# Interactions between Financial Sector Development and Underground Economic Activity: Empirical Evidence from European Countries

**Hatice İmamoğlu**

Submitted to the
Institute of Graduate Studies and Research
in partial fulfilment of the requirements for the degree of

Doctor of Philosophy
in
Finance

Eastern Mediterranean University
February 2018
Gazimağusa, North Cyprus

Approval of the Institute of Graduate Studies and Research

Assoc. Prof. Dr. Ali Hakan Ulusoy
Acting Director

I certify that this thesis satisfies the requirements as a thesis for the degree of Doctor of Philosophy in Finance.

Assoc. Prof. Dr. Nesrin Özataç
Chair, Department of Banking and Finance

We certify that we have read this thesis and that in our opinion it is fully adequate in scope and quality as a thesis for the degree of Doctor of Philosophy in Finance.

Prof. Dr. Cem Eşref Payaslıoğlu
Co-Supervisor

Prof. Dr. Salih Katırcıoğlu
Supervisor

Examining Committee

1. Prof. Dr. Eralp Bektaş
2. Prof. Dr. Murat Donduran
3. Prof. Dr. Sami Fethi
4. Prof. Dr. Fazıl Gökgöz
5. Prof. Dr. Salih Katırcıoğlu
6. Assoc. Prof. Dr. Nesrin Özataç
7. Assoc. Prof. Dr. Gülcay Tuna Payaslıoğlu

# ABSTRACT

This thesis investigates the effects of financial sector development on the size of the underground economy in the selected twenty European Union (EU) countries. In the first stage, the size of the underground economy has been estimated by using the MIMIC (multiple indicators and multiple causes) model approach. In the second stage, panel data analysis has been conducted using the period from 1994 to 2014 in order to examine the effect of the financial sector development on the size of the underground economy. Trade openness and interest rates have been selected as control variables. Results suggest that the financial sector development and trade openness have significant roles in the level of the underground economic activities. The main findings of this thesis suggest that the financial development along with trade openness has reducing effects on the size of the underground economy as parallel to the theory while interest rate increases the size.

**Keywords:** Financial Development; Trade; Underground Economy; MIMIC Model; Panel Data; European Union

# ÖZ

Bu tez, seçilmiş yirmi Avrupa Birliği Ülkesinde olan finansal sektör gelişiminin kayıtdışı ekonominin büyüklüğü üzerindeki etkileri araştırmaktadır. İlk aşamada, kayıtdışı ekonominin büyüklüğü, MIMIC (Çoklu Neden Çoklu Gösterge) model yaklaşımı kullanılarak hesaplanmıştır. İkinci aşamada, panel veri analizi kullanılarak finansal sektör gelişiminin yeraltı ekonomisinin büyüklüğü üzerindeki etkisini incelemek için 1994 yılından 2004 yılına kadar olan süreci göz önünde bulundurarak yürütülecektir. Ticaret açıklığı ve faiz oranı, kontrol değişkenleri olarak seçilmiştir. Sonuçlar, finansal sektör gelişiminin ve ticaret açıklığının kayıtdışı ekonomi faaliyetlerinin seviyesinde önemli bir role sahip olduğunu göstermektedir. Bu tezin temel bulguları, finansal gelişmenin yanısıra ticaret açıklığının, kayıtdışı ekonominin büyüklüğü üzerinde teorilere paralel olarak azaltıcı etkileri olduğunu gösterirken, faiz oranlarındaki artışın kayıtdışı ekonominin büyüklüğünü artırmasıdır.

**Anahtar Kelimeler:** Mali Sektör Gelişimi, Ticaret Açıklığı, Kayıtdışı Ekonomi, MIMIC Model Yaklaşımı,: Panel Veri Analizi, Avrupa Birliği Ülkeleri

# DEDICATION

**To my mom**

**and dad**

# ACKNOWLEDGMENT

Foremost, I would like to express my sıncere gratitude to my supervisor Prof. Dr. Salih Katırcıoğlu, Prof. Dr. Cem Payaslıoğlu, and Assoc. Prof. Dr. Gülcay Tuna Payaslıoğlu for their continuous guidance and support in the preparation of this thesis. Without their valuable supervision, it would have been impossible to accomplish my target on time.

I also would like to thank to my mom for her endless support and encouragement in my studies. Without her endless support, it would not be possible to overcome the most difficult times during my studies.

I would like to dedicate this thesis to my family for their valuable support throughout my life. I owe quite a lot to Nejla İmamoğlu, Necdet İmamoğlu, Melek İmamoğlu, and Modammed N. M. Almadhoun. Finall I would like to thank Prof. Dr. Selçuk Palaoğlu.

# TABLE OF CONTENTS

# LIST OF TABLES

# LIST OF FIGURES

# Chapter 1

# INTRODUCTION

## 1.1 Brief Overview

Underground economy is one of the important issues that received considerable attention in the literature. Even though many countries have taken many actions to struggle with unofficial activities, increasing the size of the underground activity is an inevitable fact. Schneider and Enste (2002) emphasized that the size of the underground economy in developing countries is about 35-44% of GDP, in transition countries 21-30% of GDP, and in OECD counties is 14-16% of GDP. More recently Schneider (2007) emphasized the size of the underground economy on average ranging from 28 to 43% of GDP in developing countries, 38 to 40% of GDP in transition countries, and 14 to 17% of GDP in developed countries.

There is a lack of consensus in definitions of the term underground economy[1] (Öğünç and Yılmaz, 2000). The underground economy is not merely the sum of all illegal activities but also includes legal economic activities that have gone 'unreported' to the government. The underground economy includes illegal activities, such as drug dealing, as well as economic transactions that are not measured by the government statistics, such as unreported revenues. There are too many distinct definitions for the underground economy. An exhaustive definition

[1] It also goes by various names, such as the black market, unofficial market, shadow economy, second economy, and parallel economy (Öğünç and Yılmaz 2000).

made by Smith (1994) as the underground economy is the total sum of the market basket of products and services, whether legal or illegal, those have not been added to the yearly registered gross domestic product (GDP) of a specific country. Underground economy might exert both positive and negative effects on the economies. Schneider and Enste (2000) argue that a two- third of income generated from underground economy is spent on the official economy. On the other hand, Capasso and Jappelli (2013) point out that a large portion of the underground economy causes distort in investment and omit development. Another negative effect of underground economy is that it creates unreliable macroeconomic aggregates such as unemployment rate or annual gross domestic product levels, which are in turn yields to ineffective economic policy making process and decisions. Informal firms set a competitive price advantage over the official ones, since they are avoiding tax obligation and other legal obligations as well. Avoiding social security contribution deteriorates financial positioning of social security institutions and avoiding tax obligations deteriorates financial positioning of government budget. The factors as causes of underground economy have been studied by many scholars (Schneider 2006, 2009; Öğünç and Yilmaz, 2000; Muarin et al., 2006; Dabla-Norris et al., 2008). Yet, the main reasons to go underground can be summarized as burden of taxation and burden of regulation, and labor costs.

On the other hand, the interaction between the financial development and the size of the underground economy might be an interesting research field; the links of the financial market development, banking sector development, availability of credit and its cost along with the size of the underground economy received a rare attention till the date. The expected correlation between financial sector development and the size of the underground economy is expected to be negative. For example, Capasso and

Jappelli (2013) use Italian microeconomic data to investigate how the choice of operating underground interacts with financial development by constructing a micro-based index of the underground economy. Their argument was that low-return technologies do not require external funding while high-return technologies do. The cost of credit can be reduced by pledging more collaterals (see Jappelli et al., 2005), but it has own costs as disclosing revenues and assets to financial intermediaries and tax authorities. Choosing between two technologies is complete trade off reduce credit cost by supplying more collateral against benefiting tax evasion and the other benefits of operating in low-return technologies. In addition to burden of taxation, burden of regulation, and social security contributions, also availability of credit and its costs are some of the major other factors that affect the size of the underground economy. Simply, the selection between those technologies is a choice between unofficial and official economic activities. Capasso and Jappelli (2013) regress the level of work irregularity on financial development and concluded that financial development reduces the cost of credit and intensive to go underground while revealing more profitable revenues from high-return technologies. Blackburn et al. (2012) point out the negative correlation between tax evasion i.e. underground economy and financial sector development. La Porta and Shleifer (2008) found the negative correlation between private credit availability and individual's subjective assessment to their access to credit. Dabla-Norris et al. (2008) found that the firms that observes financing as a major obstacle, has 16 percent of probability that half of their revenues are unrecorded, while firms that views financing as a minor obstacle has way lower probability of having half of their revenues unrecorded. Bose et al. (2012) evaluate the effect of both depth and efficiency in banking system on the underground economy, and found that development in the banking sector is associated with smaller underground economic activity. Berdiev and Saunoris (2016) investigate the nexus between economic growth, financial development and shadow economy and found the evidence that financial development shrinks shadow economy and shocks to the shadow economy prevent further development in the financial sector.

The interaction between trade openness and the size of the underground economy is another interesting research area despite that it did not receive much attention as well. The correlation between trade openness and the size of the underground economy is ambiguous. The foreign competition causes sectors not to comply with labor market legislation and do not provide workers benefits i.e. social security contributions. The usual argument is that trade openness leads to raise in informality, as trade reforms leads official establishments to increased foreign competition by reducing labor cost with cutting employee benefits, replacing temporary and part-time labor force with permanent labor force, or subordinating with unofficial establishments. It's worth to mention that, the usual argument is often claimed in developing countries is that foreign competition will lead to rise in underground economy. Goldberg and Pavcnik (2003) studied the impact of trade liberalization on informal labour force in the case of Brazil and Colombia, they found a positive correlation between trade policy and illegality in Colombia, but they did not find such evidence in Brazil. Ghosh and Paul (2008) provided empirical evidence of growing underground economic activity with trade openness, that is, a positive correlation between trade openness and the size of the underground economy. Fugazza and Fiess (2010) found the conventional view stating that trade liberalization would cause a rise in informality in macro-founded data set. In the other hand, the interaction between trade openness and the underground economy may have either a positive correlation or a negative correlation (see Elgin and Oyvat, 2013). A positive correlation is expected when openness facilitates the external subordination of the informal sector to the formal sector, while a negative correlation is likely to occur if openness in international trade eases the government's ability to examine informal production.

This thesis will be consented on the links that receive very little attention in both theory and in empirics. I will emphasize the direct effect of financial development, trade openness and as well as the indirect effect of interest rate on the size of the underground economy. Cornell (1983) states standard Keynesian theory predicts that actual monetary expansion leads to lower interest rates through liquidity effect. There is the inverse relationship between interest rate and money supply. Indirect effect of interest rate in respect of any fall associated with increase in money supply so does the rise of the underground economic activity. In the light of most of the underground activity transactions made in cash, increase in money in circulation may increase the size of the underground activity. I attempt to put forward some light on the case of interaction between the financial development, trade openness, interest rate and the size of the underground economy in the second stage of this thesis. Even though there are few studies that study the implication of financial or banking sector development for the size of the underground economy, among rare studies, Capasso and Japalli (2013) who studied the relationship between financial development and the size of the underground economy by using cross-section analysis in the case of Italy.

Bose et al. (2012), on the other hand, studied the relationship between banking sector development and the size of the underground economy by employing the DYMIMIC (dynamic multiple indicators multiple causes approach) and World Economic Reform (WEF) measure of the underground economy regress on two banking depth indicators which are liquid liabilities and total domestic credit provided by depository banks. Bose et al. (2012) used liquid liabilities and total domestic credit provided by depository banks as the indicators of banking sector development in measuring the size of the shadow economy. A low level of financial development is associated with luck of loanable funds, lack of competition, limited access to information by lenders, or high level of financial repression. In that circumstance, individuals or institutions will have less intensive to work in official economy due to high borrowing costs and lower probability to obtain credit. Berdiev and Saunoris (2016) investigated the relationship between financial development, economic growth and the size of the underground economy without considering the effect of trade openness and using three different measures to capture the level of financial development which are money and quasi money, domestic credit provided by financial corporations to the private sector, and domestic credit from the financial sector including gross credit to various sectors and net credit to the central government. It is likely that development in well-functioning financial sector will lead to reduce intention to operate informally by supplying ease access and cheaper financing options. To the best of our knowledge, this research is the first of its kind to establish the link between the financial development, trade openness, on the size of the underground economy; and it is also the first in terms of using interest rate variable to examine the indirect effect on the size of the underground economy separately. In the meantime, this study will use its own estimations as a proxy of the underground economy and own financial sector development index as well.

The selection of the European Union countries in this study is interesting for such topic area due to several reasons. The European Union has initiated “The Europe 2020 strategy”, which is at the agenda for growth and development in the European Union countries. This strategy emphasizes sustainable development, competitiveness, productivity in the economic sectors of the member states. This strategy also provides roadmap for eliminating weaknesses in the sectors of member states (http://ec.europa.edu, 2017). On the other hand, Tudose and Clipa (2016) point out that the shadow economies might be obstacle for the fulfilment of the cohesion and growth objectives of the Europe 2020 strategy. Therefore, it would be quite interesting to observe how ‘does financial development successfully attempt to reduce the size of the underground economy’ in order to meet The Europe 2020 strategy. Additionally, this research is the first of its kind to investigate the spillover effect of financial development on the size of the underground economy.

## 1.2 Data and Methodology in Brief

This thesis will provide theoretical and empirical study of the relationship between financial sector development, trade openness, and the interest rate on the size of the underground economy. In the first stage, although there is considerable number of studies that estimate the size of underground economy, I will measure it by employing MIMIC i.e. employ multiple indicators multiple causes model approach for European Union countries. In the second stage, the impact of financial development on the size of the underground economy through the channels of trade openness and interest rate will be investigated for the time range of 1994 to 2014 by using panel data regression analyses.

## 1.3 Structure of the Study

This study proceeds as follows: Chapter 2 describes the literature review; Chapter 3 describes financial sector and underground economy; Chapter 4 describes the data and methodology on the construction of financial development index and evaluation of the size of the underground economy; Chapter 5 describes theoretical framework; Chapter 6 describes the data and methodology; Chapter 7 presents the empirical results and discussions; and also includes application on financial services spillover effects on informal economic activity: evidence from a panel of 20 European countries and finally, Chapter 8 concludes and discusses policy implications.

# Chapter 2

# LITERATURE REVIEW

## 2.1 Underground Economy and the Financial Sector Development

The financial sector is one of the foundations that are likely to influence the relative cost and benefits of an operating underground economy, which, in turn impacts the size of the underground economy (see, Berdiev and Saunoris, 2016; Capasso and Jappelli, 2013; Blackburn et al., 2012; Bose et al., 2012; Dabla-Norris et al., 2008; Straub, 2005). On the other hand, the authors also argue that the financial system is one specific form of institutions that influence the relative cost and benefits of participating underground sector (see Capasso and Jappelli, 2013; Blackburn et al., 2012; Bose et al., 2012; Dabla-Norris et al., 2008; Straub, 2005). Capasso and Jappelli (2013) claims that the financial market enhances the efficient intermediaries entering the markets, reduces credit costs, and increases the opportunity cost of continuing to operate underground. They assert that there is adverse correlation between the financial market development and underground economy. In their study, a technical model was proposed between agents that choose low-return technology that does not require a plan versus agents that choose high-return technology, which requires external funding. High-return technology agents need to pledge more collateral in the case of external funding and to reduce its cost of credits. As pointed out by Jappelli et al. (2005), pledging more collateral will reduce the cost of credits. Moreover, pledging collateral will require the firm to divulge the income and assets to both financial intermediaries and tax officials. A choice must be made between hiding income and assets with low-return technology or pledging collateral to reduce cost of credit with high-return technology. This choice distinguishes between the formal and informal economy. Financial development decreases financial cost of credit, thereby increases the informal operating costs. Capasso and Jappelli (2013) provided empirical evidence to show that tax evasion and the size of the underground economy can be reduced through financial development.

The opportunity cost of operating the underground economy is increasing due to the higher cost of credit in the informal system. Financial development lessens the cost of credit and boosts the opportunity cost of informality, as shown by some studies in the literature. Straub (2005) built a model in which firms choose between the official and unofficial economies. Firms that choose the formal economy have to be registered, which exposes them to high entry costs. In addition, this requires firms to declare their certifiable incomes and assets, which gives them access to credit markets, as well as the advantages from key public goods and the enforcement of property rights and contracts. It also lowers the defaulting cost and financial costs. Antunes and Cavalcanti (2007) investigated the formal sector versus the informal sector; engagement in the formal sector exposes the company to higher entry costs, regulations and tax obligations, with the trade-offs of better outside financing against the higher financial cost of the informal sector. Ellul et al. (2012) pointed out that transparent firm's access cheaper financing but also have a heavier tax obligation; they studied this trade-off in a model via distortionary taxes and endogenous rationing of external finance.

According to Blackburn et al. (2012), credit market circumstances affect the size of the underground economy. The interaction between financial development and the underground economy was considered according to two concepts. In the first concept, the absence of financial sector development creates an incentive for individuals to operate underground, which will exempt them from formal rules and regulations but removes the benefit of operating legally. In terms of the second concept, luck of financial development encourages individuals to drive unofficial transactions while conducting official economy. Under the assumption of identical tax obligation and access to an identical credit market, individuals operate in the formal sector while evading taxes by underreporting their real income as an effect of the influence of financial development on agents.

Blackburn et al. (2012) searched to explain the correlation between credit market development and the underground economy using the modest model of tax evasion and financial intermediation. They showed that marginal net gain from greater net wealth disclosure increases with the level of financial development. These findings coincide with reports in the literature asserting that lower stages of development are associated with higher tax evasion and a greater magnitude of the underground economy. Blackburn et al.'s (2012) study showed that business visionaries need external resources for investment, and they can diminish information costs and financial outlies by supplying more collateral. However, this involves a higher tax burden. Given the financial expenses, entrepreneurs choose whether to evade taxes and operate informally.

La Porta and Shleifer (2008) intended to compare country by country relative size of informal and formal firms. They found unofficial firms avoid tax payment and adhering to regulations, but lose the access to public goods and other benefits of official status, such as external finance. The main conclusion is that the negative correlation between private credit availability and individual's subjective assessment to their access to credit. Dabla-Norris et al. (2008) found that the firms that views financing as a major obstacle, has 16 percent of probability that half of their revenues are unrecorded while firms that views financing as a minor obstacle has way lower probability of having 7.6 percent of their revenues unrecorded. Additionally, they put forward that the firm size is negatively correlated with the intention to go informal, that bigger the firm less possibility to operate unofficially. Large firms of the ones that intend to grow, soon or late will need to access financing. Therefore, even if they operated informally, firms will have to register to have better access of financing. Bose et al. (2012) suggested that credit availability and lending have implication for the size of the underground economy, so thay used the liquid liabilities as percent of GDP and total domestic credit provided by depository banks as depth and efficiency of the banking sector. These variables measure the volume of lending and depth. They evaluated effect of both depth and efficiency in banking system on the underground economy, and found that development in banking sector is associated with smaller underground economic activity. The development of the banking sector is associated with lower level of the underground economy. Berdiev and Saunoris (2016) investigated the relationship between economic growth, financial development and shadow economy. They used three different measures to cover the level of financial development with money and quasi money, domestic credit provided by financial corporations to the private sector, and domestic credit from the financial sector including gross credit to various sectors and net credit to the central government. They found the evidence of financial development shrinks shadow economy and shocks to the shadow economy prevent financial development.

Beck and Hosseini (2014) gauges the effect of financial deepening and bank outreach on informality by using micro data from Indian manufacturing sectors. Beck and Hosseini (2014) state that bank outreach has reduction effect on informality by reduction entry barriers to formal sector and diminishing opportunistic informality. On the other hand, financial deepening increases the productivity of formal sectors however, it has no significant effect on underground sectors, and financial development is just important for increasing the share of official production in manufacturing.

## 2.2 Underground Economy and Trade Openness

Several studies focused on the links between international trade and underground economic activity. Goldberg and Pavcnik (2003) studied the impact of trade liberalization on informal labour force in the case of Brazil and Colombia. They did not find a positive correlation between trade policy and illegality in Brazil, but they did find such evidence in Colombia. Goldberg and Pavcnik (2003) had the argument that trade liberalization boost informal economy. The main argument was that trade reforms leads to formal establishment to increase foreign competition. In response, such establishments tend to lessen labour cost in various ways such as cutting employee benefits, preferring part time labour instead of permanent labour to lower social security payments. Other ways to reduce labour cost would be subcontracting with establishment in unofficial sector that can be included home-base employed or self-employed entrepreneurs. It is worth to mention that; the usual argument is often claimed in developing countries is that foreign competition will lead to rise in underground economy. Furthermore, Ghosh and Paul (2008) provided empirical evidence of growing underground economic activity with trade openness, that is, a positive correlation between the two, in 18 Central and Eastern European and former

Soviet Union countries. Fugazza and Fiess (2010) tried to determine the sign of the relationship between trade liberalization and informality using three different data sets and concluded that macro-founded data produce results that support the conventional view states that trade liberalization would cause a rise in informality, micro-founded data results did not. On the other hand, Elgin and Oyvat (2013) stated that trade openness may have either a positive correlation or a negative correlation with the underground economy. According to these researchers, a positive correlation is expected when openness facilitates the external subordination of the informal sector to the formal sector, while a negative correlation is likely to occur if openness in international trade eases the government's ability to examine informal production.

## 2.3 Underground Economy and the Interest Rate

Interest rate is a very important factor or determinant behind going underground. Tanzi (1983) and Schneider (1986) studied on the size of the underground economic activities by using currency demand approach in modelling including interest rate with an expected negative sign. Dabla-Norris and Feltenstein (2005) stated the entry and exit into the underground economy is derived as part of optimizing behavior that depends on taxes and interest rates. Baldemir et al. (2007) estimate the size of underground economy in the case of Turkey by using MIMIC model approach. They used interest rate as cause variable and emphasized the expected sign of interest rate variable is positive. Capasso and Jappelli (2011) states as financial market develops, savings increases, and interest rate falls, increasing the opportunity cost of continuing to operate underground.

# Chapter 3

# FINANCIAL SECTOR DEVELOPMENT AND UNDERGROUND ECONOMY

## 3.1 Financial Sector Development

Various determinants used to measure the financial sector development in the literature have involved various proxies from the financial sector. Ang (2009) pointed out the major problem in the empirical economic literature is the selection of key variables to proxy the level of financial services produced, that is, financial development; another issues is measuring the extent and efficiency of financial intermediation. Beck et al. (1999) built a database that sheds light on miscellaneous measures of financial sector development.

Ang (2009) used the ratio of commercial bank offices per thousand people, the difference of liquid liabilities and broad money supply to nominal GDP, the ratio of commercial bank assets to the sum of central bank assets and commercial bank assets and the ratio of bank claims on private sector to nominal GDP as the proxies for financial development. Love (2003); Love and Zicchino (2006) has constructed financial development index with market capitalization over GDP, total value traded over GDP, total value traded over market capitalization, ratio of liquid liabilities to GDP and credit going to the private sector over GDP. Ang and Kibbin (2007) has developed financial development index by using development proxies as liquid liabilities to nominal GDP, commercial bank assets to commercial bank assets plus central bank assets , and domestic credit to private sectors divided by nominal GDP. Beck et al. (2003a) measured financial development by using indicators of financial intermediary development, stock market development, and property rights protection. They employed private credit that is equals financial intermediary credits to the private sector divided by GDP; stock market development equals the value of outstanding equity shares as a fraction of GDP; and finally property rights as an index of the degree to which the government imposes laws that protects private properties.

## 3.2 Underground Economy

The underground economy is not merely the sum of all illegal activities but also includes legal economic activities that have gone unreported to the government. The underground economy goes by various names, such as the black market, unofficial market, subterranean economy, hidden economy, unrecorded economy, unobserved economy, shadow economy, second economy, and parallel economy. The underground economy includes illegal activities, such as drug dealing, as well as economic transactions that are not measured by government statistics, such as unreported revenues.

### 3.2.1 Definition of Underground Economy

There is a lack of consensus in definitions of the term underground economy (Öğünç and Yılmaz 2000). Schneider (1986) stated that an underground economy is simply all economic activities that should be included in value added and should be incorporated in the national income but have not been reported to the government. In contrast, Smith (1994) stated that the underground economy is the total sum of the market basket of products and services, whether legal or illegal, that have not been added to the yearly registered gross domestic product (GDP) of a specific country.

Frey and Schneider (2000) further emphasized that the underground includes literally all activities that should be added to national income but have not been. Furthermore, Jie et al. (2011) defined the underground economy as all transactions, whether legal or illegal, that escape government observation, regulation, and taxation.

### 3.2.2 Effects of Underground Economy

The underground economy has both negative and positive effects. Its negative effects occur at both the microeconomic and macroeconomic levels. Öğünç and Yılmaz (2000) and Schneider and Enste (2000) stated that the underground economy causes unreliable macroeconomics, resulting in inaccurate and ineffective policymaking. Informal firms use their advantage to set a competitive price advantage over official ones. Avoiding social security contributions and tax obligations at both the institutional and individual levels causes the financial positioning of social security institutions and the government budget to deteriorate, thereby causing social tensions and lower life standards for low-income people.

In contrast, as a positive aspect of underground activity, it creates employment opportunities, since unregistered firms demand more labour; thus, social welfare may be enhanced because individuals' purchasing power increases with lower prices. Schneider and Enste (2000) pointed out that at least two-thirds of the income generated from the informal economy is immediately spent in the official economy, which represents a positive effect. However, the underground economy can also attract workers away from the official economy.

### 3.2.3 Categorization of Underground Economy

Bagachwa and Naho (1995) categorized underground economy in three sections as informal sector, parallel and black market activities. According to Bagachwa and Nahno (1995), informal sector refers to producing and distributing small-scale of goods and services that are informal in sense that majority of them are unregistered by official statistics; thereby they have the limited access to organized markets and credit institutions. Informal sector consists of employed and self-employed persons in both urban and rural areas. Parallel market activities involve manufacturing and merchandise of perfectly legal goods and services that even thought has own legal markets, which are traded in illegal markets because of excessive government interventions and government restrictions. Black market activities refer to manufacturing and distributing market and nonmarket goods that are illegal and strictly forbidden by government statute laws.

Feige (1997) categorized underground economy into four groups as illegal, unreported, unrecorded, and informal. According to Feige (1997), income that generated from all the illegal activities that followed in violation of legal statutes considered as illegal economy. Drug dealing, black market currency exchange, money laundering, loan-sharking, prostitution are some examples to the illegal economic activities. All the economic activities that circumvent from fiscal rules to declare in tax code to evade tax obligations that considered as unreported economy. Economic activities evading the institutional conventions that define the recording requirements of government statistical agencies considered as unrecorded economy. Finally, the informal economy encompasses economic activities that evades the costs and are excluded from the benefits and rights of property relationships, commercial licensing, labour contracts, torts, financial credit, and social security systems.

Marinov (2008) suggests the three categories of the underground economy which are informal, grey and black economy. Although informal, grey and black economy are similar in terms of being ‘observed by statistics; the legislative regulations are not met; the transactions are monetary or barter; completely unregistered; and unaccounted before the fiscal bodies, they differ in activities and descriptions. Informal economy: is informal legitimate activity. These are enterprises that are using informal employment to meet own needs. Grey economy is unofficial legitimate activity. Grey economy has two different indicators that are unregistered employment and undeclared income for a purpose of avoiding tax payments for insurance or the performance of other defined by the law obligations, that is, illegal activity of legal economic enterprises. Black economy is illegitimate (illegal) activity. Black economy refers to the production and distribution of goods, not allowed by the law, or illegal activity directed against the person or the property. Very often it functions as systematically organized activity (organized crime).

### 3.2.4 Causes of Underground Economy

Schneider (2009) has gleaned causes of shadow economy as the burden of taxation (both direct and indirect taxation), the burden of regulation, and tax mortality that is the willingness of individual to pay the right tax at the right time (see Muarin et al., 2006). Increasing burden of taxation provides intensive to work in the underground economy. Raising burden of regulation again provides strong intensive to go into underground economy. Government action is the most important cause of underground economy in terms of taxation and regulation (Schneider, 2006). Declining in tax mortality refers to readiness of individuals to leave official occupation and go into underground economy. Declining of tax mortality boosts underground economy.

Öğünç and Yılmaz (2000) pointed out that causes of underground economy are increasing tax burdens, social security contributions and raising governmental regulations of official economy particularly in labour markets, reduction in working hours, early retirement, and declining of tax mortality.

Maurin et al. (2006) studied the size of hidden economy in Trinidad and Tobago between 1973 and 1999; they pointed out additional reasons of underground economic activity as perception of corruption, discontent with quality of public services, degree of ethnic fragmentation in addition to increase in tax burden, intensity of government regulations, and tax mortality.

Dabla-Norris et al. (2008) pointed out the intention go into informal sector raises with excessive tax burden, excessive regulations, financial constraints, and weaknesses of the legal system.

Enste (2010) studied the relationship between density of regulation index that includes major field such as labour market regulation, product market regulation and institutional quality, and the size of the underground economy regulation. He pointed out that main causes of underground economy are regulations besides of tax wedge and tax morale.

Dabla-Norris and Feltenstein (2005) stated that an important cause of underground economy is tax burden and argued that low tax rate may eliminate the underground economy but it may result in unsustainable budget and trade deficit. However, if tax rates are too high and exceeds return on investment, then firms tend to move to underground economy by tax evasion.

### 3.2.5 Consequences of Underground Economy

Underground economy is a growing phenomenon. Besides of the lack of consensus on the definition of underground economy, its measurement approaches are also problematic since it is a difficult task to measure something that is hidden. Yet, there are so many reasons that politicians and public sector workers should be worried about the growth of the underground economy. The main consequence of the growth of the underground economy is that the actions that will be taken in order to cover the deficit in government budget, by increasing tax rates or tighting regulations to avoid underground economy, actually end up with higher growth in the underground economy and havoc the official economy.

In the light of the fact that is one of the most important causes of the size of the underground economy is the raise tax burden and social security contributions. Schneider and Enste (2000) pointed out that rise in overall tax burden and social security contributions, will lead to tax evasion and social security bases; it is associated with decrease in tax receipt, and greater budget deficits or further increase in tax rates that will lead to growth in the size of the underground economy. Feige (1990) states the most important consequence of the underground economy as to damage the stability and responsibility of political, legal and economic institutions that might otherwise serve to facilitate the development process, and he also states that an oft overlooked consequence of growth of underground economy is the unravelling of the social and political fabric. As it was stated before, one of the negative effects of underground economy is that it creates unreliable macroeconomic aggregates which will yield to ineffective policy decisions. Tanzi (1999) reported that underground economy can have immediate consequences for policy or macroeconomic variables.

### 3.2.6 Approaches for Measuring Underground Economy

Measuring the underground economy is a difficult task. As Schneider and Enste (2000) noted, underground activities that are engaged in by individuals and institutions are not declared, and it is difficult to measure something that is hidden (Öğünç and Yılmaz 2000). Still, Georgiou (2007) reviewed 14 different methodologies that measure the size of the underground economies that can help to provide accurate measurements of complicated networks of underground economic activities.

The primary concern in relation to the underground economy's impact on the official economy is that yielding nations GDP a less-than-accurate figure, which can adversely affect government policies that are based on the GDP. Such as interest rates which is determined by the central banks as monetary policy decision. If the official economy figures are not accurate, monetary policy decision may negatively impact the economy. Increase in underground economy gives rise to three major sets of concern that are macroeconomic policies likely to be too expansionary and social policy too excessive; loss in tax revenue; and finally unhealthy state between citizens and government (see Frey and Schneider, 2000).

There are several approaches that can be used to measure the size and growth of the underground economy, namely direct approaches and indirect monetary approaches, discrepancies in indirect income and expenditure approaches, indirect non-monetary approaches, and model approaches (Frey and Pommerehne 1984; Feige 1989; Schneider 1986, 1994a, 1998a; Thomas 1992, 1999; Georgiou 2007). Direct approaches, which are also known as micro-approaches, involve simple, voluntary sample surveys carried out on individuals and tax auditing (Lubell 1991). Isachsen et al. (1982) and Isachsen and Strom (1985) used voluntary sample surveys to measure the underground economy for the case of Norway, while Mogensen et al. (1995) performed a similar study for the case of Denmark. Williams (2008) used direct survey approach to undertake a cross-national variation on undeclared work for 27 European Countries; while Williams (2010) used to determine the size and the nature of the shadow economy in an English locality. Another direct approach is identifying discrepancies between income declared for tax purposes and income measured using selective checks. Furthermore, several authors have used fiscal auditing programs to measure the size of the underground economy in the US (Simon and Witte 1982; Witte 1987; Clotfelter 1983; Feige 1986).

The indirect approach uses macroeconomic indicators as a proxy for the size of the underground economy. Indirect monetary approaches include the simple currency ratio method, the transaction method, and the currency demand approach. The simple currency ratio method was created as an attempt to explain the long-run variation of the ratio of currency to the money supply in the United States by Cagan (1958), and it was further developed by Gutmann (1977). Another indirect approach is transaction method that concentrates on Fisher’s quantity equation. The transaction method uses the assumption of a constant relationship between the volume of transactions and official GNP. Feige (1979) developed the discrepancy approach between the nominal GNP (pT) and official GNP as measure of the underground economy; Boeschoten and Fase (1984) used this approach to measure the underground economy of the Netherlands, while Langfeldt (1984) used it for Germany. Currency demand approach was first used by Cagan (1958) which is than developed by Tanzi (1980). Cagan (1958) employed this approach to link currency demand and tax pressure for the US, and a similar approach without statistical procedures was adopted by Gutmann (1977). Currency demand approach used to by many scholars to measure the size of the underground economy in various countries, Fethi et al. (2004) used this approach to measure the underground economy of the Cyprus.

Indirect income expenditure discrepancy approaches are also referred to as the GDP approach, household income expenditure discrepancy, the single equation approach of consumer expenditure, and the demand system approach of consumer expenditure. The GDP approach measures the underground economy through the discrepancy between national expenditure and income statistics. Hence, some of the authors use the gross national product (GNP). MacAfee (1980) and O'Higgins (1989) used the GDP approach to measure the underground economy for the UK; Petersen (1982) and Del Boca (1981) used it for Germany; and Park (1979) and Smith (1985) used it for the USA. The household income expenditure measure is an alternative to the GDP approach; it tries to measure underground economy through the discrepancy between household income and expenditure of individuals at disaggregate levels (Dilnot and Morris 1981). The single equation of consumer expenditure was used by Pissarides and Weber (1989) to measure the size of the underground economy via family expenditure surveys employed to calculate the consumption function of food. Meanwhile, Lyssiotou et al. (2004) formulated the demand system approach to consumer expenditure as an alternative to measuring the underground economy by categorizing households by source of income to overcome heterogeneity with income effects. In the demand system approach, wages and self-employment income are used as a source of income, and 6 categories of non-durable goods are used which are food, alcohol, fuel, clothing, personal goods/ services, and leisure goods/services.

Indirect non-monetary measures include the rank method, detection control measurement, and the electricity consumption approach. The rank method was used by Frey and Weck (1983a) to measure the underground economy with a combination of weights and sensitivity analysis to rank countries in terms of the size of the informal economy. The weights were ‘inferred on the basis of the knowledge gained from the literature’, and the sensitivity analysis was based on ‘various determinants in the writings on the subject’. Feinstein (1999) used detection control measurement to assess the level of tax disparity using detection controlled measurement model with two mathematical expressions to describe ‘potential offenders with a specified probability of violation’ and regulators ‘with a specified probability of detection, conditional on non-compliance occurring’. None detected proportion of detection of violations was estimated through the joint estimation of the two expressions. The electricity consumption approach, also known as the physical input method, measures the underground economy by subtracting growth of electricity consumption from the growth of official GDP used which is a proxy for overall economic activity (GDP) and actual GDP. Del Boca and Forte (1982) used electricity consumption method; later, Kaufmann and Kaliberda (1996) and Johnson et al. (1997) adopted the same method. Another indirect approach is employment approach that considers the discrepancy between the official and actual labour forces. Under the assumption of constant labour force participation, a reduction in labour force participation in the official economy can be seen as an indication of a growing informal economy. Contini (1981) used the employment approach to measure the underground economy for Italy.

Frey and Weck (1983a, 1983b) and Frey and Weck-Hannemann (1984) developed the model approach. This approach is distinct from the other approaches in that it considers other indicators and the causes of the underground economy in the measurement process, whereas the aforementioned techniques consider only one indicator, and in particular, monetary approaches consider one cause, namely tax burden. The model approach considers multiple indicators and multiple causes of the underground economy. Model approach is based on unobserved/ latent variable; in that sense its empirical methodology is quite different than the other approaches. Underground economy is considered a latent/unobserved variable measured by factor-analytic approach.  Frey and Weck-Hannemann (1984) measured the size of the underground economy using four determinants and three indicators. The determinants were the tax burden on individuals, rate of unemployment, taxpayers' morality, and the level of economic development. Meanwhile, the indicators are labour market and the real GDP growth ratio. Schneider and Enste (2000) used the MIMIC approach, which includes causes like excessive taxation, strict regulation, reducing tax mortality, and indicators like 'monetary indicators; labour market; production market'. Giles (1999a, 1999b) and Giles et al. (1999) further developed the model approach. Schneider (2009) measured the size of the informal economy in 25 transition countries using the MIMIC approach using two tax burden variables of the shares of direct and indirect taxation; the burden of state regulation, unemployment quota, and GDP per capita were included as cause variables for the status of the official economy. Moreover, the indicators used were the employment quota, yearly GDP rate, and yearly rate of local currency per capita.

### 3.2.7 Criticisms for Measuring Approaches of Underground Economy

As mentioned before direct approaches include voluntary sample surveys carried out on individuals and tax auditing. Öğünç and Yilmaz (2000) stated the problem with direct survey is the reliability of respondents' answers. If respondent do not answer the survey questions, then conclusions will be misleading. Schneider and Enste (2000) pointed out that the problem of tax auditing is that underground economy estimates based on the tax auditing is only the portion of it that is succeeded to be discover by authorities.

Indirect monetary approaches include the simple currency ratio method, the transaction method, and the currency demand approach. Öğünç and Yilmaz (2000) pointed out the drawbacks related with indirect monetary approaches. The defect of simple currency ratio method is that any improvement in the measurement of official economy will increase rather than decrease the underground economy. Data availability and obtaining precise figures to the total volume of transactions are some of the problems of the transaction method besides its own unacceptable assumptions of the method. Transaction method has assumptions for defining a base year without underground economy and a constant nominal ratio over time. Both assumptions are unreliable and unacceptable. Currency demand approach has starting point of correlation between currency demand and tax pressure, by doing that assuming all the unofficial activities operate with cash. Main criticism of the currency demand approach is, not all transactions are made in cash and rise in currency demand deposit is because of large degree of slowdown in demand deposit and not the rise in the underground economic activity. Bhattacharyya (1999) pointed out the detailed criticism on the assumptions of currency demand model.

Indirect income expenditure discrepancy approaches are also referred to as the GDP approach, household income expenditure discrepancy, the single equation approach of consumer expenditure, and the demand system approach of consumer expenditure. Schneider and Enste (2000) pointed out the drawbacks related to GDP approach is that the components of expenditure side measured with error, discrepancies between production measure of GDP and expenditure measure of GDP will reflect omissions and errors in the underground economic activity. Georgiou (2007) stated the problems with household income expenditure discrepancy, the single equation approach of consumer expenditure, and the demand system approach of consumer expenditure. Household income expenditure discrepancy approach analyses the gap on the basis of FES (Family Expenditure Survey) with the assumption of reliability of FES. The problem associated with this approach is that the individuals who are engaged in underground activity will be unwilling to respond official survey thereby FES under-represents the underground economy. The single equation approach of consumer expenditure also uses FES data to estimate consumption function; some of the problems related with this approach are consumption function ignores savings that hide true incomes by employees. Main problem related with demand system approach of consumer expenditure are that demand system equation tries to improve single equation thereby it needs much more information that may lead to measurement error problems.

Indirect non-monetary measures include the rank method, detection control measurement, and the electricity consumption approach. Problem with ranking method is that even though it is scientifically acceptable, procedure is unfamiliar. Detection control measurement is purely statistical approach with no reference to the reasons for non-compliance and suffers from identification problem. Criticism of electricity consumption approach includes not all underground activities require using electricity that makes the approach underestimating the underground economy (see Schneider and Enste, 2000). Another indirect non-monetary measure is discrepancy between official actual labour forces, besides of the assumption of constant total labour force participation, reduction in labour force participation may occurs because of recession that made people to exit from the labour force. Fethi et al. (2006) stated the two main weaknesses of this approach as it does not consider the fact that people can work in both full-time and part-time employment; and the differences in the participation rate might have other reasons, such as demographic developments.

Georgiou (2007) summarized the criticism of MIMIC modelling approach as using the share of public employees in the total labour force as an indicator of the burden of regulation is questionable, or alternatively using tax morality burden is also problematic since it is very complex issue which cannot simply be measured by an index. Nonetheless MIMIC model can be considered as the best approach to measure latent variable because it takes into account multiple indicators and multiple causes variables at the same time distinct from other approaches. Gilles and Tedds (2002) pointed out the advantage of MIMIC modelling as quite flexible, allowing one to vary the choice of causal and indicator variables according to the particular features of the shadow economic activity studied, the period in question, and the availability of data. As long as the right causes and indicators are chosen with establishing well assumptions, and with using right data, MIMIC model estimation could yield the most reliable conclusions.

# Chapter 4

# CONSTRUCTING THE VARIABLES OF THE STUDY

This section will include construction of the variables of study that are the financial development index and estimation of the size of the underground economy. This section will include the methodology showing how financial development index is constructed and as well as how the size of the underground economy is estimated by providing information about data sources.

## 4.1 Construction of Financial Development Index

In this thesis, five different proxies will be used to construct a composite financial development index that parallels the variable selection in the studies by Beck et al. (1999), Levine et al. (2000) and Katircioğlu and Taşpinar (2017). The determinants of financial development are as follows: (1) the ratio of commercial bank assets to central bank assets plus commercial bank assets (A), (2) domestic credits to private sector by banking sector (as a percentage of the GDP; DC), (3) domestic credits provided to private sector (as a percentage of the GDP; DCP), (4) broad money supply (as a percentage of the GDP; M2), and (5) liquid liabilities (as a percentage of the GDP; M3). The financial development index is generated using principal component factor analysis in the SPSS statistical software (see Ang, 2009 and Chen 2010). Construction of composite financial development in this thesis can be introduced via the following functional relationship:

$$FD = f\,(A, DC, DCP, M2, M3) \tag{1}$$

The variables of M2, M3, DC, and DCP have been obtained from World Development Indicators, while A has been obtained from the Bankscope.

The ratio of commercial bank assets to the sum of central bank assets plus commercial bank assets (A), have been utilized to denote the relative significance of commercial banks. Levine et al. (2000) contended that private credit (DCP) is an important proxy of financial intermediation and is more than a basic measure of financial sector size. Ang (2009) also expressed that credit provided to the private sector is an essential indicator of financial development, since the private segment is able to utilize funds more productively and effectively compared to the public sector. In addition to bank credit to the private sector, as in Jenkins and Katircioğlu (2010), overall credit provided by the banking sector (DC) has been utilized in this study to incorporate the overall credit expansion as an indicator of financial development. Broad money supply (M2) has been included in this study, as in work of Gelb (1989) and King and Levine (1993a). An increase in M2 increases financial depth. Demetriades and Hussein (1996) argued that increasing broad money supply represents monetarization; this is because M2 includes a large portion of currency in developing economies rather than financial depth. Therefore, as claimed by previous researchers, M3 is a more relevant financial development indicator (Levine et al., 2000; Rousseau and Wachtel, 2000; and Rioja and Valev, 2004). Liquid liabilities (M3) have been included here, as in the work of Levine et al. (2000), as a proxy for financial depth, and as an indicator of the overall size of the financial intermediary sector because it includes central banks, deposit money banks, and other financial institutions (King and Levine 1993a).

In terms of the financial indicators that discussed, the financial development index is generated by principal component factor analysis. Principal component analysis is a statistical method that uses orthogonal transformation to convert a set of correlated variables into a smaller set of uncorrelated artificial variables, which are principal components. As Klein and Ozmucur (2003) pointed out, to deal with multi-collinearity and a shortage of degrees of freedom, principal component analysis reduces the dimensionality of the dataset while retaining most of the original variability in the data (see Feridun and Sezgin 2008). Financial development indices using principal component factor analyses were studied in the literature by Ang (2009) and Chen (2010), respectively. Principal component factor analysis enables divergent financial development indicators to be expressed in a single index. In this thesis, variance decomposition was carried out to extract a composite financial development index from A, DC, DCP, M2, and M3.

To decide whether any of these five financial indicators should be incorporated into the index, factor loadings, eigenvalues, and the percentage of variance explained were computed (see Ang 2009; Hair et al. 1998). Since all financial indicators had eigenvalues greater than 1 and their factor loadings were greater than 0.50, they were assumed to be significant and were processed in the analysis (see Hair et al. 1998).

The extracted factors from the principal component factor analysis have been utilized to construct a comprehensive score or composite index of financial development based on the computation in equation (1):

$$FD \text{ Index} = \sum_{i=1}^{n} w_i \times FS_i \quad (2)$$

where $FD$ index stands for composite financial development index, $w_i$ denotes the weight or ratio of variation explained by each financial development indicator divided by variation explained by all financial development indicators, and $FS_i$ stands for the corresponding factor score of each financial development indicator presented in equation (1).

## 4.2 Construction of the Size of the Underground Economy

### 4.2.1 Multiple Indicators Multiple Causes Model (MIMIC) Approach

Multiple Indicators and Multiple Causes (MIMIC) model, a special case of a longitudinal structural equation model (SEM), in which the influences of formative indicators on latent/unobservable variables are assessed through their impact on the reflective indicators (Lester, 2008). Structural equation modelling is a multivariate statistical analysis technique that is used to analyse structural relationships. Apart from other approaches, MIMIC (multiple indicators multiple causes) model approach measures the size of the underground economy by considering multiple indicators and multiple causes at the same. MIMIC model approach uses the relationship of covariance information of unobserved variables and observed variables to measure the underground economy. Latent/unobserved variables referred to size of the underground economy. On the other hand, observed variables include cause variables and indicator variables. Latent/unobserved variables of underground economy are measured over time by using a factor-analytic approach (see Schneider and Enste 2000). Georgiou (2007) stated that MIMIC model approach includes two parts as structural model and measurement model. Structural equation specifies the causal relationship between latent variable and its causes. Measurement model links indicators to the latent variable.

According to the relevant literature, the most important determinant of underground economy is tax burden (see Dell'Anno et al., 2007). Positive sign of the parameter expected because of generally accepted hypothesis is that any raise in tax burden is associative with the intensive to work in the underground market. Tax burden is measured as total shares of all the taxes in gross domestic product within the econometric framework. In order to test whether or not of all components of tax burden has the same effect on the underground economy; tax burden has been disaggregated into three different proxies that are direct tax, indirect tax and social security contributions. As a bottom line, the cause in another words, the explanatory variable of tax burden will be employed in model as direct tax as a percent of GDP, indirect tax as a percent of GDP, and social security contributions as a percent of GDP. Direct tax variable includes tax revenue as percent of GDP which include all the taxes in both individual and corporate level as taxes on income, profit, and capital gains of individuals/corporates; and taxes on properties. Indirect tax variable includes tax revenue as percent of GDP which include all the taxes on the goods and services. Finally, social security contributions variable generated directly from OECD statistical database like the rest of all the components of tax burden.

Another important determinant of the underground economy is the burden of regulation. The degree of regulation in the economy is a representation by the public employment as a percent of total labour force. The expected sign of this variable is ambiguous. Some authors have discovered negative sign by calming that in some industries, existence of state could provide a disincentive for individuals to work in underground economy. On the other hand, more intensive regulation provides strong incentive for individuals to participate in underground economy (see Dell'Anno et al., 2007). In our point of view, increasing regulation will raise the control on individuals, so the intensity to moving unofficial economy will be restricted. Therefore, expected sign of burden of regulation is negative. Public employment statistics have been obtained from ILOSTAT statistical database, while total labour force is obtained from WDI database. Unfortunately, public employment statistics covers really short time range and more importantly, share of public employees in the total labour force as an indicator of the burden of regulation is questionable (see Georgiou, 2007). Therefore, burden of regulation had to be excluded from the model as cause/explanatory variable of underground economy.

Finally, unemployment and self-employment are the other important determinants of underground economy. Some authors have claimed that unemployment rate has positive correlation with underground economy while other authors claimed the existence of negative correlations. So the effect of unemployment rate on underground economy is ambiguous too (see Tanzi, 1999). Individuals always look for a way to survive no matter dealing with official economy or not. So increase of unemployment rate gives strong incentives to the individual to participate in underground economy. Therefore, the expected sign of unemployment rate is positive. Unemployment rate variable is obtained directly from OECD statistics database. Bordingnon and Zanardi (1997) stated that on the light of fewer internal and external auditing controls on small firms and self-employed individuals, it is way easier for them to evade indirect taxes. So any rise in self-employment rate is linked to increase in underground economy; therefore, expected sign of self-employment rate is positive. Self-employment rate is obtained directly from WDI database.

MIMIC model approach need to fix a scale variable to estimate the rest of the variables as a function of this scale variable. In this study, three indicator variables intended to be employed that are real GDP per capita, labour force participation rate, and currency in circulation outside of banks. The effect of the underground economy upon economic growth is ambiguous. Some of the authors claimed the presence of positive relation between official and unofficial economies while others suggested the opposite. According to some well-known theoretical and empirical studies, a negative sign of the coefficient of scale will be accepted as between underground economy and the growth rate of GDP. Simply this implies that during the recession and economic slow-downs, many activities move to underground (see Dell'Anno et al., 2007). Real GDP per capita variable will be fixed as the scale variable in the model that will be discussed in the next sections of this this study. This implies the size of the underground economy is measured in terms of official GDP. Real GDP per capita variable is generated by GDP market price divided to GDP deflator and the sum is divided by total population between ages of 15 to 64, that is the number of people who are potentially be economically active. All those statistics have been obtained from WDI database.

Italian method suggests the measuring of the size the underground economy from changes in labour force participation ratio. Expected sign of labour force participation ratio is ambiguous. Some authors' changes in labour force participation ratio reflect the change in the underground economy, but some authors do not agree about the link. For instance, Dell'Anno et al. (2007) states that low rate of labour force participation relative to comparable economies is reflecting the movement from official to unofficial economy. The labour force participation ratio is ratio of the labour force to the working age group that is for ages 15 to 64 old. Labour force participation rate is obtained from OECD statistical database.

The final indicator intended to be included in the model is currency in circulation outside of the banks. In the light that unofficial activities use cash instead of checks and credit cards, actual demand for cash and demand without existence of underground economy enables to measure the size of the underground economy (see Dell'Anno et al., 2007). The variable is the ratio of M1 to M3, and the expected sign of variable is positive. Narrow money index (M1) and broad money index (M3) are obtained from OECD database. Unfortunately, due to the time range limitation of this variable, it cannot be included in the model. Hypothesized relationship of MIMIC model in this study is provided in Figure 1.

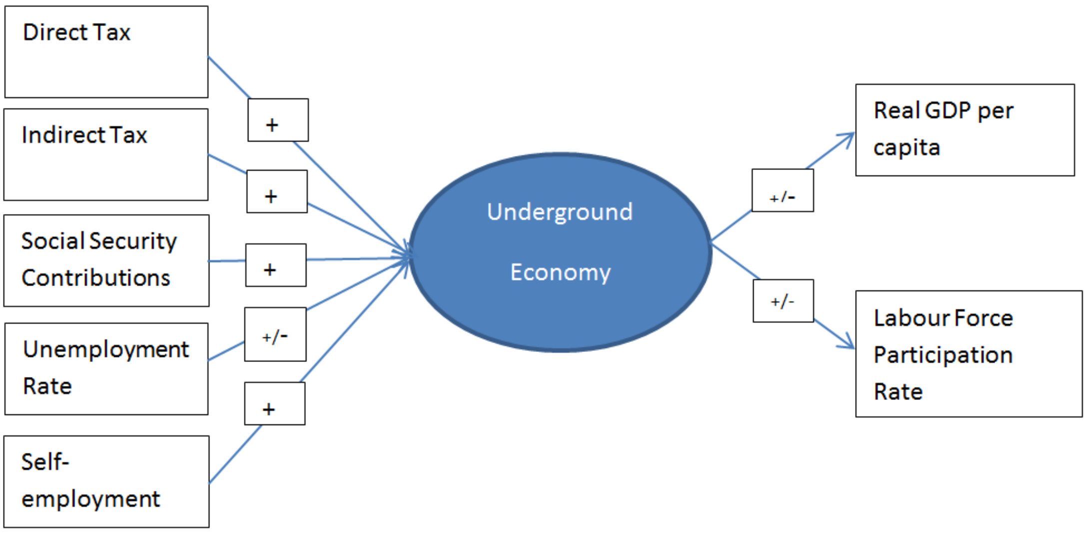

Figure 1. Hypothesized relationship in the MIMIC model.

Dell'Anno et al. (2007), measured the size of the underground economy by applying MIMIC model approach in France, Spain and Greece while using direct tax, indirect tax, social security contributions, public employment, unemployment rate, self-employment rate; indicators as real GDP per capita, labour force participation rate, and currency ratio. Parallel to the study of Dell'Anno et al. (2007), six cause variables and three indicator variables intended to be include in MIMIC model approach. However problematic nature of some variables and/or time range limitation of some variables this thesis will measure the size of the underground economy by employing only five cause and two indicator variables.

As mentioned above, MIMIC model approach includes two part/equations that make simultaneous use of it. The structural equation model that will specify the causal relationship between the underground economy and its causes, underground economy, $\eta$ is linearly determined by a set of observable exogenous causes $x_{it}$ are the cause variables $i = 1,2...k$, subjected to an error term, $\varepsilon$. Structural equation is written as follows;

$$\eta_t = \gamma' x_t + \varepsilon_t \tag{3}$$

where $x_t' = (x_{1t,}, x_{2t}, ..... \; x_{pt})$ is a $(1xp)$ vector of time series variables as indicated by subscript t. Each time series $x_{it}$, $i = 1,2...p$ is a potential cause of the latent variable of the underground economy $\eta_t$. $\gamma' = (\gamma_1, \gamma_2, ........\gamma_p)$, a $(1xp)$ vector of coefficient in the structural equation model that describes causal relationship between the latent variable and its causes. $\varepsilon_t$ is an error term for the structural equation model, that represents the unexplained part. The MIMIC model assumes that the variables are measured as deviations from their means and the error term is uncorrelated to the causes, $E(\eta_t) = E(x_t) = E(\varepsilon_t) = 0$ and $E(x_t \varepsilon_t') = E(\varepsilon_t x_t') = 0$. The matrix variance of the structural equation error term, $\varepsilon_t$, denoted by $\psi$, and $\Theta$ is the $(pxp)$ covariance matrix of the causes $x_t$.

In the second part of model, measurement equation links the indicators to the underground economy. Underground economy, $\eta$ is linearly determines a set of observable endogenous indicators subject to disturbance, $\omega_i, i = 1,2,...q$. Underground economy, $\eta$ is linearly determines set of observable endogenous indicators subject to disturbance, $\omega_i, i = 1,2,...q$. Latent variable is expressed in terms of observed variables. Measurement equation is written as follows;

$$y_t = \lambda \eta_t + \omega_t \tag{4}$$

where $y_t^{'} = (y_{1t},\ y_{2t},...y_{qt})$ is a $(1xq)$ vector of individual time series variables $y_{jt}$, $j = 1,2,....q$. $\omega_t = (\omega_{1t}, \omega_{2t},....\ \omega_{qt})$ is a $(qx1)$ vector of disturbance where every $\omega_{jt}, j = 1,2,....q$ is a white noise error term. The $(qxq)$ covariance matrix is given by $\Phi_\omega$. The single $\lambda_j, j = 1,2,....q$ in the $(qx1)$ vector of regression coefficients $\lambda$, represents the magnitude of the expected change of the representative indicator for a unit change in the latent variable. In MIMIC model also indicator variables are expressed as deviations from the mean, $E(y_t) = E(\omega_t) = 0$, and the error term is uncorrelated to the causes $x_t$ or to the $\eta_t$. So $E(x_t \omega_t^{'}) = E(\omega_t x_t^{'}) = 0$ and $E(\eta_t \omega_t^{'}) = E(\omega_t \eta_t^{'}) = 0$. As final assumption $\omega_t$ is uncorrelated to $\varepsilon_t$, i.e. $E(\omega_t \varepsilon_t^{'}) = E(\varepsilon_t \omega_t^{'}) = 0$. The general structure of MIMIC model is provided in Figure 2.

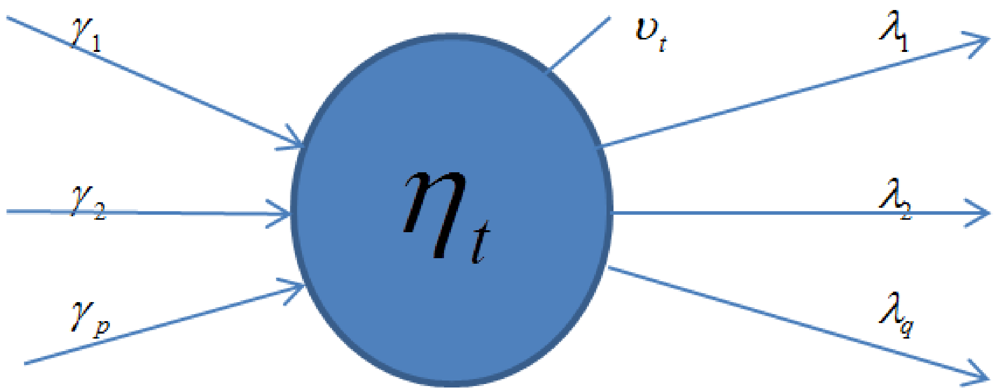

Figure 2. General structure of MIMIC model

MIMIC model's covariance matrix, $\Sigma$, was obtained from equation (3) and (4). Covariance matrix describes the relationship between cause and indicator variables in terms of their covariance's. The decomposition matrix drives structure between the observed variables and latent variable. The covariance matrix[2] is as follows;

$$\Sigma = \begin{pmatrix} \lambda(\gamma'\Theta\gamma + \Psi) + \Phi_\omega & \lambda\gamma'\Theta \\ \Theta\gamma\lambda' & \Theta \end{pmatrix} \tag{5}$$

Where $\Sigma$ is a function of parameters $\lambda$, $\gamma$ and the covariance's obtained in $\Theta$, $\Phi_\omega$, and $\Psi$. Links between the variances and covariance's between observed variables' used to estimate the parameters of the model. The aim is to estimate $\Sigma$ that is closest to the sample covariance matrix, by finding the parameters and covariance's (see Buehn and Schneider, 2008).

[2] Derivation of MIMIC model's covariance matrix can be illustrated in appendix A.

### 4.2.2 Multiple Indicators Multiple Causes Model (MIMIC) Approach Empirical Analysis

To confirm using of the correctly specified MIMIC model, several tests must be done on data set such as normality and stationarity tests of the variables.[3] In the case of absence of normality and stationarity, some of the corrections have to be done to generate unbiased standard errors and generate good chi-square tests results of overall model fit. In order to overcome of none-normality and none-stationarity issues, some of the variables are transformed to first differences and some to second differences, as proposed by Bollen (1989). With transformed variables, none-stationarity is eliminated and normality of distribution has been eliminated.

In the following step, OLS regressions will took place to determine which indicator variable is supposed to use for normalization. Breusch (2005) stated that the choice of endogenous indicator cannot be random, as it affects the interpretation. Breusch (2005) suggests that the interactions will be found to converge faster and more reliably if the model is normalized on the endogenous variable with the highest R-square. Therefore, OLS regression has been employed on both the real GDP per capita variable and labour force participation ratio. The results indicated that normalization should be made on real GDP per capita with highest R-square.[4] Therefore the coefficient on real GDP per capita is restricted ($\lambda_1 = -1$). As mentioned before, MIMIC model, underground economy as latent variable will be determined by multiple indicators variables and multiple causes variables. Underground economy cannot be observed but it can be estimated by first estimating

---

[3] Since ADF, PP, and DF-GLS unit roosts test employed, there is no need for further tests such as KPSS. Normality and stationarity tests of the variables are reported in appendix B, from Table 1 till Table 42.

[4] OLS regressions on real GDP per capita are provided in appendix B, from Table 43 till Table 53.

ordinal index of underground economy then converting to a cardinal time series of underground economy as a percent of official GDP.

Annual size of the underground economy will be estimated for the time range of 1994-2014 for 21 European Union countries based on data availability. In order to estimate the size of the underground economy, the model used five cause variables, two indicator variables and underground economy as the latent variable, as stated previously. In the MIMIC model, the interaction between the cause variables and the underground economy is illustrated in equation (6) and the interaction between the underground economy and its indicators is illustrated in in equation (7) and equation (8) respectively;

$$\begin{aligned} UndergroundEconomy_t &= \gamma_1 indirecttax_t + \gamma_2 directtax_t + \gamma_3 soc.\sec.cont._t \\ &+\gamma_4 unemployment_t + \gamma_5 selfemployment + \xi \end{aligned} \tag{6}$$

$$\mathrm{Re}\,alGDPpercapita_t = \lambda_1 UndergroundEconomy + \varepsilon_1 \tag{7}$$

$$LaborForcePart.Rate_t = \lambda_2 UndergroundEconomy + \varepsilon_2 \tag{8}$$

where indirect tax is Indirect Tax/GDP, direct tax is Direct Tax/GDP, soc.sec.cont. is Social Security Contributions/GDP, self-employment is Self-Employment/Labour Force, and $\xi, \varepsilon_1, \varepsilon_2$ are error term disturbances. IBM AMOS software has been used to estimate the coefficients by Maximum Likelihood. The estimated coefficients of MIMIC model and some test statistics regarding the model have been provided in the appendix B at Table 54 and Table 55.

The estimated MIMIC coefficients enable us to find the relative size of the underground economy as percent of GDP. MIMIC index will be calibrated to absolute values to estimate the size of the underground economy as percentage of official GDP. In order to estimate annual underground economy as percent of GDP benchmarking procedure the proposition of Dell’Anno and Schneider (2006) will be used. That procedure requires instead of growth rate of GDP as the reference variable ($Y_1$) an alternative indicator, ($GDP_t / GDP_{1999}$). Schneider (2007) had estimated the size of the underground economy in 145 countries, the size of the underground economy as percent of official GDP in 1999 will be used as the base year. The index of underground economy as the percent of GDP in the base year of 1999 is linked to the changes in the real GDP in the 1999. According with identification rule, ($\lambda_1 = -1$ ) the index of the underground economy as percent of GDP in the 1999, is linked to the chain index of real GDP as follows;

Measurement equation: $$\frac{GDP_t - GDP_{t-1}}{GDP_{1999}} = \frac{\eta_t - \eta_{t-1}}{\eta_{1999}} \quad (9)$$

Then, the structural equation model is used to obtain an ordinal time series index of underground economy obtained by coefficients of structural equation by raw data to obtain the level of underground economy, as follows;

Structural equation: $$\frac{\eta_t}{GDP_{1999}} = \gamma' X_{pt} \quad (10)$$

Finally, the estimated index scaled up to the value of underground economy as a percent of GDP in 1999 taken from the study of Schneider (2007) to obtain the underground economy as a percent of GDP in that year. Annual estimates of underground economy obtained by scaling up each year's index, as follows;

$$\frac{\hat{\eta}_t}{GDP_{1999}}\left[\frac{\eta^*_{1999}}{GDP_{1999}}\frac{GDP_{1999}}{\hat{\eta}_{1999}}\right]\frac{GDP_{1999}}{GDP_t}=\frac{\eta_t}{GDP_t} \tag{11}$$

Where

1. $\frac{\hat{\eta}_t}{GDP_{1999}}$ is the index estimated by equation 10

2. $\frac{\eta^*_t}{GDP_{1999}}$ is the external estimate of underground economy taken from Schneider (2007).

3. $\frac{\hat{\eta}_{1999}}{GDP_{1999}}$ is the value of index estimated by equation (10) in 1999.

4. $\frac{GDP_{1999}}{GDP_t}$ is able to convert the index of underground economy as a change with respect to the base year in underground economy respect to current GDP.

5. $\frac{\eta_t}{GDP_t}$ is estimated underground economy as a percent of GDP.

Due to the data availability, Bulgaria, Croatia, Cyprus, Latvia, Lithuania, Malta, and Romania are excluded from the study. The rest of European Union countries' the original MIMIC models from IBM AMOS software can be seen in the appendix B from Figure 3 till Figure 23, and the modified MIMIC models are displayed between Figure 24 and Figure 40.

The annual size of the underground economy for all the countries attempt to estimate by using the relationship of cause and indicator variables that are illustrated in Figure 1. Meydan and Şeşen (2011) state that none significant cause and/or indicator variables have to be omitted from the model and tested again in order to optimize the model. To scaling up each year's index, external estimate of the underground economy for all the countries have taken from Schneider (2007), except Luxemburg's estimate has taken from Schneider (2013) as 9.8 % in 2003.

The results of the original MIMIC model estimation provided in Table 54 and Table 55; the results of the modified MIMIC model estimation provided in Table 56 respectively. Chi-Square goodness of fit, degree of freedom, incremental fit index (IFI), comparative fit index (CFI), goodness of fit index (GFI), and root mean square error approximation (RMSEA) are provided for all estimations as absolute fit index, relative fit index, and non-centrality-based index. According to Meydan and Şeşen (2011), it is not certain which indices will be reported in the application of SEM modelling, but Chi-Square goodness of fit and goodness of fit index should be reported.

# Chapter 5

# THEORETICAL SETTING

Even though the research of the underground economy is largely investigated study in the literature, its interaction between financial sector development and trade openness did not take much attention. Changes in the level of the underground economy related to financial sector development, trade openness and the interest rate. Berdiev and Saunoris (2016) stated that theoretically, the relationship between financial development and the shadow economy is grounded in Becker's (1968) influential study on the economics of crime. Becker (1968) argues that rational individuals assess the benefits from illegal actions against the costs of detection and punishment. In this line, rational entrepreneurs evaluate the benefits of operating informally (e.g., avoiding burdensome taxes and regulations) against the direct costs (e.g., financial costs connected to apprehension) and opportunity costs (e.g., forgone access to official sector institutions).Financial development index (FD) will be used as a financial development indicator; trade openness (TRD) will be used an indicator of aggregate trade volume; interest rate (INT) will be used as a long-term interest rate. In this thesis, the functional relationship will be used to investigate the effect of financial sector development, trade openness and interest rate on the size of the underground economy. Therefore, the following functions will be used to observe functional relationships of this study:

$$UE_{it} = f(FD_{it}^{\beta 1}, TRD_{it}^{\beta 2}, INT_{it}^{\beta 3}) \quad (12)$$

where $i$ is the 20 cross-sectional countries, $t$ is time periods of proxy measures from 1994 to 2014, $FD$ is proxy for financial sector development, $TRD$ is proxy for international trade openness, and $INT$ is proxy for the long-term interest rate. $\beta_1, \beta_2$, and $\beta_3$ are the coefficients of regressors. As it mentioned previously, it is expected that the financial sector development, trade openness, and interest rate will negatively contribute to the development of the underground economic activity.

To characterize the growth effects in the size of the underground economy in the long run, equation (12) financial development and trade openness variables will be expressed through a logarithmic form, while the size of the underground economy and interest rate variables are already in percent forms, and will be used in their natural forms. Equation becomes;

$$UE_{it} = \beta_0 + \beta_1 \ln FD_{it} + \beta_2 \ln TRD_{it} + \beta_3 INT_{it} + u_{it} \qquad (13)$$

where $t$ denotes time period, $i$ denotes cross-sectional countries , $UE$ is the size of the underground economy variable, $\ln FD$ is the natural log of the financial development variable, $\ln TRD$ is the natural log of the international trade openness variable, $INT$ is the interest rate variable, and $u$ is the error disturbance.

# Chapter 6

# DATA AND EMPIRICAL METHODOLOGY

This study will examine the impact of financial sector development, international trade openness, interest rate on the size of the underground economy with evidence on the European Union countries. Static framework will be created and functional relationship will be investigated. Panel data will be employed in this thesis, because of usefulness when suspected outcome variable depends on explanatory variables which are not observable but correlated with the observed explanatory variables (see Schmidheiny, 2011). In order to drive feasible policy implications, not only balanced panel data regression will be estimated, but also variance decompositions of the size of the underground economy to examine which variable is the most important contributor to the underground economy over time and how much they contribute to the underground economy.

## 6.1 Data

Annual data covering the period of 1994 to 2014 utilized in the rest of this thesis. The variables of this study are the size of the underground economy (UE), the composite financial development index as a proxy for financial sector development (FD), international trade openness (TRD) that been proxy by the sum of exports plus imports of goods and services as a percentage of the GDP, and the long-term interest rate (INT). The size of the underground economy as percent of GDP has been estimated by using MIMIC model approach in IBM AMOS software, the financial development index has been estimated by using principal component factor analysis in SPSS software. Trade openness has been obtained from World Data Bank. Interest rate is the long-term interest rates, per cent per annum that has been obtained from OECD statistics database. Long-term interest rates refer to government bonds maturing in 10 years.  Interest rates are determined by the lender, risk from the borrower and the fall in capital value. Long-term interest rate that will be employed in this thesis is the rate that averages daily rates, measured as a percentage. The long-term interest rate will be used because long-term estimations are made between the variables of interest.

The impact of the financial development, trade openness, and interest rate on the size of the underground economy intended to be investigated in all the European Union countries, but due to the data availability, Bulgaria, Croatia, Cyprus, Estonia, Latvia, Lithuania, Malta, and Romania are excluded from the study. Therefore, the impact will be investigated for the rest of the European Union countries.

Since we are talking about the data and the cross-sectional units that will be employed in this study, it is worth mentioning about the presence of high probability of facing cross-sectional dependency in this data set. Gaibulloev et al. (2014) stated that cross-sectional dependence where cross-country observations are influenced by common consideration that dependence may arise since countries respond to similar political, economic or spatial stimuli. As the European Union countries are the study field of this study, it is expected to find the evidence of cross-sectional dependence.

## 6.2 Empirical Methodology of Static Framework

Annual data will be use to employed several analyses. Initially, variables will be checked whether they are stationary or not. On the light of existence of unit root, i.e. non-stationarity, analysis will be carried out on to examine the co-integration vector and then error correction models will be estimated for short-term and long-term coefficients. On the other hand, if the variables have stationary nature, pooled OLS, random-effects and fixed-effects estimations will be carried out. After diagnostics check, if it is necessary new estimations will be carried out in order to control the cross-sectional dependency, heteroscedasticity, and serial correlation.

As a first step, as it mentioned previously, panel unit root test will be carried out in order to determine whether the variables are stationary or not. There are several econometric approaches will be employed to detect unit root. In order to check stationary nature of series, Levin, Lin, Chu (LLC), Breitung, and Im, Pesaran, Shin (IPS) unit root tests will be applied to detect the existence of unit root. Levin, Lin, Chu (LLC) and Breitung unit root tests had been applied to detected common unit root in panel variables, while Im, Pesaran, Shin (IPS) unit root test has been applied to detect individual unit root in cross-sections. Levin, Lin, Chu (LLC), Breitung, and Im, Pesaran, Shin (IPS) unit root test uses the null hypothesis of the existence of unit root.

In the case of presence of the stationary nature of panel variables, pooled OLS (ordinary least squares), random-effects and fixed-effects estimations will be carried out. Initially pooled OLS estimation will be carried out, then random –effects estimation, and finally fixed-effects estimation. Meanwhile several tests will be applied to determine right estimation for models in addition to other diagnostics. If any of cross-sectional dependency, heterogeneity, or serial correlation has evidence in the data, new estimations will be carried out to reach optimal analysis by taking in to consideration of cross-sectional dependency, heterogeneity, and serial correlation.

### 6.2.1 Pooled OLS Estimation

As parallel to study of Schmidheiny (2011) Multiple linear regression model for individual or cross-sections i = 1, …..N and time periods t= 1, …..T.

$$y_{it} = \mu + \beta * x_{it}^{'} + \gamma * z_{i}^{'} + \alpha_i + u_{it} \quad (14)$$

Where $y_{it}$ is the dependent, $x_{it}^{'}$ is with K dimensional row vector the time varying explanatory variable, $z_{i}^{'}$ with M dimensional row vector is the time invariant explanatory variable excluding the intercept, $\mu$ is the intercept, $\beta$ is with K dimensional column vector of the slope coefficients of relevant regressors, $\gamma$ is a M dimensional column vector of parameters, $\alpha_i$ is the individual-specific effect or unobserved effect which is taken to be constant over time, $u_{it}$ is an idiosyncratic error term. The T observations for individual I can be summarized as;

$$y_i = \begin{bmatrix} y_{i1} \\ . \\ . \\ . \\ y_{iT} \end{bmatrix}_{Tx1} \quad x_i = \begin{bmatrix} x_{i1}^{'} \\ . \\ . \\ . \\ x_{iT}^{'} \end{bmatrix}_{TxK} \quad z_i = \begin{bmatrix} z_{i}^{'} \\ . \\ . \\ . \\ z_{i}^{'} \end{bmatrix}_{TxM} \quad u_i = \begin{bmatrix} u_{i1} \\ . \\ . \\ . \\ u_{iT} \end{bmatrix}_{Tx1}$$

And NT observations for all individuals and time periods as;

$$y = \begin{bmatrix} y_1 \\ . \\ . \\ . \\ y_N \end{bmatrix}_{NTx1} \quad X = \begin{bmatrix} X_1 \\ . \\ . \\ . \\ X_N \end{bmatrix}_{NTxK} \quad Z = \begin{bmatrix} Z_1 \\ . \\ . \\ . \\ Z_N \end{bmatrix}_{NTxM} \quad u = \begin{bmatrix} u_1 \\ . \\ . \\ . \\ u_N \end{bmatrix}_{NTx1}$$

Data generation process includes linearity, independence, strict exogeneity, and error variance assumptions;

P.1 Linearity;

With the assumption of E[ $u_{it}$ ]=0 and E[ $\alpha_i$ ]=0, the model (14) is linear in parameters, $\mu$ , $\beta$ , $\gamma$ , individual-specific error $\alpha_i$ , and idiosyncratic error $u_{it}$ .

P.2 Independence;

Independence states that the observations are independent across individuals but not necessarily across time, $(x_i, z_i, y_i)_{i=1}^{N}$ independent and identically distributed.

P.3 Strict Exogeneity;

The idiosyncratic error term $u_{it}$ is assumed uncorrelated with the explanatory variables of all past, current, and future time periods of same cross-section. Strict exogenity, $E[u_{it} | X_i, z_i, \alpha_i] = 0$ (mean independent) assumes that the idiosyncratic error is uncorrelated with cross-sectional effect.

P.4 Error Variance;

P.4.1 $V[u_i | X_i, z_i, \alpha_i] = \sigma_u^2 I$, $\sigma_u^2 > 0$ and finite

(homoscedastic and absence of serial correlation)

P.4.2 $V\left[u_{it} \middle| X_i, z_i, \alpha_i\right] = \sigma^2_{u,it} > 0$ finite and

$Cov\left[u_{it}, u_{is} \middle| X_i, z_i, \alpha_i\right] = 0, \ \forall s \neq t$ (absence of serial correlation)

P.4.3 $V\left[u_i \middle| X_i, z_i, \alpha_i\right] = \Omega_{u,i}\left(X_i, z_i\right)$ is p.d. and finite.

Pooled OLS Estimation;

Pooled OLS estimator ignores the panel structure of the data and estimates $\mu$, $\beta$, and $\gamma$ as,

$$\begin{pmatrix} \hat{\mu}_{POLS} \\ \hat{\beta}_{POLS} \\ \hat{\gamma}_{POLS} \end{pmatrix} = \left(W^{'}W\right)^{-1} W^{'} y$$

Where W=$\left[\iota_{NT} XZ\right]$ and $\iota_{NT}$ is a NT x 1 vector of ones.

There are several reasons to use independently cross-sections. Wooldridge (2009) states the advantages as increasing the sample size, getting more precise estimators and more powerful test statistics. Pooling is helpful if and only if the relationship between the dependent variable and at least one independent variable stays the same over time. If unobserved effects, i.e. $\alpha_i$, is constant across all units, OLS (ordinary least square) provides consistent and efficient estimates of $\alpha$ and $\beta$. Although pooled OLS estimation has also some drawbacks. First of all, in order to pooled OLS to produce a consistent estimate of $\beta$, it assumes unobserved effect is uncorrelated with regressors, $x_{it}$. Second drawback is that while pooled OLS produce consistent estimator of $\beta$, it uses the assumption composite error $v_{it}$, where $v_{it}$ is the summation of $\alpha_i$ and $u_{it}$, is uncorrelated with . This assumption is true only if single cross-section or two cross-sections are pooled to use in model. If $u_{it}$ is uncorrelated with $x_{it}$, and $\alpha_i$ is correlated with $x_{it}$, then the pooled OLS is biased and inconsistent. This called heterogeneity bias, in fact it caused from omitting a time-constant variable.

**6.2.2 Fixed -Effects Estimation**

Fixed-effects estimation explores the relationship between the dependent variable and the explanatory variables within in entity such as country or company. Each entity has its own individual characteristics that may influence the explanatory variables or not. In this study fixed-effects estimation will be use in order to analyse the impact of variables that are varying over time. Baltagi (2005) stated that fixed-effects model is appropriate specification, if specific set of counties are focused. Greene (1990) states that fixed-effects model is a reasonable approach when we can be confident that the differences between units can be viewed as parametric shifts of the regression function. The reason in using fixed-effects estimator is to eliminate $\alpha_i$ when it is thought to be correlated with one or more explanatory variables. Schmidheiny (2011) states in the fixed-effects model, individual-specific effect allowed to be correlated with the explanatory variables. Fixed-effects estimator uses a transformation to remove the unobserved effect $\alpha_i$ prior to estimation. Fixed-effects estimators subtract time averages from corresponding data. Any time constant explanatory variables are removed along with $\alpha_i$. Fixed-effects transformation which is also known as within transformation with multiple explanatory variables for each i;

$$y_{it} = \mu + \beta * x_{it}^{'} + \gamma * z_i^{'} + \alpha_i + u_{it} \qquad (15)$$

Where $\beta$ is slope coefficient of explanatory variable of $x_{it}$ , $\alpha_i$ is individual-specific error or unobserved effect of fixed-effects, it is time constant factor that effect $y_{it}$ ; $u_{it}$ is idiosyncratic error or time varying error, it is unobserved factor that change over time effect $y_{it}$ . By averaging the equation over time;

$$\bar{y}_i = \mu + \beta * \bar{x}_i + \gamma * z_i + \alpha_i + \bar{u}_i \qquad (16)$$

Subtracting equation (15) from equation (16) for every t;

$$y_{it} - \bar{y}_i = \beta(x_{it} - \bar{x}_i) + (u_{it} - \bar{u}_i), \qquad (17)$$

or

$$\ddot{y}_{it} = \beta \ddot{x}_{it} + \ddot{u}_{it}, \qquad (18)$$

Where $\ddot{y}_{it}$ , $\ddot{y}_{it} = y_{it} - \bar{y}_i$ , is the time demeaned data on y; $\ddot{x}_{it}$ , $\ddot{x}_{it} = x_{it} - \bar{x}_i$ , is the time demeaned data on $x_i$ ; $\ddot{u}_{it} = u_{it} - \bar{u}_i$ , is the time demeaned data on $u_i$ . Note that individual-specific effect $\alpha_i$ , time invariant regressor $z_i$ , and the intercept $\mu$ are cancelled from the equation. Since unobserved effect $\alpha_i$ , has disappeared, equation (18) must be estimated by pooled OLS. The pooled OLS based on time demanded variables called fixed-effects estimator or within estimator, does not include intercept $\mu$ or $z_i$ . Related effects, effect variance, and identifiability are the main fixed-effects model assumptions.

FE.1 Related Effect;

$$E[\alpha_i | X_i, z_i] \neq 0$$

Individual-specific effect is a random variable that is correlated with explanatory variables.

FE.2 Effect Variance;

This assumption declares the non-constant variance of the individual-specific effect. FE.2 assumption states the absence of assumption RE.2 that will be covered in detail in the following section.

FE.3 Identifiability;

$rank(\ddot{X}) = K < NT$ and $E(\ddot{x}_i^{'}, \ddot{x}_i)$ is p.d. and finite

where the typical element $\ddot{x}_{it} = x_{it} - \bar{x}_i$ and $\bar{x}_i = 1/T \sum_t x_{it}$

Identifiability assumption assumes the time varying explanatory variables are not perfectly collinear, that they have non-zero within variance and not too many extreme values.

<u>Fixed-effects Estimation:</u>

The fixed-effects estimator or within estimator of the slope coefficient $\beta$ estimates the within model by OLS;

$$\hat{\beta}_{FE} = \left(\ddot{X}'\ddot{X}\right)^{-1}\ddot{X}'\ddot{y} \tag{19}$$

Fixed-effects estimator is unbiased under strict exogeneity assumption on explanatory variables, that idiosyncratic error $u_{it}$ should be uncorrelated with each explanatory variable across each time period. Fixed-effects estimator allows correlation between $\alpha_i$ and the explanatory variables in any time period. The other assumption is that $u_{it}$ is homoscedastic and serially uncorrelated across time in order to obtain valid OLS analysis.

**6.2.3 Random-Effects Estimation**

Random-effects estimator is the right estimation, when unobserved effect is uncorrelated with explanatory variables. In the case of using good controls in equation, it might believe that any leftover neglected heterogeneity only includes heterogeneity induces serial correlation in the composite error term, but does not cause correlation between composite errors and explanatory variables. Since the differences across entities such as countries, might have some influence on the dependent variable, therefore random-effects estimation will be used in this study. Baltagi (2005) suggests that random-effects model is appropriate specification if N numbers of countries are drawn from a large population. Random-effects model uses the individual-specific effect model with intercept;

$$y_{it} = \mu + \beta * x_{it}' + \gamma * z_i' + \alpha_i + u_{it}, \tag{20}$$

Where $\mu$ is intercept, $\beta$ is slope coefficient of explanatory variable of $x_{it}$, $\alpha_i$ is individual-specific or unobserved effect of fixed-effects, it is time constant factor that effect $y_{it}$; $z_i^{'}$ is the time invariant explanatory variable excluding the constant; $u_{it}$ is idiosyncratic error or time varying error, it is unobserved factor that change over time effect $y_{it}$. Individual-specific error or unobserved effect has the zero mean assumption in the equation. Random-effects model assumes unobserved effect $\alpha_i$ is uncorrelated with each explanatory variable in past, current, and future times, Cov $(x_{it}, \alpha_i)$ =0, t= 1, 2, 3,…T, j= 1, 2. 3, …K. Unrelated effects, effect variance, and identifiability are random-effects model assumptions.

RE.1 Unrelated Effects

$$E[\alpha_i | X_i, z_i] = 0$$

Individual-specific effects or unobserved affect is a random variable that is not correlated with the explanatory variables in all the time fore same individual.

RE.2 Effect Variance

RE.2.1 $V[\alpha_i | X_i, z_i] = \sigma_c^2 < \infty$ ( homoscedastic)

RE.2.2 $V[\alpha_i | X_i, z_i] = \sigma_{c,i}^2 (X_i, z_i) < \infty$ ( heteroskedastic)

That assumes constant variance of the individual-specific effect or unobserved effect.

RE.3 Identifiability

RE.3.1 $rank(W) = K + M + 1 < NT$ and $E[W_i^{'}W_i] = Q_{WW}$ is p.d. and finite.

The typical element $w_{it}^{'} = [1 x_{it}^{'} z_i^{'}]$.

RE.3.2 $rank(W) = K + M + 1 < NT$ and $E[W_i^{'}\Omega_{v,i}^{-1}W_i] = Q_{WOW}$ is p.d. and finite.

Identifiability assumes that the regressors including a constant and not perfectly collinear, that all regressors have non-zero variance and not too many extreme values.

Random-effects assumptions are fixed-effects assumptions plus an additional assumption of unobserved effect $\alpha_i$ is independent of all explanatory variables in all time periods. Fixed-effects assumptions are strict exogeneity assumption on explanatory variables and other assumption is that $u_{it}$ is homoscedastic and serially uncorrelated across time in order to obtain valid OLS analysis. $\beta$'s can be consistently estimated by single cross-section, but single cross-section disregards important information in other time periods. On the other hand, if just run pooled OLS of $y_{it}$ on the explanatory variables, that produce consistent estimators of $\beta_j$ under the random-effects assumption but ignores the key feature of the model. The unobserved effect model with composite error term $v_{it}$, $v_{it} = \alpha_i + u_{it}$; If the equation (20) will be written as;

$$y_{it} = \mu + \beta * x_{it}^{'} + \gamma * z_i^{'} + v_{it} \qquad (21)$$

Where $v_{it} = \alpha_i + u_{it}$. Assuming P.2, P.4 and RE.1 in the special versions P.4.1 and RE.2.1 leads to

$$\Omega_v = V[v|X,Z] = \begin{pmatrix} \Omega_{v,1} & . & . & 0 & . & . & 0 \\ . & . & & & & & . \\ . & & . & & & & . \\ 0 & & & \Omega_{v,i} & & & 0 \\ . & & & & . & & . \\ . & & & & & . & . \\ 0 & . & . & 0 & . & . & \Omega_{v,n} \end{pmatrix}_{NTxNT} \qquad (22)$$

With typical element;

$$\Omega_{v,i} = V[v_i|X_i, Z_i] = \begin{pmatrix} \sigma_v^2 & \sigma_\alpha^2 & . & . & . & . & \sigma_\alpha^2 \\ \sigma_\alpha^2 & \sigma_v^2 & & & & & \sigma_\alpha^2 \\ . & & . & & & & . \\ . & & & . & & & . \\ . & & & & . & & . \\ . & & & & & . & . \\ \sigma_\alpha^2 & \sigma_\alpha^2 & . & . & . & . & \sigma_v^2 \end{pmatrix}_{TxT} \qquad (23)$$

The special case under P.4.1 and RE.2.1is called equicorrelated random-effects model. Equation (21) pointed out the where the $v_{it}$ are serially correlated across time. Wooldridge (2002) states the serial correlation in error term is substantial, pooled OLS ignores the correlation. Therefore, will yield to incorrect results. In order to solve serial correlation problem GLS has to be used.

**Random Effects Estimation**

Random-effects estimator is feasible with GLS (generalized least squares) estimator;

$$\begin{pmatrix} \hat{\mu}_{RE} \\ \hat{\beta}_{RE} \\ \hat{\gamma}_{RE} \end{pmatrix} = \left(W'\hat{\Omega}_V^{-1}W\right)^{-1} W'\hat{\Omega}_V^{-1} y \tag{24}$$

Where W=$\left[\iota_{NT} XZ\right]$and $\iota_{NT}$ is a NTx1 vector of ones. The error covariance matrix $\Omega_v$ is assumed block-diagonal with equicorrelated diagonal elements $\Omega_{v,i}$ which depends only the two unknown parameter $\sigma_v^2$ and $\sigma_\alpha^2$. Several ways are available to estimate $\sigma_v^2$ and $\sigma_\alpha^2$;

$$\hat{\sigma}_v^2 = \frac{1}{NT}\sum_{t=1}^{T}\sum_{i=1}^{N}\hat{v}_{it}^2\ , \quad \hat{\sigma}_\alpha^2 = \hat{\sigma}_v^2 - \hat{\sigma}_u^2 \tag{25}$$

where

$$\hat{\sigma}_u^2 = \frac{1}{NT-N}\sum_{t=1}^{T}\sum_{i=1}^{N}(\hat{v}_{it} - \bar{\hat{v}}_i\ )^2 \tag{26}$$

Where $\hat{v}_{it} = y_{it} - \alpha_{POLS} - x_{it}'\hat{\beta}_{POLS} - z_i'\hat{\gamma}_{POLS}$ and $\bar{\hat{v}}_i = 1/T\sum_{t=1}^{T}\hat{v}_{it}$ . The degree of freedom connection in $\hat{\sigma}_u^2$ is also asymptotically important when $N \to \infty$.

The advantage of random-effects over fixed-effects is that random-effects transformation allows for explanatory variables that are constant over time. Whether the explanatory variables are fixed over time or not, it is possible to assume unobserved effect is uncorrelated from with all explanatory variables.

### 6.2.4 Breusch and Pagan Langrangian Multiplier (LM)

Breusch and Pagan (1980) set forth Lagrange Multiplier (LM) test for random-effects based on simple OLS in another words pooled estimator. Breush and Pagan test for one-way random-effects model, with $\hat{u}_{it}$ that is the $i$ th residual from the OLS regression;

$$BP = \frac{NT}{2(T-1)}\left[\frac{\sum_{i=I}^{N}\left[\sum_{t=I}^{T}\hat{u}_{it}\right]^2}{\sum_{i=I}^{N}\sum_{t=I}^{T}\hat{u}_{it}^2} - 1\right]^2 \tag{27}$$

Breush and Pagan test for two-way random-effects model by Greene (2000)

$$BP2 = \frac{NT}{2(T-1)}\left[\frac{\sum_{i=I}^{n}\left[\sum_{t=I}^{T}\hat{u}_{it}\right]^2}{\sum_{i=I}^{N}\sum_{t=I}^{T}\hat{u}_{it}^2} - 1\right]^2 + \frac{NT}{2(T-1)}\left[\frac{\sum_{i=I}^{T}\left[\sum_{t=I}^{N}\hat{u}_{it}\right]^2}{\sum_{i=I}^{N}\sum_{t=I}^{T}\hat{u}_{it}^2} - 1\right]^2 \tag{28}$$

Breusch and Pagan test is distributed under Chi square statistics with two degree of freedom. The residuals are obtained from pooled regression in both cases.

In order to decide between random-effects regression or OLS regression Breusch and Pagan Lagrangian multiplier (LM) test will be carried out for random effects. LM test uses the null hypotheses of variances across entities are zero that is no significant difference across units. In the case of rejecting null hypothesis, so the evidence of significant difference across entities is obtained. Therefore, random-effects regression must to be carried out. Otherwise OLS regression must be carried out.

### 6.2.5 Heteroskedasticity

Baum (2001) states GroupWise heteroscedasticity is a condition where error process is may be homoscedastic within cross-sectional units but its variance may different across units. Greene (2000) specifies modified Wald statistics for groupwise heteroscedasticity in the residuals of fixed-effects regression model uses the null hypothesis that is $\sigma_i^2 = \sigma^2$ for $i = 1, \ldots\ldots, N_g$ is the number of cross-sectional units. Let $\hat{\sigma}_i^2 = T_i^{-1} \sum_{t=1}^{T_i} e_{it}^2$ be the estimator of the $i$ th cross-sectional unit's error variance, based upon the $T_i$ residuals $e_{it}$ available for that unit. Then define

$$V_i = T_i^{-1}(T_i - 1)^{-1} \sum_{t=1}^{T_i} (e_{it}^2 - \hat{\sigma}_i^2)^2 \qquad (29)$$

As the estimated variance of $\hat{\sigma}_i^2$. The modified Wald test statistics, defined as

$$W = \sum_{i=1}^{N_g} \frac{(\hat{\sigma}_i^2 - \hat{\sigma}^2)^2}{V_i} \qquad (30)$$

Will be distributed as $\chi^2[N_g]$ under the null hypothesis. Heteroskedastic test is the one of the diagnostic that has to be detecting weather standard error component is homoscedastic with the same variance across time and individuals, or not. Importance is that in the presence of the heteroscedasticity the standard errors of estimates will be biased. It uses the null hypothesis is that homoscedastic in another words constant variance. The null hypothesis of homoscedasticity has been rejected. In the presence of the heteroscedasticity, the standard errors of the estimates will be biased, so robust standard errors will be computed to correcting the possible presence of the heteroscedasticity in preferred model estimation that has been determined by the Hausman test.

**6.2.6 Poolability Test**

One of the main motivations behind of using independently cross-section is to increase sample size. Wooldridge (2002) states that by pooling a time series of cross-sections is to broaden the data set and get more precise and more powerful data. In order to testing the poolability of data i.e. for detecting the presence of individual-specific effects, a simple test with null hypothesis is that the OLS model: $y_{it} = \mu + \beta^{'} x_{it} + u_{it}$ and its alternative FE model: $y_{it} = \mu + \beta^{'} x_{it} + \alpha_i + u_{it}$ (see Antonie et al., 2010). Formally the null hypothesis is that, $H_0 : \alpha_i = 0, i = 1,2,3,....N$. $F$ statistics has been considered in the construction principle:

$$F_{one-way} = \frac{(ESS_R - ESS_U)/(N-1)}{ESS_U /((T-1)N - K)} \quad (31)$$

where $ESS_R$ stands for the residual sum of the squares under the null hypothesis, $ESS_U$ stands for the residual sum of the squares under the alternative hypothesis. Under null hypothesis, the statistics of $F_{one-way}$ is distributed as $F$ with $(N-1,(T-1)N-K)$ degree of freedom. Note that both sums of squares evolve from OLS and FE estimations. Rejecting null hypothesis means that the ordinary least square estimates are biases and inconsistent and OLS estimates suffers from an omission variables problem.

**6.2.7 Hausman Test**

Antonie et al. (2010) state that Hausman principle used to applied to all hypothesis testing problems, in which two different estimators are available. In this scenario, Hausman test statistics will be used to differentiate between fixed-effects and random-effects estimator in panel data, Hausman test uses the null hypothesis of preferred estimator as random-effects due to higher efficiency, against alternative hypothesis is fixed-effects estimator is at least consistent and preferred. Hausman statistics used to detect preferred estimator with;

$$H = (b_0 - b_1)'\left(Var(b_0) - Var(b_1)\right)^{-1}(b_0 - b_1) \tag{32}$$

where $b_1$ denotes random-effects estimator while $b_0$ denotes fixed-effects estimator. Null hypothesis of both estimators, $b_0$ and $b_1$, are consistent, but $b_1$ is efficient. Under the alternative hypothesis, $b_0$ is consistent while $b_1$ in not consistent. Basically, it tests whether the idiosyncratic errors are correlated with the explanatory variables or not, where null hypothesis is that idiosyncratic errors and explanatory variables are not correlated. In order to decide rather fixed-effects or random-effects estimation should be preferred in analyses, Hausman test will be carried out.

**6.2.8 Pesaran Cross-Sectional Dependency Test**

Cross-sectional dependency test is based on the pairwise correlation, $\hat{\rho}_{ij}$, that proposed by Pesaran (2004);

$$CD = \sqrt{\frac{2}{N(N-1)}} \sum_{i=1}^{N} \sum_{j=i+1}^{N} \sqrt{T_{ij}}\, \rho_{ij} \tag{33}$$

Test statistics has a zero mean for constant $N$ and $T_{ij}$ under wide class of panel data models. For every $i \neq j$, as $T_{ij} \to \infty$, $\sqrt{T_{ij}}\hat{\rho}_{ij} \Rightarrow N(0,1)$. Therefore $N$ and $T_{ij}$ tending to infinity in any order, $CD \Rightarrow N(0,1)$. In order to boost the power, against the alternative hypothesis of local dependency, $CD_p$ test proposed by Pesaran (2004). Since local dependency defined with respect of a weight matrix, the test can be applied if the cross-sectional unit can be given ordering that remains same over time. Under the alternative hypothesis of a $p$ th order local dependency, the CD statistic can be generalized to a local CD test, $CD_p$ ;

$$CD_p = \sqrt{\frac{2}{p(2N-p-1)}}\left(\sum_{s=1}^{p}\sum_{i=s+1}^{N}\sqrt{T_{i,i-s}}\,\hat{\rho}_{i,i-s}\right)$$

$$= \sqrt{\frac{2}{p(2N-p-1)}}\left(\sum_{s=1}^{p}\sum_{i=1}^{N-s}\sqrt{T_{i,i-s}}\,\hat{\rho}_{i,i+s}\right) \quad (34)$$

where p=1,….., N-1. When p=N-1, $CD_p$ reduces to the original CD test. Under the null hypothesis of zero cross-sectional dependency, the $CD_p$ statistical is centered at zero for fixed N and $T_{i,i-s} > k+1$, and $CD_p \Rightarrow N(0,1)$ as $N \to \infty$ and $T_{i,i+s} \to \infty$.

Pesaran CD (cross-sectional dependency) test checks whether there is a cross-sectional dependence in another words contemporaneous correlation or not. Pesaran CD test is other test that must be checked in macro panels. Pesaran CD tests whether the residuals are correlated across entities such as countries. It uses the null hypothesis is that residuals are not correlated. Cross-sectional dependency may lead to bias in test results. Baltagi (2005) states the cross-sectional dependency is a problem with macro panels with long time series that is over 20 to 30 years. Since this study uses macro panel it is necessary to check cross-sectional dependency. In the light of existence of cross-sectional dependency, Hoechle (2007) suggest to use fixed-effects estimation with Driscoll and Kraay standard errors that will be explained in detail in following sections.

**6.2.9 Wooldridge Test for Serial Correlation**

Wooldridge test for serial correlation in another word Wooldridge test for the presence of unobserved effect, uses the null hypothesis errors are serially correlated. Wooldridge (2002) proposed to test for AR(1) serial correlation. Test statistics proposes;

$$W = \frac{\sum_{i=1}^{N}\sum_{t=1}^{T-1}\sum_{s=t+1}^{T}\hat{u}_{it}\hat{u}_{is}}{\left[\sum_{i=1}^{N}\left(\sum_{t=1}^{T-1}\sum_{s=t+1}^{T}\hat{u}_{it}\hat{u}_{is}\right)^{2}\right]^{1/2}} \rightarrow N(0,1) \tag{35}$$

where $\hat{u}_{it}$ are the pooled OLS residuals. The test statistics W can detect many types of serial correlation in the error term $u$ .

Finally, Wooldridge test for serial correlation will be detected. Antonie et al. (2010) stated that presence of serial correlation will in linear panel data model biases the standard errors and causes the results to be less efficient. Serial correlation causes the standard errors of the coefficients to be smaller than they are actually are, and higher serial correlation. Baltagi and Li joint LM test for serial correlation and random cross-sectional effects; Wooldridge test for the presence of unobserved effects i.e. serial correlation; Bera, Sosa Escudero and Yoon modified Rao's score test in the presence of local misspecification; Baltagi and Li LM test for first-order correlation under fixed-effects; Durbin-Watson Statistic are some of the tests for serial correlation. Among many serial correlation tests, the one that propose by Wooldridge (2002) has been preferred because of implementation ease and uses few assumptions.

Wooldridge test for serial correlation uses the null of hypothesis is that no serial correlation. Drukker (2003) implemented this test in STATA software that performs Wald test with null hypothesis that is no first order autocorrelation. In case of presence of the serial correlation, serial correlation in error terms will be mitigate by using lagged depended variable as explanatory variable in preferred model estimation.

### 6.2.10 Driscoll and Kraay Estimator

Standard error estimates of commonly applied covariance matrix estimation techniques are biased hence the statistical inference that based on such standard errors are invalid. Fortunately, Driscoll and Kraay (1998) propose a nonparametric covariance matrix estimator which generates heteroscedasticity consistent standard errors that are robust to very general forms of spatial and temporal dependence. Hoechle (2007) implemented Driscoll and Kraay‘s covariance matrix estimation for pooled OLS/WLS estimation and (within) fixed-effects with assumption of the error structure is heteroskedastic, auto correlated up to some lag and probably correlated between cross-sections. And the pointed out that sample properties are significantly better than those of the alternative covariance estimators when cross-sectional dependency is presents. Let linear regression is;

$$y_{it} = \beta * x_{it}^{'} + u_{it} \tag{36}$$

where $y_{it}$ is the dependent variable; $x_{it}$ is a (K+1)x1 vector of independent variables whose first element is 1; $\beta$ is a (K+1)x1 vector of unknown coefficients i.e. slope coefficients; i denotes cross-sectional units, i=1, …., N; and t denotes time, t=1, …., T. All observations salt down as;

$y = \left[ y_{1t_{11}} .....y_{1T_1} .....y_{2t_{21}} .....y_{NT_N} \right]$ and $x = \left[ x_{1t_{11}} .....x_{1T_1} .....x_{2t_{21}} .....x_{NT_N} \right]$

It is assumed strong exogenity that is independent variables are uncorrelated with the error term for all the cross-sections and for all time periods. Meanwhile the error terms i.e. disturbances are allowed to be heteroskedastic, auto correlated, and cross-sectionally dependent. Under the assumptions, $\beta$ can be estimated by Driscoll and Kraay standard errors for pooled OLS estimation as;

$$\hat{\beta} = \left( X^{'} X \right)^{-1} X^{'} y \qquad (37)$$

Driscoll and Kraay standard errors for the coefficient estimates are then obtained as the square roots of the diagonal elements of the robust covariance matrix;

$$V(\hat{\beta}) = \left( X^{'} X \right)^{-1} \hat{S}_T \left( X^{'} X \right)^{-1} \qquad (38)$$

Where $\hat{S}_T$ is defined as in Newest and West (1987):

$$\hat{S}_T = \hat{\Omega}_0 + \sum_{j=1}^{m(T)} w(j,m) \left[ \hat{\Omega}_j + \hat{\Omega}_j^{'} \right] \qquad (39)$$

Where m(T) denotes the lag length up to which the residuals may be auto correlated and the modified Bartlett weights;

$$w(j, m(T)) = 1 - j / (m(T) + 1) \qquad (40)$$

Where (K+1)x(K+1) matrix $\hat{\Omega}_j$ is defined as;

$$\hat{\Omega}_j = \sum_{t=j+1}^{T} h_t(\hat{\beta}) h_{t-j}(\hat{\beta})' \qquad \text{where} \qquad h_t(\hat{\beta}) = \sum_{i=1}^{N(t)} h_{it}(\hat{\beta}) \tag{41}$$

In equation (40) the sum of individual time moment condition $h_{it}(\hat{\beta})$ runs from 1 to N(t) where N is allowed to vary with t. In the case of pooled OLS estimations the individual orthogonality conditions $h_{it}(\hat{\beta})$ in equation (40) are the (K+1)x1 dimensional moment conditions of linear regression model;

$$h_{it}(\hat{\beta}) = x_{it}\hat{u}_{it} = x_{it}(y_{it} - x_{it}'\hat{\beta}) \tag{42}$$

Equation (39) and (41) follows that Driscoll and Kraay's covariance matrix estimator equals the heteroskedastic and autocorrelation consistent covariance matrix. Consistent results are even holds the limiting case where $N \to \infty$.This estimation yields standard errors that are robust to very general forms of temporal and cross-sectional dependency. Fixed-effects estimation with Driscoll and Kraay standard errors implemented in two steps, in the first step all model variables $z_{it} \in \{y_{it} x_{it}\}$ are within transformed as

$$\tilde{z}_{it} = z_{it} - \bar{z}_i + \bar{\bar{z}} \qquad \text{where} \qquad \bar{z}_i = T_i^{-1} \sum_{t=t_{i1}}^{T_i} z_{it} \quad \text{and} \quad \bar{\bar{z}} = \left(\sum T_i\right)^{-1} \sum_i \sum_t z_{it}$$

Recognizing that the within estimator corresponds to the OLS estimator of;

$$\tilde{y}_{it} = \tilde{x}_{it}^{'}\beta + \tilde{u}_{it} \qquad (43)$$

In the second step then estimates transformed regression model in equation (42) by pooled OLS estimation with Driscoll and Kraay standard errors. Weighted Least Square (WLS) regression with Driscoll and Kraay standard errors is also performed in two steps. First step applies the transform $\tilde{z}_{it} = \sqrt{w_{it}}z_{it}$ to all model variables and the second step then estimates the transformed model in equation (43) by pooled OLS regression.

$$\tilde{y}_{it} = \tilde{x}_{it}^{'}\beta + \tilde{u}_{it} \qquad (44)$$

In the case of presence of serial correlation and cross-sectional dependency, fixed-effects estimation with Driscoll and Kraay standard errors will be carried out.

### 6.2.11 Variance Decomposition and Impulse Responses

In the following step, variance decomposition and impulse response will be carried out. Brooks (2008) In order to examine the whether the changes in the value of a given variable has a positive or negative effect on other variables in the system and how long it would take for the effect of the variable to work through the system. The variance decompositions for the size of the underground economy (UE) is estimated, which determines the percentage of the forecast error variance of the dependent variable the can be explained by exogenous shocks to regress and variables. Finally, impulse responses are estimated to investigate the responsiveness of selected reactions to the exogenous shocks in the series.

Impulse responses trace out the responsiveness of dependent variables in VAR (vector auto regressive) to shocks to each of the variables. Impulse responses generated on the basis of applied unit shocks to each variable from each equation separately and effects upon VAR the system over time are noted. In order to illustrate how impulse responses operate, consider bivariate VAR(1) as;

$$y_t = A_1 y_{t-1} + u_t \qquad \text{where} \quad A_1 = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \tag{45}$$

By using the elements of the matrices and the vectors, the VAR can be written as;

$$\begin{bmatrix} y_{1t} \\ y_{2t} \end{bmatrix} = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} y_{1t-1} \\ y_{2t-1} \end{bmatrix} + \begin{bmatrix} u_{1t} \\ u_{2t} \end{bmatrix}$$

Unit shock to $y_{1t}$ over time, t=0, 1, 2 illustrates respectively;

$$y_0 = \begin{bmatrix} u_{10} \\ u_{20} \end{bmatrix} = \begin{bmatrix} 1 \\ 0 \end{bmatrix}$$

$$y_1 = A_1 y_0 = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} 1 \\ 0 \end{bmatrix} = \begin{bmatrix} a \\ c \end{bmatrix}$$

$$y_2 = A_1 y_1 = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} a \\ c \end{bmatrix} = \begin{bmatrix} a^2 + bc \\ ac + dc \end{bmatrix}$$

Unit shock to $y_{1t}$ over time, t=0, 1, 2 illustrates respectively;

$$y_0 = \begin{bmatrix} u_{10} \\ u_{20} \end{bmatrix} = \begin{bmatrix} 0 \\ 1 \end{bmatrix}$$

$$y_1 = A_1 y_0 = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} 0 \\ 1 \end{bmatrix} = \begin{bmatrix} b \\ d \end{bmatrix}$$

$$y_2 = A_1 y_1 = \begin{bmatrix} a & b \\ c & d \end{bmatrix} \begin{bmatrix} b \\ d \end{bmatrix} = \begin{bmatrix} ab + bd \\ bc + d^2 \end{bmatrix}$$

On the other hand, variance decomposition offers different method for examining VAR system dynamics. They give the proportion of the movements in the dependent variables that are due to their own shocks to the other variables. Variance decompositions determine how much of the s-step-ahead forecast error variance of a given variable is explained by innovations to each explanatory variable for s=1, 2, …

# Chapter 7

# EMPIRICAL RESULTS AND DISCUSSION

This chapter covers empirical analyses from that theoretical setting defined earlier. This chapter includes two separate empirical applications which were built on theoretical setting of this research study. Firstly, static framework includes pooled OLS estimation, random-effects estimation and fixed-effects estimation by using the statistical software STATA 12. Breusch-Pagan Langrange Multiplier test will be carried out in order to choose appropriate regression for parameter estimation between simple OLS regression and random-effects regression. Then, the Hausman tests will be performed for both models to determine whether to choose random-effects or fixed-effects estimation on the analysis. Finally, other tests/diagnostics will be performed to test the cross-sectional dependency, heteroscedasticity, and serial correlation. In the light of the diagnostics, necessary estimation methods will be applied to do the analyses. Secondly, the spillover effects of financial sector on the underground economic activity will also be tested by various approaches to be introduced in the related section ahead. But, the above mentioned approaches to detect and solve Sarhan-Hansen $J$ and autocorrelation problems will be adapted in this second empirical section as well. While, the first empirical application covers the time range from 1994 to 2014, the second empirical application covers the time range of 2010 to 2014 in order to consider the dynamic framework with latest trends. ATKearney, VISA & Schneider (2013) stated that the size of the underground economy reached a 10-year low in 2013, and is estimated at 2.15 trillion Euros in the

EU. The reason of selecting 2010-2014-time range is that of considering the recent trends in the underground economic activities in Europe.

## 7.1 Testing the Role of Financial Development on the Underground Economic Activity

### 7.1.1 The Unit Root Test

As panel unit root tests Levin, Lin, Chu (LLC) and Breitung unit root tests had been applied to detected common unit root in panel variables. Im, Pesaran, Shin (IPS) unit root test has been applied to detect individual unit root in cross-sections. Levin, Lin, Chu (LLC), Breitung and Im, Pesaran, Shin (IPS) unit root test uses the null hypothesis of the existence of unit root.

Levin, Lin, Chu (LLC), Breintung T-test, and Im, Pesaran, Shin (IPS) suggest to reject the null hypothesis in trend and intercept model for the variables of the size of the underground economy, trade openness, and interest rate. Therefore, the size of the underground economy, trade openness, and interest rate variables are stationary. On the other hand, LLC and IPS suggested to reject null hypothesis in intercept and without trend model for the financial sector development variables, so financial development variable is stationary as well. Unit root test results are illustrated in Table 57 in the appendix B.

The general conclusions from the unit root tests are proved the stationarity nature of the data. Therefore, there is no need to apply the co-integration test, in the rest of this thesis static framework that is pooled OLS, fixed-effects and random-effects estimations will be carried out.

### 7.1.2 Empirical Results of Static Framework

Pooled OLS regression of growth model has all statistically significant explanatory variables at of 0.01 percent level of significance, including the intercept. Financial sector development, trade openness and interest rate explain the 31.56% of the variation in the volume of the size of the underground economy. Financial sector development has negative effects on the size of the underground economy as expected ($\beta$ = -0.440, p<0.01). Trade openness has negative effects on the size of the underground economy as expected ($\beta$ = -3.412, p<0.01). On the other hand, interest rate has positive effects on the size of the underground economy ($\beta$ = 0.897, p<0.01).

Random-effects of GLS (generalized least square) regression of growth model have all statistically significant explanatory variables at the 0.01 percent level of significance, including the intercept. Financial sector development, trade openness and interest rate explain the 24.87% of the variation in the volume of the size of the underground economy. Financial sector development has negative effects on the size of the underground economy as expected ($\beta$ = -0.416, p<0.01). Trade openness has negative effects on the size of the underground economy as expected ($\beta$ = -7.468, p<0.01). On the other hand, interest rate has positive effects on the size of the underground economy ($\beta$ = 0.417, p<0.01).

Fixed-effects within regression of growth model have all statistically significant explanatory variables at the 0.01 percent level of significance, including the intercept. Financial sector development, trade openness and interest rate explain the 22.52% of the variation in the volume of the size of the underground economy. Financial sector development has negative effects on the size of the underground economy as expected ($\beta$ = -0.400, p<0.01). Trade openness has negative effects on the size of the underground economy as expected ($\beta$ = -9.280, p<0.01). On the other hand, interest rate has positive effects on the size of the underground economy ($\beta$ = 0.339, p<0.01). Regression results of parameter estimates have been illustrated in Table 58 in the appendix B.

In order to verify validity of the pooled OLS estimation, the poolability test is conducted with null hypothesis that all the individual-effects, $\alpha_i$ are zero. Results suggest to reject the null hypothesis with a probability that is less than 0.01, so that OLS estimator is biased and not consistent. The presences of individual-specific effects have been accepted. Also $F$ statistics have been illustrated in Table 58 in the appendix B.

In order to choose between pooled OLS regression and random-effects regression Breusch and Pagan Lagrangian Multiplier test has been performed. Breusch and Pagan Lagrangian Multiplier test for random-effects has rejected the null hypothesis that variances across countries are zero with a probability that is less than 0.01. That concludes the significant differences across countries. Therefore, random-effects regression is appropriate.

Whether to decide between random-effects and fixed-effects estimations, Hausman test has employed with the null hypothesis of the preferred model is random-effects versus the alternative hypothesis of fixed-effects is preferred. Hausman test checks whether the unique errors are correlated with the regressors, while null hypothesis is the unique errors are not correlated. Since the probability of Chi Square of Hausman test is 0.0432, it is significant so fixed-effects estimation must be preferred in order to analyse the functional relationship of the model.

In order to test cross-sectional dependency in another words contemporaneous correlation, Pesaran CD (cross-sectional dependency) test will be employed. Baltagi (2005) states that the cross-sectional dependence is a problem with macro panels with long time series that is over 20 to 30 years, therefore it has to be checked. The importance of the cross-sectional dependency is that it might lead to bias test results. Since the panel data set of this thesis is macro panel, Pesaran CD test will be employed and has rejected the null hypothesis of residuals is not correlated with probability that is less than 0.01. There is the evidence of cross-sectional dependency as expected because of the cross-country observations are influenced by common consideration such as similar political or economic issues.

Heteroskedastic test is the other diagnostic that must be checked. Modified Wald statistics for GroupWise heteroscedasticity in the residuals of a fixed-effects regression, that has been implemented by Christopher Baum carried out. It uses the null hypothesis that homoscedastic in another words constant variance. Probability of test statistics rejects the null hypothesis with a probability that is less than 0.01. That proves the presence of heteroscedasticity.

Finally, Lagram-Multiplier test for serial correlation will be carried out with the null hypothesis that no serial correlation. Serial correlation causes the standard errors of the coefficients to be smaller than they actually are and it causes to higher R-square. Serial correlation is not a problem in micro panels with few years but it is a problem with macro panels with long time series that is over 20 to 30 years. Therefore, Lagram-Multiplier test for serial correlation will be carried out and has rejected the null hypothesis with probability that is less than 0.01. There is the evidence of first order auto-correlation. The entire diagnostic tests have been illustrated in Table 59 in the appendix B.

As it mentioned before, the panel data set that has been used in this thesis, since it is a macro panel, therefore, cross-sectional dependency and serial correlation and as well as heteroskedastic natures of the data set must be determined and necessary actions must be taking before the final parameter estimation for empirical analyses of the model. In the light of the presence of cross-sectional dependence, Hoechle (2007) suggest to use fixed-effects estimation with Driscoll and Kraay standard errors must be carried out. In order to control for heteroscedastic nature of the panel data set, estimations will be carried out in by using the robust option of the fixed-effects estimation. Finally, serial correlation will be eliminated by obtaining fixed-effects estimation with lags. As a bottom line, in order to drive feasible policy implications both robust regression of fixed-effects estimation and fixed-effects estimation with Driscoll and Kraay standard errors has been carried out and illustrated in Table 60 in the appendix B.

Robust regression of fixed-effects within regression of growth model has all statistically significant explanatory variables. The coefficients of financial sector development variable, trade openness variables, and intercept are statistically significant at the 0.01 level of significance, while the coefficient of interest rate variables is statistically significant at the 0.05 level of significance. Financial sector development, trade openness and interest rate explain the 22.52% of the variation in the volume of the size of the underground economy.  Financial sector development has negative effects on the size of the underground economy as expected ($\beta$ = -0.400, $p<0.01$). Trade openness has negative effects on the size of the underground economy as expected ($\beta$ = -9.280, $p<0.01$). On the other hand, interest rate has positive effects on the size of the underground economy ($\beta$ = 0.339, $p<0.05$).

On the other hand, fixed-effects estimation with Driscoll and Kraay standard errors yields almost the same results. The coefficients of financial sector development variable and intercept are statistically significant at the 0.01 level of significance, while the coefficients of trade openness and interest rate variables are statistically significant at the 0.05 level of significance. Financial sector development, trade openness and interest rate explain the 34.78% of the variation in the volume of the size of the underground economy. Financial sector development has negative effects on the size of the underground economy as expected ($\beta$ = -0.400, $p<0.01$). Trade openness has negative effects on the size of the underground economy as expected ($\beta$ = -9.280, $p<0.05$). On the other hand, interest rate has positive effects on the size of the underground economy ($\beta$ = 0.339, $p<0.05$). As it shown, there is not any difference in terms of parameter estimations, even the standard errors and t- values are so close except the probabilities that will not lead to change in general conclusion.

As a bottom line, according to both robust regression of fixed-effects estimation and fixed-effects estimation with Driscoll and Kraay standard errors result suggests any increase in financial sector development and trade openness is associated with the reduction in the size of the underground economy in the European Union countries while any increase in the interest rate is associated with raise. Since the underground economic activity has direct consequences on the government deficit, that may cause raise in interest rate. Gutmann (1985) stated that rise in government deficit would lead to increase in interest rate. Therefore, positive correlation may expect between the underground economic activity and interest rate. The evidence of negative correlation between financial sector development and the underground economy provided by many scholars (see Berdiev and Saunoris, 2016; Capasso and Jappelli, 2013; Blackburn et al., 2012; Bose et al., 2012; Dabla-Norris et al., 2008; Straub, 2005). The negative correlation between trade openness and the underground economy occurs with the government's ability to examine informal production (see Elgin and Oyvat, 2013). In overall, estimations models have low R square, that indicates that changes in the predictors are related to changes in the response variable and that model explains a approximately 35% of the response variability. Therefore, the financial sector development, trade openness and interest rate explain only the 35% of the variation in the volume of the size of the underground economy, the rest of the variation in the volume of the size of the underground economy have explained by the variables that are not considered in this model.

### 7.1.3 Variance Decomposition and Impulse Responses

Variance decompositions results are illustrated in Table 61 and Table 62 in the appendix B. The ratio of forecast error variance explained in UE (the size of the underground economy) by the given shocks in the financial development (FD), trade openness (TRD), and interest rate (INT)are generally low. This means that the variations in the size of the underground economy explained by those regressors are at low levels. For example, at period 10, forecast of variance at UE due to changes in FD is 5.02%, in TRD is 0.08%, and in INT is 7.70%.

Finally, Figure 41 in the appendix B provides line plots of impulse responses among UE, financial development, trade openness, and interest rate. As can be seen from the figure, the response of UE to a shock in financial development is negative in the first four periods but starts to increase after the fifth period. Over time, there is moderate response of UE to given shocks in financial development. The behaviour of UE to the given shocks in trade openness is irresponsive over time. The response of UE to the given shock in interest rate is significantly positive over time.

## 7.2 Application: Financial Services Spillover Effects on Informal Economic Activity: Evidence from a Panel of 20 European Countries

### 7.2.1 Introduction

Financial services sector is a major source of the aggregate income as proved and documented over many decades in the relevant literature. Many studies have examined the role of financial services sector and its development in the economy also by adapting the framework of the supply-leading hypothesis developed by Patrick (1966). However, the nexus between finance and growth is still inconclusive (Buyuksalvarci & Abdioglu, 2010; Chandio, 2014; Fethi et al., 2013; Gungor & Katircioglu, 2010; Gungor et al., 2014; Jenkins & Katircioglu, 2010; Karacaer & Kapusuzoglu, 2010; Katircioglu, 2012; Katircioglu et al., 2007; Kaushal & Pathak, 2015; Roy, 2012; Saqib & Waheed, 2011; Sodeyfi, 2016; Waheed & Younus, 2010; Soukhakian, 2007a, 2007b; Waheed and Younus, 2010). On the other hand, financial services sector precedes changes not only in formal economic activities but also in informal economic activities as proposed by Capasso & Jappelli (2013). An increase in the volume of financial services and activities might lead to positive changes in the volume of informal economic activities; for example, as a result of financial expansion at corporate level, as also mentioned by Gordon & Li (2005), although firms operate in the formal sector (even in the case they receive credits/loans in the formal sector), they might tend to avoid tax payments by shifting their cash transactions and withdrawing from the formal sector during their financial operations or they might tend to cheat from social security obligations and employee records/benefits. The avoidance of tax obligation is highly likely in the developing countries owing to high tax rates as also stated by Gordon & Li (2005). Therefore, in such a scenario, the avoidance of tax obligation by firms will be a reason behind a positive correlation between financial development and informal economic activities. The positive effect of financial services on the informality can be also explained by the institutional theory which suggests that informality would arise because of failures and imperfections in the financial markets, asymmetry in financial institutions and the existence of informal financial institutions, and institutional asymmetry as an outcome of formal institutional failures (Williams, 2017). According to Williams (2017), formal institutional failings and imperfections produce an asymmetry between formal and informal institutions and such happenings lead to greater prevalence of informal entrepreneurship. However, as a result of financial regulations and better control by authorities such as government at the further stages of financial services development, then after, financial development might result in lower informal economic activity since economic agents or firms will start to operate formally.

On the other hand, according to the pecking order theory, corporations prioritize their source of financing, first by internal funds, and then debt, and finally raising equity as a last resort. Firstly, internal financing is used till it is depleted; and then debt is issued tillwhen it is no more sensible to issue; and finally equity is issued. A firm starts initial capital which is provided by entrepreneur and is basically self-funding, and then is likely to use informal external sources such as friend environment and/or business associations (see Abdulsaleh & Worthington, 2013; Abouzeedan, 2003; and among the others); however, in order to grow further, an additional outside financing source is required, that is a process that starts with angel investors, venture capitals, private equity firm financing and all the way to initial public offerings (IPO). In order to access external financing firms, have to be transparent and provide all the information about their firms to obtain a registration statement in the case of IPO financing. In the case of debt financing, firms need to declare all of their assets and revenues and pledge them as collateral. Therefore, firms grow and their transparency improve over time as parallel to each other. Dabla-Norris et al. (2008) pointed out a negative correlation between firm size and informality; as a firm grows bigger, its tendency to operate informally lessens. With limited financial services, firms tend to operate informally as the necessity of additional cash to reinvest is arisen; however, as a result of better financial services, firms can easily access cheaper external financing in the forms of bond (debt) or stock (equity) (Ellul et al., 2012). Especially in small enterprises which face inadequate start-up capital, formality has been recognized as a crucial obstacle for growth and development, and thus ignoring the funding necessity of small enterprises results in the tendency to turn towards informal financial intermediaries to obtain the required capital sources (Hernández-Trillo et al., 2005).

There is also the possibility that financial services sector might exert negative effects on the volume of informal activities. For example, Capasso & Jappelli (2013) and Bose et al. (2012) argued that as the financial services sector develops, more efficient intermediaries will enter the market and the cost of credit will fall, increasing the opportunity cost of continuing to operate underground; thus, financial services sector might be negatively correlated with the size of the informal economy. Furthermore, as Capasso & Jappelli (2013) and Bose et al. (2012) mentioned that informality is also a result of higher costs of credit, which are the important components of the overall opportunity cost to operate informally. But if financial development leads to a decline in the cost of credit, then, this happening will increase the opportunity cost of informality and the size of informal economic activity will be lower at further levels of financial development (Bose et al., 2012; Capasso & Jappelli, 2013).

Although many studies attempted to measure the size of the informal economy in the relevant literature such as Williams (2008), Williams & Round (2009), Williams (2010), Williams (2011), and Imamoglu (2016), interactions of informal economic activities with economic sectors have not found sufficient attention from researchers yet; and, financial services sector is only one of them with this respect.

Against this backdrop, this section investigates the spillover effects of financial services sector development on the size of informal economic activity in the case of 20 European Union (EU) countries. To the best of our knowledge, this study will be the first to investigate such effect in the relevant literature. As also mentioned by Elgin & Uras (2013), the existing literature has not sufficiently documented a consensus on the determinants and consequences of the informal sector. With that considered, Elgin & Uras (2013) focused on the consequences of the informal sector in the case of financial services sector and found that informality exerts significant spillover effects on the financial services sector. They concluded that there exists an inverted U-shaped link between the informal sector and financial services sector.

But, unlike Elgin & Uras (2013), this section will focus on the financial services sector as a major determinant or driving force of the informal sector. To the best of the authors' knowledge, the latest time series dataset of informal economic activity is provided by Elgin & Öztunali (2012), which is covering the period from 1950 to 2009. In order to take the later years into consideration, the dataset which is provided by Imamoglu (2016) will be employed in this paper. Thus, a total of 20 EU countries out of 28 based on the data availability has been selected with this respect due to the reason that remaining 8 countries have suffered from the availability of related data in order to construct the size of informal economic activity as per the study of Imamoglu (2016). On the other hand, the selection of EU countries is due to the reason that they are developed countries and their financial markets constitute an important part of the global financial markets as, for example, London Stock Exchange is the center of global financial system. The data sample consists of 20 EU countries, namely, Austria, Belgium, Czech Republic, Denmark, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Luxemburg, Netherlands, Poland, Portugal, Slovak Republic, Slovenia, Spain, Sweden, and finally United Kingdom. The relationship between the size of the informal economy and the development in financial services sector is taking place over time that requires the dynamic framework to be investigated (Berdiev & Saunoris, 2016; Berdiev et al., 2015; Birinci, 2013;).

This section proceeds as follows: Section 2 describes literature review; Section 3 describes the theoretical framework; Section 4 describes the data and methodology; Section 5 presents the empirical results and discussions; and finally, Section 6 concludes and discusses the policy implications.

### 7.2.2 Literature Review

Informal economy is a potential and interesting study area which received considerable attention in the literature. A large size of the informal economy is associated with decrease in tax receipts and it causes greater budget deficit (Schneider & Enste, 2000). It damages the stability and responsibility of political, legal and economic institutions that might otherwise serve to facilitate the development process (Feige, 1990), it distorts investments, aggravates income inequality and hinders the growth (Capasso & Jappelli, 2013). These important consequences yield the necessity to investigate its relationship with other macro-economic variables. Especially the development in the financial sector will result to cheaper access to credit that may help control or lessen the size of informal activity.

Recent studies documented that the financial services sector development will have effects on the size of informal economic activities due to the fact that some financial activities will be legal while some others are likely to be illegal or unrecorded. Capasso & Jappelli (2013) claimed that financial market enhances the efficient intermediaries entering the markets, reduces credit costs, and increases the opportunity cost of continuing to operate informal. They asserted that there is an adverse correlation between the financial market development and informal economy. In their study, a technical model was proposed between agents that choose low-return technology that does not require a plan versus the agents that choose high-return technology, which requires external funding. High-return technology agents need to pledge more collateral in the case of external funding and to reduce its cost of credit.

As pointed out by Jappelli et al. (2005), pledging more collateral will reduce the cost of credit. Moreover, pledging collateral will require the firm to divulge the income and assets to both financial intermediaries and tax officials. A choice must be made between hiding income and assets with low-return technology and pledging collateral to reduce the cost of credit with high-return technology. This choice distinguishes between the formal and informal economy. Financial development decreases the financial cost of credit, thereby lessening the informal operating costs (Soukhakian, 2007a). Capasso & Jappelli (2013) provided empirical evidence to show that tax evasion and the size of informal economy can be lessened through financial development.

The opportunity cost of operating the informal economy is increasing due to the higher cost of credit in the informal system. Financial development lessens the cost of credit and boosts the opportunity cost of informality, as shown by many studies in the literature (Hachicha, 2008). Straub (2005) built a model in which a firm makes a choice between the official and unofficial economies. Firms that choose the formal economy have to be registered, which exposes them to high entry costs. In addition, this requires firms to declare their certifiable incomes and assets, which gives them access to credit markets, as well as the advantages from key public goods and the enforcement of property rights and contracts. It also lowers the defaulting cost and financial costs. Antunes & Cavalcanti (2007) investigated the formal sector versus the informal sector; engagement in the formal sector exposes the company to higher entry costs, regulations and tax obligations, with the trade-offs of better outside financing against the higher financial cost of the informal sector. Ellul et al. (2012) pointed out that transparent firm accesses cheaper financing but also has a heavier tax obligation. They studied this trade-off in a model via distortionary taxes and endogenous rationing of external finance.

According to Blackburn et al. (2012), credit market circumstances affect the size of the informal economy. The interaction between financial development and informal economy was considered according to two concepts. In the first concept, the absence of financial services sector development creates an incentive for individuals to operate informal, which will exempt them from formal rules and regulations but removes the benefit of operating legally. In terms of the second concept, the lack of financial development cause individuals to drive unofficial economy while conducting the official economy. Under the assumption of identical tax obligation and access to an identical credit market, individuals operate in the formal sector while evading taxes by underreporting their real income as an effect of the influence of financial development on agents.

Blackburn et al. (2012) sought to explain the correlation between credit market development and the informal economy using the modest model of tax evasion and financial intermediation. They showed that marginal net gain from greater net wealth disclosure increases with the level of financial development. These findings coincide with reports in the literature asserting that lower stages of development are associated with higher tax evasion and a greater magnitude of the informal economy. Blackburn et al.'s (2012) study showed that business visionaries need external resources for investment, and they can diminish information costs and financial expenses by supplying more collateral. However, this involves a higher tax burden. Given the financial expenses, entrepreneurs choose whether to evade taxes and operate informally.

Financial services sector development is likely to influence the relative cost and benefits of the operating informal economy. Furthermore, the financial services sector promotes the efficient intermediaries entering the markets, reduces credit costs, and increases the opportunity cost of continuing to operate informally (see Capasso & Jappelli, 2013) and provides access to credit and monitors business transactions for tax obligations, while financial development reduces informal working by increasing the opportunity cost of operating informal activity by providing access to credit (Blackburn et al., 2012; Capasso & Jappelli, 2013). Firms that choose formal activity have to be registered, which expose them to high entry cost, declaration to certifiable income and assets; therefore, high tax obligation and regulation arises for them but it gives the opportunity to access outside financing, against the higher financial cost of the informal sector (see Straub, 2005; and Antunes & Cavalcanti, 2007). Therefore, the role of financial services in the informal economic activity deserves attention from researchers.

#### 7.2.2.1 The Interactions of Informal Economic Activity

The nexus of the relationship between financial services sector development and informal economic activity puts forward the negative correlation (see Berdiev & Saunoris, 2016; Capasso & Jappelli, 2013; Bose et al., 2012; La Porta & Shleifer, 2008; and among many others). In the initial stages of the financial development, the size of informal economic activities is likely to increase; however, this size is likely to decline at further levels of financial development as financial services sector provides better and more efficient use of financial sources. Thus, there will be less tendency of business world towards informal activities.

On the other hand, the literature on the interaction between international trade openness and the size of the informal economy is also ambiguous. The general argument states that trade liberation and trade reforms cause foreign competition, and in response, some corporations reduce their labour force costs by cutting employee benefits, preferring part-time labour to reduce social security payments, and therefore trade reforms and trade liberalization boosts the informal economy (Fugazza & Fiess, 2010; Ghosh & Paul, 2008; Goldberg & Pavcnik, 2003; and among many others). On the other hand, Elgin & Oyvat (2013) stated that trade openness may have either a positive correlation or a negative correlation with the informal economy; a positive correlation is expected when openness facilitates the external subordination of the informal sector to the formal sector, while a negative correlation is likely to occur if openness in international trade eases the government's ability to examine informal production. From the perspective of international trade openness, the government's ability will be eased to examine and control informal production effectively and the negative correlation expected to be observed in these developed countries. Meanwhile, in addition to the intention of examining the direct effect of international trade openness on the size of the informal economy, the indirect effects of interest rate on the size of the informal economy are intended to be examined as well. Cornell (1983) stated that standard Keynesian theory predicts that actual monetary expansion leads to lower interest rates through the liquidity effect. There is the inverse relationship between interest rate and money supply. Indirect effect of interest rate in respect of any fall is associated with the increase in money supply, so does the rise of informal economy. On the light of most of the informal activity transactions made in cash, increase in money in circulation may increase the size of the informal activity. In all the cases, significantly negative effect of international trade openness on the size of informal economy can be observed.

The efficiency of public institution and the quality of public goods are the critical determinants of the opportunity cost to operate informally; institutional environments can significantly affect the choice of informality (Capasso & Jappelli, 2013). Some studies have investigated the relationship between the financial development and the size of the informal economy through employing institutional quality indicators namely law and order, bureaucratic quality, corruption control indices with expectation of higher the intuitional quality associations with a higher level of financial development as they improve the political and economic environment for the financial services sector (see Elgin, 2012; and Elgin & Uras; 2013; and among many others). Some studies have used the governance indicator to put forward its relationship with the size of the informal economic activities (Razmi & Jamalmanesh; 2014; Torgler & Schneider, 2009; Torgler et al., 2011; and among many others). In this section, worldwide governance indicators will be employed that are defined by Kaufmann et al. (2010) as ‘the control of corruption captures perceptions of the extent to which public power is exercised for private gain, including both petty and grand forms of corruption, as well as "capture" of the state by elites and private interests; government effectiveness captures perceptions of the quality of public services, the quality of the civil service and the degree of its independence from political pressures, the quality of policy formulation and implementation, and the credibility of the government's commitment to such policies; political stability and the absence of violence/terrorism measures perceptions of the likelihood of political instability and/or politically-motivated violence, including terrorism; rule of law captures perceptions of the extent to which agents have confidence in and abide by the rules of society, and in particular, the quality of contract enforcement, property rights, the police, and the courts, as well as the likelihood of crime and violence; regulatory quality captures perceptions of the ability of the government to formulate and implement sound policies and regulations that permit and promote private sector development; voice and accountability captures perceptions of the extent to which a country's citizens are able to participate in selecting their government, as well as freedom of expression, freedom of association, and a free media.'

Both economic and political system affect formal and informal economic activities. Razmi & Jamalmanesh (2014) pointed out that good institutional and governance quality increases the official economy while it reduces the unofficial one; institutional governance reduces the size of the informal economy in both developed and developing countries. The effect of voice and accountability on shadow economy is stated by Torgler et al. (2011) as 'If citizens perceive that their interests are properly represented in political institutions and they perceive to receive an adequate supply of public goods (high voice and accountability), their trust in the government and their identification with the state increases, increasing also their willingness to contribute. If the government is not benevolent, the citizens' voice has the potential to control politicians' discretionary power.' They showed the policies improving voice and accountability may help to reduce the intensive to participate informal economic activities. Johnson et al. (1998) stated that countries with more corruption tend to have larger unofficial economy. Dreher & Schneider (2010) stated that the more effective the government, the greater the advantage of operating in the official sector is, and points out that government effectiveness reduces the size of the informal sector. Torgler & Schneider (2009) stated that institutional instability, lack of both transparency and credible rule of law undermine the willingness of frustrated citizens to participate in the official economy. In addition to voice and accountability, government effectiveness, and rule of law; regulatory quality also helps to lessen incentive to participation to informal economy (see Torgler & Schneider, 2009). Elgin (2010) showed the positive correlation between political stability and official economy, while it has negative correlation between with informal sector. The expected correlation between the variables of interest and the size of the informal economy has been already illustrated in Table 63.

Baltagi et al. (2009) stated that the moment conditions utilize the orthogonality condition between the lagged values of dependent variable and the differenced errors. This assumes that the disturbances, $u_{it}$, are serially uncorrelated and that the differenced error is the first order moving average with a unit root. To this end, two diagnostics are computed using the Generalized Method of Moments (GMM) procedure to test for the first order and second order serial correlation in the disturbances. The absence of autocorrelation will be tested with AR (2) test for autocorrelation. Since the number of moment conditions increases with T, which is a special feature of dynamic panel data GMM estimation, a Sargan's $J$ test has to be performed to test the over-identification restrictions to support for the exogeneity of the instruments.

### 7.2.3 Theoretical Framework

#### 7.2.3.1 Setting

This study proposes a model which investigates the role and spillover effects of financial services on the size of the informal economic activity. Financial services in this proposed model will be considered as the independent variable as a determinant of the informal economic activity unlike the study of Elgin & Uras (2013), where financial services were selected as the dependent variable as a consequence of the informality in their study.

The nexus between informal economic activity and financial services sector should not be considered without including control variables which likely affect these two aggregates and their relationship. Furthermore, such a link would be considered by taking the related theoretical framework into consideration. Williams (2017) outlined institutional theory regarding an explanation of the informal entrepreneurship arising from three different scenarios such as (1) formal institutional failures and imperfections, (2) informal institutions and institutional asymmetry, and (3) institutional asymmetry as an outcome of formal institutional failures**.** According to the first view, informal entrepreneurship is assumed to arise from formal institutional failures and imperfections, which include formal institutional resource misallocations and inefficiencies, voids, weaknesses, and instability. In the second view, solely formal institutional failings and imperfections disregard the role played by informal institutions (Godfrey, 2015; North, 1990; Scott, 2008). The third view presented by Williams (2017) is that formal institutional failings and imperfections result in an asymmetry between formal and informal institutions, which then leads to a wider spread of informal entrepreneurship as mentioned previously in this study. Thus, in parallel to institutional theory concepts, we can assume that (1) formal institutional failures and imperfections in the financial markets, (2) informal financial institutions and institutional asymmetry in the financial markets, and (3) institutional asymmetry as an outcome of formal institutional failures again in delivering financial services will be important driving forces behind the informal economic activities. Therefore, in order to find the effects of financial services and development on the informal economic activity, the following dynamic model is established to be adapted to panel data:

$$UE_{it} = \beta_0 + \beta_1 UE_{it-1} + \beta_2 FD_{it} + \beta_3 FD_{it}^2 + \beta_4 TRD_{it} + \beta_5 INT_{it}$$

$$+ \sum_{k=1}^{n} \Theta_k X_{it} + \alpha_i + \delta_t + u_{it} \qquad (46)$$

where $UE_{it}$ is the size of the informal economy of country $i$, in year $t$; $FD_{it}$ is the development of the financial services sector of country $i$, in year $t$; $FD_{it}^2$ is the squared term of the development in the financial services sector; $TRD_{it}$ is the international trade openness; $INT_{it}$ is the long-term interest rate; and other explanatory variables are denoted by $X_{it}$ that are the governance indicators - control of corruption, governance effectiveness, political stability and absence of violence, regulatory quality, rule of law, and finally voice and accountability; country fixed-effects are represented by $\alpha_i$; time dummies presented by $\delta_i$ and finally $u_{it}$ represents the error term.

The literature studies such as Elgin & Uras (2013) showed that non-linearity exists in the relationship between financial development and informal economic activity; therefore, in parallel to the study of Elgin & Uras (2013), the square of financial development variable as seen in equation (46) ($FD^2$) has been added in the analyses of this study. Financial expansion is also expected to result in informal economic activities; thus, a positive relationship might be expected. Furthermore, the variable $FD^2$ will enable us to test the decoupling effects of financial services sector on the size of informal economic activity in addition to test for inverted U-shaped relationship between financial services sector and informal economic activity. Furthermore, in addition to squared financial development variable, international trade and interest rate variables are added to equation (46). International trade of goods and services is added to equation (46) due to the fact that financial sector is closely related with exports and imports of goods and services. As a result of, i.e., increase in exports, there will be reserve accumulation in the balance of payments which will lead to increase in financial activities in the economy. The same argument is also true in the case of imports of goods and services, where, i.e., an increase in imports might damage the reserve balance of the economy and might lead deterioration not only in current account balance but also in the volume of financial services. Previously published works proved and documented a close link between financial sector and international trade (Jenkins & Katircioglu, 2010, Kaushal & Pathak, 2015). Therefore, it is highly likely that international trade not only has impact on financial sector but also on the nexus between financial sector and informal economic activity. Furthermore, a change in the volume of international trade might exert significant changes in the size of informal economic activities. Secondly, interest rate has also been added to equation (46) due to the fact that it is the major determinant of the financial sector and money as it is well documented in the Keynesian theory. Thus, omitting the interest rate in equation (46) might provide biased results. An increase in interest rates might result in an increase in informal economic activities due to higher costs of borrowing and etc. Finally, in parallel to institutional quality theory (Dreher & Schneider, 2010; Williams, 2008), governance factors such as the control of corruption, governance effectiveness, political stability and absence of violence, regulatory quality, rule of law, and finally voice and accountability have been added also to equation (46) as they are available in the analysis of informal economic activity in the previous pioneering studies (Dreher & Schneider, 2010). This is because the institutional quality and governance quality have impact on the level of informality as proved in the relevant literature. An increase in the institutional quality as outlined above will be an important driving force behind a decline in the size of informal economic activities; thus, a negative relationship is expected between these two aggregates (Williams, 2010). Therefore, omitting governance and/or institutional quality factors from equation (46) would lead to another biased results for the link between financial services and informal economic activity.

#### 7.2.3.2 Hypothesis Development

This study proposes that financial services might be a determinant of the informal economic activity. In parallel to the theoretical inverted U-shaped relationship between financial services sector development and informal sector as documented in the relevant literature (i.e. Elgin & Uras, 2013), this study will hypothesize that financial services exert significant spillover effects on the size of the informal economy. This means that at the initial stages of financial services development, the reaction of the informal economic activities is positive while this reaction becomes negative at further stages of financial services sector development following a peak point as justified previously in the introduction section of this study. Such happening confirms the existence of the inverted U-shaped relationship between these two economic aggregates. Therefore, the following hypothesis is developed and proposed in this research study:

H1: Financial services sector exerts significant spillover effects on the size of informal economic activity.

The following section will describe data and methodology adapted in this research study in order to test for the above-mentioned hypothesis.

### 7.2.4 Data & Methodology

#### 7.2.4.1 Data

In spite of the existence of relatively large literature behind the informal economic activity, its interaction with financial development has not received much attention as mentioned before. A panel of 20 European Union Countries has been constructed in this study using annual data from 2010 to 2014. The main variables of the study are the size of the informal economy (UE) and the composite financial index as a proxy for financial development (FD). The other and control variables are presented and defined in Table 63 which are added to the model estimations for control purposes:

Table 63. Variables of the Study

| Variable | Definition | Expected Sign of Variables |
|---|---|---|
| Dependent Variable | | |
| UE | Informal economy as a percentage of GDP | |
| Independent Variables | | |
| FD | IMF's financial development index | + |
| $FD^2$ | Square of IMF's financial development index | - |
| TRD | The sum of exports plus the imports of goods and services as a percentage of the GDP | - |
| INT | The long-term interest rate | - |
| | | - |
| Control Variables | | |
| CC | Control of corruption | - |
| GE | Government effectiveness | - |
| PSAV | Political stability and absence of violence/terrorism | - |
| RLAW | Rule of law | - |
| RQUAL | Regulatory quality | - |
| VACC | Voice and accountability | - |

Prior to empirical analyses, it would be good step to present the descriptive statistics of all series under consideration as can be found in Table 64 which shows that the average size of the informal economy with respect to GDP of the selected EU countries is 13.96% while the minimum is 6.29% and maximum is 32.32%. It is clearly seen that the size of the informal economy in the EU is much less than 50%. On the other hand, financial services sector has grown by 0.66% on average while minimum growth is 0.25% and maximum is 0.94% all per annum. Descriptive statistics related with control variables which would be added to our empirical model are also presented in Table 64.

Table 64. Descriptive Statistics

| Variable | Mean | Std. Dev. | Min | Max |
|---|---|---|---|---|
| UE | 13.96905 | 4.794087 | 6.298446 | 32.32181 |
| FD | 0.668110 | 0.167391 | 0.258235 | 0.941514 |
| TRD | 4.566060 | 0.484252 | 3.819614 | 5.924651 |
| INT | 4.300262 | 2.074356 | 1.163333 | 22.4975 |
| CC | 1.278664 | 0.786538 | -0.25186 | 2.556869 |
| GE | 1.353110 | 0.545138 | 0.213577 | 2.358699 |
| PSAV | 0.844778 | 0.417483 | -0.46564 | 1.660190 |
| RQUAL | 1.324129 | 0.386275 | 0.344932 | 1.921908 |
| RLAW | 1.306658 | 0.530467 | 0.239202 | 2.120458 |
| VACC | 1.259151 | 0.268779 | 0.530957 | 1.826381 |

As it is known, there is no consensus on the definition of informal economy or how it has to be measured (see Öğünç & Yılmaz 2000). Measuring something that is already hidden is a crucial task. Individuals and institutions that engage in informal economic activities, endeavor to hide their participation from disclosure (see Öğünç & Yılmaz 2000; Schneider & Enste, 2000). However, some of the researchers have done estimates of the informal economy (see Elgin & Öztunali, 2012; Schneider 2007; Schneider, 2013). To the best of the authors' knowledge, the latest time series dataset of informal economic activity is provided by Elgin & Öztunali (2012), which is covers the period from 1950 to 2009. In order to extend the data, the dataset from Imamoglu (2016) is employed in this paper. The study of Imamoglu (2016) used the MIMIC (multiple causes and multiple indicators) model approach with five cause and two indicator variables in order to estimate the size of informal economic activities of 20 EU countries. Indirect taxation, direct taxation, social security contributions, unemployment, and self-employment rates have been used as cause variables, while real GDP per capita and the labor force participation rate have been used as indicator variables in order to measure the informal economy (% of GDP) in the study of Imamoglu (2016). The model estimates in Imamoglu (2016) have been calibrated with Schneider (2007)'s estimates.

On the other hand, there are different proxies of financial development variable which have been used in the literature. While some studies (Beck et al., 1999; Jenkins & Katircioglu, 2010; Soukhakian, 2007a; 2007b;) used individual series like money supply and domestic credits in the banking system to approximate financial development such as money, some other studies constructed indexes for financial development or financial performance using various approaches and variables (Chen, 2010; Katircioglu & Taspinar, 2017). However, unlike these previous studies, this study uses a comprehensive financial development index for countries under inspections which is available from the study of Svirydzenka (2016) in International Monetary Fund (IMF). Thus, this article adapts financial development index from

IMF in order to estimate the effects of financial sector on the size of informal economic activities in the EU.

Finally, TRD have been obtained from the World Data Bank (2017); INT has been obtained as the long-term interest rate from the OECD statistical database, and governance indicators obtained from World Bank (2017). Annual data for financial services sector development and trade openness variables are used in logarithmic forms. Although this paper attempts to investigate the empirical between the variables of interest for all UE countries, due to the data availability, some countries have been excluded from this study.

#### 7.2.4.2 Methodology

GMM estimators developed by Holtz-Eakin et al. (1988), Arellano & Bond (1991), and the approaches developed by Arellano & Bover (1995) and Bundell & Bond (1998), who developed system estimator have been used. Since the system-GMM estimator can address to omit the variable bias due to heterogeneity and endogeneity issues (see Hoeffler, 2002), recently it has been widely used particularly in the studies of macroeconomics and finance. The advantage of GMM panel data estimator provides better control for the endogeneity of all explanatory variables by exploiting time series-variation in the data and accounting for individual fixed-effects (see Beck et al., 1999). Furthermore, the system-GMM estimator complements the difference specification with the original regression specified in levels and uses lagged differences as additional instruments for the specification in levels. Blundell and Bond (1998) showed that the system-GMM estimator is considerably more efficient than the difference GMM estimator.

It is assumed that informal economic activity adjusts with delay to changes in factors such as financial development and trade sector. This assumption may motivate the use of lagged dependent variable - for informal economy in our case - as a regressor giving rise to the dynamic panel model. However, since each country may have an unobservable and time-invariant effect, it is a defacto correlated with the lagged term, thus rendering it endogenously. Any conventional estimation method (pooled OLS, fixed or random effects), because they neglect this endogeneity, may produce biased estimates.

In equation (46), the fixed country effects may be eliminated by first differentiating as presented in equation (47) and since these are time-invariants they disappear. On the other hand, purging out the individual effects does not eliminate dynamic panel bias, because it essentially makes each observation of transformed dependent variable endogenous to the error. In other words, while a source of endogeneity is eliminated, another one is introduced via transformed equation.

$$\Delta UE_{it} = \beta_1 \Delta UE_{it-1} + \beta_2 \Delta FD_{it} + \beta_3 \Delta FD_{it}^2 + \beta_4 \Delta TRD_{it} + \beta_5 \Delta INT_{it} + \sum_{k=1}^{K} \delta_k \Delta X_{kit} + \Delta u_{it} \quad (47)$$

$$E(\Delta UE_{i,t-1} \Delta u_{it}) \neq 0 \quad (48)$$

In the first differenced form in equation (48), the country-fixed effect is eliminated. However, a new form indigeneity arises due to the dependence between $\Delta UE_{i,t-1}$ and $\Delta u_{it}$.

Arellano-Bond (1991) proposed a convenient method based on GMM estimation which uses the lagged levels of the dependent variable as instruments for the transformed equation. This standard form is also called GMM-Difference. One issue concerns the relative time and unit dimensions of the panel observations: Arellano – Bond estimator is essentially designed for small-T large-N panels and not vice-versa. There are two valid reasons for this: (1) For a large T, the Arellano–Bond method generates many instruments, leading potentially to a poor performance of asymptotic results. And (2) with a panel extending over a large number of years a shock to country fixed-effects could eventually die out and the correlation of the lagged dependent variable with the error term would be insignificant (see Roodman, 2009). In such a case, one does not necessarily have to use the Arellano – Bond estimator. The standard AB methodology is based on employing the seconds lag of dependent variable and all feasible lags thereafter in such a way to create:

$$E(\Delta UE_{i,t-2}\Delta u_{it}) = 0 \qquad (49)$$

$$E(\Delta UE_{i,t-3}\Delta u_{it}) = 0$$

$$.....$$

$$E(\Delta UE_{i,t-j}\Delta u_{it}) = 0$$

As a matter of fact, prior to the estimation, the correlation between the informal economy and its first lagged value is found to be over 0.95 thus indicating a very high persistency. Sometimes the lagged levels of the regressors are poor instruments for the first-differenced regressors. In this case, one may use the augmented version – called “system GMM”. In addition to using lagged levels of dependent variable to instrument the differenced equation, the system-GMM estimator uses the differenced lagged dependent variable to instrument the levels equation so we end up with a system of two equations: one in differenced form and another in levels. Additional moment conditions are then shown as below:

$$E(\Delta UE_{i,t-2}, \alpha_i + u_{it}) = 0 \quad (50)$$

$$E(\Delta UE_{i,t-3}, \alpha_i + u_{it}) = 0$$

.....

$$E(\Delta UE_{i,t-j}, \alpha_i + u_{it}) = 0$$

Exogeneous variables can be added which are instrumented by themselves. The efficiency gain, however, might come at a cost of instrument proliferation risk.

When fitting a model by the GMM, we need to see if the instruments satisfy the orthogonality condition — i.e., whether they are uncorrelated with the errors. The following model should be subjected to diagnostic tests for model adequacy. The first test is Hansen's J test which uses the null hypothesis whereby instruments are valid or exogenous, implying cov (z, u) = 0. The test can be considered as Sargan's equivalent when robust estimation option is chosen. The second test concerns the serial correlation tests in the model errors.

Considering the relative size of the time dimension, the instruments had to be collapsed during estimation to reduce the number of instruments and avoid instrument proliferation. We used the Roodman's (2009) collapse technique to reduce the number of instruments down to 27. Although, the instrument count should ideally be no greater than the number of groups (here countries), Sargan test indicates that instruments are valid as it has large p-values. Arellano-Bond serial correlation test for AR (1) in first differences indicates correlation which is consistent with the structure of the model. It is rather AR (2) test denoting serial correlation of order 2 which is of concern here and with a high p-value the test yields a satisfactory result.

### 7.2.5 Results

Since the model passes all tests with success, we may proceed to interpretation stage. Estimation results of nine different model options that arose from equation (46) of this section are presented in Table 65. In all of the estimation cases, a U-shape relationship between informal economic activity and financial services sector development is tested with a different set of independent variables. The model estimations present consistent results with no serial correlation – AR (2); additionally Sargan's $J$ test provide the evidence of validity of models which have been selected.

Table 65. System- GMM Estimation Results

| | (1) | (2) | (3) | (4) | (5) | (6) | (7) | (8) | (9) |
|---|---|---|---|---|---|---|---|---|---|
| Dep.var.: UE | | | | | | | | | |
| UE(-1) | 0.974*** | 1.036*** | 0.962*** | 0.753*** | 0.748*** | 0.747*** | 0.778*** | 0.719*** | 0.707*** |
| | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) | (0.000) |
| FD | 6.711*** | 2.913 | 4.145 | 22.497*** | 22.818*** | 22.939*** | 18.935** | 24.152** | 25.673** |
| | (0.005) | (0.300) | (0.152) | (0.000) | (0.001) | (0.001) | (0.050) | (0.010) | (0.046) |
| FD-squared | -5.595*** | -2.259 | -2.962 | -17.154*** | -17.414*** | -17.633*** | -13.893* | -17.687** | -18.780** |
| | (0.008) | (0.355) | (0.245) | (0.000) | (0.001) | (0.001) | (0.052) | (0.014) | (0.047) |
| TRD | - | 0.055 | 0.009 | -0.440** | -0.463** | -0.445** | -0.246 | -0.360 | -0.373 |
| | | (0.661) | (0.925) | (0.037) | (0.023) | (0.028) | (0.268) | (0.184) | (0.218) |
| INT | | | 0.127*** | 0.111*** | 0.113*** | 0.110*** | 0.109*** | 0.123*** | 0.122*** |
| | | | (0.000) | (0.000) | (0.000) | (0.001) | (0.000) | (0.000) | (0.000) |
| CC | - | - | - | -0.877*** | -0.975** | -0.959** | -0.770* | -0.382 | -0.352 |
| | | | | (0.004) | (0.018) | (0.026) | (0.077) | (0.488) | (0.555) |
| GE | - | - | - | - | 0.143 | 0.166 | 0.589 | 1.156** | 1.231* |
| | | | | | (0.779) | (0.745) | (0.236) | (0.041) | (0.064) |
| PSAV | - | - | - | - | - | -0.109 | 0.086 | 0.200 | 0.250 |
| | | | | | | (0.812) | (0.852) | (0.715) | (0.680) |
| RQUAL | - | - | - | - | - | - | -0.962 | -0.848 | -0.838 |
| | | | | | | | (0.274) | (0.406) | (0.407) |
| RLAW | - | - | - | - | - | - | - | -1.585* | -1.654* |
| | | | | | | | | (0.073) | (0.088) |
| VACC | - | - | - | - | - | - | - | - | -0.321 |
| | | | | | | | | | (0.827) |
| Wald Chi test (p-level) | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 | 0.000 |
| Number of instruments | 19 | 20 | 21 | 22 | 23 | 24 | 25 | 26 | 27 |
| AR (1) test (p-level) | 0.013 | 0.011 | 0.011 | 0.023 | 0.022 | 0.021 | 0.012 | 0.011 | 0.013 |
| AR (2) test (p-level) | 0.426 | 0.457 | 0.417 | 0.562 | 0.578 | 0.555 | 0.547 | 0.412 | 0.407 |
| Sargan J test (p-level) | 0.131 | 0.124 | 0.092 | 0.162 | 0.149 | 0.150 | 0.134 | 0.217 | 0.219 |

Notes: Beta coefficients are reported with p-values in parentheses. $^{***}$ and $^{**}$ and $^{*}$ indicate rejection of null hypothesis at 1% and 5% and 10% significance level. In all estimations, twenty cross-sections are used with time range of 2010 to 2014. All panel regressions include a country fixed effect and year dummy. Time dummies are not shown here to save space. Wald Chi test gives the $p$ value for the joint significance of all variables along with cross country fixed effects and year dummies.

The inverted - U relationship is confirmed between informal economic activity and financial development, only except estimations (2) and (3) since t-values of coefficients are not statistically significant for FD and FD-squared. The volume of informal economic activity increases with the development in financial services sector initially while after a certain level it starts to decline. The sizes of coefficients of FD and FD-squared variables show that financial sector exerts highly significant effects on the size of informal economy. For example, in estimation (1), 1% change in the level of FD leads to 6.711% change ($\beta = 6.711, p < .01$) in the size of informal economy in the same direction while 1% change in squared FD leads to 5.595% change ($\beta = -5.595, p < .01$) in the size of informal economy in the reverse direction. These coefficients are 25.673 for FD ($\beta = 25.673, p < .05$) for FD and -18.780 ($\beta = -18.780, p < .05$) for FD-squared in estimation (9) of Table 65 where all control variables are added to the model. It is important to note that the sizes of FD and FD-squared variables in Table 65 are similar to those in the previous works focusing on the other economic aggregates with spillover effects (De Vita et al., 2015; Heidari et al., 2015; Katircioglu, 2014; Katircioglu, 2017; Katircioglu & Katircioglu, 2017, Katircioglu & Taspinar, 2017). On the other hand, negatively significant effects have been found in international trade openness on the size of the informal economy. However, interest rates have significantly positive effects on the size of informal economy.

Governance indicators have mixed effects on the size of informal economic activities in the EU as per results of this study. In overall, in this study, the control for corruption suggests a negative effect on the size of the informal economy in parallel to the findings of Dreher and Schneider (2010) while the governance effectiveness suggests a positive effect ts positive effect on the size of the informal economy. On the other hand, the political stability and the absence of violence/terrorism have shown positive effects on the size of the informal economy in the EU countries, but the effect is not statistically significant. Likewise, the regulatory quality and the voice and accountability exert negative effects on the size of the informal economy; however, the effect is not statistically significant. Finally, the rule of law exerts negative effects on the size of the informal economy of the EU countries.

Estimating equation (46) in nine different alternatives as can be seen in Table 65 enabled us to see that the effects of financial development on informal economic activity are fixed no matter which control variable is selected. This means, in all of these nine model alternatives, the effects of financial sector on informality are the same. Throughout all model options, the effects of financial development on informal economic activity are always positively significant at the level of financial sector variable; however, spillover or decoupling effects of financial sector (squared financial variable) are always negatively significant. This clearly indicates that the levels of international trade, interest rates, and institutional quality in the economies do not matter for the effects of financial sector on informal economic activities in the EU.

To summarize, the major finding of this study is that the evidence of inverted U-shaped relationship between financial development and the size of the informal economy has been supported, which means that at the first stage in the development of financial services sector, it contributes to the volume of the informal economy, and after a certain level, the size of the informal economy starts to decline while financial services sector development continues to increase. Another important point in the findings is the evidence of the negative correlation between the international trade openness and the size of the informal economy, and positive correlation between the interest rate and the size of the informal economy.

**7.2.6 Conclusion**

This section has attempted to investigate the spillover effects of financial development on the size of informal economic activity in the EU countries. A total of 20 countries have been selected with this respect. Through nine different model options, the inverted U-shaped interaction between financial services sector and informal economic activity has been tested by also adding various control variables as advised in the relevant literature. Estimates of this study have strongly supported the evidence of inverted U-shaped relationship between financial development and informal economic activity in the EU countries. That is, at the initial stages of financial development, informal economic activity in the EU increases while in the later stages of financial development, the size of informal economic activity tends to decline. Thus, in parallel to the findings of Capasso and Jappelli (2013) and Bose et al. (2012), this study concludes that the efficiency of financial services sector matters in reducing the size of shadow economies in the case of the EU countries. This study has found that at the initial levels of financial development, there will be tendency of corporations to operate informally as reasons behind this happening are documented previously in this study; however, it has been found that the reaction of informal economic activity to a change in financial services sector development will be negative in the EU; thus, this major finding is parallel to the findings of Torgler and Schneider (2009), where they studied the effects of tax morale and institutional quality/governance environment on the shadow economy in the cases of European countries plus other countries and found that as a result of improvement in institutional quality such as government effectiveness, voice and accountability, the rule of law, regulatory quality and the control of corruption result in lower informal economic activity in the European countries. This study has also found that the levels of international trade, interest rates, and institutional quality in the economies do not matter for the effects of financial sector on informal economic activities in the EU; that the effect of the financial sector on informal economic activity in the EU found in this study is fixed in the existence or absence of trade, interest rates, and institutional quality. Therefore, as financial services sector develops, institutional quality in the countries will improve, which in turn, it will lead to an increase in formal economic activities. Finally, this study proposes that the spillover effects of the other aggregate economic activities can be considered against informal economic activities in further researches.

# Chapter 8

# CONCLUSION AND POLICY IMPLICATIONS

## 8.1 Summary of Major Findings

This thesis attempts to study and investigate the effects of financial sector development and the size of the underground economy in the countries situated in the European Union. Meanwhile international trade openness and interest rate have been selected as control variables. The research question is ‘does financial sector development successfully attempt to reduce the size of the underground economy?’ The results of the present study are of interest to both scholars and policymakers because European Union countries are developed country with a decreasing underground economic activity, even though financial sector is consistently developing and trade openness is reaching huge aggregate numbers due to rapid industrialization. The justification for this research is that financial sector development and trade openness are expected to have a statistical relationship with the underground economic activity in such a dynamic economy. Furthermore, to the best of the author’s knowledge, this study is a first of its kind in the relevant literature to investigate the interaction between financial sector development with trade openness and underground economic activity using the panel dataset. Additionally, this study is one of the first of its kind in the relevant literature to investigate the spillover effect of financial development on the size of the underground economy.

In order to examine the interaction between the financial sector development, international trade openness and interest rate on the size of the underground economy, both structural equation modelling (SEM) and panel data analyses has been used. MIMIC model approach of SEM has been used to measure the size of the underground economy and panel data analysis has been used to examine the interaction between them. Panel data analyses proves that the size of the underground economy in the European Union countries has statistical relationship with its determinants which are financial sector development, international trade openness and interest rate. These determinants apply a statistically significant impact on the size of the underground economy. Financial sector affects the size of the underground economy through the channels of international trade openness and interest rate.

Also the variance decompositions and impulse response functions estimated through vector autoregressive system. Variance decomposition results suggest that the ratio of variance explained in the size of the underground economy by the given changes in financial development, trade openness, and interest rate are generally low. Impulse response function results demonstrate diversification in terms of reaction of the size of the underground economy to given shocks in financial development, trade openness, and interest rate. The reaction of the size of the underground economy to given shocks in financial sector development is negative; on the other hand, the reaction of the size of the underground economy to given shocks in interest rate is positive. However, the reaction of the size of the underground economy to given shocks in trade openness is irresponsive, only after eighth period increasing trade openness has a negative impact on the size of the underground economy.

On the other hand, the dynamic framework of the article supports the evidence of inverted U-shaped relationship between financial development and the size of the underground economy, which means that at the first stage in the development of financial services sector, it contributes to the size of the underground economy, and after a certain level, the size of the underground economy starts to decline while financial services sector development continues to increase Parallel to the findings of Bose et al. (2012), low level development in financial sector is associated with high level of underground economic activity. Since a low level of financial development is associated with luck of loanable funds, lack of competition, limited access to information by lenders, or high level of financial repression. Therefore, individuals or institutions will have less intensive to work in official economy since high borrowing costs and lower probability to obtaining credit. However, the further stage of financial development reduces credit costs, and increases the opportunity cost of continuing to operate underground (Jappelli, 2005; Capasso and Jappelli, 2013; and among many others), therefore it is associated with lower underground economic activity. Another important point in the findings is the evidence of the negative correlation between the international trade openness and the size of the underground economy that is openness in international trade eases the government's ability to examine informal production (see Elgin and Oyvat, 2013), and positive correlation between the interest rate and the size of the underground economy. Gutmann (1985) stated that rise in government deficit would lead to increase in interest rate.

## 8.2 Policy Implications

Major results of this study suggest that financial sector development and international trade openness have negative and statistically significant impact on the size of the underground economy, while interest rate has positive and statistically significant impact on the size of the underground economy in the European Union countries in static framework. Results supports the realities of developed countries are quite successful in terms of controlling informality (see ATKearney, VISA & Schneider, 2013). Therefore, when promoting finance and trade sector in the transaction and developing countries, authorities in those regions should effectively adapt similar policies to developed countries in order to control and reduce the underground activities. Results of this thesis show that expansion in finance and trade sector will lead to reducing the size of the underground economy through interest rate. Since the positive effect of interest rate on the underground economy was found, European Union countries have to keep low interest rates. Therefore, it is essential that the policies that takes in action regarding the control of the underground economic activities in developed countries need to be replicated by authorities in transition and developing countries as well.

## 8.3 Shortcomings at the Study

Initially all the European Union countries were intended to be employed in this study; however, some of the countries have been eliminated due to the lack of data availability. The relationship between financial sector development and the underground economy is a process that takes place over time, therefore necessitating of the dynamic framework rather than static framework (Berdiev and Sauris, 2016). Both static and the dynamic framework between the financial sector development and underground have to be used to analyse the relationship for the rest of the countries for comparative purposes. However, the time range limitation in the series would not allow to put forward some evidence in the individual bases. Therefore, this thesis is limited to provide evidence of the relationship between financial sector development and the underground economy in panel estimation.

## 8.4 Directions for Further Research

This thesis has used two indicators and five causes' variables to measure the latent variable which is the size of the underground economy. There are many other cause and indicator variables that have significant effect on the underground economy. This thesis has its own cause and indicator variables that have a significant effect in the European Union countries. Even though strict regulations are another important variable that causes underground economic activity, but do to data availability and/or its problematic nature, it couldn't be employed in the MIMIC modelling approach to measure the underground economic activity. However, there are also other cause and indicator variables for measuring the size of the underground economy that can be proposed in order to reach alternative results. Therefore, further research can be replicated by using alternative data and methods to measure for the size of the underground economy. And further research can be undertaken in the other countries such as transition of developing countries' or for other regions where there is a considerable volume of the underground economic activities for comparative purposes. Additionally, further research can be replicated by observing the spillover effect of trade and/or interest rate on the underground economy.

# REFERENCES


Abouzeedan, A. (2003). Financing Swedish small and medium-sized enterprises (SMEs): Methods, problems and impact. *43rd European Congress of the Regional Science Association*, Jyväskylä, Finland.

Abdulsaleh, A.M., & Worthington, A.C. (2013). Small and medium-sized enterprises financing: a review of the literature: *International Journal of Business and Management;* 8(4), 36–54.

Ang, J. B. (2009). Financial development and the FDI-growth nexus: The Malaysian experience: *Applied Economics;* 41, 1595–1601.

Ang, J.B., & McKibbin, W.J. (2007). Financial liberalization, financial sector development and growth: evidence from Malaysia: *Journal of Development Economics*; 84, 215–233.

Antonie, M. D., Cristescu, A., & Cataniciu, N. (2010). A panel data analysis of the connection between employee remuneration, productivity and minimum wage in Romania. *Proceedings of the 11th WSEAS International Conferance MCBE 2010*, 134-139, Stevens Point, Wisconsin, USA.

Antunes, A.R., & Cavalcanti, T.V.D.V. (2007). Start-up costs, limited enforcement, and the hidden economy: *European Economic Review;* 51, 203–224.

Arellano, M., & Bover, O. (1995). Another look at the instrumental variables estimation of error components models: *Journal of Econometrics* 68, 29–51.

Arellano, M., & Bond, S. (1991). Some tests of specification for panel data: Monte Carlo evidence and an application to employment equations: *The Review of Economic Studies* 58; 277–297.

ATKearney, VISA & Schneider, F. (2013). *The shadow economy in Europe, 2013*. Retrieved from: https://www.atkearney.com/documents/10192/1743816/The+Shadow+Economy+in+Europe+2013.pdf

Bagachwa, M.S.D., & Naho, A. (1995). Estimating the second economy in Tanzania: *World Development*; 23(8), 1387–1399.

Baldemir, E., Gökalp, F., & Avcı, M. (2007). *Türkiye'de kayıtdışı ekonominin MIMIC model ile tahminlenmesi.* Retrieved from: http://www. Ekonometridernegi /org/bildiriler/o23s1.pdf.

Baltagi, B. H. (2005). *Econometric Analysis of Panel Data.* John Wiley, Chichester.

Baltagi, B. H., Demetriades, P.O., & Law. S. H. (2009). Law, financial development and openness: evidence from panel data: *Journal of Development Economics;* 89(2), 285–296.

Baum C. F. (2001). Residual diagnostics for cross-section time series regression models: *Stata Journal*; 1, 101– 104.

Becker, G.S. (1968). Crime and punishment: an economic approach: *The Journal of Political Economy*; 76, 169–217.

Beck, T., & Hoseini, M., (2014). Informality and access to finance: evidence from India, (*CentER Discussion Paper Series No. 2014-05).* Retrieved from: https://ssrn.com/abstract=2491466 or http://dx.doi.org/10.2139/ssrn.2491466

Beck, T., Demirgüç-Kunt, A., & Levine, R. (1999). A new database on the structure and development of the financial sector: *The World Bank Economic Review;* 14, 597–605.

Beck, T., Demirgüç-Kunt, A. & and Levine, R. (2003a). Law, endowments, and finance: *Journal of Financial Economics;* 70, 137–181.

Berdiev, A.N., Pasquesi-Hill, C., & Saunoris, J.W., (2015). Exploring the dynamics of the shadow economy across US states: *Applied Economics*; 47, 6136–6147.

Berdiev, A.N., & Saunoris, J.W. (2016). Financial development and the shadow economy: A panel VAR analysis: *Economic Modelling;* 57, 197-207.

Bhattacharyya, D.K. (1999). On the economic rationale of estimating the hidden economy: *The Economic Journal;* 109, 348-59.

Birinci, S. (2013). Trade openness, growth, and informality: panel VAR evidence from OECD economies: *Economic Bulletin*; 33, 694–705.

Blackburn, K., Bose, N., & Capasso, S. (2012). Tax evasion, the underground economy and financial development: *Journal of Economic Behavior and Organization;* 83, 243–253.

Blundell, R., & Bond, S. (1998). Initial conditions and moment restrictions in dynamic panel data models: *Journal of Econometrics;* 87, 11–143.

Boeschoten, W.C., & Fase, M.M.G. (1984). *The Volume of Payments and the Informal Economy in the Netherlands 1965-1982*. M. Nijhoff, Dordrecht.

Bollen, K. A. (1989). *Structural Equations with Latent Variables*. New York: NY, John Wiley & Sons.

Bordignon, M., & Zanardi, A. (1997). Tax evasion in Italy: *Giornale degli Economisti eAnnali di Economia*; 56, 169–210.

Bose, N., Capasso, S., & Wurm, M. (2012). The impact of banking development on the size of the shadow economy: *Journal of Economic Studies;* 39(6), 620–628.

Breusch, T. (2005). Estimating the underground economy using MIMIC Models, (*ANU working paper)*, National University of Australia. Retrieved from: https://core.ac.uk/download/pdf/9310351.pdf

Breusch, T. S. & Pagan, A. R. (1980). The Lagrange Multiplier Test and its applications to model specification in econometrics: *Review of Econometric*

*Studies;* 47, 239–253.

Brooks, C. (2002). *Introductory Econometrics for Finance.* Cambridge: Cambridge University Press.

Buehn, A., & Schneider, F. (2008). MIMIC models, co-integration and error correction: an application to the French shadow economy*: Forschungsinstitut Zur Zukunft Der Arbeit Institute for the Study of Labor*; 33(06), 4-30.

Buyuksalvarci, A. & Abdioglu, H. (2010). The causal relationship between stock prices and macroeconomic variables: a case study for Turkey: *International Journal of Economic Perspectives;* 4(4), 601-610.

Cagan, P. (1958). The demand for currency relative to the total money supply: *Journal of Political Economy;* 66(3), 302-328.

Capasso, S., & Jappelli, T. (2011). Financial development and the underground economy, (*CSEF Working Papers 298).* Centre for Studies in Economics and Finance (CSEF), University of Naples, Italy. Retrieved from: http://www.csef.it/WP/wp298.pdf

Capasso, S., & Jappelli, T. (2013). Financial development and the underground economy: *Journal of Development Economics;* 111, 167–78.

Chandio, J. A. (2014). Finance-growth nexus: empirical evidence from Pakistan: *International Journal of Economic Perspectives*; 8(1), 22-31.

Chen, M-H. (2010). The economy, tourism growth and corporate performance in the Taiwanese hotel industry: *Tourism Management*; 31, 665–675.

Contini, B. (1981). Labour Market Segmentation and the Development of the Parallel Economy- the Italian Experience: *Oxford Economic Papers;* 33(4), 401-412.

Clotfelter, C.T. (1983). Tax evasion and tax rates: an analysis of individual return. *Review of Economic Statistics*: 65(3); 363–373.

Cornell, B. (1983). Money supply announcement and interest rates: another view: *Journal of Buisiness;* 56, 1-23.

Dabla-Norris, E., & Feltenstein, A. (2005). The underground economy and its macroeconomic consequences: *Journal of Policy Reform;* 8, 153–174.

Dabla-Norris, E., Gradstein, M., & Inchauste, G. (2008). What causes firms to hide output? The determinants of informality: *Journal of Development Economics;* 85, 1–27.

De Vita, G., Katircioglu, S., Altinay, L., Fethi, S., and Mercan, M. (2015). Revisiting the environmental Kuznets curve hypothesis in a tourism development context: *Environmental Science and Pollution Research;* 22(21), 16652-16663.

Dell'Anno, R., & Schneider, F. (2006). Estimating the underground economy: A Response to T. Breusch's Critique, (*Discussion Paper).* Johannes Kepler University Linz, Department of Economics, Linz. Retrieved from: https://fair.unifg.it/handle/11369/13350

Dell'Anno, R., Gomez, M., & Pardo, A.A. (2007). Shadow economy in three different Mediterranean countries: France, Spain and Greece. A MIMIC approach: *Empirical Economics*; 33, 51-84.

Del Boca, D. (1981). Parallel economy and allocation of time: *Quarterly Journal of Microeconomics*; 4(2), 13–18.

Del Boca, D., & Forte, F. (1982). Recent Empirical Surveys and Theoretical Interpretations of the Parallel Economy in Italy; Tanzi, Vito (1982) (ed.): *The Underground Economy in the United States and Abroad, Lexington (Mass.),* Lexington, D.C. Health, 160-178.

Demetriades, P., & Hussein, K.A. (1996). Does financial development cause economic growth: *Journal of Development Economies; 51*, 387-411. http://dx.doi.org/10.1016/S0304-3878 (96)00421-X

Dilnot, A., & Morris, C.N. (1981). What do we know about the black economy?: *Fiscal Studies*; 2(1), 58–73.

Dreher, A., & Schneider, F. (2010). Corruption and the shadow economy: An empirical analysis: *Public Choice*; 144, 215-238.

Driscoll, J. C., & Kraay, A. C. (1998). Consistent covariance matrix estimation with spatially dependent panel data: *Review of Economics and Statistics*; 80, 549–560.

Drukker, D. (2003). Testing for serial correlation in linear panel-data models: *Stata Journal;* 3(2), 168–177.

Elgin, C. (2010). Political turnover, taxes, and the shadow economy, (*Working Papers 2010/08)*. Istanbul, Turkey: Department of Economics, Bogazici University. Retrieved from: http://www.econ.boun.edu.tr/public_html/RePEc/pdf/201008.pdf

Elgin, C. (2012). Cyclicality of the informal economy, (*Working Papers 2012/02)*. Istanbul, Turkey: Department of Economics, Bogazici University. Retrieved from: http://www.econ.boun.edu.tr/public_html/RePEc/pdf/201202.pdf

Elgin, C., & Öztunali, O. (2012). Shadow economies around the world: model based estimates, (*Working Paper 2012/05)*. Istanbul, Turkey: Department of Economics, Bogazici University. Retrieved from: http://citeseerx.ist.psu.edu/viewdoc/download?doi=10.1.1.464.5837&rep=rep1&type=pdf

Elgin, C., & Oyvat, C. ( 2013). Lurking in the cities: urbanization and the informal economy: *Structural Change and Economic Dynamics*; 27, 36–47.

Elgin, C. & Uras, R. B. (2013). Is informality a barrier to financial development? *SERIEs;* 4(3), 309–331.

Ellul, A., Jappelli, T., Pagano, M., & Panunzi, F. (2012). Transparency, tax pressure and access to finance: *Review of Finance*; 20(1), 37–76.

Enste, D.H. (2010). Regulation and shadow economy: empirical evidence for 25 OECD countries: *Constitutional Political Economy*; 21, 231–248.

Feige, E.L. (1979). How big is the irregular economy?: *Challenge;* 1, 5–13.

Feige, E.L. (1986). A re-examination of the “underground economy” in the United States: *IMF Staff Paper;* 33(4), 768–781.

Feige, E.L. (1989). *The Underground Economics: Tax evasion and Information Distortion.* Cabridge University Press.

Feige, E.L. (1990). Defining and estimating underground and informal economies: The new institutional economics approach: *World Development*; 18, 989–1002.

Feige, E.L. (1997). Revised estimates of the underground economy: Implications of U.S. currency held abroad, in: Lippert, Owen and Michael Walker (eds.): *The*

*Underground Economy: Global Evidences of Its Size and Impact: The Frazer Institute*, 151-208. Vancouver, B.C.

Feinstein, J.S. (1999). Approaches for estimating noncompliance: examples from federal taxation in the United States: *The Economic Journal;* 109(456), 360–369.

Feridun, M., & Sezgin, S. (2008). Regional underdevelopment and terrorism: the case of South Eastern Turkey: *Defence and Peace Economics*; 19, 225–233.

Fethi, M.D., Fethi, S. & Katircioglu, S.T. (2004). Currency demand, the underground economy and tax evasion: the case of Cyprus, The special issue on Economic Development and the Underground economy: *International Journal of Economic Development;* 6(2), 120-157.

Fethi, M. D., Fethi, S. & Katircioglu, S.T., (2006). Estimating the size of the Cypriot underground economy: a comparison with European experience, the special issue on Informal Employment in Advanced economies: *The International Journal of Manpower*; 27(6), 515-534.

Fethi, S., Katircioglu, S., & Caglar, D. (2013). The Role of the financial services sector in the Turkish Cypriot Economy: Evidence from bounds and causality tests: *Turkish Studies*; 14(3), 540-563.

Frey, B.S., & Weck, H. (1983a). Estimating the shadow economy: a “naive” approach: *Oxford Economic Papers;* 35(1), 23–44.

Frey, B.S., & Weck, H. (1983b). Bureaucracy and the shadow economy: a macro-approach" in anatomy of government deficiencies, in: Hanusch, H. (ed.), *Anatomy of Government Deficiencies*, Springer, Berlin, 89–109.

Frey, B.S., & Weck-Hannemann, H. (1984). The hidden economy as an “unobserved” variable: *European Economic Review;* 26(2), 33–53.

Frey, B. S., & Pommerehne, W.W. (1984). The hidden economy: state and prospects for measurement: *Review of Income and Wealth*; 30, 1–23.

Frey, B.S., & Schneider, F. (2000). Informal and underground economy. *International Encyclopedia of Social and Behavioral Science*, Bd. 12 Economics.

Fugazza, M., & Fiess, N. (2010). Trade Liberalization and Informality: New Stylized Facts, (*UNCTAD Blue Series Papers 44*). *United Nations Conference on Trade and Development.* New York, NY.

Gaibulloev, K., Sandler, T., & Sul, D. (2014). Dynamic panel analysis under cross-sectional dependence: *Political Analysis;* 22(2), 258–273.

Giles, D.E. A. (1999a). Measuring the hidden economy: implications for econometric modelling: *The Economic Journal;* 109(456), 370-380.

Giles, D.E.A. (1999b). Modelling the hidden economy in the tax gap in New Zealand: *Empirical Economics;* 24, 621–640.

Giles, D.E.A., Tedds, L.M., & Werkneh, G. (1999). The Canadian underground and measured economies, (*Economy Department Working Paper).* University of Victoria, Canada. Retrieved from: https://econpapers.repec.org/paper/vicvicewp/9907.htm

Giles, D.E.A., & Tedds, L.M., (2002). Taxes and the Canadian underground economy. *Canadian Tax Paper*, vol. 106. Canadian Tax Foundation, Toronto. Retrieved from: https://papers.ssrn.com/sol3/papers.cfm?abstract_id=1002475

Gelb, A.H. (1989). *Financial Policies, Growth, and Efficiency*. WPS, 202. Washington: World Bank Publications.

Georgiou, G.M. (2007). Measuring the size of the informal economy: A critical review, Central Bank of Cyprus, Nicosia: *Occasional Paper in Economics*; 7(3), 1-40.

Ghosh, A., & Paul, S. (2008). Opening the Pandora's box? Trade openness and informal sector growth: *Applied Economics;* 40, 1995–2007.

Greene, W. H. (1990). *Econometric Analysis* (1st ed.), New York, NY: Macmillan Publishing Company.

Greene, W. H. (2000). *Econometric Analysis* (4st ed.), Upper Saddle River, NJ: Prentice-Hall.

Godfrey, P.C. (2015). *Management, Society, and the Informal Economy.* Routledge, London, 1-20.

Goldberg, P.K., & Pavcnik, N. (2003). The response of the informal sector to trade liberalization: *Journal of Development Economics;* 72, 463–496.

Gordon, R.H. & Li, W. (2005). Tax structure in developing countries: many puzzles and possible explanations, (*NBER Working Paper No. 11267*). Retrieved from: http://www.nber.org/papers/w11267

Gungor, H. & Katircioglu, S. (2010). Financial development, FDI and real income growth in Turkey: An empirical investigation from the bounds tests and causality analysis: *Actual Problems of Economics;* 11(114), 215-225.

Gungor, H., Katircioglu, S. T., & Mercan, M. (2014). Revisiting the nexus between financial development, FDI, and growth: New evidence from second generation econometric procedures in the Turkish context: *Acta Oeconomica;* 64(1), 73-89.

Gutmann, P.M. (1977). The subterranean economy: *Financial Analysts Journal*; 34(1), 24–27.

Hachicha, A. (2008). Does financial innovation of credit derivatives make bank riskier?: *International Journal of Economic Perspectives*; 2(1), 1-4.

Hair, J.F, Jr., Anderson, R.E., Tatham, R.L., & Black, W.C. (1998). *Multivariate Data Analysis*, (5th ed.). Englewood Cliffs, NJ: Prentice-Hall.

Heidari, H., Katircioglu, S.T., & Saeidpour, L. (2015). Economic growth, CO2 emissions, and energy consumption in the five ASEAN countries: *International Journal of Electrical Power & Energy Systems*; 64, 785-791.

Hernández-Trillo, F., Pagán, J., & Paxton,J. (2005). Start-up capital, microenterprises and technical efficiency in Mexico: *Review of Development Economics*; 9, 434–447.

Hoechle, D. (2007). Robust standard errors for panel regressions with cross-sectional dependence: *The Stata Journal;* 7(3), 281-312.

Hoeffler, A., (2002). The augmented Solow model and the African growth debate: *Oxford Bulletin of Economics and Statistics;* 64, 135–158.

Holtz-Eakin, D., Newey, W., & Rosen, H.S. (1988). Estimating vector autoregressions with panel data: *Econometrica;* 56, 1371–95.

Imamoglu, H. (2016). Re-estimation of the size of underground economy in European countries: MIMIC approach: *International Journal of Economic Perspectives;* 10(1), 171-193.

Isachsen, A.J., Klovland, J., & Strom, S. (1982). The Hidden Economy in Norway. In Tanzi, V. (Ed), *The Underground Economy in the United State and Abroad*. Vito Tanzi, ed.Lexington, D.C. Health, 209-231.

Isachsen, A.J., & Strom, S. (1985). The size and growth of the hidden economy in Norway: *Review of Income and Wealth*; 31(1), 21-38.

Jappelli, T., Pagano, M., & Bianco, M. (2005). Courts and banks: effects of judicial enforcement on credit markets: *Journal of Money, Credit, and Banking*; 37, 223–244.

Jenkins, H. P., & Katircioglu, S. (2010). The bounds test approach for cointegration and causality between financial development, international trade and economic growth: The case of Cyprus: *Applied Economics*; 42 (13), 1699-1707.

Jie, S.W., Tat, H.H., Rasli, A., & Chye L.T., (2011). Underground economy: definition and causes: *Business and Management Review;* 1(2), 14–24.

Johnson, S., Kaufmann, D., & Shleifer, A. (1997). The unofficial economy in transition: *Brooking Papers on Economic Activity;* 2, 159–221.

Karacaer, S. & Kapusuzoglu, A. (2010). Investigating causal relations among stock market and macroeconomic variables: Evidence from Turkey: *International Journal of Economic Perspectives;* 4(3), 501-507.

Katircioglu, S., Kahyalar, N., & Benar, H. (2007). Financial development, trade and growth triangle: The case of India: *International Journal of Social Economics*; 34(9), 586-598.

Katircioglu, S. (2012). Financial development, international trade and economic growth: The case of Sub-Saharan Africa: *Ekonomista*; 15 (1), 117-127.

Katircioglu, S.T. (2014). Testing the tourism-induced EKC hypothesis: The case of Singapore: *Economic Modelling*; 41, 383-391.

Katircioglu, S. (2017). Investigating the role of oil prices in the conventional EKC model: Evidence from Turkey: *Asian Economic & Financial Review;* 7(5), 498-508.

Katircioglu, S. & Katircioglu, S. T. (2017). Testing the role of urban development in the conventional environmental Kuznets curve: Evidence from Turkey: *Applied Economics Letters;* DOI: 10.1080/13504851.2017.1361004

Katircioğlu, S.T., & Taşpinar, N. (2017). Testing the moderating role of financial development in an environmental Kuznets curve: Empirical evidence from Turkey: *Renewable and Sustainable Energy Reviews;* 68, 572–586.

Kaufmann, D., & Kaliberda, A. (1996). Integrating the unofficial economy into the dynamics of post socialist economies : A framework of analysis and evidence, in: Kaminski, B. (ed.), *Economic Transition in Russia and the New States of Eurasia.* M.E. Sharpe, London, 81–120.

Kaufmann, D., Kraay, A., & Mastruzzi, M. (2010). The worldwide governance indicators: Methodology and analytical issues*: Hague Journal on the Rule of Law; 3, 220-246.*

Kaushal, L.A. & Pathak, N. (2015). The causal relationship among economic growth, financial development and trade openness in Indian economy: *International Journal of Economic Perspectives;* 9(2), 5-22.

King, R.G., & Levine, R. (1993a). Finance and growth: Schumpeter might be right: *Quarterly Journal of Economics*; 3, 717–737.

Klein, L.R., & Ozmucur, S. (2003). The estimation of China's economic growth rate: *Journal of Economic and Social Measurement;* 28(4), 187–202.

La Porta, R., & Shleifer, A. (2008). The unofficial economy and economic development: *Brookings Papers on Economic Activity*; 47(1), 123–135.

Langfeldt, E. (1984). The unobserved economy in the Federal Republic of Germany, in *The Unobserved Economy*. Edgar L. Feige, ed.. Cambridge: Cambridge University Press.

Lester, L.H. (2008). *A Multiple Indicators and Multiple Causes (MIMIC) Model of Immigrant Settlement Success*, National Institute of Labour Statistics, Flinders University, Adelaide.

Levine, R., Loayza, N., & Beck, T. (2000). Financial intermediation and growth:

Causality and causes without outliers: *Journal of Monetary Economics*; 46(1), 31–77.

Love, I. (2003). Financial development and financing constraints: international evidence from the structural investment model: *Review of Financial Studies;* 16(3), 765–791.

Love, I., & Zicchino, L. (2006). Financial development and dynamic investment behaviour: evidence from Panel VAR: *The Quarterly Review of Economic Finance;* 46, 190–210.

Lubell, H. (1991). *The Informal Economy in 1980's and 1990's, Development Centre Studies*, Development Centre of the Organisation for Economic Co-operation and Development, Paris: OECD Development Center.

Lyssiotou, P., Pashardes, P., & Stengos, T. (2004). Estimates of the black economy based on consumer demand approaches: *Economic Journal;* 114(497), 622-640.

MacAfee, K. (1980). A glimpse of the hidden economy in the national accounts: *Economic Trends;* 136, 81–87.

MacKinnon, J.G., (1996). Numerical distribution functions for unit root and cointegration tests: *Journal of Applied Econometrics;* 11(6), 601-618.

Marinov, A. (2008). Hidden economy in the rural regions of Bulgaria: *International*

*Review on Public and Nonprofit Marketing*; 5, 71–80.

Maurin, A., Sookram, S., & Watson, P.K. (2006). Measuring the size of the hidden economy in Trinidad & Tobago, 1973–1999: *International Economic Journal;* 20, 321–341.

Meydan, H.C., & Şeşen, H. (2011). *Yapısal Eşitlik Modellemesi. AMOS Uygulamaları*, Ankara: Detay Yayıncılık.

Mogensen, G.V., Kvist, H.K., Kormendi, E., & Pedersen, S. (1995). *The Shadow Economy in Denmark 1994: Measurement and Rules*, Study No.3, Rockwool Foundation Reasearch Unit, Copenhagen.

Newey, W.K., & West, K.D. (1987). A simple, positive semi-definite, heteroskedasticity and autocorrelation consistent covariance matrix: *Econometrica*; 55, 703–708.

North, D.C. (1990). *Institution, Institutional Change and Economic Performance*. Cambridge: Cambridge University Press.

O'Higgins, M. (1989). Assessing the underground economy in the United Kingdom, in *The Underground Economies: Tax Evasion and Information Distortion.* Edgar L. Feige, ed. Cambridge: Cambridge University Press, 175-195.

Öğünç, F., & Yılmaz, G. (2000). Estimating the underground economy in Turkey. Research Department, (*Discussion Paper No.15).* The Central Bank of the

Republic of Turkey. Retrieved from: http://steconomice.uoradea.ro/leonardo3/pdf/ESTIMATING%20THE%20UNDERGROUND%20ECONOMY%20IN%20TURKEY.pdf

Park, T. (1979). *Reconciliation between Personal Income and Taxable Income, 1974-77.* Washington DC: Bureau of Economic Analysis.

Patrick, H.T. (1966). Financial development and economic growth in underdeveloped economies: *Economic Development and Cultural Change;* 14, 174—189.

Pesaran, M. H. (2004). General diagnostic tests for cross section dependence in panels, Institute for the Study of Labour (IZA). *(Institute for the Study of Labour (IZA) Discussion Paper No. 1240).* CESifo Working Paper No. 1229, University of Cambridge, Department of Applied Economics. Retrieved from: http://repec.iza.org/dp1240.pdf

Petersen, H.G. (1982). Size of the public sector, economic growth and the informal economy: Development trends in the Federal Republic of Germany: *Review of Income and Wealth;* 28(2), 191–215.

Pissarides, C., & Weber, G. (1989). An expenditure-based estimate of Britain'S black economy: *Journal of Public Economics;* 39(1), 17–32.

Razmi, M. J. & Jamalmanesh, A. (2014). How political indices affect the shadow economy: *Romanian Economic and Business Review*; 9(1), 45-55.

Rioja, F., & Valev, N. (2004). Finance and the sources of growth at various stages of economic development: *Economic Inquiry;* 42, 127–140.

Roodman, D. (2009). A note on the theme of too many instruments: *Oxford Bulletin of Economics and Statistics;* 71(1), 135-158.

Rousseau, P.L., & Wachtel, P. (2000). Equity markets and growth: Cross-country evidence on timing and outcomes, 1980–1995*: Journal of Banking & Finance;* 24, 1933–1957.

Roy, A. G. (2012). U.S. foreign indebtedness, monetary policy, and economic growth: *International Journal of Economic Perspectives;* 6(2), 196-205.

Saqib, N. & Waheed, A. (2011). Financial services sector reforms and macroeconomic performance: Policy simulations based on financial macroeconomic model for Pakistan: *International Journal of Economic Perspectives*; 5(3), 241-260.

Simon, C.P., & Witte, A.D. (1982). *Beating the System: The Underground Economy*. Boston: Urban House.

Schmidheiny, K. (2011). *Panel data: fixed and random effects. Short Guides to Microeconometrics*. Retrieved from: http://www.schmidheiny.name/teaching/panel2up.pdf.

Schneider, F. (1986). Estimating the size of the Danish shadow economy using the currency demand approach: An attempt: *The Scandinavian Journal of Economics;* 4, 643–668.

Schneider, F. (1994a). Measuring the size and development of the shadow economy: Can the causes be found and the obstacles be overcome? in Hermann Brandstaetter and Werner Gtith, eds. *Essays on Economic Psychology*. Berlin: Springer, 193–212.

Schneider, F. (1998a). Further empirical results of the size of the shadow economy of 17 OECD countries over time. *54th Congress of IIPF*, Cordoba, Argentina and discussion paper, Department of Economics., U. Linz, Austria.

Schneider, F. (2006). Shadow economies and corruption all over the world: what do we really know?, (*Discussion Paper*. 2315). The Institute for the Study of Labour. Retrieved from: http://ftp.iza.org/dp2315.pdf

Schneider, F. (2007). Shadow economies and corruption all over the world: new estimates for 145 countries, Economics: *Economics - The Open-Access, Open-Assessment E-Journal*; Kiel Institute for the World Economy, 1(9).

Schneider, F. (2009). The size of the shadow economy for 25 transition countries over 1999/00 to 2006/07, What do we know*?, ( Working Paper, Johannes Kepler University of Linz)*, 1-13. Retrieved from: http://www.economics.uni-linz.ac.at/members/Schneider/files/publications/ShadEcon_25Trans.pdf

Schneider, F., & Enste, D.H. (2000). Shadow economies: size, causes, and consequences: *The Journal of Economic Literature;* 38(1), 77–114.

Schneider, F., & Enste, D.H. (2002). Hiding in the shadows: The growth of the underground economy, *International Monetary Fund*. Retrieved from: http://www.imf.org/external/pubs/ft/issues/issues30/index.htm.

Schneider, F. (2013). Size and development of the shadow economy of 31 European and 5 other OECD countries from 2003 to 2013: A Further Decline, (*Working Paper*). Retrieved from: http://www.econ.jku.at/members/Schneider/files/publications/2013/ShadEcEurope31_ Jan2013.pdf

Scott, W.R. (2008). *Institutions and Organizations: Ideas and Interests.* London: Sage.

Shleifer, A., & Vishny, R.W. (1993). Corruption: *Quarterly Journal of Economics*; 108, 599–617.

Smith, J.D. (1985). Market motives in the informal economy, in *The Economics of The Shadow Economy.* Wulf Gaertner and Alois Wenig, eds. Berlin: Springer, 161–177.

Smith, P. (1994). Assessing the size of the underground economy: The Canadian statistical perspectives. *Canadian Economic Observer,* Catalogue No. 11-010, 3.16-33.

Sodeyfi, S. (2016). Review of literature on the nexus of financial leverage, product quality, & business conditions: *International Journal of Economic Perspectives;* 10(2), 146-150.

Soukhakian, N. (2007a). Financial development and economic growth in Iran: evidence from co-integration and causality tests: *International Journal of Economic Perspectives*; 1(2), 56-63.

Soukhakian, B. (2007b). Financial development, trade openness and economic growth in Japan: Evidence from Granger causality tests: *International Journal of Economic Perspectives;* 1(3), 118-127.

Straub, S. (2005). Informal sector: The credit market channel: *Journal of Development Economics;* 78, 299–321.

Svirydzenka, K. (2016). Introducing a New Broad-based Index of Financial Development, *(IMF Working Paper, WP/16/5). Retrieved from: http://data.imf.org/?sk=F8032E80-B36C-43B1-AC26-493C5B1CD33B*

Tanzi, V. (1980). The underground economy in the United States: Estimates and implications: *Banca Nazionale del Lavoro*; 135(4), 427-53.

Tanzi, V. (1983). The underground economy in the United States: Annual estimates, 1930-1980: *IMF Staff Papers; 30(2),* 283-305.

Tanzi, V. (1999). Uses and abuses of estimates of the underground economy: *The Econonomic Journal;* 109(456), 338-40.

Thomas, J.J. (1992). *Informal Economic Activity,* LSE Handbooks in Economics. London: Harvester Wheatsheaf.

Thomas, J.J. (1999). Quantifying the black economy: “measurement without theory” yet again?: *Economics Journal*; 456, 381–89.

Torgler, B., & Schneider, F. (2009). The impact of tax morale and institutional quality on the shadow economy: *Journal of Economic Psychology;* 30, 228–245.

Torgler, B., Schneider, F., & Macintyre, A. (2011). Shadow economy, voice and accountability and corruption, in *The Shadow Economy*, ed. Friedrich G. Schneider. Edward Elgar Publishing.

Tudose, B.M., & Clipa, R.I. (2016). An analysis of the shadow economy in EU countries, (*CES Working papers, 3/2). Retrieved from: https://www.ceeol.com/content-files/document-598571.pdf*

Waheed, A. & Younus, N. (2010). Effects of financial services sector’s development and financial services sector’s efficiency on economic growth: Empirical Evidence from developing and developed Countries: *International Journal of Economic Perspectives;* 4(2), 449-458.

Williams, C. C. (2008). Cross-national variations in undeclared work: Results from a survey of 27 European countries: *International Journal of Economic Perspectives;* 2(2), 46-63.

Williams, C. C. & Round, J. (2009). Out of the margins: Re-theorizing the role of the informal economy in Ukraine: *International Journal of Economic Perspectives*; 3(1), 45-58.

Williams, C.C. (2010). Evaluating competing theories of the shadow economy: some lessons from an English locality: *International Journal of Economic Perspectives;* 4(2), 391-402.

Williams, C. C., (2011). Blurring the formal/informal economy divide: beyond a dual economies approach: *International Journal of Economic Perspectives*; 5(4), 347-362.

Williams C.C. (2017). *Entrepreneurship in the Informal Sector: an Institutional Perspective.* London: Routledge.

World Bank (2017). World Development Indicators. Retrieved from: http://databank.worldbank.org/data/reports.aspx?source=world-development-indicators&preview=on.

Witte, A.D. (1987). The nature and extent of unreported activity: A survey concentrating on recent US research, in *The Unofficial Economy:*

*Consequences and Perspectives in Different Economic Systems*. S. Alessandrini and Bruno Dallago, (eds.), Gower, Aldershot (1987).

Wooldridge, J. M. (2002). *Econometric Analysis of Cross Section and Panel Data*. Cambridge, MA: MIT Press.

# APPENDICES

# Appendix A: MIMIC Model's Covariance Matrix;

Structural equation: $\eta_t = \gamma' x_t + \varepsilon_t$

Measurement equation: $y_t = \lambda \eta_t + \omega_t$

Expressing the model in terms of co-variances in general;

$$\Sigma = \begin{pmatrix} Var(y_t) & Cov(y_t, x_t) \\ Cov(x_t, y_t) & Var(x_t) \end{pmatrix} = E\left( \begin{bmatrix} y_t \\ x_t \end{bmatrix} \begin{bmatrix} y_t \\ x_t \end{bmatrix}' \right) = \begin{pmatrix} E(y_t y_t') & E(y_t x_t') \\ E(x_t y_t') & E(x_t x_t') \end{pmatrix}$$

By using the assumptions;

1. Variables are measured as deviations from the mean, i.e.

$E(\eta_t) = E(x_t) = E(\varepsilon_t) = E(y_t) = E(\omega_t) = 0$

2. Error terms do not correlate to causes, i.e.

$E(x_t \varepsilon_t') = E(\varepsilon_t x_t') = 0$ and $E(x_t \omega_t') = E(\omega_t x_t') = 0$

3. Error terms do not correlate over across equations, i.e.

$E(\omega_t \varepsilon_t') = E(\varepsilon_t \omega_t') = 0$

4. Error term of the measurement model do not correlate to the latent variable, i.e.

$E(\eta_t \omega_t') = E(\omega_t \eta_t') = 0$

Deriving variance and covariance and distribute expectation operator, result yields to

$$E(y_t y_t') = E\left[(\lambda \eta_t + \omega_t)(\lambda \eta_t + \omega_t)'\right]$$

$$= E\left(\lambda\eta_t\lambda^{'}\eta_t^{'} + \lambda\eta_t\omega_t^{'} + \lambda^{'}\eta_t^{'}\omega_t + \omega_t\omega_t^{'}\right)$$

$$= \lambda E\left(\eta_t\eta_t^{'}\right)\lambda^{'} + \Phi_{\varepsilon},$$

$$= \lambda E\left[\left(\gamma^{'}x_t + \varepsilon_t\right)\left(\gamma^{'}x_t + \varepsilon_t\right)^{'}\right]\lambda^{'} + \Phi_{\varepsilon}$$

$$= \lambda E\left(\gamma^{'}x_t\gamma x_t^{'} + \gamma^{'}x_t\varepsilon_t^{'} + \gamma x_t^{'}\varepsilon_t + \varepsilon_t\varepsilon_t^{'}\right)\lambda^{'} + \Phi_{\varepsilon}$$

$$= \lambda\left(\gamma^{'}\Theta\gamma + \Psi\right)\lambda^{'} + \Phi_{\varepsilon}$$

$$E(x_t y_t^{'}) = E\left[x_t\left(\lambda\eta_t + \omega_t\right)^{'}\right]$$

$$= E\left(x_t\lambda^{'}\eta_t^{'} + x_t\omega_t^{'} + \eta_t^{'}\omega_t^{'}\lambda^{'} + \omega_t\omega_t^{'}\right),$$

$$= E\left(x_t\eta_t^{'}\right)\lambda^{'}$$

$$= E\left[x_t\left(\gamma^{'}x_t + \varepsilon_t\right)^{'}\right]\lambda^{'}$$

$$= E\left(x_t\gamma x_t^{'} + x_t\varepsilon_t^{'}\right)\lambda^{'}$$

$$= \Theta\gamma\lambda^{'}$$

$$E(y_t x_t^{'}) = \left(\Theta\gamma\lambda^{'}\right)^{'}$$

$$= \lambda\gamma'\Theta$$

$$E(x_t x_t') = \Theta$$

The covariance matrix of MIMIC model;

$$\Sigma = \begin{pmatrix} \lambda(\gamma'\Theta\gamma + \Psi) + \Phi_\omega & \lambda\gamma'\Theta \\ \Theta\gamma\lambda' & \Theta \end{pmatrix}$$

Where $\Phi_\omega$ is the covariance matrix of the error terms in the measurement model; $\Psi$ is the variance of the error term in the structural equation; and $\Theta$ is the covariance matrix of the causes.

## Appendix B: Test Results

Table 1. Normality test for Austria.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | 1.957 | -0.593 | 0.207 (0.025) | 0.928 (0.140) |
| **X2** | 1.712 | -0.170 | 0.184 (0.074) | 0.943 (0.274) |
| **X3** | -0.515 | -0.744 | 0.201 (0.034) | 0.911 (0.068) |
| **X4** | 0.854 | 1.417 | 0.260 (0.001) | 0.785 (0.051) |
| **X5** | -0.943 | 0.777 | 0.228 (0.008) | 0.842 (0.764) |
| **Y1** | -0.976 | -0.045 | 0.113 (0.200) | 0.966 (0.663) |
| **Y2** | -0.807 | -0.734 | 0.227 (0.008) | 0.872 (0.063) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 2. Normality test for Belgium.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | 0.372 | -0.486 | 0.143 (0.200) | 0.972 (0.790) |
| **X2** | 0.270 | 0.377 | 0.135 (0.200) | 0.976 (0.881) |
| **X3** | -0.537 | -0.601 | 0.157 (0.200) | 0.943 (0.270) |
| **X4** | -0.774 | -0.303 | 0.143 (0.200) | 0.957 (0.491) |
| **X5** | -0.695 | 0.871 | 0.250 (0.002) | 0.846 (0.105) |
| **Y1** | -1.502 | -0.275 | 0.194 (0.047) | 0.899 (0.839) |
| **Y2** | -0.828 | -0.678 | 0.201 (0.034) | 0.889 (0.226) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 3. Normality test for Czech Republic.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | -1.136 | -0.180 | 0.151 (0.200) | 0.949 (0.358) |
| **X2** | -1.207 | 0.062 | 0.149 (0.200) | 0.950 (0.363) |
| **X3** | -0.971 | -0.281 | 0.137 (0.200) | 0.949 (0.354) |
| **X4** | -0.141 | -0.952 | 0.199 (0.037) | 0.885 (0.421) |
| **X5** | -0.081 | -0.718 | 0.152 (0.200) | 0.938 (0.221) |
| **Y1** | -1.746 | -0.057 | 0.201 (0.034) | 0.878 (0.116) |
| **Y2** | -0.965 | 0.412 | 0.175 (0.929) | 0.929 (0.150) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 4. Normality test for Denmark.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | 4.451 | 1.322 | 0.303 (0.000) | 0.829 (0.052) |
| **X2** | 5.225 | -1.583 | 0.314 (0.000) | 0.808 (0.517) |
| **X3** | 1.866 | 1.715 | 0.357 (0.000) | 0.711 (0.210) |
| **X4** | -0.931 | -0.212 | 0.145 (0.200) | 0.945 (0.299) |
| **X5** | 0.262 | 0.773 | 0.220 (0.012) | 0.927 (0.134) |
| **Y1** | -1.404 | -0.312 | 0.179 (0.092) | 0.912 (0.070) |
| **Y2** | 0.424 | -0.752 | 0.158 (0.200) | 0.928 (0.143) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 5. Normality test for Estonia.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | 0.873 | -0.164 | 0.180 (0.090) | 0.907 (0.056) |
| **X2** | 0.283 | -1.106 | 0.213 (0.018) | 0.872 (0.063) |
| **X3** | 0.014 | 0.534 | 0.115 (0.200) | 0.956 (0.466) |
| **X4** | 0.278 | -0.667 | 0.181 (0.086) | 0.954 (0.435) |
| **X5** | -0.250 | -0.433 | 0.103 (0.200) | 0.968 (0.707) |
| **Y1** | -1.782 | -0.177 | 0.190 (0.057) | 0.862 (0.059) |
| **Y2** | -1.220 | -0.194 | 0.119 (0.200) | 0.941 (0.247) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 6. Normality test for Finland.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | 0.465 | 0.535 | 0.148 (0.200) | 0.943 (0.274) |
| **X2** | 1.143 | -0.806 | 0.165 (0.160) | 0.927 (0.135) |
| **X3** | 0.110 | 0.752 | 0.154 (0.200) | 0.932 (0.166) |
| **X4** | 0.636 | 0.909 | 0.218 (0.014) | 0.917 (0.086) |
| **X5** | 0.989 | 1.282 | 0.208 (0.023) | 0.857 (0.067) |
| **Y1** | -1.742 | -0.158 | 0.191 (0.054) | 0.875 (0.054) |
| **Y2** | -0.094 | -0.745 | 0.198 (0.038) | 0.926 (0.132) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 7. Normality test for France.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | 1.882 | -1.535 | 0.238 (0.004) | 0.827 (0.052) |
| **X2** | 1.263 | 1.296 | 0.217 (0.014) | 0.867 (0.061) |
| **X3** | 0.307 | 1.196 | 0.193 (0.050) | 0.831 (0.053) |
| **X4** | -0.754 | 0.434 | 0.162 (0.181) | 0.918 (0.090) |
| **X5** | 0.209 | 1.050 | 0.245 (0.003) | 0.880 (0.097) |
| **Y1** | -1.575 | -0.254 | 0.187 (0.065) | 0.893 (0.131) |
| **Y2** | -1.045 | -0.232 | 0.192 (0.051) | 0.946 (0.314) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 8. Normality test for Germany.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | -0.938 | -0.477 | 0.167 (0.146) | 0.928 (0.139) |
| **X2** | -1.021 | 0.325 | 0.133 (0.200) | 0.945 (0.292) |
| **X3** | 1.138 | -1.154 | 0.204 (0.029) | 0.897 (0.066) |
| **X4** | -0.268 | -0.711 | 0.166 (0.150) | 0.924 (0.117) |
| **X5** | -0.985 | 0.290 | 0.147 (0.200) | 0.952 (0.406) |
| **Y1** | -1.331 | -0.300 | 0.186 (0.067) | 0.919 (0.096) |
| **Y2** | -1.818 | 0.181 | 0.243 (0.003) | 0.850 (0.075) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 9. Normality test for Greece.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | 1.957 | -0.593 | 0.207 (0.025) | 0.928 (0.140) |
| **X2** | 1.712 | -0.170 | 0.184 (0.074) | 0.943 (0.274) |
| **X3** | -0.515 | -0.744 | 0.201 (0.034) | 0.911 (0.068) |
| **X4** | 0.854 | 1.417 | 0.260 (0.001) | 0.785 (0.051) |
| **X5** | -0.943 | 0.777 | 0.228 (0.008) | 0.842 (0.094) |
| **Y1** | -0.976 | -0.045 | 0.113 (0.200) | 0.966 (0.663) |
| **Y2** | -0.807 | -0.734 | 0.227 (0.008) | 0.872 (0.073) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 10. Normality test for Hungary.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | -0.412 | -0.525 | 0.112 (0.200) | 0.961 (0.574) |
| **X2** | -0.627 | 0.300 | 0.090 (0.200) | 0.974 (0.840) |
| **X3** | 0.209 | 0.710 | 0.166 (0.151) | 0.915 (0.078) |
| **X4** | -1.348 | 0.048 | 0.163 (0.170) | 0.918 (0.091) |
| **X5** | -0.490 | 0.527 | 0.135 (0.200) | 0.957 (0.178) |
| **Y1** | -0.438 | -0.551 | 0.177 (0.101) | 0.940 (0.241) |
| **Y2** | 0.997 | 0.869 | 0.120 (0.200) | 0.949 (0.350) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 11. Normality test for Ireland.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | -0.931 | -0.463 | 0.138 (0.200) | 0.937 (0.214) |
| **X2** | -0.993 | 0.359 | 0.117 (0.200) | 0.947 (0.326) |
| **X3** | -1.432 | 0.557 | 0.216 (0.015) | 0.837 (0.063) |
| **X4** | -1.900 | 0.093 | 0.221 (0.011) | 0.836 (0.052) |
| **X5** | -0.223 | 0.852 | 0.180 (0.090) | 0.911 (0.066) |
| **Y1** | -1.822 | -0.234 | 0.188 (0.062) | 0.844 (0.054) |
| **Y2** | 0.323 | -1.039 | 0.230 (0.007) | 0.883 (0.072) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 12. Normality test for Italy.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | -0.695 | 0.131 | 0.068 (0.200) | 0.973 (0.819) |
| **X2** | -0.636 | -0.267 | 0.094 (0.200) | 0.969 (0.736) |
| **X3** | -1.175 | 0.334 | 0.159 (0.200) | 0.913 (0.072) |
| **X4** | -1.092 | -0.316 | 0.159 (0.197) | 0.933 (0.178) |
| **X5** | -1.616 | -0.066 | 0.150 (0.200) | 0.897 (0.087) |
| **Y1** | -1.281 | -0.286 | 0.191 (0.054) | 0.926 (0.131) |
| **Y2** | -0.909 | -0.444 | 0.179 (0.094) | 0.940 (0.237) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 13. Normality test for Luxemburg.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | 0.458 | 0.015 | 0.159 (0.199) | 0.944 (0.283) |
| **X2** | 0.362 | -0.142 | 0.152 (0.200) | 0.945 (0.299) |
| **X3** | -1.179 | -0.202 | 0.165 (0.159) | 0.929 (0.146) |
| **X4** | -1.015 | -0.496 | 0.172 (0.121) | 0.916 (0.083) |
| **X5** | 1.054 | 0.031 | 0.128 (0.200) | 0.975 (0.847) |
| **Y1** | -1.186 | -0.133 | 0.223 (0.010) | 0.842 (0.074) |
| **Y2** | -0.870 | -0.260 | 0.122 (0.200) | 0.966 (0.673) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 14. Normality test for Netherlands.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | -0.809 | -0.625 | 0.232 (0.006) | 0.896 (0.085) |
| **X2** | -0.849 | 0.551 | 0.221 (0.012) | 0.905 (0.052) |
| **X3** | -1.011 | 0.420 | 0.161 (0.186) | 0.937 (0.208) |
| **X4** | -0.747 | 0.010 | 0.094 (0.200) | 0.971 (0.781) |
| **X5** | -0.529 | 0.795 | 0.171 (0.128) | 0.897 (0.086) |
| **Y1** | -1.659 | -0.160 | 0.185 (0.072) | 0.892 (0.059) |
| **Y2** | -0.778 | -0.404 | 0.164 (0.164) | 0.939 (0.234) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 15. Normality test for Poland.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | -0.233 | 1.126 | 0.231 (0.006) | 0.791 (0.051) |
| **X2** | 0.062 | -1.257 | 0.253 (0.002) | 0.760 (0.063) |
| **X3** | -0.444 | 0.456 | 0.138 (0.200) | 0.958 (0.500) |
| **X4** | -1.148 | 0.187 | 0.161 (0.184) | 0.935 (0.190) |
| **X5** | -1.547 | -0.107 | 0.167 (0.147) | 0.914 (0.075) |
| **Y1** | -1.634 | 0.043 | 0.172 (0.125) | 0.904 (0.052) |
| **Y2** | -0.798 | -0.075 | 0.115 (0.200) | 0.976 (0.873) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 16. Normality test for Portugal.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | 1.819 | 1.384 | 0.158 (0.200) | 0.861 (0.058) |
| **X2** | 2.702 | -1.645 | 0190 (0.057) | 0.825 (0.052) |
| **X3** | -0.958 | 0.132 | 0.106 (0.200) | 0.959 (0.530) |
| **X4** | -0.672 | 0.261 | 0.146 (0.200) | 0.950 (0.367) |
| **X5** | -0.242 | -0.771 | 0.142 (0.200) | 0.917 (0.085) |
| **Y1** | -1.360 | -0.206 | 0.166 (0.148) | 0.929 (0.148) |
| **Y2** | 0.973 | -1.437 | 0.260 (0.001) | 0.781 (0.051) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 17. Normality test for Slovak Republic.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | 0.523 | 1.183 | 0.283 (0.000) | 0.850 (0.055) |
| **X2** | 1.460 | -1.455 | 0.306 (0.000) | 0.809 (0.051) |
| **X3** | -1.181 | 0.017 | 0.149 (0.200) | 0.949 (0.359) |
| **X4** | -0.768 | -0.010 | 0.122 (0.200) | 0.959 (0.061) |
| **X5** | -1.627 | -0.279 | 0.189 (0.060) | 0.865 (0.062) |
| **Y1** | -1.711 | -0.053 | 0.216 (0.015) | 0.878 (0.071) |
| **Y2** | -0.953 | -0.133 | 0.117 (0.200) | 0.968 (0.712) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 18. Normality test for Slovenia.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | -0.768 | -0.010 | 0.122 (0.200) | 0.959 (0.523) |
| **X2** | -1.627 | -0.279 | 0.189 (0.060) | 0.865 (0.051) |
| **X3** | -1.711 | -0.053 | 0.216 (0.015) | 0.878 (0.066) |
| **X4** | 0.839 | 0.285 | 0.228 (0.008) | 0.916 (0.082) |
| **X5** | 0.046 | -0.203 | 0.118 (0.200) | 0.949 (0.356) |
| **Y1** | -0.716 | -0.501 | 0.146 (0.200) | 0.942 (0.265) |
| **Y2** | -1.651 | -0.208 | 0.198 (0.038) | 0.880 (0.078) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 19. Normality test for Spain.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | 1.975 | 1.504 | 0.209 (0.022) | 0.838 (0.053) |
| **X2** | 2.746 | -1.724 | 0.238 (0.004) | 0.802 (0.051) |
| **X3** | -0.987 | -0.748 | 0.251 (0.002) | 0.837 (0.053) |
| **X4** | -1.489 | -0.217 | 0.173 (0.119) | 0.912 (0.068) |
| **X5** | -0.345 | 0.978 | 0.259 (0.001) | 0.854 (0.076) |
| **Y1** | -1.683 | -0.191 | 0.174 (0.115) | 0.884 (0.072) |
| **Y2** | -1.507 | -0.297 | 0.152 (0.200) | 0.893 (0.081) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 20. Normality test for Sweden.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | -1.332 | -0.080 | 0.117 (0.200) | 0.935 (0.196) |
| **X2** | -1.271 | -0.068 | 0.121 (0.200) | 0.938 (0.217) |
| **X3** | -1.248 | -0.446 | 0.189 (0.058) | 0.895 (0.084) |
| **X4** | -0.788 | -0.315 | 0.148 (0.200) | 0.958 (0.500) |
| **X5** | 0.344 | 1.177 | 0.237 (0.004) | 0.842 (0.094) |
| **Y1** | -1.455 | -0.065 | 0.145 (0.200) | 0.922 (0.110) |
| **Y2** | 0.471 | 0.834 | 0.173 (0.119) | 0.940 (0.243) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 21. Normality test for United Kingdom.

| Variable | Kurtosis | Skewness | Kolmogorov-Simirgov | Shapiro-Wilk |
|---|---|---|---|---|
| **X1** | -0.995 | -0.124 | 0.116<br>(0.200) | 0.958<br>(0.514) |
| **X2** | -1.051 | 0.007 | 0.125<br>(0.200) | 0.956<br>(0.460) |
| **X3** | -1.277 | -0.398 | 0.183<br>(0.076) | 0.915<br>(0.079) |
| **X4** | -1.660 | 0.126 | 0.194<br>(0.047) | 0.886<br>(0.072) |
| **X5** | -0.307 | 0.597 | 0.107<br>(0.200) | 0.948<br>(0.344) |
| **Y1** | -1.146 | 0.009 | 0.162<br>(0.176) | 0.954<br>(0.434) |
| **Y2** | 0.709 | 0.755 | 0.153<br>(0.200) | 0.958<br>(0.499) |

Note: In addition to skewness, kurtosis, also Kolmogorow-Simirgov and Shapiro-Wilk normality tests are taking in account.

Table 22. Unit root tests of cause variables and indicator variables of Austria.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -3.046 | -4.924*** | -3.0577 | -4.977*** | -2.754 | -5.220*** | I(1) |
| X 2 | -2.995 | -5.117*** | -2.966 | -5.193*** | -2.277 | -5.427*** | I(1) |
| X 3 | 0.149 | -2.896 | 0.476 | -3.844** | -0.561 | -3.909* | I(1) |
| X 4 | -2.348 | -3.997** | -2.348 | -3.996** | -2.479 | -4.241*** | I(1) |
| X 5 | -1.986 | -4.638*** | -1.986 | -4.715*** | -2.109 | -4.675*** | I(1) |
| Y 1 | -3.610* | -5.772*** | -3.631* | -9.125*** | -3.516** | -4.753*** | I(0) |
| Y 2 | -2.156 | -4.543*** | -1.995 | -5.098*** | -2.128 | -4.732*** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 23. Unit root tests of cause variables and indicator variables of Belgium.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -1.781 | -5.268*** | -1.991 | -5.292*** | -1.788 | -5.200*** | I(1) |
| X 2 | -1.734 | -5.237*** | -1.958 | -5.264*** | -1.755 | -5.134*** | I(1) |
| X 3 | -3.274* | -4.030** | -3.371* | -5.630*** | -2.364 | -3.724** | I(0) |
| X 4 | -4.411*** | -4.502*** | -2.045 | -3.769** | -3.418** | -4.631*** | I(0) |
| X 5 | -3.728** | -6.549*** | -3.835** | -8.720*** | -3.278** | -5.294*** | I(0) |
| Y 1 | -1.933 | -4.773*** | -1.930 | -4.761*** | -1.909 | -4.461 | I(1) |
| Y 2 | -2.463 | -4.892*** | -2.553 | -4.887*** | -2.005 | -4.926*** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) $^{***}$ and $^{**}$ and $^{*}$ indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 24. Unit root tests of cause variables and indicator variables of Czech Republic.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -3.890* | -2.531 | -2.165 | -4.016** | -3.541** | -4.222*** | I(0) |
| X 2 | -3.979** | -4.112** | -2.228 | -4.112** | -3.618** | -4.309*** | I(0) |
| X 3 | -3.061 | -5.350*** | -3.080 | -9.686*** | -3.225** | -5.652*** | I(0) |
| X 4 | -2.399 | -3.856** | -1.765 | -2.783 | -2.504 | -3.226** | I(1) |
| X 5 | -2.823 | -4.145** | -2.443 | -5.823*** | -2.559 | -4.394*** | I(1) |
| Y 1 | -3.992** | -2.895 | -1.605 | -2.897 | -3.440** | -3.076* | I(0) |
| Y 2 | -0.517 | 0.707* | 1.706 | -2.535** | -2.711 | -2.635 | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) $^{***}$ and $^{**}$ and $^{*}$ indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 25. Unit root tests of cause variables and indicator variables of Denmark.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -3.113 | -3.231* | -2.329 | -2.851 | -2.831 | -3.335** | I(1) |
| X 2 | -3.127 | -3.056 | -2.313 | -2.706 | -2.864 | -3.205** | I(1) |
| X 3 | -2.511 | -5.682*** | -2.466 | -5.696*** | -2.297 | -5.889 | I(1) |
| X 4 | -1.642 | -4.150** | -1.642 | -4.039** | -1.725 | -4.291*** | I(1) |
| X 5 | -2.207 | -6.281** | -2.140 | -6.939*** | -1.815 | -6.450*** | I(1) |
| Y 1 | -4.058** | -4.857*** | -2.731 | -4.815*** | -2.317 | -4.917*** | I(0) |
| Y 2 | -2.912 | -5.965*** | -2.997 | -5.977*** | -2.477 | -5.954*** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 26. Unit root tests of cause variables and indicator variables of Estonia.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -2.535 | -5.161*** | 1.713 | 4.087** | -1.450 | 0.875 | I(1) |
| X 2 | -2.986 | -4.827*** | -2.107 | -4.877*** | -1.294 | -0.787 | I(1) |
| X 3 | -2.948 | -3.200 | -2.129 | -2.424 | -3.011* | -3.411 | I(0) |
| X 4 | -3.680* | -3.713** | -1.835 | -2.190 | -3.948*** | -3.992*** | I(0) |
| X 5 | -4.203** | -4.054** | - 5.563*** | -8.520*** | -4.290*** | -4.966*** | I(0) |
| Y 1 | -2.659 | -2.702** | -2.139 | -2.587* | -2.288 | -2.755** | I(1) |
| Y 2 | -1.792 | -4.287** | -1.766 | -4.284** | -2.852 | -4.569 | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 27. Unit root tests of cause variables and indicator variables of Finland.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -3.053 | -8.410*** | -3.026 | -9.533*** | -2.530 | -7.848*** | I(1) |
| X 2 | -2.984 | -8.616*** | -2.945 | -9.786*** | -2.584 | -8.307*** | I(1) |
| X 3 | -3.209 | -3.592** | -1.442 | -3.565** | -1.997 | -3.710** | I(1) |
| X 4 | -3.010 | -4.247** | -1.842 | -2.390 | -3.089* | -4.396*** | I(0) |
| X 5 | -1.161 | -5.002*** | -1.559 | -5.086*** | -1.346 | -5.036*** | I(1) |
| Y 1 | -3.481* | -3.900** | -2.783 | -3.953** | -3.325** | -3.849*** | I(0) |
| Y 2 | -2.519 | -4.245** | -2.178 | -4.063** | -2.590 | -4.346*** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 28. Unit root tests of cause variables and indicator variables of France.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -2.340 | -4.057** | -1.711 | -3.945** | -2.412 | -4.166*** | I(1) |
| X 2 | -2.566 | -3.982** | -2.069 | -3.764** | -2.630 | -4.108*** | I(1) |
| X 3 | -1.293 | -5.461*** | -1.551 | 5.465*** | -1.468 | -5.528 | I(1) |
| X 4 | -2.489 | -4.496*** | -2.641 | -4.496*** | -2.020 | -4.116*** | I(1) |
| X 5 | -0.453 | -5.670*** | -0.417 | -5.753*** | -0.834 | -5.492*** | I(1) |
| Y 1 | -2.022 | -5.080*** | -2.048 | -5.108*** | -2.022 | -5.080*** | I(1) |
| Y 2 | -2.346 | -5.440*** | -3.391* | -5.645*** | -2.050 | -5.284*** | I(0) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 29. Unit root tests of cause variables and indicator variables of Germany.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -2.125 | -3.961** | -1.500 | -5.507*** | -2.311 | -4.881*** | I(1) |
| X 2 | -1.522 | -3.883** | -1.486 | -6.052*** | -2.168 | -4.922*** | I(1) |
| X 3 | -2.074 | -4.337*** | -2.194 | -4.323*** | -1.880 | -4.509 | I(1) |
| X 4 | -0.951 | -3.549* | -1.060 | -2.997 | -2.003 | -3.508** | I(1) |
| X 5 | -2.722 | -4.595*** | -2.004 | -4.615*** | -1.662 | -4.609*** | I(1) |
| Y 1 | -1.903 | -4.737*** | -1.919 | -4.719*** | -1.814 | -4.487*** | I(1) |
| Y 2 | -2.534 | -5.523*** | -2.534 | -5.700*** | 2.525 | -5.280*** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 30. Unit root tests of cause variables and indicator variables of Greece.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -3.524* | -8.547*** | -3.541* | -12.997*** | -3.644** | -8.790*** | I(0) |
| X 2 | -4.105** | -8.833*** | -4.139** | -17.020*** | -4.254*** | -9.116*** | I(0) |
| X 3 | -2.014 | -6.038*** | -2.113 | -6.009*** | -1.867 | -6.234*** | I(1) |
| X 4 | -3.760** | -2.798 | -1.108 | -2.794 | -3.411** | -2.068 | I(0) |
| X 5 | -2.962 | -4.548*** | -1.456 | -4.748*** | -3.317** | -4.700*** | I(0) |
| Y 1 | -1.893 | -3.478* | -2.285 | -3.440* | -1.625 | -3.307** | I(1) |
| Y 2 | -1.985 | -4.663*** | -2.048 | -4.675*** | -1.646 | -4.832*** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 31. Unit root tests of cause variables and indicator variables of Hungary.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -1.220 | -3.829** | -1.220 | -3.413* | -2.201 | -3.631** | I(1) |
| X 2 | -2.146 | -4.029** | -1.186 | -3.084 | -2.435 | -3.596** | I(1) |
| X 3 | -1.297 | -4.277** | -1.211 | -4.275** | -1.228 | -4.164*** | I(1) |
| X 4 | -3.239 | -2.375** | -1.435 | -2.375* | -2.431 | -2.351* | I(1) |
| X 5 | -3.016 | -3.927** | -1.854 | -4.725*** | -2.099 | -3.859*** | I(1) |
| Y 1 | -3.677** | -2.640 | -2.243 | -2.635 | -3.299** | -2.780 | I(0) |
| Y 2 | -3.291* | -2.813 | -3.124 | -2.720 | -1.132 | -2.697 | I(0) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) $^{***}$ and $^{**}$ and $^{*}$ indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 32. Unit root tests of cause variables and indicator variables of Italy.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -3.841** | -6.955*** | -3.915** | -8.145*** | -2.608 | -6.619*** | I(0) |
| X 2 | -3.548** | -7.179*** | -3.497* | -10.656*** | -2.859 | -7.151*** | I(0) |
| X 3 | -2.971 | -6.697*** | -2.945 | -7.758*** | -2.969* | -6.950*** | I(0) |
| X 4 | -1.235 | -3.551* | -1.880 | -3.572** | -1.852 | -3.669** | I(1) |
| X 5 | -2.133 | -6.348*** | -2.133 | -6.648*** | -1.713 | -6.537*** | I(1) |
| Y 1 | -3.383* | -4.289*** | -3.457* | -5.154*** | -2.350 | -3.771*** | I(0) |
| Y 2 | -2.037 | -5.839*** | -1.682 | -5.840*** | -1.516 | -5.987*** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) $^{***}$ and $^{**}$ and $^{*}$ indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 33. Unit root tests of cause variables and indicator variables of Ireland.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -1.307 | -6.274*** | -2.538 | -5.078*** | -2.958* | -2.322 | I(0) |
| X 2 | -1.315 | -6.166*** | -2.580 | -5.384*** | -2.923* | -5.091*** | I(0) |
| X 3 | -0.575 | -3.220 | -0.717 | -4.284** | -1.201 | -3.203** | I(1) |
| X 4 | -1.716 | -3.139 | -1.204 | -3.139 | -1.878 | -3.165* | I(1) |
| X 5 | -1.213 | -5.283*** | -1.311 | -5.284*** | -3.707** | -5.434*** | I(0) |
| Y 1 | -2.143 | -5.188*** | -2.296 | -5.501*** | -2.279 | -4.795*** | I(1) |
| Y 2 | -1.569 | -3184 | -1.649 | -3.184 | -1.734 | -3.199** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 34. Unit root tests of cause variables and indicator variables of Luxemburg.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -2.732 | -6.307 | -2.732 | -6.307*** | -2.536 | -6.282 | I(1) |
| X 2 | -2.768 | -6.544 | -2.756 | -6.544*** | -2.530 | -6.418*** | I(1) |
| X 3 | -2.787 | -5.599*** | -2.569 | -6.321*** | -2.513 | -5.787*** | I(1) |
| X 4 | -4.183** | -4.854*** | -2.536 | -6.024*** | -2.262 | -4.092*** | I(0) |
| X 5 | -2.445 | -7.551*** | -2.325 | -10.483*** | -2.603 | -7.782*** | I(1) |
| Y 1 | -1.725 | -4.815*** | -1.674 | -4.817*** | -1.631 | -4.488*** | I(1) |
| Y 2 | -2.471 | -6.382*** | -2.233 | -12.024 | -2.378 | -6.608*** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 35. Unit root tests of cause variables and indicator variables of Netherlands.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -2.225 | -5.209*** | -2.410 | -5.209*** | -2.261 | -5.229*** | I(1) |
| X 2 | -2.253 | -5.294*** | -2.445 | -5.294*** | -2.271 | -5.286*** | I(1) |
| X 3 | -2.055 | -5.906*** | -2.086 | -5.912 | -1.921 | -6.059*** | I(1) |
| X 4 | -2.568 | -3.204*** | -2.395 | -3.092 | -2.752 | -2.779*** | I(1) |
| X 5 | -0.570 | -6.544*** | -0.430 | -6.561*** | -0.899 | -6.326*** | I(1) |
| Y 1 | -2.614 | -4.633*** | -3.005 | -6.109*** | -2.239 | -3.909*** | I(1) |
| Y 2 | -1.410 | -5.570*** | -1.356 | -6.478*** | 1.556 | -5.719*** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) $^{***}$ and $^{**}$ and $^{*}$ indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 36. Unit root tests of cause variables and indicator variables of Poland.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -1.402 | -3.936** | -1.540 | -3.936** | -1.502 | -3.887*** | I(1) |
| X 2 | -1.403 | -4.584*** | -1.482 | -4.584*** | -1.517 | -4.373*** | I(1) |
| X 3 | -1.926 | -5.147*** | -2.007 | -5.124*** | -2.036 | -5.433*** | I(1) |
| X 4 | -2.818 | -3.046 | -1.806 | -2.433 | -2.967* | -3.242** | I(0) |
| X 5 | -3.040 | -3.452* | -2.549 | -3.382* | -3.259** | -3.382** | I(0) |
| Y 1 | -3.132 | -3.851** | -3.132 | -3.836 | -2.125 | -3.881*** | I(1) |
| Y 2 | -3.132 | -3.851** | -3.132 | -3.836** | -2.125 | -3.881*** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) $^{***}$ and $^{**}$ and $^{*}$ indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 37. Unit root tests of cause variables and indicator variables of Portugal.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -5.073*** | -5.123*** | -5.073*** | -6.010*** | -3.222** | -4.383*** | I(0) |
| X 2 | -1.892 | -5.631*** | -1.892 | -7.612*** | -2.186 | -5.864*** | I(1) |
| X 3 | -3.257* | -3.490* | -3.761** | -6.115*** | -3.293** | -5.964*** | I(0) |
| X 4 | -2.929 | -4.979*** | -1.914 | -2.398 | -3.009* | -1.609 | I(0) |
| X 5 | -1.892 | -5.631*** | -1.892 | -7.612*** | -2.186 | -5.864*** | I(1) |
| Y 1 | -2.607 | -4.262** | -1.806 | -4.280** | -2.373 | -4.255*** | I(1) |
| Y 2 | -2.002 | -6.280*** | -1.608 | -3.573* | -2.062 | -3.725** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 38. Unit root tests of cause variables and indicator variables of Slovak Republic.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -1.452 | -5.276 | -1.357 | -5.344*** | -1.678 | -5.510*** | I(1) |
| X 2 | -2.119 | -5.899*** | -2.110 | -6.037*** | -2.003 | -5.896*** | I(1) |
| X 3 | -0.515 | -4.545** | -0.602 | -4.512** | -1.527 | -4.379*** | I(1) |
| X 4 | -3.200 | -2.746 | -1.712 | -2.826 | -3.081* | -2.827 | I(0) |
| X 5 | -0.931 | -0.860 | -0.931 | -3.661* | -2.044 | -3.311* | I(1) |
| Y 1 | -3.011 | -2.622** | -1.851 | -2.580* | -2.467 | -2.792* | I(1) |
| Y 2 | -0.956 | -3.993** | -1.309 | -4.020** | -2.191 | -4.148*** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 39. Unit root tests of cause variables and indicator variables of Slovenia.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -1.879 | -2.201** | -1.002 | -1.976*** | -2.194 | -2.245*** | I(1) |
| X 2 | -1.884 | -2.333* | -1.050 | -1.907** | -2.187 | -2.728** | I(1) |
| X 3 | -2.529 | -1.991 | -1.750 | -2.041 | -2.509 | -3.270** | I(1) |
| X 4 | -1.336 | -2.851 | -0.965 | -1.951 | -1.809 | -3.185* | I(1) |
| X 5 | -3.231 | -3.950** | -3.217 | -8.750*** | -3.095* | -4.350*** | I(0) |
| Y 1 | -0.786 | -4.310** | -0.714 | -6.693*** | -1.102 | -3.675** | I(1) |
| Y 2 | -1.103 | -3.067 | -1.110 | -3.873* | -1.373 | -3.430** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 40. Unit root tests of cause variables and indicator variables of Spain.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -2.538 | -5.504*** | -1.946 | -5.676 | -1.677 | -5.676*** | I(1) |
| X 2 | -2.298 | -5.122*** | -2.069 | -5.448*** | -1.864 | -5.275*** | I(1) |
| X 3 | -2.337 | -5.401*** | -2.356 | -5.458*** | -2.461 | -5.307*** | I(1) |
| X 4 | -2.434 | -3.045 | -1.863 | -2.884 | -2.458 | -2.938* | I(1) |
| X 5 | -1.987 | -3.880** | -1.811 | -3.870** | -1.939 | -3.926*** | I(1) |
| Y 1 | -3.339* | -3.658** | -3.324* | -3.575** | -2.180 | -3.336** | I(0) |
| Y 2 | -2.603 | -5.094*** | -2.599 | -5.090*** | -1.774 | -5.022*** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 41. Unit root tests of cause variables and indicator variables of Sweden.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -3.210* | -4.168** | -2.053 | -4.136** | -2.971* | -3.994*** | I(0) |
| X 2 | -3.339* | -4.099** | -2.291 | -3.758** | -3.089* | -4.361*** | I(0) |
| X 3 | -1.578 | -5.957*** | -1.566 | -6.243*** | -1.711 | -5.969 | I(1) |
| X 4 | -3.859** | -3.819** | -2.106 | -2.491 | -3.999*** | -3.825*** | I(0) |
| X 5 | -1.778 | -6.704*** | -1.778 | -7.125*** | -1.894 | -6.900*** | I(1) |
| Y 1 | -3.198 | -4.471*** | -3.198 | -4.888*** | -2.340 | -4.433*** | I(1) |
| Y 2 | -1.953 | -3.566** | -1.346 | -3.142 | -2.133 | -3.411** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 42. Unit root tests of cause variables and indicator variables of United Kingdom.

| Series | ADF | | PP | | DF-GLS | | Conc |
|---|---|---|---|---|---|---|---|
| | In Level | In difference | In Level | In difference | In Level | In difference | |
| X 1 | -2.737 | -3.068 | -1.807 | -3.045 | -2.599 | -3.170* | I(1) |
| X 2 | -2.674 | -3.173 | -1.820 | -3.195 | -2.537 | -3.281** | I(1) |
| X 3 | -2.042 | -5.922*** | -2.030 | -5.922*** | -1.819 | -6.130*** | I(1) |
| X 4 | -2.203 | -3.449* | -1.665 | -3.492* | -2.231 | -3.620** | I(1) |
| X 5 | -1.352 | -4.753*** | -1.692 | -4.890*** | -1.363 | -4.920*** | I(1) |
| Y 1 | -3.813** | -4.158** | -2.465 | -4.114** | -3.279** | -4.195*** | I(0) |
| Y 2 | -2.163 | -3.332* | -2.474 | -3.332* | -1.858 | -3.432** | I(1) |

Notes: (i) To discover unit roots, Augmented Dickey Fuller (ADF), Phillips-Perron (PP) and Dickey Fuller-GLS DF-GLS) tests are used. All tests are performed with trend & constant. Both ADF and PP and DF-GLS tests take unit root as null hypothesis. (ii) *** and ** and * indicate rejection of null hypothesis at 1% and 5% and 10% significance level. (iii) Lag length for ADF and DF-GLS test has been decided on the basis of Schwarz info criterion, lags 2 and Barlett-Kernel with Newey-West Bandwith is implemented for PP. (iv) P-values are one sided based on Mackinnon (1996).

Table 43. OLS regression results for Austria and Belgium.

| Austria | | | | | Belgium | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Model** | R | R Square | Adj. R Square | SE | **Model** | R | R Square | Adj. R Square | SE |
| Model 1 | 0.986 | 0.972 | 0.962 | 0.007 | Model 1 | 0.933 | 0.870 | 0.824 | 0.012 |
| Model 2 | 0.913 | 0.834 | 0.775 | 0.107 | Model 2 | 0.848 | 0.718 | 0.618 | 0.134 |

Notes: (i) Model 1 indicates while Real GDP per capital is dependent variable while the rest are independent in original MIMIC model. (ii) Model 2 indicates while Labour Force participation rate is dependent variable while the rest are independent in original MIMIC model.

Table 44. OLS regression results for Czech Republic and Denmark.

| Czech Republic | | | | | Denmark | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Model** | R | R Square | Adj. R Square | SE | **Model** | R | R Square | Adj. R Square | SE |
| Model 1 | 0.928 | 0.861 | 0.812 | 0.179 | Model 1 | 0.865 | 0.748 | 0.658 | 0.005 |
| Model 2 | 0.498 | 0.248 | 0.021 | 0.015 | Model 2 | 0.816 | 0.665 | 0.545 | 0.130 |

Notes: (i) Model 1 indicates while Real GDP per capital is dependent variable while the rest are independent in original MIMIC model. (ii) Model 2 indicates while Labour Force participation rate is dependent variable while the rest are independent in original MIMIC model.

Table 45. OLS regression results for Estonia and Finland.

| Estonia | | | | | Finland | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Model** | R | R Square | Adj. R Square | SE | **Model** | R | R Square | Adj. R Square | SE |
| Model 1 | 0.964 | 0.930 | 0.905 | 0.106 | Model 1 | 0.942 | 0.886 | 0.846 | 0.004 |
| Model 2 | 0.882 | 0.778 | 0.698 | 0.014 | Model 2 | 0.941 | 0.885 | 0.844 | 0.096 |

Notes: (i) Model 1 indicates while Real GDP per capital is dependent variable while the rest are independent in original MIMIC model. (ii) Model 2 indicates while Labour Force participation rate is dependent variable while the rest are independent in original MIMIC model.

Table 46. OLS regression results for France and Germany.

| France | | | | | Germany | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Model** | R | R Square | Adj. R Square | SE | **Model** | R | R Square | Adj. R Square | SE |
| Model 1 | 0.896 | 0.803 | 0.733 | 0.008 | Model 1 | 0.843 | 0.710 | 0.606 | 0.128 |
| Model 2 | 0.772 | 0.595 | 0.451 | 0.157 | Model 2 | 0.843 | 0.710 | 0.606 | 0.128 |

Notes: (i) Model 1 indicates while Real GDP per capital is dependent variable while the rest are independent in original MIMIC model. (ii) Model 2 indicates while Labour Force participation rate is dependent variable while the rest are independent in original MIMIC model.

Table 47. OLS regression results for Greece and Hungary.

| Greece | | | | | Hungary | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Model** | R | R Square | Adj. R Square | SE | **Model** | R | R Square | Adj. R Square | SE |
| Model 1 | 0.986 | 0.972 | 0.962 | 0.007 | Model 1 | 0.913 | 0.833 | 0.773 | 0.017 |
| Model 2 | 0.913 | 0.834 | 0.775 | 0.107 | Model 2 | 0.775 | 0.600 | 0.457 | 0.155 |

Notes: (i) Model 1 indicates while Real GDP per capital is dependent variable while the rest are independent in original MIMIC model. (ii) Model 2 indicates while Labour Force participation rate is dependent variable while the rest are independent in original MIMIC model.

Table 48. OLS regression results for Ireland and Italy.

| Ireland | | | | | Italy | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Model** | R | R Square | Adj. R Square | SE | **Model** | R | R Square | Adj. R Square | SE |
| Model 1 | 0.968 | 0.937 | 0.915 | 0.013 | Model 1 | 0.970 | 0.940 | 0.919 | 0.009 |
| Model 2 | 0.957 | 0.916 | 0.886 | 0.115 | Model 2 | 0.907 | 0.822 | 0.759 | 0.087 |

Notes: (i) Model 1 indicates while Real GDP per capital is dependent variable while the rest are independent in original MIMIC model. (ii) Model 2 indicates while Labour Force participation rate is dependent variable while the rest are independent in original MIMIC model.

Table 49. OLS regression results for Luxemburg and Netherlands.

| Luxemburg | | | | | Netherlands | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Model** | R | R Square | Adj. R Square | SE | **Model** | R | R Square | Adj. R Square | SE |
| Model 1 | 0.951 | 0.904 | 0.870 | 0.104 | Model 1 | 0.973 | 0.946 | 0.927 | 0.010 |
| Model 2 | 0.915 | 0.838 | 0.780 | 0.021 | Model 2 | 0.881 | 0.776 | 0.695 | 0.121 |

Notes: (i) Model 1 indicates while Real GDP per capital is dependent variable while the rest are independent in original MIMIC model. (ii) Model 2 indicates while Labour Force participation rate is dependent variable while the rest are independent in original MIMIC model.

Table 50. OLS regression results for Poland and Portugal.

| Poland | | | | | Portugal | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Model** | R | R Square | Adj. R Square | SE | **Model** | R | R Square | Adj. R Square | SE |
| Model 1 | 0.965 | 0.932 | 0.908 | 0.088 | Model 1 | 0.856 | 0.732 | 0.637 | 0.018 |
| Model 2 | 0.897 | 0.805 | 0.736 | 0.010 | Model 2 | 0.829 | 0.688 | 0.576 | 0.118 |

Notes: (i) Model 1 indicates while Real GDP per capital is dependent variable while the rest are independent in original MIMIC model. (ii) Model 2 indicates while Labour Force participation rate is dependent variable while the rest are independent in original MIMIC model.

Table 51. OLS regression results for Slovak Republic and Slovenia.

| Slovak Republic | | | | | Slovenia | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Model** | R | R Square | Adj. R Square | SE | **Model** | R | R Square | Adj. R Square | SE |
| Model 1 | 0.993 | 0.986 | 0.981 | 0.045 | Model 1 | 0.973 | 0.946 | 0.927 | 0.054 |
| Model 2 | 0.925 | 0.855 | 0.804 | 0.004 | Model 2 | 0.948 | 0.899 | 0.863 | 0.009 |

Notes: (i) Model 1 indicates while Real GDP per capital is dependent variable while the rest are independent in original MIMIC model. (ii) Model 2 indicates while Labour Force participation rate is dependent variable while the rest are independent in original MIMIC model.

Table 52. OLS regression results for Spain and Sweden.

| Spain | | | | | Sweden | | | | |
|---|---|---|---|---|---|---|---|---|---|
| **Model** | R | R Square | Adj. R Square | SE | **Model** | R | R Square | Adj. R Square | SE |
| Model 1 | 0.985 | 0.971 | 0.961 | 0.013 | Model 1 | 0.921 | 0.848 | 0.794 | 0.104 |
| Model 2 | 0.859 | 0.738 | 0.645 | 0.148 | Model 2 | 0.619 | 0.384 | 0.164 | 0.009 |

Notes: (i) Model 1 indicates while Real GDP per capital is dependent variable while the rest are independent in original MIMIC model. (ii) Model 2 indicates while Labour Force participation rate is dependent variable while the rest are independent in original MIMIC model.

Table 53. OLS regression results for United Kingdom.

| United Kingdom | | | | |
|---|---|---|---|---|
| **Model** | R | R Square | Adj. R Square | SE |
| Model 1 | 0.948 | 0.899 | 0.863 | 0.061 |
| Model 2 | 0.869 | 0.755 | 0.667 | 0.003 |

Notes: (i) Model 1 indicates while Real GDP per capital is dependent variable while the rest are independent in original MIMIC model. (ii) Model 2 indicates while Labour Force participation rate is dependent variable while the rest are independent in original MIMIC model.

Table 54. Coefficients and test for original MIMIC model.

| Series | X1 | X2 | X3 | X4 | X5 | Y1 | Y2 | IFI | CFI | GFI | RMSEA | Ch2 | df |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | 0.422 | 3.412 | 0.082 | 0.094 | -1.679 | -1 | 0.209 | 0.857 | 0.850 | 0.722 | 0.385 | 41.9 | 11 |
| | (0.248) | (0.356) | (0.665) | (0.000) | (0.000) | | (0.000) | | | | | | |
| Belgium | -41.223 | -184.025 | -0.888 | 0.313 | -2.049 | -1 | 0.174 | 0.946 | 0.943 | 0.768 | 0.228 | 23.9 | 12 |
| | (0.035) | (0.034) | (0.135) | (0.093) | (0.000) | | (0.000) | | | | | | |
| Czech Rep. | -5.928 | -42.502 | 8.689 | -0.781 | 2.168 | -1 | -0.006 | 0.891 | 0.886 | 0.745 | 0.285 | 33.0 | 13 |
| | (0.532) | (0.692) | (0.000) | (0.000) | (0.000) | | (0.504) | | | | | | |
| Denmark | -22.448 | -55.473 | -0.061 | 0.248 | -1.239 | -1 | -0.064 | 0.896 | 0.891 | 0.783 | 0.267 | 30.6 | 13 |
| | (0.064) | (0.057) | (0.024) | (0.015) | (0.057) | | (0.060) | | | | | | |
| Estonia | -5.127 | -39.145 | 2.395 | -0.712 | 1.339 | -1 | 0.044 | 1.023 | 1.000 | 0.911 | 0.000 | 7 | 11 |
| | (0.002) | (0.025) | (0.000) | (0.000) | (0.000) | | (0.000) | | | | | | |
| Finland | 0.950 | 4.785 | 2.412 | -1.296 | 0.468 | -1 | 0.060 | 0.891 | 0.885 | 0.796 | 0.427 | 35.7 | 8 |
| | (0.731) | (0.708) | (0.016) | (0.000) | (0.658) | | (0.000) | | | | | | |
| France | 7.784 | 47.698 | 2.840 | -0.101 | -0.905 | -1 | 0.108 | 0.975 | 0.974 | 0.895 | 0.282 | 10 | 4 |
| | (0.031) | (0.046) | (0.004) | (0.635) | (0.173) | | (0.000) | | | | | | |
| Germany | 4.755 | 35.285 | 0.009 | -0.590 | 2.798 | -1 | 0.216 | 0.977 | 0.976 | 0.832 | 0.159 | 14.8 | 10 |
| | (0.170) | (0.205) | (0.987) | (0.000) | (0.000) | | (0.000) | | | | | | |
| Greece | 0.468 | 4.047 | 0.092 | 0.084 | -1.148 | -1 | 0.286 | 0.831 | 0.824 | 0.72 | 0.400 | 48.5 | 12 |
| | (0.120) | (0.170) | (0.508) | (0.008) | (0.004) | | (0.002) | | | | | | |
| Hungary | -0.358 | -1.393 | -0.138 | -0.016 | -0.598 | -1 | 0.368 | 0.912 | 0.905 | 0.782 | 0.300 | 24.4 | 9 |
| | (0.777) | (0.911) | (0.407) | (0.759) | (0.029) | | (0.038) | | | | | | |

Note: (i) z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1, (ii) since the value -1 is imposed on the coefficient of Real GDP per capita it is not possible to perform z test.

Table 55. Coefficients and test for original MIMIC model continuous

| Series | X1 | X2 | X3 | X4 | X5 | Y1 | Y2 | IFI | CFI | GFI | RMSEA | Ch2 | df |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Ireland | -2.242 | -15.378 | 0.907 | -0.276 | -1.024 | -1 | 0.276 | 0.866 | 0.860 | 0.729 | 0.455 | 44.4 | 9 |
| | (0.450) | (0.411) | (0.000) | (0.000) | (0.001) | | (0.000) | | | | | | |
| Italy | -9.237 | -50.029 | -0.526 | -0.096 | -1.901 | -1 | 0.266 | 0.943 | 0.939 | 0.833 | 0.292 | 20.9 | 8 |
| | (0.004) | (0.004) | (0.008) | (0.009) | (0.000) | | (0.000) | | | | | | |
| Luxemburg | -0.124 | -0.327 | 0.751 | 0.602 | -0.490 | -1 | 0.147 | 0.937 | 0.934 | 0.805 | 0.271 | 24.0 | 10 |
| | (0.990) | (0.995) | (0.044) | (0.000) | (0.003) | | (0.000) | | | | | | |
| Netherlands | -8.146 | -59.340 | -0.638 | -0.227 | 1.135 | -1 | 0.251 | 0.928 | 0.925 | 0.794 | 0.347 | 26.3 | 8 |
| | (0.231) | (0.272) | (0.000) | (0.000) | (0.000) | | (0.000) | | | | | | |
| Poland | 3.319 | 24.570 | -1.757 | 0.460 | -3.452 | -1 | -0.011 | 0.830 | 0.821 | 0.733 | 0.493 | 50.6 | 9 |
| | (0.046) | (0.104) | (0.000) | (0.006) | (0.000) | | (0.534) | | | | | | |
| Portugal | -0.238 | -1.469 | 0.664 | -0.078 | -0.108 | -1 | 0.910 | 0.919 | 0.912 | 0.836 | 0.487 | 22.0 | 4 |
| | (0.747) | (0.802) | (0.531) | (0.532) | (0.587) | | (0.486) | | | | | | |
| Slovak Rep. | 0.279 | -2.351 | 0.048 | -0.557 | 0.990 | -1 | -0.015 | 0.852 | 0.845 | 0.712 | 0.513 | 48.1 | 8 |
| | (0.700) | (0.783) | (0.784) | (0.000) | (0.000) | | (0.011) | | | | | | |
| Slovenia | 0.315 | -0.679 | 1.341 | -0.203 | 0.166 | -1 | 0.106 | 0.822 | 0.812 | 0.781 | 0.401 | 44.6 | 11 |
| | (0.005) | (0.000) | (0.000) | (0.000) | (0.172) | | (0.000) | | | | | | |
| Spain | 0.476 | 1.976 | -3.200 | 0.072 | -1.801 | -1 | 0.318 | 1.003 | 1.000 | 0.899 | 0.000 | 8.1 | 9 |
| | (0.643) | (0.774) | (0.014) | (0.277) | (0.000) | | (0.000) | | | | | | |
| Sweden | 7.025 | 30.018 | -1.349 | 0.517 | -2.127 | -1 | 0.030 | 1.017 | 1.000 | 0.953 | 0.000 | 3.5 | 7 |
| | (0.087) | (0.088) | (0.001) | (0.002) | (0.011) | | (0.001) | | | | | | |
| UK | -1.041 | -8.456 | 0.855 | -0.411 | 2.347 | -1 | 0.031 | 0.973 | 0.971 | 0.851 | 0.213 | 13.1 | 7 |
| | (0.784) | (0.654) | (0.029) | (0.000) | (0.000) | | (0.000) | | | | | | |

Note: (i) z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1, (ii) since the value -1 is imposed on the coefficient of Real GDP per capita it is not possible to perform z test.

Table 56. Coefficients and test for modified MIMIC model.

| Series | X1 | X2 | X3 | X4 | X5 | Y1 | Y2 | IFI | CFI | GFI | RMSEA | Ch2 | df |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| Austria | - | - | - | 0.111<br>(0.000) | -1.872<br>(0.000) | -1 | 0.200<br>(0.000) | 0.999 | 0.999 | 0.974 | 0.055 | 1.1 | 1 |
| Belgium | - | - | - | 0.537<br>(0.016) | -2.476<br>(0.000) | -1 | 0.160<br>(0.000) | 0.932 | 0.967 | 0.887 | 0.049 | 5.6 | 1 |
| Czech Rep. | -32.732<br>(0.000) | -327.646<br>(0.000) | 17.613<br>(0.000) | -0.487<br>(0.006) | - | -1 | -0.006<br>(0.000) | 0.991 | 0.953 | 0.889 | 0.079 | 130.5 | 9 |
| Finland | - | - | 1.430<br>(0.000) | - | -1.085<br>(0.000) | -1 | 0.053<br>(0.000) | 0.934 | 0.979 | 0.884 | 0.052 | 5.8 | 1 |
| France | 7.111<br>(0.063) | 43.024<br>(0.086) | 1.630<br>(0.039) | - | - | -1 | 0.129<br>(0.000) | 0.946 | 0.954 | 0.852 | 0.047 | 12.5 | 3 |
| Germany | - | - | - | -0.609<br>(0.000) | 2.565<br>(0.000) | -1 | 0.219<br>(0.000) | 1.003 | 1.000 | 0.952 | 0.000 | 1.8 | 2 |
| Greece | - | - | - | 0.111<br>(0.000) | -1.872<br>(0.000) | -1 | 0.200<br>(0.000) | 0.999 | 0.999 | 0.974 | 0.055 | 1.1 | 1 |
| Hungary | - | - | - | - | -0.779<br>(0.009) | -1 | 0.294<br>(0.021) | 1.000 | 1.000 | 1.000 | 0.073 | 0.0 | 0 |
| Ireland | - | - | 1.348<br>(0.001) | -0.448<br>(0.000) | -2.198<br>(0.000) | -1 | 0.145<br>(0.000) | 1.000 | 1.000 | 1.000 | 0.061 | 0.0 | 0 |
| Luxemburg | - | - | 0.748<br>(0.060) | 0.607<br>(0.000) | -0.491<br>(0.003) | -1 | 0.147<br>(0.000) | 0.903 | 0.967 | 0.894 | 0.039 | 16.0 | 4 |
| Netherlands | - | - | -0.886<br>(0.000) | -0.200<br>(0.002) | 1.608<br>(0.000) | -1 | 0.202<br>(0.000) | 0.934 | 0.982 | 0.861 | 0.007 | 8.6 | 3 |
| Poland | 3.319<br>(0.000) | 24.570<br>(0.000) | -1.757<br>(0.000) | 0.460<br>(0.000) | -3.452<br>(0.000) | -1 | -0.011<br>(0.059) | 0.905 | 0.961 | 0.930 | 0.074 | 202.4 | 14 |
| Portugal | - | - | - | 0.236<br>(0.000) | -0.448<br>(0.067) | -1 | 0.107<br>(0.034) | 0.947 | 0.986 | 0.872 | 0.079 | 32.2 | 2 |
| Slovak Rep. | - | - | 0.477<br>(0.029) | -0.698<br>(0.000) | 0.895<br>(0.000) | -1 | -0.026<br>(0.002) | 1.005 | 1.000 | 0.973 | 0.000 | 1.4 | 2 |
| Slovenia | 0.178<br>(0.103) | -0.598<br>(0.000) | 1.202<br>(0.000) | -0.133<br>(0.011) | - | -1 | 0.102<br>(0.000) | 0.904 | 0.988 | 0.863 | 0.038 | 22.5 | 6 |
| Spain | - | - | -4.378<br>(0.000) | - | -1.911<br>(0.000) | -1 | 0.320<br>(0.000) | 1.008 | 1.000 | 1.000 | 0.000 | 0.0 | 1 |
| UK | - | - | 1.418<br>(0.000) | -0.442<br>(0.000) | 1.927<br>(0.000) | -1 | 0.031<br>(0.000) | 0.941 | 0.963 | 0.872 | 0.029 | 7.9 | 3 |

Note: (i) z-statistics in parentheses *** p<0.01, ** p<0.05, * p<0.1, (ii) since the value -1 is imposed on the coefficient of Real GDP per capita it is not possible to perform z test.

Table 57. Panel Unit Root Tests

| | | Levels | | |
|---|---|---|---|---|
| Variables | | Levin, Lin and Chu | Breitung | Im, Pesaran, and Shin |
| UE | | | | |
| | $\tau_T$ | -2.871* | -2.986* | -2.611* |
| | $\tau_\mu$ | -0.308 | | 1.863 |
| | $\tau$ | -3.178* | | |
| Log(FD) | | | | |
| | $\tau_T$ | 0.067 | 0.331 | -0.522 |
| | $\tau_\mu$ | -3.570* | | -3.033* |
| | $\tau$ | 0.562 | | |
| Log(TRD) | | | | |
| | $\tau_T$ | -4.285* | -4.611* | -2.441* |
| | $\tau_\mu$ | -3.396* | | 0.726 |
| | $\tau$ | 6.273 | | |
| INT | | | | |
| | $\tau_T$ | -5.945* | -1.920** | -6.116* |
| | $\tau_\mu$ | -5.549* | | -4.814* |
| | $\tau$ | -10.124* | | |

Note: UE represents the size of underground economy as percent of GDP; Log(FD) is the natural logarithm of the financial sector development; Log(TRD) is the natural logarithm of the trade openness; INT is the long-term interest rate; $\tau_T$ represents the most general model with a intercept and trend; $\tau_\mu$ is the model with a intercept and without trend; $\tau$ is the most restricted model without a intercept and trend. Optimum lag lengths are selected based on Schwartz Criterion. * denotes rejection of the null hypothesis at the 1% level. ** denotes rejection of the null hypothesis between the 1% level and 5 % level. *** denotes rejection of the null hypothesis between the 5 % level and 10 % level. Tests for unit roots have been carried out in E-VIEWS 8.0.

Table 58. Parameter Estimates for Panel Regression.

| Parameter Estimates | Pooled OLS | Random-Effects | Fixed-Effects |
|---|---|---|---|
| log(FD) | -0.440* | -0.416* | -0.400* |
| | [0.000] | [0.000] | [0.000] |
| log(TRD) | -3.412* | -7.468* | -9.280* |
| | [0.000] | [0.000] | [0.000] |
| INT | 0.897* | 0.417* | 0.339* |
| | [0.000] | [0.000] | [0.000] |
| C | 28.039* | 48.561* | 57.020* |
| | [0.000] | [0.000] | [0.000] |
| R-square | 0.3156 | 0.2487 | 0.2252 |
| F-test | - | - | 26.79 |
| | | | [0.000] |

Note: Panel regression performed with strongly balanced panel. Probabilities of the regression coefficients illustrated in parenthesis. * denotes rejection of the null hypothesis at the 1% level. ** denotes rejection of the null hypothesis between the 1% level and 5 % level. *** denotes rejection of the null hypothesis between the 5 % level and 10 % level. Regressions have been carried out in STATA 12.

Table 59. Hausman Test and Diagnostics for Growth Model.

| Other Tests/Diagnostics | Test Statistics | Probabilities |
|---|---|---|
| Hausman Test | 8.14 | [0.043] |
| Breusch and Pagan LM Test | 974.41 | [0.000] |
| Pesaran CD Test | 32.479 | [0.000] |
| Heteroskedasticity Test | 461.18 | [0.000] |
| Lagram- Multiplier Test for Serial Correlation | 587.104 | [0.000] |

Table 60. Parameter Estimates for Robust Regression of Fixed-Effects Estimation and Fixed-Effects Estimation with Driscoll and Kraay Standard Errors.

| Parameter Estimates | FE-robust | FE-dris~y |
|---|---|---|
| log(FD) | -0.400* | -0.400* |
| p-value | [0.000] | [0.000] |
| SE | 0.081785 | 0.0828864 |
| t-value | -4.90 | -4.83 |
| | | |
| log(TRD) | -9.280* | -9.280** |
| p-value | [0.003] | [0.012] |
| SE | 2.688517 | 3.33606 |
| t-value | -3.45 | -2.78 |
| | | |
| INT | 0.339** | 0.339** |
| p-value | [0.011] | [0.029] |
| SE | 0.1208683 | 0.144235 |
| t-value | 2.81 | 2.36 |
| | | |
| C | 57.020* | 57.020* |
| p-value | [0.000] | [0.002] |
| SE | 12.28352 | 15.56909 |
| t-value | 4.64 | 3.66 |
| | | |
| R-square | 0.2252 | 0.3478 |

Note: Panel regression performed with strongly balanced panel. Probabilities of the regression coefficients illustrated in parenthesis. * denotes rejection of the null hypothesis at the 1% level. ** denotes rejection of the null hypothesis between the 1% level and 5 % level. *** denotes rejection of the null hypothesis between the 5 % level and 10 % level. Regressions have been carried out in STATA 12.

Table 61. Variance Decompositions.

| Variance Decomposition of UE: | | | | | |
|---|---|---|---|---|---|
| Period | S.E. | UE | log(FD) | log(TRD) | INT |
| 1 | 1.34451 | 100.00000 | 0.00000 | 0.00000 | 0.00000 |
| 2 | 2.24333 | 98.36168 | 1.52568 | 0.01226 | 0.10038 |
| 3 | 2.92695 | 96.26272 | 3.16925 | 0.01137 | 0.55667 |
| 4 | 3.44205 | 94.32858 | 4.15068 | 0.01082 | 1.50991 |
| 5 | 3.83645 | 92.54878 | 4.62477 | 0.01066 | 2.81579 |
| 6 | 4.14343 | 90.96680 | 4.83642 | 0.00951 | 4.18727 |
| 7 | 4.38390 | 89.65026 | 4.93295 | 0.00924 | 5.40755 |
| 8 | 4.57234 | 88.61060 | 4.98127 | 0.01615 | 6.39198 |
| 9 | 4.72000 | 87.80918 | 5.00786 | 0.03845 | 7.14452 |
| 10 | 4.83592 | 87.18979 | 5.02287 | 0.08346 | 7.70389 |

| Variance Decomposition of log(FD): | | | | | |
|---|---|---|---|---|---|
| Period | S.E. | UE | log(FD) | log(TRD) | INT |
| 1 | 1.97606 | 0.34287 | 99.65713 | 0.00000 | 0.00000 |
| 2 | 2.50511 | 0.34140 | 98.38282 | 0.24744 | 1.02834 |
| 3 | 2.60686 | 0.41896 | 98.11114 | 0.38024 | 1.08967 |
| 4 | 2.62061 | 0.58723 | 97.77049 | 0.37978 | 1.26251 |
| 5 | 2.63237 | 0.85488 | 96.92695 | 0.39819 | 1.81997 |
| 6 | 2.64375 | 1.17833 | 96.09881 | 0.43044 | 2.29242 |
| 7 | 2.65215 | 1.49610 | 95.50276 | 0.44949 | 2.55165 |
| 8 | 2.65812 | 1.77141 | 95.09222 | 0.45609 | 2.68028 |
| 9 | 2.66252 | 1.99548 | 94.79566 | 0.45721 | 2.75165 |
| 10 | 2.66588 | 2.17359 | 94.57073 | 0.45664 | 2.79905 |

Table 62. Variance Decompositions continuous.

Variance Decomposition of TRD:

| Period | S.E. | UE | log(FD) | log(TRD) | INT |
|---|---|---|---|---|---|
| 1 | 0.06172 | 0.52454 | 0.11028 | 99.36518 | 0.00000 |
| 2 | 0.08664 | 1.92922 | 2.13803 | 95.74093 | 0.19182 |
| 3 | 0.10550 | 2.70900 | 2.37002 | 94.78388 | 0.13711 |
| 4 | 0.12180 | 3.07417 | 2.04300 | 94.64491 | 0.23793 |
| 5 | 0.13673 | 3.20948 | 1.70784 | 94.49285 | 0.58983 |
| 6 | 0.15051 | 3.22650 | 1.45540 | 94.31536 | 1.00274 |
| 7 | 0.16316 | 3.18203 | 1.27235 | 94.19160 | 1.35402 |
| 8 | 0.17480 | 3.10432 | 1.13581 | 94.13971 | 1.62016 |
| 9 | 0.18558 | 3.00895 | 1.02939 | 94.14612 | 1.81554 |
| 10 | 0.19563 | 2.90535 | 0.94331 | 94.19259 | 1.95875 |

Variance Decomposition of INT:

| Period | S.E. | UE | log(FD) | log(TRD) | INT |
|---|---|---|---|---|---|
| 1 | 1.17037 | 1.36094 | 0.55224 | 2.05184 | 96.03498 |
| 2 | 1.56433 | 2.38196 | 1.13889 | 3.87219 | 92.60696 |
| 3 | 1.70944 | 3.72160 | 1.82452 | 4.25444 | 90.19944 |
| 4 | 1.76593 | 5.01156 | 2.18680 | 4.24494 | 88.55670 |
| 5 | 1.79306 | 6.09827 | 2.31375 | 4.16940 | 87.41857 |
| 6 | 1.80933 | 6.96848 | 2.35342 | 4.10141 | 86.57669 |
| 7 | 1.82050 | 7.65465 | 2.37095 | 4.05123 | 85.92317 |
| 8 | 1.82870 | 8.19274 | 2.38479 | 4.01882 | 85.40366 |
| 9 | 1.83494 | 8.61324 | 2.39801 | 4.00284 | 84.98591 |
| 10 | 1.83980 | 8.94114 | 2.40987 | 4.00161 | 84.64738 |

## Figures

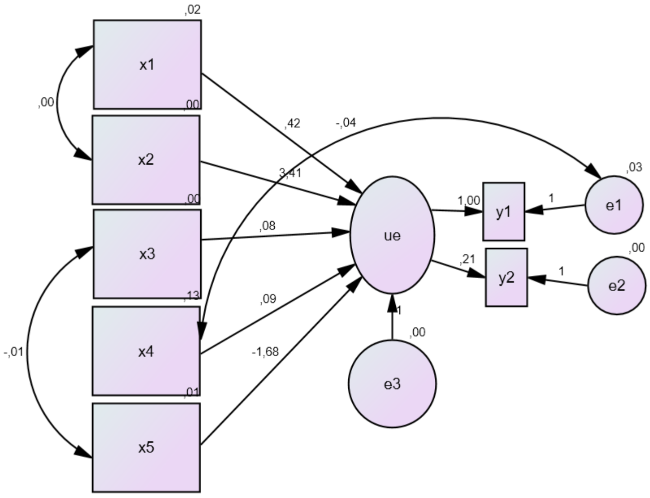


Figure 3. Original MIMIC model of Austria.

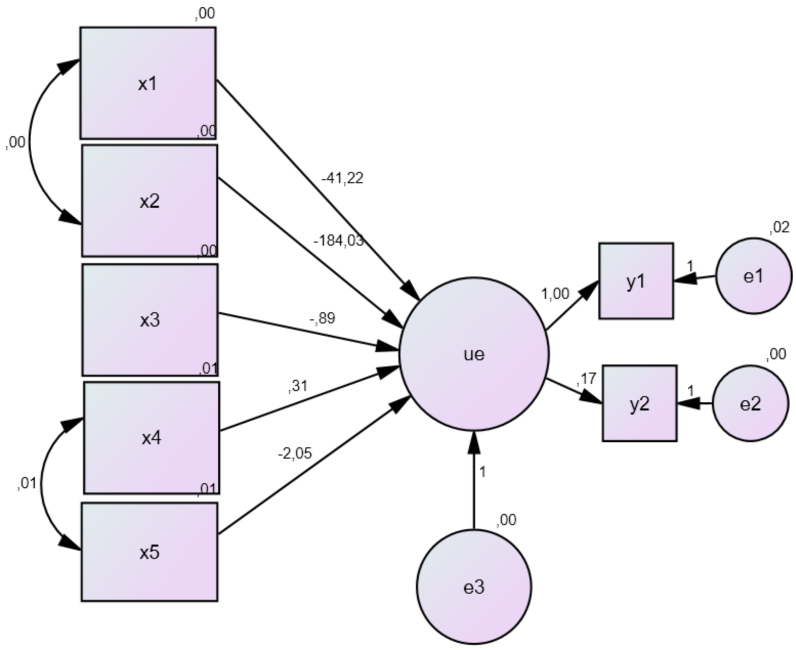


Figure 4. Original MIMIC model of Belgium.

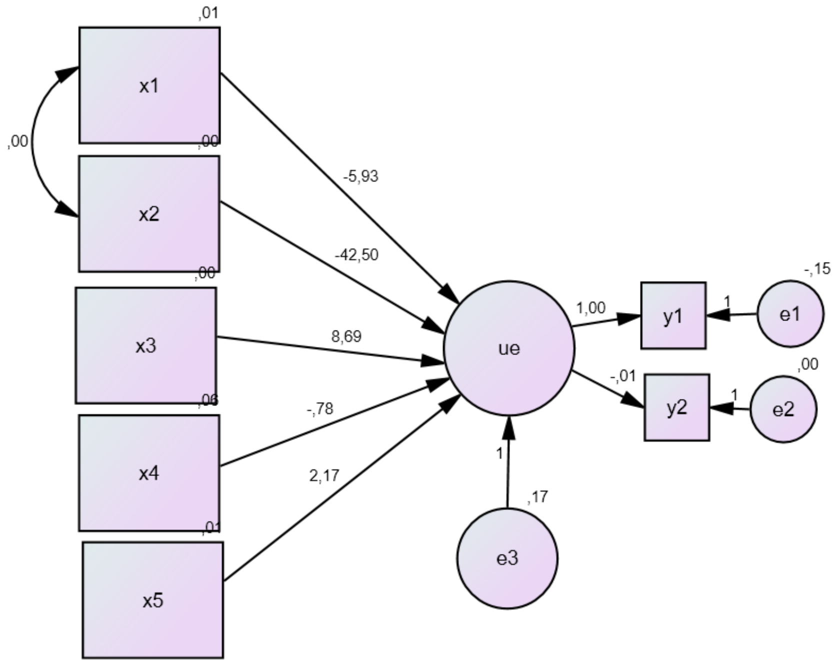


Figure 5. Original MIMIC model of Czech Republic.

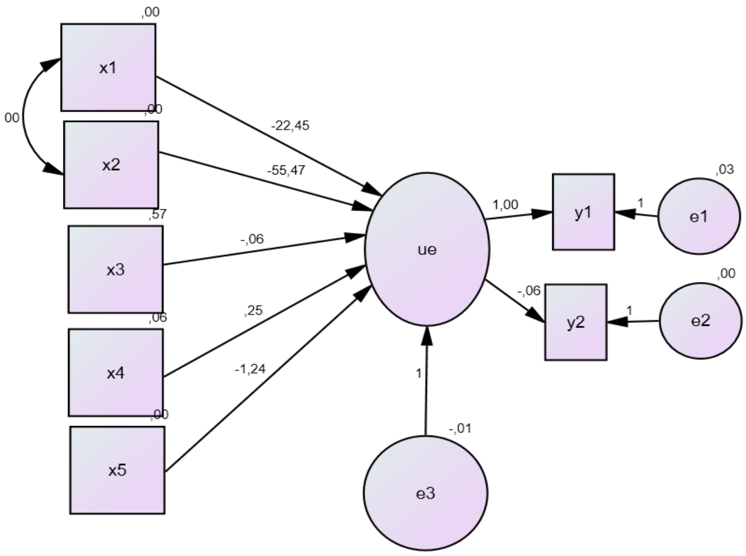


Figure 6. Original MIMIC model of Denmark.

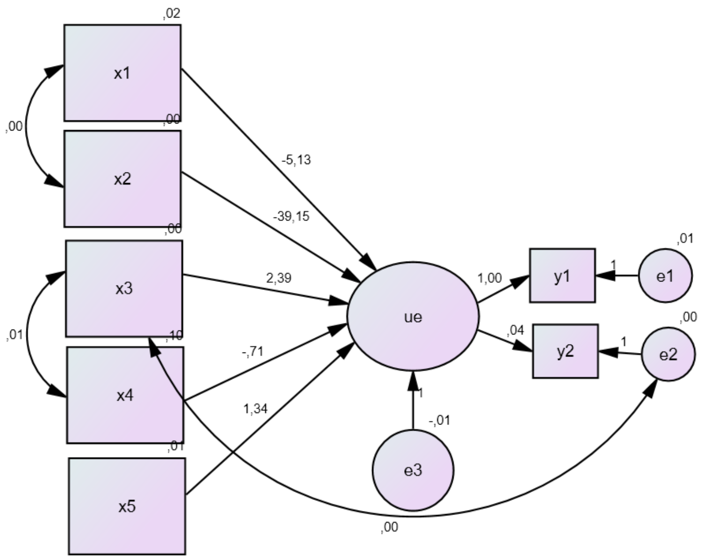

Figure 7. Original MIMIC model of Estonia.

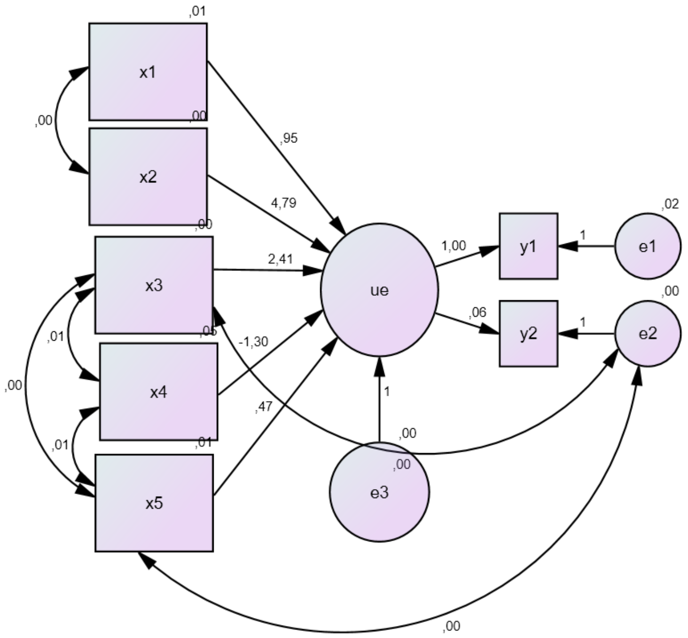

Figure 8. Original MIMIC model of Finland.

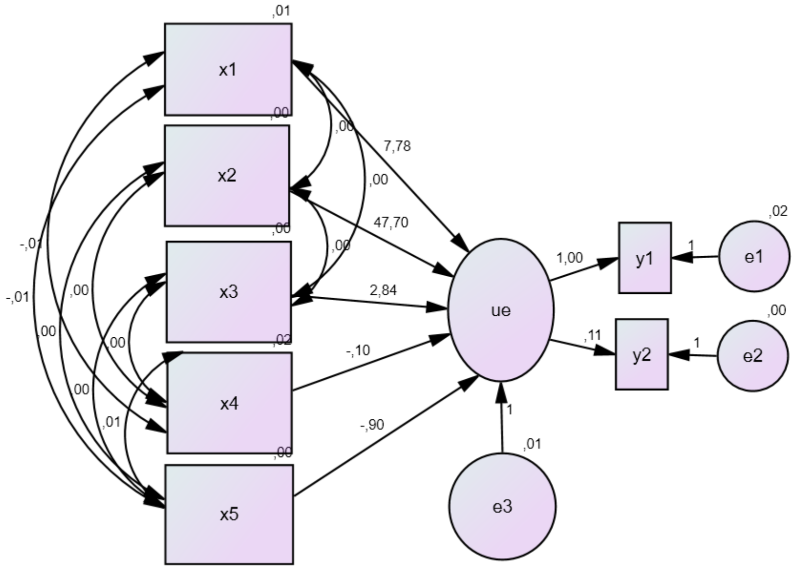

Figure 9. Original MIMIC model of France.

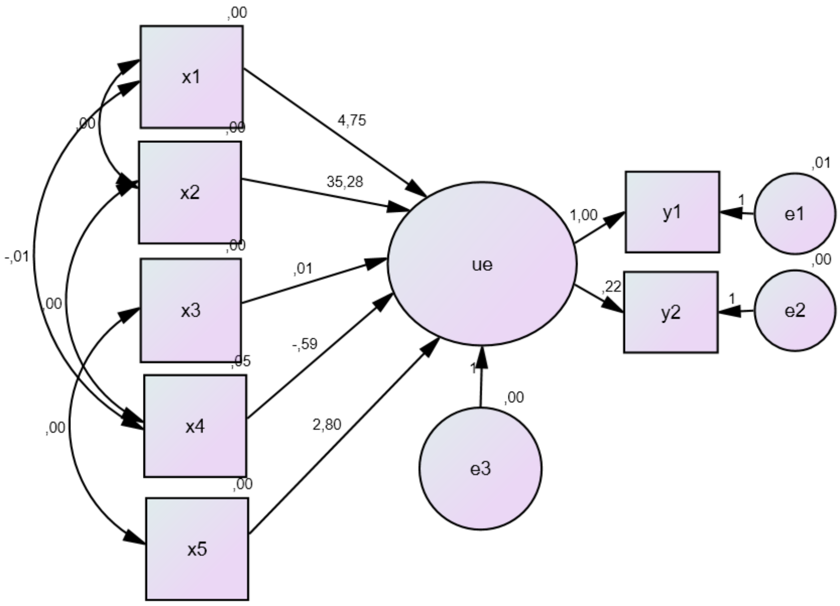

Figure 10. Original MIMIC model of Germany.

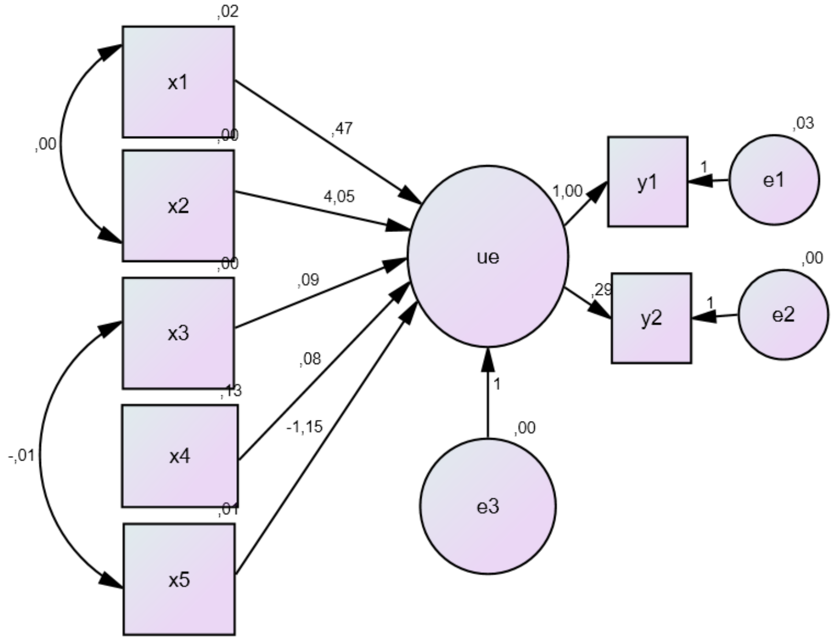

Figure 11. Original MIMIC model of Greece.

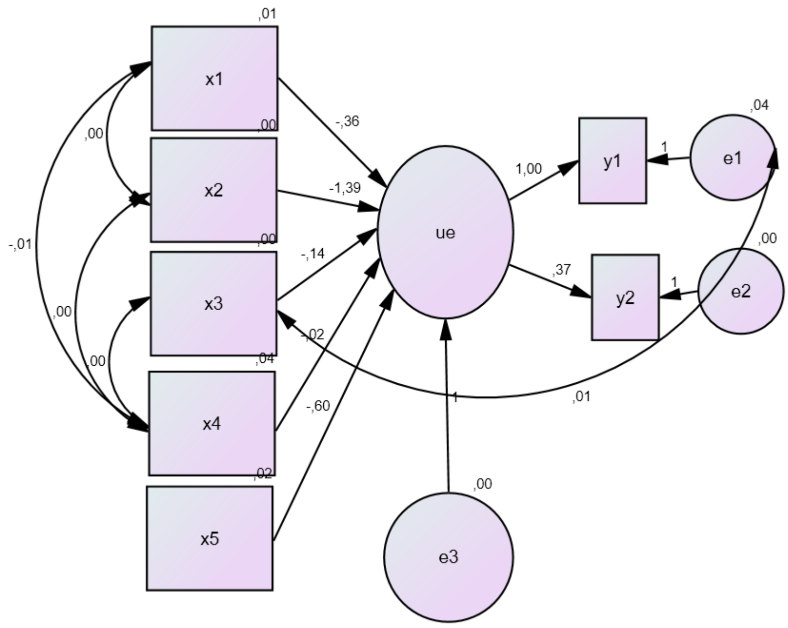

Figure 12. Original MIMIC model of Hungary.

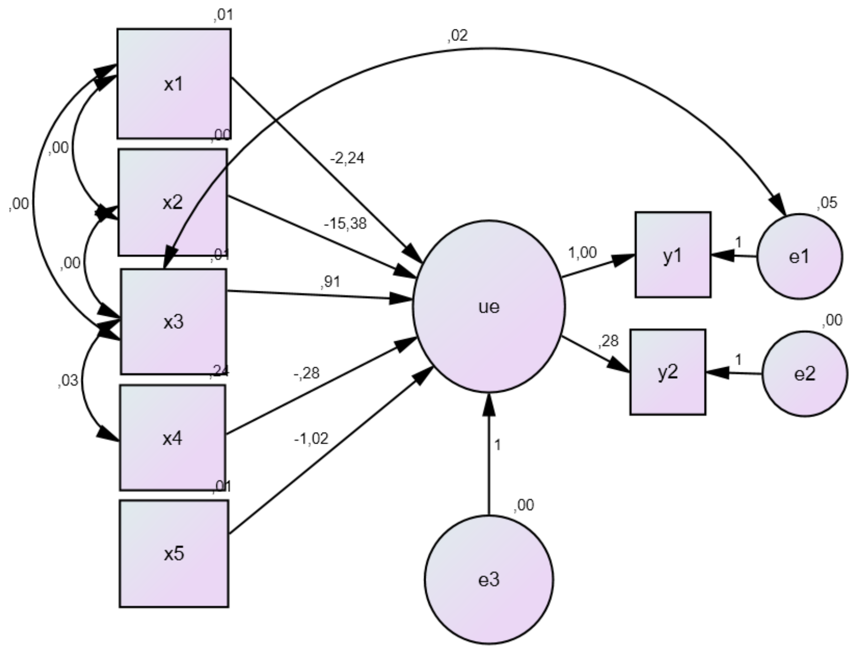


Figure 13. Original MIMIC model of Ireland.

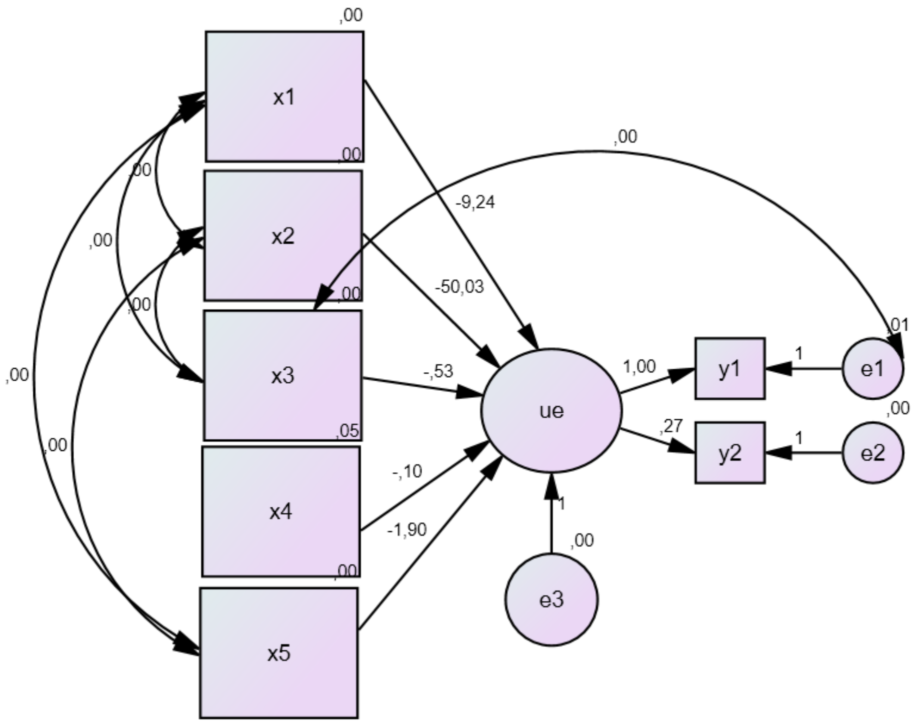


Figure 14. Original MIMIC model of Italy.

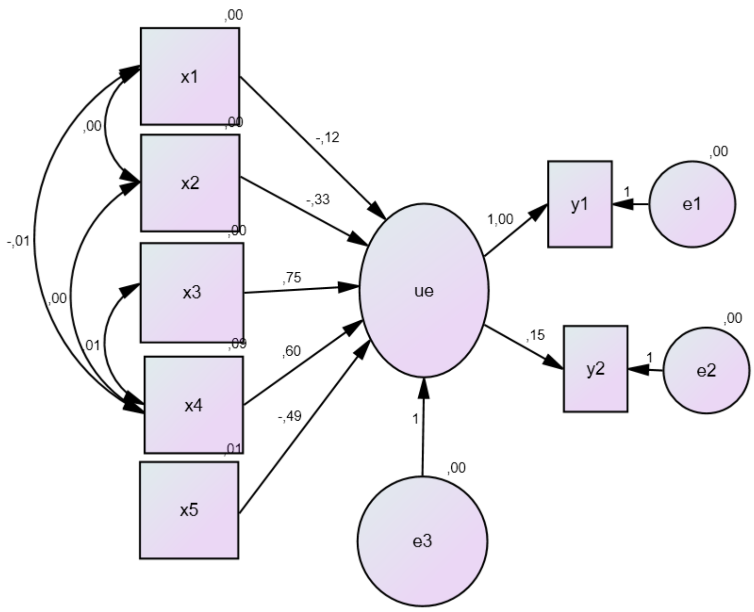


Figure 15. Original MIMIC model of Luxemburg.

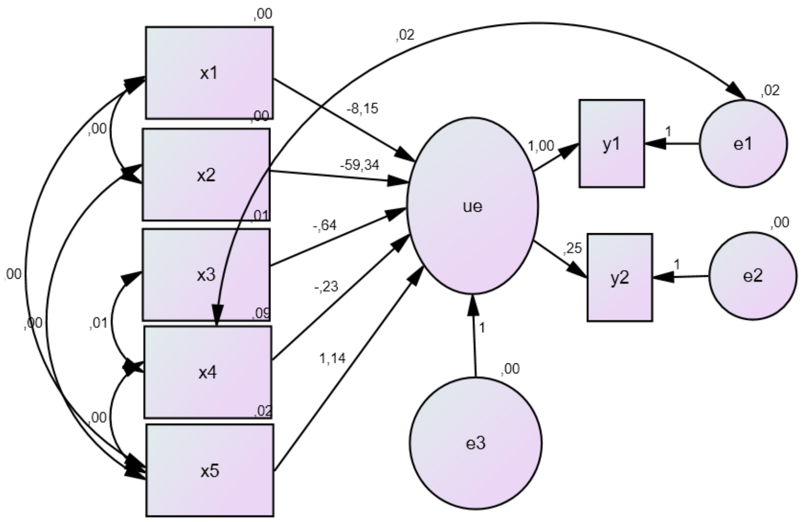


Figure 16. Original MIMIC model of Netherlands.

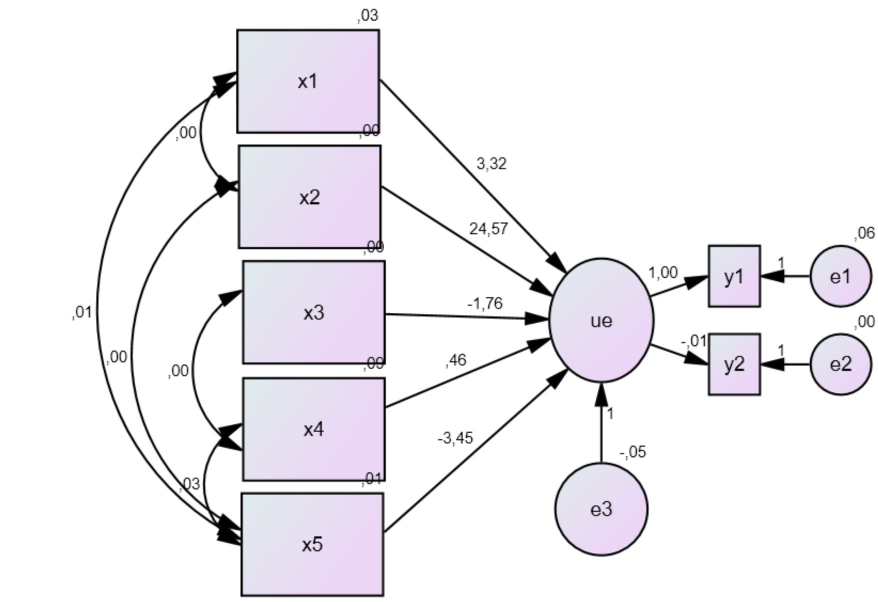

Figure 17. Original MIMIC model of Poland.

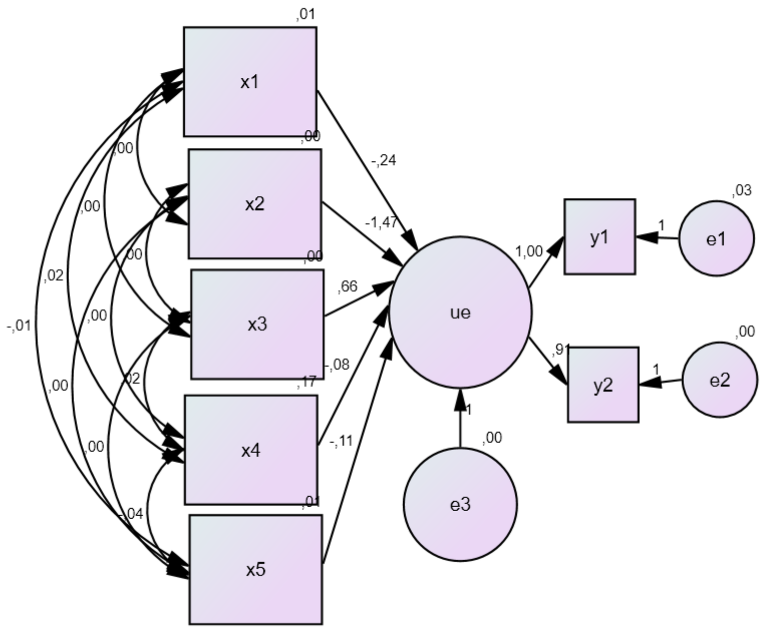

Figure 18. Original MIMIC model of Portugal.

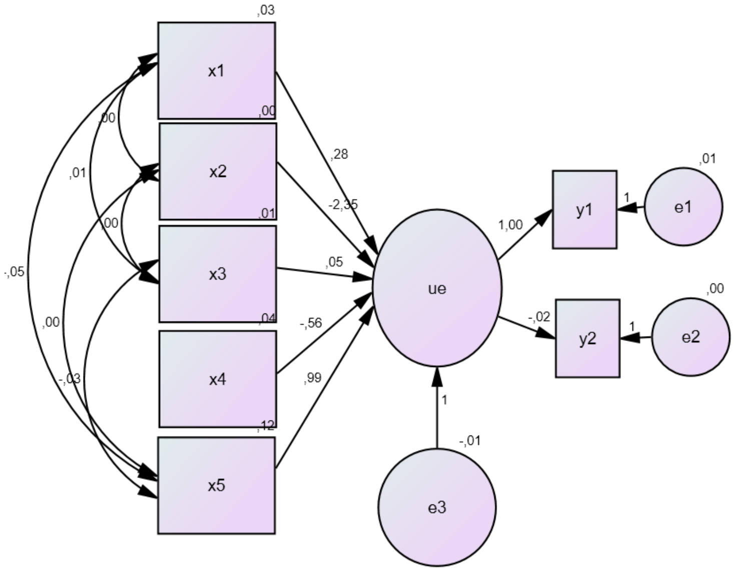


Figure 19. Original MIMIC model of Slovak Republic.

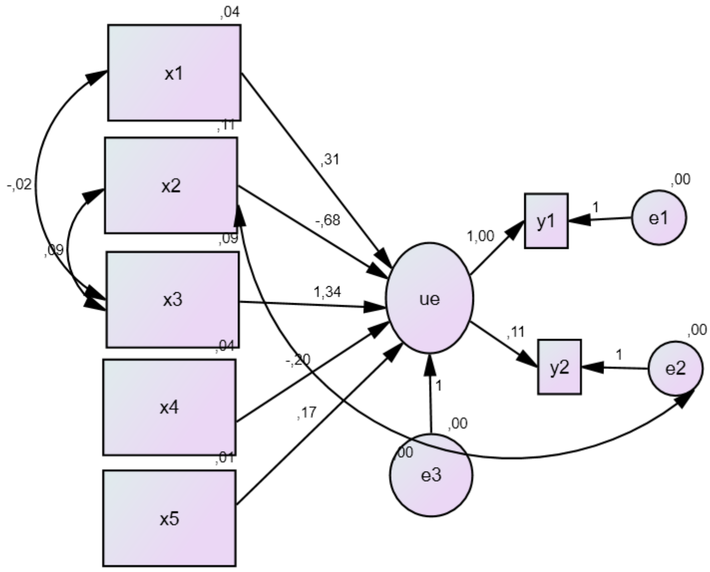


Figure 20. Original MIMIC model of Slovenia.

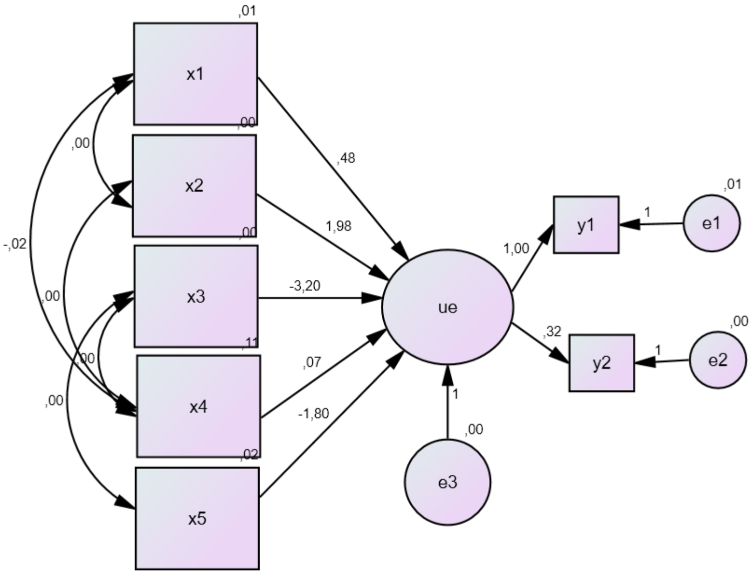

Figure 21. Original MIMIC model of Spain.

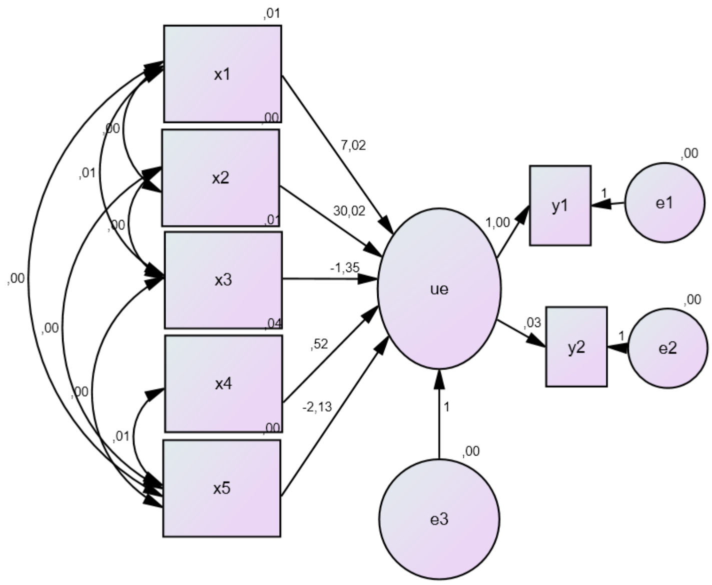

Figure 22. Original MIMIC model of Sweden.

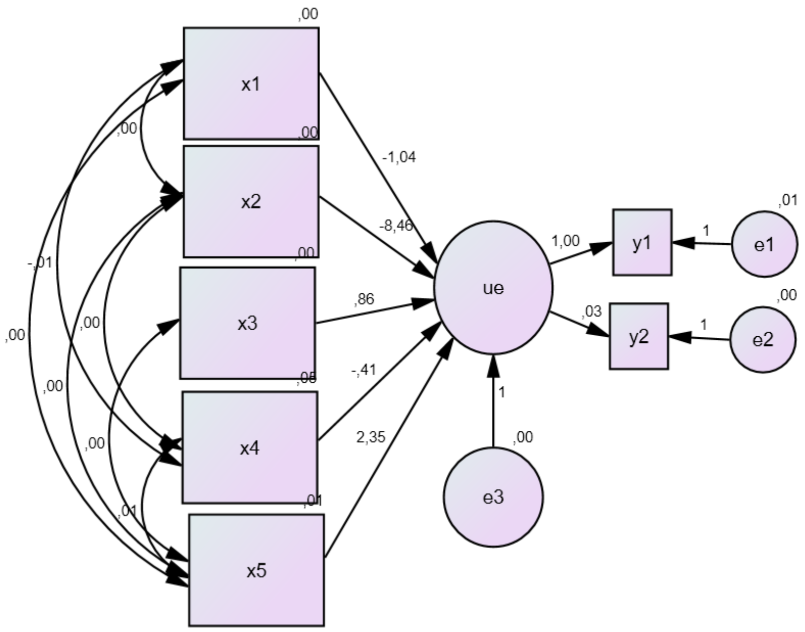

Figure 23. Original MIMIC model of United Kingdom.

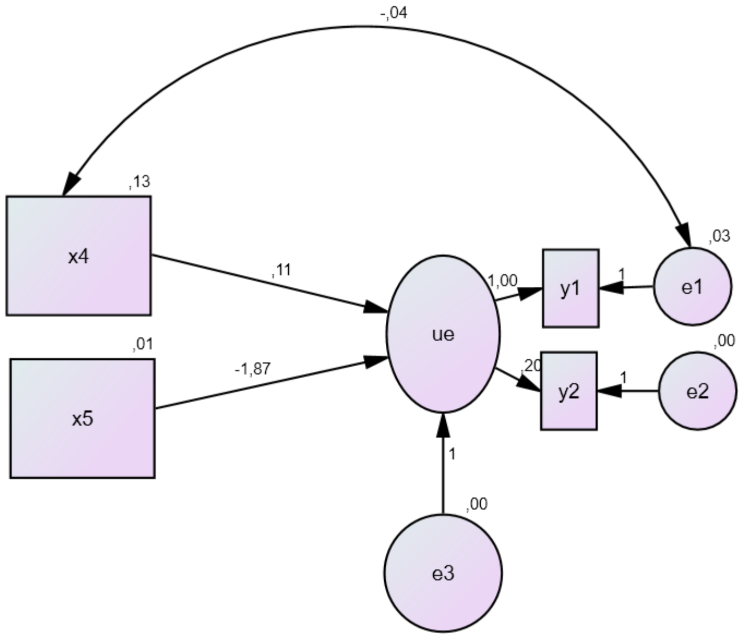

Figure 24. Modified MIMIC model of Austria.

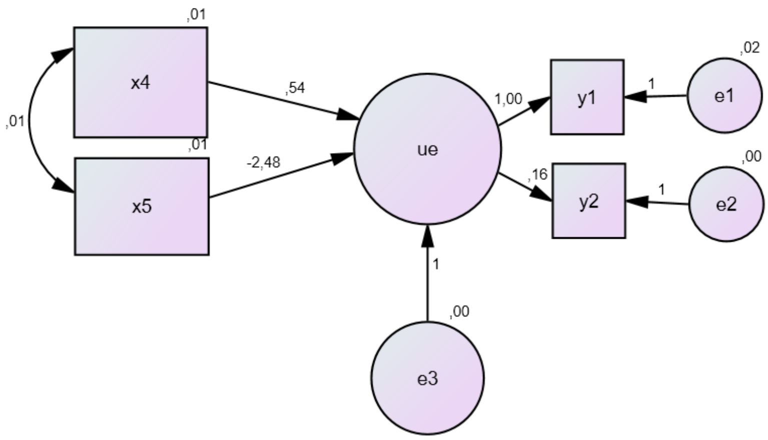

Figure 25. Modified MIMIC model of Belgium.

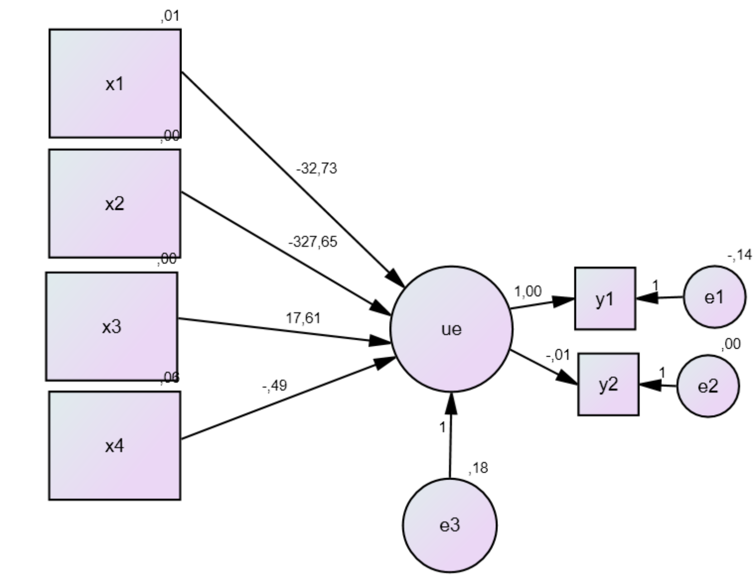

Figure 26. Modified MIMIC model of Czech Republic.

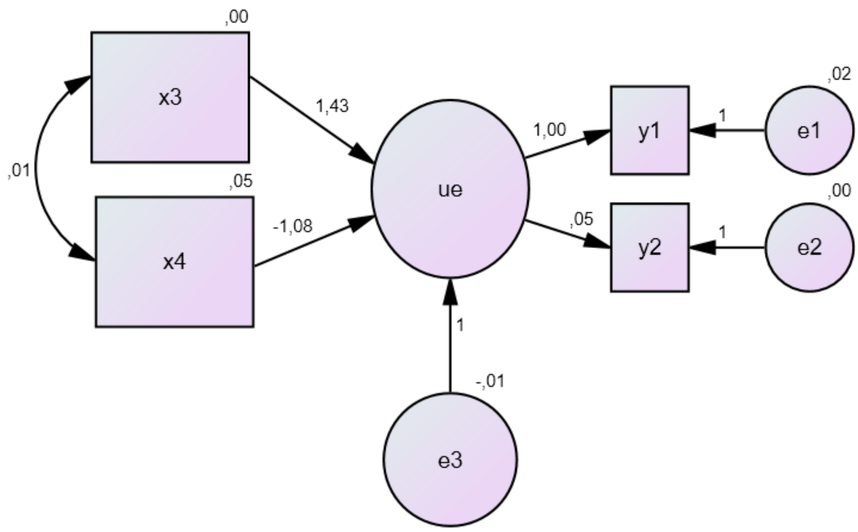

Figure 27. Modified MIMIC model of Finland.

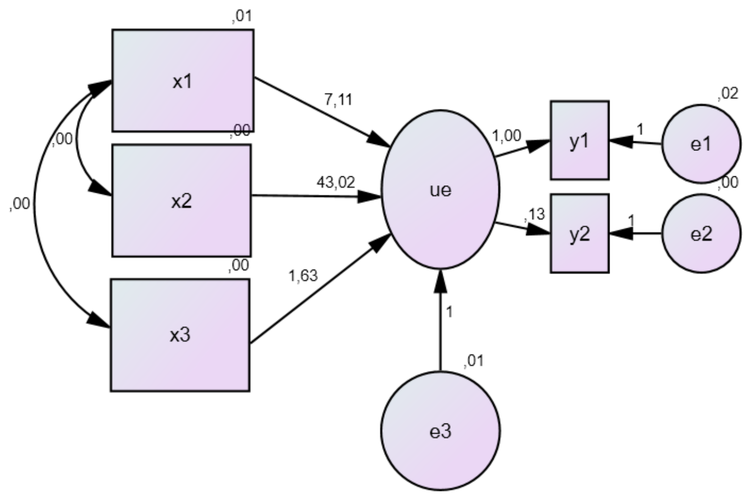

Figure 28. Modified MIMIC model of France.

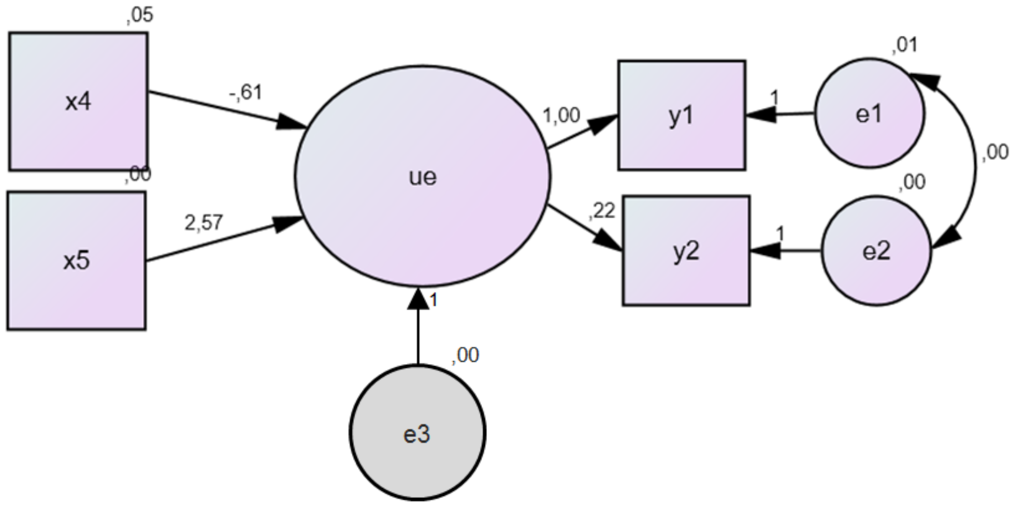

Figure 29. Modified MIMIC model of Germany.

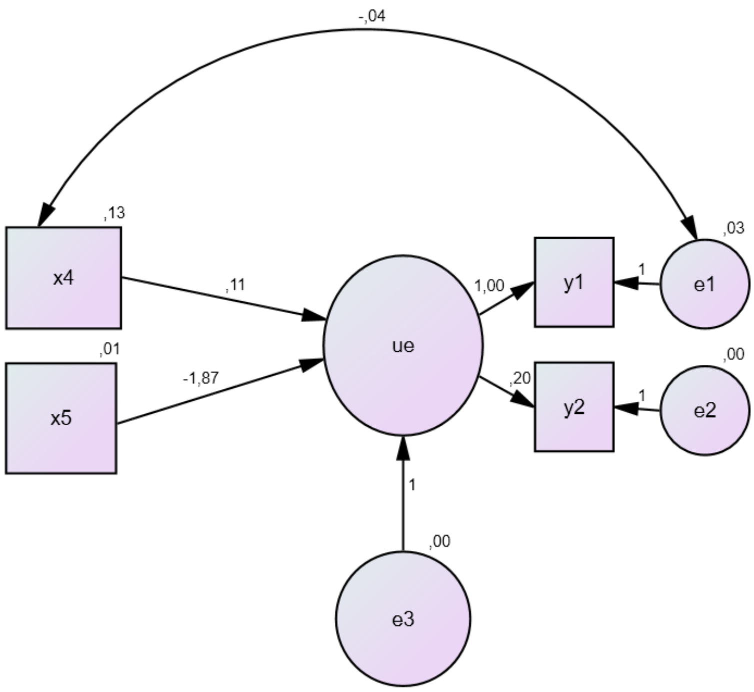

Figure 30. Modified MIMIC model of Greece.

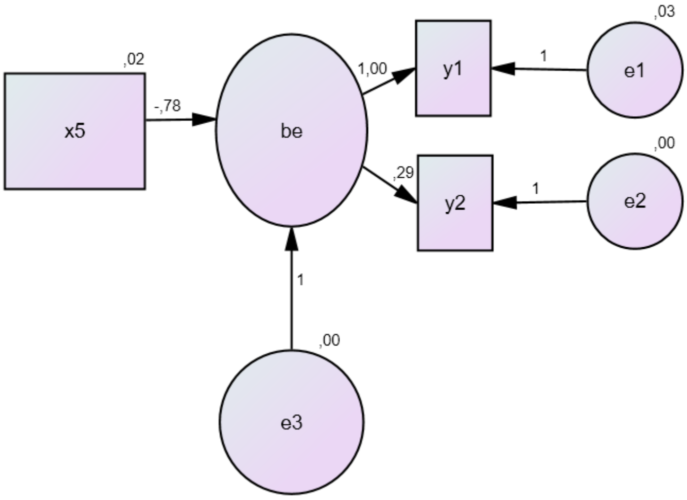

Figure 31. Modified MIMIC model of Hungary.

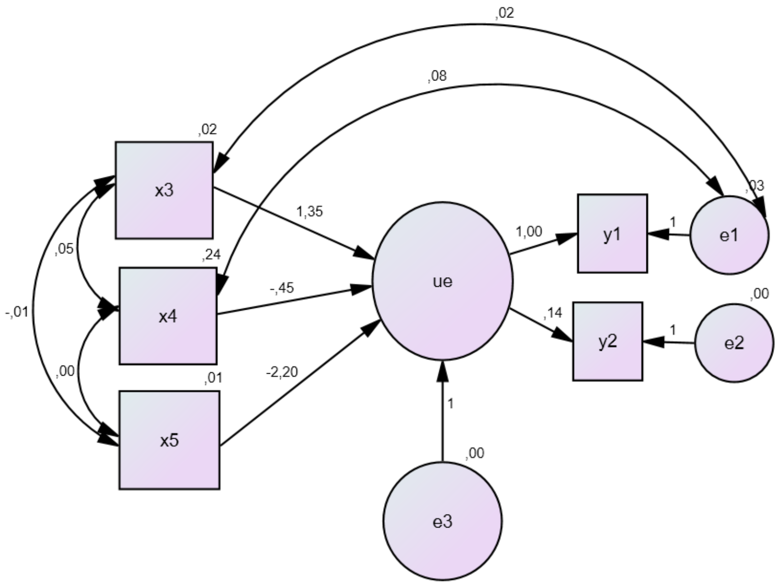

Figure 32. Modified MIMIC model of Ireland.

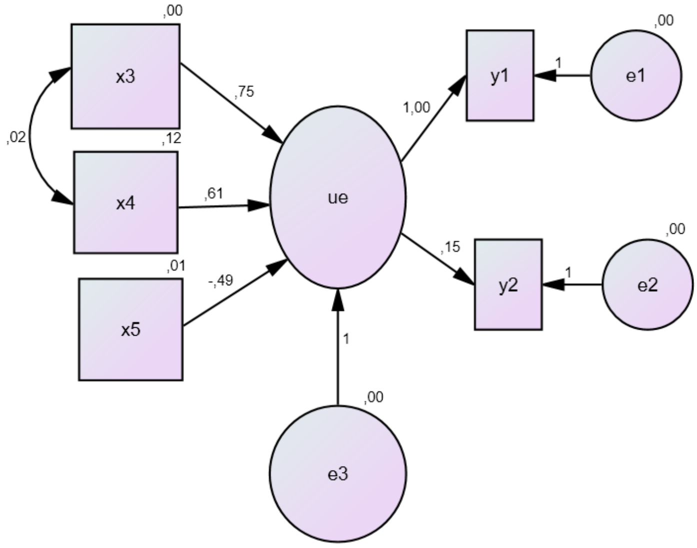

Figure 33. Modified MIMIC model of Luxemburg.

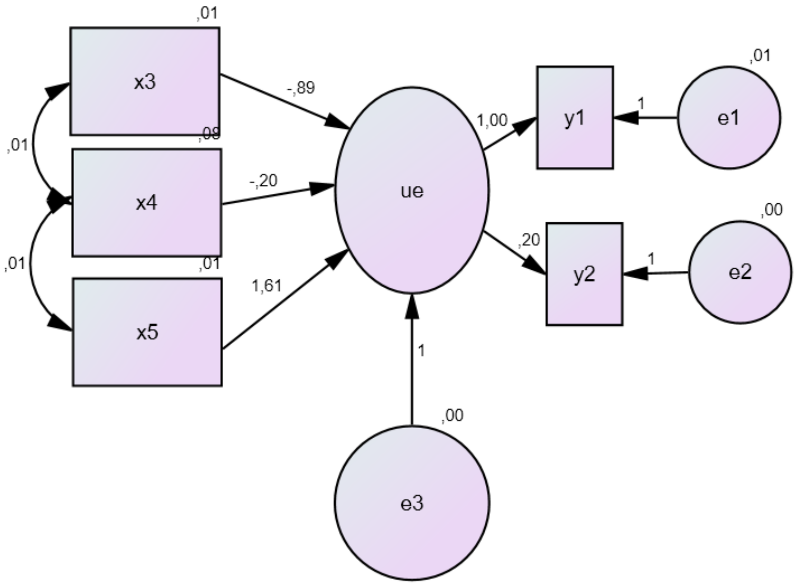

Figure 34. Modified MIMIC model of Netherlands.

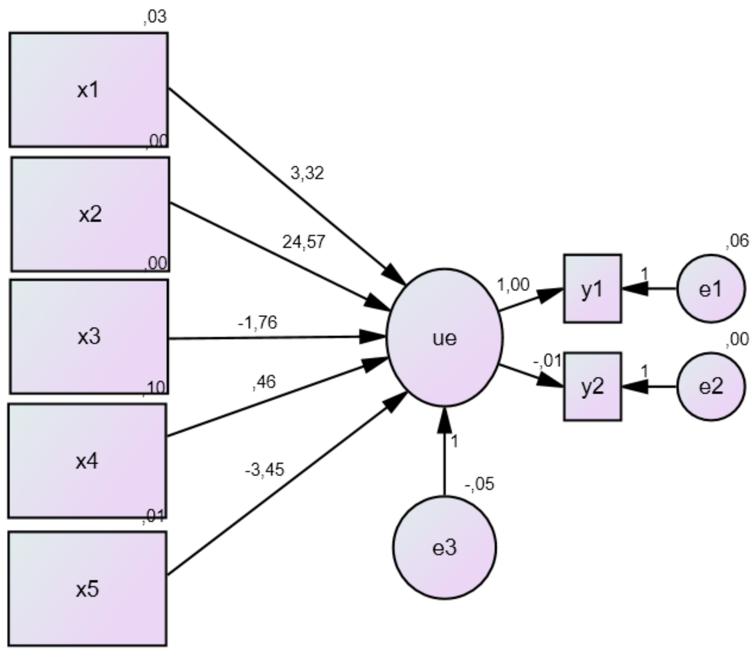

Figure 35. Modified MIMIC model of Poland.

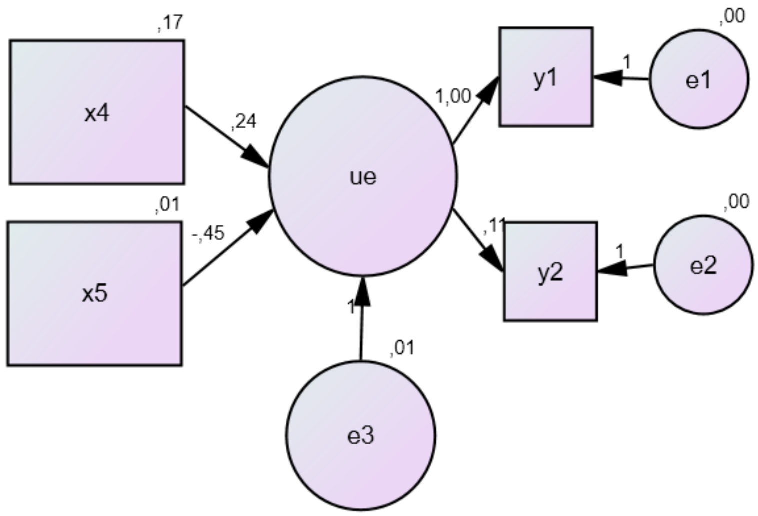

Figure 36. Modified MIMIC model of Portugal.

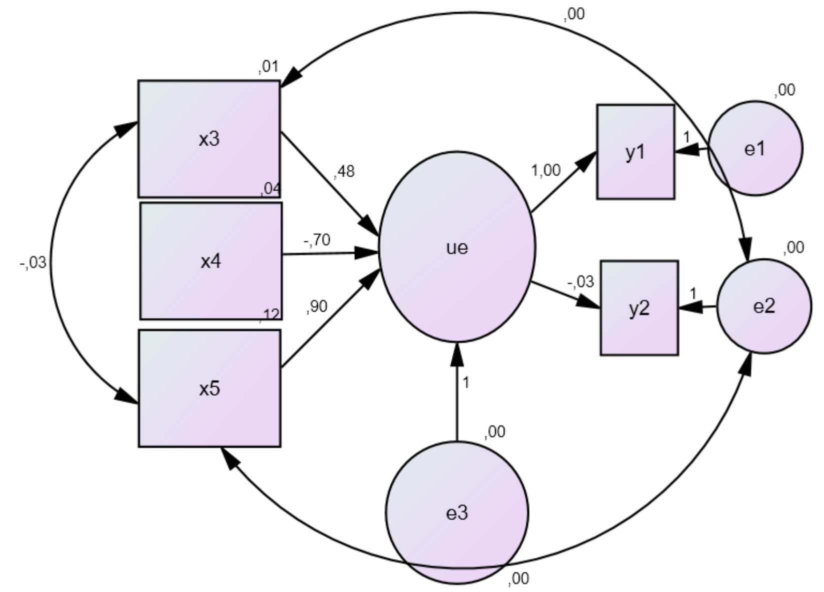

Figure 37. Modified MIMIC model of Slovak Republic.

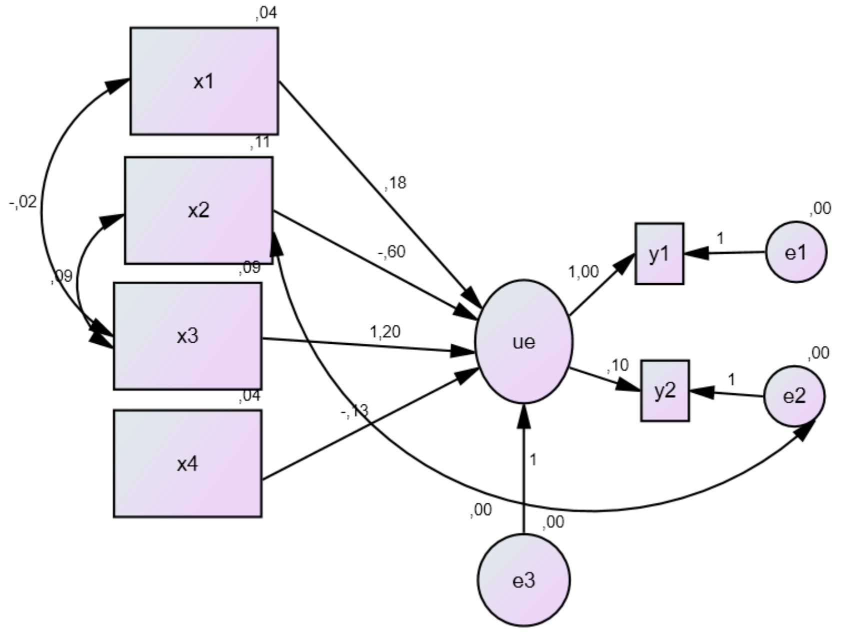

Figure 38. Modified MIMIC model of Slovenia.

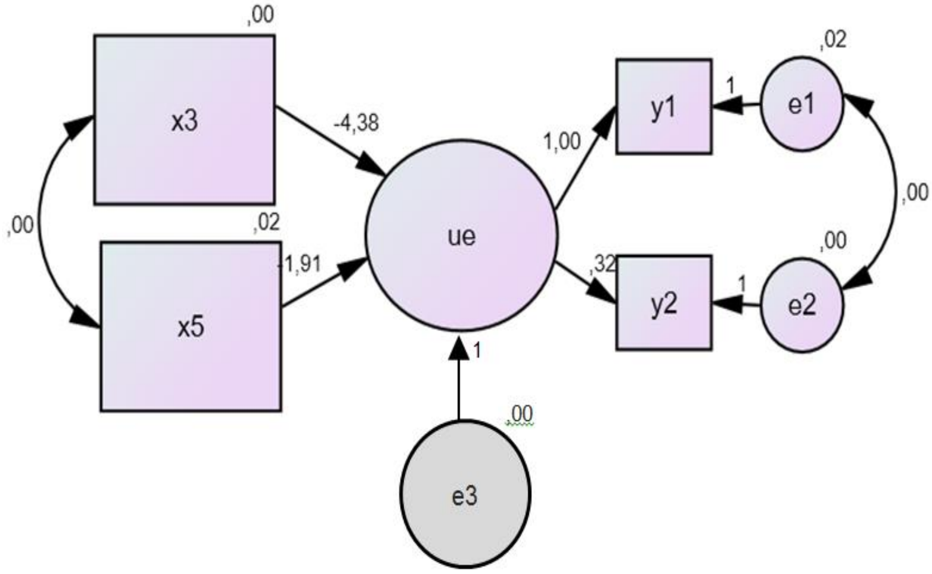

Figure 39. Modified MIMIC model of Spain.

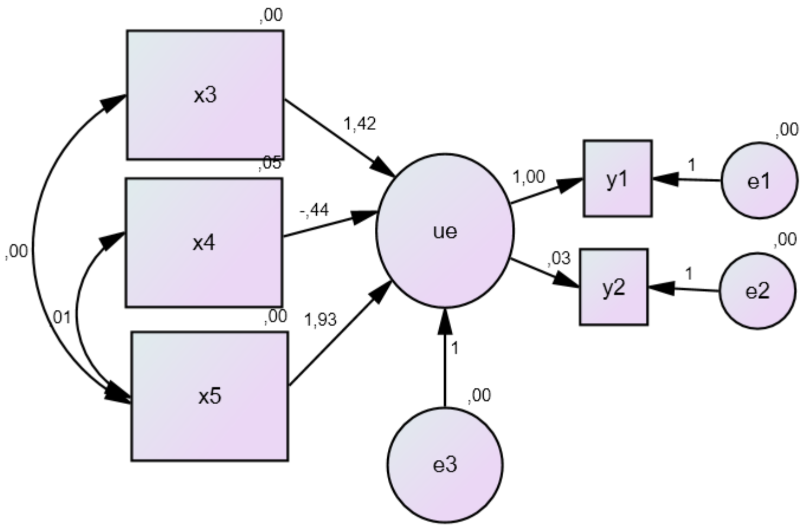

Figure 40. Modified MIMIC model of United Kingdom.

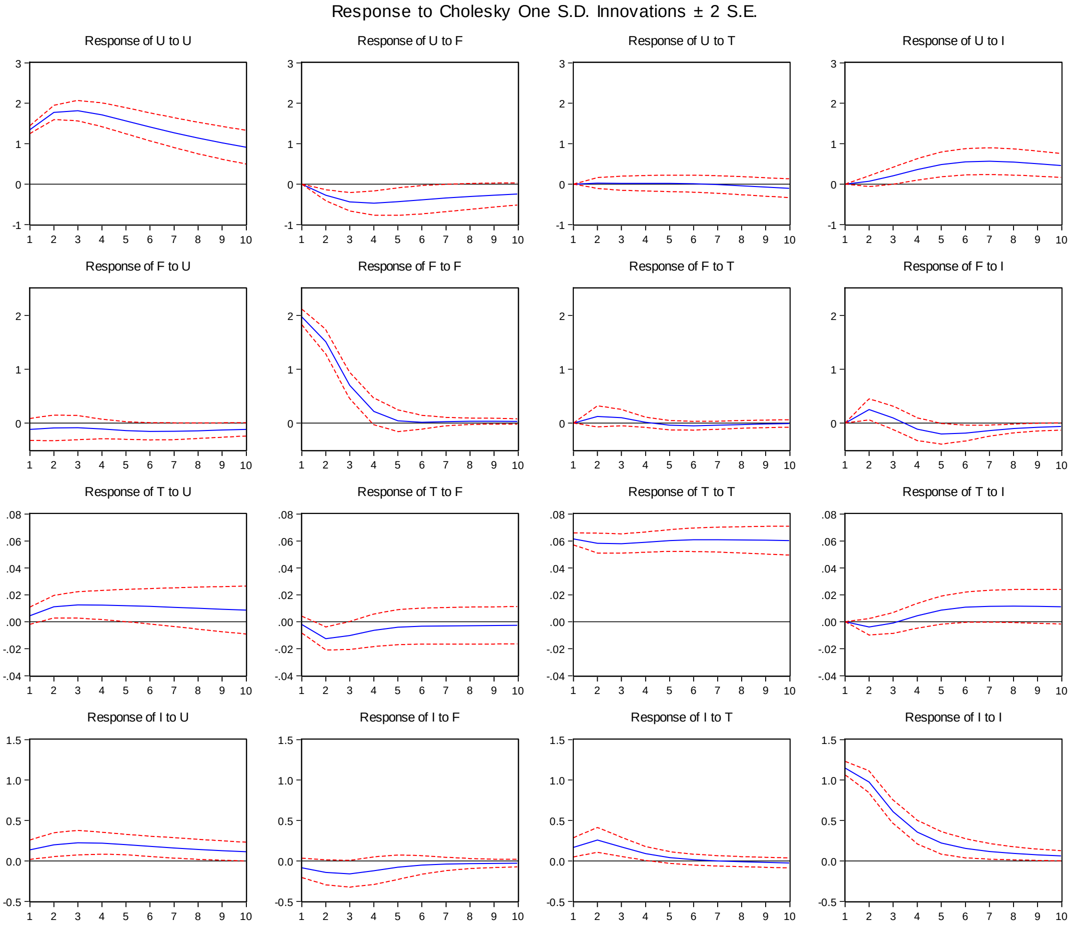


Figure 41. Impulse Response Analysis