# Investigation of the Shadow Economy in Egypt

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# ABSTRACT

The purpose of this thesis is to investigate the shadow economy in Egypt over the period 1997-2013. The thesis explains the main drivers and the effects of the shadow economy for the Egyptian economy. The study explains the definition of the shadow economy, its current status in Egypt and how the government can play a crucial role in issuing laws that create a better environment for the Micro and Small Enterprises (MSEs), which represent the largest segment of the shadow economy in Egypt. We also examine the impact of the shadow economy in reducing unemployment levels, poverty alleviation and accelerating economic growth in Egypt.

The thesis uses the Multiple Indicator Multiple Causes (MIMIC) approach to analyze the main drivers of the shadow economy. Our MIMIC model suggests that the main forces for the shadow economy in Egypt are the unemployment rate, the quality of government regulations and institutions, and the net tax payments. Our model also shows that the main indicator is the secondary enrollment ratio. We find out that among three indicators (gross domestic product, government expenditure, and secondary enrollment ratio), the shadow economy mostly affects the secondary enrollment ratio. Our model suggests that as the size of shadow economy in Egypt increases, the secondary enrollment ratio is the mostly (and negatively) affected indicator.

Finally, based on our empirical results, we try to provide some policy recommendations that the Government of Egypt should apply in order to formalize

the informal sector in Egypt and how to gradually integrate the informal activities into the formal economy.

**Keywords:** Shadow Economy, Multiple indicators Multiple Causes (MIMIC), Latent Variable, Tax Burden, Regulation, Formalization

# ÖZ

Bu tezin amacı 1997-2013 yılları arasında Mısır'daki kayıt dışı ekonomiyi incelemektir. Tez, kayıt dışı ekonominin Mısır ekonomisi için ana dinamiklerini ve etkilerini incelemektedir. Çalışma, kayıt dışı ekonominin tanımlarını yapmakta, Mısır'daki mevcut durumunu açıklamakta, ve Mısır hükümetinin gerekli yasal düzenlemeleri yaparak en yüksek kayıt dışılığı oluşturan Mikro ve Küçük İşletmelere (MSE) daha iyi bir iş ortamı sağlamada ne kadar önemli bir rol oynayabileceğini anlatmaktadır. Çalışmada, kayıt dışı ekonominin işsizlik seviyesini düşürmede, fakirliğin giderilmesinde ve Mısır ekonomisinin büyümesini hızlandırmadaki etkileri de ayrıca incelenmiştir.

Tez kayıt dışı ekonominin ana dinamiklerini açıklamak için Çoklu Göstergeler Çoklu Sebepler (MIMIC) yaklaşımını kullanmaktadır. MIMIC modelimize göre Mısır kayıt dışı ekonomisinin ana etkenleri işsizlik oranı, hükümet yasal düzenlemelerinin ve kurumlarının kalitesi, ve net vergi ödemeleridir. Modelimiz ayrıca göstermektedir ki ana gösterge orta eğitim kayıt oranıdır. Üç gösterge arasında (gayri safi yurt içi hasıla, hükümet harcamaları, ve orta eğitim kayıt oranı) kayıt dışı ekonominin en fazla etki yaptığı gösterge orta eğitim kayıt oranı olduğu tespit edilmiştir. Modelimize göre Mısır ekonomisinde kayıt dışılık arttıkça orta eğitim kayıt oranı en fazla etkilenmekte ve azalmaktadır.

Son olarak, ampirik sonuçlarımıza dayanarak, kayıt dışılığın kayıt altına alınması konusunda Mısır hükümetinin uygulaması gereken politika önerilerinde bulunmaktayız.

**Anahtar Kelimeler:** Kayıt Dışı Ekonomi, Çoklu Göstergeler Çoklu Sebepler (MIMIC), Gizli Değişken, Vergi Yükü, Yasal Düzenleme, Kayıt Altına Alma

# DEDICATION

I dedicate this Thesis to my father for the opportunity he gave me to undertake this project, to my parents for their support and effort, my brothers and sisters, and my friend Sara.

# ACKNOWLEDGMENT

For anybody to be successful in life, he needs the support, advice and encouragement of others. This thesis is devoted to all those who helped me throughout the journey. To the family that has bared me all the way; my father a great man for whom I have always looked up, the biggest heart ever found my mum, my brothers Mohanned and Youssef, my best friend and sister Sara, Dr. Kemal who directed me through my work and friends who made me feel home when I was far away from home; Hayatu, Itodo, Saint, Abu Bakr, George, pejman and Salim. Thank you for each and every one of you.

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| | |
|---|---|
| ASEAN | Association of Southeast Asian Nation |
| ADF | Augment Dickey Fuller |
| CMIN | Chi-Square |
| DF-GLS | Dickey Fuller –Generalized least Squares |
| GDP | Gross Domestic Product |
| GNI | Gross National Income |
| ICLS | International Conference of Labor Statisticians |
| ILO | International Labor Organization |
| MIMIC | Multiple Indicators Multiple Causes |
| OCED | Organization for Economic Cooperation and Development |
| PP | Phillip Perron |
| RMSEA | Root Mean Square Error of Approximation |
| SEMs | Structural Equation Models |
| WB | World Bank |
| WDI | World Bank Development Indicators |
| WTO | World Trade Organization |

# Chapter 1

# INTRODUCTION

## 1.1 Overview of the Study

The aim of this thesis is to investigate the shadow economy in Egypt over the period of 1997 - 2013. In the thesis we first explain the taxonomic framework about the shadow economy. We explain the informal sector by giving definitions for the informal economy.

The thesis explains the main characteristics of the informal sector that are (i) small economies of scale, (ii) labor intensive production process, (iii) low qualifications, (iv) so easy to enter the market and (v) skills are gained outside the formal education. We discuss the main macroeconomic indicators that are known as the drivers for the underground economies. These indicators are, first, taxes that increase the tendency of workers to supply their labor force in the shadow economy. Second is the impact of the intensity of government regulations, where the more intense the state regulations the higher the informal sector. Third is the quality of the public sector services and institutions, where the higher the quality of public services and institutions the smaller the size of the shadow economy. In line with this indicator, the Tax Moral, that is indirectly affected by the efficiency of the public sector quality. The final indicator is corruption. Although corruption is well-known concept, the question of whether the higher the rate of corruption results in a growth in shadow economy or vice versa is still an unanswered question.

Regarding the labor force working in the shadow economy, we investigate why people choose to supply their efforts and time to work in the unofficial economy, in which they may lack all of their basic working conditions.

The thesis also explores the impact of the informal sector on the official economy. The shadow economy's impact on the formal economy is a very debatable issue. The thesis clarifies objectively the main advantages and disadvantages of the shadow economy over the formal economy and leaves the reader to evaluate the costs and benefits of this phenomenon and make their own conclusions.

## 1.2 Statement of the Problem

The main problem of the shadow economy is

- The working conditions of the informal sector and lack of social security rights; and
- The government does not collect taxes and the production is not counted in the country's Gross Domestic Product (GDP).

## 1.3 Research Questions

We can summarize the research questions raised over this study as follow:

a. What are the main drivers for shadow economy of Egypt?

b. How can the Government of Egypt formalize the informal sector?

## 1.4 Purpose of the Study

The main purpose of the thesis is to analyze the main drivers for shadow economy in Egypt, while the study would specifically:

I. Identify the shadow economy and the main forces for it.

II. Compare between the advantages and the disadvantages of the shadow economy on the GDP and on the economy

III. Estimate the impacts of the main drivers of the shadow economy of Egypt from 1979 till 2013.

IV. Recommend policies to the Egyptian government on how to formalize the shadow economy.

## 1.5 Research Methodology

This thesis implements time series analysis to measure main drivers of the shadow economy of Egypt.

The data used in the thesis spans the period from 1979 till 2013. The MIMIC approach has been used to detect the nature of the main drivers and forces of the Egyptian shadow economy.

## 1.6 Organization of the Study

Together with an introduction, our thesis contains five chapters. The rest of the thesis is organized as follows.

Chapter two explains the taxonomic framework for shadow economy, and gives wide definitions for the informal economy. The chapter demonstrates the main macroeconomic indicators considered as drivers for the underground economies. The study explores and investigates the Shadow Economy and Labor Force performing in it and their impact on the formal economy.

Chapter three discusses the methodology used throughout the thesis. The chapter explains the data, model specification, stationarity tests and goodness of model fit.

Chapter four interprets the estimated empirical results of the thesis. Finally chapter five concludes the thesis and recommends some policies.

# Chapter 2

# SHADOW ECONOMY AND THE LITERATURE

This chapter aims to give a background on what are the different global definitions of the shadow or the underground economy. We explain the main causes for the underground economy in terms of macroeconomic indicators. We also explain the main incentives for workers to choose to perform in the hidden economy rather than the formal one.

## 2.1 Taxonomic Framework for Shadow Economy

Before explaining the taxonomic framework of the shadow economy, we present definitions of the shadow economy in Table 1 below.

Table 1: Four different types of shadow economy

| | Definition |
|---|---|
| Illegal Economy | "Totality of the revenues that are generated by those economic activities that violate the legal status of legitimate forms of trade" |
| Unreported Economy | "Totality of economic activities that escape or avoid fiscal rules as they are defined in fiscal codes" |
| Unrecorded Economy | "Activities that avoid institutional conventions that define the necessary requirements for the report to governmental agencies for statistics." |
| Informal Economy | "Economic activities that avoid costs and excluded from the rights and benefits that come along with leasing, work contracts, loan and social security" |

Source: (Jie, Tat and Rasli, 2011)

As shown in Table 1 there are four major types for shadow economy. The illegal economy is the type in which entrepreneurs are working in producing and

distributing illegal goods and services. Mainly those illegal activities are either the production of restricted substances like drugs and black market currency exchange rate. From the economic point of view the production of those illegal activities are even more profitable than the production of other cash crops, but the major disadvantage for it is the political instability, legal and economic development. The black market for exchange rate is very useful in minimizing the transaction costs to exchange currencies and acts as a barrier to any fluctuation in the legal domestic market exchange rates.

The unreported economy includes activities that dodge the fiscal rules in tax codes. This is the real amount of income that would have been reported to the governmental tax authorities, but is not reported. A corresponding measure for the unreported shadow economy would be the “tax gap“, which represents the difference between the expected amount of taxes based on fiscal authority estimations and the amount of tax revenues that are collected. The size and the development of the unreported activities and income directly affect government budget deficits, debts and tax reform policies.

The unrecorded economy contains activities that evade institutional laws that represent reporting needed for government statistical agencies. A measurement for the unrecorded economy would be the amount of income that should be reported based on current rules and laws in the national accounting systems, but is not recorded. A country’s unrecorded income would be the difference between the total income and the income that is recorded by its statistical accounting system.

The informal economy is the self-regulated non-formal part of the market economy that produces goods and services. Informal attributes to the economic activities of entrepreneurs and labor that are not completely done under formal regulations.

**Definitions for the Informal Economy**

- De soto clarifies the informal sector is by SME's to overcome the complicated regulation by the government bureaucracies.

- The International Labor Organization (ILO) in 1972 defined the informal sector as an independent one that is not related to the formal economy that provides income and safety network to poor people.

- Castells and Portes (1989) classify the shadow economy as confounded sector to the formal economy. According to the authors, capitalists aim to overcome lesser producers and traders in order to reduce their costs.

- International Conference of Labor Statisticians (ICLS) (1993) defined the informal sector as a bunch of enterprises owned by the households. This includes informal own-account enterprises, which may utilize contributing family workers and employees on an infrequent premise; and enterprises of informal employers, which employ one or more employees on a nonstop premise.

- Loayza (1997) views the informal sector as a set of economic units that do not adhere completely or moderately to the government regulations.

- Tokman (2001) defines the informal sector as trading off firms with restricted possession that is employing unpaid relatives, local hiring, less educated employees, and have less than five specialists including the proprietor. (Attia, 2009).

It is common to view the shadow economy as producing only survivalist activities rather than productive ones. Different negative traits have been used to describe the informal sector as being undeclared labor force, tax evasion, and unregulated enterprises, illegal and criminal activity. Most of the informal economy operators produce goods and services that are legal. The informal activities are not being done with intention of tax evasion, escaping payments of social security or labor legislations or any regulations. The shadow economy includes both restricted illegal and restricted legal operations, but not criminal operations. There is a clear difference between shadow economy and criminal economy. There are different perspectives in defining the informal economy (Becker, 2004).

## 2.2 Main Drivers for Shadow Economy

Although there are no certain definite causes for the shadow economy, there are main macroeconomic drivers that many researchers showed to be effective in the size of the informal sector in different counties. The main reasons are related to taxes, government regulations, public institutions and avoidness.

1. **Tax and Social Security Subscription Costs**

Most of the literature view tax burden and social security subscription levels as the main reasons for the informal sector in an economy. Taxes impact the work leisure choices and increase the labor supply for the informal sector. In other words, the exaggeration of taxes is a crucial point in the creation of the shadow economy. The

larger the difference between the labor cost in the formal economy and the net earnings, the higher the motivation to try to decrease tax obligations by choosing to operate in the shadow economy. Both the social security taxes and contributions and other type of business operation taxes are major determinants for the continuation of the existence of the shadow economy (Schneider and Williams, 2013).

Neck, Hofrrither and Schneider (1989) showed that the larger the marginal income tax rates, the higher the size of shadow economies. They also showed that enterprises' demand for underground labor force relies positively on the wage rate of the formal economy and on the indirect tax rate of the official economy.

Cebula (1997) suggests that whenever the marginal federal personal income increases by one percent, the size of the informal sector increases by almost 1.4 percent. On the other hand, the tax burden and constrained labor market restrictions have a direct relationship with the size of the shadow economy. The efficiency and effectiveness of the state institutions also have an indirect effect on shadow economy. The higher the indirect tax and marginal income tax rates, the higher the supply of goods and services and labor in the hidden economy. The market equilibrium of labor and goods and services of the shadow economy relies on different variables such as the penalization value and detection possibilities of tax, which are under the control of tax authorities (Headen, 2001).

### 2. Intensity of Regulation

The tenseness of government regulations like labor market regulations, trade tariffs and labor constrains for foreigners is a crucial factor that limits enterprises participation in the formal economy. Johnson et al. (1998) found out a significant

empirical result that the more intense the state regulations the larger the expected shadow economy. High regulations lead to higher labor costs for the formal economy, but mainly those regulation costs are taken by the labor themselves rather than the owners of the business. Hence, people tend to shift to work in the informal economy, where they can avoid such costs.

Regarding the case of migrants, the regulatory duties are even more costly and time consuming. For instance, because it is not easy to get work permission, they tend to work in the informal sector. Johnson et al. (1997) conclude that countries with larger regulatory procedures for their economic activities tend to have a larger size of a shadow economy compared to other countries that have easier regulatory procedures. They concluded that the application of regulation is the main burden for firms and workers who operate in the shadow economy (Schneider and Williams, 2013).

Johnson, Kaufmann and Schneider (1997) also claim that countries having less regulations in their economic activities have a smaller shadow economy.

### 3. Public Services and Organizations

The higher the utility of the public services and organizations; the smaller the shadow economy. The correlation between public services and the impact of changes in tax rates is very crucial. The larger the informal economy; the higher the tax dodging so the lower the tax revenues collected by the government which can have a negative impact of the public services. Unfortunately the state can just go for increasing the tax rates on the registered formal firms to try to balance its shortage in tax revenues which provides higher incentives to prefer to operate in the shadow economy rather than the official one. There is a high percentage of falling into a

vicious circle with higher taxes increasing the size of the informal sector, which results in a fall in tax revenues and in the services produced by the state.

Johanson et al. (1998a, 1998b) present an empirical model concluding that smaller shadow economies are in countries that their governments have high tax revenues by imposing low taxes, few laws, legislations and governance. Countries with average rule of law also experience smaller informal sectors. Transition countries experienced a high size of estimated shadow economies due to their complicated regulatory frameworks and high extent of extortion.

The quality of public institutions contributes to shadow economy. The efficient implementation of tax regulations by the state also helps in reducing the tendency towards the shadow economy. Specifically the quality of institutions is related to corruption rates and how major officials are practicing hidden activities. (Schneider and Williams, 2013).

### 4. Tax Moral

Tax moral is indirectly affected by the efficiency of the public sector quality and the amount of public services. Feld and Frey (2007) argue that tax consent is derived from a psychological tax contract between the citizens that should pay taxes and the governments and their tax authorities. Taxpayers need to pay taxes genuinely if they get beneficial and profitable public services in return. In conclusion, tax authorities should treat citizens as partners in a tax contract and taxpayers will pay based on their responsibilities of the psychological tax contract (Schneider and Williams, 2013).

### 5. Corruption

There is no doubt that corruption is an important factor that affects the shadow economy. We may define corruption with Tanzi's (1998) words as the abuse of public power for private benefits. Based on previous literature estimates, there is a relationship between corruption and shadow economy, but the direction of causality is not really clear. The question of "whether the higher the rate of corruption results in a growth in shadow economy, or vice versa," is still an unanswered question. Empirical analysis showed a strongly and directly positive correlation between corruption rates and shadow economy. That is to say, the higher the corruption rates, the higher the expected size of the shadow economy. The most common activities that corruption is integrated in are as follows:

- Accusation of public and private bodies for public investment contracts;
- Ability of connecting propaganda for given goods and services;
- Land zoning for official decision makers;
- Controlling the arrangements for tax incentives;
- Controlling employing and empowerment in the public sector jobs;
- Regulations and licenses to employ in certain business.

Mauro (1995) found out that there is an indirect negative correlation between corruption rates and index on the investment rate or the growth in the GDP. A one unit decrease in the rate of corruption levels is estimated to increase the investment rate by five percent (Headen, 2001).

## 2.3 Shadow Economy and Labor Force

All activities in the shadow economy include shadow labor market supply and demand. The question is "why do some people prefer to work in the informal sector?" The main explanation is that in the formal economy the costs that

enterprises have to pay by hiring new person are excessively higher by the tax burden and social contributions on wages to control the economic activities. In many Organization for Economic Cooperation and Development (OCED) countries those costs are way higher than the after tax wages earned by workers in the shadow economy. Naturally this leads workers to choose to perform in underground economy.

Lemieux, Fortin and Fréchette (1994) provide a theoretical data on the labor supply in the choice shadow economy using microeconomic data from a survey done in Canada in Quebec City. The paper found out that the hours worked in the informal economy are more influenceable to variations in the after-tax wages in the formal sector, so this leads to a reallocation of labors from the formal to the informal economy. The empirical study reveals that "participation rates and hours worked in the underground sector also tend to be inversely related to the number of hours worked in the regular sector (Lemieux, Fortin and Fréchette 1994, p. 235). This shows an inverse relationship between the hours worked in the informal sector and both the high mobility between different sectors and the wage rate given in formal sector (Schneider, 2014).

Working in the shadow economy can be in different ways and hours. The hidden economy labor can be part time job working after regular formal working hours. The second types of workers are individuals who do not participate at all in the formal labor market. The third type is hiring of not allowed legally to work in the formal economy for example like illegal immigrants. It is not easy to find out reliable empirical analysis on the informal sector labor force due to the fact that we are unable to determine the real shadow economy value added as we are do not have the

enough information about how many hours an informal sector labor might be working (Schneider, 2014).

Labor force of Egypt is estimated to be 29,596,846 individuals, and the labor force participation rate of people aged between 15 and 65 is 52.9%. (WDI, 2015) Schneider (2011) studies the shadow economy labor force concerned with estimating the size and the development of the labor force supplying the underground economy. He explained that it is important to know more about the labor supply themselves in these hidden economies to be able to fight tax evasion. The interaction between the size of the underground economy and unemployment has been explained and analyzed. Kucera and Roncalto (2008) discuss the informal sector employment, and suggest two major causes of labor market issues:

- The complicated labor market regulations as a crucial reason for employment in the shadow economy;
- The "voluntary" informal employment.

## 2.4 The Impact of the Informal Sector on the Official Economy

The shadow economy's impact on the official economy is a very debatable issue. This section of the thesis discusses the main positive and negative impacts of the shadow economy.

First let us discuss the negative impacts of the shadow economy:

1. A continuous increase of the shadow economy results in a biased estimates for the official statistics by the official government of major macroeconomic indicators like official labor force, unemployment, income and consumption. (Schneider, 2012)

2. The problem of falling in a vicious cycle where when the size of the shadow economy increases, this means that the tax revenues fall as more people evade taxes. As a result for the government to offset this shortage in its revenues, it increases taxes more on firms who are working in the official economy and this gives them a higher incentive to shift towards the shadow economy. (Schneider and Williams, 2003)
3. Empirical studies have not clearly explained how growth in shadow economy affects the economic growth. However, it is generally accepted that the shadow economy depresses the growth of GDP. (Schneider and Enste, 2002)
4. Shadow economy has a negative impact on the quality and quantity of public services. The higher the transactions in the shadow economy, the lower the state revenues, the less the ability to provide the needed public goods and services at a reasonable satisfying rates. (Schneider and Enste, 2002)
5. It creates unfair market competition for firms performing in the official economy, where they have to pay taxation and regulatory costs while the enterprises operating in the informal sector can simply produce at lower costs. (Florea and Şchiop, 2008).
6. The correlation between the shadow economy and corruption, where they both affect each other in a bi-directional causality. As there is higher size of shadow economy, the higher there are the expected rates of corruption and vice versa. (Headen, 2001)
7. When shadow economy is related to illegal work, the larger the shadow economy the higher the waste of resources. Government spends more

money and waste time in order to limit those practices (Florea and Șchiop, 2008).

Additionally, there is a contradictory other perspective viewing the shadow economy positively stimulating the overall economic growth through different ways explained below:

1. The market in the shadow economy is more competitive and efficient than the official economy, so a growth in the size of the shadow economy will lead to the increasing the country's economic growth. (Florea and Șchiop 2008).
2. Some empirical studies show that minimum two-thirds drawn incomes in shadow economy are rapidly consumed in the formal economy. Schneider (1998) shows that over 66% of the earnings generated by the shadow economy are quickly spent in the formal sector.
3. The shadow economy helps in reducing the unemployment through establishing a hidden bound economy where it offers job opportunities for workers who are unskilled and cannot meet the legal and qualification procedures to produce in the formal economy.
4. According to studies by the Fraser Institute, the shadow economy represents a real democratic process. As citizens castigate and object their government policies through their economic decision on not to pay taxes and work in the informal economy. The study argues that efforts to try to control the size of the shadow economy are considered to be an indication of totalitarianism. (Florea and Șchiop, 2008).
5. The concept of liberal market, the main concern of which is to restrict government interventions and regulations on economic activities, is a main

cause for the existence of the shadow economy all over the world. The ideas of individualism, lack of state intervention, the freedom of the shadow economy practices gives a clear evaluation of the real efficiency of the shadow economy.

6. As the shadow economy replies fast to consumers' requests, the shadow economy determines the increase in the overall market innovation. As the formal sector takes more time to modify itself to the new market changes due to the complex bureaucratic regulations
7. The shadow economy increases the sates political stability as it provides different opportunities for citizens and foreigner that are economically marginalized without any government interventions.

For more information about how previous studies viewed the size and the development of the shadow economy throughout different periods and in different countries all over the world, see Schneider and Enste (2000), Matthew Headen (2001), Bajada and Schneider (2003) , Syrichas and Georgiou (2004), Schneider and Klinglmair (2004), Chaudhuri, Schneider and Chattopadhyay (2005), Schneider (2007), Schneider, Buehn and Montenegro (2010), Ceyhun Elginy and Oguz Oztunal (2012), Schneider and Raczkowski (2013), Schneider (2015), Schnider ( 2015), and reference therein.

# Chapter 3

# DATA AND METHODOLOGY

## 3.1 Introduction

This chapter of the thesis aims at explaining the methodology that we will use in our analysis of the shadow economy in Egypt.

## 3.2 Data

The thesis will use a time series over the period from 1979 till 2013. We have obtained the data used in this study from secondary sources namely, World Bank (WB), World Development Bank Indicators (WDI) and the Freedom House Data. Prior to empirical estimations, we applied Augmented Dickey Fuller (ADF) unit root stationary tests to determine the order of integration of the series to prevent spurious estimation. The model variables are the (i) GDP, (ii) the government expenditure as percentage of GDP, (iii) secondary school enrollment ratios, (iv) unemployment rate, (v) civil rights representing the quality of government regulations and institutions, (vi) the net direct tax payment on products as a percentage of GDP, (vii) lending interest rates and (viii) electricity consumption rates. Descriptive statistics of our data set are given in Table 2 below.

Table 2: Descriptive statistics for model variables

| Variable Name | Mean | Median | Standard Deviation | Jarque-Bera[1] |
|---|---|---|---|---|
| Unemployment (%) | 8.74 | 9 | 2.21 | 1.15 |
| Net tax (%) | 2.08 | 1.52 | 2.10 | 6.06 |
| Civil rights | 5.28 | 5.50 | 0.60 | 2.41 |
| Lending interest rates (%) | 14.53 | 13.79 | 2.44 | 3.37 |
| Electricity consumption (KWH) | 930.92 | 803.51 | 419.58 | 3.00 |
| GDP (%) | 3.26 | 2.91 | 1.47 | 2.84 |
| Government Expenditure (%) | 12.93 | 11.60 | 2.62 | 6.42 |
| Secondary enrollment (%) | 71.79 | 74.06 | 13.99 | 3.15 |

We have chosen our model variables entitled to those papers, Singh, Jain-Chandra and Mohommad (2012) and Schneider (2012).

In Table 3 below, we explain the expected signs of the relationship between the indicators used in the model and the shadow economy.

Table 3: Expected signs for the model

| *Variables* | *Expected Relation between the causes and indicators and shadow economy* |
|---|---|
| Unemployment | As unemployment increases, we expect the shadow economy to increase. (positive relationship) |
| Net tax | As net tax payment increases, we expect the shadow economy to increase. (positive relationship) |
| Civil rights | As civil rights increases, we expect the shadow economy to |

[1] Statistics to test the hypothesis that a sample is a normal random variable with unknown mean and distribution.

| | |
|---|---|
| | decrease. (negative relationship) |
| Lending interest rates | As interest rates increases, we expect the shadow economy to increase. (positive relationship) |
| Electricity consumption | As electricity consumption increases, we expect the shadow economy to decrease. (negative relation) |
| Indicators | |
| Government expenditure | As shadow economy increases, we expect the government expenditure to decrease. (negative) |
| Secondary enrolment | As shadow economy increases, we expect the secondary enrollment to decrease. (negative relationship) |

## 3.3 Model Specification and Tests

### The MIMIC Approach Analysis

As mentioned earlier, we employ the MIMIC approach to analyze the shadow economy of Egypt. The studies cited in the previous chapter use different methods to estimate informal economy. The main problem with those approaches is that they consider only one indicator or cause for the shadow economy. These approaches contain the currency demand approach and the physical output method. However, in reality the existence of the shadow economy is related to several indications. The MIMIC approach includes different causes as well as multiple effects for the shadow economy. The methodology makes use of the associations between the observable causes and the observable effects of an unobserved variable, in this case the informal economy, to estimate the unobserved factor itself (Loayza, 1996).

The MIMIC structural equation model was founded by Jöreskog and Goldberger in 1975. The model explains the correlation between the observable variables considered as the causes and indicators for the shadow economy and an unobservable variable, which is the size of the shadow economy. In order to do so, the MIMIC minimizes the difference between the sample covariance matrix and the covariance

matrix predicted by the model. The observable variables are the causes and the indicators of the latent variable. The MIMIC model is expressed by two equations as structural and measurement equations. Our explanation of the model below closely follows Buhn and Schnider (2008). The structural equation of the hypothesized MIMIC model is as follows.

$$ב_t = y' x_t + u_t \quad (1)$$

Where $x_t$ = ( $x_{1t}\, x_{2t}, \ldots, x_{qt}$) is a ( 1× q) vector of time series variables . Every time series$x_{it}$, i = 1... q is a plausible cause of the latent variable $ב_t$ .

$y_t$ = ( $y_{1t}\, y_{2t}, \ldots, y_{qt}$) and ( 1× q) vector of coefficients in the structural model explaining the causal correlation between the latent variable and its causes. The structural equation model partially explains the latent variable$ב_t$, and the error term $u_t$ corresponds to the unexplained component. The MIMIC model hypothesizes that the estimated variables are deviated from their means and that the error term is not correlated to the causes.

**E** ($ב_t$) = **E** ($x_t$ ) = **E** ($u_t$) = **0** also **E** ($x_t\, u_t'$ ) = **E** ($u_t\, x_t'$) = **0.** The variance of $u_t$ is abbreviated by ψ and **Φ** is the vector of (q × q) as a covariance matrix of the causes $x_t$ .

The second equation of the MIMIC model is the Measurement Equation, which shows the relationship between the indicators and the latent variable (shadow economy). The equation explains the latent unobservable variable in terms of observable indicators.

$$y_t = \lambda \, ב_t + \varepsilon_t \qquad (2)$$

Where $y_t^{'}$ = $(y_{1t}, y_{2t} \ldots\ldots, y_{pt})$ is as (1× q ) vector of independent time series variables $y_{jt}$, j=1…., P and $\varepsilon_t^{'}$ = $(\varepsilon_{1t}, \varepsilon_{2t} \ldots\ldots, \varepsilon_{pt})$ is (1× q ) vector of disturbances in which each $\varepsilon_{jt}$, j=1…., P is a white noise error term. The (p× p) covariance matric is shown as $Ϙ_\varepsilon$. The single $\lambda_j$ , j=1…., P is a (p× 1) vector of regression coefficients $\lambda$ , showing the length of the predicted variations of the respective indicator to a one unit change in the latent variable.

The causes and the indicators in the MIMIC model are observably measured and are deviated from their means so that **E** $(y_t)$ = **E** $(\varepsilon_t)$ = **0,** also by the assumption that error terms in the model are not correlated with the causes $x_t$ or with the latent variable $ב_t$ so **E** $(x_t \ \varepsilon_t^{'})$ = **E** $(\varepsilon_t \ x_t^{'})$ = **0** and **E** $(ב_t \ \varepsilon_t^{'})$ = **E** $(\varepsilon_t ב_t^{'})$ = 0.

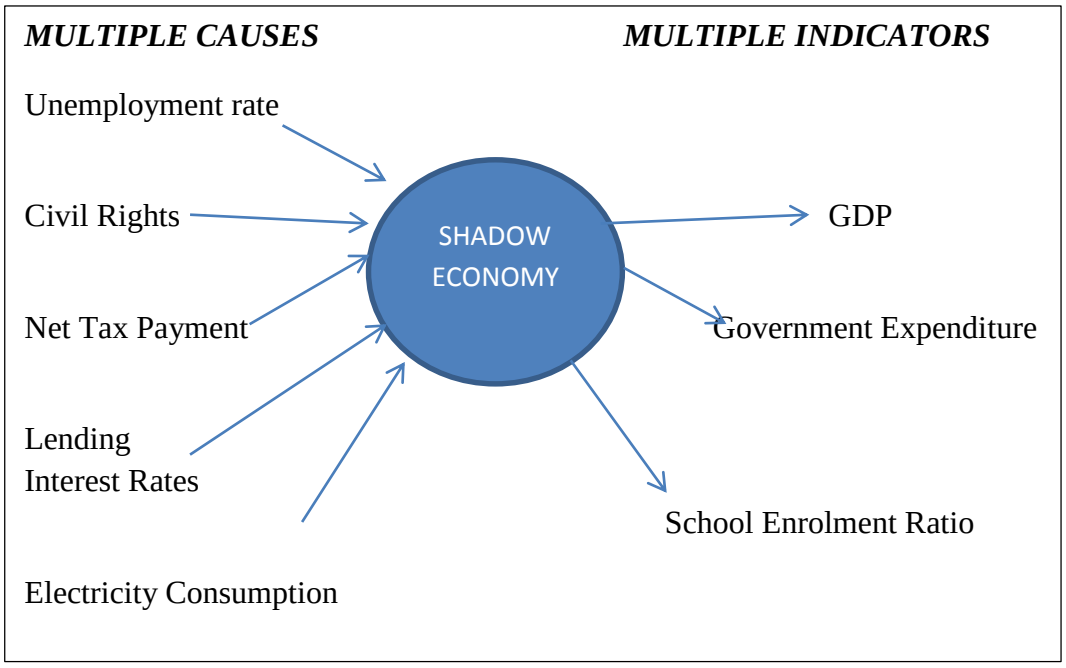


Figure 1: Hypothesized MIMIC Model

Schneider (2014) compares the different methods used to estimate the size of the informal sector and the advantages, strengths and disadvantages and weakness of each way of estimation. He concludes that there is no perfect way to estimate the size and development of the informal sector of the economy and that the MIMIC model is flexible and easy method to measure and capture the macro factors of the size of shadow economy.

Duc Hong and Thinh Hung Ly (2014) criticized the other approaches to calculate the size of the shadow economy like the monetary demand approach and the electricity consumption approach as it only reflects one variable or indicator, while most of the previous researches on this topic indicated and concluded that the shadow economy is affected by different variables and indicators not only one and eliminating the others.

## 3.4 Stationarity Tests and Goodness of Fit

In order to estimate the model, we first need to make sure that our data is stationary at level or not. Stationarity briefly means that the data has a constant mean and variance over time. Time series data that is non-stationary are most probably characterized by a trend. Trends can be either stochastic or deterministic. There are different ways to identify if the time series is stationary or not, as we discuss below:

I. **Plotting the Variables**: may plot the data in order to determine if there is a deterministic trend or not. For example, below is the plot of GDP used in the thesis.

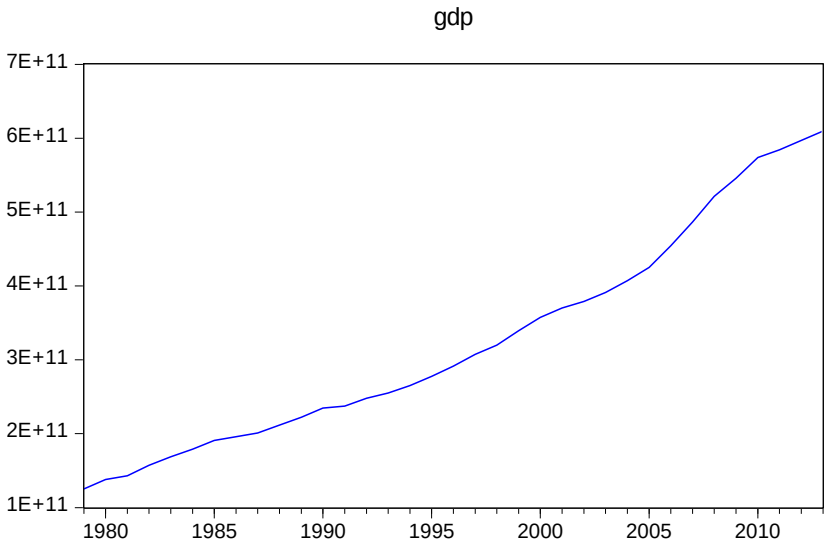


Figure 2: GDP graph

As shown in Figure 2, GDP has an upward trend. This means that GDP is not stationary at level.

II. **Unit root tests**: In addition to graphical test for stationarity, there are commonly used unit roots tests such as ADF, Phillip Perron (PP), Dickey Fuller–Generalized least Squares (DF-GLS), and Kwiatkowski–Phillips–Schmidt–Shin (KPSS). In the thesis we employ the ADF test.

Appendix A contains the unit root test results of our study where we show that all variables are non-stationary in level. According to our test results, we estimate variables either in first difference of log or first difference depending on the type of the variable.[2]

As explained in Jöreskog and Sörbom (1989), in structural equation models (SEMs), the parameters of a proposed model are estimated by minimizing the discrepancy

[2] See Appendix for details.

between the empirical covariance matrix, and a covariance matrix implied by the model. In order to measure the goodness of fit of an SEM, the minimum value of the discrepancy function (CMIN) is calculated. We present below the CMIN of our model in Table 4.

Table 4: Chi-Square CMIN

| Model | NPAR | CMIN | DF | P | CMIN/DF |
|---|---|---|---|---|---|
| Default model | 34 | 9.038 | 10 | .529 | .904 |
| Saturated model | 44 | .000 | 0 | | |
| Independence model | 8 | 31.531 | 36 | .681 | .876 |

Discrepancy function (CMIN) p-value is 0.529 which indicates that the model fits the data well. A p-value that is less than 0.5 indicates a poorly fitted model.

Another measurement of the goodness of fit of SEMs is called Root Mean Square Error of Approximation (RMSEA). We present the RMSEA of our MIMIC model in Table 5 below.

Table 5: Root Mean Square Error of Approximation (RMSEA)

| Model | RMSEA | LO 90 | HI 90 | PCLOSE |
|---|---|---|---|---|
| Default model | .000 | .000 | .173 | .597 |
| Independence model | .000 | .000 | .100 | .788 |

RMSEA value in the estimated MIMIC model is equal to 0.000. The closer the RMSEA to zero the better the model fits the data. We conclude that the model fits the data very well.

To our knowledge, it is more important for the MIMIC approach to have high degree of goodness of fit rather than the statistically significance of each variable in the model. As we present in the next chapter, we may have some statistically significant variables, but what matters is the goodness of fit of the model which is measured by RMSEA. That is why we have not reported the standard errors of the variables.

# Chapter 4

# EMPIRICAL RESULTS

In this chapter we fit the MIMIC into a SME. We first define the names of the variables as shown in Table 6 below.

Table 6: The Model Variables

| **Multiple causes** | **Names** |
|---|---|
| DUNEM | First difference of unemployment rates as a percentage of labor force |
| DLNETTAX | First difference of log of net tax payment on products |
| DCIVILRIGHTS | First difference of civil rights representing the quality of government regulations and institution |
| DLENDINGIR | First difference of lending interest rates |
| DLEC | First difference of log of electricity consumption rates. |
| **Multiple Causes** | |
| DLGDP | First difference of log of gross domestic product |
| DGDPEXP | First difference of government expenditure as a percentage of GDP |
| DSECENROLL | First difference of secondary enrollment ratios in schools. |

To be able to estimate the MIMIC model we used structural equation modeling, in which we have the latent (unobservable) variable that we want to estimate. As shown in Figure 3 we build the latent variable that has multiple observable causes and indicators.

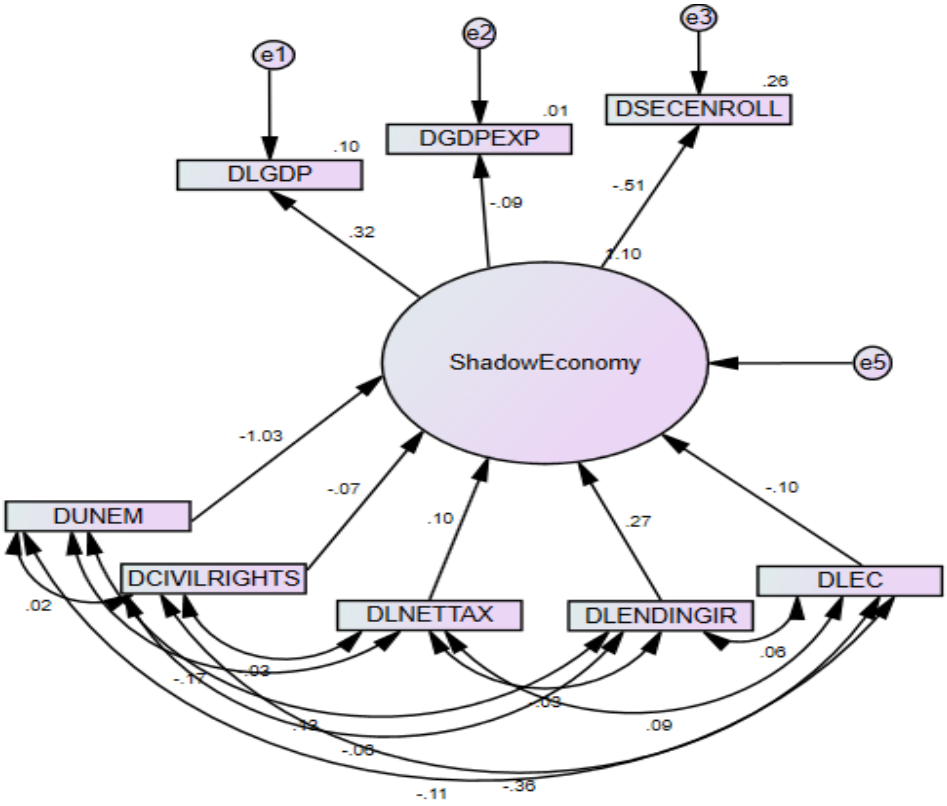


Figure 3: The estimated MIMIC model

As shown in Figure 3 MIMIC path is estimated. The coefficients that appear on each arrow explains by how much this variable that the arrow comes from is able to explain changes on the other variable that the arrow goes in, holding other variables constant. Those coefficients shown in Figure 3 are path affects not regression coefficients. The MIMIC regression coefficients shown in the next section is interpreted the same way we interpret an ordinary least square multiple regression model.

Our MIMIC model shown in Table 7 below suggests that the main forces for the shadow economy in Egypt are the unemployment rate, the quality of government regulations and the net tax payments. Our model also shows that the main indicator is the secondary enrollment ratio. We find out that among three indicators (GDP,

government expenditure, and secondary enrollment ratio), the shadow economy mostly affects the secondary enrollment ratio. Our model suggests that as the size of shadow economy in Egypt increases, the secondary enrollment ratio is the mostly (and negatively) affected indicator.

Table 7: Estimation Results of Our MIMIC Model

| | | | Estimate | S.E. | C.R. | P |
|---|---|---|---|---|---|---|
| ShadowEconomy | <--- | DLENDINGIR | .002 | .002 | .973 | .331 |
| ShadowEconomy | <--- | DLEC | -.017 | .047 | -.368 | .713 |
| ShadowEconomy | <--- | DUNEM | -.007 | .004 | -2.022 | .043 |
| ShadowEconomy | <--- | DCIVILRIGHTS | -.002 | .006 | -.282 | .778 |
| 0ShadowEconomy | <--- | DLNETTAX | .003 | .007 | .397 | .691 |
| DLGDP | <--- | ShadowEconomy | 1.000 | | | |
| DGDPEXP | <--- | ShadowEconomy | -13.760 | 24.871 | -.553 | .580 |
| DSECENROLL | <--- | ShadowEconomy | -269.513 | 152.311 | -1.769 | .077 |

Let us compare the empirical results to the expected signs we discussed before we estimated the model. Although we were expecting a positive relationship between the unemployment rate and the shadow economy, we found out that as unemployment increases by one unit, shadow economy falls by 0.007. Florea and Şchiop (2008) found that shadow economy helps in reducing the unemployment rate through establishing a hidden bound economy where it offers job opportunities for workers who are unskilled and cannot meet the legal and qualification procedures to produce in underground economy and that this is applicable on the Egyptian case.

In line with our expectations, we have found that as net tax payment and interest rates increase, the shadow economy increases as well. The impacts of civil rights, which is the quality of governmental institutions, and electricity consumption are also in line with our prior expectations that higher the indicators, lower the shadow economy. Finally as the shadow economy increases, we expected the government

expenditure and secondary enrolment ratios to decrease, which is the conclusion we obtained from our MIMIC model.

Table 8 below shows the direct and the indirect effects of the model variables. We can see that as unemployment increases by 1 standard deviation, secondary enrolment ratio increases by 1.951 and GDP falls by 0.007.

Table 8: Total Effects

| | DUNEM | DCIVILRIGHTS | DLEC | DLNETTAX | DLENDINGIR | Shadow Economy |
|---|---|---|---|---|---|---|
| Shadow Economy | -.007 | -.002 | -.017 | .003 | .002 | .000 |
| DSECENROLL | 1.951 | .422 | 4.685 | -.696 | -.544 | -269.513 |
| DGDPEXP | .100 | .022 | .239 | -.036 | -.028 | -13.760 |
| DLGDP | -.007 | -.002 | -.017 | .003 | .002 | 1.000 |

As civil rights increases by 1 standard deviation, shadow economy falls by 0.002, secondary enrolment increases by 0.422 and government expenditure increases by 0.022.

When electricity consumption increases by 1 standard deviation shadow economy falls by 0.017, secondary enrolment ratios increases by 4.685 and government expenditure increases by 0.239.

As net tax payment increases by one standard deviation shadow economy increases by 0.003, secondary enrolment falls by 0.696 and government expenditure falls by 0.036.

When lending interest rates increases by one standard deviation shadow economy increases by 0.002, secondary enrolment falls by 0.544 and government expenditure falls by 0.028.

Finally as shadow economy increases by 1 standard deviation secondary enrolment ratios falls by 269.513 and government expenditure falls by 13.76.

# Chapter 5

# CONCLUSION AND POLICY RECOMMENDATION

## 5.1 Conclusions

In this thesis we have investigated the shadow economy in Egypt by using the MIMIC approach. We have structures a SEM where the Causes are measured by unemployment, civil rights net tax, lending interest rates, electricity consumption and the Indicators are measured by GDP, government expenditure and secondary enrollment. The main finding of the study is as that the better and the higher the quality of government regulation index the lower the size of the shadow. This implies that the government should work more on improving its quantity and quality of its regulations and institutions.

Our MIMIC model suggests that there is a positive relationship between the tax burden and the tendency for Egyptian people to work in the informal economy. As we explained earlier, the main reason behind this finding is to avoid tax payments. Regarding the impact of the lending interest rates and inflation rate on the shadow economy, we have obtained the same conclusion that the higher the rates the higher the size of the informal economy. As the cost of borrowing increases for investors or entrepreneurs, this leads to higher input costs and higher output prices, creating intention towards the informal market rather than the formal market. Similarly, we have found that as electricity consumption increases, the size of the shadow economy decreases as individuals choose to apply for illegal ways.

As government spends more over the official economy this leads to a decrease in the shadow economy, because government tend not to spend that much over public utilities but rather be corrupted and use those money to serve their own interests. As the shadow economy increases by one unit, the official and transparent government expenditure increases falls by 13.760

Finally as estimates as the shadow economy increases by one unit the secondary enrolment ratios falls by 269.513. Those results imply that as previous literature concluded that the shadow economy is characterized by larger segment of child labor.

## 5.2 Recommendations

Here we present our policy recommendations that the Government of Egypt can implement to try to formalize the informal economy in Egypt based on our results.

1. The government should spend more on education sector in order to encourage people to continue their secondary education and not to escape schools. If the government spends more on educational system reform that will help in producing well educated generations that will increase the official economy and reduce the shadow economy, which provides job opportunities mainly to unskilled illegal workers.

2. Based on our results we found out that as civil rights, which is a proxy for the institutional quality and regulations, increases, shadow economy falls and government expenditure increases. We recommend that the government should spend more on the institutional quality and on regulations. The institutional and regulatory framework stands as a huge obstacle for enterprises. The parliament needs to measure and analyze whether the current laws, regulations and institutions are well constructed in terms of their impact on the enterprises and labor costs. The government needs to ensure that the current legislations are cost effective, maintain needed business information that enterprises acquiesce with them, and provide security and protections.
3. We found that as net tax payment increases, shadow economy increases. This implies that the government should work on reducing that tax burden over investors to discourage them to join shadow economy. This way the government would have enough tax revenues to spend on other important sectors and reduce its debts and deficit.
4. Finally as interest rates increases we found that shadow economy increases and government expenditure falls. We recommend that the government should concentrate more on its monetary policy to try to manage and moderate the domestic lending interest rates. We believe that this will encourage investors to invest more, which indirectly increase government's collected tax revenues.

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# APPENDIX

## Appendix A: ADF Unit Root Test Results

Table A1: Unemployment Ratio as a percent of labor force unit root at level

Null Hypothesis: UNEM has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

| . | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.011669 | 0.7379 |
| Test critical values: | 1% level | -3.639407 | |
| | 5% level | -2.951125 | |
| | 10% level | -2.614300 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A1 we tested for stationarity of the causal variable unemployment as a percentage of labor force. The null hypothesis is that unemployment has a unit root, with the t statistic of -1.011669 we fail to reject the null, so unemployment is non-stationary at level so we have to use unemployment at first difference.

Table A2: Unemployment Ratio as a percentage of labor force unit root at level

Null Hypothesis: D(UNEM) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -5.209002 | 0.0002 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A2 we tested for the first difference of the causal variable unemployment as a percentage of labor force. The null hypothesis is that the first difference of unemployment has a unit root, with the t statistic of -.5.209002 we can

reject the null, so unemployment is stationary at first difference at 1% level of significance.

Table A3: Civil rights unit root at level
Null Hypothesis: CIVILRIGHTS has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.501649 | 0.5207 |
| Test critical values: | 1% level | -3.639407 | |
| | 5% level | -2.951125 | |
| | 10% level | -2.614300 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A3 we tested for stationarity of the casual variable civil rights representing the quality of government regulations and institution. The null hypothesis is that civil rights has a unit root, with the t statistic of -1.501649 we fail to reject the null, so civil rights is non-stationary at level so we have to use Civil rights at first difference.

Table A4: Civil rights unit root first difference

Null Hypothesis: D(CIVILRIGHTS) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -4.925130 | 0.0003 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A4 I tested for the first difference of the causal variable civil rights representing the quality of government regulations and institution. The null

hypothesis is that the first difference of civil rights has a unit root, with the t statistic of -4.925130 we can reject the null, so civil rights is stationary at first difference at 1% level of significance.

Table A5: Log Net tax payment on products unit root at level

Null Hypothesis: LNETTAX has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.290648 | 0.6221 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A5 we tested for stationarity of the casual variable log of net tax payment on products. The null hypothesis is that log net tax payment has a unit root, with the t statistic of -1.290648 we fail to reject the null, so net tax is non-stationary at level so we have to use net tax at first difference.

Table A6: Log Net tax payment on products unit root first difference

Null Hypothesis: D(LNETTAX) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -8.916675 | 0.0000 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A6 we tested for the first difference of the causal variable log of net tax payment on products. The null hypothesis is that the first difference of log of

net tax payment has a unit root, with the t statistic of -8.916675 we can reject the null, so log of net tax is stationary at first difference at 1% level of significance.

Table A7: Lending interest rates unit root al level

Null Hypothesis: LENDINGIR has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.559469 | 0.4915 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A7 we tested for stationarity of the casual variable lending interest rates The null hypothesis is that interest rates has a unit root, with the t statistic of -1.559469 we fail to reject the null, so lending interest rates is non-stationary at level so we have to use Civil rights at first difference.

Table A8: Lending interest rates unit root at First difference
Null Hypothesis: D(LENDINGIR) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.450418 | 0.0161 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A8 we tested for the first difference of the causal variable interest rate. The null hypothesis is that the first difference of interest rate has a unit root,

with the t statistic of -3.450418 we can reject the null, so lending interest rates is stationary at first difference at 5% level of significance.

Table A9: Log Electricity Consumption Unit root at level
Null Hypothesis: LEC has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.850714 | 0.3506 |
| Test critical values: | 1% level | -3.639407 | |
| | 5% level | -2.951125 | |
| | 10% level | -2.614300 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A9 we tested for stationarity of the casual variable log of electricity consumption rates The null hypothesis is that log of electricity consumption has a unit root, with the t statistic of -1.850714 we fail to reject the null, so log of electricity consumption is non-stationary at level so we have to use log of electricity consumption at first difference.

Table A10: Log Electricity Consumption unit root first difference

Null Hypothesis: D(LEC) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -5.692814 | 0.0000 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table 10 we tested for the first difference of the causal variable log of electricity consumption. The null hypothesis is that the first difference of log of electricity consumption has a unit root, with the t statistic of -5.692814 we can reject the null, so log of electricity consumption is stationary at first difference at 1% level of significance.

Table A11: Log GDP unit root at level

Null Hypothesis: LGDP has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.143557 | 0.6864 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A11 we tested for stationarity of the indicator variable log of gross domestic product. The null hypothesis is that log gross domestic product has a unit root, with the t statistic of -1.143557 we fail to reject the null, so log of gross domestic product is non-stationary at level so we have to use log of gross domestic product at first difference.

Table A12: Log GDP unit root first difference
Null Hypothesis: D(LGDP) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -3.155512 | 0.0327 |
| Test critical values: | 1% level | -3.661661 | |
| | 5% level | -2.960411 | |
| | 10% level | -2.619160 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A12 we tested for the first difference of the indicator variable log of gross domestic product. The null hypothesis is that the first difference of log of gross domestic product has a unit root, with the t statistic of -3.155512 we can reject the null, so log of gross domestic product is stationary at first difference at 5% level of significance.

Table A13: Government expenditure as a percent of GDP unit root at level

Null Hypothesis: GDPEXP has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.625319 | 0.4591 |
| Test critical values: | 1% level | -3.639407 | |
| | 5% level | -2.951125 | |
| | 10% level | -2.614300 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A13 we tested for stationarity of the indicator variable of government expenditure. The null hypothesis is that government expenditure has a unit root, with the t statistic of -1.625319 we fail to reject the null, so government expenditure is non-stationary at level so we have to use government expenditure at first difference.

Table A14: Government expenditure as a percent of GDP unit root first difference

Null Hypothesis: D(GDPEXP) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic based on SIC, MAXLAG=8)

| | t-Statistic | Prob.* |
|---|---|---|
| Augmented Dickey-Fuller test statistic | -3.993400 | 0.0043 |

| | | |
|---|---|---|
| Test critical values: | 1% level | -3.653730 |
| | 5% level | -2.957110 |
| | 10% level | -2.617434 |

*MacKinnon (1996) one-sided p-values.

As shown in Table A14 we tested for the first difference of the indicator variable government expenditure. The null hypothesis is that the first difference of government expenditure has a unit root, with the t statistic of -3.993400 we can reject the null, so government expenditure is stationary at first difference at 1% level of significance.

Table A15: Secondary enrollment ratio as a percent of population unit root at level

Null Hypothesis: SECENROLL has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -1.502418 | 0.5203 |
| Test critical values: | 1% level | -3.639407 | |
| | 5% level | -2.951125 | |
| | 10% level | -2.614300 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A15 we tested for stationarity of the indicator variable secondary enrollment ratio. The null hypothesis is that secondary enrollment has a unit root, with the t statistic of -1.502418 we fail to reject the null, so secondary enrollment ratio is non-stationary at level so we have to use secondary enrollment ratio at first difference.

Table A16: Secondary enrollment ratio as a percent of population unit root first difference

Null Hypothesis: D(SECENROLL) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=8)

| | | t-Statistic | Prob.* |
|---|---|---|---|
| Augmented Dickey-Fuller test statistic | | -4.730235 | 0.0006 |
| Test critical values: | 1% level | -3.646342 | |
| | 5% level | -2.954021 | |
| | 10% level | -2.615817 | |

*MacKinnon (1996) one-sided p-values.

As shown in Table A16 we tested for the first difference of the indicator variable secondary enrollment ratio. The null hypothesis is that the first difference of secondary enrollment ratio has a unit root, with the t statistic of -4.730235 we can reject the null, so secondary enrolment ratio is stationary at first difference at 1% level of significance.