the private sector divided by nominal GDP as the Islamic banking main variable. However, in this chapter authors are interested more to analyze whether countries with excessive IB assets performed different from countries with no or low IB assets. It is reasonable to assume that size of IBs, relative to the banking system of each country, in terms of total assets contribute to the performance of this sector and its effect on economic growth. The number of IBs (IBnb) in a country is used as an alternative variable.

Y_2 is a vector of control variables. First, banking performance is important to be measured since IBs and CBs coexist in the same economies. Such control isolates the effect of IBs from the development of the whole banking sector. Referring to most of the empirical literature mentioned in the second section, this is measured through the ratio of private sector credit by banks over GDP (PCREDIT), which shows the size of intermediation achieved by the banking system. Alternative variables for banking development are the total assets of all financial institutions (in logarithm) and the number of conventional banks (CBnb). Second, macroeconomic factors are measured by four variables according to Ben Naceur and Ghazouani (2007); Ductor and Grechyna (2015); Pradhan et al. (2014); Samargandi et al. (2015). Trade openness (TO) is the sum of exports and imports over GDP. Countries that are more open are likely to acquire higher economic growth. This is due to economies of scale, technological transfer, allocation of resources, and competition in domestic and international markets. Foreign direct investment (FDI) equals to total amount of foreign direct investment over GDP. It is expected to affect economic growth positively since it stands for productivity enhancement. Inflation rate (IR) is used as an indicator of macroeconomic stability. Inflation uncertainty increases the variability of prices and thus decreases real output growth. In addition, a high inflation may have a negative impact on economic growth because of unsustainable monetary policies. Finally, government consumption (GC), which is equal to government final consumption expenditure over GDP. Such a variable affects economic growth positively as it reflects financing public goods and services such as infrastructure. At the same time, an excessive governmental spending may crowd out private sector resources and thus declines the economy. Third, a dummy variable

(CRISIS) is used to control for GFC period. Fourth, oil prices (OIL) is used, as it is predictable that higher oil prices play a significant role for oil exporters countries in boosting the economy. The relation may be reversed for oil importers.

2.3.2 Highlights from data

Figure 2.1 shows the trend of IBper from 2000 to 2017 in 10 countries. The overall growth in this industry is obvious from the graphs. Kuwait, for example, experienced an increase in the percentage of IB total assets from 7% to 13% just after the GFC. Malaysia jumped from 3% to 6% in 2010; however, it declined again to 3% for the next years. Islamic banking existed in Lebanon, Oman and Tunisia only after the crisis. Moreover, numerous conventional banks started Islamic financial services after the GFC, especially in gulf countries, Bangladesh, Malaysia and Turkey. Availability of such data would have increased the percentage significantly. On another hand, several banks, as in Saudi Arabia, are preparing to convert from conventional services to pure Islamic banking. Ahmed and Hussainey (2015) discuss this process. Shortly, there are assets of Islamic financial services not included in this study and number of CBs converting gradually into IBs but they will be considered IB once they perform 100% Islamic services.

Comparing variables across countries, we observe some interesting characteristics. First, Qatar has the highest mean of GDP per capita, followed by the Netherlands and United Arab Emirates. On the other hand, Tanzania has the lowest GDP per capita compared to Senegal and Vietnam. Second, data on bank size and number of banks is not available for Iran and Sudan, the only countries with 100% Islamic banking. For this reason, these countries are dropped upon regressing on these variables. Third, apart from Iran and Sudan, Malaysia has the highest average of IBper (26%) followed by Bahrain and Bangladesh (23% and 22 %); however, Pakistan has the highest number of IBs with 22 banks then Bangladesh 14 banks. This can be justified since total bank size variable is also higher for Pakistan, but it indicates as well that IBs of Pakistan are of smaller size than other countries. Fourth, PCREDIT is higher in Cyprus then the Netherlands and Malaysia. This values the structure and development of banking sector of these countries in comparison with counterparts.

Table 2.3 provides some indications on the correlations between variables. As expected,

the correlation between GDP and credit to private sector, trade openness, foreign direct investment and governmental consumption is positive. The inflation rate is negatively related with per capita GDP as it reflects instability in the economy. One can also note the high positive correlation between IBper and IBnb, which is anticipated, but this will not create any problem since they are alternative variables and will not be regressed in the same model.

2.4 Methodology

Estimating the impact of IB development on economy performance poses different econometric challenges. First, it is true that IBs are growing fast, but this business is still minor compared to GDP and low compared to conventional banking assets. Second, indicators of IB performance are still limited to their assets and number of banks. Additional indicators on profitability and stability would contribute to a wider understanding for this industry development. The percentage of total assets may be underestimated because only pure IBs are considered.

In light of these challenges, three different econometric approaches are used, which include pooled OLS, panel data with fixed effects and GMM.

Pooled OLS is a basic approach following 2.1 to estimate the relationship between IB development and GDP per capita. Johnson (2013) used it in similar context. The problem of this model is that it gives a common intercept and slope coefficients for all cross-sections and thus disregards individual heterogeneity Gambin (2004).

The main approach used in same framework is panel data with fixed effects Imam and Kpodar (2016) according to the model:

$$Y_{1,it} = \lambda_t + X'_{it}\beta_0 + Y'_{2,it}\gamma_0 + C_i + U_{it} \tag{2.2}$$

where i and t stands for country and year, λ is a time-specific effect and C is country specific effect. The advantage of this approach is that controls for unobserved country specific heterogeneity invariant over time. However, as per Campos and Kinoshita (2008) parameters

of such methodology may be biased if some of the explanatory variables are endogenous and correlated with error term. Furthermore, a problem of loss of degree of freedom was argued by Baltagi (2008) in the case of panel data with individual specific effects.

In both models, two central regressions are applied. The first one with IB percentage of total assets as main variable after controlling for banking development, macroeconomic factors, crisis dummy and oil prices. The second one with number of Islamic banks as main variable adding bank size and number of conventional banks to the controls after excluding Iran and Sudan from the analysis. Oil prices is not controlled in panel data with country specific effects, as it is implicitly included in the time variant coefficient.

An influential extension on static models is to consider Generalized Method-of-Moment (GMM) with over-identification. "No Contemporaneous Correlation" (NCC) which is also known as "Over-identified Panel GMM" assumes that regressors at each period of time t are not correlated with error terms of the same time period t. To explain this further, pooled restrictions assume

$$\begin{cases} EU_{i1} = 0 \\ \cdots \\ EU_{iT} = 0 \\ \sum_{t=1}^{T} EX_{it}U_{it} = 0 \end{cases}$$

while NCC restrictions are

$$\begin{cases} EU_{i1} = 0 \\ \cdots \\ EU_{iT} = 0 \\ \sum_{t=1}^{T} EX_{it}U_{it} = 0 \end{cases}$$

This method works well in panel data providing exogeneity assumption in every year. For example in 2001 the explanatory variables are orthogonal to the error and then again in 2002 the orthogonality is repeated. There are two main advantages of NCC. First, it is over-identified resulting in more efficiency and smaller errors. Second, it permits testing the model specification using the extra moment conditions via Hansen test known as "J-statistic" with null hypothesis that over-identifying restrictions are valid.

2.5 Empirical Results

2.5.1 Pooling OLS

Tables 2.4 and 2.5 present the results of the estimations using pooling OLS on the main and alternative IB variables, respectively. The findings of both tables confirm the results found in part of the economic literature that Islamic finance enhance economic performance. The coefficients of IBper and IBnb are positive and significant in all specifications at the 1 percent significance level. Column (4) of Table 2.4 shows that a one unit increase in percentage of IB assets rises the per capita GDP by 1.1% keeping all other variables constant. After controlling for total assets of banks and number of CBs, the effect increases tremendously. The coefficient of IBper in column (5) is 7 times the one in column (4). This substantial change in the weight of the coefficient shall be revised in different econometric approach to confirm its validity since OLS does not consider country or time specific effect. The four regressions in Table 2.5 present similar results. The positive relationship is significantly identified in both Islamic banking variables using pooling OLS.

These outcomes propose that Islamic banking responds to certain needs of individuals and firms, which would have been otherwise unmet and the related economic growth would have been forgone. The results also suggest that IBs complement CBs and they are not substitutes, since for a given level of financial development, more assets in IBs increase economy performance.

Regarding the control variables, as shown in the two regressions, countries with more trade openness and better government spending tend to grow faster. This also seems to be the case for countries with a positive well developed financial system in terms of credits to private sector. Other factors like foreign direct investments and inflation rate do not affect the dependent variable significantly. Finally, oil prices have a significantly positive effect on GDP.

2.5.2 Country-Specific Effects

Tables 2.6 and 2.7 present the results of the estimations using fixed effects on the IBper and IBnb, respectively. Before including time specific effect, the relationship of IB and GDP per capita is similar to the results in the previous section. For instance, comparing column (1) of

Tables 2.4 and 2.6 reveals an increase in the contribution of assets of IBs on the economy, but slightly less significant. The same trend continues after controlling for the financial crisis. However, Column (3) of Table 2.6 shows that the large impact of bank size on the regression is absorbed in this approach. This states that there is a country specific effect affecting large banks, for example corporate culture or banking climate. Hence, estimating the percentage of IB assets on per capita GDP, while controlling for banking size through country specific effect, corrects the unexpected results conducted by OLS. Similarly, comparing column (2) of Table 2.7 with column (4) of Table 2.5 validates the same coefficient in both regressions. An additional Islamic bank triggers GDP (log) by 0.05.

Surprisingly, adding time dummies to the regression, shuffles the impact of the main variable completely. Observing column (4) of Table 2.6, the effect of IBper is significantly negative on GDP. The weight is decreased and less significant when bank size and CB are added. There are unobserved changes throughout time that affect GDP and IBper simultaneously. The standard errors of time specific effects in both columns (4) and (5) are very low triggering a time trending. This can also be observed in Figure ‘2.2, which shows graphically the time trending of the dependent variable and the main explanatory variable across the time period. It is necessary to de-trend the variable by regressing each variable alone on GDP per capita (log) to reserve the residual. Then the residuals of all variables are regressed adding time dummies in order to observe the de-trended coefficients with time specific effect in Table 2.8. The two columns state clearly the positive impact of Islamic banking on GDP per capita with time dummies after neglecting the time trend. Comparing column (1) of Tables 2.6 and 2.8 shows that positive relationship decreased after de-trending time specific effect, however, it is more significant and that credit to private sector lost its significant coefficient. Column (2) of Table 2.8 is compared with column (3) of Table 2.6. Again the percentage of assets of IB helps improving the economy by raising GDP even after excluding countries with 100% Islamic financial system and controlling for size of banking industry. In conclusion, the results of columns (4) and (5) of Table 2.6 should be dismissed because they are biased due to time trend.

Furthermore, yearly partitions of IBper are regressed to determine how this relationship changed over time. The graph in Figure ‘2.3 explains yearly changes of the effect of Islamic banking on GDP based on the model below.

$$Y_1 = \mathrm{I}_1\alpha_1 + \cdots + \mathrm{I}_{18}\alpha_{18} + \mathrm{I}_1 X'\beta_1 + \cdots + \mathrm{I}_{18} X'\beta_{18} + Y_2'\gamma_0 + U \tag{2.3}$$

As the graph shows, the effect of IB on economic growth was negative at the beginning of 2000. It improved slightly barely exceeding zero for 4 years. Two years before the crisis, IBs were more renowned in some countries and the pattern starts to become increasing. During the crisis, the impact of Islamic banking was stable at 0.7; after the crisis, IBs started to affect economy positively and significantly with a maximum coefficient of 1.54 in 2014. Figure 2.3 implies that this growing business became mature after the GFC taking advantage of some conventional banks' failures to prove itself as a resilient banking system able to perform stable and enrich economy cycle.

2.5.3 No Contemporaneous Correlation (NCC)

Table 2.9 shows the results of two regressions using NCC. The first regression includes the whole set of countries with credit to private sector and macroeconomic factors as controls. Oil prices are omitted as they are equal for all countries over time and this approach considers exogeneity assumption at each year. The results displayed in column (1) confirms the highly significant positive relationship between Islamic banking and economy performance. The coefficients of control variables confirm again the positive impact of credit to private sector, trade openness and government consumption on per capita GDP. The estimation imposes over identification, most importantly not excessive over identification, and Hansen test fails to reject the null hypothesis. Hence, additional restrictions in this model are valid. Column (2) presents the outcome of alternative variable after dropping for the two countries of exclusive Islamic financial system. The size of banking system and number of CBs are added to the controls. Once more, the model estimates a highly significant positive impact of number of IBs on per capita GDP. Hansen test provides validity of the restrictions, as well.

2.6 Conclusions

Islamic finance is one of the fastest growing segments in global financial services. It has become important in many markets and too big to ignore in others. The global financial crisis offered IBs an opportunity to show their resilience. CB intermediation is mainly debt-based and per-

mits for risk transfer while IB intermediation is asset-based and centers on risk sharing. These and other characteristics make IB's model closer to the real economy and have a tendency to reduce their involvement to excesses and bubbles.

The mainstream of research on efficiency of Islamic banking focuses on its relation with financial stability. This chapter complements previous literature by evaluating the impact of the size of Islamic banking on the development of economy using a panel data of 32 countries between 2000 and 2017. Empirical results suggest that, holding constant the level of financial performance, macroeconomic factors and other controls, an increase in the portion of Islamic banking has a positive effect on the GDP per capita. Findings confirm theoretical expectations that although Islamic banking still represents a relatively very small share of the economy and of the overall size of the financial system, yet it is growing generating an economy boost and insuring a stable banking industry. This is justified since IBs are less prone to financial markets shocks, more close to tangible economic activities and attracts savings and investments of devout Muslims thus enhancing economic cycle. At the empirical level, this chapter confirms results of previous studies like Ali and Azmi (2017); Boukhatem and Ben Moussa (2018); Imam and Kpodar (2016) , but also tackles shortcomings of existing studies, which fail to address potential endogeneity problems. Furthermore, the results in this study are more powerful as they are robust under various conditions. First, Islamic banking indicators were measured by two variables, the percentage of total assets with respect to whole banking sector and the number of institutions as an alternative variable. Second, different econometric estimators (pooling OLS, fixed effects and over-identified panel GMM) revealed significant relationship. Third, results are coincided upon using new data source for banks different from what has been used in the literature.

Although this chapter provides robust outcome, nevertheless there are necessary recommendations for further research. First, measuring the Islamic windows of conventional banks and including non-listed banks give more accurate indicator for the size of this business. Second, estimating the impact on different variables of economy efficiency and growth. Third, assessing the influence of Islamic banking on other areas like financial stability, inequality and social development. Fourth, comparing the impact of banking development on economic growth between countries with exclusive CBs, exclusive IBs and duality system can answer the question on which banking system has a better impact on economy.

2.A Appendix

Figure 2.1: Percentage of Islamic Banking in Countries

This figure shows the changes in the percentage of Islamic Banking assets over total banking assets in 10 countries where IB exists.

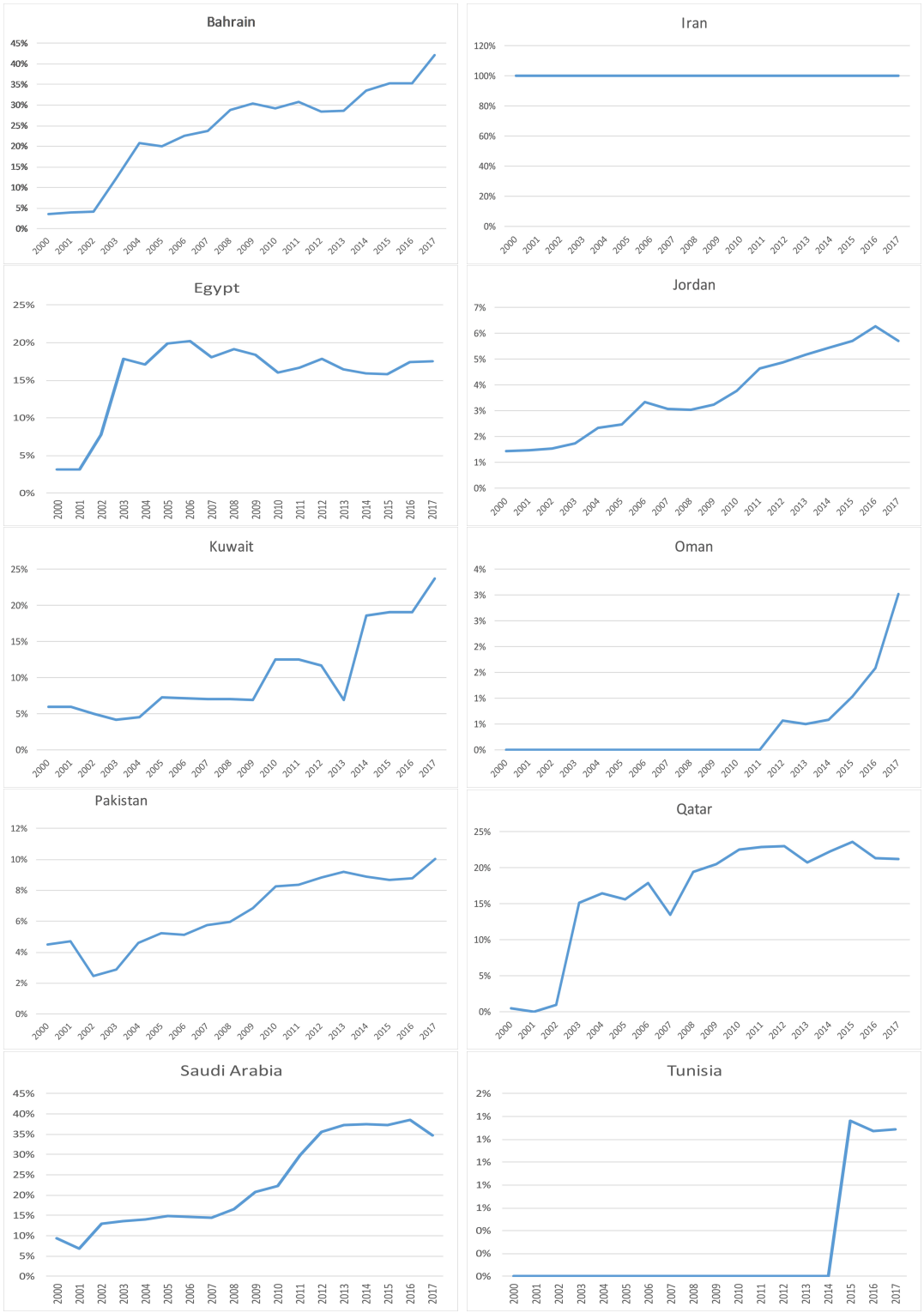


Figure 2.2: Time Trending of Islamic Banking and GDP per capita

This figure shows the time series of Islamic Banking assets over total banking assets and GDP per capita (log) between 2000 and 2016.

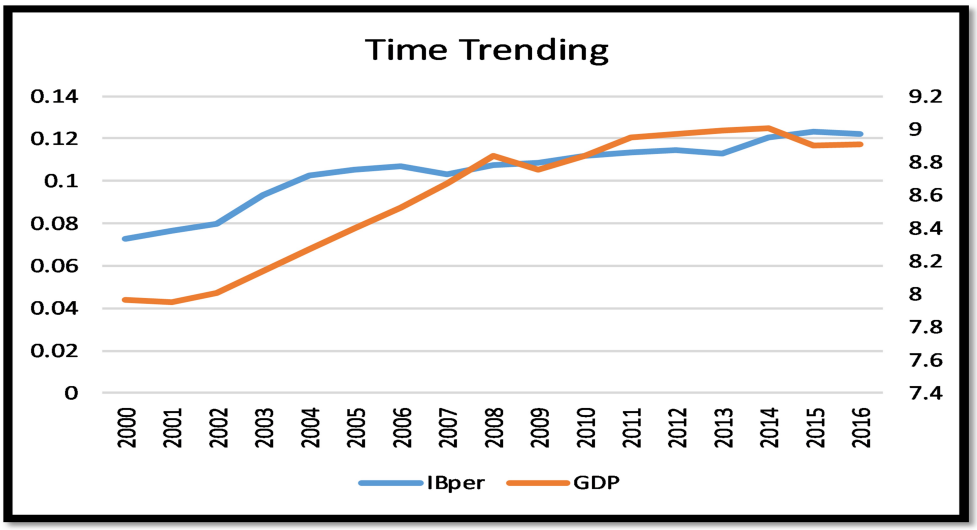


Figure 2.3: Change of effect of Islamic Banking assets on GDP over time

This figure shows the yearly changes of the effect of Islamic banking on GDP based on 2.3

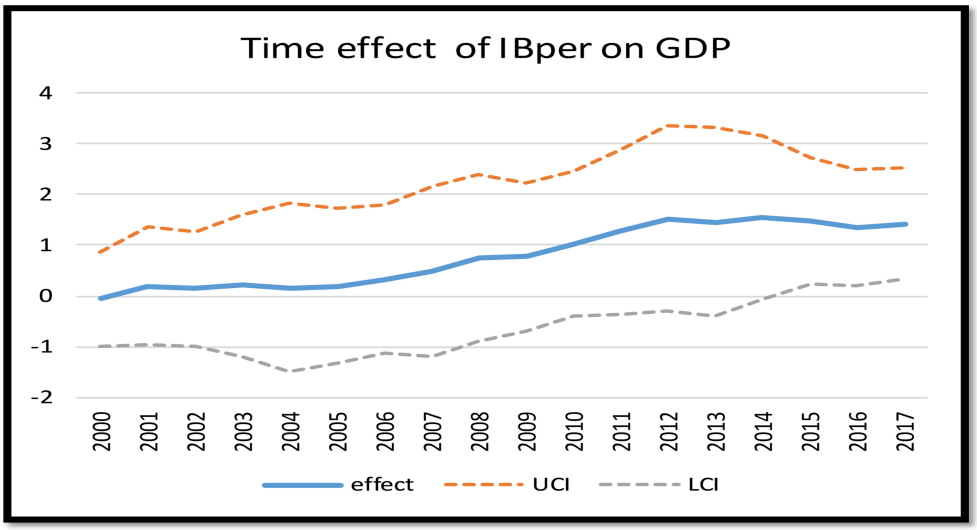


Table 2.1: List of countries

List of countries included in this study

Countries with IB		Countries with no IB	
Developed	Developing	Developed	Developing
Bahrain	Egypt	Cyprus	Brazil
Kuwait	Bangladesh	Czech Republic	Bulgaria
Qatar	Iran	Estonia	Georgia
Saudi Arabia	Jordan	Netherlands	Mauritius
UAE	Lebanon	Slovenia	Morocco
	Malaysia		Sri Lanka
	Oman		Peru
	Pakistan		Senegal
	Sudan		Thailand
	Tunisia		Tanzania
	Turkey		Vietnam

Table 2.2: List of variables and sources

Definitions of all variables used in this chapter

Variable	Definition	Source
IBper	percentage of IB total assets over banking assets	Author's calculation (based on Compustat Global Fundamentals)
IBnb	Number of Islamic Banks	
CBnb	Number of Conventional Banks	
Bnksize	Total assets of banking sector (in logarithm)	
GDP	real GDP per capita (in logarithm)	World Bank (World Development Indicators)
PCREDIT	Domestic credit to private sector over GDP	
TO	Total amount of exports and imports over GDP	
FDI	Total amount of foreign direct investment over GDP	
IR	Increasing rate of consumer price index over 1-year period	
GC	Government final consumption expenditure over GDP	
CRISIS	Dummy variable reflecting financial crises	Author's calculation
OIL	Annual average of international oil prices	Organization of the Petroleum Exporting Countries (OPEC)

Table 2.3: Correlation Matrix

This table provides correlations between variables in our model. GDP refers to gross domestic product per capita in logarithm, IBper refers to percentage of IB assets over total banking assets, IBnb is number of Islamic Banks, PCREDIT is domestic credit to private sector, Bnksize is total assets of banking sector in logarithm, CBnb is number of conventional banks, TO refers to total openness, FDI is foreign direct investment, IR is inflation rate and GC is governmental consumption. This is country level data per year.

	GDP	IBper	IBnb	PCREDIT	Bnksize	CBnb	TO	FDI	IR	GC
GDP	1.00									
IBper	0.19	1.00								
IBnb	0.01	0.66	1.00							
PCREDIT	0.40	-0.11	-0.14	1.00						
Bnksize	-0.13	0.05	0.13	0.09	1.00					
CBnb	-0.02	-0.16	-0.10	0.28	0.39	1.00				
TO	0.46	-0.03	-0.12	0.54	-0.06	0.02	1.00			
FDI	0.14	-0.10	-0.12	0.30	-0.03	0.03	0.16	1.00		
IR	-0.21	0.05	0.13	-0.25	0.34	0.04	-0.27	-0.05	1.00	
GC	0.45	-0.23	-0.31	0.16	-0.35	-0.10	0.15	0.16	-0.25	1.00

Table 2.4: Islamic Banking and Economic Growth: Pooling OLS – main variable

This table shows the results of 2.1 using OLS . GDP refers to gross domestic product per capita in logarithm, IBper refers to percentage of IB assets over total banking assets, PCREDIT is domestic credit to private sector, Bnksize is total assets of banking sector in logarithm, CBnb is number of conventional banks, TO refers to total openness, FDI is foreign direct investment, IR is inflation rate, GC is governmental consumption, CRISIS is a time dummy for years of global financial crisis, OIL is a dummy for countries that export oil. This is country level data per year.

	Pooling OLS				
	(1)	(2)	(3)	(4)	(5)
IBper	0.781	0.790	0.790	0.770	4.446
	[0.202]***	[0.202]***	[0.203]***	[0.197]***	[0.540]***
PCREDIT	0.007	0.007	0.007	0.006	0.007
	[0.001]***	[0.001]***	[0.001]***	[0.001]***	[0.001]***
Bnksize (log)					-0.005
					[0.014]
CBnb					-0.001
					[0.001]
TO	0.010	0.010	0.011	0.010	0.009
	[0.010]***	[0.001]***	[0.001]***	[0.001]***	[0.001]***
FDI	-0.033	-0.003	-0.003	-0.004	-0.001
	[0.002]	[0.003]	[0.002]	[0.002]	[0.002]
IR	0.007	0.006	0.006	0.001	0.001
	[0.007]	[0.007]	[0.007]	[0.009]	[0.010]
GC	0.107	0.107	0.108	0.109	0.115
	[0.009]***	[0.009]***	[0.009]***	[0.009]***	[0.010]***
CRISIS		0.207		0.077	0.097
		[0.117]		[0.118]	[0.116]
OIL			0.207	0.007	0.006
			[0.116]**	[0.001]***	[0.001]***
Constant	5.470	5.454	5.459	5.117	5.089
	[0.185]***	[0.177]***	[0.177]***	[0.191]***	[0.268]***
Observations	575	575	575	575	537
Nb of Countries	32	32	32	32	30
R-squared	0.42	0.41	0.42	0.42	0.50

Table 2.5: Islamic Banking and Economic Growth: Pooling OLS – alternative variable

This table shows the results of 2.1 with alternative measurement of Islamic Banking growth using OLS . GDP refers to gross domestic product per capita in logarithm, IBnb is the number of Islamic Banks, PCREDIT is domestic credit to private sector, Bnksize is total assets of banking sector in logarithm, CBnb is number of conventional banks, TO refers to total openness, FDI is foreign direct investment, IR is inflation rate, GC is governmental consumption, CRISIS is a time dummy for years of global financial crisis, OIL is a dummy for countries that export oil. This is country level data per year.

	Pooling OLS			
	(1)	(2)	(3)	(4)
IBnb	0.069	0.062	0.068	0.060
	[0.013]***	[0.013]***	[0.013]***	[0.014]***
PCREDIT	0.007	0.006	0.007	0.007
	[0.001]***	[0.001]***	[0.001]***	[0.001]***
Bnksize (log)			-0.001	-0.001
			[0.014]	[0.014]
CBnb			-0.001	-0.002
			[0.001]	[0.001]
TO	0.010	0.010	0.010	0.010
	[0.001]***	[0.001]***	[0.001]***	[0.001]***
FDI	-0.001	-0.001	-0.001	-0.002
	[0.002]	[0.002]	[0.002]	[0.002]
IR	0.004	-0.001	0.004	-0.001
	[0.008]	[0.010]	[0.009]	[0.010]
GC	0.119	0.120	0.118	0.118
	[0.010]***	[0.010]***	[0.010]***	[0.010]***
CRISIS		0.079		0.095
		[0.124]		[0.124]
OIL		0.006		0.006
		[0.002]***		[0.001]***
constant	5.266	5.003	5.322	5.060
	[0.203]***	[0.206]***	[0.254]***	[0.257]***
Observations	537	537	537	537
Nb of Countries	30	30	30	30
R-squared	0.43	0.45	0.43	0.45

Table 2.6: Islamic Banking and Economic Growth: fixed effects – main variable

This table shows the results of 2.2. GDP refers to gross domestic product per capita in logarithm, IBper refers to percentage of IB assets over total banking assets, PCREDIT is domestic credit to private sector, Bnksize is total assets of banking sector in logarithm, CBnb is number of conventional banks, TO refers to total openness, FDI is foreign direct investment, IR is inflation rate, GC is governmental consumption, CRISIS is a time dummy for years of global financial crisis, OIL is a dummy for countries that export oil. This is country level data per year.

	Panel data with fixed effect				
	(1)	(2)	(3)	(4)	(5)
IBper	1.646	1.615	1.642	-1.112	-0.659
	[0.578]**	[0.576]**	[0.574]**	[0.431]**	[0.394]
PCREDIT	0.013	0.012	0.006	0.001	-0.001
	[0.002]***	[0.003]***	[0.002]**	[0.002]	[0.002]
Bnksize (log)			0.056		0.014
			[0.042]*		[0.185]
CBnb			0.015		0.006
			[0.002]***		[0.002]**
TO	0.002	0.002	0.003	-0.003	-0.002
	[0.003]	[0.003]	[0.002]	[0.001]	[0.002]
FDI	-0.001	-0.001	0.001	-0.001	-0.001
	[0.001]	[0.001]	[0.001]	[0.001]***	[0.001]
IR	0.005	0.003	-0.018	-0.001	-0.009
	[0.010]	[0.010]	[0.004]***	[0.002]	[0.003]**
GC	-0.036	-0.035	-0.018	-0.019	-0.012
	[0.024]	[0.023]	[0.020]	[0.013]	[0.014]
CRISIS		0.160	0.162	0.961	0.833
		[0.037]***	[0.033]***	[0.065]***	[0.064]***
Time Dummies	No	No	No	Yes	Yes
				[0.003]***	[0.004]***
constant	8.040	8.016	7.244	8.611	8.350
	[0.508]***	[0.496]***	[0.688]***	[0.285]***	[0.445]***
Observations	575	573	537	575	537
Nb of Countries	32	32	30	32	30
R-squared	0.33	0.35	0.52	0.84	0.86

Table 2.7: Islamic Banking and Economic Growth: fixed effects – alternative variable

This table shows the results of 2.2. GDP refers to gross domestic product per capita in logarithm, IBnb is number of Islamic Banks, PCREDIT is domestic credit to private sector, Bnksize is total assets of banking sector in logarithm, CBnb is number of conventional banks, TO refers to total openness, FDI is foreign direct investment, IR is inflation rate, GC is governmental consumption, CRISIS is a time dummy for years of golbal financial crisis, OIL is a dummy for countries that export oil. This is country level data per year.

	Panel data with fixed effect		
	(1)	(2)	(3)
IBnb	0.064	0.051	-0.014
	[0.012]***	[0.016]**	[0.010]
PCREDIT	0.011	0.006	-0.001
	[0.003]***	[0.002]**	[0.002]
Bnksize (log)		0.049	0.015
		[0.002]	[0.018]
CBnb		0.014	0.006
		[0.002]***	[0.002]***
TO	0.003	0.003	-0.002
	[0.003]	[0.003]	[0.001]*
FDI	-0.001	-0.001	-0.001
	[0.001]	[0.001]	[0.001]
IR	-0.008	-0.017	-0.009
	[0.005]	[0.004]***	[0.003]**
GC	-0.025	-0.018	-0.012
	[0.023]	[0.020]	[0.018]
CRISIS	0.151	0.139	0.811
	[0.037]***	[0.035]***	[0.099]***
Time Dummies	No	No	Yes
constant	8.026	7.333	8.279
	[0.544]***	[0.706]***	[0.441]***
Observations	537	537	537
Nb of Countries	30	30	30
R-squared	0.40	0.54	0.87

Table 2.8: Islamic Banking and Economic Growth: fixed effects – time de-trending

	Panel data with fixed effect	
	(1)	(2)
IBper	1.018	0.969
	[0.007]***	[0.009]***
PCREDIT	0.001	0.001
	[0.001]	[0.001]
Bnksize (log)		0.036
		[0.023]*
CBnb		0.019
		[0.003]***
TO	0.001	0.001
	[0.001]	[0.001]
FDI	0.001	0.001
	[0.001]	[0.001]
IR	-0.001	-0.003
	[0.001]	[0.001]*
GC	0.001	0.001
	[0.001]	[0.001]
2001	0.001	0.001
	[0.006]	[0.006]
2002	0.001	0.001
	[0.006	[0.006
2003	-0.008	-0.008
	[0.006]	[0.005]
2004	-0.014	-0.016
	[0.006]	[0.006]
2005	-0.015	-0.017
	[0.006]	[0.007]
2006	-0.015	-0.015
	[0.007]	[0.007]
2007	-0.011	-0.013
	[0.006]	[0.006]
2008	-0.011	-0.011
	[0.006]	[0.005]
2009	-0.011	-0.010
	[0.006]	[0.006]
2010	-0.010	-0.012
	[0.006]	[0.006]
2011	-0.009	-0.009
	[0.006]	[0.006]
2012	-0.008	-0.009
	[0.006]	[0.006]
2013	-0.004	-0.004
	[0.006]	[0.006]
2014	-0.006	-0.004
	[0.006]	[0.006]
2015	-0.004	-0.004
	[0.006]	[0.006]
2016	0.001	0.003
	[0.006]	[0.007]
2017	0.001	0.005
	[0.004]	[0.006]
Observations	575	537
Number of Countries	32	30
R-squared	0.99	0.98

Table 2.9: Islamic Banking and Economic Growth: panel data GMM over-identified

This table shows the results of our model assuming No Contemporaneous Correlation. GDP refers to gross domestic product per capita in logarithm, IBnb is number of Islamic Banks, IBnb is the number od Islamic Banks, PCREDIT is domestic credit to private sector, Bnksize is total assets of banking sector in logarithm, CBnb is number of conventional banks, TO refers to total openness, FDI is foreign direct investment, IR is inflation rate, GC is governmental consumption. This is country level data per year.

	No Contemporaneous Correlation	
	(1)	(2)
IBper	0.972	
	[0.175]***	
IBnb		0.052
		[0.012]
PCREDIT	0.006	0.007
	[0.001]***	[0.001]***
Bnksize (log)		-0.001
		[0.011]
CBnb		-0.002
		[0.001]**
TO	0.009	0.009
	[0.001]***	[0.001]***
FDI	-0.001	-0.001
	[0.001]	[0.001]
IR	0.005	0.015
	[0.007]	[0.006]
GC	0.113	0.127
	[0.008]***	[0.008]***
Observations	575	537
Nb of Countries	32	30
Nb of parameters	23	25
Nb of moments	119	153
Hansen test	0.99	1.00

Chapter 3

Tokenization of Sukuk: Ethereum Case Study

3.1 Introduction

The Islamic finance (IF) market will be worth US 3.5 trillion by 2024 Mohamad and Al Taitoon (2019) and Moody estimations predict an increase in sovereign and supranational sukuk issuance to over $93 billion in 2020 Moody's (2019). There exists a strong demand for Shariah-compliant securities from IF institutions. Sukuk offers a stable methodology of financing to institutions looking to diversify their sources of financing. The various projections reinforce the strong foothold of this relatively nascent financial industry. The emergence of new technologies poses a threat to the finance industry and consequently the IF industry is also facing inevitable disruption by a storm of nascent technologies. Blockchain counts as the most potent to cause such a disruption, as the emerging academic literature in finance also argues (see Yermack (2017)). If the industry does not innovate and adopt to such disruptive trends, then there is a likelood of a loss of existing client base. The conventional sector is using blockchain to create digital assets like stocks, bonds and land titles e.g. NASDAQ, Chain. The IF industry is also venturing in these areas by creating Sukuk or Islamic bonds on top of the blockchain. The IF sector has witnessed the rise of Sakkex Sakkex (2018) and SmartSukuk Blossom (2019), which are blockchain-based sukuk issuing platforms. Employment of emerging technologies, in this era of disruption, is an opportunity for the sector to reinvent the established methodologies by incorporating novel technologies to progress ahead of the financial technology startups.

Sukuk has immense potential to fund startups and small and medium enterprises (SMEs). However, sukuk issuance remains confined to large corporations and governments, with the

primary target market being large investment funds. The smallest issue is still limited to millions with capital needs of SMEs and startups in the IF domain remaining largely unmet through sukuk. The employment of sukuk for funding SMEs can help to expand the Islamic economy and increase the user base. In Solé (2008), Solé describes sukuk issuance and SME financing using a concrete setup of Kuwait and in Patel (2014), Patel describes a similar setup for the French market. In these discussions the need for lower transaction costs, transparency and a lack of historic-track record is highlighted, which can be resolved using blockchain.

Sukuk issuance remains plagued with several challenges, the primary being the involvement of multiple intermediaries resulting in both high costs and an increase in the probability of human error. Tokenization of bonds is an application of blockchain technology to lower the various costs associated with the issuance process. Sukuk are Islamic bonds that can also benefit from tokenization by increasing the operational efficiency, cost reduction and enhancing transparency, which is one of the primary characteristics of blockchain. Transparency is also one of the essential attributes that would serve as validation of Shariah adherence for the masses. Notable organizations have tokenized bonds including World Bank, which launched *bond-i*, which was the world's first bond to be created, allocated, transferred and managed through Ethereum blockchain platform Bank (2018). In 2019 secondary bond trading was enabled on the *bond-i* platform, which was also a pioneer in the world. The Central Bank of China recently issued $2.8 billion of special bonds to fund small and micro-enterprise businesses, using their self-developed blockchain issuance system Kuznetsov (2019).

The IF domain is characterized by research on sukuk that is largely qualitative rather than quantitative and overall research in sukuk in IF is still underdeveloped Zulkhibri (2015). The present chapter seeks to fill this gap. In this chapter, we tokenize Sukuk al-Murabaha using Ethereum through smart contracts to program the necessary conditions like payment frequency, registering investors, automating the periodic payments to the investors while getting the deferred payment amount from the purchaser of the Murabaha asset. We do a cost-benefit analysis of sukuk tokenization with conventional sukuk issuance and conduct a feasibility analysis based on our results. This chapter thus provides an impact-assessment approach for institutions, SMEs and even startups to support the adoption of blockchains for sukuk issuance. As a consequence, our analytical approach allows organizations to prepare for current market challenges in a systemically efficient manner, by understanding the cost and performance consequences of tokenization. Our chapter is therefore a pioneer in the IF domain as well as the conventional finance domain.

The rest of the chapter is organised as follows. Related work is given in the chapter in Section

3.2. The chapter gives the requisite background on sukuk in subsection 3.3.1, including the key challenges and circumvention of some of the challenges encountered during sukuk issuance. Relevant background on blockchain technology is given in subsection 3.3.2 while a taxonomy of blockchain applications in the financial sector is given in Section 3.4. An assessment of the available blockchain platforms in the context of their viability for usage in tokenization is given in Section 3.5. Tokenization of Sukuk al-Murabaha by means of a basic smart contract is elaborated upon in Section 3.6. The cost-benefit analysis is discussed in Section 3.7. Feasibility of tokenization of sukuk is discussed in Section 3.8 while the conclusion is given in Section 3.9.

3.2 Related Work

In Schletz et al. (2020), authors highlight that both debt and equity instruments can be managed by tokenization, which decreases transaction costs by disintermediation and automation, improves transparency, and thus shortens liquidity requirements. Nam and Yang (2017) observe that blockchain bonds convey information safely between the participating institutions, ensure access to the same distributed ledger through a smart contract and reduce the cost of processing complicated transaction information by absolving the need for a relay center. Uzsoki and Guerdat highlights that the financial feasibility increases significantly by tokenizing debt instruments used for financing a project or diversifying a portfolio. Uzsoki also adds that tokenization absolves most of the financial, legal and regulatory intermediaries reducing transaction costs. Sukuk issuance involves compliance to the Shariah and investors request higher transparency depicting the adherence to the Shariah. Zaka and Shaikh postulate that blockchain-based sukuk can enable traceability of assets thereby increasing the investors' confidence Zaka and Shaikh (2019). Mohsin and Muneeza (2019) discuss a novel Waqf Sukuk model and emphasize on the usage of blockchain-based smart contracts to make the waqf collection process more efficient and transparent. Muneeza et al. (2018) conclude that blockchain can enable fundraisers in crowdfunding platforms to issue their own shares as a blockchain-based issuance enhances efficiency and reduces costs. HSBC Centre of Sustainable Finance in collaboration with Sustainable Digital Finance Alliance published a report where they conduct a study on blockchain-based bonds, including a green bond, issued by banks up to Q3 2019 and demonstrated efficiency achieved and cost reduction spanning all bonds HSBC and Sustainable Digital Finance Alliance (2019). Blockchain energizes crowdfunding Muneeza et al. (2018) and blockchain-based crowdfunding in conventional bonds is also a potential support to SMEs and startups. BNP Paribas along with six other European financial institutions has

initiated a blockchain platform to permit SMEs to borrow money to their businesses through "mini-bonds" Rizzo (2016). The present chapter differs in being a pioneer to conduct a case study on sukuk tokenization using Ethereum. The chapter reviews blockchain platforms for their suitability for tokenization, provides a taxonomy of blockchain applications in IF, provides an algorithm and a basic smart contract for tokenization of Sukuk al-Murabaha on Ethereum. The chapter also conducts a feasibility study based on a comparison of the cost-benefit analysis using conventional issuance and Ethereum sukuk tokenization.

3.3 Background

3.3.1 Sukuk

Sukuk represents the plural form of the Arabic word, Sakk, which means a certificate. Evidence of sukuk can be found as early as 1st century Hijri (Islamic Calendar) and in Imam Malik's 'Muwatta'. In the Umayyad dynasty, the government issued sukuk to public servants and soldiers, which they could redeem at the end of the fixed-term period in exchange for food commodity or sell to others prior to maturity Marifa Academy (2015). In 1988, Islamic Fiqh Academy (IFA) passed a resolution 30 (3/4), which defined a sukuk, making it a recognised financial instrument in the IF industry. Accounting and Auditing Organization for Islamic Financial Institutions (AAOIFI) defined sukuk as certificates of equal value, representing an undivided share in ownership of tangible assets, usufructs or services Marifa Academy (2015).

Sukuk, sometimes referred to as Islamic bonds, are also described as Islamic Investment Certificates. However, it must be noted that a bond is a contractual obligation whereby the issuer is obliged to pay bond holders, on certain specified dates, interest and principal. In comparison, under a sukuk structure, the sukuk holders hold an undivided beneficial ownership in the underlying assets. Consequently sukuk holders are entitled to share in the revenue generated by the sukuk assets as well as share in the proceeds of the realization of the sukuk assets. Sukuk are Islamic bonds which behave in practice like any highly-rated conventional bond. However, sukuk should not simply be regarded as a substitute for conventional interest-based securities. The aim is not to engineer financial products that mimic fixed-rate bills and bonds, and floating-rate notes as is largely misunderstood by many, but rather to develop innovative types of assets that comply with Shariah.

A sukuk issuance comprises of an Obligor, asset and typically a Special Purpose Vehicle (SPV) to accumulate taxation benefits and solvency. Issuance of sukuk in global Islamic cap-

ital markets is predominantly structured as trust certificates, governed by English law, which generally requires the creation of an orphan offshore SPV in a suitable jurisdiction. This structuring involves the recognition of the concept of trust in the jurisdiction of the Obligor. In other jurisdictions, like those governed under the civil law, this is not the norm and sukuk structuring is being accomplished in accordance with local laws. A pertinent example is that of Turkey, which has legislated the creation of asset-leasing companies acting as SPV to enable the use of sukuk. The essential underlying concepts of sukuk are:

- Transparency and clarity of rights and obligations.
- Income from securities must be related to the purpose for which the funding is used, and not simply comprise interest.
- The securities should be backed by real underlying assets, rather than being simply paper derivatives.

Most commonly used sukuk structures replicate the cash flows of conventional bonds. Such structures are listed on exchanges, commonly Luxembourg Stock Exchange and London Stock Exchange in Europe, and made tradable through conventional organizations like Euroclear or Clearstream. Luxembourg Stock Exchange (LSE) is a principal European centre for listing sukuk, which can be done in the Regulated Market, the Euro MTF market or the LuxSE securities Official List (SOL). The securitization vehicles may be used to issue several classes of sukuk. A depiction of Sukuk issuances in Luxembourg since 2002 and their issue sizes can be seen in Fig. 3.1.

Key Challenges in Sukuk Structuring

Some of the key challenges that are an obstacle to a greater adoption of this market are as follows:

a. **Slow process.** The documentation process of sukuk issuance is not as fast and efficient as the conventional bond market, resulting in higher costs.

b. **Decision of the Shariah scholars.** The decision of the Shariah scholars is crucial to any sukuk structuring process and the integration of the Shariah rulings increases the cost of the process.

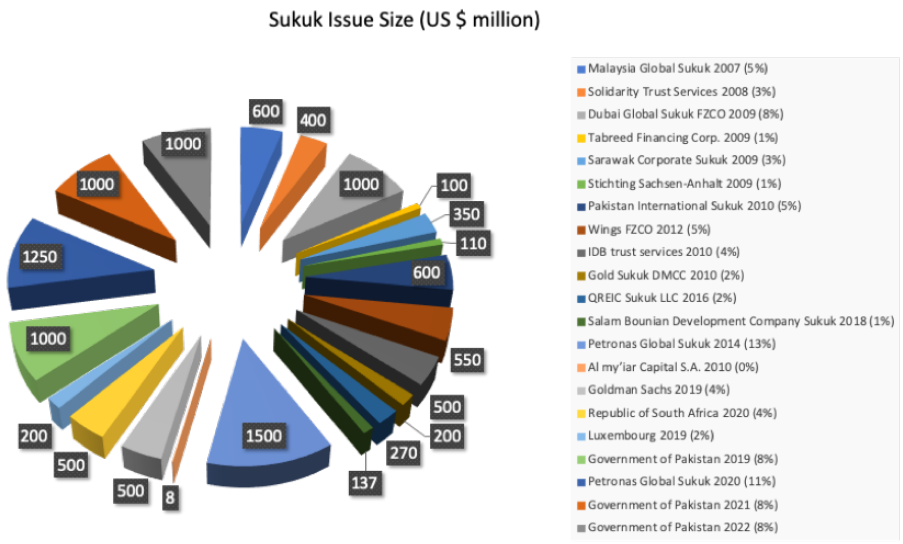


Figure 3.1: Sukuk Listed on Luxembourg Stock Exchange since 2002

c. **Lack of standardization.** There are no standards as in the conventional bond market and this slows down the structuring process, adds to the cost and makes the market deployment restricted.

d. **Globally acceptable Shariah standards.** There is a need for Shariah standards to different sukuk structures to have a unified view in the situation of differing Shariah opinions.

e. **Miscellaneous challenges.** There are other challenges like different tax treatments as compared to conventional bonds in different jurisdictions, requirement of a good credit rating and issues related to assets during the transaction life.

Circumvention of Key Challenges

A detailed discussion on the circumvention of all the listed challenges in 3.3.1 is outside the scope of this chapter. We focus on the listed challenges that can be tackled utilizing emerging technologies like blockchain and highlight the circumvention possible. We sort the circumvention into the following four categories, where all except the last, are addressed in this chapter:

a. **Tokenization.** Tokenization of sukuk using blockchain can help to generate more secure and immutable data while reducing the number of intermediaries involved. Tokenization also facilitates smaller denominations in sukuk issuance potentially extending the benefits of the structure to SMEs.

b. **Smart contract template.** A smart contract template for usage on a blockchain can be provided for different sukuk structuring methodologies in consultation with prominent Shariah scholars. Once the basic template exists, developers can code the IF smart contract with the requisite terms required for a particular sukuk issuance. Validating an enhanced smart contract developed from a basic validated smart contract template, to see if it adheres to a specific protocol, is faster and easier than documenting a sukuk issuance catering to a specific IF smart contract from scratch.

c. **Automation.** A sukuk issuance involves two different contracts namely, between the Obligor and the SPV, and the SPV and the investors. Multiple smart contracts deployed by the SPV or a third party providing this service, can automate the process and make it more transparent. The automation of periodic payments to the SPV and the proceeds to the investors can make the procedure extremely efficient, transparent and in real time.

d. **Credit rating and market expansion.** Artificial intelligence can be used on the blockchain data relevant to sukuk issuances to develop alternate credit scoring methodologies and expand the market for more organizations to raise capital through sukuk issuance.

3.3.2 Blockchain

Blockchain is heralded as one of the most disruptive innovations of the fourth industrial revolution Chuen and Lee (2017). The technology absolves the need of intermediaries resulting in a reduction of transaction costs, while providing a decentralized, immutable database. It came into inception with Bitcoin N. (2008), which was the first blockchain-based payment platform that came into existence. This was followed by other blockchain platforms like Ethereum G. (2015), Hyperledger The Linux Foundation Projects (2019) and Stellar Stellar (2019) among others. Blockchain can be described as a ledger of transactions that consists of a peer-to-peer network and a decentralised distributed database. A distributed ledger is a decentralized database, which is managed by multiple entities across multiple nodes (computing devices). Blockchain is a kind of distributed ledger, where transactions are stored immutably using cryptography. All blockchain platforms are distributed ledgers but not all distributed ledgers are blockchains as they might not have the underlying data structure present in blockchain platforms. Blockchain allows multiple parties to securely transact without the need of a trusted third party working as an intermediary. Further it allows all participants to see all the transactions that are taking place. Cryptography and pseudonyms can be used to hide some aspects

of the transactions but even then the amount of information leaked is more than traditional centralised databases. So a blockchain permits all users in the blockchain network to read all publicly available data while writing to the blockchain is limited to a certain section of users known as validators (miners in Bitcoin and Ethereum). The validators are responsible for validating transactions by the users and once validated, a chosen validator writes the transaction to the distributed database of the blockchain network referred to as mining in Bitcoin and Ethereum. The new data record is then distributed in the entire blockchain network and thereafter verified by all the other validators. The choice of the validator to write the transactions to the blockchain is governed by different mechanisms based on the blockchain platform like proof of work (PoW) consensus mechanism determines the miner (validator) adding transactions to the Bitcoin blockchain. Blockchain thus transfers the power in the hands of the users creating not just transparency but inculcating a feeling of trust.

Fig. 3.2 represents a diagrammatic representation of the blockchain. The different blocks are linked to each other by way of references to the former, creating a chain of blocks. Each block contains a set of transactions verified by all the validators in the network. The ledger represented is ever expanding and is protected against revision, deletion and tampering. Any manipulation of data would be easily discovered as the original data would still exist on multiple other nodes. Blockchain adds transparency, enhances trust and can provide more security. The security is directly linked to the number of validators holding copies of the entire data of blockchain. In Bitcoin and Ethereum, the block header hash is computed by using only the block header and serves as a digital fingerprint of a block. A hash is a mathematical function that gives an output of a certain length, when given an input and it is irreversible. The block header contains a reference to the previous block, data related to the mining operation and information on all the transactions in the block N. (2017a).

Blockchain platforms can be categorized into public, private and consortium. In a public blockchain all users have equal rights to read and update the blockchain. A private blockchain has a single entity or a set of rules managing the access rights of the users in the network and it is controlled who can be a part of the private blockchain. Further a private blockchain can define roles for the network participants including restricting who can act as a validator while the data remains private to the participants of the network. A consortium blockchain usually represents a conglomerate of multiple organizations with the management restricted to the participating organizations. The right to be a validator is also usually restricted to the partnering organizations and the data can be private with the visibility restricted to the network participants. To summarise our overview above, the features of blockchain that make

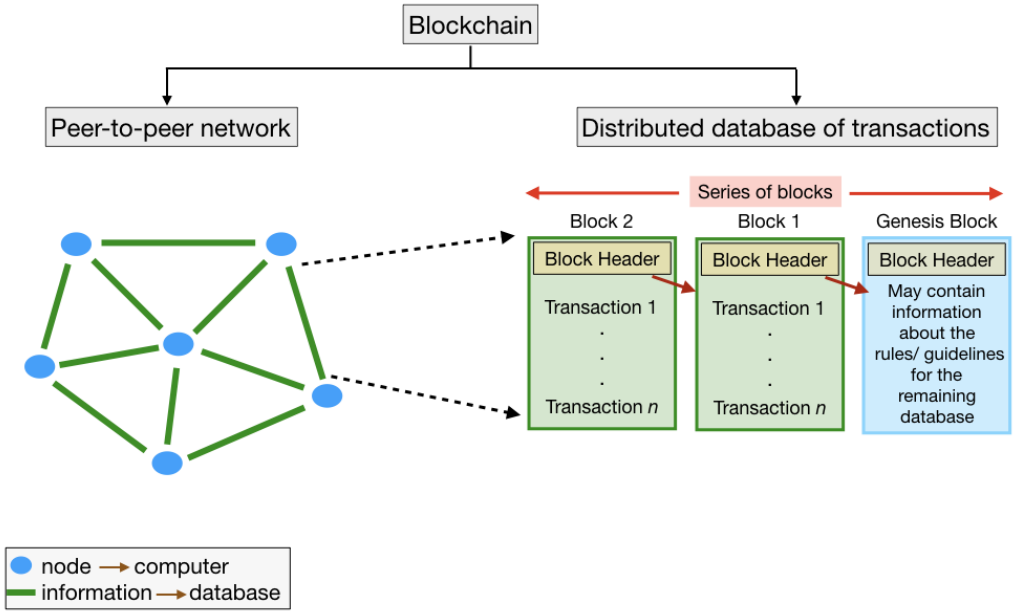


Figure 3.2: Diagrammatic Representation of Blockchain

it beneficial for the IF industry are thus the following:

a. Transparency

b. Immutable data

c. Absolving the need for intermediaries

d. Smart contracts

e. Decentralized transaction settlement

f. No single point of failure

It is important to mention that blockchain technology is still in its early stages of commercial diffusion. The main underlying reason is that it still suffers from drawbacks, which we discuss in Section 3.8. It is a nascent technology and many providers have come to the forefront offering a blockchain platform. The chapter discusses the implementation of sukuk on Ethereum. Sakkex sukuk issuance is based on Stellar blockchain, whereas SmartSukuk uses public Ethereum. Wethaq's Sukuk platform is based on Corda blockchain platform r3. (2019).

3.4 Applications of Blockchain in the Financial Sector

Blockchain technology finds applications in diverse domains ranging from e-commerce for traceability of shipped physical assets Hasan and Salah (2018a); Salah and Hasan (2018) to solutions

catering to monetization of data exchanges between IoT devices Suliman et al. (2019). Mobile telecommunications using 5G can leverage upon blockchain technology to enable novel business models and services Chaer et al. (2019) while blockchain can also be employed to empower artificial intelligence Salah et al. (2019). The healthcare industry too can benefit from the incorporation of blockchain in the domain Agbo et al. (2019). In this work, focusing on blockchain applications for finance, and in particular for Islamic Finance, we developed a taxonomy of pertinent financial applications that leverage on blockchains, characterised by their added value and by the markets they target. Fig. 3.3 depicts the resulting taxonomy, which classifies the applications into the following, nine domains:

a. **Capital markets.** Securities that are based on payments and rights, which are executed according to predefined rules can be coded as a smart contract in capital markets. Experiments are ongoing on the issuance of smart bonds and creation of digital assets like stocks, bonds and land titles Davradakis and Santos (2019). In Islamic capital markets (ICM), sukuk issuance follows a strict Shariah law together in conjunction with the principles followed in conventional bonds with the exception of riba, which can be coded by a smart contract.

b. **Escrow accounts.** Smart contracts can easily be utilized to set up escrow accounts monitoring the exchange between two parties. Real estate projects can use smart contract driven escrow account to facilitate the conditional transaction Kirit (2017). In Islamic finance, an application would be where in a Murabaha contract, the buyer would transfer funds to the smart contract account and post transfer of ownership, the smart contract would automatically release the funds to the seller.

c. **Insurance.** Blockchain-based smart contracts, when used in the insurance sector would reduce the operating costs, increase the speed of execution and enhance the efficiency in claims processing Gatteschi et al. (2018). The transparency and lack of textual ambiguity in coded smart contracts can prevent legal disputes. There would also be less insurance fraud on account of the contract being pre-programmed according to some specific conditions. Takaful involves peer-to-peer insurance with policyholders supporting each other financially in critical times. Islamic insurance involves management by a takaful operator, where the operator can be replaced by a smart contract managing a pool of policyholders in a permissioned blockchain automating the process and enhancing the transparency.

d. **Loans.** Automating the lending process through the blockchain Henriquez et al. (2019)

can result in cost reductions Manda and Yamijala (2019). Smart contracts can be used to provide and receive the periodic repayments of the loan together with information on the deposited collateral. In case the borrower misses a payment or a few designated payments, then the smart contract can initiate to revoke access to the collateral. Islamic finance mortgages can reap similar benefits by employing the use of blockchain for granting loans.

e. **Proxy lawyers.** When considering routine financial transactions, lawyers are involved in repetitively processing mundane tasks and yet consumers have to spend a large amount on their fees to have them go through their wills or contracts. Theoretically smart contracts can do a greater portion of what the lawyers do and using them to support the legal system would reduce the costs associated with the process. The smart contracts could function as an intermediate layer between transacting and going to court by coding of legal rules to automate basic dispute resolution De Filippi and Hassan (2018). Islamic finance needs lawyers, who can resolve disputes in the Islamic finance domain in the light of the Shariah and similar to the conventional domain, many basic contractual regulations can be encoded in smart contracts with the violation automatically imposed in case of a deviation from the encoded terms.

f. **Digital ID.** The blockchain ID can be used to sign digital documents or sign in to websites. Banks can be set up for authentication of such blockchain ID's or they can partner with blockchain companies working on the same for facilitating instantaneous cross-border transactions. Blockchain-based identity management systems can be used in Islamic finance to make identification and record sharing easier. However privacy issues need to be tackled in this context El Haddouti and El Kettani (2019).

g. **Crypto wallets.** Cryptocurrency wallets can be set up and controlled by smart contracts. These can include conditional clauses like daily withdrawal limits and restrictions like money that can be spent only on certain kinds of assets, in a certain geographical region or between two dates and likewise. The possibilities are endless and the savings would be huge considering the global reach of a blockchain platform. These can serve as an alternative to bank accounts for the unbanked and underbanked populations Khan et al. (2019). In Islamic finance there is a large percentage of Muslims not utilizing banking services on account of ethical reasons and this population can greatly benefit by the creation of customized cryptocurrency wallets adhering to the Shariah.

h. **Supply chain finance.** Supply chain management comprises of tracking the origin and

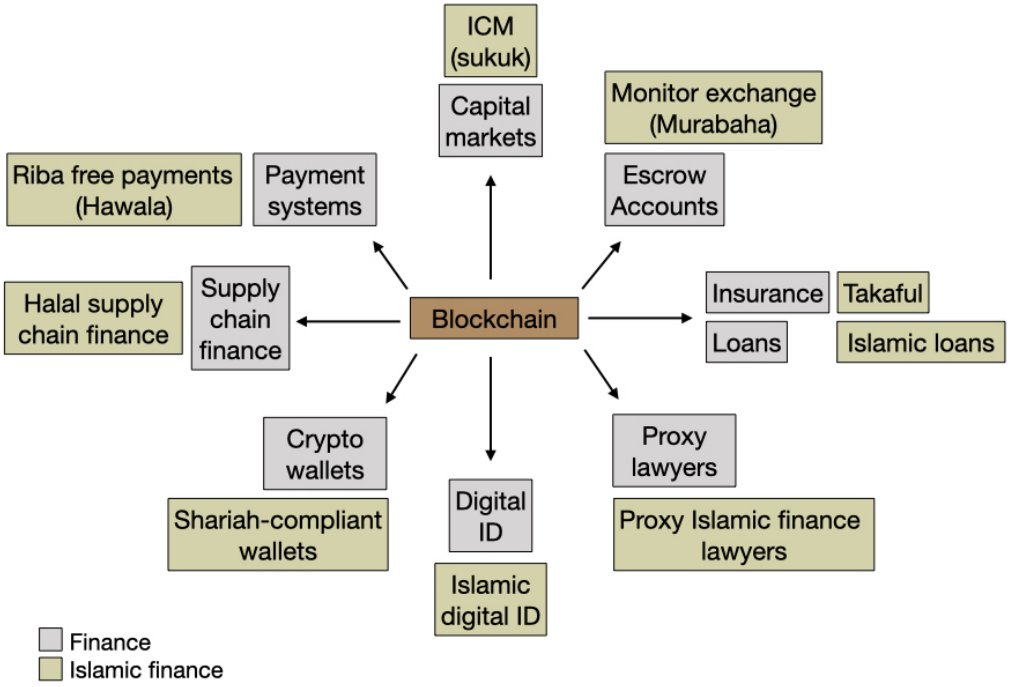


Figure 3.3: Taxonomy of Blockchain Applications in Finance and Islamic finance

movement of items which can suffer from counterfeiting and theft. The financially critical items like bills of lading or letters of credit can be tracked by a blockchain taking away the possibility of a group of users from corrupting the documents and end users would have more trust in what they receive paving the way for a smart supply chain finance (SCF) Hofmann et al. (2017). Examples of companies using this technology are *Skuchain* and *Wave*. The halal economy can benefit greatly by utilizing blockchain for non-repudiated data sharing between the suppliers and verification of halal certificates through the blockchain Tieman and Darun (2017). The digital platform can create opportunities for investors in the Islamic finance domain to invest in the halal supply chain.

i. **Payment systems.** Bitcoins are being used to send money to anyone across the world and merchants are accepting bitcoins as payments. The bitcoin transactions are recorded on the blockchain with transfer of ownership of bitcoin from one user to another, imitating the transfer of physical cash from one wallet to another person's wallet. The entire record of this movement is recorded in the blockchain e.g. *BitPay*. Islamic finance can develop their own payment systems on the blockchain Zhong et al. (2019) and make it Shariah compliant to protect users from the interest associated with the available digital payment methods.

Our goal in this chapter is to assess and to evaluate the employability of blockchains for sukuk issuance. Using our taxonomy above, this chapter thus provides insights on application develop-

ment for Islamic capital markets. We seek to answer important questions for organisational, i.e. commercial adoption of blockchain applications that are developed to support sukuk issuance. Issues, such as the emerging cost factors and their magnitude, and the benefits that blockchain would embrace for this particular financial instrument are equally important. Therefore, the rest of this chapter is centered around a concrete tokenization exercise of sukuk using the Ethereum blockchain platform. The analysis of this exercise allows us to evaluate the potentials of tokenization both quantitatively (i.e. cost assessment) and qualitatively (i.e. benefits and concerns of commercialization), providing thus the answers we are seeking for.

3.5 Assessment of Blockchain Platforms for Tokenization

In order to assess the feasibility of sukuk tokenization by measuring its performance, related costs and addressing its benefits, it is imperative to know that sukuk tokenization relies on employing smart contracts for execution. In this section, we review the blockchain platforms available that can support smart contracts. Smart contracts are heralded as the most important application of blockchain. A smart contract is a computer program that formalizes relationships over computer networks through a combination of protocols with user interfaces Szabo (1997). They form the base of blockchain-based decentralized applications, which might function as products or services for mass usage. Smart contracts reside and are executed on the blockchain, where the correct execution is enforced by the consensus protocol. It relies on a programming language provided by the blockchain platform to encode its operations and the ways to handle user transactions. It can implement a wide range of applications including gaming, financial, notary or computation Bartoletti and Pompianu (2017). The distinguishing feature in comparison to paper-based agreements is that smart contracts are computer programs with the capability of unilaterally applying strict rules and consequences on the basis of fresh data inputs. Further the blockchain assures that everyone is seeing the same thing without the reliance on having to trust each other.

Bitcoin, the first blockchain platform to be launched, does not support complex smart contracts. There is the availability of using simple smart contracts, but their execution is costly and designing is cumbersome Das et al. (2019). The main platform for implementing smart contracts is Ethereum and its high level programming language Solidity Ethereum (2020) which is Turing complete and compiled into bytecode language. A programming language is said to

be Turing complete if it can computationally solve a given problem with finite resources and a programming language that is not Turing complete cannot measure up to the Turing complete programming language in terms of functionality. Each compiled smart contract is stored in the blockchain and executed by the Ethereum virtual machine (EVM) running on the network nodes. There are numerous other blockchain platforms that are providing the functionality of smart contracts and a comparison of the prominent platforms is given in Table 3.1. A review of the listed platforms indicates that only Ethereum, NEO and Tezos have smart contracts using programming languages that are Turing complete and can serve as feasible blockchain platforms for tokenization of sukuk in case a public blockchain platform is desired for issuance. We decided to conduct a case study on Ethereum on account of the above reasons. Ripple has invested in a smart contract platform, Flare Ajiboye (2020), which is still being tested and was therefore not in consideration for our discussion. Stellar is not a typical blockchain supporting smart contracts as it does not have a smart contract programming language or a virtual machine to support the execution of smart contract code and is hence not a part of the review process.

Table 3.1: Comparison of Smart Contract-based Blockchain Platforms

Blockchain platform	Turing complete	Programming language	Consensus algorithm	Execution environment	Wallet Model	Public
Algorand	✗	TEAL[1]	PoS[2]	Stack	account	✓
Bitcoin	✗	Script	PoW	Stack	UTXO[3]	✓
Ethereum	✓	Solidity	PoW	EVM	account	✓
Hyperledger	& Go	FBA [4]	Docker	account	✗	
NEO	✓	Kotin, C++, VB.Net, F#, Java	dBFT [5]	NeoVM	UTXO, account	✓
Tezos	✓	Michelson	PoS	Michelson	account	✓
Waves	✗	Ride	LPoS [6]	Docker	account	✓
Corda	✓	Kotlin, Java	pluggable[7]	JVM [8]	UTXO	✗

[1]Transaction Execution Application Language
[2]Proof of stake
[3]Unspent transaction outputs
[4]Federated Byzantine Agreement
[5]delegated Byzantine Fault Tolerance
[6]Leased Proof of Stake
[7]permitting the usage of the desired consensus algorithm
[8]Java virtual machine

3.6 Tokenization of Sukuk

The applications of smart contract technology are diverse but restricting it to the financial world, it can be conveniently said that any kind of business logic relying on data can be coded by way of smart contracts. Securities that are based on payments and rights, which are executed according to predefined rules can be coded as a smart contract in capital markets. Experiments are ongoing on the issuance of smart bonds. Sukuk issuance follows a strict Shariah law and other principles, many of which can be programmed to ensure both compliance to the Shariah and transparency for all involved increasing the mass appeal of the product amongst Muslims N. (2017b).

Sukuk al-Murabaha is a possible structure to fulfill the capital requirements of an entity, when there is an absence of an identification of a tangible asset against which investment can be sought. It is heralded as a preference when other structures using Mudarabah, Ijarah or Musharakah are not possible, since it is debt-based. Hence, Sukuk al-Murabaha cannot be traded in the secondary market as per the Shariah prohibition of not trading debt except at par value. Fig. 3.4 is a diagrammatic representation of Sukuk al-Murabaha and the fundamental steps involved in the issuance process are given below:

- The Obligor creates a SPV to issue the sukuk. SPV is a separate legal entity with it's own assets, created by an organization to isolate financial risk, ensuring the survival of the entity even if the parent company goes bankrupt. Its role is to protect the underlying assets from investors in case of financial deficits.

- Investors agree on the sukuk and pay the principal amount to the SPV in return for sukuk certificates.

- SPV utilizes the proceeds in buying the required asset and resells the asset at a markup to the Obligor on deferred payment terms through a Murabaha contract.

- Obligor pays the installments as agreed to the SPV and the SPV transfers the requisite profit from the payment proceeds to the different investors.

An algorithm to implement the Ethereum smart contract for Sukuk al-Murabaha is given in Algorithm 1. Sukuk al-Murabaha was chosen for our consideration since our case study involved a sukuk issuance involving the Murabaha contract (refer to Section 3.7). The algorithm indicates that it is essential to register the SPV and Obligor on the smart contract using their Ethereum address. Each investor, who intends to buy sukuk, should register through the smart

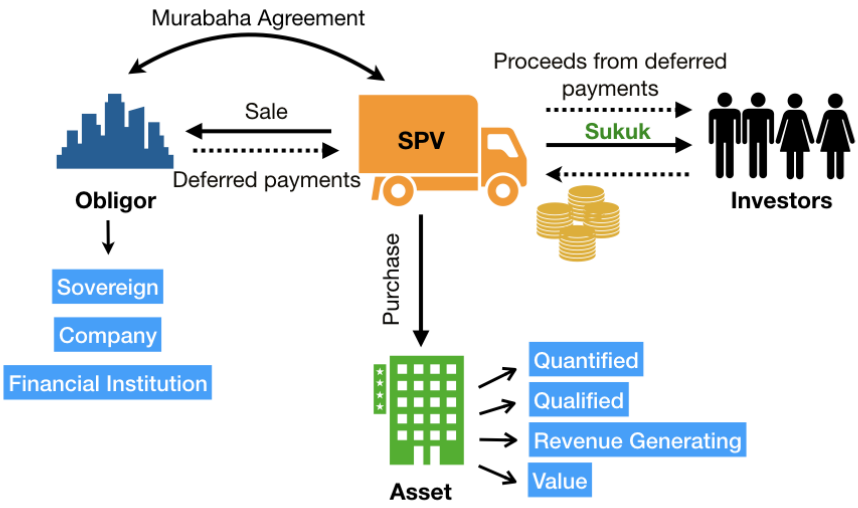


Figure 3.4: A Simplified Representation of Sukuk Al-Murabaha

Algorithm 1 Tokenization of Sukuk al-Murabaha on Ethereum

Require: Register the SPV and Obligor using their Ethereum address
Require: Initialize the payment frequency, number of sukuk coins, issue size, face value of the sukuk, maturity and profit rate
Require: Link to the Murabaha contract and relevant documentation is shared
Require: Register each investor using Ethereum address
Ensure: Obligor and investors buy sukuk coins to use in exchange for fiat currency.
Ensure: Obligor pays the periodic amounts for the asset

1: **for** entire period till sukuk maturity **do**
2: **if** payment is due **then**
pay fee to the SPV from Obligor's deferred payments and deduct the fee from the paid amount
3: **end if**
4: **end for**
5: **for** entire period till sukuk maturity **do**
6: **while** payment is due and number of investors $\neq 0$ **do**
pay each investor the profit based on his investment
7: **end while**
8: **end for**

contract using his Ethereum address. It is assumed that the SPV and the Obligor have entered into a Murabaha contract outside the smart contract. Notary services are not recognized online legally to the best of our knowledge and hence we excluded the purchase and sale of the sukuk asset from the smart contract. The SPV would however need to provide documentation relevant for the sukuk asset on the smart contract for the investors to see. The smart contract would collect the periodic payments from the Obligor, pay the fee to the SPV and the profit to the investors based on the payment frequency. Sukuk coins are a kind of token introduced through the smart contract.

The algorithm guided in the coding of the smart contract for Sukuk al-Murabaha. The smart contract was coded in Ethereum using the programming language, Solidity. Only basic functions required for sukuk issuance were coded and necessary control statements to check for identity verification, balance requirements, conversion from fiat to cryptocurrency, event notifications, security and privacy measures were not taken into account. The purpose of the smart contract was to code a proof of concept to determine the requirements for deploying a fully functional smart contract on Ethereum in terms of cost and development effort needed. The smart contract that was coded to analyze sukuk tokenization can be accessed from N. (2019). The basic functions in Sukuk al-Murabaha smart contract with the objective of their usage is given in Table 3.2. The smart contract can be deployed and run on Remix for testing purposes. Remix is a tool for writing Solidity smart contracts directly from the browser and aids in testing, debugging and deploying smart contracts Remix, Ethereum-IDE (2019). A decentralized application on the blockchain using the coded smart contract can be visualized in OneClickDapp (2019).

Table 3.2: Basic Functions in Sukuk al-Murabaha Smart Contract

Function	Objective
registerObligor	Registers the Ethereum address of the Obligor.
newInvestor	Registers a new investor by recording the Ethereum address, investor's name and initializing the sukuk coins owned as well as the owned sukuk as zero.
buyCoins	The registered investor buys sukuk coins.
investInSukuk	The registered investor uses sukuk coins to invest in sukuk.
enterProceeds	The Obligor pays the periodic deferred payment.
automaticPayment	The owner of the smart contract, the SPV, initiates the automatic payment for the investors from the payment proceeds collected from the Obligor.

Figure 3.5 highlights the code for a function to distribute the profit accrued on the investment certificates (sukuk) on the basis of the payment frequency entered by the owner of the

```
pragma solidity 0.6.1;
contract BlockSukukSPV {
//code preceding the function
  function automaticPayment()public {
     require(now >= paymentFrequency);
     if(msg.sender!=owner){revert();}
     uint track;
     uint counter=numInvestors;
     while(counter>0){
        address i= investorList[track];
        uint factor=investors[i].ownSukuk;
        uint profit = (factor*475*proceedsPayment)/100;
        investors[i].profitReceived=profit;
        investors[i].sukukCoin+=profit;
        proceedsPayment-=profit;
        Transaction storage t=transactions[numTransactions++];
        t.sender=msg.sender;
        t.receiverID=investors[i].investorID;
        t.ID=numTransactions++;
        t.amount=investors[i].profitReceived;
        transactionList.push(t.ID);
        t.time=now;
        track++;
        counter--;
       }
   }
//rest of the code
}
```

Figure 3.5: Tokenization of Sukuk smart contract: function-Automatic Payment to Investors

smart contract in the constructor passed during smart contract deployment. The function needs the payment frequency to execute and can be called only by the owner of the smart contract. The investors are accessed through their Ethereum addresses and the profit distributed to the investor depends upon the number of sukuk (equivalent to bonds) owned by him and the profit rate, which was 4.75% in our case study (see Section 3.7). The number of sukuk coins owned by the investor increases on the basis of the profit accrued. The sukuk coins are tokens introduced to function only for the users registered through the smart contract to ensure security of fiat money held outside the blockchain and validity of ownership of the same. The exchange rate should be specified on the website of the issuer of sukuk.

3.7 Cost-Benefit Analysis

After introducing and analysing the technicalities related to sukuk tokenization, this section turns our analytical angle towards concerns of commercial, i.e. organizational adoption. Socio-economic, in particular financial feasibility concerns are often bottlenecks of technology adoption, as it is also argued in Gordijn and Akkermans (2003). Therefore, we first revisit our

implementation and address its cost consequences as follows. The costs of the transactions on Ethereum were computed by deploying the Sukuk al-Murabaha smart contract on Remix and executing the various functions. The tabulation of the various costs is given in Table 3.3. The transaction fee is computed by adding both the transaction cost and execution cost in terms of the gas used. In Ethereum, gas is a unit which helps to measure the amount of computational effort required to execute a certain operation on Ethereum. The exact price of the gas is determined by the miners and the price determines the speed with which the transaction is mined and recorded on the Ethereum blockchain. The calculations in Table 3.3 were done using average gas price of 1 gwei. The Ethereum cryptocurrency can be broken into smaller denominations like *wei* similar to a fiat currency being denominated into pennies. Wei is the smallest denomination for ETH, the cryptocurrency of Ethereum. 10^9 wei is equal to 1 gwei and is used to measure gas prices ETH Gas Station (2019). The cost is computed for a single investor for automatic payment of profit and thereafter for 5 investors and it is seen that the cost is simply 5 times the cost for a single investor. Reading data from Ethereum does not cost any gas unless it is through another contract, whereas writing to the blockchain incurs a cost and hence only the functions that involve a transaction fee have been listed in Table 3.3. It is also assumed that the total number of sukuk issued have been declared before contract deployment. However, the number can be changed and a function can be provided in the smart contract to increase the number of sukuk issued in case of over-subscription. Similarly a function to destroy the smart contract after maturity or at the will of the owner of the smart contract can be provided to prevent damage in case some error is discovered in the code after smart contract deployment. The costs have been calculated using the basic functions and should only be used for a theoretical assessment of cost-benefit analysis. Costs for the practical deployment of the full smart contract might vary, including the exchange rates causing a change in the transaction fee. The exchange rate utilized correspond to 28$^{\text{th}}$ December, 2019.

Table 3.3: Transaction Costs on Ethereum

Transaction (Tx)	**Gas Used**	**Tx fee (ETH)**	**Costs ($)**
Deploy Smart Contract on Ethereum	2737722	0.0027377	0.35043
registerObligor	63336	0.0000633	0.0081
newInvestor	278484	0.0002785	0.03565
buyCoins	406430	0.0004064	0.05202
investInSukuk	389826	0.0003898	0.04989
enterProceeds	77130	0.0000771	0.00987
automaticPayment (1 investor)	371594	0.0003716	0.04756
automaticPayment (5 investors)	1650610	0.0016506	0.21128

We compare the cost of sukuk issuance the conventional way to a blockchain-based issuance. In blockchain, the issue price and profit per annum will not affect the transaction costs but the payment frequency, the number of investors and the number of sukuk issued will directly impact the cost incurred by the issuing organization. We use the data for the transaction fee from Table 3.3 and use the sukuk issued by Aldar as a reference Islamic Markets (2018). The details of the sukuk issuance are given below:

- Amount: $500,000,000
- SPV/ Issuer: Aldar Sukuk
- Obligor: Aldar Investment Properties
- Minimum settlement amount: $200,000
- Par amount, integral multiple: $1,000
- Issue date: 01/October/2018
- Maturity date: 29/September/2025
- Coupon frequency: Semiannual
- Issue price (% of face value): 99.718%
- Profit per annum: 4.75%
- Sukuk type: Hybrid involving Wakala and Murabaha

In order to compensate for the Wakala structure in our smart contract, we paid a fee to the SPV acting as a *wakeel* over the underlying assets. We did the following assumptions for the cost benefit analysis:

- Each investor bought the minimum number of sukuk defined in the prospectus of Aldar Sukuk.
- The Obligor, Aldar Investment Properties, also makes the periodic payment for the Murabaha contract semiannually.
- The sukuk tenor is 7 years, which would involve 14 transactions for the periodic payments by the Obligor and also profit accrued to the investors with regards to the coupon frequency.

We did the following calculations to do the cost-benefit analysis for tokenization of sukuk on Ethereum:

$$\begin{aligned} \#\text{ Investors} &= \text{Amount/Minimum settlement amount} \\ &=> 500000000/200000 = 2500 \end{aligned} \tag{3.1}$$

$$\begin{aligned} \#\text{ sukuk each investor bought} &= \text{Minimum settlement amount/Par amount} \\ &=> 200000/1000 = 200 \end{aligned} \tag{3.2}$$

Thereafter, we compute the total transaction costs referring to the transaction fees given in Table 3.3 for the basic functions as given below:

- ***registerObligor*** $= 1 * 0.0081 =$ \$0.0081
- ***newInvestor*** $= 2500 * 0.03565 =$ \$89.125
- ***buyCoins*** $= 2500 * 0.05202 =$ \$130.05
- ***investInSukuk*** $= 2500 * 0.04989 =$ \$124.725
- ***enterProceeds*** $= 14 * 0.00987 =$ \$0.13818
- ***automaticPayment*** $= 14 * 2500 * 0.04756 =$ \$1664.6

We chose the case of Aldar Sukuk for our study because it is an average size issuance. The usual range of corporate sukuk issuance is between \$100M to \$2B International Islamic Financial Market (2020). As per the financial statement of Aldar for 2019 (page 69 of Aldar (2020)) the total issuance cost of the mentioned bond was \$7,165,532 or 1.43% from the total proceeds. Table 3.4 gives the cost components for tokenization on public Ethereum blockchain for a sukuk analogous to Aldar sukuk issuance. In Table 3.4 expenses mentioned refer to World Bank estimations for similar size and maturity bonds. The demarcation of the expenses was not given for Aldar and hence, we used the estimations from the World Bank for bond issuance Van der Wansem et al. (2019). According to an academician, the standard Shariah advisory fee is generally about one-quarter to one-half of a percent of the total value Rudnyckyj (2018). In the absence of availability of the Shariah advisory fee paid by Aldar, we consider it one-quarter of a percent to the total value.

Table 3.5 gives the cost components for tokenization of sukuk on a private/ consortium blockchain. The private blockchain and the consortium blockchain would be analogous in their cost components with the difference being in the number of nodes or computing devices

Table 3.4: Cost Components for Sukuk Tokenization on Public Ethereum

Sukuk Component	In quoted format	USD proceeds
Issuance	99.718%	$498,590,000
Smart contract deployment		$0.35
Fees: newInvestor & buyCoins		$102,130
Fee: investInSukuk		$124,725
Fee: enterProceeds		$0.14
Fee: automaticPayment		$16,646
Fee: registerObligor		$0.01
Independent advisor	0.020%	$99,718
Legal expenses	0.030%	$149,577
Bond rating	0.100%	$498,590
Rating costs	0.005%	$24,929.50
Shariah advisory fee	0.25%	$1,250,000
Total fees and expenses to be paid upfront	0.45%	$2,266,316
Total Proceeds to Obligor		$496,323,684
All-in price (proceeds/amount)	99.26%	

employed as validators and distribution of profit accrued from the blockchain platform. In case of a consortium blockchain, the transactions for the distribution of the fee for the provided services as *wakeel* would be directly proportional to the number of partners whereas it would be a single transaction in case of a private blockchain. It is assumed that the partners in setting up this private/ consortium blockchain would not be charging any fee for the transactions through their hosted blockchain and hence the transactions are all free and cost $0. We give a common Table 3.5 for the cost components of a private and a consortium blockchain highlighting the difference in the costs. We assume that the total number of nodes in the blockchain platform is equivalent to the number of partners in a consortium blockchain platform. The consortium consists of 3 partners based in Paris, Dubai and Malaysia. The private blockchain can be assumed to have 3 nodes located in Paris, Dubai and Malaysia.

The private/ consortium blockchain uses Amazon Elastic Compute Cloud (Amazon EC2) to avail a secure and resizable compute capacity in the cloud AWS (2019a) for hosting the nodes. The infrastructure costs for t3.large reserved instances in EC2 will be as follows AWS (2019b):

- EU (Paris) region for the blockchain node in Paris:
    a. Standard 3-Year Term: All upfront = $1096
    b. Standard 1-Year Term: All upfront = $545
- Middle East (Bahrain) region for the blockchain node in Dubai:
    a. Standard 3-Year Term: All upfront = $1154

Table 3.5: Cost Components for Sukuk Tokenization on Private/ Consortium Ethereum

Sukuk Component	**In quoted format**	**USD proceeds**
Issuance	99.718%	$498,590,000
Smart contract deployment		$0
Fees: newInvestor & buyCoins		$0
Fee: investInSukuk		$0
Fee: enterProceeds (private Ethereum)		$0
Fee: enterProceeds (consortium Ethereum)		$0
Fee: automaticPayment		$0
Fee: registerObligor		$0
Website Hosting		$2,737
Blockchain Node Paris		$2,737
Blockchain Node Dubai		$2,856
Blockchain Node Malaysia		$2,589
Independent advisor	0.020%	$99,718
Legal expenses	0.030%	$149,577
Bond rating	0.100%	$498,590
Rating costs	0.005%	$24,930
Shariah advisory fee	0.25%	$1,250,000
Total fees and expenses to be paid upfront	0.41%	$2,033,734
Total Proceeds to Obligor		$496,556,267
All-in price (proceeds/amount)	99.31%	

b. Standard 1-Year Term: All upfront = $548

- Asia Pacific (Singapore) region for hosting the node in Malaysia:

a. Standard 3-Year Term: All upfront = $1023

b. Standard 1-Year Term: All upfront = $543

- Website Hosting from Paris: Price is similar to the hosting of blockchain node in Paris

The other cost assumptions remain the same in the cost-benefit analysis as they were in the case with sukuk tokenization on the public blockchain. The computed results for the cost-benefit analysis are given in Table 3.6.

Table 3.6: Cost Comparison for Sukuk Issuance vs Tokenization

Sukuk Issuance Type	Total Cost= Fees and Expenses paid upfront + Issue price	
Conventional Issuance	$7,165,532	
Tokenization on Public Ethereum	$3,676,316	
Tokenization on Consortium Blockchain	$3,443,734	

3.8 Sukuk Tokenization: Feasibility Analysis

The results of the performed cost-benefit analysis thus brings us closer to understand the commercial, i.e. financial consequences of sukuk tokenization. Combined with the findings of the concrete implementation exercise of a basic smart contract for tokenization, we articulated and assessed important feasibility concerns from the commercial, i.e. the financial market point of view, including implications for regulatory compliance. In the following, we report our findings and emphasize their significance:

a. **Issuance vs Tokenization cost comparison.** The cost incurred by Aldar for issuance was $7,165,532, while tokenization of a similar sukuk on public Ethereum involved a cost of $3,676,316. Private/ consortium blockchain recorded the minimal cost incurred for tokenization with a value of $3,443,734. The cost ratio of conventional sukuk issuance to tokenization on public Ethereum is 1.95 whereas the cost ratio of conventional issuance to tokenization on private/ consortium Ethereum is 2.10 indicating a significant reduction in expenses using Ethereum for tokenization.

b. **Role of Shariah advisors.** The role of the Shariah scholars will be paramount in tokenization and a common understanding of the programmed smart contract between the Shariah scholars, sukuk issuing organization and the technology team needs to exist to avoid potential incorrect Shariah adherence in tokenization to be legitimated as Shariah-compliant. The achievement of a common understanding is crucial for transparency and is a difficult process as it involves experts from three diverse domains to agree on a common outcome. This goal might entail the requirement of additional experts well versed in the Shariah law and technology, thus adding on to the costs. Industry exchanges on the subject give a comparatively lower Shariah advisory fee than we used but is undocumented preventing it's incorporation in our analysis. A higher limit, where the Shariah advisory fee is indicated to be in millions of dollars, also exists Sophie (2012).

c. **Clearing and Settlement.** Clearing and settlement processes are more efficient by using blockchain, which ensures an automated delivery and payment mechanism in the absence of a central authority. This confines the settlement risk exposure significantly Chiu and Koeppl (2019).

d. **Counterparty Risk.** The counterparty risk is mitigated as the settlement is occurring in real time as a result of the automation of periodic payments.

e. **Smart contract evaluation.** The smart contract coded was with minimal functions to implement a Murabaha contract for sukuk issuance. A complete smart contract would involve more functions and events, that indicate to the owner of the smart contract when a stipulated action has happened in the smart contract like the payment by the Obligor. Thus the smart contract development and deployment on Ethereum would incur higher fees.

f. **Additional Costs.** The front-end development of the smart contract into a functional decentralized application would need to be accomplished and a payment gateway would need to be used to convert the fiat currency to ETH and buying of sukuk coins if the structure involves their usage. All this would increase the costs more.

g. **Know Your Customer (KYC).** KYC is a strict regulatory measure to assure institutional compliance regarding client verification, validation and transaction monitoring. Therefore, including digitalized tools to perform KYC related to sukuk tokenization is an essential part for investor validation. There exist numerous third-party solutions for KYC compliance. Alternatively, a tool needs to be developed in-house by the issuing organization. The detailed cost assessment of KYC clearance is out of the scope of this chapter, nevertheless, raising awareness on this cost element is of high importance.

h. **Legal Issues.** Smart contracts are not considered to be legal in most jurisdictions and as such a legal contract would still need to be drawn up for the investors for their entitlement to a share in the underlying asset.

i. **Absence of an online notary.** The implemented smart contract focuses only on sukuk issuance to the investors whereas the Murabaha sale and purchase is conducted outside the blockchain network. This is primarily because the mechanism of online notary is not available in most jurisdictions as of now, to the best of our knowledge.

j. **Data privacy.** Privacy issues would need to be tackled when using blockchain and if available for this kind of a structure, privacy-preserving blockchain platforms should be employed. An alternative strategy would be to go for a hybrid of a traditional database for private data interoperable with a blockchain platform for recording transactions. The development skills needed to achieve either of the two is not easily available, thus adding on to the development costs.

k. **Scalability and throughput.** Blockchain is still in the early stages of development

with scalability and performance bottlenecks impeding its mass scale usage Chauhan et al. (2018); Dinh et al. (2017).

l. **Key management.** Management of public-private key pairs associated with an Ethereum address and a more than basic technical awareness from the user is expected to engage with the blockchain platform.

m. **Vulnerabilities in smart contracts.** Post deployment on Ethereum, the smart contract cannot be updated to remove any potential coding errors and any undetected errors have the potential to be exploited like the DAO attack in which an anonymous hacker stole over $50M worth of ETH Mehar et al. (2019). Efforts should be made to adhere to a secure development process for smart contracts on the blockchain and deploy them post an optimum security analysis Hasan and Salah (2018b), otherwise their usage in tokenization can make them vulnerable to attacks causing major losses Mense and Flatscher (2018). It would be worthwhile to know the key aspects governing the security analysis, testing and implementation of smart contracts Almadhoun et al. (2018) in other domains before using them to issue sukuk to help conceptualize a framework for their secure deployment in the Islamic finance sector.

The above analysis indicates that to ensure economic viability for tokenization of sukuk, the technology needs to be developed to a level where it can be aptly used in the market on a large scale and appropriate regulations have been framed by governments for recognition of an online notary. Additionally there should exist legalization of smart contracts in all the concerned jurisdictions to ensure dispute resolution and complaints redressal. It is recommended for organizations embarking on the initiative to conduct a cost-benefit analysis adding the costs listed above to the assessment conducted in this chapter to come to a more just estimate of the process.

3.9 Conclusion

In this chapter we evaluated the present challenges in sukuk issuance and discussed circumvention of some of them using blockchain. We discussed the blockchain platforms, in the light of their architecture, that can prove to be suitable for sukuk tokenization. We elaborated on a taxonomy for blockchain applications in finance and the Islamic finance domain in particular. We conducted a case study on tokenization of Sukuk al-Murabaha on Ethereum and coded a

basic smart contract to gauge the contract development complexity and effort required. Developers with the requisite skills are not readily available and Islamic finance personnel should be trained to cater to this need in the sector. Our performed cost-benefit analysis of sukuk tokenization indicates that tokenization itself, leveraging on blockchain, incurs significantly less expenses when compared to conventional sukuk issuance. Furthermore, our more detailed analysis shows that sukuk issuance on the public Ethereum blockchain incurs a higher cost than tokenization on a private/ consortium Ethereum blockchain platform. The results are, however, dependent on the concrete implementation characteristics and assumptions based on the particular application domain, such as the choice of the number of nodes, sukuk tenor, number of investors and other similar factors. Feasibility analysis of sukuk tokenization on Ethereum needs to be considered in the light of economic viability, when viewed from the broader perspective considered in Section 3.8, and the advantages it offers in terms of expanding the investor base and proving to be a solution for the funding needs of SMEs.

As an important contribution, this chapter provides a step-wise, systematic approach to assess and to analyse fundamental elements of commercial feasibility of sukuk tokenization. By addressing the fundamental factors of cost-benefit analysis in Section 3.7, such as the cost factors of blockchain transactions, and by conceptualising the main findings and concerns of adoption in Section 3.8, we provide a solid assessment framework for organizations that intend to tokenize sukuk. However, it is crucial that the investors ensure that appropriate regulations are in place for sukuk tokenization to protect their interests before investing in blockchain-based sukuk. Technology is developing at a rapid pace and eventually regulations will follow to discipline its usage. Besides, technological advancements would result in more cost reductions in their employment with the passage of time. Therefore, hybrid arrangements which take into account the existing regulations and legacy systems should be integrated with blockchain to develop novel structuring methodologies for sukuk tokenization to leverage on the benefits of the technology.

Chapter 4

Lying for Money: Role of Religion

4.1 Introduction

One of the fundamental assumptions regarding standard preferences in economics is strict convexity and strict monotonicity. These assumptions, together with others, lie behind the utility-maximization theory that is at the core of neoclassical economics: a rational individual's actions result from the maximization of utility subject to constraints. Individuals may sometimes cross lines of acceptability for monetary reasons by acting fraudulently, as in the cases of Nick Leeson, Jérôme Kerviel and Kweku Adoboli (Rafeld et al., 2017) or the LIBOR manipulation case (Abrantes-Metz et al., 2012). Laws do not cover all ethical behaviors. Modern economics does not clearly discourage unethical actions if they are profitable, legal and maybe undetected, even if they produce a public bad as long as there is a private return. On the contrary, there is greater acceptance of and justification for lying, with the potential victims being asked to protect themselves rather than standards being set to defend them (Frankel, 2008).

A series of fraud cases have damaged the trust relationship between financial institutions and clients (Gounaris and Prout, 2009). Trust and honesty have consequently become more valuable in the financial industry. Islamic finance considers trust to be the central tenet in every financial transaction (Ali, 2017), and ethical values such as honesty and anti-corruption increase the adoption of the principles of the Islamic financial system (Afkar et al., 2018). The two main types of prohibitions in Islamic financial transactions are *Riba* and *Gharar*: these refer respectively to the predetermined interest rate on loans and the uncertainty driven by speculation or excessive risk. Truth-telling plays a central role in both, and financial contracts will be voided if lying was directly involved.

The main motivation for clients to work with Islamic banks (IB) is their religious values, despite their services being more expensive than those of conventional banks (Ahmad et al., 2011), in addition to their social responsibility and transparency (Al-Ajmi et al., 2009; Amin, 2008). IBs sell their products under the environmental, social or governance (ESG) framework. The ethical motivation of IB clients suggest they are less likely to have fraudulent intentions and have greater trust in their banker. Client honesty is one criterion that IBs use to evaluate their clients.

Trust is also required from the bank's side. IBs are mandated to abide by *Sharia* rules in addition to public legislation. A client's contract with an IB represents an implicit consent to adhere to Shariah rules, even if this is not enacted. The parallel regulatory system creates additional complications and opens the door for clients to take advantage. For example, Islamic banks cannot charge additional interest on late loan payments. It is therefore of interest to analyze the trust relationship between Islamic banks and their clients. Banks operating under the ESG framework expect to have an enhanced mutual-trust relationship with their clients. Religious beliefs have a direct effect on loyalty to the bank, which is mediated by trust and honesty (Suhartanto et al., 2018).

There are a variety of types of Islamic finance that are relevant for sustainable development programs. The tripod of Islamic finance, ethics and sustainability has a two-way relationship with the real economy, financial stability and social prosperity. The United Nations Development Program (UNDP) joint with the Islamic Development Bank in 2017 launched the first project on the impact of Islamic finance on sustainability. The Organization for Economic Co-operation and Development (OECD) has put forward a set of initiatives to embed the USD 2.5 Trillion of Islamic finance into sustainability projects. Islamic finance encourages reasonable profit motives but does not prioritize them, as opposed to the central role of profit and private ownership in economic theory. These latter motives were identified as the main source of the 2007-2008 financial crisis by Christine Lagarde, the former IMF managing director and current President of the European Central Bank.

The current chapter tests whether religion has an effect on honesty when there are monetary incentives. Establishing a financial system based on ethics is in contradiction with completeness, the first axiom of economics principles. This underlines the importance of the ethical behavior of the religious in financial decision-making. I here carry out an experimental investigation of these beliefs on behavior, and analyze the role of priming.

Following Fischbacher and Föllmi-Heusi (2013), I conduct a dice-under-the-cup experiment in Lebanon for two samples of 581 volunteer participants to measure honesty among the religious

and non-religious. The payoffs ranged between one and six US Dollars: these are not trivial amounts, as six Dollars corresponds to 17.8% of the monthly minimum wage in Lebanon during the experimental period due to the economic crisis. Participants rolled a die inside a cup and reported the outcome, which they alone observed. They then completed a questionnaire including questions on gender, age, education, religion, and whether they consider themselves to be a practising member of their religion. They subsequently received the cash Dollar amount corresponding to their reported dice outcome. This experiment was then repeated to analyze the priming effect of religion on decisions. The priming experiment was identical in all aspects except for a reminder of religious beliefs before the individual reported the dice outcome.

I then carry out a mind-game experiment as in Tan (2006) on two samples of 470 volunteer participants to further analyze the honesty differences between the religious and non-religious. In the first sample, participants were in the same room as the experimenter and had to choose a number between 1 and 6 and memorize it. They then rolled a fair dice and stated whether the outcome matched their chosen number. If the number matched, participants received 6 USD; if it did not they received 1 USD. I expect more participants to cheat in this game, as the experimenter cannot know their real chosen number and they thus cannot be identified as having cheated. There is moreover a greater incentive to lie, as the payoff is either 6 or 1. I repeat this experiment to analyze the self-reputation effect on honesty. In the second sample, participants carried out the same mind-game experiment as the individuals in the first sample, but in a room with no-one else present. In this treatment, there was only a table with the instructions, a dice, the questionnaire and the money. I expect participants with greater self-reputation concerns to cheat more in this experiment. Any remaining honesty should reflect intrinsic values.

The main objective of this research is to measure the honesty that comes from internal values in the absence of external deterrents such as punishment and the individual's public image. If participants consider the experimenter to be a second player in the game, they receive private but noisy information about the state of the world and their decision on what outcome to report determines the payoff. Participants also receive a noisy signal through the religiosity question before making the decision that determines their welfare. The rationality of participants and their reaction to the signal may affect their decision to cheat (Crawford and Sobel, 1982). Any misunderstanding of the signal or insensitivity to the religious signal will render this as "cheap talk", and thus will not lead to a Pareto-efficient outcome (Farrell and Rabin, 1996).

The findings of the dice-under-the cup experiment show that the religious cheat less on average than the non-religious. In the first experiment, 23.6% of the non-religious earn the

maximum amount by reporting 6 as their outcome (as compared to a fair-dice figure of 16.7%), and 26.5% report a score of five. As such, there are 6.9% income maximizers amongst the non-religious, and 9.8% partial liars. Their average reported dice score is 4.4 (as compared to the fair-dice score of 3.5). The religious in this experiment cheat less, with an average reported score of 3.7, 2.4% income maximizers and 2.4% partial liars. In the second experiment, the religious are honest and report an average outcome corresponding to the fair dice. However, 16% of the non-religious are income maximizers and 8% partial liars. This may reflect the priming effect of the religion question reminding participants of their internal beliefs before they take their decisions. This religious priming effect in similar experiments has not been tested in the literature to my knowledge.

The findings of the mind game confirm that the religious cheat less, even when there is no chance of being caught and when they have no self image to lose. In the first experiment, 9.8% of the religious and 19.5% of the non-religious cheat in order to receive the additional 5 USD. Controlling for the self-reputation effect, 15.2% of the religious and 32.5% of the non-religious lie to maximize their income. The mind game explains part of the honesty behavior in the dice-under-the-cup experiment via worries about being caught cheating and self-reputation, with the non-religious giving more weight to these concerns.

4.2 Literature Review

There is a large experimental literature on honesty when faced with monetary incentives. Gneezy (2005) analyzed sender-receiver experiments, where only the sender knows the real monetary payoffs to the sender and the receiver associated with two options. One option involves a higher payoff to the sender and the other a higher payoff to the receiver. The sender passes information about the two payoffs in each option to the receiver, and the sender may lie about these payoffs. The receiver subsequently chooses one of the two options. This experiment was repeated three times with increasing payoffs each time. A number of factors affected the propensity to lie, of which the economic gain was the most important. Individuals in larger economies with more-developed institutions were more likely to be honest (Bidner and Francois, 2011), while those in countries with more corruption and tax evasion cheated more (Gächter and Schulz, 2016).

Fischbacher and Föllmi-Heusi (2013) were the first to measure honesty using the dice-under-the-cup experiment. They gave participants a fair dice, and asked them to report the outcome of a dice roll. Participants received 1,2,3,4 and 5 Swiss Francs for the outcomes of

1,2,3,4 and 5 respectively, and zero for the outcome of 6. Fischbacher and Föllmi-Heusi (2013) analyzed the percentage of reported 4s and 5s, and found 22% "income maximizers", defined as the excess percentage of reported 5s over the fair-dice figure, and 10% "partial liars", defined as the analogous figure for 4s. A second experiment with tripled payoffs produced similar results. Last, in the third experiment lying rose to 43% in the second round of this same game when the game was played twice by the same individuals. After finding that even increasing monetary incentives 50-fold did not increase cheating, Kajackaite and Gneezy (2017) modified the replication of the dice-under-the-cup experiment to eliminate concerns about being exposed as a cheater and thus identify the intrinsic cost of lying. In this case, these intrinsic lying costs are compared to the monetary gains to determine cheating (Kajackaite and Gneezy, 2017).

The interaction between religion and ESG has been studied from a number of different angles. An empirical analysis of 17,432 firm-year observations across 33 countries between 2004 and 2017 shows that religiosity encouraged companies toward non-financial disclosure(Terzani and Turzo, 2022). Shariah-compliant firms have on average, higher ESG score and show lower levels of idiosyncratic risk and higher levels of systematic risk than their conventional counterparts (Hassan et al., 2021). The authors conclude that religious firms are more likely to take part in sustainable practices.

Abeler et al. (2019) carry out a meta-analysis of the experiments following Fischbacher and Föllmi-Heusi (2013), covering 90 papers with 44,000 participants and 270,000 decisions in 47 countries. They conclude that around 25% of individuals cheat to obtain more money. This contradicts one of the main predictions of economic theory that individuals will act to maximize their monetary gains. Empirical evidence underlines the motives for truth-telling from internal honesty behavior and the preference to be seen as honest for reputational reasons (Abeler et al., 2019).

There are a variety of conclusions in the literature as to gender differences in honesty. Replications of the experiment in (Gneezy, 2005) show that men cheat more than women for monetary benefit (Childs, 2012; Dreber and Johannesson, 2008; Friesen and Gangadharan, 2012), while another replication of this experiment with smaller monetary incentives reveals no gender differences in honesty (Gylfason et al., 2013). Regarding age, the results from the sender-receiver experiment indicate that the young cheat more than the old (Glätzle-Rützler and Lergetporer, 2015).

Previous work has examined honesty and religiosity, finding no difference in cheating in an unsupervised Math test where it was easy to cheat (Aveyard, 2014), nor in sender-receiver and dictatorship games (Childs, 2013; Tan, 2006). However, in the sender-receiver experiment in

Christie (2019), the highly-religious are more truthful. Other empirical analyses have shown that religion is positively related with attitudes that are conducive to believing that market outcomes are fair. Believers tend to trust each other, follow regulations, and are less willing to break the Law (Guiso et al., 2009). On a different level, (Hugh-Jones, 2016) performs two experiments across 15 countries to measure honesty using a coin flip with a reward and an online quiz with an opportunity to cheat. Honesty is found to be positively correlated with GDP per capita and the population percentage of Protestants.

Priming has an effect on honesty. Bank employees lie more when their job title is salient than when it is unobserved. This effect is specific to bank employees, and not found in other industries (Cohn et al., 2014). Cheating was identical between participants recalling names of books and the Biblical Ten Commandments before performing an experiment (Mazar et al., 2008). Aveyard (2014) showed that religious priming (via hearing the "Athan" Islamic call to prayer) led to greater honesty in easy to cheat Math tests. In a dictator-game experiment, where one participant decides the monetary payout of the other, thinking about God reduced selfishness among the religious but not among the non-religious (White et al., 2019). In a set of four experiments, making religious beliefs implicitly salient increased individuals' self-control (Rounding et al., 2012). The experiment in Benjamin et al. (2016) reveals that religious priming has a positive impact on contributions to public goods for Protestants, a negative effect for Catholics, and no effect for the Jewish.

The work described below combines honesty, religion and priming effects in incentivized games. These three elements have not been jointly addressed in this context in the previous literature to my knowledge.

4.3 Experimental Design

4.3.1 The Dice-Under-The-Cup Experiment

I carried out the dice-under-the-cup experiment as in Fischbacher and Föllmi-Heusi (2013). Participants received monetary payoffs in this experiment, and were of different genders, age groups, education levels and religious beliefs representing layers of society. Participants rolled a fair dice hidden inside a cup, that only they could see, and then reported the outcome. I hypothesize that believers and the highly-educated will cheat less.

Unlike the original paper of Fischbacher and Föllmi-Heusi (2013), there was a payoff of one dollar for each dice point: from 1 USD for a dice roll of 1 up to 6 USD for a roll of 6.

The experiment took an average of around 10 minutes per participant, in order to explain setup and the payoff, fill out the questionnaire, roll the dice and sign the money receipt. The experimental instructions appear in Appendix 4.A. Participants could roll the dice a number of times to check that it was fair, although they were explicitly told to only report the result of the first dice roll. Cheating will be reflected by an excessive number of 5s and 6s in order to earn more. The experimenter cannot observe individual cheating in this experiment, which avoids self-image or shame effects. However, we can compare the aggregate declarations to the fair-dice probabilities of 1/6 for each number. To avoid the breach of Shariah rules on gambling and dice payoffs, participants were told that the dice roll was to reward their effort in participating in the experiment.

The experiment was carried out on two samples, with the only difference being that the second included a religious-priming effect treatment. The first experiment took place in Lebanon during the first week of August with 207 participants (29% Christians, 32% females, and 54% with university degrees, as shown in Table 4.4) and the second in the last week of November with 374 participants (33% Christians, 30% females, and 57% with university degrees: see Table 4.4). Both took place in public places, particularly at the university, shopping malls and cafes. Lebanon was chosen for this experiment for three reasons. First, it is the most religiously-diverse country in the Middle East, with 58% Muslims and 36% Christians of different sects according to the CIA World Factbook (2020). The society is harmonized in terms of religion, with no religious legislation. Over 75% of people surveyed answered "Strongly agree" regarding having a person of a different religious faith living next door. Second, asking religiosity questions in public is culturally acceptable: people are open to discussing their beliefs, especially given that the religion mentioned on their ID cards may not represent their internal beliefs. About one half of the Lebanese go to a place of worship at least once a week according to the Gallup survey, which is considered a very high figure for the Western world but lower than that in other Middle Eastern countries. Third, the highest experimental payoff represents 17.8% of the monthly minimum wage in the country. During the experimental period the average USD/LL exchange rate was 20,000. The monthly minimum wage in Lebanon in 2021 was 675,000 LL, so that the highest payoff of 6 USD was around 120,000 LL or 5.6 days of the minimum wage. This provides participants with a greater incentive to cheat, as compared to the payments in similar experiments in the literature.

4.3.2 The Mind Game

To control for the fear being caught cheating in the Dice-Under-The-Cup experiment (even though cheating could not be identified in this experimental set-up), two additional experiments were conducted following Jiang (2013). In the first, participants chose and remembered a number between 1 to 6. They then rolled a dice and stated whether the outcome matched their chosen number. They received the full payoff of USD 6 for a match and 1 USD otherwise. This game produces greater cheating incentives, as the payoff is either 6 or 1 and cheating cannot be identified.

The second experiment was identical, except that it was carried out in an isolated room. Participants entered a closed room with a table on which were the experimental instructions, a dice, a five USD bill and a one USD bill, and the questionnaire to be completed. They carried out the experiment alone, took the money, filled out the questionnaire and left without any direct contact with the experimenter. This treatment controls for self image and reputation. I expect greater cheating in the mind game, and especially so in the self-reputation treatment.

Both mind-game experiments took place in April 2022 in the same locations as the previous experiments. There were 207 participants (25% Christians, 49% females, and 51% with university degrees, as shown in Table 4.4) in the first experiment, and 263 participants (28% Christians, 52% females, and 54% with university degrees: see Table 4.4) in the second experiment with the self-reputation treatment. The USD to Lebanese Lira exchange rate was very similar to that in the first two experiments.

4.4 Results

4.4.1 Basic Experiment

After explaining the experimental instructions and approving their participation in this experiment, 207 participants rolled the dice and reported the outcome, and then filled out a questionnaire including information on gender, age, education level and religious denomination. Religiosity was determined by a YES/NO question: "Do you consider yourself a practising member of your religion?". It was made clear that the respondent should only report the result of the first roll, even they could roll the dice a number of times to check its fairness.

Figure 4.1 shows the distribution of reported outcomes, where the straight line is the distribution from a fair dice. The non-religious had an average score of 3.99, which is higher than the fair-dice figure (3.5), with 9.8% partial liars and 6.9% income maximizers. The partial-liar

figure refers to the excess percentage reporting outcome 5 above the expected fair dice figure, and the income maximizers figure is the analogous calculation for outcome 6. The religious are more honest than the non-religious, with an average score of 3.69, 2.4% partial liars and 2.4% income maximizers. These results are in line with Fischbacher and Föllmi-Heusi (2013), but with some interesting differences. First, the lowest-payoff outcome is not the least-reported: participants in both experiments do not seem to cheat when they had a dice-roll of 1. Second, the highest-payoff outcome is not the most-reported. The non-religious cheat more by declaring 5 than 6, and the religious declare both equally. Third, the total cheating figure is 22%, below the 29% figure in Fischbacher and Föllmi-Heusi (2013).

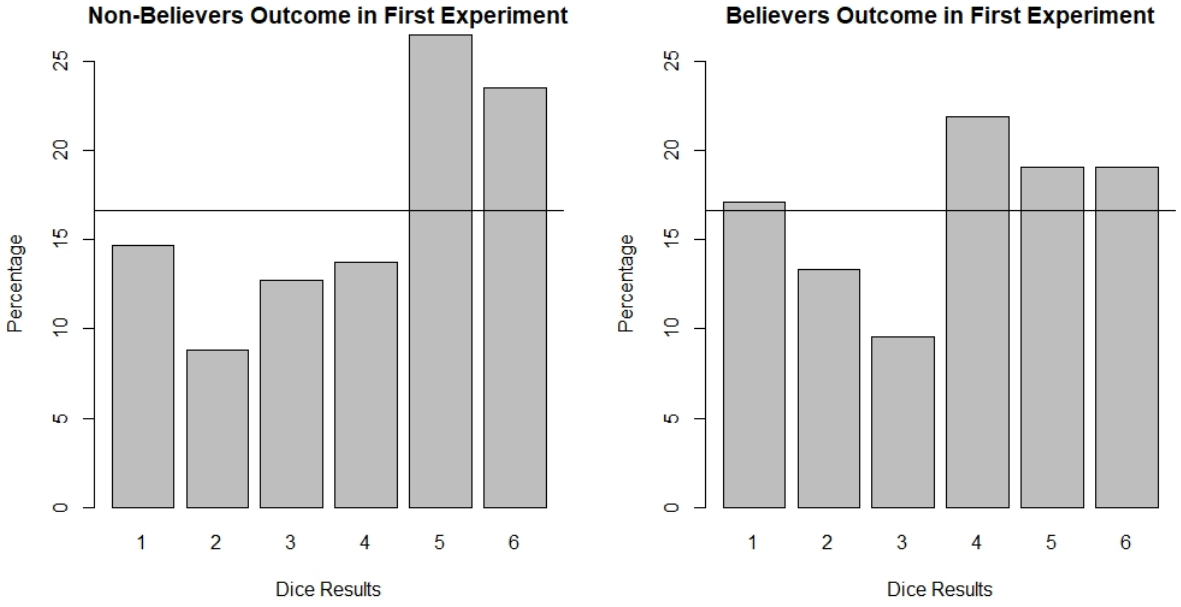


Figure 4.1: **Outcomes in the first experiment.** This figure shows the percentage dice-roll distribution for the non-religious and religious in the first experiment. The horizontal line is the expected probability figure for a fair dice. Cheating is measured as the positive gap from the horizontal line.

The estimation results from Equation (1) are presented in Table 4.1.

$$y^* = \beta x + \epsilon \tag{4.1}$$

Here y^* is an unobserved dependant variable; x is a vector of explanatory variables that include Belief as a dummy variable for the religious, gender, age and education which is classified into three categories: School dropout, High School and University; ϵ is error term assumed to have a standard logistic distribution.

Instead of y^*, the is following observed:

$$y_i = \begin{cases} 1, & \text{if } y^* \leq \alpha_1 \\ 2, & \text{if } \alpha_1 < y^* \leq \alpha_2 \\ 3, & \text{if } \alpha_2 < y^* \leq \alpha_3 \\ \vdots & \\ J, & \text{if } y^* > \alpha_{J-1} \end{cases} \tag{4.2}$$

Here y is the dice outcome; α is a vector of thresholds of dice outcome; i represents participant in experiment; J is the six possible outcomes of dice.

Probability of observing dice outcome will be:

$$Prob(y_i = j) = F(\alpha_j - \beta' x_i) - F(\alpha_{j-1} - \beta' x_i), j = 1, 2, ..., J \tag{4.3}$$

F(.) is the CDF of logistic distribution. Thus:

$$Prob(y_i = j) = \frac{1}{1 + e^{-\alpha_j + \beta' x_i}} - \frac{1}{1 + e^{-\alpha_{j-1} + \beta' x_i}} \tag{4.4}$$

Equation (1) is estimated via ordered logit, an extension of the binomial logistic regression, as the dependent variable takes on six discrete ordered values. In some specifications, I will introduce interactions between religiosity, on the one hand, and gender, age and education on the other. The Wald test measures the goodness of fit, and the Chi-squared value of 39.3 with four degrees of freedom and a p-value of under 1% indicates that the explanatory variables significantly predict the dependent variable. The one-sample Kolmogrov-Smirnov test (p= 2.2e-16) confirms that the outcome distribution differs significantly from the uniform fair-dice distribution.

In Table 4.1 there is a positive but insignificant effect of religion on cheating. The estimated coefficients on the other control variables are insignificant, with signs indicating that women cheat less than men. The interaction variables also attract insignificant estimated coefficients.

4.4.2 The Priming-Effect Experiment

The same questionnaire was used in the second experiment, but this time was filled out before the dice was rolled. There were 374 participants in this second experiment, with the gender, age and education distributions being similar to those in the first experiment.

Answering the religiosity question may triggers participants' internal beliefs and so affect

their decision-making. The automatic activation of mental representation involves reflexive replies to some triggering conditions. Among many phenomena in social psychology, this automatic thinking includes religion, and religious depictions can directly inspire the religious. But does this work in both directions? Priming could remind the religious of certain internal barriers to lying, and the non-religious of the absence of such barriers. No previous research has found a religion-priming for the non-religious.

The results show that the average dice outcome is 3.98, with the deviation from the fair-dice outcomes due to an excessive number of 5s (75 instead of 62.3) and 6s (94 instead of 62.3). Figure 4.2 shows the dice outcomes for the religious and non-religious. The non-religious results are similar to those in the literature, as in Fischbacher and Föllmi-Heusi (2013), with a score of 4.44, 8% partial liars and 16% income maximizers, and monotonicity as theory would predict. The religious are clearly more honest, with an average score of 3.47 and no deviations for the 5 and 6 figures. Apart from the excessive number of 2s, the histogram for the religious suggests complete honesty when they are reminded of their beliefs. The 6% above-average figure for outcome 2 can be interpreted as a simple outlier, anti-cheating behavior, or being afraid of being suspected of cheating. Cheating is hard to explain in this case, as if the participant believes that lying is unethical then the effect should work in both directions: cheating either to gain more or gain less. It is perhaps more likely that the religious after priming were cautious of reporting high payoffs to avoid being suspected of being dishonest.

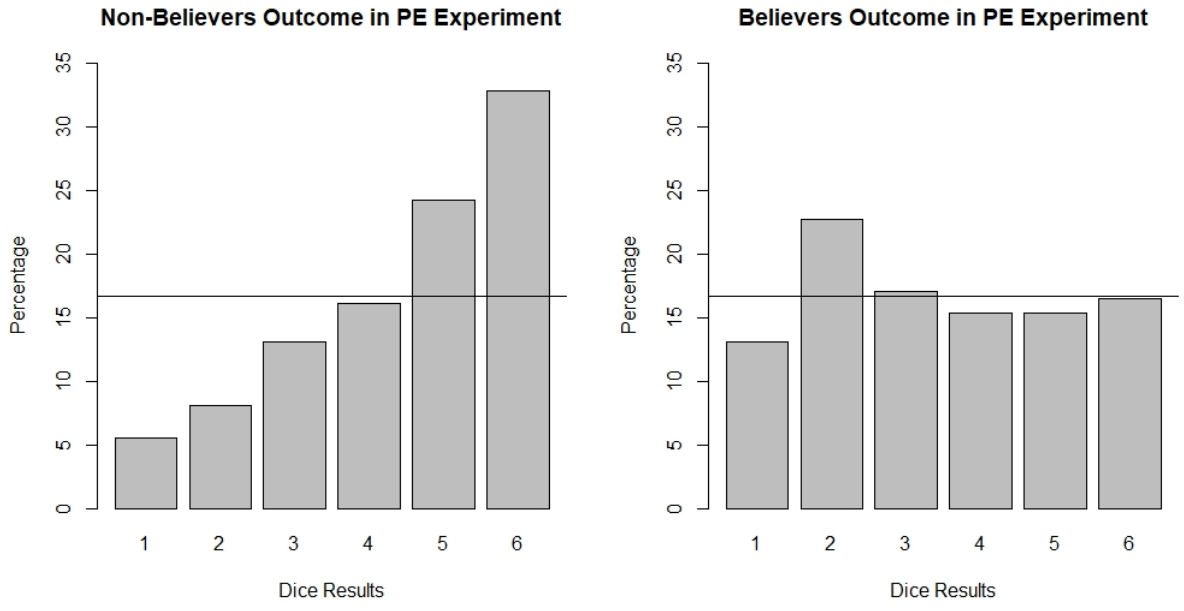


Figure 4.2: **Outcomes in the priming effect experiment.** This figure shows the percentage of reported dice outcomes for the non-religious and religious in the second experiment where participants reported their beliefs before reporting outcomes. The horizontal line is the expected probability from a fair dice. Cheating is measured by the positive gap from the horizontal line.

Table 4.2 shows the regression results from the priming-effect experiment in Equation (1). The Wald test Chi-squared value of 39.3 reveals that the explanatory variables predict the outcome. The one-sample Kolmogrov-Smirnov test (p= 2.2e-16) confirms that the distribution of allocations is significantly different from the uniform distribution associated with a fair dice. The results show that religiosity reduces cheating when participants report their religious beliefs prior to the dice outcome.

4.4.3 The Mind Game

The first mind game was used to control for the risk of being caught as a cheater in the Fischbacher and Föllmi-Heusi (2013) game, and the second to control for self-reputation effects. The results of both show that the religious continue to cheat less than the non-religious. In Figure 4.3, 9.8% of the religious lied in the basic mind game, higher than the figure in Fischbacher and Föllmi-Heusi (2013). This suggests that part of the honesty of the religious in the first experiment resulted from their fear of being caught cheating. The figure also shows that 19.5% of the non-religious cheat in this experiment, a figure that is 10% points higher than that for the religious. Figure 4.3 also shows that when participants carried out the experiment on their own with no self-reputation effect, 15.2% of the religious and 32.5% of the non-religious cheat. Self reputation thus has an effect on the cheating of the religious and an even stronger effect for the non-religious.

Table 4.3 shows a negative significant effect of religion on cheating, while the self-reputation treatment increases cheating. The gender coefficients suggests that women are honest than men (although the coefficients are not significant), and the educated cheat less. There is no relationship between honesty and either age or the interaction variables.

4.4.4 Gender and Education

The results of the two dice-under-the-cup experiments suggest that women cheat a little less than men, with average figures of 3.78 and 3.99 respectively as shown in Figure 4.4.4. Similar results are observed for the mind game in Figure 4.5. This cheating difference arises in the treatment experiment, so that relatively more men are honest for self-reputation reasons. The effect of education on truth-telling appears in Figures 4.6 and 4.7. Participants with higher education reported an average figure corresponding to a fair dice in the dice-under-the-cup experiment. High school and university students had an average score of 3.95 with 4% partial liars and 6% income maximizers, while those with less education cheated more with an average

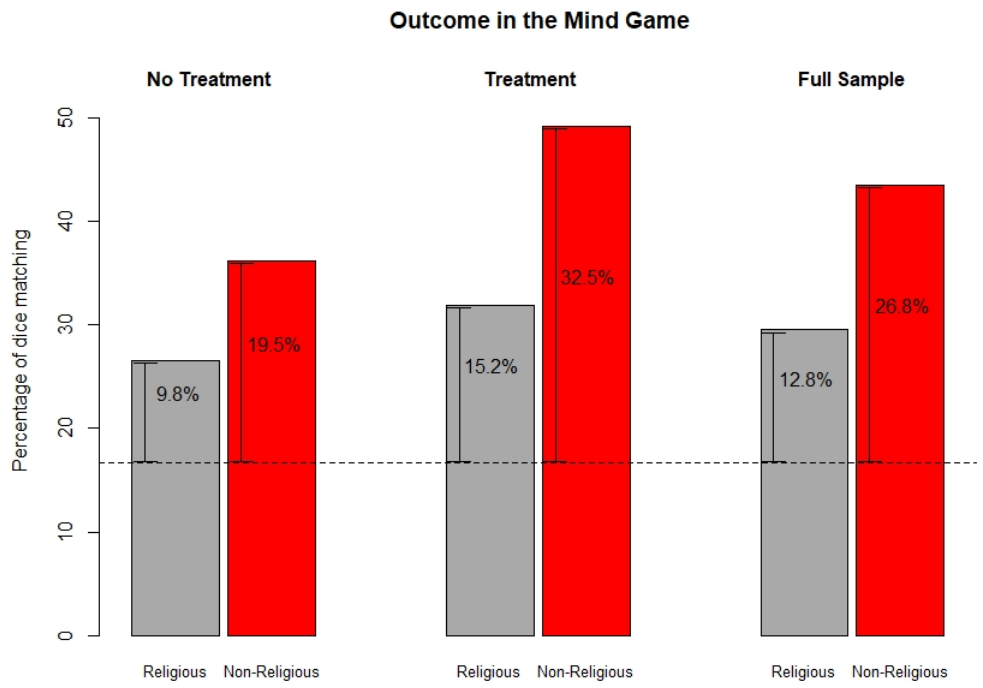
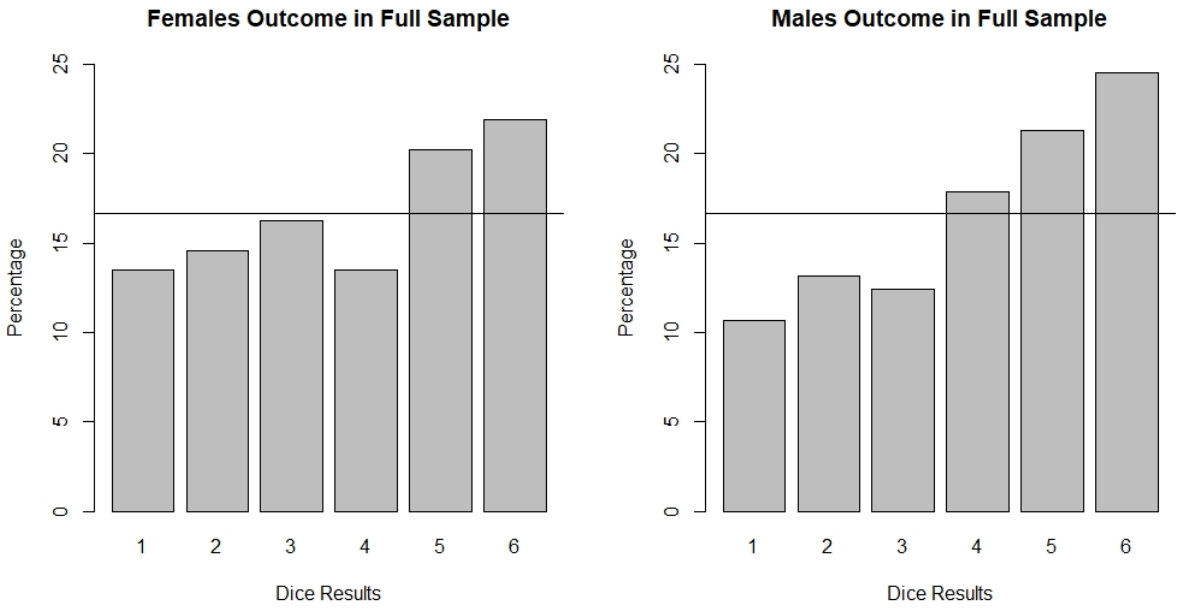


Figure 4.3: **Outcomes in the Mind Game.** The figure shows the percentage of dice matching the previously-chosen number for the non-religious and religious. Treatment refers to the second sample in this game, where participants carried out this experiment on their own in a closed room with no contact with the experimenter. The horizontal line represents the expected probability average for a fair dice. The percentage figure is the gap between the experimental outcome and the fair-dice probability, and indicates cheating.

score of 4.2 and there being 17% income maximizers. The Mind Game reveals that the educated are relatively less concerned about being caught cheating in this game, but are more sensitive to self-reputation. Participants with university degrees cheated at a similar rate to those with less education when they were not afraid of being seen as cheaters. Age did not affect honesty in either experiment.

These results are robust to checks using multinomial logistic regression in Table 4.5 and a linear regression in Table 4.6 in Appendix 4.B. This robustness is required for the assumption that the 6-category dependent variable's underlying structure is an interval scale. The multinomial logistic regression explains the model well, but does not take ordinality into account. In the linear regression the variable is treated as continuous. Both estimation techniques reveal that religiosity significantly increases honesty when cheating has a monetary payoff.



Gender outcomes in the full sample. The figure shows the percentage dice-outcome distribution for women and men in the two experiments. The horizontal line represents the expected probability for a fair dice, and cheating is the positive gap to this line.

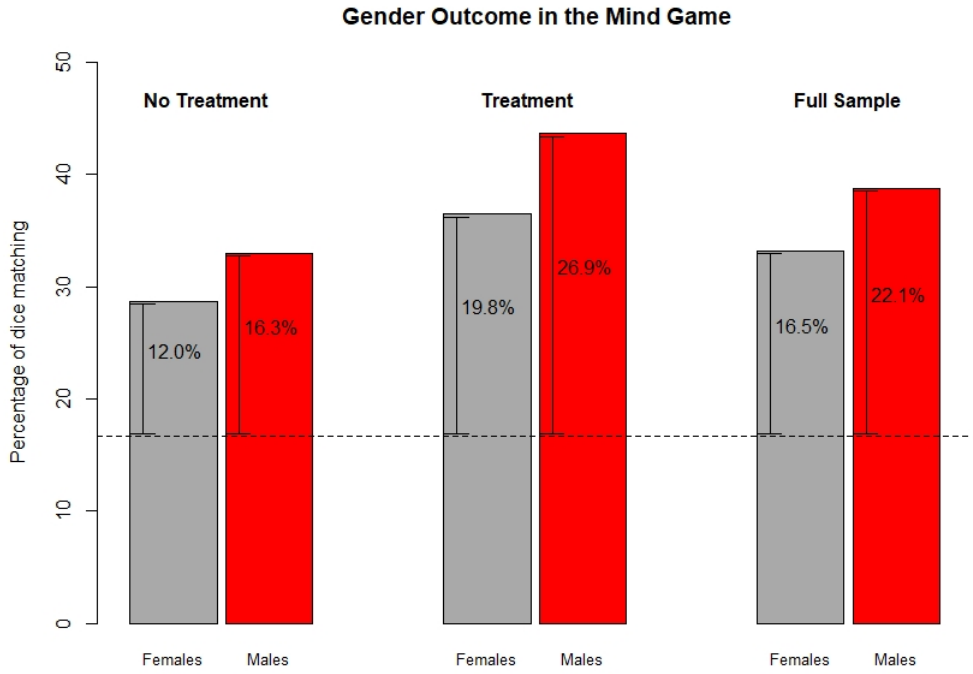


Figure 4.5: **Gender Outcomes in the Mind Game.** The figure shows the percentage of dice matching to a previously-chosen number for women and men. Treatment refers to the second sample, where participants carried out the experiment on their own in a closed room with no contact with the experimenter. The horizontal line is the expected probability from a fair dice. The percentage figure is the gap between the experimental outcome and the fair-dice probability, and represents cheating.

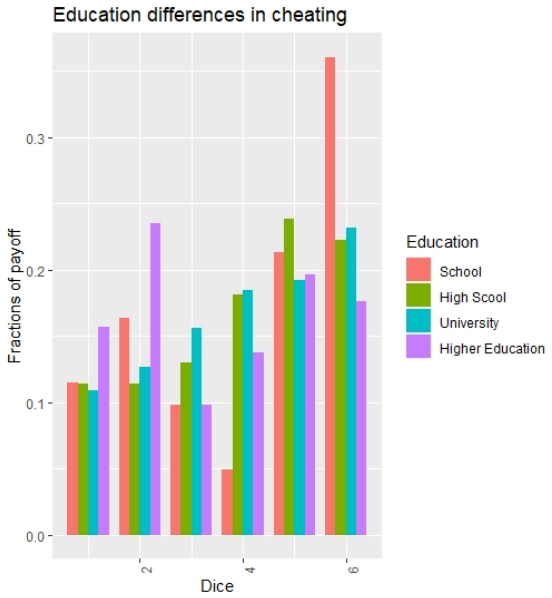


Figure 4.6: **Education outcomes in the full sample.** This figure shows the reported dice outcomes by education: from left to right, these are school dropouts, high school, university and post-graduate studies.

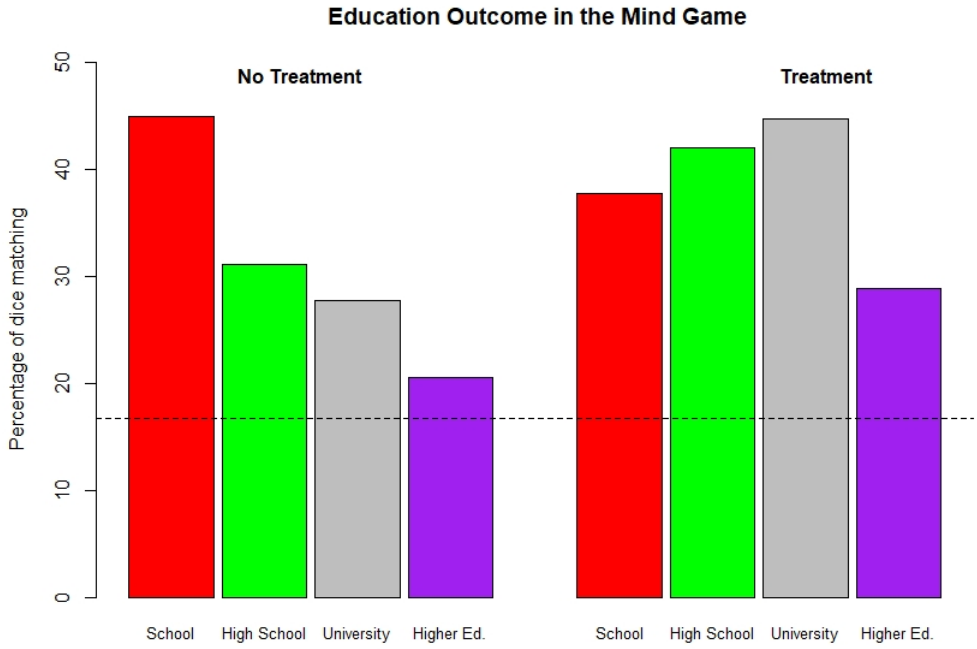


Figure 4.7: **Education Outcomes in the Mind Game.** This figure shows the percentage of dice matching with a previously-chosen number by education. Treatment refers to the second sample of this game, where participants carried out the experiment on their own in a closed room with no contact with the experimenter. The horizontal line is the expected probability from a fair dice. The percentage figure is the gap between the experimental outcome and the fair-dice probability, and represents cheating.

Table 4.1: **Cheating with no religious priming: ordered logit estimates.** These are Ordered Logit estimates for the dice-under-the-cup experiment where participants did not reveal their religious beliefs before rolling the dice. *, **and *** denote significance at the 10%, 5% and 1% levels, respectively. Belief is 1 for the religious, gender is 1 for females, school dropouts is 1 if participant didn't continue school education, high school is 1 if participant didn't continue education after school, other participants hold university degrees.

	Dependent variable:				
	Dice				
	(1)	(2)	(3)	(4)	(5)
Belief	−0.278	−0.417	0.014	0.277	0.334
	(0.256)	(0.304)	(0.335)	(0.855)	(0.912)
Gender	−0.013	−0.361	−0.016	−0.012	−0.269
	(0.276)	(0.451)	(0.280)	(0.280)	(0.455)
School Drop.		0.358	0.549	0.390	0.449
		(0.587)	(0.722)	(0.584)	(0.737)
High School		−0.160	0.216	−0.138	0.183
		(0.258)	(0.370)	(0.257)	(0.372)
Age	0.009	0.007	0.009	0.018	0.016
	(0.011)	(0.011)	(0.011)	(0.018)	(0.019)
Belief*Gender		0.518			0.444
		(0.578)			(0.580)
Belief*School Drop.			−0.263		−0.162
			(1.190)		(1.223)
Belief*High School			−0.697		−0.653
			(0.515)		(0.517)
Belief*Age				−0.015	−0.013
				(0.023)	(0.024)
Observations	207	207	207	207	207

Table 4.2: **Cheating behaviour with religious priming: ordered logit estimates**. These are Ordered Logit estimates for the dice-under-the-cup experiment where participants revealed their religious beliefs before rolling the dice. *, **and *** denote significance at the 10%, 5% and 1% levels, respectively. Belief is 1 for the religious believers, gender is 1 for females, School dropouts is 1 if the participant did not finish School education, High School is 1 if the participant did not continue education after High School, and the other participants hold University Segrees.

	Dependent variable:				
	Dice				
	(1)	(2)	(3)	(4)	(5)
Belief	-1.120^{***}	-1.199^{***}	-0.915^{***}	-0.714	-0.911
	(0.195)	(0.231)	(0.251)	(0.685)	(0.697)
Gender	-0.437^{**}	-0.548^{**}	-0.383^{*}	-0.410^{**}	-0.525^{*}
	(0.202)	(0.266)	(0.204)	(0.206)	(0.269)
School Drop.	0.250	0.231	0.869^{**}	0.267	0.861^{**}
	(0.304)	(0.306)	(0.411)	(0.305)	(0.414)
High School	0.123	0.106	0.214	0.136	0.196
	(0.207)	(0.209)	(0.273)	(0.208)	(0.274)
Age	0.014	0.013	0.017^{*}	0.020	0.016
	(0.010)	(0.010)	(0.010)	(0.013)	(0.013)
Belief*Gender		0.267			0.358
		(0.420)			(0.422)
Belief*School Drop.			-1.386^{**}		-1.409^{**}
			(0.601)		(0.619)
Belief*High School			-0.160		-0.164
			(0.424)		(0.426)
Belief*Age				-0.012	-0.003
				(0.020)	(0.020)
Observations	374	374	374	374	374

Table 4.3: **Cheating behaviour in the mind game: logit estimates**. These are Logit estimates for the mind-game experiment with two samples, where treatment refers to the sample carrying out the experiment on their own with no contact with the experimenter. *, **and *** denote significance at the 10%, 5% and 1% levels, respectively. Belief is 1 for the religious, gender is 1 for females, and education is 1 for School dropouts, 2 for High School, 3 for University and 4 for post-graduate studies.

	Dependent variable:				
	Dice				
	(1)	(2)	(3)	(4)	(5)
Belief	-0.700^{***}	-0.853^{**}	-1.191^{**}	-0.788	-1.562^{*}
	(0.260)	(0.333)	(0.570)	(0.678)	(0.909)
Treatment	0.600^{**}	0.617^{**}	0.620^{**}	0.598^{**}	0.642^{**}
	(0.284)	(0.286)	(0.287)	(0.285)	(0.290)
Gender	-0.289	-0.434	-0.270	-0.287	-0.451
	(0.201)	(0.283)	(0.202)	(0.201)	(0.286)
Education	-0.174^{*}	-0.166	-0.281^{*}	-0.174^{*}	-0.289^{*}
	(0.102)	(0.103)	(0.151)	(0.102)	(0.152)
Age	0.002	0.002	0.002	0.0002	0.001
	(0.010)	(0.010)	(0.010)	(0.017)	(0.017)
Belief*Treatment	0.357	0.369	0.368	0.352	0.382
	(0.400)	(0.401)	(0.401)	(0.402)	(0.404)
Belief*Gender		0.292			0.371
		(0.399)			(0.405)
Belief*Education			0.198		0.232
			(0.204)		(0.207)
Belief*Age				0.003	0.003
				(0.021)	(0.021)
Constant	0.474	0.520	0.712	0.526	0.869
	(0.447)	(0.452)	(0.513)	(0.585)	(0.651)
Observations	470	470	470	470	470
Log Likelihood	-297.583	-297.314	-297.111	-297.573	-296.678
Akaike Inf. Crit.	609	610	610	611	613

4.5 Conclusion

I have here carried out dice-under-the-cup and mind-game experiments on four samples to measure the honesty of the religious and non-religious. In the basic dice-under-the-cup experiment the religious were more honest than the non-religious when faced with a monetary incentive to cheat. The other three games attempted to explain this honesty difference between the two groups. Reporting religiosity before the experiment increased the honesty of the religious but reduced that of the non-religious. Although the religious cheat more when they are not afraid of being caught or have no self reputation to lose, they continue to be more honest than the non-religious. There are a number of explanations of this residual honesty of the religious in this experiment or others in the literature such as Abeler et al. (2019). This mainly reflects the fear of God, moral teaching, and cultural norms. Ethical values and honesty norms in a society lead to less fraud and more-trustworthy financial contracts.

In general, the dice-under-the-cup experiment in Lebanon reveals less cheating than in the meta analysis in (Abeler et al., 2019), except for the non-religious when they were primed with their beliefs. The mind-game results also show less cheating behaviour as compared to (Kajackaite and Gneezy, 2017). There are a number of analyses of country cross-section differences in honesty and their relation to economic, cultural and religion variables. There might be a particular effect in Lebanon due to cultural norms or high religiosity rates that produces greater honesty. The current chapter compares people by their religion who are in the same macroeconomic situation and with similar cultural norms.

The results of the analysis here suggest that the religious will be more likely to respect their loan repayments and their duties towards Banks. Honesty is an important component for better social interactions. This chapter adds to the ESG literature showing the role of religion in a more honest society. Honesty in fulfilling promises creates mutual trust in businesses. Trust in financial contracts allows for the easier enforcement of formal contracts, and thus strengthens financial intermediation and enhances economic growth.

4.A Appendix: Experimental Instructions

These instructions were originally written in Arabic

This experiment is part of a study funded by the University of Luxembourg. Thank you for taking part in this project.
In front of you there is a dice which is hidden inside a covered cup. You can see the face of the dice from the top of the cup.
The payoff for your participation will be determined by the result of the dice rolled and revealed by you. You will receive:

- $1 for a dice of 1
- $2 for a dice of 2
- $3 for a dice of 3
- $4 for a dice of 4
- $ for a dice of 5
- $6 for a dice of 6

You will be asked by the experimenter to shake the cup and write the dice result here: ____
You can now throw the dice as many times as you wish to check its fairness. However, only the first time will be counted for the payoff.
If you have any questions, feel free to ask the experimenter.
After finishing this experiment, you will receive a questionnaire to be filled out. This will take approximately 3-5 minutes.
Finally, you will receive the money by cash and sign a payment receipt.
Thanks for your time!

These instructions were originally written in Arabic

This experiment is part of a study funded by the University of Luxembourg. Thank you for taking part in this project.
Please, choose a number from 1 to 6 and remember it.
In front of you there is a fair dice. Please roll this dice and state if the outcome matches the number that you chose.
The payoff for your participation will be determined by the result of the dice roll.

- $1 if the dice didn't match the number chosen and remembered.
- $6 if the dice matched the number chosen and remembered.

Please write YES if the dice matches your number and NO otherwise: ____
In front of you there is a 5 USD bill and a 1 USD bill. If your answer above is "YES", please take both bills. If your answer is "NO", please take only the 1 USD bill.
Thanks for your time!

4.B Tables

Table 4.4: **Descriptive Statistics**. The table presents, in percentages, the distribution of participant characteristics in the four experiments. Belief is 1 for the religious believers, gender is 1 for females, School dropouts is 1 if the participant did not finish School education, High School is 1 if the participant did not continue education after School, and the other participants hold University Degrees. Age is the average of participants. Christian is 1 if the participant belongs to the Christian religion, and the other participants are Muslims.

	Experiment:			
	(1)	(2)	(3)	(4)
Belief	50.7%	47.0%	54.5%	53.6%
Gender	31.8%	29.9%	48.7%	52.0%
School Drop.	11.4%	13.1%	19.3%	20.1%
High School	34.2%	29.6%	29.4%	26.2%
Age	34.9	32.8	32.4	30.9
Christian	29.4%	32.8%	25.1%	27.7%
Participants	207	374	207	263

Table 4.5: **Cheating behaviour with religious priming: multinomial logistic regression**. The model is a Multinomial Logistic Regression for the dice-under-the-cup experiment where participants reported their religious beliefs before carrying out the experiment. *, **and *** denote significance at the 10%, 5% and 1% levels, respectively. Belief is 1 for the religious, gender is 1 for females, School dropouts is 1 if the participant did not finish School education, High School is 1 if the participant did not continue education after School, and the other participants hold University Degrees.

	Dependent variable:				
	2	3	4	5	6
	(1)	(2)	(3)	(4)	(5)
Belief	0.148	−0.631	−0.957**	−1.329***	−1.691***
	(0.484)	(0.467)	(0.467)	(0.452)	(0.444)
Gender	−0.209	0.018	−0.605	−0.253	−0.855*
	(0.474)	(0.465)	(0.484)	(0.452)	(0.454)
School Drop.	0.137	−0.668	−1.024	−0.030	0.254
	(0.647)	(0.719)	(0.801)	(0.653)	(0.607)
High School	−0.073	0.085	0.097	0.740	0.004
	(0.538)	(0.520)	(0.515)	(0.493)	(0.498)
Age	−0.002	0.018	−0.027	0.018	0.022
	(0.024)	(0.024)	(0.026)	(0.022)	(0.022)
Constant	0.538	0.339	2.180**	0.749	1.330*
	(0.831)	(0.824)	(0.869)	(0.782)	(0.766)
Akaike Inf. Crit.	1,302.267	1,302.267	1,302.267	1,302.267	1,302.267
Note:					*p<0.1; **p<0.05; ***p<0.01.

Table 4.6: **Cheating behaviour: linear regression**. The model is a linear regression for the dice-under-the-cup experiment. Column 1 covers all participants, column 2 covers participants who reported their religious beliefs before carrying out the experiment, and column 3 covers participants who reported their religious beliefs after carrying out the experiment. *, **and *** denote significance at the 10%, 5% and 1% levels, respectively. Belief is 1 for the religious, gender is 1 for females, School dropouts is 1 if the participant did not finish School education, High School is 1 if the participant did not continue education after School, and the other participants hold University Degrees.

	Dependent variable:		
	Dice		
	(1)	(2)	(3)
Belief	-0.729^{***}	-1.013^{***}	-0.236
	(0.138)	(0.168)	(0.252)
Gender	-0.227	-0.380^{**}	-0.113
	(0.149)	(0.181)	(0.267)
School Drop.	0.205	0.181	0.226
	(0.237)	(0.259)	(0.550)
High School	0.026	0.144	-0.171
	(0.152)	(0.188)	(0.257)
Age	0.008	0.012	0.011
	(0.007)	(0.009)	(0.011)
Constant	4.048^{***}	4.124^{***}	3.657^{***}
	(0.252)	(0.303)	(0.462)
Observations	581	374	207
R^2	0.055	0.103	0.017
Adjusted R^2	0.047	0.091	-0.007
Residual Std. Error	1.656 (df = 575)	1.590 (df = 368)	1.755 (df = 201)
F Statistic	6.689^{***} (df = 5; 575)	8.456^{***} (df = 5; 368)	0.706 (df = 5; 201)
Note:			*p<0.1; **p<0.05; ***p<0.01.

Chapter 5

General conclusions

This thesis studied three aspects of Islamic Finance from different angles. The three aspects answer questions about the relationship of Islamic banking with economic growth, the adaptability of Islamic Bonds with modern blockchain technology and the relationship of trust among users of Islamic financial products. Having answered these questions permits us to understand the structure of Islamic Finance itself but also its applicability within different cultures and countries. Scholars of IF promote it as an alternative financial system based on justice and ethics. Understanding the ramification of IF, extend the knowledge about it and it is applicability in other financial systems.

In the first chapter different empirical methods were applied to study the effect of changes in the size of IB on the GDP per capita using a panel data of 32 countries during the period from 2000 until 2017. Empirical results suggest that, considering a constant level of financial performance, macroeconomic factors and other variables, an increase of Islamic banking has a positive effect on the GDP per capita. Findings confirm theoretical expectations that although Islamic banking still represents a relatively very small share of the economy and of the overall size of the financial system, it is growing, generating an economy boost and insuring a stable banking industry.

IF is one of the fastest growing segments in global financial services. It has become important in many markets and too big to ignore in others. The global financial crisis offered IBs an opportunity to show their resilience. CB intermediation is mainly debt-based and permits for risk transfer while IB intermediation is asset-based and fucuses on risk sharing. These and other characteristics make IB's model closer to the real economy and have a tendency to reduce

their involvement to excesses and bubbles.

In the second chapter, we tokenize Sukuk al-Murabaha using Ethereum through smart contracts to program the necessary conditions like payment frequency, registering investors, automating the periodic payments to the investors while getting the deferred payment amount from the purchaser of the Murabaha asset. We did a cost-benefit analysis of sukuk tokenization with conventional sukuk issuance and conducted a feasibility analysis based on our results. This chapter thus provides an impact-assessment approach for institutions, SMEs and even startups to support the adoption of blockchains for sukuk issuance. As a consequence, our analytical approach allows organisations to prepare for current market challenges in a systemically efficient manner, by understanding the cost and performance consequences of tokenization.

Sukuk benefits from tokenization by increasing the operational efficiency, cost reduction and boosting transparency. Transparency is one of the essential elements of an ethical financial contract. It confirms Shariah adherence in financial markets.

We conducted a case study on tokenization of Sukuk al-Murabaha on Ethereum and coded a basic smart contract to gauge the contract development complexity and effort required. We execute a cost-benefit analysis of sukuk tokenization that shows significant cost cuts if compared to conventional sukuk issuance. Our study shows that public Ethereum blockchain incurs a higher cost than tokenization on a private/ consortium Ethereum blockchain platform. This chapter provides a step-wise, systematic methodology to assess and to understand the practicality of sukuk tokenization. It forms a solid evaluation framework for institutes that plan to tokenize sukuk.//

In the third chapter, I covered the influence of religion on fraud when there are monetary incentives. The results of a dice-under-the-cup experiment in Lebanon showed that non-religious participants cheated significantly more than religious participants. This gap becomes larger when participants are primed with their beliefs ex-ante. I then carried out a mind-game experiment to analyse the origins of this honesty gap. Even by controlling the risk of being exposed and implementing the self-reputation effect, religious participants continued to cheat less than non-religious participants.//

There are various explanations for the difference in honesty levels between religious and non-religious participants in this experiment. This mainly reflects the fear of God, ethics in education, and cultural norms. Ethical standards and trust result in less fraud in the society

and in financial contracts. The findings of my experiment suggest that religious people will be more likely to respect their loan repayments and their duties towards Banks

5.1 List of abbreviations

This lists the abbreviations used in this Thesis

CB	Conventional Bank
CBnb	Number of Conventional Banks
DAO	Decentralized Autonomous Organization
dBFT	delegated Byzantine Fault Tolerance
ESG	Environmental Social or Governance
ETH	Ethereum
EVM	Ethereum Virtual Machine
FBA	Federated Byzantine Agreement
FDI	Foreign Direct Investment
GC	Government Consumption
GDP	Gross Domestic Product
GFC	Global Financial Crisis
GMM	Generalized Method of Moments
IB	Islamic Banking
IBnb	Number of Islamic Banks
IBper	Islamic Banking Assets Percentage
ICM	Islamic Capital Market
IF	Islamic Finance
IMF	International Monetary Fund
IR	Inflation Rate
JVM	Java Virtual Machine
KYC	Know Your Customer
LIBOR	London Inter-Bank Offered Rate
LSE	Luxembourg Stock Exchange
LPOS	Leased Proof of Stake
MTF	Multilateral Trading Facility
NCC	No Contemporaneous Correlation
OECD	Organization for Economic Cooperation and Development

OLS	Ordinary Least Squares
PCREDIT	Private Sector Credit
POS	Proof of Stake
PoW	Proof of Work
SCF	Supply Chain Finance
SME	Small and Medium Enterprises
SOL	Securities Official List
SPV	Special Purpose Vehicle
TEAL	Transaction Execution Application Language
TO	Trade Openness
VAR	Vector Autoregression
UNDP	United Nations Development Program
USD	United States Dollars

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