

## The Impact of Financial Inclusion on Economic Growth in Egypt Using Fuzzy Regression

### أثر الشمول المالي على النمو الاقتصادي في مصر باستخدام الانحدار الضبابي

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#### **Abstract**

Not only in developed nations but also in developing nations, participation in the financial system is turning into a key focus of attention and effort. It is considered a valid instrument for the purpose of fostering economic growth and bringing about a reduction in levels of poverty. This study's objective is to investigate the factors that contribute to the expansion of Egypt's economy, particularly financial inclusion. The researchers used a possibilistic fuzzy regression to investigate the effect of financial inclusion on economic growth in Egypt throughout the span of time between 2004 and 2019. Their findings led them to the conclusion that financial inclusion has no bearing on economic growth. The study recommends paying more attention to eradicating financial illiteracy by placing issues of improving financial inclusion at the forefront of economic and financial policy priorities and developing the infrastructure of the financial system as well as enhancing disclosure and transparency in banking transactions.

**JEL classification:** C33, C54, F43, O11, P52.

**Keywords:** Financial inclusion, Economic growth, Possibilistic Fuzzy Regression.

## المستخلص

بدأ الشمول المالي في أن يصبح محوراً رئيسياً للاهتمام في الدول المتقدمة والدول النامية. ويعتبر الشمول المالي أداة صالحة يمكن من خلالها تعزيز النمو الاقتصادي وخفض مستويات الفقر. تهدف هذه الورقة إلى دراسة العوامل التي تساهم في توسع الاقتصاد المصري بالتركيز على المؤشرات الخاصة بالشمول المالي باستخدام نموذج الانحدار الضبابي لفهم وتحليل تأثير الشمول المالي على النمو الاقتصادي في مصر باستخدام بيانات في الفترة الزمنية بين عامي 2004 و 2019. تشير النتائج إلى أن الشمول المالي ليس له أي تأثير على النمو الاقتصادي في مصر. ولذلك توصي الدراسة بإيلاء المزيد من الاهتمام للقضاء على الأمية المالية أولاً ، ومن ثم وضع قضايا تحسين الشمول المالي في مقدمة أولويات السياسة الاقتصادية والمالية وتطوير البنية التحتية للنظام المالي وتعزيز الإفصاح والشفافية في المعاملات المصرفية.

**الكلمات المفتاحية:** الشمول المالي ، النمو الاقتصادي ، الانحدار الضبابي الاحتمالي.

## 1- Introduction

Recent financial crises have reignited the discussion on how the financial sector affects economic growth. In order to ensure sustainable development and foster the welfare of countries and to promote social, economic, and environmental development, the United Nations (UN) set financial inclusion as one of the main goals in the Millennium Development Goals (MDG).

Financial inclusion refers to the inclusion of people who have difficulty utilizing and accessing bank accounts, payment methods, credit, and savings products. Financial inclusion, defined as better access and more intensive use of financial institutions' services (Guérineau and Jacolin, 2014), still remains limited in many countries. Sarma (2008) emphasizes that this is a set of means which ensure the accessibility, availability, and use of affordable financial services for all members of an economy.

The level of financial inclusion in the Middle East and North Africa (MENA) region is one of the lowest worldwide. According to World Bank data from 2014, Egypt has significant levels of financial exclusion, with only approximately 12% of Egyptians and 14% of adults having a bank account. Low financial penetration is strongly associated with the presence of a major informal sector (estimated to account for 40% of GDP). This is in addition to the low degree of financial literacy, which is an important key to financial inclusion, and the high poverty and unemployment rates. Furthermore, Egypt is regarded as a cash-based economy, with cash transactions dominating most of its activity. The level of financial inclusion in Egypt improved in 2017, as we observe a significant shift in the percentage of financially included persons due to significant improvements in accessibility. This

led to a boost in the usage level of formal and informal banking services, in addition to the dramatic decline in the percentage of perceived barriers to financial inclusion. In order to improve the financial system and promote economic growth in Egypt, numerous development initiatives have been undertaken over the past 20 years.

According to the International Monetary Fund, bank assets to GDP in Egypt in 2020 represented 89.69% as banks dominate the activity of financing the economy. The relationship between financial intermediation and the well-being of individuals is established according to the degree of financial inclusion of the agents (Saab, 2018) and according to the quality of institutions (Beck, 2016). In general, financial inclusion constitutes an important lever for the development of developing economies as it increases households' income, reduces poverty, and creates employment (Pearce, 2011; Park & Mercado, 2015). Financial inclusion allows the participation of all individuals in financial services by providing a set of local financial products or services to all social strata, especially those excluded from traditional financial services (Demirgüç-Kunt & Klapper, 2012).

Although financial inclusion in Egypt has improved, it is not known how this will affect economic growth, or whether financial inclusion alone should be prioritized to drive the economy. Thus, the main objective of the paper is to assess the impact of financial inclusion on economic growth in Egypt in the short and long terms using the deductive method which is studying the research problem holistically based on postulates, theories or general knowledge, and then moving on to the particulars, through conclusions. The paper is organized as follows. Section 2 provides a discussion on the past literature review on financial inclusion as related to growth. Section 3 describes the variables of the study and collected data. Section 4 represents the empirical model and the econometric method. Section 5 discusses the empirical findings and robustness of the study. Finally, Section 6 provides a summary, conclusion, and policy implications.

## **2- Literature review**

Though the literature is rich in research tackling the topic of financial inclusion and its impact on individuals and the economy, there is no unified definition for this term. The inclusion of individuals differs according to cultural and geographical aspects. The link between financial inclusion and economic growth has been discussed and examined since the early 1950s. The debate around the subject has resulted in the emergence of multiple theories. Early scholars have debated the role played by banks in the growth and development of countries. In 1952, Robinson suggested that, in general, finance does not cause economic growth. In his view,

proper financial conditions are only a result of healthy high demand from the real sector.

On the other hand, Gurley and Shaw (1960) proposed that the importance of the financial sector and, more specifically, banks, stems from their ability to achieve optimal resource allocation within an economy. Hence, a diverse and more competitive environment for banks would lead to better outcomes and economic growth. According to Mckinnon (1973), credit channels and financial institutions are critical in financing the real economy. In 1986, Romer argued that savings, investment, and capital accumulation are the drivers of growth which banks stimulate and manage. Thus, in his view, the financial sector has a positive endogenous effect on economic growth. In 1999, Akhand demonstrated that bank loans to the private sector as well as stock market liquidity can predict countries' economic growth. However, De Gregorio and Guidotti (1995) argued that financial development can cause economic growth. However, efficiency, and not the volume of investments, is what causes this long-term growth.

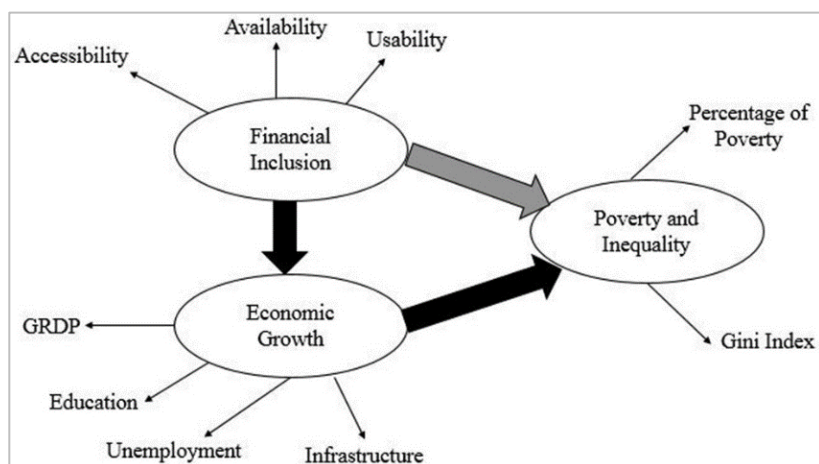
Several studies over the past 20 years have investigated the link between the health of the financial sector and growth. Levine (2005) views banks as critical to the economy. Banks can limit risks, manage, and transfer the flow of savings, reduce costs of transactions and acquire information, and encourage specialization. Recently, scholars have started to emphasize the importance of financial inclusion. For banks to perform, more individuals have to be included in the financial sector. For example, women and the poor are amongst the least financially included groups. In many countries, both poor individuals and women have lower chances of getting formal jobs and hence have no bank accounts. Shihadeh (2018). However, it is not enough to have a bank account to be considered financially included. There are several limitations that could hinder people from using their accounts. For example, transaction costs, the lack of bank branches, the distance between the branch and the location of residence, or other psychological reasons (Diniz et al., 2012). Therefore, the number of bank accounts cannot solely reflect financial inclusion. In this regard, several efforts have been made to come up with a multidimensional index. For example, the financial access index (Honohan, 2008), the multi-dimensional index (Sarma, 2012), the composite index (Mialou et al., 2017), or the African financial inclusion index (Ezzahid & Elouaourti, 2021).

The direct linkage between financial inclusion and economic growth has been empirically investigated in several papers using different estimating methods. The results of this research appear mixed. Most recent research has concluded that financial inclusion and economic growth are positively and significantly related (Kim et al. (2018); Andrianaivo & Kpodar, 2012; Chatterjee, 2020; Shen et al., 2021; Singh & Stakic, 2021); the positive impact is known as finance-led growth or supply-

led growth (Chinoda & Mashamba, 2021). Some studies have concluded that economic growth and financial inclusion have a bi-directional relationship (Ali et al., 2021; Adedokun & Ağa, 2021). Other studies found that the relationship might even be negative (Naceur & Ghazounai (2007); Khan, 2011) or neutral (Gour'ene & Mendy 2017). Dahiya & Kumar (2020) argue that conclusions depend on the elements used to estimate financial inclusion.

The mainstream finding is that financial inclusion can enhance economic growth and reduce inequality. Beck et al. (2007) discussed how financial inclusion not only reduces income inequality but also alleviates poverty. Erlando et al. (2020) have demonstrated this link in more depth. See figure 1.

**Figure 1.** The Impact of Financial Inclusion on Economic Growth and Poverty and Inequality.



Source: Erlando et al. (2020).

Rajan (2009) illustrated how financial inclusion triggers economic growth through two major channels. The improved standard of living of the poor is achieved through accessing more funds by using financial tools and through the enhanced flow of savings deposited in the banks and used for investments. Effective and efficient allocation of resources is necessary for these resources to be transferred to the real economy in a productive way and to cause economic growth (Claessens & Perotti, 2007).

Several factors determine the effect of financial inclusion on growth. Barajas et al. (2011) found a negative effect of private credit on growth in the MENA region. Sassia and Goaid (2012) showed how economies in the MENA region can only benefit from financial development once they reach a certain level of ICT development. Emara and El Said (2021) revealed that, under better conditions, financial inclusion can have a favorable impact on growth in the MENA region.

These conditions are better rule of law, higher political stability, more control of corruption, judicial independence, and contract enforcement.

Financial inclusion in the MENA region is low for several reasons. Access to finance is limited; the security of transactions is questionable; banks dominate the financial market; and financial markets are underdeveloped. (Emara & El Said, 2021). In general, policymakers in developing countries have to give more attention to building confidence in the financial system, which can only happen by investing more in financial literacy and education (Mindra et al., 2017).

In Egypt, few studies have examined the topic of financial inclusion. Access to banking services for small and medium enterprises is constrained. This is due to the fact that the banking industry prioritises funding the government rather than the private sector. Additionally, a growing percentage of the loans are "non-performing," demonstrating the inability of the financial institutions in the market to adequately manage their risks (Ayadi et al., 2018). Non-bank institutions like insurers, mortgage lenders, leasing firms, and others are small but expanding. Microfinance and credit guarantee companies, which play a role in improving financial access, help to alleviate the private sector's (micro businesses and SMEs) limited access to credit (Ayadi et al., 2018). The financial markets have a shallow depth and are difficult to access.

Approximately 20% of the GDP is represented by the market value of the listed companies, and government bonds make up almost the entire bond market. A number of reforms have been made to the accounting and financial sector regulations in order to bring them into compliance with global standards and start reducing government involvement. 2018 (Ayadi et al., 2018). To examine the link between financial inclusion and growth, Noureldin et al. (2020) found a positive association between GDP and the number of ATMs, and a negative association between GDP and total deposits in Egypt. Maher (2022) found a negative association between total deposits by households and SMEs and the rate of inflation.

A significant positive relationship between loans authorized to SMEs and inflation only existed in certain specifications, according to the study. According to Helmy's study (2021), human development and financial inclusion in Egypt have a negative association as a result of the widespread inequity in education and income, which may have negative effects on the level of economic development. ElDeeb et al., (2021) suggested three main pillars that determine financial inclusion in Egypt: (1) marketing tools Usage of Banking Services (3) evaluation of macroeconomic risks The study suggested that the interaction between these pillars accounts for a variability of 86.6% in the level of financial inclusion of small and medium enterprises.

Rashdan and Eissa's 2020 study focused on the elements that influence financial inclusion in Egypt. According to their empirical findings, there are no gender differences in the degree of financial inclusion in Egypt. However, older, wealthier, and more educated individuals are more deeply assimilated into the financial system. The results reveal that the main barrier to financial inclusion is actually a lack of resources, which prevents people from opening bank accounts.

A contradicting study by Awad & Eid (2018) revealed that only 58% of women and 72% of men in their sample had bank accounts; fewer women than men had personal bank accounts. However, the study found three primary reasons why Egyptians do not have personal bank accounts, which are in line with Rashdan and Eissa's (2020) findings: first, a lack of funds (29%); second, a lack of need for financial institutions (18%); and third, religious considerations (13%). According to the study, 68 percent of the respondents typically pay with cash.

A few studies introduced indices for financial inclusion in Egypt. Ismail et al. (2018) developed a multi-dimensional index using the confirmatory factor modelling technique. Using a three-stage principal component analysis, Ismail and Ali (2021) introduced a comprehensive financial inclusion index for Egypt. By combining access, usage, and barrier indicators for the traditional financial index and access and usage indicators for the digital financial index, the author created two distinct indices for traditional and digital financial inclusion. The traditional index and the digital financial index play equal roles in reflecting Egypt's overall financial inclusion. As a result, digital finance is viewed as an addition to traditional financial services rather than as a replacement for them. Furthermore, findings showed that although Egypt has a low level of financial inclusion, digital finance is significantly and positively contributing to achieving greater financial inclusion.

The use of financial services is influenced by the variety of financial products and services that are offered. Sayed and Shusha (2019) highlighted the importance of religion in influencing the consumption of financial services in Egypt. Regarding this, it is essential that financial institutions take religious principles into account when developing financial products and services in order to increase consumer use of financial services. The degree of consumer and financial services knowledge has a sizable impact as well. The results of Sayed and Shusha (2019) showed that financial institutions in Egypt must think about diversifying their financial products and services despite the high rate of adoption of various financial services and products. Egypt has not yet created a comprehensive strategy for financial inclusion, and its efforts in this area consist of a few initiatives.

In addition, the lack of data and standardized reporting procedures hinders the formation of evidence-based policy. Access to financial services is also restricted by current social norms. By creating an inclusive environment and developing banking

financial institutions capable of offering practical and affordable services that satisfy the needs and aspirations of both men and women, meaningful financial inclusion in Egypt can be achieved (Beckzada & Fouad, 2018). Despite their limited financial resources, Egypt's post offices have the potential to be a key player in promoting financial inclusion (Beckzada & Fouad, 2018). Additionally, digital services make it easier to spread financial services throughout Egypt's rural areas and mobilize savings for marginalized groups. Digital services can expand the scope of traditional banking services and pave the way for a more promising future for Egypt's banking industry (Al-Adwey, 2019).

### 3- Variables of Study and Data Sources

The collected data covers the annual data for the period between 2004 and 2019. Data was collected from the World Bank, the IMF, the Egyptian Central Bank, and the Egyptian Ministry of Finance. This study incorporates variables that have an impact on Egypt's GDP. These variables are: ATMs per 100,000 adults (*ATM*), as indicator of financial inclusion, gross domestic savings (*GS*), gross national expenditure (*GEXP*), domestic credit to the private sector by banks (*DCR*), openness (*OPEN*), real interest rate (*RINT*), and Table 1 lists all the dependent and independent variables and data sources.

**Table 1.** Variables Definitions and Sources

Variable	Definition	Source
<i>GDP</i>	Gross Domestic Product	World Bank
<i>ATM</i>	Growth Rate (%). Financial inclusion; the number of Automatic Teller Machines per 100,000 adults.	Central Bank of Egypt
<i>GS</i>	Gross savings of households in (% of GDP)	World Bank
<i>GEXP</i>	Public Expenditure (constant 2012 USD)	World Bank
<i>DCR</i>	Domestic credit to the private sector by banks (% of GDP)	Central Bank of Egypt
<i>OPEN</i>	The degree of openness (% of GDP).	IMF



The number of ATMs and the domestic credit provided to the private sector are the variables of interest and represent financial inclusion in this study. The other selected variables are all expected to impact economic growth. According to the economic literature, economic growth is affected by the level of public spending (Landau, 1983; Romer, 1986; Barro, 1991; Morley & Perdakis, 2000), savings (Lucas 1988; Ribaj & Mexhuani, 2021), credit granted to the private sector and to households (Bui, 2020; Amoo et al., 2017; Korkmaz, 2015; Yahaya, 2015), trade openness (Michaely, 1977; Kormendi et al., 1985; Frankel et al., 1995; Allen & Ndikumana, 2000; Asselain & Blancheton, 2006), and interest rates (Lucian-Liviu, 2006; Obamuyi & Olorunfemi, 2011; Saymeh & Orabi, 2013)

#### 4- Empirical Model

This study investigates the effects of ATMs variable and other independent variables on the economics growth GDP, assuming the following function:

$$GDP = f(ATM, GS, GEXP, DCR, OPEN, RINT)$$

Traditional multiple regression is a suitable approach to determine the strength and direction of the relationship between the variables of the proposed model if the statistical conditions for applying this method are met. However, it becomes inappropriate if:

1. The sample size is small (as in this study, the time period is small, and the data set is small).
2. There is any type of ambiguity between the dependent and the independent variables.
3. The assumptions of the traditional regression model are either violated or cannot be verified.

To achieve the aim of the research, the Fuzzy Regression method, or what is called specifically Possibilistic Regression, introduced by Tanaka et al. (1982), is used for many reasons. Firstly, one of the common problems that faced in the analysis of financial data is the phenomenon of autocorrelation between the observations of the time series. Then it would be wrong to apply traditional regression to such data. Secondly, this study uses annual data of a limited observations over a very short period. Therefore, it is not safe to use the traditional regression model in this case due to the small sample size.

The traditional regression model assumes that the model error arises from two sources; factors that were excluded from the model and measurement errors. In contrast, the Fuzzy Regression assumes that the deviations between the observed values and the estimated values of the dependent variable are due to the ambiguity of the regression model. Or the inaccuracy in the observations, or the lack of clarity, or the lack of determination of the phenomenon.

Many approaches of fuzzy regression were suggested since 1980, this study applies the Possibilistic Regression Analysis (Tanaka et al.,1982), in which the parameters of fuzzy regression model are estimated using linear programming approach. This approach assumed that the inputs (the independent variables) are crisp numbers, while the outputs (the dependent variable) is fuzzy numbers.

The Fuzzy Regression model takes the following form:

$$\tilde{Y}_j = \tilde{A}_0 + \tilde{A}_1 X_{1j} + \dots + \tilde{A}_m X_{mj}$$

Where  $\tilde{Y}_j, j = 1, 2, \dots, n, n > m$  represents the  $j^{\text{th}}$  value of the dependent variable, and  $X_{ij}, i = 1, 2, \dots, m$  represents the values of the independent variables, while  $m$  represents the number of independent variables, which are crisp numbers.  $\tilde{A}_i, i = 0, 1, \dots, m$  represents model parameters that assumed to be fuzzy numbers. The dependent variable  $\tilde{Y}_j$  is assumed to be a symmetric triangular fuzzy number (STFN), and is represented as the following:

$$\tilde{Y}_j = (Y_{jC}, Y_{jS})$$

Where  $Y_{jC}$  is the center of the dependent variable  $Y_{jS}$  is the spread of the dependent variable. Thus, the  $\alpha$ -cut of the fuzzy number  $\tilde{Y}_j$  is denoted by  $Y_{j\alpha}$  and is represented as follows:

$$Y_{j\alpha} = \langle \tilde{Y}_{jC}, \tilde{Y}_{jS} \rangle = [ Y_{jC} - Y_{jS} (1-\alpha) , Y_{jC} + Y_{jS} (1-\alpha) ]$$

Using available data, the Tanaka approach aims to estimate the model coefficients  $\tilde{A}_i$  which represented as STFN

$$\tilde{A}_i = (a_{iC}, a_{iS}) , \quad i = 0, 1, 2, \dots, m$$

The coefficients estimate of the Fuzzy model  $\tilde{A}_i$  can be written as follows:

$$\hat{\tilde{A}}_i = (\hat{a}_{iC}, \hat{a}_{iS})$$

and the estimates of  $\widehat{Y}_j = (\widehat{Y}_{jC}, \widehat{Y}_{jS})$  will be as follows:

$$\widehat{Y}_j = \widehat{A}_0 + \widehat{A}_1 X_{1j} + \dots + \widehat{A}_m X_{mj} \dots \dots \dots (1)$$

Thus,  $\widehat{Y}_j$  can be written as follows:

$$\begin{aligned} \widehat{Y}_j &= (\widehat{Y}_{jC}, \widehat{Y}_{jS}) = (\widehat{a}_{0C}, \widehat{a}_{0S}) + (\widehat{a}_{1C}, \widehat{a}_{1S}) X_{1j} + \dots + (\widehat{a}_{mC}, \widehat{a}_{mS}) X_{mj} . \\ &= (\widehat{a}_{0C} + \widehat{a}_{1C} X_{1j} + \dots + \widehat{a}_{mC} X_{mj}, \widehat{a}_{0S} + \widehat{a}_{1S} X_{1j} + \dots \\ &+ \widehat{a}_{mS} X_{mj}) \\ &= (\sum_{i=0}^m \widehat{a}_{iC} X_{ij}, \sum_{i=0}^m \widehat{a}_{iS} |X_{ij}|) \end{aligned}$$

To obtain the estimated parameters  $\widehat{a}_{iC}$  and  $\widehat{a}_{iS}$ , Tanaka et al. proposed the following approach to solve the fuzzy regression equation in (1), so that the total degree of fuzziness embedded in relations can be minimized:

$$\text{Minimize } Z = \sum_{j=1}^n \widehat{Y}_{jR} = \sum_{j=1}^n \sum_{i=0}^m \widehat{a}_{iS} |X_{ij}|$$

subject to:

$$\mu (Y_j \subseteq \widehat{Y}_j) \geq \alpha$$

Where :

- $j = 1, 2, \dots, m$
- $\widehat{a}_{iS} \geq 0, \quad i = 0, 1, \dots, m$
- $\alpha \in [0, 1]$

Hence, the  $\alpha$  level in the Fuzzy regression model is referred to as a measure of the extent of membership, relevance, or agreement between the estimated Fuzzy regression model and the observed data, meaning that the observed value of the dependent variable  $Y_j$  belongs to a range of the estimated Fuzzy dependent variable  $\widehat{Y}_j$  greater than or equal to  $\alpha$ .

The Fuzzy regression model has outperformed the traditional regression model, especially in small sample applications (Kim et al., 1996). To apply Tanaka approach a source code would be created to estimate the centre and spread of the model parameters because there is no software package to use with this type of

regression. So, we wrote a source code to apply fuzzy regression using GAMS (2014). The Fuzzy regression method does not provide tests of significance for the estimated parameters of the model. But, we can use algorithm similar to Stepwise regression algorithm to choose the most effective independent variables and give the best model that fits available data.

The proposed algorithm , Wang and Tsaur (2000), is represented in the following steps:

- 1- Choose the univariate model (a model with one independent) that has the greatest Interpretation Criterion (IC) out of all combination of univariate models.
- 2- Add a new variable to the selected model in step (1) and calculate the partial Interpretation criterion PIC for the new model which is:

$$PIC = \frac{SSE(X) - SSE(X, X_{N+1})}{SSE(X)}$$

Where  $SSE(X)$  is the sum squared errors of the model before adding the new variable, and  $SSE(X, X_{N+1})$  is the sum squared errors of the model after adding the new variable.

- 3- Choose the model that has the largest partial explanatory value (PIC) among the new models in step (2)
- 4- Repeat steps (2) and (3) by adding new independent variables in the last selected model.
- 5- The best model is the one that has the largest positive partial Interpretation criterion PIC.

This algorithm has been applied to annual data collected during the period 2004 to 2019, Using a GAMS code created by the study researchers.

## 5- Results and Discussion

The descriptive statistics presented in table 2 provide us with a historical picture of the behavior of the variables under study. The standard deviation shows that trade openness is the most volatile variable compared to the rest of the variables, followed by the domestic credit index provided to the private sector and then gross domestic savings. The standard deviation shows that the interest rate variable is the least volatile compared to other variables in the same period.

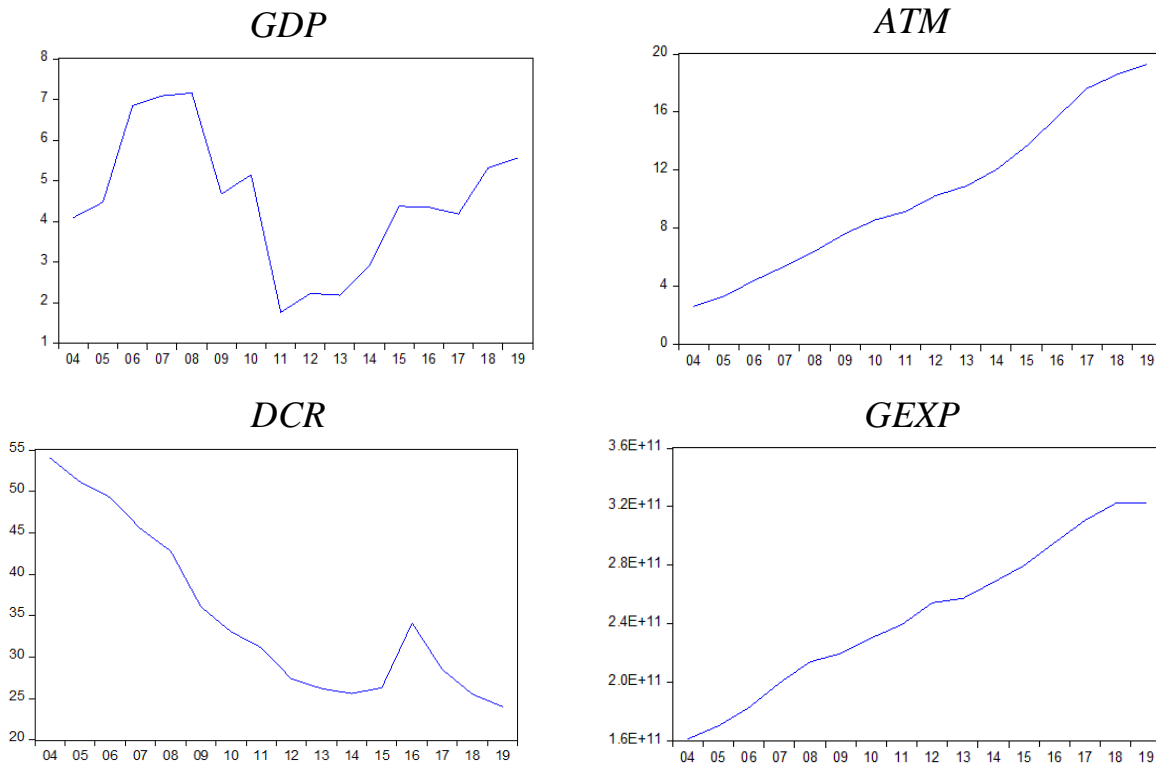
**Table 2.** Descriptive Statistics

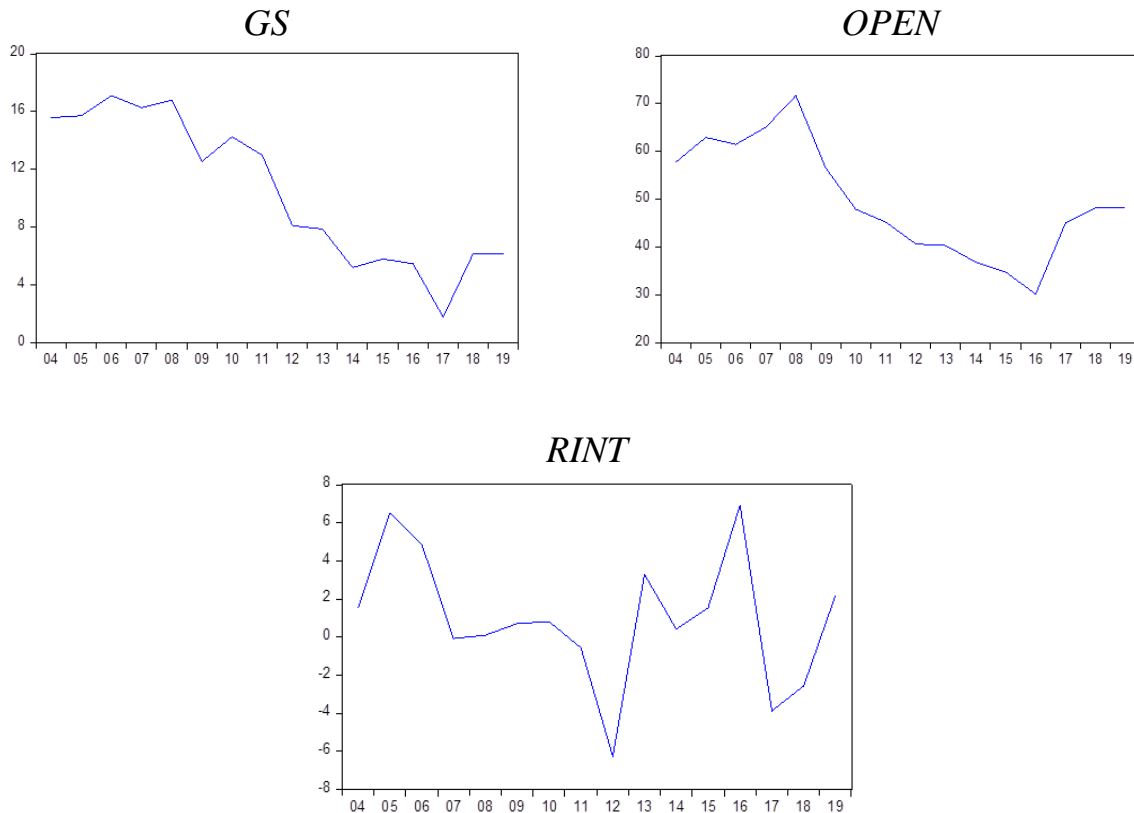
	<i>GDP</i>	<i>ATM</i>	<i>DCR</i>	<i>GEXP</i>	<i>GS</i>	<i>OPEN</i>	<i>RINT</i>
<b>Mean</b>	4.52102	10.3461	35.0557	2.46E+1	10.4963	49.5984	0.97458
	7	3	9	1	3	9	8
<b>Median</b>	4.42188	9.70837	32.1136	2.47E+1	10.3296	48.1073	0.76437
	2	5	1	1	4	1	9
<b>Maximum</b>	7.15628	19.2911	54.0429	3.22E+1	17.1118	71.6806	6.92201
	4	5	1	1	7	3	1
<b>Minimum</b>	1.76457	2.62741	24.0237	1.62E+1	1.78386	30.2465	-
	2	9	3	1	2	5	6.262720
<b>Std. Dev.</b>	1.67923	5.41151	10.2319	5.23E+1	5.13015	11.9042	3.48216
	8	4	1	0	7	8	3
<b>Skewness</b>	-	0.27205	0.66329		-	0.21552	-
	0.006174	6	7	-0.025936	0.074014	7	0.142188
<b>Kurtosis</b>	2.18530	1.89778	1.96164		1.50722	2.06011	2.86399
	3	4	8	1.879770	0	0	5
<b>Jarque-Bera</b>	0.44258	1.00729	1.89201		1.50020	0.71280	0.06624
	9	2	8	0.838404	2	1	4
<b>Probability</b>	0.80148	0.60432	0.38828		0.47231	0.70019	0.96742
	1	3	8	0.657571	9	2	0
<b>Sum</b>	72.3364	165.538	560.892	3.93E+1	167.941	793.575	15.5934
	4	1	6	2	3	8	1
<b>Sum Sq. Dev.</b>	42.2975	439.267	1570.38	4.11E+2	394.777	2125.67	181.881
	9	3	0	2	7	9	8
<b>Observations</b>	16	16	16	16	16	16	16

A historical graphical representation of the study's chosen variables is shown in Figure 2. The GDP growth rate experienced significant swings; from 2004 to 2008, it increased, followed by a slight decline from 2009 to 2010, then a significant decline in 2011 during the Egyptian revolution. From 2017 to 2019, the rate saw gradual improvements. Although the rates of increase were higher between 2015 and 2019, the number of ATMs showed a consistent upward trend over the study period. Domestic credit continued to decline throughout the study period, with the exception of 2016, when it slightly increased before declining once more until 2019. Although there was an upward trend in public spending from 2017 to 2019, this increase was primarily for economic stabilization following the liberalization of the Egyptian

pound. Figure 2 depicts a general decline in domestic savings for the majority of the studied period. Started in the studied period, there was a tendency to rise, which was followed by a sharp decline in 2009 following the financial crisis. It then continued to decline, reaching its lowest levels in 2017 following the floating of the Egyptian pound. Domestic savings levels increased since 2018 according to the data. Until the Egyptian currency depreciated in value in 2016, which increased exports, trade openness was generally on the decline. From 2017 to 2019, however, trade openness increased once more. Large fluctuations were observed in the real interest rate over the course of the study period. It began with a noticeable rise and then began to sharply decline, reaching some negative values that peaked in 2012, the year after the Egyptian revolution. Interest rates then started to rise again until they reached their peak in 2016, after which they began to decline sharply again in 2017 and 2018, before rising again in 2019.

**Figure 2.** Selected Variables Over the Period Between 2004 to 2019





By applying possibilistic regression (Tanaka et al 1982) and variable selection algorithm (Wang and Tsaur 2000), the following results were obtained:

**Table 3.** The Fuzzy regression estimates for the coefficients of the variables

PIC	RINT	Open	DCR	GEXP	GS	ATM	Constant	
0.36269	0.175294	0.173521	-	-	0.274936	-	-7.09003	C
	0	0	-	-	0	-	2.835004	S

Table 3 shows the fuzzy regression estimates for the coefficients of the independent variables. Each estimated coefficient has two values: the value of the center of the coefficient (C) and the value of the spread of the coefficient (S). The value of the coefficient (which represents as fuzzy number) is confined between its upper bound (C+S) and its lower bound (C-S). The algorithm used provides us with an alternative to the statistical significance of the model transactions. If the variable is not selected through this algorithm (such as the DCR variable), the variable is has an insignificant effect. The table shows the explanatory value of the model (IC), which matches the  $R^2$  value in the traditional regression and expresses a low interpretation power of the independent variables in the model.

The results of the table show that the real interest rate, trade openness, and gross domestic savings are the variables that have a significant effect on the rate of economic growth in Egypt during the study period. The number of ATMs and domestic credit provided to the private sector by banks, which are the variables that represent financial inclusion in Egypt, had no significant effect on economic growth. This finding is inconsistent with findings of Noureldin et al. (2020) who found a positive association between GDP and the number of ATMs, and a negative association between GDP and total deposits in Egypt.

Numerous factors support the negligible correlation between financial inclusion and growth in Egypt. Firstly, there is a passive use of financial services as it depends largely on salary transfers. This makes the increase in the number of ATMs ineffective in promoting growth; the number of ATMs increased from 9.15 per 100,000 people in 2011 to 19.29 in 2019. Secondly, the infrastructure of the financial sector is underdeveloped. It is still challenging to establish a supervisory framework for microfinance institutions and there is an absence of any financial and legal classifications for them; they are classified as non-governmental organizations. Thirdly, there is difficulty in opening bank branches, especially in rural and remote areas, which leads to difficulty in accessing bank branches in these areas. The same applies to ATMs, which are very few in rural areas, an inadequate number for the number of residents in these areas.

## **6- Conclusion and Policy Implications**

The relationship between financial inclusion and economic growth has been investigated by several research in the economic literature. With many of socioeconomic factors, financial inclusion's impact on economic growth is generally still very difficult to measure. This study used possibilistic fuzzy regression to examine the impact of financial inclusion on economic growth in Egypt during the period between 2004 and 2019 and concludes that financial inclusion has no impact on economic growth.

The study recommends placing issues of improving financial inclusion at the forefront of economic and financial policies, and encouraging educational institutions to become platforms for the elimination of financial illiteracy. This is in addition to prioritizing the development of the necessary infrastructure as well as enhancing disclosure and transparency in banking transactions.

Policymakers should work on strengthening cooperation with international institutions concerned with financial inclusion issues and work to provide the technical support required for the success of national policies to spread financial inclusion. The research also recommends facilitating the procedures required for



companies to create a parallel funding channel through which the process of financial inclusion can become more effective in influencing economic growth.

At the same time, fintech companies should work on gaining customer confidence to change the consumer culture in addition to developing financial products and services to provide innovative and low-cost services that are compatible with the needs of excluded groups, especially women and low-income groups. Through integrating small and medium-sized enterprises and expanding the actual scope of formal financial services, the informal economy will shrink. Future research is recommended to increase the sample size and to use alternative variables to represent financial inclusion.

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