



## ICT and Information Asymmetry; New Evidence of the Financial System in Selected MENA Countries

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Received: 28 April 2020, Revised: 16 September 2020, Accepted: 06 October 2020  
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### Abstract

The present study aims to investigate the role of ICT in reducing the effect of information asymmetry on financial development. The research's data associated with the selected countries of MENA during the timeframe of 2004-2015 are extracted from the official sources. Then, the research model is evaluated in the short- and long-term using the dynamic generalized method of moments and FMOLS, respectively. First, the results show information asymmetries negatively affect financial development. Second, ICT reduces but cannot eliminate the negative effect of information asymmetry on financial development. Third, the threshold effect of ICT on the information asymmetry and thus on financial development was within the minimum and maximum ICT indices. Due to the role of ICT in reducing the information asymmetry in the financial system of the examined countries, the policy proposal of this paper is to expand the various areas of access, benefit, and use of ICT in the financial sector.

**Keywords:** ICT; Information Asymmetry, Financial Development, MENA.

**JEL Classification:** G20, G29, L96, O40, O55.

### Introduction

The debate over the role of information in the economy began with the rethinking of one of the assumptions of perfect market competition. This assumption is based on the fact that all market participants are fully informed of all prices Eaton et al. (2005). For example, the incomplete buyer information about the transaction provides the seller with monopoly power and practically prevents the realization of a fully competitive market or, in contrast, incomplete seller one (e.g. insurance agent) about the customers, leads to the company losses. Therefore, the fully competitive market's results not possible under the conditions of incomplete information and this market does not perform well.

The study of asymmetric information in financial markets began in the early 1970s. The 2001 Nobel Prize in economics for the study of asymmetric information was given to Akerlof et al. (2001). Akerlof (1970) specifically indicated that the asymmetric information might increase the possibility of "adverse selection" on the markets. For example, in the second-hand car market, due to the information asymmetry of buyers and sellers, buyers prefer lower quality second-hand cars rather than high-quality ones, therefore, bad good eliminates the good one. Or in the labor market, due to the lack of accurate information provided by the highly skilled labor force, the employer prefers the low skilled labor force to the high-skilled one Akerlof (1970). Spence (1973) showed that under certain conditions, brokers with sufficient information can improve their market return by disseminating their private

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information on those who lack the necessary one. For example, corporate management can implicitly indicate high company's profitability by imposing additional tax on dividends.

A large number of studies have been carried out on the information asymmetry in financial markets over different countries and regions. However, the number of investigations dealing with the role of ICT in reducing information asymmetry in the financial markets is scarce. In addition, in the case of MENA region countries which suffer from financial system weaknesses, ICT can lead to the information asymmetry decrement and financial system improvement through reducing market failures and friction such as information and transaction costs. Therefore, the main purpose of this paper is to investigate the influence of ICT on reducing the information asymmetry within the financial section of the selected MENA countries.

## Literature Review

### *Information asymmetry in the financial markets*

Information asymmetry refers to a situation in which the two economic agents do not have the same information in contrast to each other. Under these situations one party might not have as much information as the other party or one of them might not have the information at all. The created information asymmetry is due to the hidden necessary information prior to or concealing them after contract. The first one is called adverse selection while the second one is moral hazard. For example, stock publishers are generally more aware of the stock's value than the buyers and are more willing to sell when they know that buyers evaluate their stocks more. On the other hand, information concealment (adverse selection) exists in this case.

Moral hazard frequently happens in the insurance market because the insured can change its obligations to the insurer without noticing him. Hawkins et al. (2010) believe that information theories are the origin of economics: observation enhances the information participation and information improves economics as well. Information asymmetry occurs when one party based on a contract or transaction has more information provided than information effectively while communicating with the other one. Aboody and Lev (2000), Baldwin and Trinkle (2011) and Jones and Willis (2003) have indicated that the phenomenon of information asymmetry in financial markets occurs when investors make their financial decisions based on the information provided by the corporate management. In fact, there is a conflict of interest between information users and providers. Therefore, it can be stated that information asymmetry between managers and investors is a fundamental issue for the investors and market watchers. Information asymmetry directly affects the performance of financial markets by reducing market efficiency. For example, Myers and Majluf (1984) have shown that managers possess more information than information investors about the cash flows, investment opportunities, future prospects and the true value of the company. Claus and Grimes (2003) have stated that information asymmetry occurs when borrowers are aware of the real returns of the information project completion, leading to the moral hazard. The moral hazard increases when the borrower does not have the incentive to pay off the loans.

In the case of information asymmetry, investors spend a lot of time and money for acquiring more information. As a result, their profits decline and they leave the financial markets. Thus, financial markets and corporations must provide the additional information needed by investors to reduce the information asymmetry and increase market efficiency, thereby attracting the investors' confidence.

### *The Effect of Information Asymmetry on Financial Markets*

Adverse selection and moral hazard Borrowers usually have more information than lenders

about the reimbursement ability and participation risk in the investing projects. This problem arises before the loan or financial activity is transferred, and then transferred to the time afterwards, so lenders are faced with an adverse selection due to the lack of applicants' information. Another problem that is caused by the lack or asymmetry of information after the financial activity performance is called moral hazard. For example, the borrower does not repay it after receiving the loan or extend the debt repayment due to the financial collaterals. Also, borrowers face the common risks of investing and financial resources mobilizing. To this end, lenders increase the credit risks, credit rationing and interest rates despite non-payment risk, which has negative consequences for the financial development and growth Claus and Grimes (2003), Claus (2011), Asongu et al. (2016). Problems with adverse selection or moral hazard pose significant obstacles to the proper functioning of the financial market. However, financial intermediaries can alleviate these issues through screen signaling.

Stiglitz and Weiss (1981) and Claus and Grimes (2003) have argued that banks are willing to identify borrowers capable of repayment. Interest rate is one of the means of borrowers screening. Those who are eager to pay higher interest rates, have a higher risk and accept higher ones because of the low probability of repayment. As interest rates rise, the average borrowers risk increases, thereby lowering banks' profits. On the other hand, with an increment in the interest rate, the expected return of the lenders increases. However, if the probability of default borrowers increases, the expected cost of lenders monitors increases, thereby increasing the asymmetry between lenders and borrowers and resulting into credit rationing as a consequence. In fact, rising interest rates has adverse effect on the borrowers' investing combination. Besides, Boateng et al. (2018) have illustrated that expecting future interest rates or fear of being deprived in the credit market, encourage borrowers to completely pay their debts in due time.

Some studies have investigated the effects of inflation and information asymmetry Huybens and Smith (1998; 1999). Inflation worsens the information asymmetry in the credit market and reduces the actual return rate and credit values. Boyd et al. (2001), Gupta et al. (2005) and Dehesa et al. (2007) indicated that inflation negatively affect the financial depth.

Claus (2011) showed that information asymmetry between borrowers and lenders leads to the increasing additional financial cost, capital and production, but reduces the long-term stable investment conditions. Financial intermediaries and markets can help reduce information asymmetry in the credit markets and thus increase the resource efficiency allocation and long-term economic performance. Minimizing information asymmetry requires the production and discovery of information through screening and monitoring. These negative consequences can restrict borrowers by sharing information. The information sharing offices (ISO) such as private credit bureaus (PCB) and public credit bureaus (PCR) have been implemented as indices of sharing information. Asongu et al. (2016), Houston et al. (2010) and Jappelli and Pagano (2002) have found that information sharing like PCRs and PCBs act as an intermediary for providing the banks' required information. These intermediaries can reduce the transaction costs through the expertise they have gained. The relationship between ISOs and financial accessibility can be examined from the two perspectives of adverse selection of lenders and moral hazard of borrowers. ISO, the advantage of lenders with information over borrowers is their ability to reduce the interest rates which is an incentive for adverse selection.

In an article entitled Information sharing, lending and defaults: cross-country evidence, Jappelli and Pagano (2002) indicated that the information sharing reduce the adverse selection and moral hazards. Therefore, the interest rate decreases due to the moral hazard of lending. Also, in countries where information sharing exists among the lenders, irrespective of the public or private information sharing mechanism, bank lending increases and credit risk is reduced. In a recent paper entitled "Information asymmetry and financial development

dynamics in Africa”, Asongu et al. (2016) investigated the information sharing policy for the financial development in 53 African countries during the timeframe of 2004-2011 using generalized method of moments (GMM). Firstly, PCRs and PCBs have negative effect on the financial depth due to the high past value. Secondly, unlike PCRs which have significant effects, PCBs have a negative effect on the banking system’s performance. Thirdly, PCRs and PCBs have negative impacts on the financial activities due to their high past values, both of which have negative marginal effects. Fourth, both PCRs and PCBs have positive marginal effects with respect to the positive impact on the financial size.

In a research entitled “Credit bureaus and registries and access to finance: new evidence from 42 African countries”, Triki and Gajigo (2012) implemented the panel method for investigating the effect of public and private credit deposits on the companies’ access to the finance together with that of public ones on the severe financial constraint using 17240 small, medium and large companies for 42 African countries during the timeframe of 2006-2009. The results showed that financial access in countries with PCBs was higher than average compared to those having PCRs or without institutions. In addition, countries having PCRs which collect positive and negative information about the borrowers’ credit history are associated with fewer barriers to the financial access. Likewise, simultaneous credit information provision is only effective when the internet penetration rate in the country is high and the reduction of minimum loan coverage by PCRs will help secure the financial constraint when negative and positive information is provided.

In an article entitled “Information asymmetry and market power in the African banking industry”, Boateng et al. (2018) examined 162 banks from 42 countries during the yearly period of 2001-2011.

The results first show that the effect of information sharing offices with PCR is significant in estimating the two-stage least squares (2SLS). Second, GMM test results indicate that PCR increases the market power. Third, PCB steadily increases the market power with quintile regressions. Also, in the GMM regression, the network effect of PCB on the market power is negative.

In an article entitled “Conditional determinants of mobile phones penetration and mobile banking in Sub-Saharan Africa”, Asongu (2018) investigated the determinants of mobile and banking in 49 African countries using the data of 2011 and principal component analysis (PCA). The obtained results indicated that the mobile phone penetration has a positive effect on several items including: 1) education, internal savings, quality of regulation and patent application, especially at low levels of mobile penetration, 2) banking density 3) urban population density and 4) internet penetration. Further to these, paying bills with the mobile phone has positive relationship with the influence of Internet, business of sending or receiving money.

Credit institutions select a qualified borrower with a certain level of interest rate. These institutions cover only a small portion of the credit application. In the credit market, the interest rates are kept constant but not all loan applicants are checked. Therefore, banks cannot distinguish between good and bad debtors before the loan repayment. Thus, this information asymmetry leads to the adverse selection Busuioac and Birau (2001).

There were similar conditions in the first decade of the 2000s where the credit market was facing excess demand, some customers were not eligible and banks had limited resources for lending. Thus, information asymmetry led to the allocation deficiencies in the credit and capital markets, which required government intervention to improve the equilibrium in these markets. For this purpose, in the first decade of the 2000s, the United States attempted to correct the credit market deficiencies. The main purpose of the interventions was economic growth and housing market. Interest rates were constant during the period of 1987-2006, which was considered as a crisis factor. Monetary authorities, from one side, have

implemented poor lending policies and, on the other hand, have instabilized the interest rate through declining and rising rapidly. In just two years, the interest rates increased by 2% and debtors who did not anticipate this change, have converted into bad ones.

In this regard, Banerji and Basu (2017) stated that bankers were motivated to hide information from shareholders in the stock market bankruptcy within the financial crisis of 2008-2009. Financial institutions can exchange and merge information in order to reduce the information asymmetry. Djankov et al. (2007), McDonald and Schumacher (2007) have shown that information sharing leads to the greater financial development. Also, Gupta et al. (2005) indicated that the credit information access and credit bureau coverage are associated with a deeper credit market.

Brown et al. (2009) have argued that a decrement in the corporation transparency due to the weakness of corporate laws, leads to an increase in the information asymmetry and a decrease in the banks' incentives to lend. When banks evaluate the credit application, they collect information from the primary applicant or other information sources of the lender. PCBs or PCRs. Help lenders exchange the information, which overcomes the adverse selection on the credit market and moral hazard reduction by increasing the borrowers' attempts to repay loans. The exchange of bank customers' information, leads to the improved understanding of the applicant profiles via the past behavior and current debt disclosure. This reduction in the information asymmetry can reduce the problems of adverse selection in lending, and reduces the banks' uncertainty about the borrowers. Boateng et al. (2018) have indicated that sharing moral hazard credit's information reduces the adverse selection, enhances borrowers' order, improves competition and thereby market power as a consequence. The data sharing reduces information asymmetry (adverse selection and moral hazard), increases incentives to pay loans, reduces excessive borrowing and enhances economic competition and growth. Jappelli and Pagano (2002) showed that lenders can generate customers' information through screening and monitoring to overcome the information issues. They can observe their customers' business before and after the loan guarantee by collecting and exchanging information from the public registries. This exchange is either voluntarily or legally compulsory and affects the information of the brokers such as credit bureaus. If lenders act on a large scale, they use this data to manage the statistical risk and price of the loans based upon the past performance.

In an article entitled "The impact of information integration on financial performance: A knowledge-based view", Gu et al. (2017) examined the effects of internet connectivity and exchange of additional information on the financial performance of 220 demand-based companies with mass production strategy using the structural equation modeling approach. The results indicated that the strong relationship among the suppliers only improves their operational performance which has a direct and indirect positive impacts on the producers and financial sector, respectively.

Information sharing between lenders can be both a leader and a follower. Ivashina (2009) investigated the lending by traditional and syndicate banks and showed that lending of the lead bank originates from the sale prices of loans to other banks. The lead bank holds part of the loan and oversees it as a manager. Bank participation depends on the information collected by the lead Bank. The problem of adverse selection is emerged because the lead bank puts the syndicate's loans at risk. Also, as the lead bank sells part of the loan with the syndicate participation, they reduce their oversight, resulting in a moral hazard issue. In a syndicated loan, the private information content collected by the lead bank creates additional collateral and leads to the information asymmetry between the lead and partner banks. The increasing loan share of the leading banks, reduces the asymmetry between the leading and participating banks, thereby reducing the bail requested by the participating banks and increasing that for the leading ones. The variety of credit risk among the major sources of loan

is sold by the lead bank. Thus, the two mutual effects (information asymmetry and variety) simultaneously affect the loan expansion. On the other hand, Albertazzi et al. (2015) indicated that the increasing loan repayment in the syndicate is reduced by bank risk screening and supervision and effective bank's incentives. In this regard, in an article entitled "Information sharing and credit: Firm-level evidence from transition countries", Brown et al. (2009) have examined the effect of bank information sharing on the credit market performance for 1333 companies from 23 Countries in Eastern Europe and Soviet countries using cross-sectional estimation and public panel techniques. The results showed that information sharing is associated with improved access and lower credit cost of the companies. This relationship is stronger for non-transparent companies than the transparent ones and also for countries with the poor legal environment rather those with strong one. Also, Sufi (2007) indicated that non-transparent borrowers increase the syndicate's concentration. In addition, Focarelli et al. (2008) illustrated that investors demand lower interest rates as the syndicates' concentration increases.

In an article entitled "The emergence of information sharing in credit markets", Brown and Zehnder (2010) indicated how the information asymmetry and competition in the credit market affect voluntary information sharing among lenders using the systematic empirical analysis. The information asymmetry on the credit market, significantly increases the information sharing among the lenders. However, competition among lenders reduces the information sharing. Despite the information asymmetry, the degree of information sharing, results in the sharing of real information among the lenders rather than the competition.

#### *The Role of ICT in Reducing Information Asymmetry within Financial Markets*

ICT can lead to asymmetries and price volatility by reducing market failures and trading friction in the financial system such as information and transaction, search and monitoring costs. In the banking industry, using information technology has provided the conditions for internet banking, electronic payment, investment security and information exchange. Financial organizations utilize ICT to provide customers with higher quality services with less effort. The development of the information industry has led to major changes in terms of money and service systems in the banking industry and new phenomena under the heading of home, telephone, remote, internet and virtual bankings.

The development of electronic systems and the World Wide Web has fundamentally changed the expectations of customers regarding the speed, accuracy, price and services of financial institutions and banks. Geographical distance has lost its meaning and the availability, ease and speed of service delivery have created a competitive advantage for organizations including banks, and they have to provide the latest and most enticing services that customers need in order to compete in this complex business environment. Thus, the development of ICT can play a significant role in the development of the financial sector by reducing costs and diversifying the provision of banking services and financial intermediation. Overall, it can be stated that the development of ICT can play a significant role in the development of the financial sector by reducing costs and diversifying the provision of banking services and financial intermediation Pradhan et al. (2016). This development has provided potential and actual opportunities for the insurance industry in Iran and worldwide. The basis of insurance is the data and databases and ICT offers golden opportunities to the insurance industry. The use of ICT enables the provision of insurance products during day and night, reduces insurance issuance costs and eliminates spatial distances. In this regard, experience in other countries has opened new markets for insurers. On the other hand, the time of issuing insurance may be long for some customers. ICT reduces the time taking for the issuing insurances so that it is expected to return a market

segment which refuses to buy due to the lengthy process of issuing insurance back to the insurance companies. The use of ICT covers the market segments that have not been covered yet. In addition, advances in information technology and growth in the customer compatibility with new computer and communications technologies have enabled insurance companies to provide their customers with alternative distribution channels such as call centers, mobile sales force, cell phones and internet Kabiriparvizi (2008).

In an article entitled financial development, technology, growth and performance: Evidence from access to the EU, Zagorchev et al. (2011) found that financial development and investment in ICT via the structural reforms in macroeconomics, has significant positive effects on gross domestic product (GDP). Their investigation included eight central Asian and eastern European countries which have recently joined the European Union. To ensure the macroeconomics stability, the country is considered by privatization, harmonization and regulation of the economy based on the convergence criteria. They considered the system of simultaneous equations estimated by GMM for GDP per capita, financial development and investment in telecommunication technology (TEL) and also found that the development of information technology contributes to the financial development.

## **Data and Methodology**

### *Methodology*

#### *Generalized Method of Moments (GMM)*

The panel data method is better able to identify and measure the effects that are not easily predictable in cross-sectional and specific time-series studies. Therefore, panel data method was used in this study and Eviews 9 software was implemented in order to estimate the model. However, the basic problem with using common estimation methods such as ordinary least squares and maximum likelihood methods is that these estimators are incompatible for the dynamic panel data in the case of high number of observations and low time period. Since some common regression model's assumptions such as correlated explanatory variable and error term may not be established, other methods such as instrument variables have been proposed that are generally based on the differences. Hence GMM which was developed by Arellano and Bond, has been presented for estimating the dynamic linear panel regression models Baltagi (2005). In the dynamic panel model, the dependent variable lag is correlated with the error term, and therefore, it can be used together with other lagged variables as a tool for the dependent lagged variable variable based on GMM Baltagi (2005). The compatibility of GMM estimator depends on the validity of the lack serial correlation assumption of the error terms and tools which can be examined using the two confirmed tests by Arellano and Bond (1991), Arellano and Bover (1995) and Blundell et al. (2001). The first one, Sargan test, is of predefined constraints examining the validity of the tools. The second test is the  $m_2$  statistic which examines the second-order serial correlation existence in the first-order difference error terms. Non-rejection of the null hypothesis of both tests, provides evidences indicating the lack of serial correlation and tools validity. The GMM estimator is consistent if there is no second-order serial correlation in the error terms from the first-order differential equation.

#### *Panel Cointegration Test*

The panel cointegration method is used to investigate the long-term relationship between the financial intermediation development and other variables. In this study, Kao's cointegration

method (1999) has been implemented for investigating the existence or inexistence of the cointegration relationship. Kao's test is based on Engle–Granger two-step procedure and considers the homogeneity of the panel components in the cointegration test performance. The null hypothesis in this test, representing that there is no cointegration relation, examined use of augmented Dickey–Fuller one.

#### *Fully Modified Least Squares Method (FMOLS)*

This method is actually an asymptotically unbiasedness and effective estimating approach with normal distribution which, possibly use the Wald test for linear constraints with chi-square distribution. To introduce this method, the following convergence equation for time series variables of X and Y are given as below

$$y_t = \hat{X}_t\beta + \hat{X}_{1t}\gamma_1 + u_{1t} \quad (1)$$

$$X_t = \hat{\Gamma}_{21}D_{1t} + \hat{\Gamma}_{22}D_{2t} + \epsilon_{2t} \quad (2)$$

$$\Delta\epsilon_{2t} = u_{2t} \quad (3)$$

$$\Delta X_t = \hat{\Gamma}_{21}\Delta D_{1t} + \hat{\Gamma}_{22}\Delta D_{2t} + u_{2t} \quad (4)$$

where,  $D_t = (D'_{1t} D'_{2t})'$ , with  $D_{1t}$  as the independent variables presented in both convergence and following equations:

$$X_t = \hat{\Gamma}_{21}D_{1t} + \hat{\Gamma}_{22}D_{2t} + \epsilon_{2t} \quad (5)$$

Also,  $D_{2t}$  stand for the definitive trend variables used only in the equations of the independent variables. To estimate the convergence equation, first it is necessary to calculate the long-term covariance matrices as:

$$\Lambda = \sum_{j=0}^{\infty} E(u_t \hat{u}_{t-j}) = \begin{bmatrix} \lambda_{11} & \lambda_{12} \\ \lambda_{21} & \lambda_{22} \end{bmatrix} \quad (6)$$

$$\Omega = \sum_{j=0}^{\infty} E(u_t \hat{u}_{t-j}) = \begin{bmatrix} \omega_{11} & \omega_{12} \\ \omega_{21} & \omega_{22} \end{bmatrix} \quad (7)$$

#### *Model Introduction*

In this research, the GMM and FMOLS methods have been implemented to investigate the role of ICT in reducing the information asymmetry for the financial access within selected MENA<sup>1</sup> countries during the timeframe of 2004-2015. The data associated with the financial development index, ICT, information symmetry index and control variables have been extracted from the World Bank. According to the study conducted by Asongu and Moulin (2016), the research model is considered as follows:

<sup>1</sup> Selected MENA countries include Egypt, Iran, Kazakhstan, Kyrgyzstan, Pakistan, Saudi Arabia, Tajikstan, Turkey and Georgia.

$$TFD_{i,t} = \sigma_0 + \sigma_1 TFD_{i,t-\tau} + \sigma_2 PCR_{i,t} + \sigma_3 TICT_{i,t} + \sigma_4 PCR_{i,t} \times TICT + \sum_{k=1}^4 \delta_k W_{k,i,t-\tau} + \eta_i + \xi_t + \varepsilon_{i,t} \quad (8)$$

Here,  $TFD_{i,t}$  defines the financial development index for the  $i$ th country at  $t$  period and  $PCR$  is for supporting, improving and supervising the banking sector.  $TICT$  is the combinative ICT index including the mobile cellular subscriptions per 100 people (Mcs), Internet users per 100 people (Iu), fixed-telephone subscriptions per 100 inhabitants (Fts) and fixed-broadband subscriptions per 100 inhabitants (Fbs). Furthermore,  $PCR \times TICT$  is the mutual reaction between  $PCR$  and  $ICT$  indices and  $W$  stands for the control variables including the economic growth, inflation rate, gross capital formation (% of GDP) and trade openness as well. Also,  $\sigma_i$  at period  $t$ ,  $\alpha$  is a constant,  $\tau$  represents tau,  $\eta_i$  is the country-specific effect,  $\xi_t$  is the time-specific constant and  $\varepsilon_{i,t}$  is the error term.

## Experimental Results

Table 1 lists the estimated results obtained via the GMM and FMOLS models.

**Table 1.** The Estimation of Short-term (GMM) and Long-term (FMOLS) Models for the Dependent Variable of Financial Development

	Iu		Mcs		Fts		Fbs		Tict	
	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2	Model 1	Model 2
<b>TFD(-1)</b>	0.586 (0.000)	0.991 (0.000)	0.854 (0.000)	0.997 (0.000)	0.766 (0.000)	0.988 (0.000)	0.563 (0.000)	0.986 (0.000)	0.636 (0.000)	0.991 (0.000)
<b>PCR</b>	-0.016 (0.028)	-0.005 (0.000)	-0.022 (0.004)	-0.004 (0.000)	-0.003 (0.000)	0.002- (0.003)	-0.012 (0.008)	-0.0008 (0.268)	-0.008 (0.000)	-0.003 (0.000)
<b>Iu</b>	-0.001 (0.807)	0.0005 (0.051)								
<b>PCRoIu</b>	0.0002 (0.067)	0.00009 (0.000)								
<b>Mcs</b>			0.0007 (0.39)	-0.0004 (0.6974)						
<b>PCRoMcs</b>			0.0002 (0.002)	0.00005 (0.000)						
<b>Fts</b>					0.005 (0.000)	-0.0007 (0.362)				
<b>PCRoFts</b>					0.0003 (0.000)	0.0001 (0.345)				
<b>Fbs</b>							0.001 (0.893)	0.008 (0.000)		
<b>PCRoFbs</b>							0.0007 (0.000)	9E07 (0.989)		
<b>TICT</b>									0.039 (0.000)	0.004 (0.276)
<b>PCRoTICT</b>									0.006 (0.000)	0.002 (0.000)
<b>G</b>	-0.006 (0.018)	-0.014 (0.000)	-0.01 (0.000)	-0.015 (0.000)	-0.013 (0.000)	-0.015 (0.000)	-0.006 (0.012)	-0.014 (0.000)	-0.008 (0.000)	-0.014 (0.000)
<b>INF</b>	-0.671 (0.01)	-0.504 (0.000)	-0.814 (0.009)	-0.76 (0.000)	-1.277 (0.000)	-1.104 (0.000)	-0.536 (0.041)	-0.638 (0.002)	-0.683 (0.000)	-0.533 (0.000)
<b>GCF</b>	0.026 (0.000)	0.009 (0.000)	0.023 (0.000)	0.009 (0.000)	0.019 (0.000)	0.008 (0.000)	0.027 (0.000)	0.007 (0.000)	0.017 (0.000)	0.0009 (0.000)

$\Delta$  TFD is the combinative index of financial development calculated by the principal component analysis. The utilized indices are including: 1) financial system deposits (current debt to GDP), 2) Banking system efficiency (bank credit to bank deposits), 3) financial system efficiency (financial credit on financial deposits), 4) banking system activity (d credit to private sector by banks (% of GDP)) and 5) financial system activity (domestic credit provided by financial sector (% of GDP)).

$\tau$  The PCR database contains personal credit information about borrowers which enables the implementation of advanced techniques and measures the extent of banking credit risk.

	Iu		Mcs		Fts		Fbs		Tict	
	Model 1	Model 2								
<b>OPEN</b>	-0.007 (0.002)	-0.0003 (0.004)	-0.004 (0.015)	-0.0006 (0.000)	-0.002 (0.000)	-0.0003 (0.782)	-0.006 (0.005)	-0.0001 (0.096)	-0.004 (0.000)	-0.0003 (0.005)
<b>C</b>		-0.064 (0.000)		-0.007 (0.631)		0.025 (0.096)		-0.05 (0.000)		-0.032 (0.032)
<b>Net effect of Internet</b>	-0.007	-0.001								
<b>Net effect of Mobile Phones</b>			-0.001	0.001						
<b>Net effect of Fixed-telePhones</b>					0.001	-0.0004				
<b>Net effect of Fixed-broadband</b>							-0.007	-0.0007		
<b>Net effect of Tict</b>									-0.007	-0.082
<b>Thresholds (-/+)</b>	80	55	110	80	10	20	17.142	888.889	1.333	1.5
<b>Kao test</b>	-5.262 (0.000)		-3.007 (0.000)		-2.352 (0.009)		-3.053 (0.001)		-4.399 (0.000)	
<b>Sargan test</b>		1.26E-26		1.78E-24		1.1E-25		3.78E-26		1.36E-26
<b>Hausman test</b>		14.62 (0.066)		14.26 (0.075)		13.16 (0.106)		11.88 (0.156)		11.78 (0.16)
<b>AR(1)</b>		(0.49)		(0.44)		(0.48)		(0.47)		(0.42)
<b>AR(2)</b>		(0.19)		(0.22)		(0.44)		(0.38)		(0.3)
<b>Observations</b>	108	108	108	108	108	108	108	108	108	108
<b>Cross Prob</b>	12	12	12	12	12	12	12	12	12	12
<b>(J-Statistic)</b>										

**Source:** Research finding.

In Table 1, the Kao test indicates the existence of a long-term relationship among the variables. The Sargan statistic represents that the instrumental variables are valid. Models (1) and (2) represent the long- and short-term estimations, respectively. The coefficient of PCR variable is negative and significant in both short and long-term cases, expressing that the financial development decreases as the information asymmetry in the financial system increases. The short-term ICT indices (except communication) and long-term ones (except internet) lead to the increasing financial development.

The coefficients of PCROIu, PCROMcs, PCROFts, PCROFbs and PCROTICT (product of ICT indices and that of information asymmetry) terms are all positive. Hence, it can be stated that ICT reduces the negative effect of information asymmetry on the financial development.

### *Margin Effect of ICT*

$$\text{Net effect of Indicator's ICT} = \text{PCR} + (\text{Mean}_{\text{Indicator's ICT}} + \text{PCR} \times \text{Indicator's ICT}) \quad (9)$$

In Eq. (8) the absolute numerical value of the expression in the parentheses is smaller than the first term. Therefore, the margin effect of ICT is negative. In other words, ICT reduces but can not completely eliminate the negative impact of information asymmetry on the financial development. For example, the margin effect of Internet is negative and significant in the short- and long-term, indicating that Internet cannot eliminate the negative effect of information asymmetry on the financial development. However, the trend is different in the case of communication technology indices. The margin effect of mobile is positive and

negative in the short- and long-term, respectively. This means that mobile eliminates the negative effect of information asymmetry on the financial development in the short-term. However, that is not the case in the long-term. The margin effect of fixed telephone is negative and positive in the short- and long-term, respectively. This means that fixed telephone eliminates the negative effect of information asymmetry on the financial development in the long-term.

### *Thresholds Effect*

The thresholds effect is defined as the ratio of the absolute value of PCR to the production of PCR and ICT indicator as:

$$\text{Thresholds effect}_{\text{Indicator's ICT}} = \frac{|\text{PCR}|}{\text{PCR} \times \text{Indicator's ICT}} \quad (10)$$

The threshold value obtained from this formula for each ICT indicator must be within the maximum and minimum ICT ones. According to Table I (appendix), the thresholds effect of ICT indicators was within the expected range in all cases.

The negative coefficient of economic growth also implies that the economic growth in these countries, which is mainly of the current type, does not lead to the improved financial development. The inflation rate and degree of openness in these countries also have a negative impact on the financial development. However, the formation of gross fixed capital (% of GDP) in these countries has a positive effect on the financial development.

## **Results and Discussion**

One of the assumptions of the perfect competition market is complete existing profile for the sellers and buyers. In practice, this assumption may not be realized for some reasons and result in the market system inefficiency. This is more sensitive in the case of the financial markets. Investigating the information asymmetry in the financial markets was initiated in the early 1970s and reached its summit upon winning the 2001 Nobel Prize by George Akerlof, Spence and Stiglitz for their related studies. One of the tools playing a key role in the distribution and symmetry of information, especially in the financial markets, is the ICT. With the expansion of broadband Internet over the landline of fixed and mobile telephone networks and online systems, it is now possible to buy and sell the financial instruments at any time and place with more information symmetry. Investigating the influence of ICT on reducing the information asymmetry and its impact on the financial development in selected MENA countries was the main objective of the present research. Investigating this can help increase the efficiency of the financial system together with information symmetry through the ICT channel. To this aim, MENA countries (Egypt, Iran, Kazakhstan, Kyrgyzstan, Pakistan, Saudi Arabia, Tajikistan, Turkey and Georgia) have been selected in view of the access to information. The principal component method was used for calculating the combined financial development index among the five financial development ones. The PCR variable was utilized as an indicator for the information sharing (information asymmetry) and internet, mobile, fixed telephone and broadband Internet were used as ICT indicators.

The research model is estimated based on the study conducted by Asongu and Moulin (2016) in two cases of short-term via the dynamic GMM and long-term through FMOLS. The obtained results illustrated: first, the more short-term and long-term information asymmetry is, the less financial development will be. Second, ICT through information symmetry leads to the improved financial system in the investigated countries. Third, the thresholds effect of ICT variables on the financial development was within the expected range (minimum and

maximum ICT index).

The policy proposal of this paper is that the policymakers and planners should strive to reduce the information asymmetry in the financial markets through the ICT development in the infrastructure, access and utilization in the country and to help improve the financial system.

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## Appendix

**Table I:** Summary Statistics (2004-2015)

	Mean	Min	Max	S.D	Observations
TFD	-1.53E-16	-2.2	5.27	1.64	120
PCR	11.57	0.1	74.9	13.36	120
Iu	38.19	1.24	92.88	24.35	120
PCRoIu	544.91	0.002	4025.49	773.29	120
Mcs	99.09	14.41	194.51	44.39	120
PCRoMcs	1202.65	0.009	7191.99	1445.1	120
Fts	15.47	1.88	38.33	8.9	120
PCRoFts	232.65	0.4	1879.05	351.44	120
Fbs	5.48	0.01	25.39	5.19	120
PCRoFbs	93.97	0.0004	928.01	168.04	120
TICT	9.62E-17-	-2.79	3.36	1.57	120
PCRoTict	8.12	-30.67	92.28	23.53	120
G	4.84	-28.09	34.5	6.48	120
INF	0.07	-0.04	1.77	8.15	120
GCF	25.27	1.77	46.01	8.15	120
OPEN	59.34	0.85	143.22	37.32	120

**Source:** Research finding.

**Notes:** S.D: Standard Deviation. Min: Minimum. Max: Maximum. TFD: financial development index. PCR: public credit registries. TICT: combinative ICT index. Iu: Internet users. Mcs: mobile cellular subscriptions. Fts: fixed-telephone subscriptions. Fbs: fixed-broadband subscriptions. PcroTict: PCR×ICT indices. G: economic growth. INF: inflation rate. GCF: gross capital formation. OPEN: trade openness.



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