INSTITUT DE FINANCEMENT DU DÉVELOPPEMENT DU MAGHREB ARABE

معهد تمويل التنمية للمغرب العربي

End of Studies Project

Topic :

The effects of exchange rate fluctuations on Tunisian economic growth: an econometric approach using simultaneous equations

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Janvier 2023

Acknowledgements

I would like to express my gratitude to all those who contributed to the preparation of this work.

I would like to express my deepest gratitude to the members of the administration and all my teachers at the ***IFID*** *for their assistance during our two years of training.*

To my supervising professor, Pr. ***Riadh EL FREKTAJI*** *for his valuable work, the patient guidance, encouragement and advice he has provided throughout this research.*

I would like to express my gratitude to Mr. ***Mourad ABDESSALEM*** *and Mr.* ***Rached BOUAZIZ*** *and the rest of the members of the General Department of Studies and Researches in Central Bank of Tunisia for their help to accomplish this work.*

To my beloved parents: ***Hatem*** *and* ***Faiza*** *for their love and unconditional support and to my dear sisters:* ***Farah*** *and* ***Ines*** *for their precious advices and encouragements.*

Finally, I would like to express my sincere thanks to the members of the jury for agreeing to judge my work.

Summary

List of abbreviations

Abbreviation	Explanation
ADF	Augmented Dickey Fuller
CBT	Central Bank of Tunisia
FDI	Foreign Direct Investment
GDP	Gross Domestic Product
REER	Real Effective Exchange Rate
WB	World Bank
2SLS	Two-Stage Least Squares
3SLS	Three-Stage Least Squares

List of tables

List of figures

General introduction

Rapid economic growth is the ultimate objective of any economy. Among the four objectives of an economy presented by Nicolas Kaldor's famous magic square is economic growth (COUTO & TEIXEIRA, 2014).

The global economy has long been characterized by an amplification of the processes of openness and by an intensification of international exchanges. In the 1970s, the Bretton Woods system ended but left a permanent influence on international currency exchange and on trade. This is when the exchange rate received considerable attention from researchers and policy makers, in view of its importance at the macroeconomic level and particularly for growth. This topic concerns both developed and developing countries. However, the influence of the exchange rate is much more pronounced in developing countries than in developed countries (AMAN, and al. 2013), as one of the most important structural problems in developing countries is the phenomenon of foreign dependence (KARAHAN, 2020).

The exchange rate plays an important role in an economy's growth by influencing its competitiveness in the international market and affecting the capacity of export, import, and attract foreign capital. Economists have long known that poor management of the exchange rate can be disastrous for economic growth, while keeping the exchange rate at competitive levels and avoiding excessive volatility makes it easier to capitalize on this instrument (EICHENGREEN, 2008). Each country chooses its exchange rate system according to its economic policy objectives. Thus, Tunisia is a developing country that is the focus of our analysis. Initially, Tunisia adopted a fixed exchange rate regime, then an intermediate regime and finally a managed floating regime since 2002.

The main question of this thesis is the following:

« What is the impact of exchange rate fluctuations on Tunisian economic growth? »

The exchange rate, however, is not directly linked to economic growth. The direct relationship between these two variables is not entirely clear.

Several authors have examined the relationship between the exchange rate and economic growth. In addition to the interest in the direct impact of the exchange rate on economic growth, some authors have focused on the channels through which exchange rate changes affect economic growth. Many studies found insignificant effect of exchange rate fluctuations on economic growth.

In this research, we studied the link between exchange rate changes and economic growth using the simultaneous equations approach. This approach allows us to examine the different mechanisms by which the exchange rate influences economic growth.

Therefore, we will try to answer the following question:

« What are the indirect effects of exchange rate changes on Tunisian economic growth? »

To conduct this study, which consists of an analysis of the relationship between the exchange rate fluctuations and economic growth, we have divided our work into three chapters defined as follows:

The first chapter will be devoted to the presentation of the theoretical framework. This chapter is divided into two sections. In the first section, we will present the definition and the basic concepts of the exchange rate and the presentation of its different types. In the second section, we will discuss the basic concepts of economic growth and the theories on the determinants of economic growth.

In the second chapter, we will present the review of the literature on economic growth and the exchange rate. This chapter will also be divided into two sections. The first section will be devoted to the determinants of growth in the empirical literature. The second section will be devoted to the direct and indirect link between exchange rate changes and economic growth. In this section, the different channels through which exchange rate changes affect economic growth will be highlighted.

In the third chapter, we will present the empirical investigation on Tunisian economy. This chapter will be divided into two sections. The first section will concern the exchange rate and economic growth in Tunisia as we will describe the economic growth and the exchange rate policy adopted by the country. The second section will be dedicated to the empirical analysis where we will display the different equations of our models and the methodology.

CHAPTER 1: Exchange rate and economic growth: Theoretical framework

Introduction

The opening of a country to the outside world implies exchanges of goods, services and assets. Each country has a currency in which the prices of transactions concluded within its territory are expressed. Exchange rates are at the center of international economic relations and are an essential element of the daily activity of economic agents. Each country has its own exchange rate regime depending on its objectives and policies.

It is important to have an overview of the exchange rate concept, its different regimes, its classifications to better understand it.

In this paper, the main objective is to identify the effects of exchange rate changes on economic growth. Therefore, we will discuss the different models of economic growth in order to get an idea on its determinants.

Section 1: The exchange rate

1. Definition

Foreign exchange is a financial transaction that consists of converting one currency into another at a rate known as the foreign exchange rate (GAUTHIER,1990).

The exchange rate is the value of one currency in terms of the other currency. It represents the amount of foreign currency that can be exchanged for one unit of the other currency. A rise in the exchange rate represents a depreciation of the local currency.

Bilateral exchange rate

The bilateral exchange rate indicates the exchange rate between two currencies, the local currency and the currency of the foreign country. For example: (EUR/TND) = x; where x is the amount needed of Tunisian dinar to buy one euro.

Real exchange rate

The real exchange rate is the rate at which an individual can exchange domestic goods and services with those of another country. The real exchange rate is a measure of the purchasing power of one currency against another.

The RER is determined as follows:

$$RER = e\frac{P^*}{P}$$

Where e is the nominal exchange rate, P^* is the price of domestic goods and P is the price of foreign goods.

The RER can be also defined according to many economists, MONTIEL (1999), BAFFES and al. (1999), EDWARDS (1989, 1994) and WILLIAMSON (1994) as:

$$RER = \frac{Price\ of\ tradables}{Price\ of\ non\ tradables}$$

A decrease in the RER (lower exchange rate) represents an appreciation in the real exchange rate. Likewise, an increase in the RER (higher exchange rate) indicates a depreciation of the real exchange rate.

Effective exchange rate

- **Nominal effective exchange rate**

The nominal effective exchange rate (NEER) refers to the exchange rate of a given currency against other currencies, weighted according to their share in the country's international trade or financial transactions.

- **Real effective exchange rate**

The REER index is used when multiple partners are considered. it is the weighted sum of the real exchange rates with the different trading partners. The REER reflects the evolution of a country's competitiveness on the international market. It is defined as the ratio of domestic prices to foreign

foreign prices expressed in the same currency. It is measured as a geometric average of the bilateral real exchange rates:

$$REER = \prod_{i=1}^{n} \left\{ N. \frac{P_{foreign}}{P_{home}} \right\}^{\omega_i} \quad \text{with} \quad \sum_{i=1}^{n} = 1$$

Where N represents the NEER between the local currency and the currency of each trading partner i, $P_{foreign}$ is the index of the foreign country i, P_{home} is the price index of the home country and ω reflects the structure of trade in the home country. An increase (decrease) in the REER represents an appreciation (depreciation).

2. Exchange rate regimes

The exchange rate regimes are divided into three broad categories: fixed, flexible and intermediate exchange rate regimes.

2.1. Fixed exchange rate

A Fixed exchange rate is a system in which the government of a country sets the value of its national currency by pegging the exchange rate to the currency of another country. To prevent the price of the currency from fluctuating, the central bank buys and sells its currency in the foreign exchange market, causing a strong demand or supply of its currency. Although this regime ensures currency stability, it requires a country to have sufficient foreign exchange reserves to maintain the value of its currency at a specific rate.

2.2. Flexible exchange rate

A Flexible exchange rate is defined as a currency whose value is determined by the supply and demand factors of other currencies. FRIEDMAN (1953) argued that a flexible exchange rate would ease the external adjustment. However, his work took place in a period where capital mobility was low.

There are two categories in this regime:

- Clean float: the Central Banks do not intervene and let the market balance itself freely according to the law of supply and demand.
- Managed float (also called "dirty float"): the central banks intervene to prevent large and rapid movements in the value of their currencies. Therefore, they ensure that their currency is not under or overvalued for a long period.

In this type of regime, monetary policy regains its independence, but the Central Bank loses control over the evolution of the nominal exchange rate.

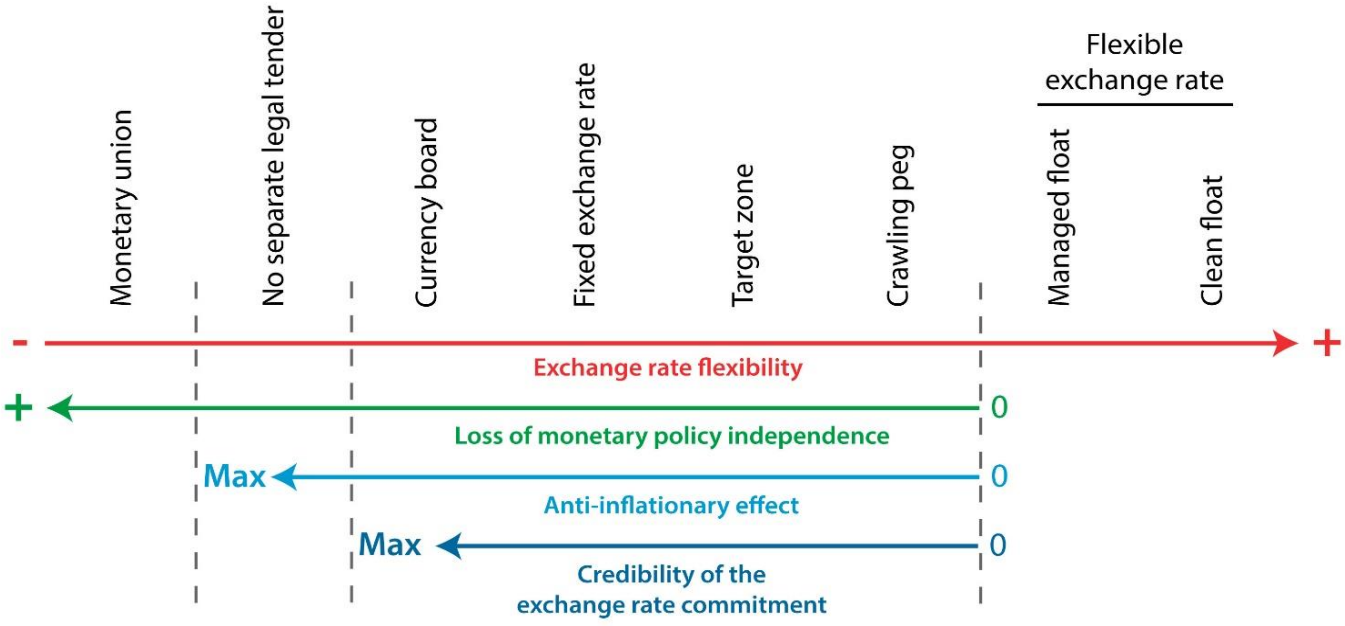
2.3. Intermediate exchange rate

The intermediate exchange rate is a regime between fixed and flexible exchange rates. It attempts to combine the stability of the former and the monetary policy independence of the latter. In this system, the central bank allows the exchange rate to fluctuate between a maximum and a minimum rate. There are various categories in this regime, for example, those cited by FRANKEL (2011):

- Target zone or band: a monetary system in which countries agree to maintain their exchange rates within a predetermined range.
- Basket peg: The adoption of this type of exchange rate regime means that a country's exchange rate is linked to a basket of two or more currencies.
- Crawling peg: The Crawling Peg is an exchange rate regime in which the authorities allow the exchange rate to fluctuate by a certain percentage. This system is generally adopted in countries where there is a systematic mismatch between its inflation rate and the rate of its main trading partners.
- Adjustable peg: an exchange rate regime in which the rate is fixed against a foreign currency (e.g., the U.S. dollar). The level of currency fluctuation is generally about 2%.

Every exchange rate regime has unique characteristics, advantages, and disadvantages. The figure below shows the different regimes based on four variables: the flexibility of exchange rate, loss of monetary policy autonomy, anti-inflation effect, and trustworthiness of the exchange rate commitment:

Figure 1: Typology of exchange rate regimes



Source: Policonomics

Does the choice of the exchange rate regime have an impact on growth?

The debate on the choice of exchange rate regimes has been revived after the currency crises that particularly affected emerging countries in the 1990s. This topic has been the subject of several empirical studies where some economists argue that fixed ERRs can help accelerate economic growth. According to GHOSH, and al. (2000), fixed ERRs limit exposure to speculative movements in the foreign exchange market. In showing the disadvantages of floating exchange rate regimes, BLEANEY and FIELDING (1999) confirm that adoption of a floating exchange rate will have a serious cost for developing countries, with inflation tending to be 10% higher than in countries that adopt pegged exchange rates.

However, some other economists hold that that floating RREs can result in faster economic growth. In this context, LEVY-YEYATI and STURZENEGGER (2003) found in a study conducted on a sample of 183 countries over the period 1974-2000 that less floating exchange rate regimes are linked to slow economic growth and higher output volatility in developing countries. However, the exchange rate regime seems not to impact the growth of industrialized economies.

3. Classifications of exchange rate regimes

There are two main approaches used to classify exchange rate regimes: Firstly, the de jure approach based on countries' statements, and secondly, the de facto classifications, which are based on their actual actions.

3.1. The de jure classification

Since 1950, the International Monetary Fund's annual report "*Exchange Arrangements and Exchange Restrictions*" report was the main source of information on exchange rate regimes. Indeed, the IMF classifies countries on the basis of their stated exchange rate regime, and this is part of the requirements or conditions that member countries of the organization must respect. This classification is then called *de jure*, because it is simply based on an official declaration by the countries.

The IMF has a long history of frequent updating of its exchange rate classification. The initial IMF exchange rate regime classification divided members' exchange rate regimes based on official statements. Between 1975 and 1998, the level of exchange rate flexibility was set by their

own official announcement (as shown in table 1, first column). Unfortunately, the IMF classification was unable to represent a country's true exchange rate regime, as exchange rate regimes frequently differed from what governments officially stated them to be. Acknowledging the problem, the IMF adopted a more *de facto* classification scheme in January 1999 (as shown in table 1, second column).

Table 1: The original and the new International Monetary Fund classification of exchange rate regimes

The original IMF classification	The new IMF classification
(1) Pegged regimes (2) Regimes with limited flexibility (3) More flexible arrangements ➔ These three categories are further divided into 15 sub-categories.	(1) A regime with no separate legal tender (2) Currency board (3) Conventional pegged (4) Pegged exchange rates within horizontal bands (5) Crawling pegs (6) Crawling bands (7) Managed floating with no predetermined path for the exchange rate (8) Independent floating

Source: ROGOFF, and al. (2004); REINHART and ROGOFF (2004)

3.2. The de facto classifications

Several *de facto* classifications have been developed in the literature. The IMF has itself adopted a de facto classification scheme in 1999 as indicated above. This is because of the problems associated with the de jure classification of exchange rate regimes. In fact, several exchange rate regimes differed widely from their de jure codification (CALVO and REINHART, 2002). The most important classifications are those proposed by REINHART and ROGOFF (2004) and LEVY-YEYATI and STURZENERGGER (2005).

Firstly, the classification scheme developed by REINHART and ROGOFF, as shown in table 2 first column, reclassified exchange rate regimes by focusing on dual and parallel market-

determined exchange rates, as well as on a statistical analysis of observed exchange rate behavior for 153 countries over the period 1946-2001.

Secondly, LEVY-YEYATI and STURZENERGGER (2005) constructed a de facto classification, as shown in table 2 second column, based on data obtained on the behavior of three variables: nominal exchange rate changes, the volatility of these changes, and the volatility of international reserves for all IMF reporting countries over the period 1974-2000.

Table 2: De facto classification according to REINHART and ROGOFF (2004) and LEVY-YEYATI and STURZENERGGER (2005)

***De Facto* by REINHART and ROGOFF**	***De Facto* by LEVY-YEYATI and STURZENEGGER**
(1) No separate official currency (2) Currency board (3) Horizontal band announced in advance that is less than or equal to ± 2% (4) De facto peg (5) Crawling peg with prior announcement (6) Crawling peg with prior announcement that is lower than or equal to ± 2% (7) De facto crawling peg (8) De facto crawling band less than or equal to ± 2% (9) Crawling band with prior announcement that is larger than or equal to ± 2%. (10) De facto crawling band less than or equal to ± 5% (11) Moving band which is less than or equal to ± 2% (12) Managed floating (13) Freely floating (14) Freely falling	(1) Fixed (2) Crawling Peg (3) Dirty Floats (4) Flexible (5) Inconclusive

Source: REINHART and ROGOFF (2004); LEVY-YEYATI and STURZENERGGER (2005).

4. The equilibrium exchange rate

The equilibrium exchange rate is defined as the rate at which at which a currency's supply and demand are equal. There are three types of equilibrium exchange rate depending on the time horizon, DRIVER and WESTAWAY (2003):

- The concept of short-term equilibrium, is defined as the exchange rate that operates when its fundamental determinants are at their current level, after abstraction of the influence of random effects (for instance from the impact of asset market bubbles).
- The concept of medium-term equilibrium, is defined when the economy is at both internal and external balance. The first part of the equilibrium is internal balance, which occurs when the economy is functioning at normal capacity and when demand reaches its supply potential. The second part is external balance, which occurs when the current account of the balance of payments would be at a level that can support a potential convergence to the stock-flow balance.
- The concept of long-term equilibrium, which is defined as the point where the stock-flow equilibrium is reached for all agents in the economy.

There are different methods to measure the equilibrium exchange rate:

- The purchasing power parity (PPP) method, which is an old theory of exchange rate determination. This method has two variants: absolute PPP, where the equilibrium real exchange rate is equal to unity; and relative PPP, which assumes that the change in the real exchange rate is equal to zero in the long run;
- The Fundamental Equilibrium Exchange Rate (FEER) developed by (Cline, 2008; Williamson, 1994);
- The Behavioral Equilibrium Exchange Rate (BEER), consists of estimating an econometric model of the real exchange rate (Clark et MacDonald, 1998);
- The Natural Real Exchange Rate (NATREX) developed by (Stein et Allen ,1997);

5. Factors influencing the exchange rates

Exchange rates fluctuate in response to supply and demand as well as other economic factors. The main factors that could impact the foreign exchange rate are the following:

- **Interest rates**

Key interest rates are one of the monetary policy tools available to central banks. The level of interest rates depends on inflation and economic activity. If growth is slow, monetary authorities will tend to lower interest rates to boost growth and encourage investment. On the contrary, high interest rates will prevent the economy from overheating. Generally speaking, currencies with high interest rates will attract investors and currencies with low interest rates will be abandoned.

- **Inflation**

Inflation refers to the rate at which the price of goods and services increases over time. Inflation diminishes the value of a currency. Because of the overall rise in prices, the same amount of money will buy fewer goods and services.

- **Current account**

The current account consists of the balance of trade (exports and imports), factor income (earnings on abroad investments less payments made to foreign investors), and net one-sided transfers. It measures the country's foreign income and expenditures. Therefore, a current account deficit will cause a depreciation of the local currency.

- **Government debt**

A country's public debt represents its financial liabilities. If the funds are used to finance investments, this may be viewed positively by investors. If, on the other hand, these funds are spent to pay interest on previously contracted debt, this will send a negative sign. As a result, it will have disastrous effects on the economy. In general, the higher the country's debt, the more skeptical investors become. Indeed, a high level of debt creates concerns about the country's solvency and generates inflation that will depreciate the value of the currency.

- **Political Stability**

The value of a country's currency can be affected by its political situation. A country with a low risk of political instability is more attractive to an international investor. Increased foreign capital leads to an increase in the value of the country's currency, whereas countries experiencing political problems are likely to have their currency rate depreciate.

6. Exchange rate misalignment

There is broad agreement that keeping the RER at the wrong level has considerable welfare costs. It generates false signals to economic agents and leads to higher economic instability (WILLET, 1986).

Exchange rate misalignments correspond to sustained deviations of the observed real exchange rate from its equilibrium level (EDWARDS, 1989). Misalignments are measured as the differences between the observed values of real exchange rates and the values of the equilibrium rate. A positive sign indicates an overvaluation, i.e., the value of a country's currency is higher than it is supposed to be, resulting in a loss of competitiveness compared to trading partners. Whereas a negative sign indicates that the currency is undervalued, where the value of the currency becomes cheaper than expected, implying greater competitiveness.

Unfortunately, all countries are exposed to exchange rate misalignments, and for several authors, the latter particularly affects economically weak countries (BIKAI and OWOUNDI, 2016). The misalignment, whether positive or negative, reflects a poor exchange rate policy, which would be harmful in terms of external equilibrium, allocation of productive resources and well-being, and could lead to a crisis such as the financial Asian crisis in the 1990s.

Section 2: Economic growth

1. Definition

Rapid economic growth and general economic development are the macroeconomic objectives of all countries in the medium and long-term.

Economic growth is defined as the increase in the number of goods and services produced. It evaluates the variation in production over a given period. This variation is measured by the annual evolution of an indicator called: Gross domestic product.

« Gross domestic product (GDP) measures the total final output of goods and services produced by an economy that is, by residents and nonresidents, regardless of the allocation to domestic and foreign claims. » (World Bank, 1984)

2. Theories on the determinants of economic growth

2.1. Classical economics

The analysis of economic growth was the main feature of the work of classical economists such as Adam SMITH; Thomas MALTHUS; David RICARDO who are considered the precursors of the modern theory of growth.

The publication in 1776 of Adam SMITH's "The Wealth of Nations" marked the beginning of the classical economics that dominated economic thought at that time. Adam SMITH (1776) Smith suggests that the division of labor is a source of productivity. Specialization results in the capacity to perform a given task. But it also gives the ability to invent more specialized and therefore more efficient techniques and tools.

Thomas MALTHUS (1798), on the other hand, suggests two essential factors for growth: natural resources and labor. He asserts that the power of the population is greater than the power of the earth to generate subsistence for man. As a result, he believes that in the long run, the economy will reach a stationary state: growth will slow down, eventually reaching zero.

However, in their theory of growth, SMITH, and MALTHUS neglect technological change in the growth process.

For RICARDO (1819), international trade and technological progress are the determinants of economic growth. He also believes, like MALTHUS, that the economy will tend towards a stationary state due to diminishing returns.

2.2. Innovation growth theory of Schumpeter: the long economic cycle

While classical economists believe that the economy will no longer grow in the long run, KONDRATIEV (1926) argue that the period of a wave varies between 45 and 50 years. SCHUMPETER (1942) developed a long-run growth theory based on KONDRATIEV's work. He believes that innovation driven by entrepreneurs is the engine of growth. He argues that the former is part of a process described as *creative destruction*. The former is a process in which older activities are eliminated and replaced in response to innovations. SCHUMPETER identifies three types of business cycles to explain variations in growth:

- KONDRATIEV wave: it consists of a long cycle that lasts between 45 and 50 years.
- Jugular cycle: it is a cycle that extends from 7 to 11 years.
- Kitchin cycle: is a short business cycle lasting around 40 months.

2.3. Post-Keynesian economics: HARROD-DOMAR model

In 1940, a growth model was established by the two economists HARROD and DOMAR (inspired by KEYNES (1936)). They assume that savings play a key role in economic growth. Because it promotes investment. The latter has a double influence on the economy: demand and supply (MUET, 1993). On the demand side, the change in investment determines the level of income and aggregate demand (Keynesian Multiplier). And increases production capacity, on the supply side.

They discuss the possibility of a balanced growth, where demand grows at the same rate as production capacity, which would guarantee full employment. They concluded that it is not possible to achieve a balanced economy.

2.4. Neoclassical economics: SOLOW model

The SOLOW model seeks to describe the long-term evolution of the economy. It is based on two equations: a production function equation and a capital accumulation equation. The first equation takes a Cobb-Douglas form:

$$Y = AK^{\alpha}L^{1-\alpha} \qquad 0 < \alpha < 1 \qquad (1)$$

Where Y, A, K, L, and α represent respectively the production, technological progress, capital input, and elasticity. An increase in technology results in higher production without the need to raise inputs. It is commonly referred to as *total factor productivity* (TFP) since a rise in technological progress boosts the productivity of other factors.

The production function has the following features:

- Constant returns to scale;
- The marginal returns to factor accumulation are decreasing i.e., that an increase in these factors by a certain proportion leads to a smaller increase in output.

The second equation is as follows:

$$\dot{K} = sY - \delta K \qquad (2)$$

Where s is the savings rate (which is considered constant) and δ represents the rate of capital depreciation.

In the absence of population growth (i.e., if L remains constant) and technological development (i.e., if A remains constant), the economy cannot expand at a positive rate eternally. Indeed, due to the fall in capital returns, national income Y does not expand as quickly as capital stock, implying that savings sY cannot grow as fast as capital depreciation. At some point, depreciation catches up with savings, as a result, both the capital stock and the economy stop growing.

When SOLOW introduced technological progress in his model, he considered it as exogenous i.e., he did not explain its sources. Thus, in the presence of technological change, stable and balanced growth is possible in contrast to the HARROD-DOMAR model.

2.5. Endogenous growth theory

In the 1980s, the theory of endogenous growth made an important contribution to the growth theory. It was developed mainly by ROMER (1986), LUCAS (1988), and BARRO (1990).

While SOLOW's model assumes that technological progress is exogenous, the new theory seeks to make it endogenous, that is, to build models that explain its sources. Another main difference is that the core of endogenous growth lies in the assumption that the marginal productivity of capital does not tend toward zero when the capital stock increases.

First of all, starting from the endogenous growth model initiated by ROMER in 1986. He developed a long-term growth model which is based on the ***accumulation of knowledge***. Assuming that knowledge and physical capital can be related to each other. The process of knowledge accumulation is based on learning by doing. The more the workers produce, the more they learn to produce effectively. By producing, experience is gained, which increases productivity. ROMER's second model (1990) highlighted the importance of the research and development sector (R&D) in the growth mechanism. In this model, growth is driven by technological change that results from intentional investment decisions made by profit-maximizing agents.

Then, LUCAS (1988) proposed a model of endogenous growth based on the accumulation of human capital. He shows that there are two sources of the latter: education and learning by doing. He explains that accumulating human capital allows the worker to be more productive.

Finally, BARRO (1990) emphasized the role of public capital accumulation on growth: public infrastructure (such as roads, airports, public lighting, water distribution network, etc.) stimulates the productivity of private agents and therefore economic activity. Thus, the government collects more taxes with growth, so it can finance new infrastructure. Thus, public investment promotes growth and vice versa.

Table 3: Summary of the determinants of growth in the theory

Theories	Economists	Determinants of growth
Classical economics	Adam SMITH David RICARDO Thomas Robert MALTHUS	The division of labor, natural resources, labor, international trade, technological change.
SCHUMPETER growth theory	Joseph SCHUMPETER	Innovation
Post-Keynesian	Roy HARROD Evsey DOMAR	Saving and investment
Neoclassical economics	Robert SOLOW	Populationn and Technological development
Endogenous growth theory	Paul ROMER Robert LUCAS Jr. Robert BARRO	Knowledge, technology, human capital, and public capital

Conclusion

The exchange rate is an important variable in an economy. However, despite its importance it is not considered as a policy variable. EICHENGREEN (2008) argues that policymakers do not directly regulate relative prices. They are, rather, the result of other policies and processes that influence supply and demand. The same view is shared by RODRIK (2008), the real exchange rate is defined in terms of equilibrium with other relative prices.

In an open economy, the exchange rate is one of the most significant variables since it influences macroeconomic variables such as inflation, trade, foreign reserves, foreign direct investment, capital flows, remittances, etc. Since the exchange rate influence these variables, it is logical that they might affect the economic growth.

CHAPTER 2: Exchange rate and economic growth: Literature review

Introduction

The integration of the exchange rate into the analysis of growth is a complex exercise, initially neglected, since neoclassical and endogenous growth models traditionally focus on potential sources such as: competition, technological diffusion, savings and capital investment in the broad sense.

Exchange rates change continuously based on supply and demand. The fluctuation can be either a decrease in the value of the local currency (depreciation) or an increase in the value of the latter (appreciation). To attain economic policy, the government may choose to devalue its currency. This situation is called "devaluation". This strategy aims to preserve the competitiveness of Chinese exports (AIZENMANN and LEE (2007).

An open economy has several advantages (e.g., international trade, and knowledge exchange), but it can have potential impacts. It makes domestic prices more sensitive to changes in international prices and the exchange rate.

Section 1: Economic growth determinants in the empirical literature

Economic growth is one of the goals that every developed or developing nation wants to achieve. The purpose of this section is to identify economic growth determinants through the empirical works.

1. Economic determinants

1.1. Trade components

Globalization is a process of rapid economic integration among countries. Integration of countries into the global economy is essential for successful economic development. Economic growth is boosted by openness to international flows of products, labor, capital, technology, and ideas (World Development Report, 1991). Openness may have a significant impact on economic growth through different mechanisms, such as technological transfers, comparative advantage, and increasing returns of scale (CHANG, and al. 2009).

a. Exports

The export of goods and services provides foreign exchange reserves that are essential to the economy. For developing countries where domestic markets are small, international trade can develop markets that are crucial for economic growth.

A lot of research tests the “export-led growth” hypothesis i.e., the causality runs from exports to economic growth. Indeed, export-oriented trade policies promote rapid growth. Thus, it develops the competitiveness, encourage "learning by doing", increases the efficiency of resource allocation and allows to benefit from the positive externalities resulting from access to better technology (LUCAS (1988), ROMER (1986 and 1990).

BROCHAT (1985) tested the correlation between economic development and export expansion on a selection of middle and low-income economies as well as a wide sample of developing economies (African countries). It is found that exports have played an important role in the economic progress of developing countries.

b. Imports

The link between economic expansion and imports is viewed as negative, due to the fact that most imports expenditures deplete national income resources. Nevertheless, economists commonly acknowledged that the influence of imports on GDP derives from the fact that imports allow a country to obtain the factors of production that it cannot create on its own due to a lack of required technology, labor force, skills, etc.

COE, HELPMAN, and al (1997) showed that by having access to a wider variety of intermediate goods and equipment embodying the technological progress of the developed countries. Thus, countries of the South can, through international trade, benefit from the knowledge of the less developed countries at a lower cost.

HYE and BOUBAKER (2011) investigated the import-led growth hypothesis in Tunisia for the period 1960-2008 employing Autoregressive Distributed Lag approach. They found a bidirectional relationship between imports and economic growth. This finding is also confirmed by numerous empirical studies in different countries (HYE, and al. 2013; GOSSEL and BIEKPE, 2013; HUSSAINI, and al. 2015).

1.2. Foreign direct investment

FDI has an important role in increasing employment levels, enhancing productivity of host countries, and improving exports. According to a study done by NAIR-REICHERT and WEINHOLD (2001) on 24 developing countries, FDI and economic growth are significantly and positively correlated. There is a bidirectional causality between the two variables in the short term and the long term in more open economies (BASU, et al. 2003).

FDI stimulates economic growth by transferring advanced technology from the developed world to the developing countries (BORENSZTEIN, GREGORIO, and LEE, 1998). MELLO (1997) also agrees with the technology transfer channel, but adds another mechanism, which is knowledge transfer. FDI increases the recipient economy's knowledge stock through labor training, skill development and diffusion, as well as the introduction of new management methods and organizational arrangements. Most empirical research suggest that FDI enhances host-country factor productivity and economic development (OCDE, 2002).

Yet, the positive effects of FDI depend largely on the level of human capital. This is because the implementation of new technology needs an educated labor force (BORENSZTEIN, GREGORIO, and LEE, 1998).

1.3. External Debt

Debt is sometimes required to fund investments; however, it should not be excessive, otherwise it might have a negative effect on the economy[1]. The relationship between debt and economic growth has always been the subject of controversy.

Numerous studies found a negative correlation between external debt and economic growth (MALIK, and al. 2010; KASIDI and SAID, 2013; ABDELHAFIDH, 2014)

These findings generally highlight that debt could have a negative effect on growth. However, for countries that manage their debt ratio properly, the impact of debt will be positive (BEN LTAIEF ,2014).

- **Positive relationship between external debt and economic growth**

External debt increases the accumulation of physical capital. External borrowing should be invested in productive and profitable projects. In addition, each country must ensure that it will eventually repay the debt. For solvent countries, external debt plays a fundamental role.

External debt is only beneficial to economic growth if certain conditions satisfied, for instance:

- The productivity of borrowed capital is higher than its cost;
- External resources are invested in profitable projects.

- **Negative relationship between external debt and economic growth**

The theoretical arguments that support the hypothesis of a negative relationship between external debt and economic performance support the idea that a high level of indebtedness has negative effects on the indebted country. The debt overhang implies fiscal adjustment measures, such as privatization, increase in taxes or restrictions on foreign exchange.

[1] This negative effect is explained in the "debt overhang theory", developed by KRUGMAN (1988), SACHS (1989) and COHEN (1992), states that, beyond a given threshold, external debt discourages consumption and investment, and consequently reduces economic growth.

Section 2: The relationship between exchange rate and economic growth

Many economists studied the effects of overvaluation or undervaluation of the currency on macroeconomic variables. Regarding how the exchange rate affects growth, the literature presents two opposing points of view. According to the traditional view, the foreign exchange rate and economic expansion are positively correlated. Contrary to the structuralists who argue that a devaluation could lead to contractionary effects on the economy.

The purpose of this section is to go through the impacts of exchange rate fluctuations on economic growth in the literature.

1. Effects of foreign exchange rate variability on growth

1.1. Direct effect of exchanges rate changes on economic growth

Since globalization and the development of international relations, each country's economy is influenced not only by internal factors, but also by external factors that can have a substantial impact on the economy. This is one of the main reasons to assess the direct impact of exchange rate variability on economic expansion.

The general idea is that when exchange rate fluctuations occur, they affect the country's exports and imports and thus its competitiveness. A depreciation will make exports more competitive, but imports will be more expensive and vice versa for the case of an appreciation.

There are few arguments on the mechanism of direct influence of the exchange rate on economic growth, where the argument put forward concerns the influence of the exchange rate system on growth through its effects on economic policy through the adjustment to shocks that affect the economy (YOUGBARE, 2009).

1.2. Indirect effect of exchanges rate changes on economic growth

a. The traditional view

The traditional view asserts that an undervaluation (or devaluation) has expansionary effects on the economy.

In most cases, countries intervene to limit the appreciation of their currency rather than to contain the depreciation, LEVY-YEYATI and STURZENEGGER (2007) "fear of appreciation". Developing countries should avoid an exchange rate overvaluation, to provide export incentives to promote domestic exports and make them more competitive in the international market and to promote import substitution (World Development Report, 1984). GALA (2008) attempted to discover the difference between East Asian and Latin American growth models. While East and Southeast Asian countries demonstrate a successful growth strategy, Latin American countries show the opposite. He asserted that the main distinction is in the trade regime and currency rate management. While Latin America adopted an inward-looking development strategy with maintaining an appreciated currency, East and Southeast Asia focused on developing a growth-led strategy and kept a competitive currency rate to pursue its outward-looking strategy.

RODRIK (2008) also holds a similar view: "*Overvalued currencies are associated with foreign currency shortages, rent seeking and corruption, unsustainably large current account deficits, balance of payments crises, and stop-and-go macroeconomic cycles, all of which are damaging to growth.*". He posits that a higher undervaluation of the currency stimulates economic growth, especially in developing countries.

DORNBUSCH (1988) discussed that overvaluation hinders economic growth. He argued the repercussions of the appreciation on the growth of an economy:

- First, the exchange rate appreciation *undermines external competitiveness*, due to the increase in export prices. This loss of competitiveness in the foreign trade market leads to a decrease in exports and an increase in imports. This deterioration in the trade balance can be financed by debt or foreign exchange reserves. However, these resources are not intended to finance the trade deficit.
- Second, appreciation may lead to a *decline in domestic production*, as firms find it difficult to continue operating and competing with other international firms. Because of the higher price of the intermediate products that they use in their production process and also due to the reduced

demand. Therefore, these firms may decide to reduce their production first and if the overvaluation remains, the production may even stop. This will adversely affect employment and tax revenues.

- Finally, the overvaluation will cause *negative effects on the domestic financial market*, traders will seek to borrow in the local currency to finance accumulated imports or to hold stocks of exports temporarily until the currency devalues. Therefore, the demand for domestic currency will result in a higher interest rate that will harm other industries. If devaluation remains, many sectors or banks will go bankrupt due to speculation. This will make the government rescue the financial system.

However, only a high overvaluation causes the economic growth to slow down and while a significant undervaluation will accelerate it, according to RAZIN and COLLINS (1997), this means that a slight overvaluation can contribute to the economic expansion.

i. The channels through which exchange rate depreciation acts positively on growth

The recent literature has focused on studying the correlation between growth and the exchange rate rather than on identifying the mechanisms or channels through which exchange rate fluctuations might affect economic growth, EICHENGREEN (2008). The exchange rate changes influence the economic growth through the following channels:

- **Total factor productivity growth channel**

As defined the exchange rate is the relative price of tradable products to non-tradable products. An increase in the tradables compared to non-tradables goods - a depreciation of the exchange rate - will enhance the profitability of the trade sector. As a result of the price incentive, output shifts from the non-trade to the trade sector. The economy's overall productivity rises. This increase in productivity across the economy eventually promotes growth, (MBAYE, 2012). The increase of the size of tradable goods sector improves the productivity by the effect of learning by doing, MATSUYMYA (1992).

MCLEOD and MILEVA (2011) investigated the relationship between exchange rate changes on total factor productivity on 58 developing countries from 1975 to 2004. They find a positive correlation between the two variables. As a result, they identify that the traded goods sector is a key TFP transmission mechanism.

- **Tradable sector channel**

RODRIK (2008) begins by defining the RER as the relative price of tradable products in terms of non-tradable products, and then computes a PPP undervaluation index that is corrected for the Balassa Samuelson effect. This indicates that the RER is regressed on RGDP per person. According to RODRIK (2008), the operative channel that explains the link between undervaluation and economic development is revealed to be the tradable sector. He argues that undervaluation expands the size of the trade sector. He explains that tradable goods suffer from institutional weaknesses and market failures (e.g., learning externalities, credit market imperfections, etc.), therefore, a depreciation of the exchange rate will help to alleviate the costs of these distortions.

Considering that RER misalignment may have an effect on economic growth through affecting the tradable sector, it is logic to conclude that RER misalignment would have an effect on exports. RER overvaluations harm exports since these types of misalignments act as an implied tax on exports, as shown by GHURA and GRENNES (1993).

However, YEYATI and STURZENEGGER (2007) disagree on the trade sector being the channel through which exchange rate variability acts on the output via export booms and import substitution. Instead, the mechanisms are capital accumulation and domestic savings.

- **The capital accumulation channel**

Capital accumulation was seen as a major element in economic growth. It was incorporated into the growth model of classical economics. The main idea of this channel is that a high real exchange rate tends to improve domestic savings, as a result, a greater savings rate boosts GDP by rising the capital accumulation rate, GLUZMANN, and al. (2012). They explained that a depreciated exchange rate decreases labor costs, enabling firms to save money and increase their capacity for investment, which as a result fosters growth. When an investor is willing to invest in a country, the cost of labor is the most important factor in his choice. This is when undervaluation makes the difference. An undervalued currency reduces labor costs and thus increases profitability and savings levels, which will lead to a higher investment and thus growth, BHALLA (2007).

GALA (2008) showed that one of the main differences between East Asia's success and Latin America's failure in economic development. East Asian countries are generally known for having high levels of savings and investment, whereas Latin American countries are well known for their high consumption and low savings.

Nevertheless, the capital accumulation channel appears to have an issue with its two conceptual links: from the depreciated exchange rate to high savings, and from the latter to higher growth.

Starting with the first link, BERNANKE (2005) investigated the link between the depreciated exchange rate and the savings rate. He explains that several developing countries have maintained their internal balance by keeping a depreciated exchange rate, because a high level of savings reduces domestic consumption. Therefore, he argued that a high savings rate will lead to a depreciated exchange rate, rather than the opposite. In addition, MONTIEL and SERVEN (2008) argue that the link between the exchange rate and the rate of saving is empirically weak.

The second link - growth and savings - also has been analyzed by several authors, especially the causality between the two variables. CARROLL and WEIL (1994) argued that there is a positive correlation between the wealth or savings and the income growth using households and cross-country data. They find that growth generates savings rather than the opposite.

As mentioned by RAZIN and COLLINS (1997) capital accumulation is the "engine of growth". They believe that exchange rate misalignments (an under or over-valuated currency rate) may have an impact on both local and foreign investment, as a result, affecting the process of capital accumulation. On the one hand, undervaluation makes exports more competitive, but on the other hand, imports become more expensive, hence, demand shifts to more affordable domestic products. Investments will increase to cover the demand for local products.

b. The structuralist view

The structuralist economists assert that a depreciation may harm the economic growth, especially in developing economies. This view is called "structuralist" because the economic problems encountered by Least Developed Countries are often structural (ACAR,2000).

i. The channels through which exchange rate depreciation acts negatively on growth

The structural approach, like the traditional approach, also presents the channels through which the exchange rate affects economic growth. These channels will be divided into two categories: Demand side and supply side channel.

- **Demand side channels**

A depreciation can have serious impacts on aggregate demand, which in turn will lead to contractionary effects on growth and output. The mechanisms of such results are the following:

- **Import cost channel**

The impact of currency depreciation on output can be seen in many ways, but the rise in import prices is one of the main mechanisms. KRUGMAN and TAYLOR (1978) support the idea that currency depreciation reduces national output if the country already has trade deficit. Following the depreciation, given that imports outweigh exports, prices of imported goods will increase discouraging the demand because they will cost more than they were before and prices of exported goods will decrease, resulting in a reduction in the home country's income since foreign exchange payments exceed foreign exchange revenues.

- **Income distribution channel**

When wages do not adjust in the short run to the rising prices of imported goods - in the absence of the trade deficit assumption - this lowers the real wage as domestic goods become more expensive because of the increase in the prices of intermediate goods that firms need in the production process. This may cause a redistribution of income from wage earners, who have lower marginal propensity to save, to exporters and business owners, who have higher marginal propensity to save, dampening aggregate demand and therefore production (KRUGMAN and TAYLOR, 1978).

- **Tax Channel**

When ad valorem export and import taxes are substantial, aggregate demand can also suffer. Devaluation increases the value of exports and imports in terms of the national currency, resulting in increased tax revenues. Government revenues will increase and this will result in income from the private industry to the government or the public sector. Thus, private spending is expected to decline following the fall in private income. As KRUGMAN and TAYLOR (1978) assume that the government savings propensity is equal to one in the short-term (this implies that variations in income levels lead to corresponding variations in savings). As a result, the total expenses will be

lower. Therefore, the overall demand will drop. The negative impact on aggregate demand increases with the level of ad valorem duties in government budget income.

- **External debt channel**

The existence of large amounts of debt can have adverse effects on the economy, particularly if the debt is used to finance the deficit and not to finance projects that could contribute to the economy.

When a country with substantial foreign debt devalues its own currency or when the latter loses its value, the economy will be affected negatively. Therefore, debtors need more units of the national currency to pay the same amount of foreign debt. The increase in both the debt and the interest attached to it will lead to a deterioration in the net wealth. In this situation, debt holders (including firms, households and governments) may reduce their spending as a result of rising debt payment costs and the stock value of their loans. CAVES, and al. (1996) mention that after the devaluation of the peso by the Mexican government in 1994, the economy phased a recession because it was unable to pay for its external debt due to the reduction in the international reserves.

- **Supply side channels**

VAN WIJNBERGEN (1986) outlines three main mechanisms through which depreciation may affect negatively the aggerate supply and thus the output.

- **Intermediate imports channel**

Many developing countries rely on imported goods in their production process such as intermediate commodities, raw materials, etc. Devaluation raises the price of imports particularly and domestic output in general by increasing the cost of imported inputs. In this context, the decrease in imports implies a shortage of inputs needed for production. Production will eventually slow down as a consequence of the shortage of inputs and rising costs, which will result in a reduction in the overall supply. This is particularly evident in LDCs that import oil. Since oil is an important factor in the production process, the cost of production increases instantly when the price of oil rises. As production costs rise, firms will produce less, which lowers the aggregate supply and generates unemployment.

- **Wage Indexation Channel**

Another supply-side mechanism via which a devaluation may cause a contraction in the economy has to do with the wage system. It is logical to assume that employees will demand for nominal wage increase to preserve their purchasing power as devaluation drives up the costs of traded goods and eventually the overall price level, causing a drop in real wages. If wages are not rigid, they will adjust to the changing prices as a result of the devaluation. Likewise, if there is a wage indexation system that automatically raises nominal wages in accordance to price movements, then greater wages will increase production costs. Because of this procedure, output will decline due to a decrease in production.

- **Real volume of the credit channel**

This channel could be known as the working capital mechanism. In an economy with a developed financial market, firms may simply borrow money if they require short-term funding. However, it is widely known that in the majority of LDCs, financial markets are underdeveloped and financing options are not immediately available. Thus, it is asserted that working capital is another variable component of production in LDCs. Devaluation reduces the market's real credit supply and often leads to higher interest rates (VAN WIJNBERGEN ,1986). The cost of production will become greater as a result, which will reduce the amount offered.

2. Empirical studies

The table below summarizes various empirical works other than the ones presented above done on different countries, as well as the results and potential channels that will be relevant in **Chapter 3**.

Table 4: Summary of empirical studies on Exchange rate changes on economic growth

Author(s)	Country–Time period	Model	Variables		Result	
			Dependant variables	Independant variables	+/- relationship	Possible mechanisms
YAMANI, and al. (2019)	Morocco (1988-2017)	Ordinary least squares	GDP growth rate	REER, external debt, financial development, investment, human capital, trade openness	Insignificant	-
AMAN, and al. (2013)	Pakistan (1976-2010)	Simultaneous equation model – three stage least square	GDP (*first equation of the model*), export (*second equation*)	RER, Investment, import, domestic saving, FDI, indirect taxes, export, GDP.	(+) ➔ A depreciation stimulates economic growth.	Export promotion, Investment, FDI.
KABAMBA, and MATADI (2021)	Republic of the Congo (1990-2019)	OLS	GDP	EX, inflation, gross fixed capital formation, public expenditure, net Exports, money supply	(-)➔ A depreciation reduces economic growth.	-

HAN (2020)	125 different countries (1997-2017)	Simultaneous equation model – two stage least square	Real GDP growth rate	Rate of EX, FDI ratio in GDP, trade volume (which represents a percentage of GDP), government purchases, aging, urbanization and inflation.	(-) ➔ An appreciation reduces economic growth.	FDI
CAKRANI (2014)	Albania 2002Q1-2011Q4	Cointegration method & Vector Error Correction Model	GDP	REER, investment, government spending, trade openness	Insignificant	-
HSING (2018)	Taiwan 1999Q1-2016 Q4	IS-MP-AS model	RGDP	Government spending, government tax revenue, the real lending rate, the stock price, REER, real policy rate, inflation, inflation target, potential real GDP, global real interest rate, expected inflation rate, and real oil price.	(+): from 1999 Q1 and 2010 Q2 ➔ A depreciation raises econommic growth. (-): from 2010 Q3 and 2016 Q4➔ An appreciation raises economic growth.	-

Conclusion

The objective of this chapter was to identify the direct and indirect effects of exchange rate fluctuations on economic growth in the literature. The direct effects reflect the competitiveness of the economy. However, the exchange rate is not a determinant of economic growth. Moreover, a depreciation has both positive and negative effects on the economy, as does an appreciation. Furthermore, in the empirical studies in Table (4), some studies show a non-significant effect of the exchange rate on economic growth when one tries to examine the direct effect. It is also not possible to understand the mechanisms of these effects.

This is why it is important to investigate the indirect effects of exchange rate changes on economic growth. The indirect effects are represented by the channels such as: import cost, capital accumulation, external debt, etc.

CHAPTER 3: Empirical analysis of the impact of exchange rate fluctuations on economic growth

Section 1: Linkage between exchange rate and economic growth in Tunisia

1. Characteristics of the Tunisian economy

Each country has its own characteristics and its own engine of growth, some countries rely heavily on foreign trade, service sector, and others also rely heavily on debt, which may be beneficial but may also be detrimental for the economy.

Figure 2: Evolution of real GDP growth

Source: CBT

After independence (1956), the Tunisian government focused on human development, education and reduction of poverty, etc. Tunisian manufacturing industry was artisanal and relied on food processing, agriculture, and mining. The economy was reliant on the public sector and was characterized by import substitution.

In the 1970s, the country adopted a policy that was a particular combination of import substitution and export promotion, and co-existence between the public and private sectors.

The Tunisian economy suffered a decline in growth during the period 1981-86. The devaluation of the Tunisian dinar is one of the economic stimulus measures that the government has put in place. This particular measure encouraged the private sector to increase its export activities.

During the 1990s, the Tunisian government promoted liberalization measures that encouraged foreign investment and accelerated privatization. As shown in the figure 2, the FDI experienced an upward trend since 1990.

During the period 2002-2006, there was a significant growth in GDP, investments, FDI and exports of goods and services. In addition, the service sectors also knew a substantial development during the same period.

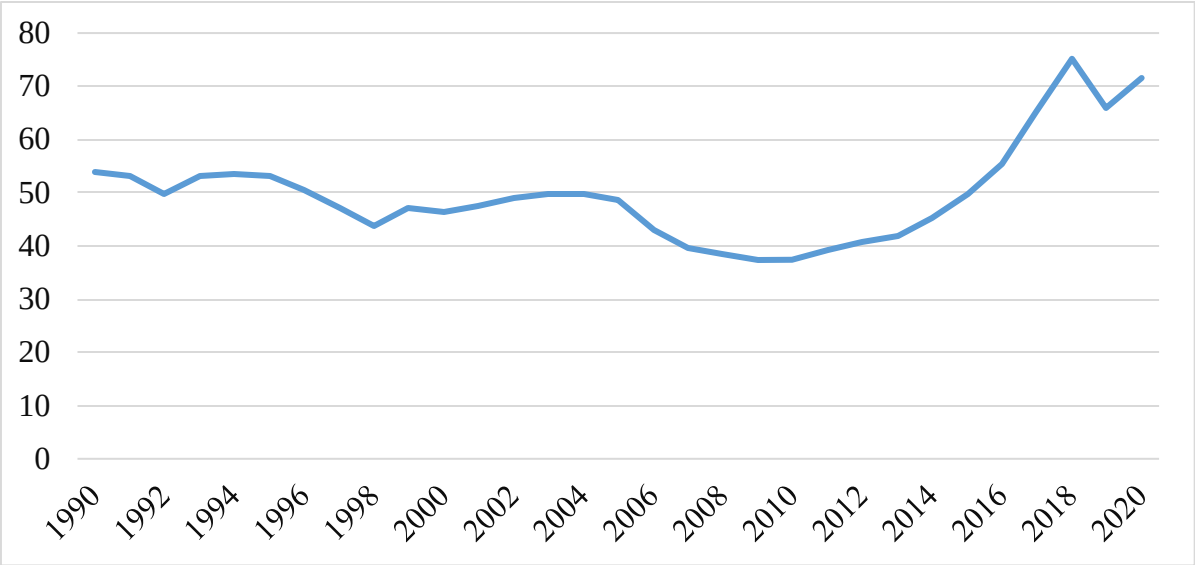
Until 2010 and before the January 14, 2011 revolution, the Tunisian economy had a decent growth indicator despite high unemployment, corruption and other factors that led to the revolution.

After the Tunisian revolution, the country still faces a fragile political environment and has yet to reap the economic benefits of the democratic transition efforts. Tunisia's economy grew by an average of 2% per year from 2012 to 2019.

In 2020, the Covid-19 pandemic challenged Tunisia's already fragile economic and socio-political context. GDP contracted by 8.6 percent as the pandemic negatively impacted tourism, transportation, and the export-oriented textile and automotive cable industry.

Tunisia has always been marked by a high level of indebtedness dating back to the 1960s in order to pay off its deficits. As shown in the graph below, the external debt has followed an upward trend especially after 2011.

Figure 3: Evolution of external debt stocks (% GDP)



Source: Graph constructed by the author from CBT data

2. Exchange rate policy in Tunisia

The IMF officially classifies Tunisia's exchange rate regime as a "managed float," in which the Central Bank of Tunisia intervenes in a discretionary manner when it finds it necessary. First, it is necessary to provide an overview of the exchange rate regimes previously adopted in Tunisia.

- ***Early 70s***

In the early 70s, the authorities decided to peg their currency to the French Franc, given that France is considered as a main trading partner.

- ***After 1973: collapse of Bretton woods system***

After the Bretton-Woods system of fixed exchange rates was abolished in 1973, Tunisia decided to abandon a fixed value compared to the French franc and instead peg to a basket of currencies (US Dollar, Deutschmark and French Franc).

- ***During the 1980s***

In the 80s, the Tunisian government's objectives of promoting exports and improving the country's external competitiveness, as well as other external factors, led the authorities to further expand the basket by including other currencies.

- ***During the 1990s***

During the 1990s, Tunisia made considerable progress in the development of the external sector. This strategy aimed at guaranteeing a competitive environment for domestic companies and products. In 1992, the government decided to adopt a more flexible foreign exchange rate regime by regularly adjusting the value of the nominal exchange rate to target the Real Effective Exchange Rate (REER) and enabled the convertibility of the Tunisian dinar for non-residents. In addition to preventing financial and currency crises, this exchange rate policy also helped in reducing inflation from 8% in 1991 to approximately 3% since 2000 (Fanizza and al ,2002).

- ***Since 2001***

The central bank of Tunisia reduced its intervention in the foreign exchange market and increased exchange rate flexibility by implementing a managed float according to the IMF's recommendations.

- ***Since 2012***

In response to the worsening current account deficit, the CBT adopted a more flexible exchange rate policy by changing, during 2012, its mode of intervention on the foreign exchange market. Ibn Instead of using a predefined basket of currencies, the reference exchange rate is based on the average exchange rate of the interbank market.

The table below summarizes the type of exchange rate regime adopted in Tunisia in different time of period.

Table 5: Exchange rate regime in Tunisia

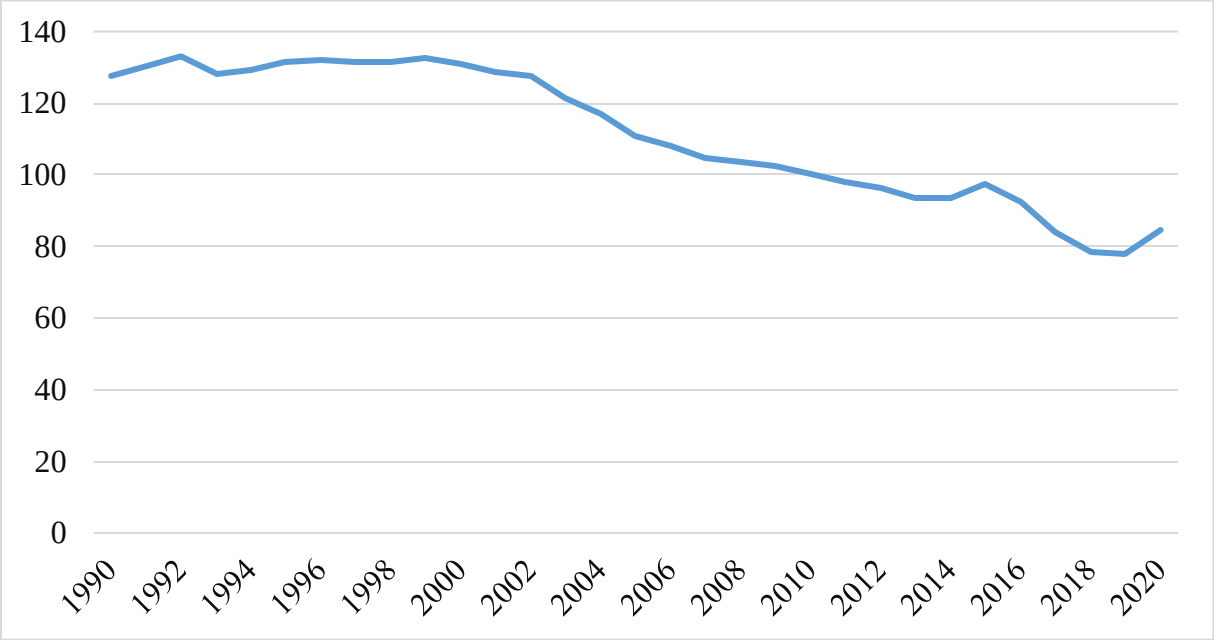
Period	Exchange rate regimes
From 1970 to 1978	Fixed
From 1979 to 2001	Intermediate
From 2002 to 2020	Managed Float

The objective of this research is to study the impact of exchange rate fluctuations on economic growth. The real effective exchange rate is chosen to conduct this study.

Following the significant depreciation of 1986/87, the Tunisian dinar was devalued at moderate rates, in response to the inflation gap between Tunisia and its main trading partners. As

a result, the real effective exchange rate has remained stable. During the 1990s, Tunisia adopted a policy of targeting the real effective exchange rate in order to stabilize the high volatility of the terms of trade and the exchange rate and to promote growth. Over the long term, the REER follows a downward trend depreciation as shown in Figure 4.

Figure 4: Evolution of REER

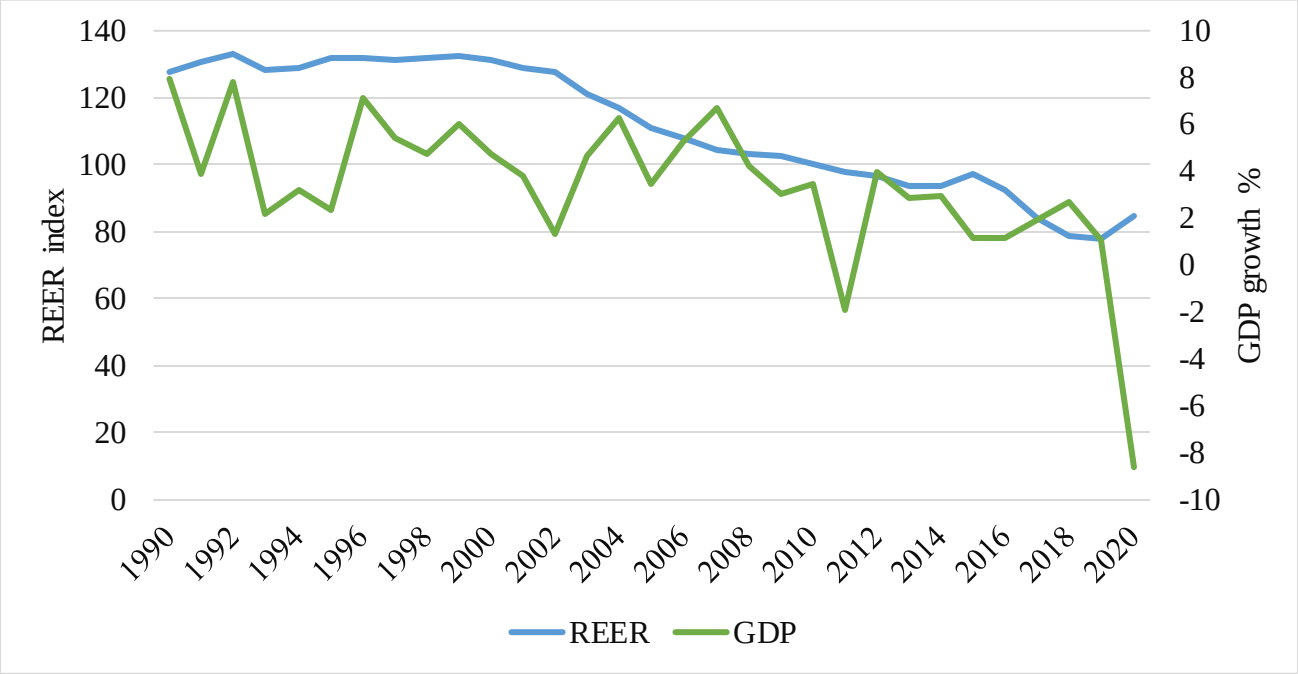


Source: CBT

Most developing economies have experienced significant exchange rate variability since the implementation of financial liberalization policies. The relationship between the exchange rate and economic growth has been investigated by several recent studies. These studies have not been able to distinguish a clear link between the two variables.

According to the Figure 5 below it is difficult to detect the type of the relationship between the two variables. An appreciation of the exchange rate could be beneficial as it could be not. The same case for a depreciation because while depreciation help with promoting exports, it makes imports more expensive.

Figure 5: Evolution of REER and real GDP growth



Source: CBT

Section 2: Econometric investigation of the impact of exchange rate fluctuations on Tunisian economic growth

1. Model presentation

1.1. Model

Based on the factors that appear to influence the economic growth in Tunisia, the literature and the channels through which the foreign exchange rate affects the economic growth the main equation of the model is presented as follows:

$$\boldsymbol{Ecogrowth = f(Exp, Imp, Fdi, Extdebt)} \qquad \textbf{(1)}$$

This equation presents the determinants of economic growth in Tunisia. The equation is expressed in terms of exports, imports, foreign direct investment and external debt. These variables are the channels through which the exchange rate affects economic growth.

The exchange rate is not included in this equation due to the difficulty of finding a direct connection between the exchange rate and economic growth. Therefore, the indirect relationship will be analyzed through four possible channels: Exports, Imports, FDI, and external debt.

1.2. Equations of the model

In addition to the first equation which is the main equation of the model, there is four equations that represents the channels that link the exchange rate to the economic growth.

The second equation of our model is a function of the following variables: the economic growth, exchange rate and FDI.

$$\boldsymbol{Exp = f(Ecogrowth, REER, Fdi)} \qquad \textbf{(2)}$$

These variables represent the factors that affect the export performance. First starting with the economic growth that is measured by growth of GDP. The latter is a measure of future potential and sustainability of output levels. GDP growth is a measure of future potential and sustainability

of output levels. Growth is a more reliable determinants of exports than GDP since it assesses the sustainability of production levels.

Second, the REER is a key determinant of exports since a decline in relative local prices as a result of a depreciation makes exports cheaper in foreign markets, resulting in increased export demand.

Finally, FDI could contribute to export performance through increased export capacity, technology transfer, and skills that could help promote exports.

The third equation of our model is a function of the following variables: economic growth, REER, exports earnings, and relative import prices.

$$\boldsymbol{Imp = f(Ecogrowth, REER, Rprice, Exp)} \quad \textbf{(3)}$$

The main determinants of imports are income and relative import prices (SINHA, 1997; HUSSAIN, 2007; YUSOP, 2010). To these two determinants, we can add another determinant, which is export earnings. It is important to have revenues and foreign currency to pay for the imports in order to ensure the supply of imported goods and services needed for the production process.

The fourth equation of our model is a function of the following variables: economic growth, REER financial development, inflation rate and trade openness.

$$\boldsymbol{Fdi = f(Ecogrowth, REER, Fdvp, Infl, Open)} \quad \textbf{(4)}$$

The variables in this equation represent the possible determinants of FDI inflows. We have included the REER as in the above equations to see if it has an impact on FDI in Tunisia.

The fifth equation of our model is a function of the following variables: economic growth, REER, budget deficit, current account deficit and domestic savings.

$$Extdebt = f(Ecogrowth, REER, Budgetdef, Currentdef, Sav) \quad \textbf{(5)}$$

We have included the REER in the equation as it might have an impact on the external debt stocks.

Beside from REER and budget deficit that could influence external debt stocks. One of the key issues confronting undeveloped and developing countries is a lack of capital accumulation and insufficient domestic savings. These countries are obligated to incur foreign debt in order to sustain economic growth processes. Furthermore, these countries employ debt to finance the import of investment goods (BILGINOGLU and AYSU, 2008). We decided then to include current account deficit and domestic savings as explanatory variables.

Table 6: Expected signs of the variables

Endogenous variables	Exogenous variables	Expected sign
Equation (1)		
Ecogrowth	Exp	+
	Imp	+/–
	Fdi	+
	Extdebt	+/–
Equation (2)		
Exp	Ecogrowth	+
	REER	–
	Fdi	+
Equation (3)		
Imp	Ecogrowth	+/–
	REER	+
	Rprice	+/–
	Exp	+
Equation (4)		
Fdi	Ecogrowth	+
	REER	–
	Fdvp	+
	Infl	–
	Open	+
Equation (5)		
Extdebt	Ecogrowth	–
	REER	–
	Budgetdef	+
	Currentdef	–
	Sav	+/–

2. Univariate analysis

2.1. Description of variables

In this section, the different variables used in the econometric analysis will be presented taking into account the literature and the availability of data.

a. Endogenous variables

Economic growth

To measure economic growth, the most appropriate indicator is GDP. It is the sum of the gross value added of all of all resident producers in the economy plus taxes on products and subsidies not included in the value of products.

The series covers the period 1990 -2020, that is 31 annual observations. The series represent the real growth GDP as a proxy of the Tunisian economic growth.

Exports

Exports of goods and services will be used for the estimation. It refers to the value of all goods and other tradable services provided to the rest of the world. They are composed of the value of goods, transport, travel and many other services. The series represents the exports of goods and services as a percentage of GDP from 1990 to 2020.

Imports of goods and services

Imports of goods and services will be used for the estimation. It refers to the value of all goods and other tradable services received from the rest of the world. The series represents the imports of goods and services as a percentage of GDP from 1990 to 2020.

Foreign direct investment

This variable refers to the flow of equity capital of direct investment in the economy. It is the sum of equity, reinvestment of earnings and other capital. It is measured here as net inflows (new investment minus disinvestment) of FDI as a percentage of GDP during 1990-2020.

External debt

This variable refers to is the total external financial liabilities owed to non-residents by a country. The series represents the external debt stocks as a percentage of GDP from 1990 to 2020.

b. Exogenous variables

Exchange rate

For the exchange rate variable, the REER will be used for the estimation. As defined in chapter 1 (section 1). The REER index is used when multiple partners are considered. it is the weighted sum of the real exchange rates with the different trading partners.

Relative import price

The relative import price is measured as a ratio of the import price to the price of domestic products. The series is obtained by dividing the import price index (2010=100) by the consumer price index (2010=100) (used as an indicator of domestic prices) from 1990 to 2020.

Financial development

The main indicator used in the literature to measure the level of financial development of a country is the credit provided to the private sector. Tunisia's banking sector is more developed than the financial sector. The Tunisian banking sector has long been considered a key element in the country's development process. It has served as the principal financial intermediary. Between 1995 and 2017, commercial banks provided of 81% (on average) of all domestic credits requested by the private sector (JELASSI and DELHOUMI, 2021). Therefore, the variable used will be domestic credit to the private sector by provided by banks as a percentage of GDP from 1990 to 2020.

Inflation rate

The inflation rate is defined as the percentage change in the general price level, as measured by the percentage change in the consumer price index (2010=100).

Openness

The openness of an economy is reflected in a strong increase in its foreign trade and its interdependence with the rest of the world. The degree of openness of an economy can be measured by the ratio of the value of foreign trade to GDP.

Budget deficit

A budget deficit, or negative budget balance, exists when the revenues generated by a government (mainly taxes) are less than its expenditures. The series represents the budget deficit as a percentage of the GDP.

Current account deficit

The current account records a country's exports and imports of goods and services, as well as payments to foreign investors and transfers. A current account deficit indicates that a country is a net borrower. The series represents the current account deficit as a percentage of the GDP.

Domestic savings

Gross domestic savings is the difference between GDP and final consumption expenditure. More precisely, it is the part of domestic disposable income that is not allocated to final consumption expenditure, whether by households, businesses or the government. This series is measured as a percentage of gdp.

Table 7: Description of variables

Name of the series	Variable	Measurement	Source of data
gdp	Economic growth	Real GDP growth (%)	CBT
exp	Exports	Exports of goods and services as a % of GDP	World development indicators - World bank
imp	Imports	Imports of goods and services as a % of GDP	WDI- WB
fdi	FDI	FDI net inflows as a % of GDP	WDI- WB
exdt	External debt	External debt stocks as a % of GDP	CBT
reer	Exchange rate	Real effective exchange rate (2010=100)	WDI- WB
rprice	Relative import price	Import price index divided by CPI (2010=100)	CBT
fdvp	Financial development	Credit to private sector as a % of GDP	WDI- WB
infl	Inflation rate	Annual change in CPI (2010=100)	CBT
open	Openness	Trade as a % of GDP	WDI- WB
bdef	Budget deficit	Budget deficit as a % of GDP	CBT
cdef	Current account deficit	Current account deficit as a % of GDP	CBT
sav	Domestic savings	Gross domestic savings as a % of GDP	WDI- WB

c. Unit Root Test

The unit root test not only detects the existence of non-stationarity but also determines the type of non-stationarity, i.e., whether it is a difference stationary or trend stationary process, and therefore determines the correct way to make a series stationary.

- Difference stationary (DS) processes: represent a non-stationarity of the stochastic type. Differencing the time series is the solution to make the process stationary.
- Trend Stationary (TS) processes: represent a non-stationarity of the deterministic type. In order to make the process stationary, it is needed to extract the trend from the time series.

i. Dickey-Fuller test

One of the most know test of unit root is developed by DICKEY FULLER (1979). The test is based on estimating the three following models by with Ordinary Least Squares:

Model [1] : $X_t = \varphi X_{t-1} + \varepsilon_t$: without intercept and without trend

Model [2] : $X_t = c + \varphi X_{t-1} + \varepsilon_t$: with intercept and without trend

Model [3] : $X_t = c + b_t + \varphi X_{t-1} + \varepsilon_t$: with intercept and with trend

They seek to test the unit root hypothesis:

H_0: $\varphi = 1$ ➔ series contains a unit root (non-stationary).

H_1: $\varphi < 1$ ➔ series is stationary.

ii. Augmented Dickey-Fuller

The augmented Dickey-Fuller test is identical to the simple DF, except that the three models were modified to include delayed differentiated terms. The ADF test however requires the determination of the number of lags in each series. We follow the strategy of unit root tests explained by BOURBONNAIS (2015)[2].

Most of the variables are not stationary by looking at the graphs (appendix 1), but it is confirmed with ADF test. First, we applied a logarithmic transformation to most of the variables. Second, we tested the significance of the trend in model [3] to determine the type of process, DS or TS. Third, if the trend is not significant, we need to test the significance of the intercept in the model [2] to see if the process is DS or stationary. Fourth, we proceed to test the model [1], if the non-significance of the intercept is proven.

[2] Bourbonnais (2015). Économétrie: Cours et exercices corrigés, chapitre 8, p 251.

Table 8: ADF test

Series name	Lag[1]	Model 3			Model 2			Model 1		Decision
		t_{tr}[2]	t_{φ}[3]	t_{ADF}[4]	t_{int}[5]	t_{φ}	t_{ADF}	t_{φ}	t_{ADF}	
"gdp"										
gdp	1	2,53**	-2,37	-3,58	-	-	-	-	-	NS
gdpD	0	-	-7,1	-3,58	-	-	-	-	-	I(1)
"exp"										
ln_exp	1	0	-	-	2,61***	-	-	-	-	NS
ln_expD	0	-	-	-	-	-4,57	-2,98	-	-	I(1)
"imp"										
ln_imp	1	1,51	-	-	2,22**	-2,22	2,98	-	-	NS
ln_impD	0	-	-	-	-	-4,28	2,99	-	-	I(1)
"fdi"										
ln_fdi	0	-0,46	-	-	3,87***	-4,45	-2,98	-	-	I(0)
"exdt"										
ln_exdt	4	0.59	-	-	2.05**	-2.04	-2.99	-	-	NS
ln_exdtD	0	-	-	-	-	-3.67	-2.98	-	-	I(1)
"reer"										
ln_reer	4	-2,53**	-2,35	-3,59	-	-	-	-	-	NS
ln_reerD	8	-	-3,73	-3,58	-	-	-	-	-	I(1)
"rprice"										
rprice	1	-0,68	-	-	0,63	-2,88	1,95	-	-	I(0)

"infl"										
ln_infl	4	2,19**	-1,81	-3,59	-	-	-	-	-	NS
ln_inflD	1	-	-5.42	-3.58	-	-	-	-	-	I(1)
"open"										
ln_open	1	1,03	-	-	2.59***	-2.59	-2.98	-	-	NS
ln_openD	0	-	-4.65	-2.98	-	-	-	-	-	I(1)
"fdvp"										
ln_fdvp	1	2.29**	-1.57	-3.58	-	-	-	-	-	NS
ln_fdvpD	0	-	-5.69	-3.58	-	-	-	-	-	I(1)
"cdef"										
ln_cdef	1	1.03	-	-	1.52	-	-	-0.42	-1.95	NS
ln_cdefD	0	-	-	-	-	-	-	-5.84	-1,95	I(1)
"bdef"										
ln_bdef	2	1.45	-	-	1.82*	-1.77	-2.99	-	-	NS
ln_bdefD	1	-	-4.38	-2.99	-	-	-	-	-	I(1)
"sav"										
ln_sav	5	0,191	-	-	-0,63	-	-	-1,19	-1,95	NS
ln_savD	0	-	-	-	-	-	-	-2,74	-1,95	I(1)

[1]lag length is calculated using information criterion procedures.
[2]t-statistic of the trend.
[3] t-statistic of « φ ».
[4] critical value (5%).
[5] t-statistic of the intercept.

3. Bivariate analysis: Estimation

3.1. Simultaneous equations and estimation methods

a. Simultaneous equations models

The objective of this research is to study the direct and indirect effects of exchange rate fluctuations on the economic growth. However, it is not evident to find a direct link between exchange rate and economic growth. Therefore, we focus on the indirect effects that are presented by the four last equations.

The simultaneous equation model thus takes the following form:

$$Y_j = \beta_j X_j + \varepsilon_j \quad \text{with j=1…, n}$$

Where Y_j represents the endogenous variables;

X_j represents the exogenous variables;

ε_j represents the error term;

n represents the number of equations.

When dealing with simultaneous equation models, it is common for an endogenous variable in one equation to appear as an explanatory variable in another equation. This dual status of some variables leads to a bias in the estimation of the coefficients when we use OLS. **Which estimation method should we use then?**

To answer this question, we must go through the identification problem to identify the appropriate estimation method.

b. Identification problem

The identification condition is considered one main problem in simultaneous equations models. Before the estimation of the model, we have to deal with the identification problem:

- First, to check if we could estimate the model
- Second, identify the appropriate method

In fact, the identifiability condition is applied to each equation in order to avoid biased results. There are three cases of identification:

- The model is under-identified if any of the equations in the model are under-identifiable. In this case, it is impossible to solve the model.
- The model is exactly identified if all the equations are exactly identifiable.
- The model is over-identified if the equations are either exactly identifiable or over-identifiable.

The identification rule[33] is as follows:

If $g - 1 > g - g' + k - k'$ ➔ the equation is under-identified
If $g - 1 = g - g' + k - k'$ ➔ the equation is exactly identified
If $g - 1 < g - g' + k - k'$ ➔ the equation is over-identified

With: g: The number of endogenous variables in the model;
k: The number of exogenous variables in the model;
g': The number of endogenous variables appearing in an equation;
k': The number of exogenous variables appearing in an equation.

The application of the identifiability condition shows that our model is over-identified since all its equations are over-identified according to the method followed. This gives us the ability to estimate the model.

Since our model is over-identified the estimation method could be according to BOURBONNAIS (2015):

- Double stage least squares (2SLS): it is a limited information method that concerns only one equation.
- Three stage least squares method (3SLS): it is a full information method that concerns the estimation of the whole system.

The 2SLS method is the separate estimation of each equation of the system by the method of instrumental variables as defined by Éric DOR (2004). While, the 3SLS method is the 2SLS

[3] BOURBONNAIS (2015). Économétrie: Cours et exercices corrigés. Chapitre 8, p 221-223.

estimator with a generalized least squares correction, which takes into account the correlations between the error terms of the structural equations of the model.

According to Éric DOR (2004), when some equations of the model are over-identified, the 3SLS methods are more efficient than the 2SLS methods.

We estimated the two models: the 2SLS (see appendix) and the 3SLS. We found that the latter provides better results. The estimation method followed is therefore the 3SLS.

3.2. Empirical results

Equation (1): $\boldsymbol{Ecogrowth = f(Exp, Imp, Fdi, Extdebt)}$

The result of our main equation highlights the factors that influence Tunisian economic growth in the context of the exchange rate. Firstly, we found that exports of goods and services have a positive and significant effect on Tunisian economic growth. Secondly, the import of goods and services and the external debt have a negative and significant effect on the Tunisian economy. While, surprisingly, FDI has insignificant effect on the economy as it does not contribute to growth. We will try to explain the reasons for these results.

Table 9: Results of equation 1

Variables **Ecogrowth**	**Coefficients**
Exp	57.97*** (0.000)
Imp	-44.57*** (0.01)
Fdi	0.025 (0.992)
Extdebt	-27.075** (0.03)

***significant at 1%; **significant at 5%; *significant at 10%

Equation (2): $Exp = f(Ecogrowth, REER, Fdi)$

The result of the second equation shows that REER has a negative and significant impact on exports of goods and services. In addition, the FDI has a positive and significant sign. While economic growth has insignificant impact.

Table 10: Results of equation 2

Variables **Exp**	**Coefficients**
Ecogrowth	0.005 (0.439)
REER	-1.07*** (0.008)
Fdi	0.122*** (0.001)

***significant at 1%; **significant at 5%; *significant at 10%

Equation (3): $Imp = f(EGrowth, EXR, Exp, Rprice)$

The third equation shows that REER has insignificant impact on imports of goods and services. Also, the relative import prices have insignificant sign. Exports earnings and economic growth impact significantly imports with respectively positive and negative signs.

Table 11: Results of equation 3

Variables Imp	Coefficients
EGrowth	-0.006** (0.028)
REER	0.05 (0.821)
Exp	1.08*** (0.039)
Rprice	-0.002 (0.647)

***significant at 1%; **significant at 5%; *significant at 10%

Equation (4): $Fdi = f(Ecogrowth, REER, Fdvp, Infl, Open)$

In this equation, the only significant variable is trade openness. Whereas our main interest is in the significance of REER. These insignificant results could lead us to many conclusions.

Table 12: Results of equation 4

Variables Fdi	Coefficients
Ecogrowth	0.040 (0.394)
REER	3.22 (0.242)
Fdvp	0.881 (0.535)
Infl	0.271 (0.228)
Open	3.95*** (0.000)

***significant at 1%; **significant at 5%; *significant at 10%

Equation (5): $Extdebt = f(Ecogrowth, REER, Budgetdef, Currentdef, Sav)$

The fifth equation shows that REER and current account deficit have a negative and significant effect on external debt stocks. The rest of variables shows insignificant effect.

Table 13: Results of equation 5

Variables Exdt	Coefficients
Ecogrowth	-0.013 (0.163)
REER	-0.870** (0.014)
Budegtdef	-0.0015 (0.941)
Currentdef	-0.048* (0.098)
Sav	-0.098 (0.408)

***significant at 1%; **significant at 5%; *significant at 10%

3.3. Interpretation of results

Exports, imports, external debt and economic growth: equation (1)

Imports of goods and services and external debt have a negative and significant impact, while exports of goods and services have a positive and significant impact. These results indicate that all three variables are considered as the factors that influence economic growth in Tunisia. However, FDI is statistically insignificant.

To analyze the link between economic growth and exchange rate fluctuations, we need to interpret the following tables: **tables 10, 11, 12, 13.**

Exports, REER and economic growth: equation (2)

To analyze the relationship between economic growth, REER and exports, we need the following tables: **table 9** and **table 10**.

As **table 10** shows, the REER has a negative and significant sign on exports of goods and services. When the REER decreases, exports increase. This indicates that when the REER depreciates, exports become more competitive in the international market. As a result, the country will gain additional export revenues, which will have a positive effect on economic growth. This is confirmed with the results obtained in the **table 9** as exports of goods and services impact positively the economic growth. This result is consistent with the findings of AMAN, and al. (2013).

Tunisian exports of goods and services definitely contribute to the economic growth. First, on the merchandise side there are three main sectors that characterize the merchandise exports:

- Mechanical and electrical industries: The electric wires and cables industry dominates this sector, accounting for 12% of total merchandise exports.
- Textile, apparel and leathers: The apparel industry dominates this sector, accounting for 10.5% of total merchandise exports.
- Agriculture and agrifood industries: There are two main products for which Tunisia is known: olive oil and dates, which represents respectively 6% and 2% of the total merchandise exports in 2020.

Second, speaking of the service sector, tourism dominates the services sector representing 31% of services sector revenues. Since the independence in 1956, the Tunisian government has relied on international mass tourism which has become one of the pillars of its national economy. It contributes to GDP with a percentage ranging from 7 to 14% (HELLAL, 2020).

The FDI has a significant and positive effect on exports (similar to the same finding as PFAFFERMAYR (1996)). FDI has an impact on the host country's exports both directly and indirectly. The direct consequences apply to exports made by overseas affiliates. The indirect effect involves the spillovers effects of multinational companies on the export activity of local firms (UNCTAD, 2002).

Imports, REER and economic growth: equation (3)

To analyze the relationship between economic growth, REER and exports, we need the following tables: **table 9** and **table 11**.

The REER has a positive and insignificant sign on imports of goods and services. This insignificance means that even though the REER fluctuates (depreciates), imports does not seem to be affected.

Tunisia is a country that relies heavily on imports, that could explain why when the exchange rate depreciates, Tunisia will continue to import because some goods and/or services are essential to the economy. These imports will have a positive effect on growth as they will allow businesses to continue operating.

However, as shown in the **table 9**, imports of goods and services does have a negative and significant effect on Tunisian economic growth. Recent endogenous growth models have highlighted the importance of imports as a key channel for external technology and knowledge to flow into the home economy (MAZUMDAR, 2001). New technologies may be embodied in imports of intermediate goods like equipment and machines, and labor productivity may grow over time as employees gain understanding the new technology (THANGAVELU and RAJAGURU, 2004).

In the case of Tunisia, however, as noted above, the opposite is true. This could be explained by two reasons. First, when a country imports goods from the foreign market it will take money out of the country and reduce economic growth. Second, the import of unnecessary products especially in the presence of a trade deficit.

The relative import price has a negative sign in accordance with the theory, meaning that when relative import price increases, the imports will follow. However, this variable is statistically insignificant. This implies that Tunisia's import demand is not very responsive to changes in the relative price of imports.

Finally, the economic growth has a positive and significant effect on imports. Indeed, an increase in economic activity would lead to an increase in imports, because high real income encourages spending (RIVERA-BATIZ, 1985).

FDI, REER and economic growth: equation (4)

To analyze the relationship between economic growth, REER and exports, we need the following tables: **table 9** and **table 12**.

As it is commonly known, when an economy's currency depreciates, it attracts foreign investors because of lower production costs and lower wages. However, a lower exchange rate is certainly not the only criterion that motivates an investor to invest in a country.

In the case of Tunisia, the REER has insignificant effect on FDI as shown in **table 12**. Furthermore, the FDI has insignificant effect on the Tunisian economic growth (**table 9**). As a result, we cannot consider the FDI as a channel through which exchange rate changes impact the Tunisian economy.

Since 1972, Tunisia has encouraged FDI through the Foreign Investment Promotion Agency (FIPA) and major tax advantages for the offshore sector.

Tunisia experienced political and economic instability following the Arab Spring revolution in 2011. Since then, Tunisia's FDI has not recovered to the historical levels seen between 2005 and 2009. FDI inflows reached a peak of 9.4 percent of GDP in 2006.

Foreign investors are still investing in Tunisia by evidence FDI inflows represent 1.9% and 1.4% of GDP in 2019 and 2020 respectively, but they have a downward trend since the 2011 revolution.

Economic growth, financial development and inflation rate have a positive and insignificant effect on FDI inflows. However, the only significant variable is trade openness. This means that when trade increases, it attracts more investors to invest in Tunisia.

External debt, REER and economic growth: equation (5)

To analyze the relationship between economic growth, REER and exports, we need the following tables: **table 9** and **table 13**.

As **table 13** shows, the REER has a negative and significant effect on external debt stocks. A depreciation of the exchange rate increases the stock of foreign debt, which results in an additional cost of the debt. Furthermore, the new debts will be more expensive than before.

In addition, the results in **table 9** shows that external debt has a negative and insignificant effect on economic growth. The depreciation of the exchange rate makes the stocks of external debt larger, which negatively affects economic growth.

Another factor that appears to contribute to the increase in external debt is the current account deficit. This latter has a negative and significant impact on external debt stocks.

The effect negative of external debt on economic growth is expected because Tunisia borrows to cover its deficits, whereas debt only has a positive effect when the money borrowed is invested in profitable projects.

However, domestic savings and budget deficit have insignificant effects on the external debt. The budget deficit is no longer the largest contributor to the increase in public debt since 2016. The exchange rate effect has increased since the CBT's independence and exchange rate liberalization in April 2016 (BEN ROUINE, 2019).

4. Recommendations

The study we conducted allowed us to draw conclusions about the Tunisian economy's strengths and limitations, which helped us in developing these suggestions:

- First, as indicated in the findings, exports of goods and services are the only contributor to Tunisia's economic development. Tunisia must focus on the exports of products with high added value. For example, olive oil that accounts for 60% of all Tunisian agricultural exports in 2020. However, the majority of Tunisian olive oil sent to Europe is in bulk before it is combined with other olive oils. Furthermore, while we agree that depreciation boosts, we believe that selling olive oil in bulk with a low price will not help Tunisia to overcome its financial difficulties.

- Second, imports of goods and services were revealed to have detrimental effect on Tunisian economic growth through the depreciation of the Tunisian dinar. This might be due to the import of unnecessary products that represents a waste of foreign exchanges reserves especially in this time of period (having a large trade deficit). The government could implement measures to limit non-essential imports.

- Third, FDI inflows declined following the 2011 revolution in comparison to their pre-revolutionary levels. The government should implement measures in order to attract FDI in Tunisia such as investing in infrastructure projects.

- Fourth, external debt stocks keep increasing with the depreciation of the Tunisian dinar and the increasing level of current account deficit. As we said above Tunisia should limit the unnecessary imports and should adjust its export strategy in order to make it more profitable.

Conclusion

In this chapter, our main objective is to analyze empirically the relationship between the variation of the exchange rate and economic growth in the case of Tunisia between 1990 and 2020. We were able to reach some findings that can be summarized as follows:

- First, we found that when the Tunisian dinar depreciates, it encourages exports by increasing the demand for Tunisian products abroad, which has a positive impact on Tunisian economic growth.

- Second, when the Tunisian dinar depreciates, it does not affect imports, which means that Tunisia will continue to import products even if the dinar loses its value, which has a negative impact on economic growth.

- Third, the FDI does not contribute to Tunisian economic development; this might be attributed to the period after the 2011 revolution, which was marked by political and economic instability.

- Fourth, external debt is affected by the depreciation of the Tunisian dinar which has a negative impact on economic growth.

General conclusion

The objective of this paper is to study the effects of exchange rate fluctuations on Tunisian economic growth during the period 1990-2020. Despite the importance of this topic, empirical studies are limited, especially those that investigate the indirect effects of exchange rate variability on economic growth.

In order to carry out this study, we first defined the basic concepts of exchange rate and economic growth. We focused on the determinants of economic growth in order to detect possible channels through which the exchange rate affects economic growth.

In the second chapter we reviewed the literature on the relationship between exchange rate fluctuations and economic growth. We have devoted the first section to the study of the different determinants of economic growth in the empirical literature. The second section has been dedicated to the study of the indirect effect of exchange rate fluctuations on economic growth through the different channels cited in the literature: foreign trade, investment, foreign debt, and the development of the economy.

Finally, we concluded the theoretical section by examining empirical studies that have been conducted to examine the relationship between exchange rate fluctuations and economic growth.

In the third chapter, we focused on the effects of exchange rate changes on economic growth in the Tunisian context using the simultaneous equations approach.

In order to do this, we began by examining the stationarity of various variables in order to ensure that all variables are stationary in order to avoid spurious regressions. Then, we tested the identification of the equations; this is a crucial step when dealing simultaneous equation models. All the equations are overidentified. As a result, the estimation method could be the 3SLS or the 2SLS. The 3SLS is more efficient since it is a full information technique. Then we proceeded to the estimation and we found that the depreciation of the dinar stimulates economic growth through

the increase of Tunisian exports of goods and services but also has adverse effects through the high cost of imports and the increase in the stock of foreign debt.

In light of these results, Tunisia must increase its exports to take advantage of the persistent depreciation of the Tunisian dinar. In addition, it must reduce imports of non-essential products to reduce the deficit of the balance of goods and services. This will reduce the amount of debt to be more flexible in terms of decisions and objectives to avoid the consequences of the conditions imposed by lenders.

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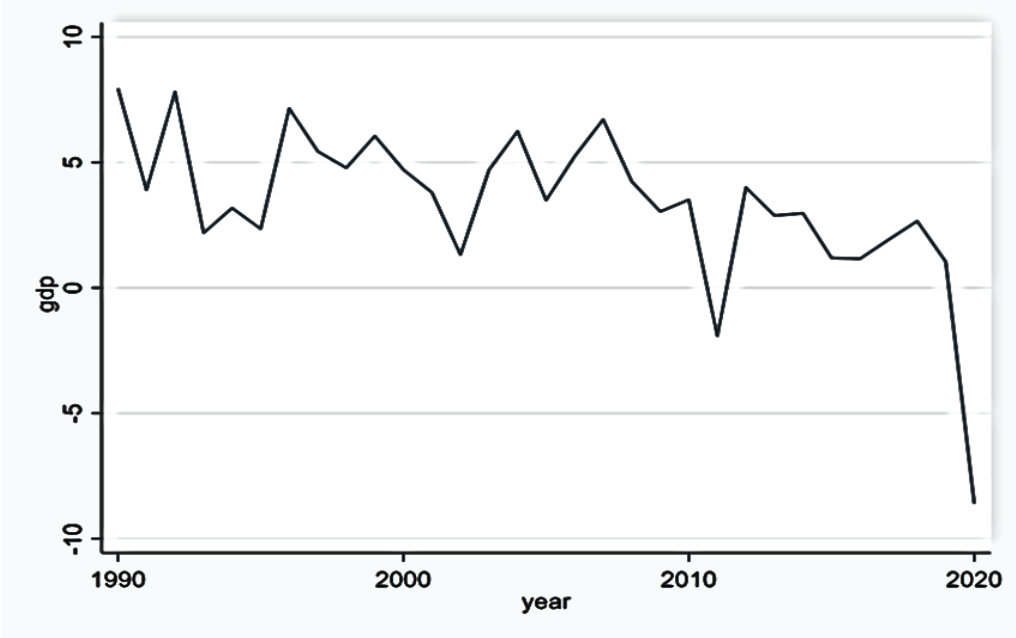
Appendices

Appendix 1: Graphs representation of variables' evolution

- "gdp" series



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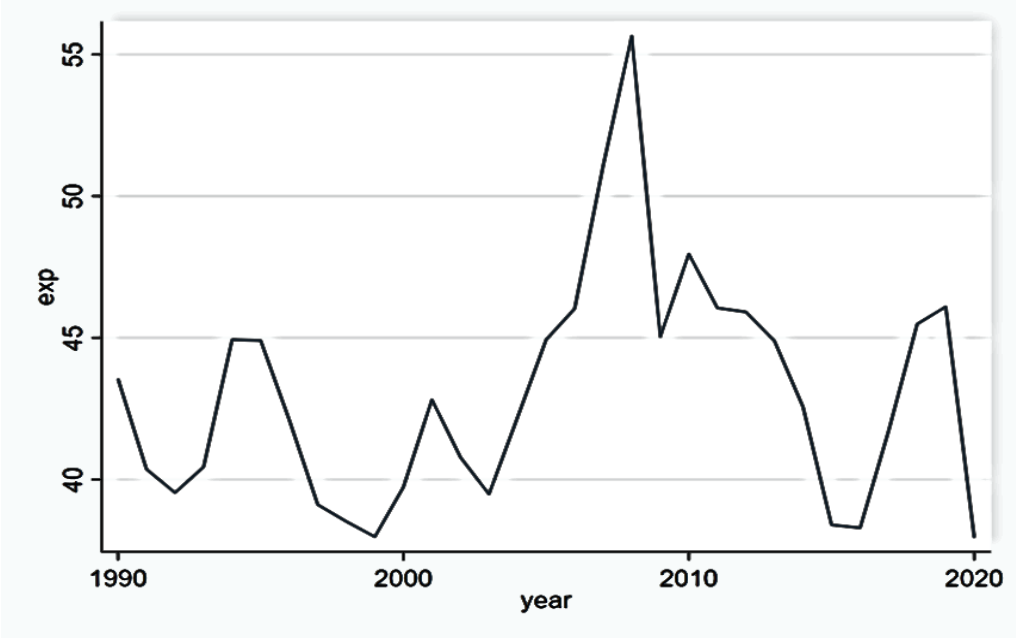

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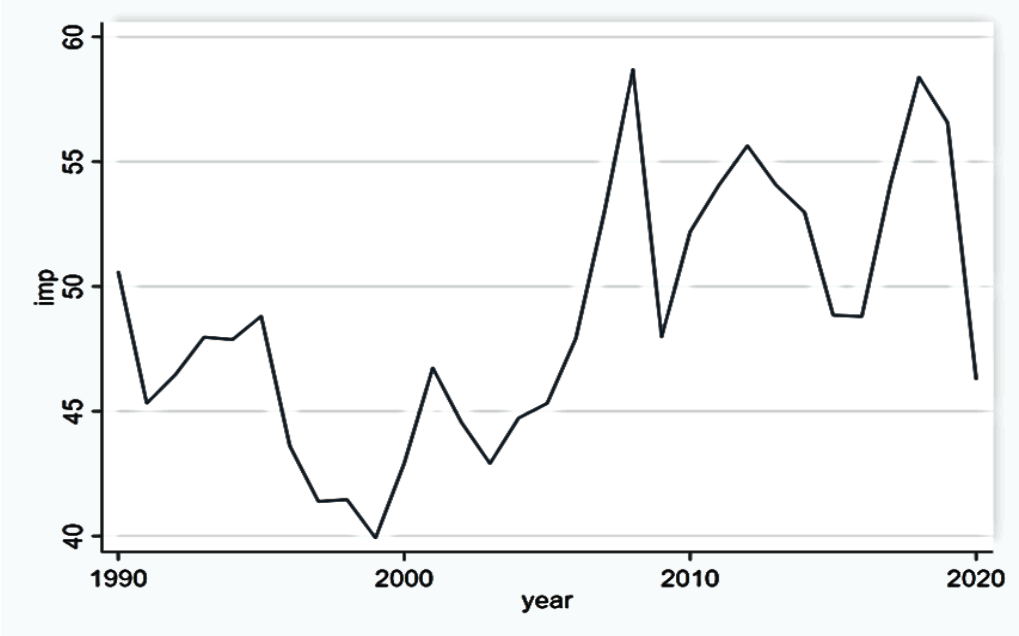

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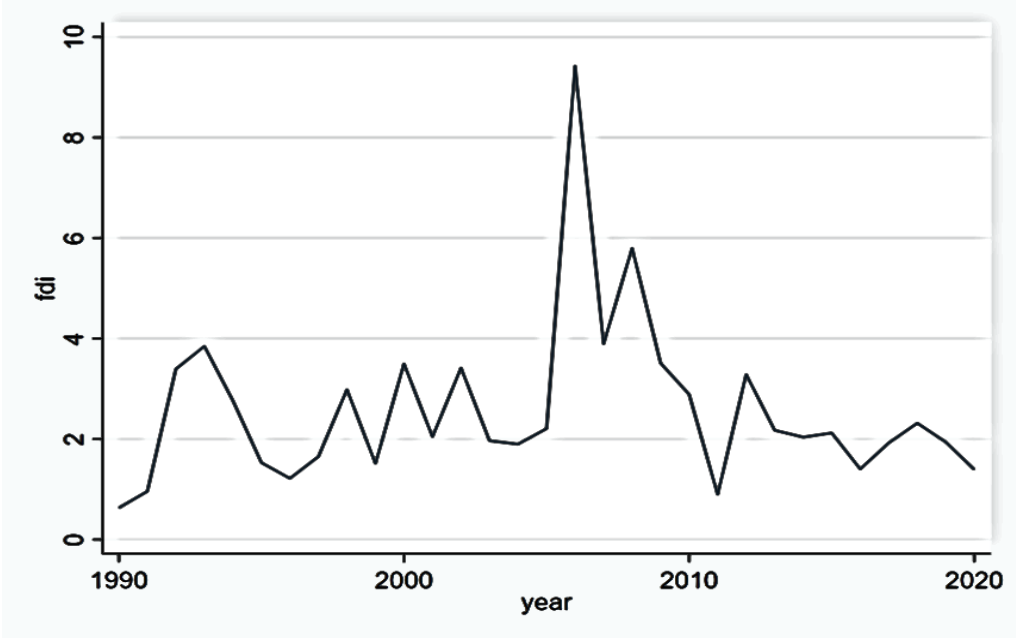

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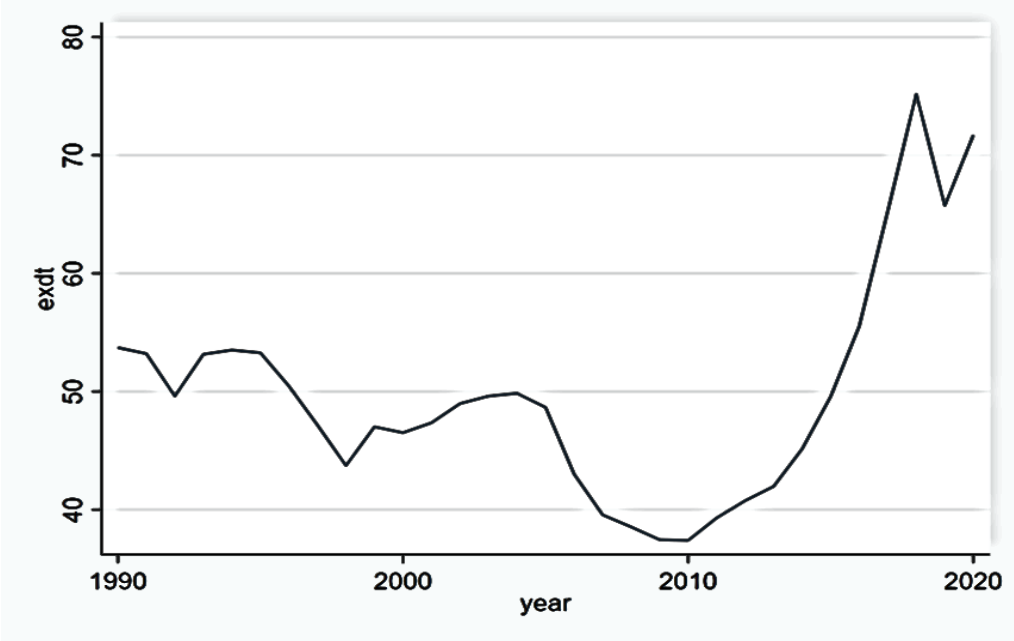

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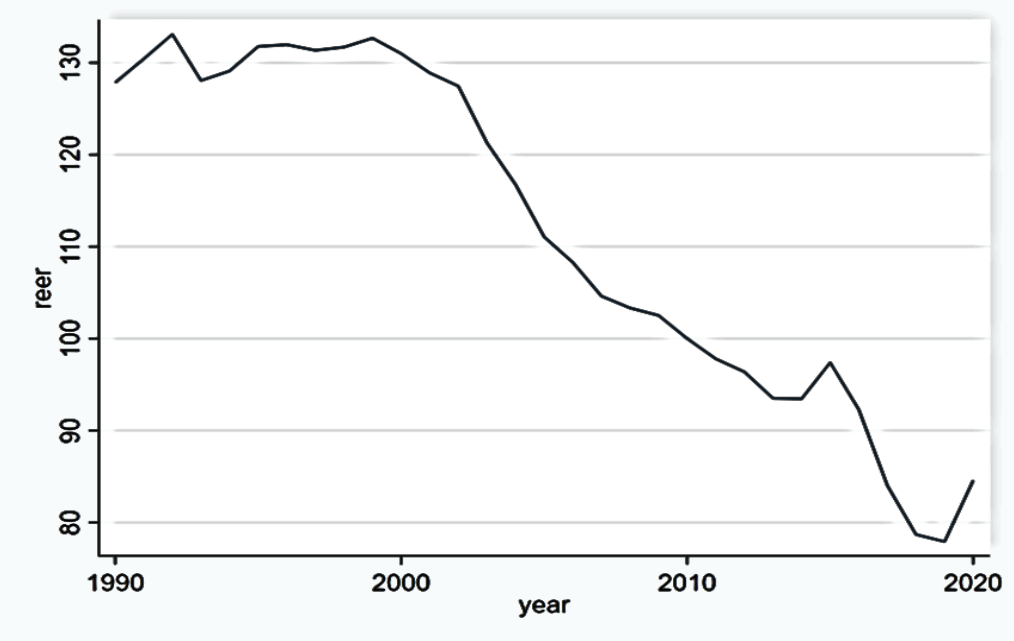
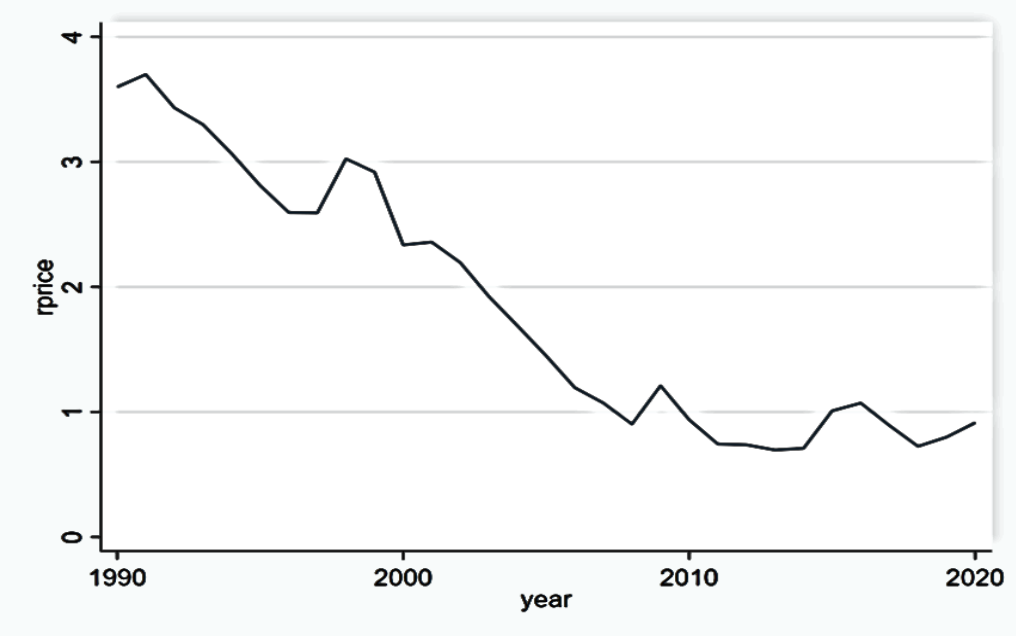
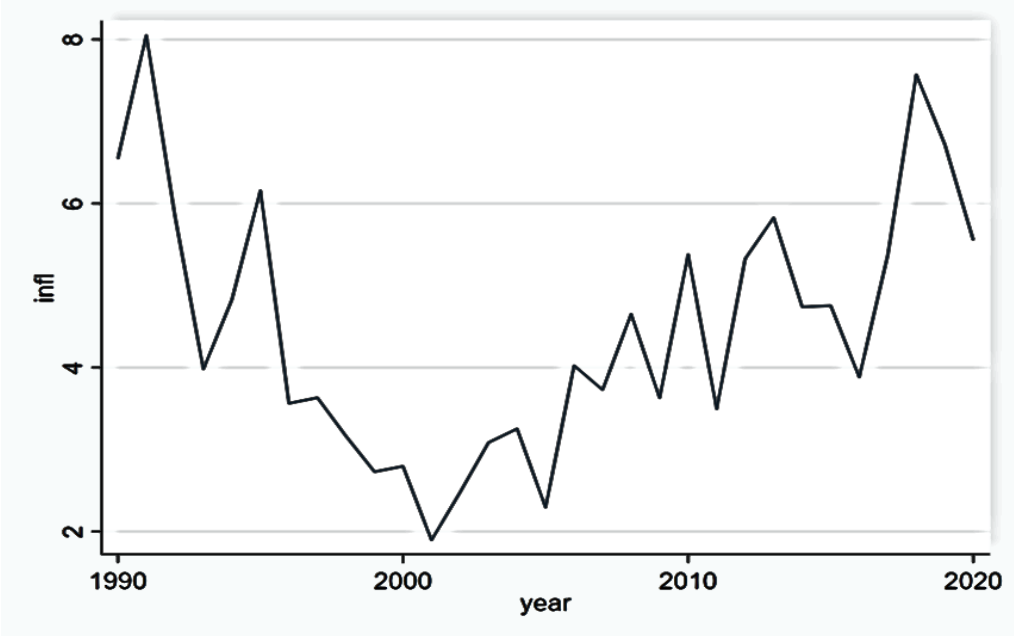


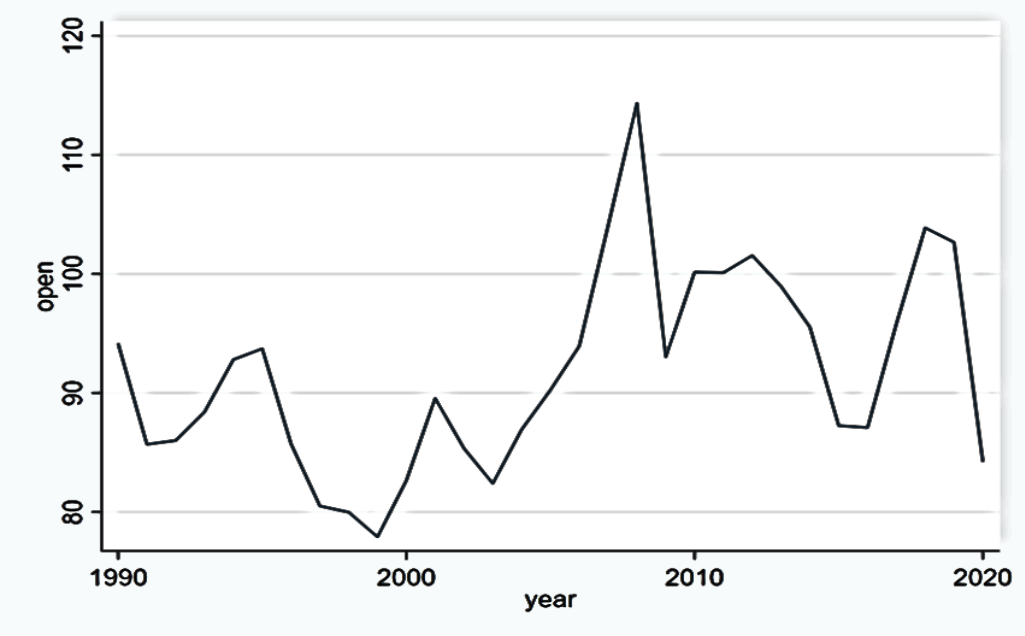
- “rprice” series



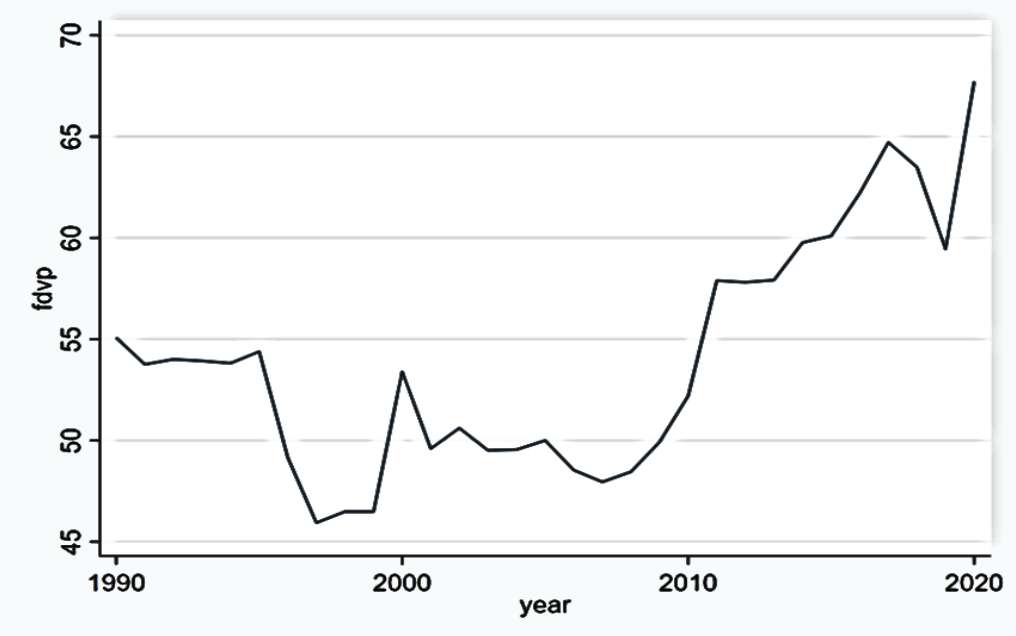
- “infl” series



- “open” series



- “fdvp” series



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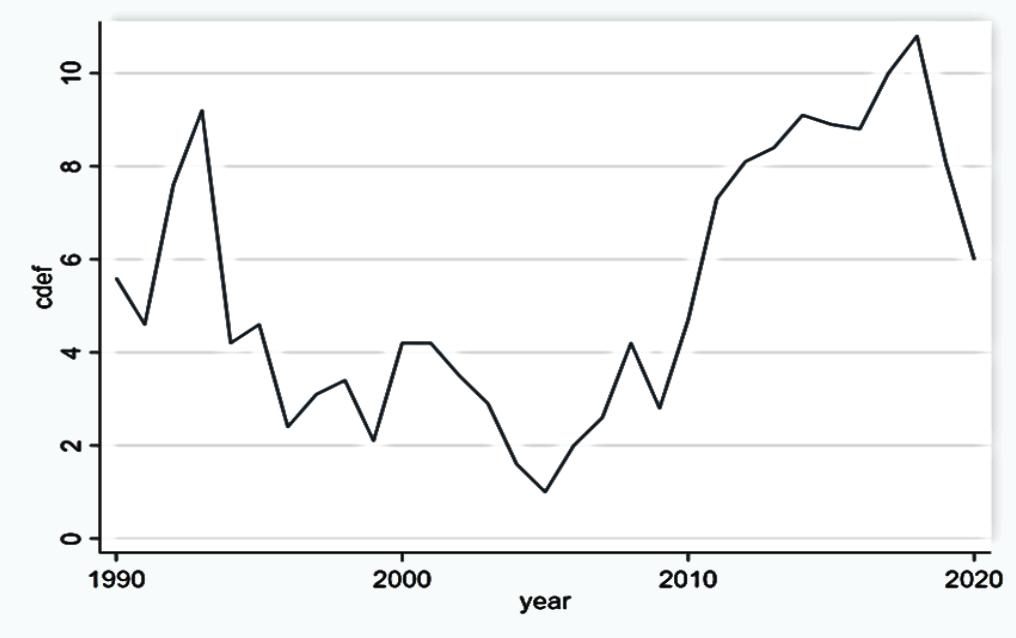

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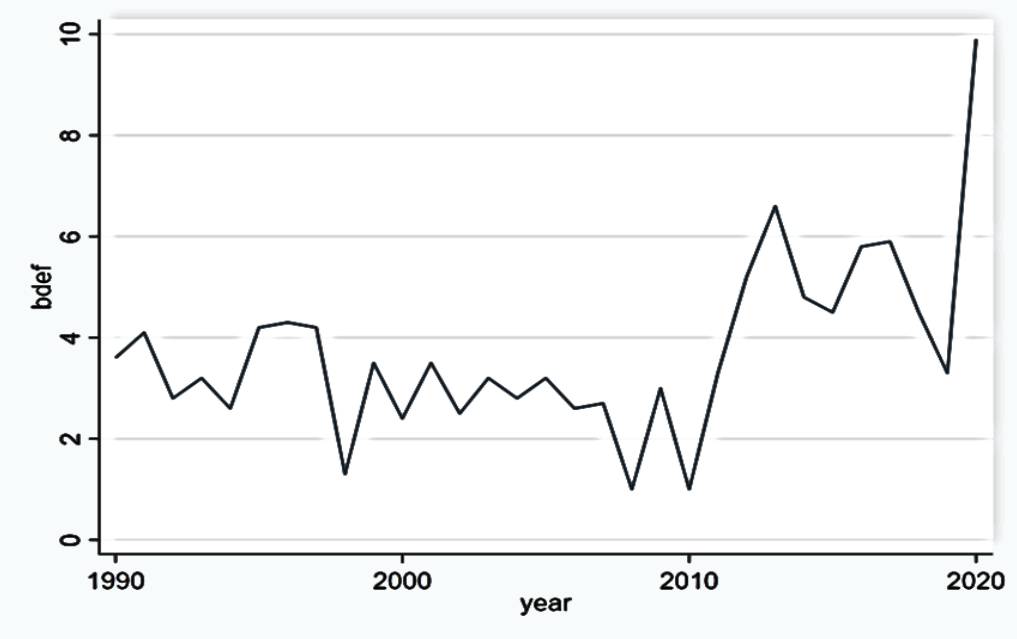
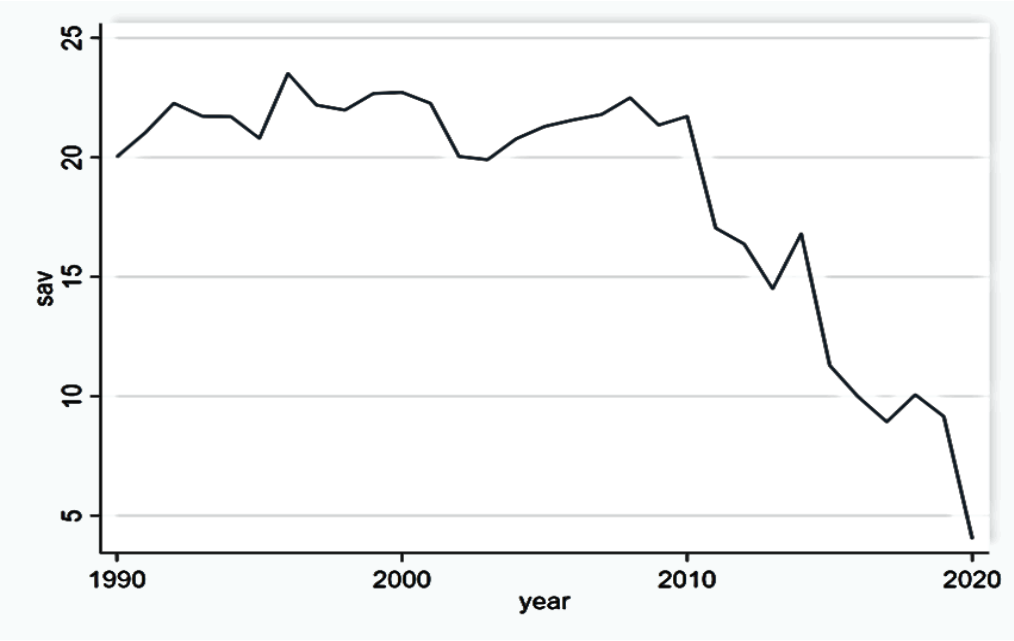


- "sav" series



Appendix 2: Stationarity study of the variable "ADF test"

1) « gdp » series :

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.366	-4.343	-3.584	-3.230

MacKinnon approximate p-value for Z(t) = 0.3980

D.gdp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
gdp						
L1.	-.9519196	.4023847	-2.37	0.026	-1.780646	-.1231928
LD.	.0158715	.2722587	0.06	0.954	-.5448557	.5765988
_trend	-.2012445	.0795798	-2.53	0.018	-.3651421	-.0373468
_cons	6.263883	2.588025	2.42	0.023	.9337461	11.59402

Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-7.100	-4.343	-3.584	-3.230

MacKinnon approximate p-value for Z(t) = **0.0000**

D.gdpD	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
gdpD						
L1.	-1.449523	.2041718	-7.10	0.000	-1.869204	-1.029842
_trend	-.0779028	.0652199	-1.19	0.243	-.2119642	.0561587
_cons	.6303965	1.122487	0.56	0.579	-1.676909	2.937702

2) « exp » series :

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-2.426	-4.343	-3.584	-3.230

MacKinnon approximate p-value for Z(t) = **0.3661**

D.ln_exp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp						
L1.	-.4327751	.1784149	-2.43	0.023	-.8002273	-.0653228
LD.	.2524267	.2156305	1.17	0.253	-.1916727	.6965261
_trend	2.28e-06	.0017594	0.00	0.999	-.0036213	.0036259
_cons	1.625388	.6626814	2.45	0.021	.26057	2.990206

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.610	-3.723	-2.989	-2.625

MacKinnon approximate p-value for Z(t) = **0.0909**

D.ln_exp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exp						
L1.	-.4327012	.1657567	-2.61	0.015	-.7734189	-.0919835
LD.	.2524074	.2109393	1.20	0.242	-.1811845	.6859994
_cons	1.625146	.6235391	2.61	0.015	.3434435	2.906849

Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-4.568	-3.723	-2.989	-2.625

MacKinnon approximate p-value for Z(t) = **0.0001**

D.ln_expD	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_expD						
L1.	-.9709532	.2125554	-4.57	0.000	-1.407081	-.5348255
_cons	-.0021876	.0150455	-0.15	0.885	-.0330584	.0286832

3) « imp » series :

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.679	-4.343	-3.584	-3.230

MacKinnon approximate p-value for Z(t) = 0.2450

D.ln_imp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_imp						
L1.	-.521472	.1946727	-2.68	0.013	-.922408	-.120536
LD.	.216264	.2106508	1.03	0.314	-.2175794	.6501074
_trend	.0034729	.0023051	1.51	0.144	-.0012746	.0082203
_cons	1.967963	.7301487	2.70	0.012	.4641937	3.471732

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.215	-3.723	-2.989	-2.625

MacKinnon approximate p-value for Z(t) = 0.2008

D.ln_imp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_imp						
L1.	-.3178611	.1434995	-2.22	0.036	-.6128285	-.0228937
LD.	.1679244	.2132165	0.79	0.438	-.2703483	.6061971
_cons	1.233575	.5567289	2.22	0.036	.089202	2.377947

Augmented Dickey-Fuller test for unit root — Number of obs = 28

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-4.288	-3.730	-2.992	-2.626

MacKinnon approximate p-value for Z(t) = 0.0005

D.ln_impD	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_impD						
L1.	-1.344724	.3136364	-4.29	0.000	-1.990671	-.698778
LD.	.3257961	.2097723	1.55	0.133	-.106238	.7578301
_cons	.0016642	.015261	0.11	0.914	-.0297665	.0330949

4) « fdi » series :

Dickey-Fuller test for unit root — Number of obs = 30

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-4.269	-4.334	-3.580	-3.228

MacKinnon approximate p-value for Z(t) = 0.0035

D.ln_fdi	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_fdi						
L1.	-.7279698	.170543	-4.27	0.000	-1.077895	-.3780445
_trend	-.0049215	.0107354	-0.46	0.650	-.0269488	.0171059
_cons	.6975778	.2200436	3.17	0.004	.2460857	1.14907

Dickey-Fuller test for unit root — Number of obs = 30

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-4.454	-3.716	-2.986	-2.624

MacKinnon approximate p-value for Z(t) = 0.0002

D.ln_fdi	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_fdi						
L1.	-.7399728	.1661273	-4.45	0.000	-1.080269	-.3996764
_cons	.6311032	.1631565	3.87	0.001	.2968922	.9653142

5) « exdt » series :

Augmented Dickey-Fuller test for unit root — Number of obs = 26

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.185	-4.371	-3.596	-3.238

MacKinnon approximate p-value for Z(t) = 0.9135

D.ln_exdt	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exdt						
L1.	-.2368252	.1998245	-1.19	0.251	-.6550628	.1814124
LD.	.2696227	.2437314	1.11	0.282	-.240513	.7797584
L2D.	.3767435	.4012996	0.94	0.360	-.4631862	1.216673
L3D.	.2348633	.3724622	0.63	0.536	-.5447092	1.014436
L4D.	.0239284	.3762473	0.06	0.950	-.7635662	.811423
_trend	.0017896	.0030277	0.59	0.561	-.0045476	.0081267
_cons	.8853648	.8007305	1.11	0.283	-.7905835	2.561313

Augmented Dickey-Fuller test for unit root — Number of obs = 26

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.042	-3.743	-2.997	-2.629

MacKinnon approximate p-value for Z(t) = 0.2686

D.ln_exdt	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exdt						
L1.	-.3113424	.1524899	-2.04	0.055	-.6294308	.0067459
LD.	.3252168	.2211633	1.47	0.157	-.1361217	.7865553
L2D.	.4884196	.3482301	1.40	0.176	-.2379757	1.214815
L3D.	.3358823	.325506	1.03	0.314	-.3431113	1.014876
L4D.	.1200436	.333726	0.36	0.723	-.5760967	.8161839
_cons	1.201599	.5859738	2.05	0.054	-.0207214	2.423919

Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.667	-3.723	-2.989	-2.625

MacKinnon approximate p-value for Z(t) = **0.0046**

D.ln_exdtD	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_exdtD						
L1.	-.683857	.1864899	-3.67	0.001	-1.066503	-.3012114
_cons	.008085	.0134071	0.60	0.552	-.0194242	.0355942

6) « reer » series :

Augmented Dickey-Fuller test for unit root — Number of obs = 26

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.348	-4.371	-3.596	-3.238

MacKinnon approximate p-value for Z(t) = **0.4075**

D.ln_reer	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_reer						
L1.	-.3489722	.1486108	-2.35	0.030	-.6600182	-.0379262
LD.	.6565616	.2311781	2.84	0.010	.1727002	1.140423
L2D.	-.3361529	.2701485	-1.24	0.229	-.9015803	.2292745
L3D.	-.1219324	.2423727	-0.50	0.621	-.6292242	.3853595
L4D.	-.137007	.2480541	-0.55	0.587	-.6561903	.3821762
_trend	-.0078244	.0030971	-2.53	0.021	-.0143066	-.0013422
_cons	1.757582	.7514752	2.34	0.030	.1847267	3.330438

Augmented Dickey-Fuller test for unit root — Number of obs = 28

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.730	-4.352	-3.588	-3.233

MacKinnon approximate p-value for Z(t) = **0.0204**

D.ln_reerD	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_reerD						
L1.	-1.05628	.2831657	-3.73	0.001	-1.640705	-.4718545
LD.	.599938	.2318266	2.59	0.016	.1214714	1.078405
_trend	-.0006908	.0008375	-0.82	0.418	-.0024192	.0010376
_cons	-.0058831	.0124075	-0.47	0.640	-.0314909	.0197247

7) « rprice » series :

Augmented Dickey-Fuller test for unit root — Number of obs = 22

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-3.769	-4.380	-3.600	-3.240

MacKinnon approximate p-value for Z(t) = **0.0182**

D.ln_reer	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_reer						
L1.	-1.234115	.3274485	-3.77	0.003	-1.954824	-.5134054
LD.	1.124076	.2599598	4.32	0.001	.5519082	1.696244
L2D.	.2986701	.3267426	0.91	0.380	-.4204855	1.017826
L3D.	.1965107	.273392	0.72	0.487	-.405221	.7982425
L4D.	-.0532198	.2543025	-0.21	0.838	-.6129358	.5064961
L5D.	.2745517	.2908869	0.94	0.366	-.365686	.9147894
L6D.	.7839518	.3665693	2.14	0.056	-.0228618	1.590765
L7D.	.4288985	.3194146	1.34	0.206	-.2741284	1.131925
L8D.	-.1992503	.2980341	-0.67	0.518	-.855219	.4567185
_trend	-.026659	.0068511	-3.89	0.003	-.0417382	-.0115797
_cons	6.295729	1.672823	3.76	0.003	2.613871	9.977587

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.257	-4.343	-3.584	-3.230

MacKinnon approximate p-value for Z(t) = 0.8981

D.rprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rprice						
L1.	-.1596075	.1269627	-1.26	0.220	-.4210922	.1018771
LD.	.1329157	.2047659	0.65	0.522	-.2888075	.5546389
_trend	-.0102663	.0151081	-0.68	0.503	-.041382	.0208493
_cons	.3677344	.4743497	0.78	0.445	-.6092071	1.344676

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.022	-3.723	-2.989	-2.625

MacKinnon approximate p-value for Z(t) = 0.2769

D.rprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rprice						
L1.	-.0774379	.0382933	-2.02	0.054	-.1561509	.0012751
LD.	.0721542	.1822939	0.40	0.695	-.3025563	.4468647
_cons	.0500224	.0791968	0.63	0.533	-.112769	.2128138

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-2.881	-2.654	-1.950	-1.602

D.rprice	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
rprice						
L1.	-.0567868	.0197115	-2.88	0.008	-.0972314	-.0163422
LD.	.0531593	.1777837	0.30	0.767	-.3116227	.4179412

8) « infl » series :

Augmented Dickey-Fuller test for unit root — Number of obs = 26

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-1.819	-4.371	-3.596	-3.238

MacKinnon approximate p-value for Z(t) = 0.6957

D.ln_infl	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_infl						
L1.	-.3731579	.2051765	-1.82	0.085	-.8025972	.0562813
LD.	-.377094	.2549458	-1.48	0.155	-.9107016	.1565136
L2D.	-.2809787	.2558396	-1.10	0.286	-.8164571	.2544997
L3D.	-.2372107	.2465549	-0.96	0.348	-.7532561	.2788347
L4D.	.0794298	.2130894	0.37	0.713	-.3665715	.5254311
_trend	.0199115	.0091098	2.19	0.042	.0008444	.0389785
_cons	.1790475	.2709602	0.66	0.517	-.3880787	.7461736

Augmented Dickey-Fuller test for unit root — Number of obs = 28

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-5.422	-4.352	-3.588	-3.233

MacKinnon approximate p-value for Z(t) = 0.0000

D.ln_inflD	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_inflD						
L1.	-1.87122	.3451049	-5.42	0.000	-2.583481	-1.158958
LD.	.3148318	.2003693	1.57	0.129	-.0987102	.7283738
_trend	.0131882	.0069459	1.90	0.070	-.0011475	.0275238
_cons	-.2082664	.1189648	-1.75	0.093	-.4537977	.0372649

9) « open » series :

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.707	-4.343	-3.584	-3.230

MacKinnon approximate p-value for Z(t) = 0.2333

D.ln_open	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_open						
L1.	-.5312425	.1962591	-2.71	0.012	-.9354457	-.1270392
LD.	.2688482	.2141855	1.26	0.221	-.172275	.7099715
_trend	.0020244	.0019723	1.03	0.315	-.0020377	.0060864
_cons	2.365769	.868265	2.72	0.012	.5775436	4.153994

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-2.593	-3.723	-2.989	-2.625

MacKinnon approximate p-value for Z(t) = **0.0944**

D.ln_open	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_open						
L1.	-.4136316	.1594988	-2.59	0.015	-.7414861	-.0857772
LD.	.235772	.211965	1.11	0.276	-.1999283	.6714723
_cons	1.867024	.7202998	2.59	0.015	.3864263	3.347621

Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	-4.653	-3.723	-2.989	-2.625

MacKinnon approximate p-value for Z(t) = **0.0001**

D.ln_openD	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_openD						
L1.	-.989986	.2127699	-4.65	0.000	-1.426554	-.5534182
_cons	-.0006261	.0146594	-0.04	0.966	-.0307047	.0294525

10) « fdvp» series :

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.568	-4.343	-3.584	-3.230

MacKinnon approximate p-value for Z(t) = 0.8047

D.ln_fdvp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_fdvp						
L1.	-.1962913	.1251902	-1.57	0.129	-.4541253	.0615427
LD.	-.1199119	.2086871	-0.57	0.571	-.5497109	.3098871
_trend	.0032559	.0014227	2.29	0.031	.0003258	.0061859
_cons	.7363568	.4844082	1.52	0.141	-.2613005	1.734014

Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-5.692	-4.343	-3.584	-3.230

MacKinnon approximate p-value for Z(t) = 0.0000

D.ln_fdvpD	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_fdvpD						
L1.	-1.191325	.2092903	-5.69	0.000	-1.621528	-.761123
_trend	.0019342	.0011778	1.64	0.113	-.0004867	.0043552
_cons	-.0205517	.020062	-1.02	0.315	-.0617898	.0206864

11) « cdef » series :

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.854	-4.343	-3.584	-3.230

MacKinnon approximate p-value for Z(t) = 0.6781

D.ln_cdef	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_cdef						
L1.	-.2530131	.1364618	-1.85	0.076	-.5340615	.0280353
LD.	.0037484	.1989771	0.02	0.985	-.4060527	.4135495
_trend	.0097777	.009492	1.03	0.313	-.0097715	.0293269
_cons	.2328603	.2131701	1.09	0.285	-.2061717	.6718923

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.573	-3.723	-2.989	-2.625

MacKinnon approximate p-value for Z(t) = 0.4969

D.ln_cdef	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_cdef						
L1.	-.1974987	.1255165	-1.57	0.128	-.4555015	.0605041
LD.	.0009698	.1991925	0.00	0.996	-.4084763	.4104158
_cons	.3059206	.2012611	1.52	0.141	-.1077776	.7196187

Augmented Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-0.422	-2.654	-1.950	-1.602

D.ln_cdef	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_cdef						
L1.	-.0195173	.0462941	-0.42	0.677	-.1145049	.0754703
LD.	-.0908782	.1943578	-0.47	0.644	-.4896675	.3079112

Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-5.838	-2.654	-1.950	-1.602

D.ln_cdefD	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_cdefD						
L1.	-1.103807	.189084	-5.84	0.000	-1.491128	-.7164863

12) « bdef » series :

Augmented Dickey-Fuller test for unit root — Number of obs = 28

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.178	-4.352	-3.588	-3.233

MacKinnon approximate p-value for Z(t) = 0.5022

D.ln_bdef	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_bdef						
L1.	-.6088966	.279566	-2.18	0.040	-1.187223	-.0305701
LD.	-.2406968	.2726004	-0.88	0.386	-.8046138	.3232201
L2D.	.1433987	.2169493	0.66	0.515	-.305395	.5921925
_trend	.0171126	.0117853	1.45	0.160	-.0072672	.0414924
_cons	.4659088	.332828	1.40	0.175	-.2225984	1.154416

Augmented Dickey-Fuller test for unit root — Number of obs = 28

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-0.069	-2.655	-1.950	-1.601

D.ln_bdef	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_bdef						
L1.	-.0054911	.079238	-0.07	0.945	-.1686849	.1577027
LD.	-.6307913	.2189101	-2.88	0.008	-1.081645	-.1799376
L2D.	-.0215764	.2150899	-0.10	0.921	-.4645624	.4214096

Augmented Dickey-Fuller test for unit root — Number of obs = 28

	Test Statistic	Interpolated Dickey-Fuller 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-4.452	-2.655	-1.950	-1.601

D.ln_bdefD	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_bdefD						
L1.	-1.657882	.3723913	-4.45	0.000	-2.423343	-.8924206
LD.	.023432	.2092923	0.11	0.912	-.4067745	.4536385

13) « sav » series :

Augmented Dickey-Fuller test for unit root — Number of obs = 25

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	0.274	-4.380	-3.600	-3.240

MacKinnon approximate p-value for Z(t) = 0.9962

D.ln_sav	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_sav						
L1.	.0796794	.2904507	0.27	0.787	-.5331181	.6924769
LD.	-.6889223	.3891626	-1.77	0.095	-1.509984	.132139
L2D.	-.3608581	.4635487	-0.78	0.447	-1.33886	.617144
L3D.	-.654593	.4733599	-1.38	0.185	-1.653295	.3441092
L4D.	.4138699	.4915141	0.84	0.411	-.6231343	1.450874
L5D.	1.129218	.4528619	2.49	0.023	.1737631	2.084673
_trend	-.0086851	.006383	-1.36	0.191	-.022152	.0047817
_cons	-.1586717	.9170029	-0.17	0.865	-2.093379	1.776035

Augmented Dickey-Fuller test for unit root — Number of obs = 25

	Test Statistic	1% Critical Value	5% Critical Value	10% Critical Value
		Interpolated Dickey-Fuller		
Z(t)	0.594	-3.750	-3.000	-2.630

MacKinnon approximate p-value for Z(t) = 0.9875

D.ln_sav	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_sav						
L1.	.1716391	.2890822	0.59	0.560	-.4357001	.7789782
LD.	-.6267016	.3955015	-1.58	0.130	-1.457619	.2042162
L2D.	-.2570894	.4679214	-0.55	0.589	-1.240156	.7259771
L3D.	-.5630843	.4795121	-1.17	0.256	-1.570502	.4443331
L4D.	.5744431	.4882916	1.18	0.255	-.4514194	1.600306
L5D.	1.223649	.4579745	2.67	0.016	.2614802	2.185818
_cons	-.5633844	.887704	-0.63	0.534	-2.428381	1.301612

Augmented Dickey-Fuller test for unit root — Number of obs = 25

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-1.189	-2.660	-1.950	-1.600

D.ln_sav	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_sav						
L1.	-.0117179	.009854	-1.19	0.249	-.0323425	.0089068
LD.	-.4487134	.2744541	-1.63	0.119	-1.023152	.1257256
L2D.	-.0036085	.2399201	-0.02	0.988	-.5057671	.4985501
L3D.	-.3021266	.2427933	-1.24	0.228	-.8102987	.2060455
L4D.	.8403906	.2466903	3.41	0.003	.3240619	1.356719
L5D.	1.444579	.292875	4.93	0.000	.8315843	2.057573

Dickey-Fuller test for unit root — Number of obs = 29

	Test Statistic	Interpolated Dickey-Fuller: 1% Critical Value	5% Critical Value	10% Critical Value
Z(t)	-2.745	-2.654	-1.950	-1.602

D.ln_savD	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
ln_savD						
L1.	-.8824922	.3215165	-2.74	0.010	-1.541089	-.2238955

Appendix 3: 3SLS regression

Three-stage least-squares regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
gdpD	30	4	3.62793	-0.3495	20.71	0.0004
ln_expD	30	3	.0753562	0.0666	31.73	0.0000
ln_impD	30	4	.0389368	0.7579	172.54	0.0000
ln_fdi	30	5	.4628419	0.1413	21.71	0.0006
ln_exdtD	30	5	.0686808	0.0849	16.20	0.0063

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
gdpD						
ln_expD	57.97062	15.01897	3.86	0.000	28.53397	87.40726
ln_impD	-44.56841	17.30977	-2.57	0.010	-78.49492	-10.64189
ln_fdi	.0248385	2.463176	0.01	0.992	-4.802897	4.852574
ln_exdtD	-27.07503	12.45609	-2.17	0.030	-51.48851	-2.661546
_cons	-.1786246	2.222641	-0.08	0.936	-4.534922	4.177672
ln_expD						
gdpD	.0048697	.0062953	0.77	0.439	-.007469	.0172083
ln_reerD	-1.06978	.4016929	-2.66	0.008	-1.857083	-.282476
ln_fdi	.1221813	.0380211	3.21	0.001	.0476612	.1967013
_cons	-.1197138	.0355283	-3.37	0.001	-.1893479	-.0500796
ln_impD						
gdpD	-.0064214	.0031718	-2.02	0.043	-.012638	-.0002047
ln_reerD	.0449252	.2381316	0.19	0.850	-.4218042	.5116545
rprice	-.0028363	.005987	-0.47	0.636	-.0145705	.0088979
ln_expD	1.09461	.0990075	11.06	0.000	.9005584	1.288661
_cons	.0041338	.0140867	0.29	0.769	-.0234755	.0317432

ln_fdi						
gdpD	.0398897	.0467974	0.85	0.394	-.0518315	.1316108
ln_reerD	3.222508	2.752139	1.17	0.242	-2.171585	8.616601
ln_openD	3.951754	1.082037	3.65	0.000	1.831001	6.072507
ln_fdvpD	.8808944	1.418574	0.62	0.535	-1.899459	3.661248
ln_inflD	.2713222	.2248548	1.21	0.228	-.1693851	.7120295
_cons	.9200933	.0956391	9.62	0.000	.7326441	1.107543
ln_exdtD						
gdpD	-.012691	.0090867	-1.40	0.163	-.0305006	.0051186
ln_reerD	-.8709341	.355336	-2.45	0.014	-1.56738	-.1744883
ln_cdefD	-.048415	.0292821	-1.65	0.098	-.1058069	.008977
ln_bdefD	-.0015202	.0204582	-0.07	0.941	-.0416174	.0385771
ln_savD	-.0979528	.1183609	-0.83	0.408	-.329936	.1340303
_cons	-.0144452	.0135771	-1.06	0.287	-.0410559	.0121654

Endogenous variables: gdpD ln_expD ln_impD ln_fdi ln_exdtD
Exogenous variables: ln_reerD rprice ln_openD ln_fdvpD ln_inflD ln_cdefD ln_bdefD ln_savD

Table of contents