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End of Studies Project

Topic :

Exchange rate misalignment and pass-through in Tunisia

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Abstract

In the light of the tight relationship between exchange rate movements and inflation known as the "exchange rate pass-through", the misalignment between the observed exchange rate and its equilibrium state is believed to have a considerable impact on prices. In this thesis, we examine the impact of such misalignment on consumer prices in Tunisia. First, an estimation of the Tunisian equilibrium exchange rate following the BEER approach via a Vector Error Correction Model allowed the identification of overvaluation and undervaluation phases throughout the past 21 years. The obtained output was later on employed within a VAR model as we estimated the exchange rate pass-through to prices within the distribution chain in general as well as its direct impact on consumer prices in particular. Considering the 2011 revolution a transitioning point, splitting the study period into two subperiods allowed the identification of changes in the behavior of prices within the chain as well as a decreased pass-through. Misalignment from its side showed a fair impact on consumer prices, with a slight retreat following 2011.

Keywords: Misalignment, exchange rate pass-through, BEER, VECM, VAR, inflation, distribution chain

List of acronyms:

ADF	Augmented Dickey-Fuller
AIC	Akaike information criterion
BEER	Behavioral equilibrium exchange rate
CA	Current account
CBT	Central Bank of Tunisia
CPI	Consumer price index
ECM	Error Correction Model
ERPT	Exchange rate pass-through
FEER	Fundamental equilibrium exchange rate
GDP	Gross domestic product
HQ	Hannan–Quinn information criterion
IMF	International monetary fund
ISPI	Industrial selling price index
KA	Capital account
KPSS	Kwiatkowski–Phillips–Schmidt–Shin
MPI	Import price index
NATREX	Natural real exchange rate
NEER	Nominal effective exchange rate
NER	Nominal exchange rate
NFA	Net foreign assets
OECD	Organisation for Economic Co-operation and Development
PP	Phillips-Perron
PPP	Purchasing power parity
PRO	Productivity
REER	Real effective exchange rate
RER	Real exchange rate
SAP	Structural adjustment program
SC	Schwarz Criterion
TOT	Terms of trade
VAR	Vector Auto-regression
VECM	Vector error correction model

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General introduction

On August 15th, 1971, **President Richard M.Nixon**'s words announced the demise of the Bretton Woods's international monetary system of pegged exchange rate when he declared the "closing of the gold window". The system hence collapsed as countries allowed new levels of freedom to their exchange rates. These new regimes, however, still featured a salient role played by authorities as they allowed to bring adjustments to rates when necessary. The increased activism in exchange rate management ended up arousing the question of how to properly choose the appropriate value of a currency, an enigma which managed to keep economists busy and to represent one of the central concerns of macroeconomic policies in developed countries. Exchange rate crises which have invaded different parts of the world like Mexico, Russia and Brazil, have accentuated the cruciality of this matter, especially within a world which has been witnessing an increasing degree of capital markets integration.

A general agreement among economists has accused exchange rate misalignment of playing the key role in these crises, that being a situation in which the observed real exchange rate significantly differs from its long run equilibrium state. Two new issues have hence been raised: the first is with regard to what is meant by the "long-run equilibrium state", the second is about the appropriate way to estimate it. Since neither issue is trivial, different studies and analytical frameworks have been elaborated, offering a multitude of definitions and computing methods, leading by that to no consensus on both.

While the question of misalignment continued to preoccupy several parties, the exchange rate, from its side, kept playing its role as a value measurement unit. In the middle of proliferating trade operations and increasing financial openness, the matter of exchange rates movements' impact on domestic prices, commonly referred to as the "exchange rate pass-through", received an increased attention especially that these latter made proof of a historically high sensitivity to changes in rates, leading by that to considerably high inflation levels. The assimilation and assessment of ERPT's speed and magnitude have hence became of a particular importance in conducting effective monetary and exchange rate policies.

Given both facts, some central banks have been seen exerting influence on local currencies' value as they sought to guide and contain inflation levels. It is hence in this context that a strand

of literature was interested in the examination of the impact of a currency's misalignment on a country's performance indicators in general, and on the overall price level in particular.

Just like in many other countries around the world, the exchange rate regime applied in Tunisia has known several changes as the authorities sought to keep in line with the consecutive mutations and newly emerged necessities which have characterized the economic environment and international relationships of the country.
With the aim of sustaining local production's competitiveness on international markets, a shift toward a more flexible exchange rate was decided in the early 2000s, and later on in 2016. While the first shift was accompanied by contained inflation rates, the second has witnessed a parallel up rise in its levels, stimulated by a multitude of unprecedented heavyweight events which will forever mark the history of the country.

In front of a prime mission of maintaining the stability of prices, the exchange rate has been deployed under different types of strategies, and has itself, known different phases of under and overvaluation, as suspected by specialists.

In this context, a modest number of studies has been conducted putting under the scope the eventual misalignment of the Tunisian dinar, as well as the pass-through to domestic prices. Despite leading to sometimes diverging results, the empirical literature is still considered fairly rich.

However, it caught our attention the lack of empirical assessment in regard with the eventual contribution of exchange rate misalignment to the level of prices in Tunisia. It is hence in this context that our study falls.

This thesis will hence seek to answer the following question: **to what extent does the exchange rate misalignment contribute to inflation rates in Tunisia?**

For this purpose, the current thesis will be organized into two main parts, each containing two chapters:

The first part will be dedicated to the assessment of the eventual exchange rate misalignment in Tunisia.

The first chapter will hence be dedicated to an overall presentation of theoretical and empirical aspects related to the matter. A first section will consider the issues that arise in the definition and measurement of the actual real exchange rate, as well as its main determinants. A second section will later on review the theoretical underpinnings of the equilibrium exchange rate and

the extraction of a currency misalignment, and surveys the existing techniques for its empirical assessment.

The following second chapter will include an empirical assessment of the exchange rate misalignment in Tunisia. While a first section will introduce the evolution of the Tunisian exchange regime and its real rates, the second will include an application of a VECM model destined to estimate the equilibrium exchange rate along with the positioning of the actual rate compared to our estimations.

The second part will focus on the exchange rate pass-through in Tunisia and the evolution of the eventual contribution of misalignment to inflation in the country.

The first chapter of this part will again be dedicated to an overall presentation of theoretical aspects and empirical studies in regard with the pass-through to prices concept. The first section will hence contain a general introduction of the inflation phenomenon and the role of monetary authorities played in keeping inflation rates under control. The second section will later on be presenting an overview of the theoretical concepts related to the exchange rate pass-though, and its transmission throughout the chain prices as well as drawing the link between misalignment and inflation behavior.

The second chapter will be dedicated to the empirical assessment of the exchange rate pass-through to prices in Tunisia, we will be employing the previously estimated misalignment. A first section will thus present an overview on the evolution of inflation in Tunisia in relation to that of the exchange rate, while a second chapter will be employing a VAR model to estimate the exchange rate pass-through without considering misalignment, before moving on to the inclusion on the misalignment variable in the model to see whether or not it has any impact on prices.

PART-I

Real exchange rate concept, equilibrium state and misalignment

Chapter 1: Exchange rate fundamental theories and concepts

Introduction:

The past few decades went down in history as an era of contemporary globalization. Following the fall of the Bretton Woods System back in the 70s, deep changes were brought to the economic landscape features, as macroeconomic policies were called into question, trade of goods and services occupied a more pronounced position in international relationships, and capital flows across borders picked up the pace. In the middle of such deep shifts and evolutions, the exchange rate had, and continues to have, one of the lead roles to play. Considering its nature as a measurement of a given currency's value, the behavior of an exchange rate would hence condition a country's trade patterns and costs, investment attractiveness, the weight of its indebtedness and its overall economic performance. However, the exchange rate's level and freedom of fluctuation are themselves conditioned by a wide set of determinants such as prevailing policies, market performances and even exogenous, sometimes unpredictable, shocks…

One of the major concerns which have aroused within this context is the issue of exchange rate misalignment which measures the deviation of an observed exchange rate from its "appropriate" level, commonly referred to as the equilibrium level. In fact, prolonged and substantial misalignments are usually considered a threatening source of exchange rate crisis. However, within the economy field, there seem to be no consensus in regard to the appropriate measurement of the equilibrium level, a preliminary and crucial step necessary for the detection of eventual misalignments. This has long generated several types of problems, among which the multiplicity of theories underlying this matter and the ambiguity of some of them are ought to be mentioned.

In this context, we find it appropriate to dedicate the first chapter to the assimilation of the basic concepts related to the exchange rate and to get an understanding of the theories underpinning its measurement. The structure of this chapter will hence contain two sections and will be organized as follows:

The first section will present the elementary concepts relative to exchange rates. It will thus define what an exchange rate refers to before proceeding to a review of the principal exchange rate concepts and methodologies in regard with its measurement as well as its main determinants. These will then be followed by a general overview on the evolution of the monetary system and types of exchange rate regimes.

The following second section will undertake the concept of the equilibrium exchange rate. Within this context, a presentation of the concept along with its main three fundamental approaches: the FEER, BEER and the NATREX will be detailed individually, before being able to move on to the concept of misalignment.

Section 1: Elementary concepts related to the exchange rate:

I- The exchange rate concept:

1- Theoretical definition:

The exchange rate can be defined as the value of one currency expressed in terms of another. It is hence the price for which one currency can be exchanged for another or, in other words, bought and sold.

The exchange rate between two currencies of two different countries can be expressed or "quoted" in one way or another:

- The first is called the direct quotation and shows the value or the price of one unit of a foreign currency in terms of units of a currency considered as local;
- The second is called the indirect quotation and expressed the value of one unit of a local currency in terms of units of a foreign one.

A third sort of quotation can also be encountered, known as the cross rate. Given the fact that not all currencies are quoted against each other, the need for a specific unavailable quotation gave place to such method. This latter hence uses the quotations of two currencies valued against a common third one to deduce a single quotation implying the first two ones.

The Expressed currency would be named "base currency", the second serving as the price would be called "term currency".

2- Exchange rate categories:

Within the context of the exchange rates, a multitude of conceptual definitions have been elaborated, each based on an analytical framework, and each being suitable for a specific use or within a specific circumstance.

2.1- Bilateral exchange rates:

Bilateral exchange rates is the category of rates which seek to assess the value of one currency considering the value of only one other. This category counts:

- The nominal exchange rate;
- The real exchange rate.

2.1.1-The nominal exchange rate (NER):

The IMF defines the nominal exchange rate as the relative price of one currency in terms of another, usually that of a domestic currency expressed in unites of a foreign one.

This very rate is the one found displayed on the currency market and used in foreign exchange contracts and is determined based on the levels of supply and demand on the said market.

Taking the case of a direct quotation, when the exchange rises, we say that the foreign currency gained in value or "appreciated", and when it drops down, it "depreciates".

2.1.2-The real exchange rate (RER):

The real exchange rate is a second measurement of a country's currency value. This measurement, however, can be defined based on two points of view:

- The first one is based on the purchase power parity theory (Which will be further developed in the second chapter). This theory considers the external real exchange rate to be the nominal one adjusted by the ratio of broad-based price index both in the domestic and the foreign countries such as the consumer price index (CPI) or the deflator for gross domestic product (GDP). Expressed differently, it is "the ratio of the price of foreign to that of domestic goods, expressed in domestic currency" (Black, 1994). The RER hence generally takes the following expression:

$$RER = NER.\frac{p*}{p} \qquad (1)$$

Where (p*) and (p) are the foreign and the domestic prices of the same set of goods in the foreign and local economies, respectively, and the NER is the value of the foreign currency expressed in units of local currency.

Hence, an upraise in a country's RER can only mean that the difference between both countries' prices got wider, with the foreign prices getting higher. The local currency has then depreciated. The external real exchange rate can hence be used as an indicator reflecting the evolution of a given country's competitiveness compared to that of the rest of the world.

- The second one is based on distinguishing between tradable and non-tradable goods, based on Salter-Swan policy theory. From its perspective, within a small economy considered as a "price taker", the competitiveness of a country in international trade can be used in the determination of the internal real exchange rate. Consequently:

$$RER = \frac{p_t}{p_n} = NER\frac{p_t^*}{p_n} \qquad (2)$$

Where p_t and p_t^* are respectively the local and foreign prices of tradable goods, and p_n is the price of non-tradable goods.

Based on the above equation, a rise in domestic non-tradable production costs leads to the decrease of the calculated RER and hence the depreciation of the domestic currency and vice versa.

However, the existing literature shows that, among these two measurements, the internal real exchange rate is the most reliable and the most used. Nevertheless, its measuring remains quite problematic given the fact that prices for tradable and non-tradable goods are not always available. Interest has hence shifted towards more well-founded rates known as the "effective exchange rates".

2.2- Effective exchange rates:

The effective exchange rate is a second group of rates which takes into consideration the values of more than one currency to examine that of the one in question. Also known as "the multilateral exchange rates", these are rather indexes which indicate either the appreciation or

the depreciation of the currency, and consequently, the strengthening or the weakening of the competitiveness of the examined economy. This category counts:

- The nominal effective exchange;
- The real effective exchange rate.

2.2.1-The nominal effective exchange rate (NEER):

The Nominal Effective Exchange Rate is an unadjusted weighted rate which estimates the value of a domestic currency against a basket of a given combination of foreign currencies. These currencies count the world's major ones (USD, EUR, YEN...) as well as those of the country's most important trade partners, each of these being given a weight in relation to their part in total transactions. For that, it is also known as the "trade-weighted currency index".

The most used method when it comes to the determination of the NEER is the weighted geometric average of the basket's countries' bilateral nominal exchange rates, following the below formula:

$$NEER = \prod_{i=1}^{n} \left(\frac{S_i}{S_i^*}\right)^{w_i} \quad (3)$$

Where n is the number of foreign countries within the basket, S_i is the exchange rate giving the value of the local currency in terms of the foreign currency i, S_i^* expressing its exchange rate against the same currency but during the base period, and w_i the allocated weight.

It is hence an index used to evaluate the local economy's competitiveness evolution on the international scale. When the value of the NEER increases, then the local currency has appreciated against the basket of currencies as a whole, and vice versa.

2.2.2-The real effective exchange rate (REER):

Similar to the NEER, the REER is also a weighted geometric average of a given country's bilateral exchange rates in relation to a basket of significant foreign currencies. However, the REER comes as an adjustment to the NEER by adding an index of costs or prices to the formula in order to take into consideration the difference of inflation levels between each set of countries. The REER is then a deflated version of the NEER.

The REER formula is as follows:

$$REER = \prod_{i=1}^{n} \left(\frac{S_i}{S_i^*} \frac{p_i}{p} \right)^{w_i} \quad (4)$$

Where p_i is the general prices index in foreign countries forming the chosen basket, and p is the general prices level in the domestic country.

An upraise in the value of a country's REER can be explained by the increasing difference between its prices and those of the international competition, these latter being cheaper. Such situation means that the cost of her imports are evaluated to be cheaper than her exports. The concerned country is losing of its competitiveness.

3- Determinants of the exchange rate:

Being a delicate matter which guides the conception and orientation of countries' vital policies, the determinants of exchange rates presents on an active research area which seeks to assimilate exchange rate determinants. The main determinants of a currency's value can hence be summarized in what follows:

3.1- Inflation levels:

The inflation level refers to the overall upraise in goods and services prices during a specified period of time, within a given economy.

Inflation hence plays a major role in the evolution of a country's exchange rate since it has a pivotal impact on the terms and conditions of its transactions negotiated with investors and trade partners.

The assimilation of new information regarding inflation levels can have two possible opposite exchange market reactions. In fact, a decrease in the inflation rate leads to an increase in the purchase power of the currency in question. Investors would then seek to seize potential investment opportunities and exports volume would swell leading to relative appreciation in the currency's value, in other terms, its exchange rate, and vice versa.

3.2- Interest rates:

Interest rates and inflation within the same economy are highly correlated. Countries with a higher level of inflation tend to offer higher interest rate levels to mitigate the increase in prices.

From the one hand, an increase in interest rates is capable of stabilizing the exchange rate on the short run. In fact, it reassures investors that inflation rates will remain under control, and

that no adverse consequences would be experienced due to extra inflationary pressures. Investors would also prefer to borrow from countries with lesser interest rates to lend to those offering higher interest levels. the result of a such mechanism eventually implies the appreciation of the exchange rate of the lending economies and the depreciation of that of the borrower.

From the one hand, domestic financial assets would gain in terms of attractiveness. Investors seizing the opportunity would generate new capital inflows, increasing the demand on the local currency and feeding the country's exchange supply. These capital inflows are hence capable of uplifting the value of the local currency.

3.3- Public debt:

Also known as national debt, the public debt can be defined as the total sum of a country's outstanding financial obligations destined to cover a shortage in its own resources, with the aim of financing its public expenditures and, eventually, economic growth. These financial obligations are generated by loans which can be contracted on a national scale (domestic debt) as well as an international scale with other foreign governments and international institutions (external debt).

In the latter situation, debt levels are most likely to influence exchange rates. Such is the case when investors start to question default probabilities and the risks they are taking, which might result in a significant cash outflow or and an increase in required interest rates, and hence the depreciation of the country's exchange rate.

3.4- Political stability:

Max Weber defines political stability as the consequence of the legitimate use of physical force by the government. If the latter cannot provide basic services to people, such as security, food and shelter; he loses the power to enforce laws. Which causes political instability".

This latter has been proven to have adverse consequences on economic growth: circumstances of disturbed markets activities and stumbling production are direct threats to productivity. The country hence loses of its economic attractiveness and fails to draw new foreign investments. The demand on the country's currency falls back, leading to the depreciation of its exchange rate.

3.5- Economic performances:

Economic performance can be defined as the reflection of how well a country is achieving its economic objectives. It is an overall image summarizing a wide range of economic indicators, each assessing an economic aspect such as national income, investment levels, competitiveness alongside many others…

From foreign investors' perspective, a country showing good economic performance is a country with positive growth perspectives and hence worth investing in. Foreign currency inflows will generate supplementary demand on the local currency and thus its appreciation.

3.6- Terms of trade:

Another factor which can influence the evolution of a currency's exchange rate are its country's terms of trade. Terms of trade are defined as the ratio between the index of export prices and the index of import prices. If the export prices increase more than the import prices, a country has a positive terms of trade, as for the same amount of exports, it can purchase more imports **(OECD, 2022)**.

Following this index, an appreciation in a country's terms of trade reflexes greater revenue of foreign origins and, symmetrically, a greater demand on its local currency, leading to its appreciation.

3.7- Speculation activities:

Currency speculation consists in buying and selling of a currency based on the previsions regarding the future fluctuations of its value. The aim of such operations is to make significant profit from price differences of opposite transactions.

Based on investors' beliefs regarding the current valuation of a currency (overvalued or undervalued), and taking into consideration the newly gathered information about governmental announcements, political events and others, an increase might be observed in the buying orders which leads to the currency's appreciation, or in the selling orders, which leads to its depreciation.

3.8- Intervention on the exchange rate market:

Based on their analysis and readings of the economic and financial situations, monetary authorities might sense the need to intervene through the adjustment of their currency's

exchange rate. Their intervention on the exchange market allows the control of excessive exchange rate fluctuation, and might have for motive the control of inflation, the strengthening of the country's international competitiveness or the support of its financial stability.

3.9- Monetary policy:

In case of an expansionary monetary policy, interest rates would know a decrease in their levels. Such decrease encourages consumption and thus increases demand on domestic currency. Higher supply levels of this latter would generate rising capital outflows and consequently an appreciation of the currency's price or exchange rate and vice versa.

From another perspective, with time, higher levels of money in circulation push domestic products prices to go higher, damaging the economy's competitiveness and decreasing foreign demand, pushing exchange rates to go downward.

3.10- Fiscal policy:

Fiscal policy is the use of government spending and taxation procedures to influence the economy **(IMF, 2020)**. Taking the example of an expansionary fiscal policy where the government increases its spending in order to promote productivity and create new jobs, sufficient resources will need to be gathered. Mainly through turning into borrowing, such activities lead to higher interest rates, adding to the attractiveness of the economy and hence to the appreciation of its currency given the increase in its demand.

An opposite simultaneous effect is however the increase in local production prices which orientates consumption toward foreign products considered cheaper. A fact that raises demand on foreign currency and pulling exchange rate of local currency to lower levels

4- The role of an exchange rate within an economy:

Within an open economy, exchange rate fluctuations have impacts capable of reaching different economic and social aspects.

It goes without saying that the exchange rate plays one of the leading roles when it comes to international trade, since it conditions the general level of prices at which tradable commodities, finished products and requested services will be settled **(Dornbuch, 1976)**, and can be taken into account to fix trade conditions. An upraise in a country's exchange rate means that its exports got more expensive. Even though this might procure higher revenues and benefit the economy from efficiency improvement and technological progress via workers' motivation,

education and capital intensity, it still risks to exercise negative effects by deteriorating the country's international competitiveness and consequently causing unemployment rates to rise **(OECD, 2011)**. Trade partners would prefer to import their needs from more competitive economies displaying cheaper prices.

Yet the impact process doesn't stop at that level. In fact, in accordance with the evolution of import prices, especially those of raw materials, production costs will follow, leading to changes in inflation rates. A raise in domestic currency makes imports, for a local economy, cheaper. This results in the reallocation of resources in way that stimulates production within the import sector, which will notice greater demand levels, as opposite to exported goods.

The behavior of the exchange rate also conditions the evolution of foreign direct investment, both within the counties borders and investment abroad. As a matter of fact, the appreciation of a currency increases the level of wages and leads production costs to get heavier. Such factors may reduce the country's locational advantage, leading foreign investors to seek better investing opportunities in cheaper countries.

The overall of exchange rate evolutions effects hence has an inevitable influence on the country's economic growth, as it conditions several of its fundamental variables.

II-Exchange rate institutional frame: regimes and exchange rate policies:

Throughout the past century and a half, the world has known numerous events which have gone down in history. These events did not fail to introduce fundamental mutations to basic systems which might have reigned for years, among which the international monetary system (IMS) has not been spared. Within this system, exchange rate regimes adopted by countries around the world have known constant evolutions and changes to their principles and fundamentals, leading to the genesis of distinguished categories, each having its own characteristics.

1- The international monetary system:

1.1- Definition:

The international monetary system can be defined as "an integrated set of money flows and related governance institutions that establish the quantities of money, the means for supporting currency requirements and the basis for exchange among currencies in order to meet payments

obligations within and across countries. Central banks, international financial institutions, commercial banks and various types of money market funds, along with open markets for currency and, depending on institutional structure, government bonds, are all part of the international monetary system." **(Gail D. Fosler, 2011)**.

It is hence an ensemble of internationally agreed rules, conventions and supporting institutions destined to insure and facilitate international trade, cross border investment and reallocation of capital between countries.

1.2- The international monetary system: a brief history:

1.2.1-The bimetallic standard:

Among the very first forms of monetary systems, we can state the Bimetallic Standard, also known as the Bimetallism. Within this system, gold and silver were the only two metals used for coinage. Minted coins were then officially recognized as legal tender, and by the means of which trades were settled. Despite the fact that silver was considered a subsidiary currency compared to gold, coins made out of both metals were not given any calculated bullion value. Instead, they served as payment mediums based on their metallic content or fiat value.

However, across markets, the value used for these coins was noticed to be unequal to their supposedly metallic content value, which set fertile ground to the Gresham Law (1558) according to which this "bad money drove out good money", this latter getting stored or transferred by owners and hence to its disappearance against its prevalence in partner markets, and calling for the disappearance of this system around 1870.

1.2.2-The gold standard:

The system which took over after that was called the Gold Standard. Currencies of countries around the world had their value (or exchange rate) defined as a predetermined value of an amount of gold. Coins and bills could however be redeemed against golden coins at the same fixed price. The characteristic of this system consists in its self-correcting feature. In fact, international balance of payment differences between economies oriented the evolution of gold stocks at their disposal in a way that influences international competitiveness through the reaction of prices, and consecutively, the balance of payment. It is also believed to help reduce government intervention in form of money issuing likely to create inflationary pressures, and ameliorate employment levels alongside revenue.

The choice of gold can be explained by its intrinsic features. Aside from the human nature which believes it to be a prestigious metal, gold is also one of the most versatile rare commodities, and has proven itself to be highly resistant to oxidation and corrosion throughout centuries. Its value will therefore be maintained and is not likely to decrease.
However, initial gold stock and their evolution was considerably dependent on countries geographic distribution, raising concerns about their adequacy with a continuously evolving economy. By the rise of World War I in 1914, distrust was spread among countries. Redemption of currencies and gold transfer across borders were limited. the Gold System was put to end.

1.2.3-The Bretton Woods system:

The post war period has been characterized by an intense instability. Attempts to go back to the Gold Standard were in vein given the past breakdown of confidence. In order to improve the performance of the world's economy when competitive and uncoordinated 'beggar my neighbor' policies had contributed to world-wide recession and unemployment as well as shrinking world trade **(G. Bire, 1996)**, the Bretton Woods summit was held in 1944, attended by delegates of 44 countries.

The outcome of this summit was the Britton Woods Agreement which established:

- The Britton Woods monetary system: This system used gold again as a fundamental reference. However, among currencies, only the united-states dollar was given the possibility of being converted into gold, and had its value fixed at 35 dollars per ounce. The rest of the countries which currencies did not keep such feature were to fix the value of their currencies in terms of gold too. After determining the exchange rate they saw fit against the dollar, they calculated the gold par value of the currency based on that exchange rate.

  However, one commitment was to be abided by: countries were not to make use of devaluation technique to increase their international competitiveness.
- The international monetary fund (IMF): destined to maintain order within the newly established monetary system, and "promote international monetary cooperation, exchange stability and orderly exchange arrangements; to foster economic growth and high levels of employment; and to provide temporary financial assistance to countries to help ease balance of payments adjustment." **(IMF)**.

- The world bank: this organization was established in order to insure the reconstruction of damaged suffering economies, and promote their development. The world bank provides financing, policy advice, and technical assistance to governments, and also focuses on strengthening the private sector in developing countries. **(World Bank)**.
- The world trade organization (WTO): which purpose is to facilitate, promote and supervise world trade.

But with time, the gold stocks at the disposal of the united states started go insufficient compared to the rising demand on the U.S. dollar. The gold hence underwent a certain depreciation. Added to the fact that, despite their commitment to abide by the restrictions regarding payment in gold certain countries showed some uncooperative behavior by accumulating certain gold stocks, the Bretton Woods could not hold any longer and shortly collapsed.

1.2.4-Birth of the contemporary international monetary system:

After the breakdown of the Bretton woods system, countries were no longer under the obligation of maintaining their currencies at a fixed value determined by a base peg. On the contrary, currencies gained the ability of having their value fluctuating in accordance with a number of factors characterizing the economic environment both on the national and international scale. The examination of the currently existing monetary system proves the co-existence of various types of exchange rate regimes across the countries, each of these latter having the right to choose the regime it considers most appropriate seen the fact that their choice is highly correlated with their macroeconomic performances and sustainability of the international monetary system **(A.Gosh & J.Ostry, 2009)**.

2- Exchange rate regimes:

2.1- Definition:

An exchange rate regime, which can be also called "exchange rate system", is a set of rules which guides and regulates the determination of a given country's currency value, that is its exchange rate.

Each country has the right to choose the regime it sees fit to ensure prosperity and economic growth.

2.2- Categories of exchange rate regimes:

Exchange rate regimes are usually classified based on an appreciation of their flexibility. The apparent main two regimes are hence a totally flexible one and a perfectly fixed one, referred to as "polar rates". However, intermediate regimes do exist. The choice of adopting one or the other lies with each country's monetary authorities.

2.2.1-The pegged exchange rate regime:

The pegged exchange rate regime stands at the first one of two extremes tracing the range of possible currency regimes.

Also known as the "fixed exchange rate regime", a pegged rate is that of a currency which value was decided to be tied to that of another or a whole basket of specific currencies. The previously explained Gold Standard hence falls in this category of regimes as money had a predefined fixed valuable reference which is gold. Within modern economies however, the anchor is usually a widely recognized currency, or that of a major trading partner, such as the U.S. Dollar. Or even a basket of delicately selected currencies each weighting proportionally with the geographical distribution of trade, services or capital flows with major trading or financial partners. Such peg hence allows the exchange rate to remain stable and unresponsive to changes in the market.

The selection by a country of this type of regime can be explained by trade purposes. By holding it fixed, a country can bring more stability to its exchange rate. This stability is ought to benefit its trading activities with the rest of the world as it brings some protection to its competitiveness and profitability on international markets. It also increases its attractiveness among foreign investors as it reduces the risks of harmful volatility repercussions. Another explanation would involve inflation. An exchange rate pegged to the world's major currencies allows it an extra protection against increases in import and trade costs, capable of generating inflationary pressures.

However, such regime might prove costly to maintain as the monetary authority would have the extra obligation of preserving the adequate exchange supply necessary for maintaining the targeted exchange rate.

2.2.2-The flexible exchange rate regime:

Opposite to previously mentioned regime, the flexible exchange rate, also known as the floating rate, is the worth of a currency left to be freely determined by the activity characteristics

on the exchange market. The floating rate is hence the result of the confrontation of demand and supply levels. When monetary authorities do not intervene to control or influence its evolution, we hence talk about a "clean float" or "pure float".

Under this type of regime, monetary authorities dispose of high degree of independence as they can elaborate and adopt the policies they consider most appropriate for the local economy without having to be constrained by policies applied abroad the stay in line with the chosen peg. It also avoids having a stagnant currency value and hence helps decreases the risk of speculative attacks as the market's activity would ensure a permanent adjustment of the exchange rate. Last but not least, such regime does not put an extra obligation of maintaining a certain and usually high level of foreign currencies' reserves necessary for maintaining a currency at a fixed level. However, under flexible exchange rate regimes, the parities would make proof of a high level of volatility.

2.2.3-Intermediate regimes:

The constant changes in the economic environment awakened long lasting debates in regard to which, among the pegged and the floating, is ought to be considered most fit. Considering wide inflation differentials and international economic problems between countries, **Helmut M. (1982)** argues that both are bound to lead to unacceptable results if applied exclusively, and insists on the need for permanent exercise of judgement and discretion.

- A managed float: Where the exchange rate determined by the market's activity can be submitted to authorities' adjustment in order to influence its level or re-orientate its evolution. This very sub-category of the floating regime is attributed to what is known as "the fear of floating", as undesirable fluctuations in the exchange rate risk a damaging depreciation of the currency's value, losing control over the local currency, jeopardizing the country's financial system and increasing the cost of contracted debts given the fact that emerging countries borrow from the rest of the world in foreign currency as they cannot do so in their own currency[1].
- Adjustable peg regimes: Within this regime, the exchange rate of a country is fixed to an anchor like explained above, however, it presents the possibility of being regularly manipulated or "readjusted" by monetary authorities when the need arises.
- Crawling peg regime: Even though pegged to another reference, this regime allows slight fluctuations of the exchange rate value. These fluctuations are nevertheless

[1] This phenomenon is also referred to as « the original sin » by Berry Eichengreen and Ricardo Hausmann.

restrained within a band drawn by a maximum and a minimum rates which cannot be exceeded.

- Target zone regime: Target zone differs from a fixed rate regime in allowing a fairly wide range of variation for the exchange rate around some reference rate. **(PAUL R. KRUGMAN, 1991)**.

Section 2: Equilibrium real exchange rate theories and misalignment:

During the 1980s, the correct alignment of the real exchange rate and its stability were seen as key factors for a proper economic development process **(Williamson, 1996)**. However, a prior step would be to assess the equilibrium level from which exchange rate misalignment is believed to have a multitude of consequences.

I- Fundamental concepts related to the equilibrium real exchange rate:

1- Definition:

The concept of an equilibrium exchange rate can be defined as the rate that maintains simultaneously the internal and the external balances of an economy.

The internal balance has been interpreted as a state of equilibrium within the non-tradable goods market at a high to almost full employment rate. This idea assumes that the observed effective demand on the said market, at a full employment state, is of a maintained level given a distribution of wages presenting a constant level themselves, and thus a stable level of prices. In other terms, it is the maximum level of growth which does not accelerate the rates of inflation. As for the external balance, it can be achieved by insuring a current account balance which is neither way in deficit nor way in surplus. For instance, if the current account presents a deficit, an external balance would then mean that this deficit is capable of being covered through future structural capital inflows.

The equilibrium exchange rate can have two forms:

- An ex ante form expressing the rate that could have allowed an equilibrium situation in an anterior period of time;
- An ex post form expressing the eventual rate that is likely to help achieve a future equilibrium situation.

2- Equilibrium exchange rate theories:

Several competing views trying to offer an appropriate measurement of the equilibrium exchange rate were able to establish a collection of theories known to be sometimes diverging yet other times complementary. We will hence proceed to the presentation of the most applied ones among them.

2.1- The purchasing power parity theory:

The Purchasing Power Parity theory of exchange rate is one of the oldest theories interested in the determination of a country's equilibrium exchange rate which goes back to the 17th century and which was renewed during the 19th.

This theory establishes the fact that the "real parity between two countries is represented by this quotient between the purchasing power of the money in the one country and the other." **(Cassel 1918)**. According to this principle, the equilibrium exchange rate is nothing other than the rate at which the general level of prices applied within two different nations in relation to the same basket of goods are equal when expressed in the same currency, and thus the set of units would have the same purchasing power.

This, however, is based on the validity of a fundamental hypothesis, that of the "Law of one price" which indicates that "In the assumed absence of transport costs and trade restrictions, perfect commodity arbitrage insures that each good is uniformly priced (in common currency units) through-out the world." **(Isard, 1977)**.

At that point, the PPP of a given country can take two forms:

- The absolute purchasing power parity;
- The relative purchasing power parity.

2.1.1- The absolute purchasing power parity:

According to this first aspect of the PPP, the equilibrium exchange rate is simply the result of the ratio of the domestic price to the foreign price of a given bundle of commodities as follows:

$$S = \frac{P}{p*} \qquad (5)$$

Where:

S = The exchange rate of a domestic currency against a foreign currency

P = The domestic price of the considered basket of commodities;

P* = The foreign price of the same basket of commodities.

However, such considerations imply that the resulting exchange rate is a invariable and thus, such theory can't really hold.

2.1.2-The relative purchasing power parity:

This second form is considered to be an expansion of the first one, destined to take into consideration the variation in currencies purchasing power following the fluctuation in the countries inflation levels. This means that the current exchange rate will be adjusted for inflation differentials over a period between the two currencies in question.

Consequently, this version of the PPP does not consider the prices in both countries to be equal, however, it assumes that the relative purchasing power of each would stay the same on a long run scale. Following this idea, the exchange rate can be determined thusly:

$$S_{At} = S * \frac{P_{Bt}/P_{B0}}{P_{At}/P_{A0}} \quad (6)$$

Where:

S = The exchange rate in the base period;

P_{A0} and P_{At} = The prices indices respectively in the current and base periods of the country A;

P_{B0} and P_{Bt} = The prices indices respectively in the current and base periods of the country B.

2.1.3- Validity of the theory:

It goes without saying that the PPP theory did receive numerous critiques over the years, mainly stimulated by currencies' behavior as several industrialized countries switched to flexible exchange regimes around 1976. In fact, exchange rates showed a great fluctuations pushing them away from staying aligned with the PPP. Such was the case of the British pound and the Italian lira which remained undervalued compared to their theoretical PPP value, while the Swiss franc and the German mark were considered overvalued[2].

[2] The undervaluation and overvaluation phenomena are further explained and developed in the following sections.

Consequently, some questioned the validity of the "law of one price" given the fact that it does not apply to the non-tradable commodities since their prices are not subject to international arbitrage. Aside from the fact that it implies an equilibrium level equal to unity, the above mentioned law is also based on hypothesis that cannot be verified, like the absence of transaction costs which are actually quite significant as well as barriers to international trade.

Other critiques questioned the constancy of the exchange rate on the long run. Such is the case of the Balassa-Samuelson effect which highlighted the factors causing PPP distortion. For this, it explains how international relative productivity differences between tradable and non-tradable goods leads to the unsustainability of the exchange rate. In fact, in the case of a developing country, an increase in productivity is generally much more observed in tradable goods sector which leads to a raise in prices proportional to that of salaries. Non-tradable goods sector, however, would undergo a similar raise in wages in a way that cannot be absorbed unless a considerable raise a prices is announced, and hence the appreciation of the exchange rate.

Last but not least, as it is considered to be a mean-reverting stationary process, an exchange rate considered to be highly volatile on the short run would converge back toward its long run level, however, this proves to be a quite slow process, and quite unlikely to happen, and thus owning its name as "the PPP Puzzle" **(Rogoff, 1996)**.

2.2- The "macroeconomic" theories:

As a response to the identified lack of consideration of macroeconomic factors in the determination of the exchange rate by the PPP method, another group of studiers believed that there is more to the equilibrium rate than relative prices. A belief regarding the existence of a set of real determinants which keep inspiring the exchange rate to change of equilibrium level helped push research into the establishment of several new guiding models among which we chose to present the three most applied approaches: the FEER, the BEER and the NATREX.

2.2.1-The Fundamental Equilibrium Exchange Rate approach (FEER):

The FEER method was first established by **John Williamson (1983)**. As defined by its establisher, the Fundamental Equilibrium Exchange Rate is "the rate which is expected to generate a current account surplus or deficit equal to the underlying capital flow over the cycle,

given that the country is pursuing internal balance as best it can and not restricting trade for balance of payment reasons" **(Williamson, 1985)**.

The FEER can simply be introduced as a REER which is consistent with sustainable macroeconomic balance over medium and long run, meaning a balance on both internal and external levels, as explained above. Yet the internal balance is believed to be achieved once the external one is, meaning a sustainable balance of payment. It is thus the rate that seeks to equalize its two main components: the country's capital account and a sustainable targeted current account, which can be written as follows:

$$CA = -KA \tag{7}$$

And since the current account is the sum of the net tradable balance (ntb) and the net foreign assets (nfa), with:

$$\text{ntb} = \beta_0 + \beta_1 q + \beta_2 \bar{y}_d + \beta_3 \bar{y}_f \tag{8}$$

$$nfa = f(q) \tag{9}$$

Where:

- $\beta_1 > 0$; $\beta_2 < 0$; $\beta_3 > 0$
- $\bar{y}_d$ and $\bar{y}_f$ are full employment outputs in local and foreign economies, respectively;
- q is the REER.

To find the equilibrium exchange rate following the FEER approach, the first step would be to determine the level of capital account at equilibrium on a medium run $\overline{KA}$, and then to find the FEER. Equations above then lead to the equalities below:

$$CA = f\left(q^{FEER}, \bar{y}_d, \bar{y}_f\right) = -\overline{KA} \tag{10}$$

$$q^{FEER} = f\left(\overline{KA}, \bar{y}_d, \bar{y}_f\right) \tag{11}$$

According to Williamson, the fluctuations of the REER across the time should lead the actual current account to meet its equilibrium sustainable level. However, it is important to mention that the application of such approach faces a number of difficulties. Such is the definition of the sustainable level of the current account, given the fact that the FEER to be sought depends of the level to be chosen and accepted as sustainable. This latter depends mainly on external debt level, openness degree as well as internal equilibrium. Noting that the first of the said three

factors is not limited and hence can take an infinity of "sustainable levels", the definition of the FEER would need thorough study, especially for countries which current accounts are in deficit.

Aside from that, there are the GDP previsions, both domestic and foreign, which need to be calculated and followed in order to maintain internal equilibrium.

As it is based on desired levels of macroeconomic identities, the FEER is hence a normative value of the exchange rate and not an exchange rate per se **(Clark and MacDonald, 1998; Bayoumi et al., 1994)**.

2.2.2-The Behavioral Equilibrium Exchange Rate approach (BEER):

Elaborated by **MacDonald (1998)**, the Behavioral Equilibrium Exchange Rate (REER) approach is considered to be an extension of the FEER approach. It seeks to further explain the dynamic of the exchange rate by taking into consideration a variety of economic fundamentals, on short, medium and long run scales, in the aim of exploiting the eventual co-integration links relating them.

The initial equation explaining the NER would then take this following form:

$$q_t = \beta_1 Z_1 + \beta_2 Z_2 + \tau T_t + \varepsilon_t \quad (12)$$

Where :

- Z_1 and Z_2 are vectors of economic fundamentals relative to long run and medium run, respectively;
- T is the vector of transitory factors relative to the short run;
- β_1 , β_2 and τ and the vectors of reduced for coefficients;
- ε_t is the random distribution error term.

From which derives the rate q'_twhich can insure an equilibrium state given the existing economic factors:

$$q'_t = \beta_1 Z_1 + \beta_2 Z_2 \quad (13)$$

To move further, this approach takes as underpinning theory the concept of uncovered interest rate parity, according to which the change in exchange rates of a country is explained by the difference in interest rates between the said country and the foreign one, thusly:

$$E_t(e_{t+1}) - e_t = i_t - i_t^* \quad (14)$$

With $E_t(e_{t+1})$ being the expected NER at t for the t+1 period and i_t and i_t^* being the nominal interest rates in the local and foreign economies, consecutively, without considering the risk premium component for now. Taking into account the inflation differential leads to:

$$E_t(q_{t+1}) - q_t = r_t - r_t^* \quad (15)$$

Where $E_t(q_{t+1})$ being the expected real exchange rate value for t+1, and r_t and r_t^* being the real interest rates in the local and foreign economies, consecutively.

Yet within the context of this approach, the $E_t(q_{t+1})$ is supposed to be mainly explained by long run economic factors represented by the Z_t. Adding this fact to the above equation, we conclude so far that:

$$q_t^{REER} = f\left(Z_t\,;(r_t - r_t^*)\right) \quad (16)$$

According to **Clark and MacDonald (1998)**, the Z_t factor includes three long run factors:

- The above explained Balassa-Samuelson effect (tnt);
- The terms of trade (tot): reflecting the state of the trade balance;
- And the net foreign asset (nfa): this factor helps take into account the variations in interest income which have to be counterbalanced by equivalent but opposite adjustment to the current account. **(Lane and Milesi-Ferretti, 2002)**.

To which is added the risk-premium component represented by $\left(\frac{g_{debt}}{g^*_{debt}}\right)$, leading to the equilibrium exchange rate:

$$q_t^{BEER} = f\left(Z_t\,;(r_t - r_t^*)\,;tnt;tot;nfa;\left(\frac{g_{debt}}{g^*_{debt}}\right)\right) \quad (17)$$

2.2.3-The Natural Rate of Exchange (NATREX):

Despite the abundance of researches concerned by the exchange rate and its determination, their grasp remains mostly limited to its movement on a short run scale, leaving its long run fluctuation in need for deeper explanation.

Given this fact, **Jerome L. Stein (1994)** conceptualized the NARTEX approach destined to follow the real exchange rate movement on both medium to long run scales, based on the changes touching the main real fundamental factors considered to have a major role in orienting its fluctuations.

The NATREX is hence an inter-cyclical moving equilibrium exchange rate influenced by a number of fundamental disturbances. In Stein's words, it is "the equilibrium real exchange rate that clears the balance of payment in the absence of cyclical factors, speculative capital flows, and movements in international reserves" **(Stein, 1994)**.

- **General approach:**

The starting point of the NATREX approach is a state at which a medium run equilibrium is achieved, in which prices have adjusted and output has returned to its inter-cyclical potential level **(Stein, 1994)**.

A balanced BOP and goods market can be presented by the standard national income accounts equation:

$$I - S + CA = 0 \tag{18}$$

Where I stands for "desired national investment" and S stands for "desired national saving", both considered to take part in the dynamic of the exchange rate, and CA for "current account" at its desired level.

It is important to note that the medium run equilibrium needs to submit to three conditions:

- The domestic securities market to be clear;
- The cyclical and speculative capital flows to be canceled out;
- The difference between investment end saving to represent the excess flow of supply of long term securities.

Under such conditions, fundamental disturbances to desired levels of saving and investment, which alter the exchange rate from its equilibrium level, would lead to the need of adjusting the current account balance, in a way that pushes the exchange rate to find a new equilibrium level.

With regard to the fundamental disturbances, Stein defines them as disturbances to productivity and social thrift (that is the time taken both by households and the government to spend what they have of money), to which he adds changes in terms of trade and the world real interest rate when the economy in question is a small one. These factors have a major effect on the country's stock of capital, wealth and foreign debt, which variation alter the levels of investment and saving. For this, these are considered to be at the origin of the NATREX dynamic.

One major characteristic of the NATREX is that it distinguishes between the medium run equilibrium from the long run one. It is in fact considered to be a series of three models, each representing a horizon of time:

- The first one is concerned with the exchange rate on the short term which is referred to as the "actual rate". It expresses the exchange rate as a function of the stock of net real assets (A), short run cyclical and speculative factors (C) and exogenous fundamental factors (Z), and so:

$$q_t = q_t(A; C; Z) \quad (19)$$

- The second one presents the exchange rate on the medium term, known as the equilibrium rate or NATREX.

$$q = q(A; Z) \quad (18)$$

- The last presents the long-term exchange rate, referred to as the steady-state rate, toward which the NATREX tries to converge.

$$q^* = q * (Z) \quad (19)$$

Given the fact that the fundamentals are not of consistent values, the NATREX is hence non stationary.

3- Exchange rate misalignment:

3.1- Misalignment defined:

Following the adoption of different forms of floating exchange rates around the world, exchange rate movements became an inevitable fact. While exchange rate fluctuations refer to constant movements of currencies' values, the exchange rate misalignment is a concept which refers to the deviation of the current observed real exchange rate from its equilibrium level **(Frait & Komarek, 2001)**. Considering the definition previously given to the equilibrium exchange rate, misalignment hence reflects the general degree of exchange rate deviation generated by the presence of disequilibrium in the economic environment, was it on the internal or the external level.

Such deviations might take two forms:

- either the current exchange rate is going to be considered higher than its equilibrium level, in that case the currency would be labeled "overvalued";

- or it is going to be below its equilibrium level, in which case the currency is said to be "undervalued".

The assessment of exchange rate misalignment can be expressed relative to the actual or the equilibrium level of the real exchange rate. As the degree of deviation from the equilibrium level, the exchange rate misalignment denoted Mis below can be calculated as follows:

$$Mis = \left(\frac{REER}{REEReq} - 1\right) * 100 \quad (20)$$

Where REER is the current real effective exchange rate and $REEReq$ refers to the REER's equilibrium level.

Given the fact that the current REER's value is known and observed while the equilibrium level remains uncertain, the exchange rate misalignment can hence be calculated in a way that it expresses the appreciation or depreciation needed to bring the actual REER back to its equilibrium level. The misalignment can thusly be calculated as follows:

$$Mis = \left(\frac{REEReq}{REER} - 1\right) * 100 \quad (21)$$

3.2- Sources of misalignment:

According to **Edward (1994)**, observed exchange rate misalignments can have two origins. they can either be:

- **Macroeconomic-induced misalignments:**

These deviations from equilibrium levels are the result of an inconsistency between applied macroeconomic policies, mainly monetary policies, and the current official nominal exchange rate. Such is the case, for example, of an expansionary monetary policy which would rely on dropping interest rates to boost the economic activity. Within a predetermined nominal exchange rate system, such policy would stimulate a rise among domestic goods prices leading by that to the appreciation of the real exchange rate. Within a floating exchange rate system, this might lead to an increase in both non-tradable goods' prices and the nominal exchange rate. Other examples can include the implementation of capital controls in concerning inflows and the increase of the liberalization of capital outflows, monetary authorities' interventions on exchange markets with the aim of nominal depreciation associated with an anti-inflationary

policy, such as price and wage moderation are also capable of leading a currency to its undervaluation.

- **Structural misalignments:**

These misalignments are generated by changes in the fundamentals determining the equilibrium level. Since the impact of such changes on the real exchange rate can only be observed with a delay in time, the current exchange rate might hence present a significant deviation from its equilibrium state.

4- Empirical literature on exchange rate misalignments:

4.1- General empirical literature:

Literature interested in the equilibrium exchange rates and their determinants is considerably extensive. Mentionable empirical works would count **Froot and Rogoff (1995), Rogoff (1996)** and, for developing countries, we encounter **Edwards (1989), Hinkle and Montiel (1999), and Edwards and Savastano (2000)**. Along with many others, these studies adopted different approaches as they employed each time a different set of fundamentals.

For comparative purposes, **Ca'Zorzi & al. (2020)** assess the equilibrium exchange rate for a set of countries using the BEER and the PPP approaches. Their results came in line with existing theories sustaining the fact that, while the PPP has a useful forecasting power, the BEER possess a better "storytelling" capability as it employs the historical series of used fundamentals to trace the trajectory having been followed by the exchange rate.

From their side, **Saadaoui, Mazier and Aflouk (2013)** applied the FEER approach as they aimed to identify the main determinants of real exchange rate misalignments for a panel of emerging and industrialized countries throughout 1982 to 2008. The achieved result led to trade openness, financial openness as well as regional specialization playing the main role. From that, they supported the previously argued point of view of **Saadaoui (2001)** by sustaining that the estimated undervaluation could be reduced through an increase in the capital account openness.

Seeking to explain long-run movements in the REER, **Faruquee (1995)** applies the cointegration technique in the case of the U.S.A and japan in the post-war era. Results suggested that net foreign assets and productivity differentials are the key explanatory factors, sustaining by that the idea that current and capital accounts balances intervene deeply in dictating the

REER path. **Combes, Kinda, and Plane (2011)** employ a sample of emerging and low-income countries to examine the potential influence of capital inflows on real exchange rates. They discover that overall capital inflows are strongly related to actual appreciation.

Among the very first adoptions of the NATREX approach was the empirical study held by **J. Stein (1995)**. Applied to the US dollar, he was able to obtain evidence supporting the unstable nature of equilibrium real exchange rates, which he attributes to the constant changes in fundamentals, apposing by that the claims of the PPP theory. His theoretical results were able to discern the impact of chosen fundamentals responsible for the shape of this trajectory and which count the productivity of capital at home and abroad, the US index of social consumption and the difference in interest rates between the US dollar and the G-10. This set of fundamentals was indeed not reflected in the RER in the short run as short run movements are considered to be mere results of speculative capital flows, as opposite to longer run movements which translate the pressure put by the market leading the RER to find its NATREX level.

Another attempt was made by both **Lim & Stein (1995)** seeking to extract adequate explanation of the medium to long run behavior of the RER in a small open economy such as Australia. Obtained results firstly showed that Australian RER has exogenous determinants consisting in the terms of trade as well as relative foreign prices ratio of non-tradable to tradable goods. Similar studies conducted by the Central Bank of Australia indicated that terms of trade do have the highest influence among a set of three elements including long term interest rates differential and net foreign assts. Endogenous effect, on the other hand, comes from its proper ratio of non-tradable to tradable goods prices.

Inspired by these original works, **Bouoiyour & Rey (2005)** adopted a similar approach seeking to examine the behavior of the real exchange rate of the Moroccan dirham against the European currencies. Analysis of its movements concluded that the overvaluation of the Dirham has undeniable impact on the trade flows as it pushed forward its imports compared to its exports.

Chaouch, Medhar and Toumach (2020) were able to prove that an increase in domestic Algerian productivity and terms of trade would lead to the appreciation of the REER on the long run. Similarly, time preference plays a huge role in the orientation of REER evolution. However, they describe its impact to be rather ambiguous, at least for the Algerian case.

4.2- Existing studies in regard with Tunisia:

Many studies have also considered the case of the Tunisian economy and attempted to examine whether or not the real value of the Tunisian dinar and its estimated equilibrium level are misaligned. Several periods and different sets of fundamental variables have been considered. Obtained results showed some convergence as well as some divergence as models, periods and fundamentals differed.

After proving the existence of a long run relationship bounding the REER of the Dinar, **Ben Mbarek H. and Ben Romdhane H. (2011)** investigated the origins of observed instability in this estimated long-run equilibrium between 1979 and 2001. They were able to identify a link between the observed disruption periods and the level of control applied by authorities over the exchange rate. In fact, during that period, the exchange rate regime features showed continuous changes as it went from strict due to severe trade balance deficit (1976-1985), to even stricter following the launch of the structural adjustment plan (1986-1988) before becoming lenient after a general mastery of the external deficit (1989-2001).

An attempt to assimilate the set of fundamental determinants of the Tunisian Dinar and assess the efficiency of the exchange rate policy was also made by **Ben Ali.T and Amara.T (2012)** and which covered the period from 1976-2010 employing the VECM model. Variables of interest counted the terms of trade, domestic investment, public expenditure, trade openness, foreign direct investment along with GDP. Their conclusions were positive in regard with the efficiency of the exchange rate policy which main target back then was to consolidate and reinforce the economy's competitiveness.

Charfi (2008) considered the period 1983Q4 to 2000Q4 to examine the evolution of the REER compared to its equilibrium level in Tunisia. The estimation of this latter was based on the selected fundamentals counting terms of trade, trade openness, net foreign assets and productivity. A VECM application returned an undervaluation which reached a maximum of 35% throughout the first 10 years before finding its equilibrium level around which it kept slight fluctuations of around 5%.

A working paper prepared by the **African developed bank (2013)** used the net foreign assets, government consumption, openness, terms of trade and investment to examine whether there is misalignment between the REER and estimated equilibrium levels in the case of Egypt, morocco and Tunisia. The latter case seemed to reflect a low level of misalignment which did not exceed 5% of overvaluation between 1997 and 2004 nor of undervaluation between 2004

and 2009, and which was explained by the abandonment of exchange rate targeting and the switching toward a more flexible exchange rate regime.

Bouzid A. (2021) also followed the BEER approach to estimate the equilibrium equation of the REER in Tunisia. In her case, the selected variables consisted in productivity, terms of trade, openness, debt, and public expenditure. The results reflected an undervaluation over a first period of the sample from 1987 to 2003 with an average undervaluation of -14.53%, before transforming into an overvaluation over the period from 2004 to 2015 with an average of +13.38%.

An ARDL model has been constructed by **Benzid L. (2021)** which included productivity, government expenditure, investment, net foreign assets and commercial openness with a sample of observations covering the 1980-2019 period. The obtained results suggested a permanent overvaluation of the Tunisian dinar, to which the author associated the poor competitiveness of Tunisian economy.

Published work of **Elbaz and Tmar (2020)** applied the methodology of error correcting model via the implication of the following fundamentals: economic openness, money supply in terms of GDP and GDP per capita. Seeking to evaluate the competitiveness of the Tunisian REER, the results returned three sub-periods: an overvaluation from 1975 to 1987, an undervaluation until 2008 and then an overvaluation again until then and of the sampled period.

Seemingly, a recent work was conducted by **Derbali.A (2021)** for the period 1990-2020 adopting the BEER approach which aim was to evaluate the applied exchange rate policy in Tunisia through the application of a vector error correction model (VECM) which included the terms of trade, openness level and local and trade partners' productivities. Despite the efforts of the monetary policy, these remain insufficient on their own, as the intensified overvaluation over the last 5 years with a peak of 33% in 2019 expressed the need for a further synergy between the central bank's actions and the fiscal policy to be able to face the dysfunctions and imbalances of the economy.

Conclusion:

Given the macroeconomic role of the exchange rate as one of the central and key factor in the context of the overall performance of a given country, this first chapter was dedicated to the definition, the determinants and the existing possible measurements of this factor. Following that, a second important topic was evoked, and which examined the concept of misalignment, a derivative issue which finds its origins in that of exchange rate equilibrium levels. While theories and empirical conceptions might present some convergence under the effect of the studied economy's circumstances and the use trying to be made out of the built calculations, the substantial richness of the existing literature can only put extra emphasis on this field of study, especially that these specific topics are crucial when it comes policy conceptualizing and general welfare of economies. While no consensus has been achieved neither in regard to the most appropriate estimation method, nor to the most representative set of fundamentals capable of tracing the most accurate trajectory followed by the REER, the selection of a study methodology is left to the economic characteristics of the country in question as well as the examiner's appreciation.

Chapter 2: Equilibrium REER and misalignment: An application to the Tunisian Dinar

Introduction:

After shedding light on the misalignment concept, we dedicate this chapter to the assessment of eventual misalignment of the Tunisian dinar. However, to check whether the dinar's REER is under or over-valued, a concrete estimation of its equilibrium rate is a necessary first step.

In our attempt, we chose to employ the BEER approach. Our choice is explained by the fact that this approach represents a consistent method with the equilibrium concept. It is also considered to be most appropriate for small economies.

In what follows, we will dedicate a first section to present some stylized facts about the exchange rate policy in Tunisia and the evolution of the dinar throughout the 21st century. A second section will later present the chosen determinants we selected to conduct our study before diving into the estimation of the equilibrium exchange rate and assessing the misalignment of the Tunisian dinar.

Section 1: Stylized facts from Tunisia:

I- The exchange rate policy in Tunisia:

As structural changes in the economic environment's features marked history after the collapse of the Bretton woods system, and after obtaining its independence in 1956, the Tunisian authority had to consider the reorientation of its exchange rate policy several times as it sought to protect general welfare.

Starting with a fixed exchange rate regime which it maintained from 1973 to 1986, this latter knew five consecutive adjustments **(Safra & Ben Marzouka, 1987)** resumed in the following table:

Table 1: Evolution of the exchange rate regime in Tunisia 1973-1986

Period	PEG characteristics
1973-1978	The Tunisian Dinar was pegged to the Deutsche Mark.
1978-1981	The Tunisian Dinar became pegged to a basket of currencies counting the European currency unit, the U.S. Dollar and the Deutsche Mark to avoid the risks aroused by the fluctuations of this latter.
1981-1984	The reference basket was expanded in accordance with the international trade features following the fall in oil prices.
1984-1985	The reference basket was expanded again to include competing countries as the Tunisian currency has been appreciating. The aim was to reinvigorate exports and strengthen the competitiveness of Tunisian products.
1985-1986	Adjustments were once again brought to the reference currencies basket following the prevailing recession and the recorded deficit in the balance of payment. As these adjustments proved insufficient, the central bank had to devalue the Dinar by 10%, marking the switching towards an intermediate exchange rate regime.

Source: Own construction

During the early 90s, the Tunisian government did not dispose of a clear platform treating of macroeconomic stability. As a consequence, the exchange rate was considered to be a determinant and crucial variable when it comes to macroeconomic stability **(Kalai & Helali, 2015)**. Amidst such circumstances, the central bank of Tunisia adopted a policy which targeted the real effective exchange rate as it sought to preserve the competitiveness of the country's economy. This policy which consisted in a periodic adjustment of the nominal exchange rate to maintain the real exchange rate rather constant proved to be more or less efficient.

At the start of the 21st century, the Tunisian dinar was granted increased fluctuation freedom as recommended by the IMF with the aim of enhancing competitiveness and boosting exports. Up until the revolution which busted in 2011, the Tunisian dinar was kept anchored to a basket of currencies relative to its main trading partners. Following the revolution event and until 2016, the IMF classified the exchange rate regime as floating, before switching back to crawl-like arrangement in 2017 **(Khatat, End & Kolsi, 2020)**.

II-An overview on the real exchange rate of the Tunisian dinar:

Under the influence of the consecutive changes brought to the exchange rate policy followed by the central bank of Tunisia, and given its exposer to continuous changes in the macroeconomic environment, it would not be surprising to identify changes in the behavior of the Tunisian currency.

Figure 1:Compared evolution of bilateral exchange rates

Source: CBT

As it can be seen in the above figures, since the very first observation in our sample, the Tunisian dinar has been following a general downward trend against the main settlement currencies of the country, be the euro and the USD. The dinar's depreciation, however sluggish, proved to be constant, particularly against the euro.

Such depreciation has accelerated its pace by the year 2016 as the central bank of Tunisia switched toward a floating exchange rate regime, to lead the dinar to its lowest values by the start of 2019. In fact, the euro reached a maximum value of 3.44 dinars while the USD could be sold for 3.02 dinars. These depreciations can find their origin in the overall deterioration in the external balance as the current account deficit showed deep negative balances, reaching a record level of -11 760 billion TND, approximating -11.2% of the country's GDP. The dinar recovered some of its value throughout the following years, as the external balance knew some

stabilization in its evolution. The year 2021 was hence closed at 3.26 dinars the euro, and 2.87 dinars the USD.

Section 2: presentation and statistical description of chosen variables:

Before diving into empirical analysis, introducing the selected macroeconomic variables which will build our model would be appropriate. A brief theoretical analysis of their impact on the real exchange rate, as established by existing literature, will also be given.

I- variables definitions and sources:

1- Introducing the selected variables:

For the selection of the variables to be included in our model, we examined the existing attempts concerned with the estimation of the equilibrium Tunisian dinar rate as well as literature studying small open economies in general. The consulted works employed several fundamentals such as: the terms of trade, the degree of trade openness, the relative productivity, net foreign assets, foreign direct investment, current account, GDP, the balance of payment, government expenditure, gross saving, real interest differential …

Based on our research, we decided to follow the model of **Montiel P. (1999)** as it is a model intended to analyze the determinants of the REER in small open economies, and takes into consideration a set of factors relative to different economic aspects. The selected variables which will build our model are hence explained in what follows.

1.1- **The real effective exchange rate (REER):**

As previously explained, the REER is a weighted geometric average of a given country's bilateral exchange rates in relation to a basket of significant foreign currencies adjusted by an index of costs or prices.

We focus on the *real* exchange rate for two reasons:

- First, the real, rather than the nominal, rate determines basic economic decisions about consumption, growth, and resource allocation;
- Second, a moving inter-cyclical equilibrium, neutral with respect to money, can be expressed wholly in real terms, making the equilibrium *real* exchange rate independent of the nominal exchange-rate regime.

1.2- The terms of trade (tot):

The terms of trade variable is a factor which helps capture the changes in the international economic environment. As Tunisia is considered to be among the small open economies category, terms of trade are expected to play a major role as an exogenous fundamental.

Terms of trade refer to the relative price of exports in terms of imports. It can also be interpreted in terms of units of goods, that is the amount of import goods that can be purchased against one unit of export goods.

Considered to be one of the economy's health indices, the "terms of trade ratio" communicates an idea on the capital flows leaving and entering a given economy. In fact:

- when the tot ratio is greater than 100%, the economy makes more from its exports than what it has to pay for its imports. It is hence accumulating capital.
- When tot is less than 100%, capital flows leaving the economy surpass entering flows, and so the country's capacity to import would be reduced.

Commodity price booms and busts are generally admitted to pose complex challenges for the determination of the long-run rate in which the real effective exchange rate adjusts to ensure equilibrium of the macroeconomic system **(Ricci et al., 2013)**. As trade prices change over time, terms of trade can either improve or deteriorate. The former case can result from an increase in export prices or a decrease in import prices, and vice versa. As generally linked to demand, such variations have two possible effects on the real exchange rate: An income effect and a substitution effect.

When import prices get higher, a substitution effect takes place, diverting demand from imported goods to non-tradable goods which rise in prices leads to an appreciation in the real exchange rate. However, existing evidence suggest that the terms of trade affect the real exchange rate mainly through an income effect **(José Dc Gregorio Holger C. Wolf 1994)**. As national income grows, public and private expenditure would tend to increase leading to a rise in prices of non-tradable goods. And given the fact that tradable goods prices are rather exogenous, an appreciation in the real exchange rate can be observed **(Mien E. 2020).** Nevertheless, the opposite can also take place, according to **Edwards (1989)**, when the substitution effect dominates the income effect, a depreciation in the real exchange rate would be observed. **Rudiger Dornbusch (1980)** from his side explains that if the terms of trade

improvement is generated by a decrease in import prices, the income and substitution effects would work in opposite directions. For **P. Neary (1988)**, unless there is a dominating complementary relationship, a term of trade improvement tends to lead to a real appreciation.

1.3- Trade openness:

The degree of trade openness within a country plays the role of a commercial policy factor. In fact, trade openness can be understood as the degree to which non-domestic actors can or do participate in a domestic economy **(Grabner & Heimerberger, 2018).** It hence represents a proxy for the country's commercial policy **(Elbadawi, 1994).** It is generally estimated by comparing the value of an economy's total imports and exports to its GDP. Consequently, the greater the value of import and export transactions is, the higher the openness degree.

As for its impact on the real exchange rate, several works **(Dornbusch, 1974; Balassa, 1975; Li 2004)** explained how an increase in the openness degree of a given economy would theoretically lead to a real exchange rate depreciation. In fact, when an economy dives deeper into the liberalization of trade through the easing of custom tariffs and reduction of existing barriers to trade, demand for foreign goods would rise in a way that might damage the current account balance, and depreciation of the local currency would hence be necessary.

Literature review **(Hau 2002; C. Calderon, 2004; Devereux and Lane's 2003)** also proves the existence of a negative relationship between trade openness and real exchange rate volatility. Substantial evidence explained how a high level of openness would facilitate a quick adjustment of the aggregate domestic price level, limiting by that the effects of money supply in the short-term, and consequently leading to a decrease in the effects on the exchange rate.

1.4- Productivity:

In our model, productivity will be included as a domestic supply-side factor. Theoretically, the impact of productivity on real exchange rate can be explained by referring to the **Harrod (1933)** and **Balassa-Samuelson (1964)** theory, also known as "the productivity bias hypothesis". In higher-income countries, focus would generally target tradable-goods-producing sectors leading to an increase in their productivity compared to those of non-tradable goods, and thus to higher wages. This would influence non-tradable goods prices to rise themselves. Considering the Law of one price to be valid, prices of tradable goods in foreign less productive countries would seemingly rise, which is not the case for non-tradable goods.

The difference in prices behavior is hence a key factor: in less productive countries when it comes to tradable goods, protecting competitiveness is a major concern. Prices would tend to stay aligned with those in more productive countries, as opposite to non-tradable goods sectors which keeps the gap significant between prices in countries.

It draws out from this theory that a rapid increase in high-income countries' productivity leads to an appreciation of the real exchange rate.

1.5- Government expenditures:

The **World Bank defines** general government consumption expenditure as expenses of goods and services (including compensation of employees). It also considers most expenditures on national defense and security, yet leaves out government military expenditures as they are part of government capital formation.

Government expenditures hence present a fiscal policy factor. Theoretical discussions agree that government expenditures' impact on the real exchange rate is itself ambiguous as it is likely to be both positive or negative. Government expenditure may impact the evolution of the exchange rate via two channels **(Frenkel & Razin1996)**. The first is referred to as "the Resource-withdrawal channel" which is assimilated to a negative supply shock. According to this first channel, the consequences of such expenditure will depend on the share destined to non-tradable goods as opposite to that destined to tradable goods. Theoretically, the largest proportion generally falls on non-tradable goods. Consequently, when the government spending increases, prices of non-tradable goods increase, leading by that to the appreciation of the real exchange rate. **(Bergstrand, 1981; Froot & Rogoff, 1991; wolf, 1994; Chinn, 1999; Kollmann, 2010)**. The second is known as "the consumption-tilting channel" which depends on the intertemporal complementarity against the substitutability between private and government spending.

Another source of ambiguity lies in the fact that the impact of government expenditure is likely to switch sign within a short period of time. **Edwards (1989)** explains that by considering two consecutive periods t_1 and t_2. He argues that even if the government spending focuses mainly on non-tradable goods leading as a consequence to the appreciation of the REER in t_1, the said government, which has more likely financed its acquisitions by means of debt, would also be witnessed rising taxes to pay for he purchased. Pressures on disposable income would hence decrease domestic demand on non-tradable goods depreciating by that the REER at t_2.

From what precedes, the relationship between the real exchange rate and selected fundamental determinants can be given the following linear function expression:

$$REER = f(TOT;\ OPN;\ PRO;\ GEX) \qquad (22)$$

2- Series description and data sources:

The following table summarizes our chosen variables series, the notations to be employed in the model, their measurement units, as well as the expected signs of the coefficients we seek to estimate and which will indicate the direction of the eventual impact of each of the fundamentals on the equilibrium of the REER.

Table 2: Variables selected for the study

Variable	Notation	Unit	Expected sign
Real exchange rate	REER	Base period: 2015	
Terms of trade	TOT	Percent	+/-
Trade openness	OPN	Percentage of GDP	-
Relative productivity	PRO	Percent	+
Government expenditure	GEX	Percentage of GDP	+/-

Source: Own construction

Our sample consists of 88 quarterly observations for a combination of time series spanning from 2000-Q1 to 2021-Q4. For the REER, the terms of trade, openness, and government expenditures, necessary data were retrieved from the Central Bank of Tunisia's data quarry. The determination of the relative productivity required additional data from the INS website, the OECD website, Turkish Statistical Institute website, and Investing website.

2.1- Statistical description:

Following the theoretical presentation of retained fundamentals, we move on in this second subsection to the statistical description of the data series and their evolution throughout the study period. We should however mention that we proceeded to the logarithmic transformation of the series prior to putting them into any use.

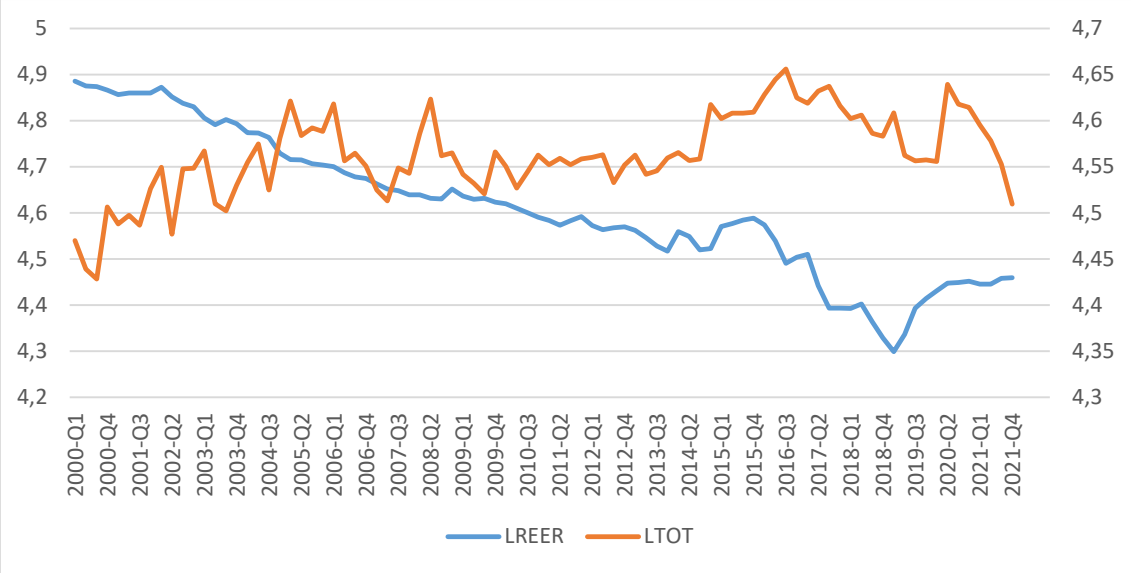
- Terms of trade:

As Terms of trade refer to the relative price of exports in terms of imports, the most used formula to measure their value can be presented as follows:

$$tot = \frac{Export\ prices\ index}{Import\ prices\ index} * 100 \qquad (23)$$

Our calculations resulted in a series of values that seem to be following an upward general trend as opposite to the real exchange rate of the dinar which has been following a general downward trend since the very first observation in our sample. Throughout 2021, a progressive deterioration of the terms of trade can be easily observed. This fact can be explained by the sharper increase in import price index compared to that of export price index of 12.4% against 7.2%, respectively (CBT, 2022). As the terms of trade showed a mentionable decline, a parallel deceleration in the appreciation of the Tunisian REER, which has started around 2019, can be observed.

Figure 2: Dynamics of LREER and LTOT between 2000 and 2021



Source: Own construction

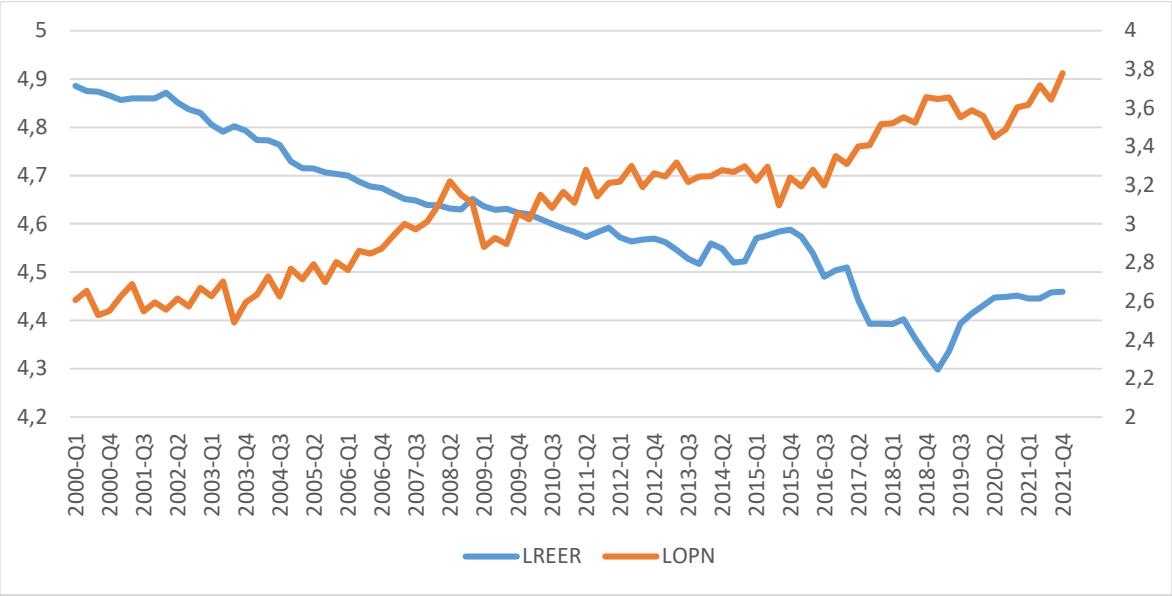
- Trade openness:

The degree of an economy's trade openness is usually measured by the trade openness index, also known as the IMPAX, which compares the value of a country's trade in its relationship with the rest of the world to its own GDP as follows:

$$Impex = \frac{Export + Import}{GDP} \tag{24}$$

The obtained results show a general upward trend followed by Tunisian commercial openness which means that the value of its participation in international trade through its imports and exports is in a continuous increase as represented by the graphic below. However, we can still identify two appearing periods where the IMPAX recorded a mentionable refrain. The first to mention is the fall observable around the second quarter of 2008. This retreat can be attributed to the subprime crises which busted in the USA before proving contagious and hitting the rest of the world's economies. Adverse spillover effects touched Tunisia's trade mainly due to the close nature of its commercial ties with Europe which led to exports growth slowing down from 12% in 2007 to 1% in 2008 and -22% early 2009. The second fallback is noticeable around the last quarter of 2019. This can be easily ascribed to the COVID-19 pandemic, against which necessary measures called for closed boundaries and halted transport and international exchange.

Figure 3: Dynamics of LREER and LOPN between 2000 and 2021



Source: Own construction

- Relative productivity:

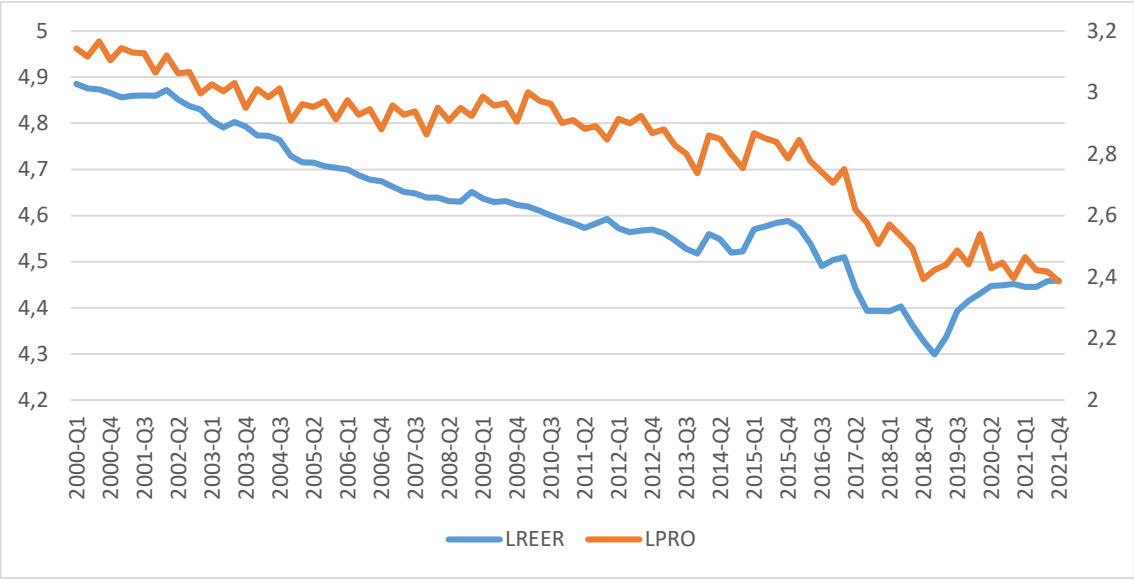
As it is commonly admitted that data about tradable and non-tradable goods prices is generally unavailable, the inclusion of the impact of productivity within empirical literature is usually done through a proxy that considers the local economy's productivity compared to that of its main trade partners. This relative productivity proxy can hence be calculated as follows:

$$PRO = \frac{Prod_{tn}}{\prod_{i=1}^{n} Prod_i^{w_i}} \quad (25)$$

Where productivity for both local and foreign economies is calculated as the ratio of real GDP per active person and w_i is the weight of each of the main trade partners in their trade relationship with the local economy.

It appears clearly, throughout the whole period, that the movements of the REER and the relative productivity follow the same direction. In fact, both variables show a downward trend between 2000Q1 and 2018Q4. As productivity appreciated slightly afterwards, the REER adopted an upward trend too.

Figure 4: Dynamics of LREER and LPRO between 2000 and 2021

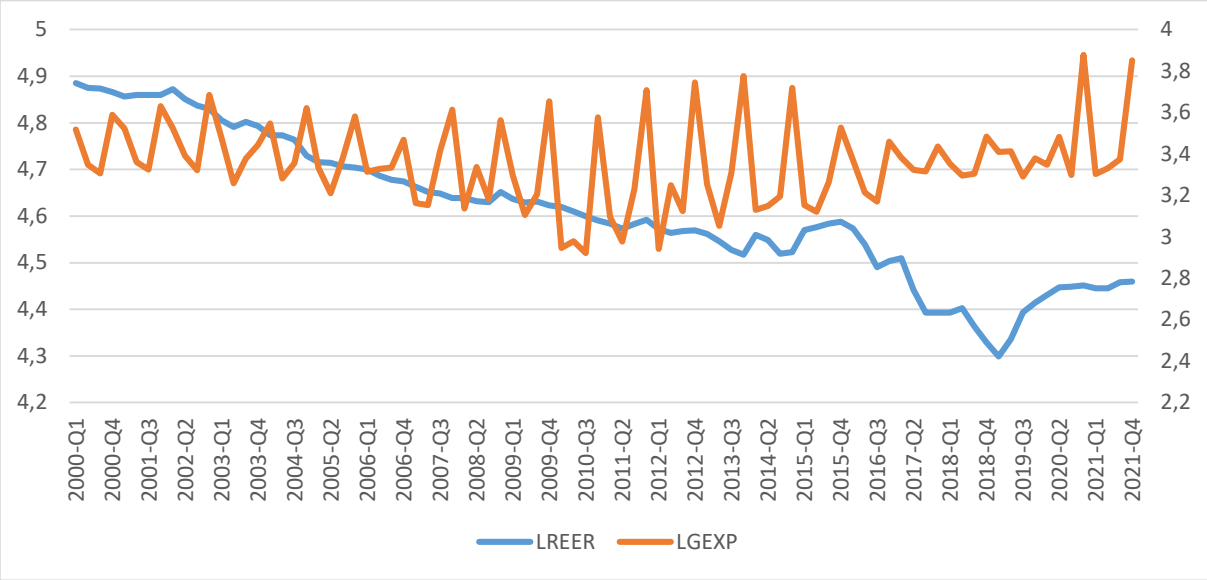


Source: Own construction

- Government expenditures:

The data relative to government expenditures is expressed in percentage of GDP. Through contemplating the data series, we can clearly see that the share of GDP attributable to government expenditures was considerably and gradually reduced starting from the last quarter of 2015 up to the second quarter of 2020, before finding back its old behavior. Throughout this specified period, we can seemingly identify a sharp drop in the value of the Tunisian REER.

Figure 5: Dynamics of LREER and LGEX between 2000 and 2021



Source: Own construction

Table 3: Descriptive statistics of used variables

	LREER	LTOT	LPRO	LOPN	LGEXP
Mean	4.611585	4.562706	2.895141	4.192620	3.355212
Median	4.591445	4.559252	2.966967	4.248774	3.333280
Maximum	4.885555	4.655768	3.131298	4.879091	3.877743
Minimum	4.298609	4.427943	2.467389	3.587609	2.921900
Std. Dev.	0.150991	0.045276	0.193764	0.351430	0.203731
Skewness	0.121257	-0.391642	-1.003031	-0.027682	0.258742
Kurtosis	2.239540	3.311955	2.672160	1.913941	3.000332
Jarque-Bera	2.336077	2.606453	15.14980	4.336157	0.981897
Probability	0.310976	0.271654	0.000513	0.114397	0.612046
Observations	88	88	88	88	88

Source: E-views 12

The above table shows that our selected variables have means which are different from 0. The high standard deviation also hints at the high volatility of the variables. Our series hence do not evolve around their means.

2.2- Testing for stationarity:

To avoid cases of spurious and misleading regressions, stationarity tests are crucial. These tests study the verify whether or not studied time series present a unit root. Such unit root would hence suggest the non-stationarity of the series in question.

From the existing unit root tests, we selected a set that counts the most generally used ones and which are the Augmented Dickey-Fuller (ADF) test, the Phillips-Person (PP) test and the Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test. Applying several tests is preferable in order to allow a properly based decision in regard with the stationarity of the variables especially in the case of diverging results.

2.2.1-The Augmented Dickey-Fuller (ADF) test:

This first test studies the stationarity of the series through considering the following hypothesis:

H_0: The time series has a unit root

H_1: The time series does not have a unit root

The validity of each depends on the obtained results:

- If probability > 0.05 and /or $\mathrm{t-Statistic} >$ critical value, then we fail to reject H_0;[3]
- else reject H_0.

The tests elaborated at level relative the involved variables in our study gave the following results (Appendix 1):

[3] Among the test's critical values, the one with an error chance of 5% is generally accepted as a reference.

Table 4: Results of the ADF test

	LREER	LGEX	LPRO	LOPN	LTOT
			At level		
P-value	0.4881	0.3882	0.9787	0.9292	0.0108
t-Statistic	-1.5804	-1.7795	0.3349	-0.2320	-3.4817
			At first difference		
P-value	0.0000	0.0001	0.0507	0.0000	
t-Statistic	-7.3218	-23.3460	-2.8935	-7.7614	
Integration order	I(1)	I(1)	I(1)	I(1)	I(0)

Source: E-views 12

According to this first ADF test, with the exception of TOT, all the other involved series present a unit root test at level, but not at first difference. All series are hence integrated of order 1 except for TOT which seems to be integrated of order 0.

2.2.2-The Phillips-Perron (PP) test:

The PP test considers the same hypothesis as the ADF test. The tests elaborated at level on each of the variables in our study showed the following results (Appendix 2):

Table 5: Results of the PP test

	LREER	LGEX	LPRO	LOPN	LTOT
			At level		
P-value	0.5076	0.0000	0.8918	0.9619	0.0222
t-Statistic	-1.5423	-9.4559	-0.4656	-0.0733	-3.2191*
			At first difference		
P-value	0.0000		0.0001	0.0001	0.0001
t-Statistic	-6.4777		-23.7093	-17.4043	-12.6175
Integration order	I(1)	I(0)	I(1)	I(1)	I(1)

*Accepted at 5% level.

Source: E-views 12

The PP test returned results in favor for the first-order integration of all series except for government expenditure which seems to be integrated at level.

2.2.3-Kwiatkowski-Phillips-Schmidt-Shin (KPSS) test:

This third stationarity test, though similar to the above tests, follows an opposite logic as its null hypothesis consists in the absence of a unit root in the time series. So following the obtained results, decisions are made as follows:

- If $\mathrm{t-Statistic} > \text{critical value}$; then we reject H_0;
- else we fail to reject H_0.

Applied to our set of variables, we obtained the following results (Appendix 3):

Table 6: Results of the KPSS test

	LREER	LGEX	LPRO	LOPN	LTOT
	At level				
t-Statistic	1.1177	0.2349*	0.9865	1.1630	0.7599
	At first difference				
t-Statistic	0.1469	0.0757	0.3156	0.1865	0.2671
Integration order	I(1)	I(1)	I(1)	I(1)	I(1)

*With intercept and trend.

Source: E-views 12

This third KPSS test comes in favor of the non-stationarity at level of all selected data series. It considers the five of them to be integrated of order 1.

⇨ Decision:

After conducting the three most used stationarity test (ADF, PP and KPSS), we obtained results that agree upon the absence of a unit root at level in the case of REER, PRO and OPN. However, we noticed a divergence between some tests when it comes to GEX and TOT series. As most tests suggest the non-stationarity of the series at level, we chose to consider the five of them as integrated of order 1.

II-Empirical estimation of the exchange rate misalignment:

In this section, we seek to assess the relationship between the real exchange rate of the dinar and the set of variables selected as "fundamentals", as well as the estimation of the dinar's misalignment. Our choice fell on the BEER approach as it is the most appropriate for a small open economy, which is the case for the Tunisian economy. Moreover, as the existing literature generally adopts the Vector Error Correction Model (VECM) for similar purposes, we chose this approach to estimate a reduced-form single-equation model following **Clark and MacDonald (1998)** and **Baffes, Elbadawi and O'Connell (1999)**.

The purpose of the following subsections will then be to present the method to be followed for the estimation of the real effective exchange rate equilibrium as well as the extent of eventual existing misalignments, and then to present the results returned by the calculations.

1- A general presentation of the approach:

To explore the relationship between the Tunisian real exchange rate and its fundamentals, we chose to apply the cointegration technique. The previously discussed integration order property of our series allow us to proceed with the VECM model. This latter can be considered as a special application of the vector autoregressive (VAR) model to which is introduced an error correction mechanism (ECM). It will hence allow us to estimate two types of relationships: one on the long run and one on the short run.

The use of the VECM model, however, calls for the existence of a cointegration relationship between the variables of interest. The cointergration concept was first introduced by Robert Engle and Clive Granger according to which two or more non stationary variables are considered cointegrated when at least one linear combination involving these variables is proved to be stationary. This very cointegration relationship will hence represent the long-run relationship and which will also represent the equilibrium trajectory. Commonly, the most used test to examine the existence of such cointegration is the Johanson Cointegration test. The long-run relationship between the real effective exchange rate and the fundamentals is defined as follows:

$$REER_t = x_t\beta + z_t \qquad (26)$$

Where $x_t$is the vector of fundamentals, β is the vector of cointegration coefficients, and $z_t$is the error term.

The short-run dynamics will then represent the "correction mechanism" which will try to bring the REER back to its equilibrium in case of any deviation. The short-run relationship consistent with the long-run equilibrium are modeled as an error correction mechanism (ECM):

$$\Delta REER_t = \alpha z_{t-1} + \sum_{i=1}^{p} \gamma_i \, \Delta REER_{t-1} + \sum_{i=0}^{q} \sigma_i \, \Delta x_{t-1} + \sum_{i=0}^{p} \zeta_i \, \Delta w_{t-1} + \varepsilon_t \qquad (27)$$

Where w_t represent the vector of short-run variables.

2- Calculations and results:

2.1- Specifying optimal lag:

Prior to any examinations, a preliminary step would be to determine the optimal lag to use in the model. The choice of the lag length represents a trade-off between what is known as the curse of dimensionality and reduced models, which are not appropriate to indicate dynamic adjustments. While a high lag length would enhance the model's adjustment, it implies a loss in the degree of freedom. A low lag length however would reduce the precision of the used model.

As it is commonly agreed upon, we would be selecting the lag length for our model based on standard information criteria. Considering the available number of 88 observations in our sample, and since these are expressed in a quarterly frequency, we were allowed to choose a lag ranging from 1 to 8. The optimal lag as suggested by the information criteria (Appendix 4) are resumed in the table below:

Table 7: Suggested optimal lags

Selection criteria	LR	FPE	AIC	SC	HQ
Lag length	8	4	8	2	3

Source: E-views 12

According to the obtained results, the selected lag to be applied in the rest of our tests is going to be p=8.

2.2- Johansen co-integration test:

At this level, we proceed to the examination of whether or not our selected series do present a long term relationship, expressed by the eventual existence of at least one co-integration relation joining them to each other. As we have already showed that all of our series are non-stationary at level, we move on to the application of the Johansen's "Trace test" and "Maximum Eigenvalue test" to verify if we are in a position to proceed with the Vector Error Correction Model (Appendix 5).

Table 8: Results of the co-integration test

Unrestricted Cointegration Rank Test (Trace)				
Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.441934	79.21936	69.81889	0.0074
At most 1	0.160545	33.14034	47.85613	0.5491
At most 2	0.135339	19.31513	29.79707	0.4704
At most 3	0.092397	7.827119	15.49471	0.4840
At most 4	0.002127	0.168194	3.841465	0.6817
Trace test indicates 1 cointegrating eqn(s) at the 0.05 level				
Unrestricted Cointegration Rank Test (Maximum Eigenvalue)				
Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.441934	46.07902	33.87687	0.0011
At most 1	0.160545	13.82520	27.58434	0.8345
At most 2	0.135339	11.48801	21.13162	0.5986
At most 3	0.092397	7.658925	14.26460	0.4144
At most 4	0.002127	0.168194	3.841465	0.6817
Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level				

Source: E-views 12

Both Trace and maximum eigenvalue tests showed the existence of at least 1 co-integration relationship at an error risk level of 5%. Hence both testing methods sustain the existence of a long-run relationship between our variables. We can thusly proceed with the estimations according to the VECM method.

2.3- Analyzing the long-run relationship:

2.3.1-Estimating the long run relationship:

At this level, and taking into consideration the data available, we sought to extract the long-run relationship that might exist between the REER of the Tunisian dinar and the fundamentals capable of tracing its dynamic equilibrium trajectory.

After introducing the collected data, and under the constraint of the available number of observations, the obtained results in regard with the relationship between each of the introduced variables and the REER (Appendix 6) are detailed in the following table:

Table 9: Results for the long-run relationship coefficients

	LTOT	LPRO	LOPN	LGEX	C
Coefficient	-1.0310	0.1525	-0.2040	0.2920	8.7510
t-statistic	5.4634	-1.6965	4.3627	-2.7438	

Source: E-views 12

2.3.2-Results interpretation:

A preliminary examination of the results was interested in how well the estimated model fits the observed data values. Expressed by an $R^2 = 0.7275$, we can say that 72.75% of the variability in the REER is explained by our model.

The signs and statistical significance of the coefficients presented in the above table strongly corroborate the generally proved and accepted theories. We can hence proceed to the economic interpretation of the equation's components.

- Terms of trade:

As mentioned in the previous section, the implications of shocks to the terms of trade is considered rather ambiguous as they may go in both directions (an appreciation or a depreciation in the REER value). In our model, a deterioration in the terms of trade of 1% would result in the REER appreciating by 1.03%. This negative sign suggests that, in our case, the substitution effect is dominant compared to that of income. Our findings are hence coherent with **Edwards & Wijnbergen (1987)** and **El Badawi & Soto (1997)** works which proved this case to be generally true in the case of small open economies. It is also in the line with several

studies interested in the Tunisian dinar like the work of **Charfi (2008), Hend & Srdjan (2010), the african development bank (2013)** and **Bouzid (2021)**.

- Relative productivity:

Results reported in the above table associate a positive sign to the relative productivity variable. This supposes that for each increase of 1% in relative productivity, Tunisian REER would appreciate by 0.15%.

- Trade openness:

The result for the ratio of volume of trade to GDP is also negative and significant. According to the obtained results, an additional 1% degree of openness depreciates the REER by around 0.2%. This result is quite expected as it is in line with the literature treating of small economies' exchange rates and trade strategies and behavior. In fact, as they are generally highly open to international tared, small economies' imports are usually larger than their exports, with these latter having a rather specialized structure **(Lederman & Lesniak, 2018)**. It is hence worth mentioning that Tunisia, in its import liberalization program, exempts about 97% of the goods from a prior authorization **(International Trade Administration, 2021)**. Under such circumstances, and increase in import volumes would keep competing non-tradable goods' prices at lower level while adding, on the other side, to the trade deficit, leading consequently to the depreciation of the Tunisian dinar.

- Government expenditure:

The elasticity expressing to the impact of government expenditures on the REER was positive according to the obtained results. This means that for every extra 1% spent by the government, we are more likely to observe an increase of 0.29% in the Tunisian REER. This is not a surprising result since literature sustains the fact that within small open economies, government spending tends to fall more on non-tradable goods rather than tradable, which leads to the increase of the formers' relative prices. According to **El Badawi & Soto (1997)**, in the case of similar spending, unsustainable government deficit would be seen participating in the exchange rate overvaluation.

2.4- Estimating the error correction model:

While data series might present an equilibrium relationship on the long-run, shocks and occasional events might push them to diverge from such equilibrium. For such reason, and aside from the long-term dynamic relative to the long-run equilibrium relationship, the error correction model allows to jointly check for the existence of a short-term dynamic capable of restoring equilibrium. In our case, we were able to obtain the results presented below:

Table 10: Results for the short-run relationship coefficients

	Error correction term	D(LTOT)	D(LPRO)	D(LOPN)	D(LGEX)
Coefficient	-0.5724	0.2855	-0.4118	0.6526	1.3763
t-statistic	-4.8228	1.4109	-1.4729	1.5918	1.6010

Source: E-views 12

From the above table, we can affirm that the error correction term is negative and statistically significant at a 99% level of certitude. This affirms that the long-run causality runs from the chosen fundamentals to the real effective exchange rate and not otherwise. We can also conclude the existence of an error correction mechanism capable of restoring equilibrium with a pace of 57.24% per trimester. Such a pace of -0.5724 $\in$[-1;0] is considered relatively slow. To find the overall adjustment speed, we consider the following general formula as applied by **El Badawi & Soto (1994)**:

$$1 - \beta_0 = (1 - |\alpha_1|)^t \tag{28}$$

$$t = \frac{\log(1 - \beta_0)}{\log(1 - |\alpha_1|)} \tag{29}$$

Where t is the number of periods necessary to find equilibrium (in our case expressed in trimesters), α_1 is the error correction coefficient and β_0 is the percentage of disequilibrium to be corrected within the t period, that is 99,99% of the deviation.

In our case, it hence takes around 11 periods (2.7 years) for the real exchange rate to find its equilibrium back after shocks occur. Our estimation falls within the range of 2.5 to 5 years agreed upon by the works of **Frankel (1986), Lothian & Taylor (1996) Cheung & Lai (2000) and Murray & Papell (2000)**.

We also add that only government expenditures seem to exert on the REER the same positive effect both on the long-run and the short-run, as opposite to the rest of the fundamentals.

2.5- Estimating misalignment:

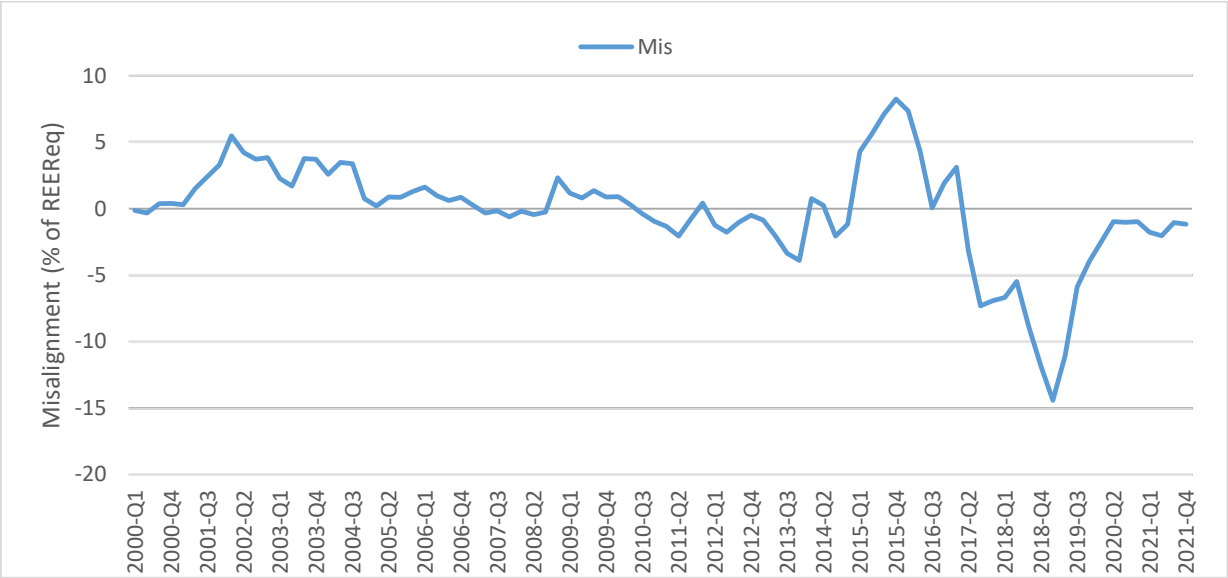
At this level, we are capable of assessing the misalignment of the Dinar's REER. We begin by computing the equilibrium real exchange rate series based on the previously constructed long-run relationship equation. Yet the use of the fundamentals data series is not straightforward. Since their fluctuations are generated by both temporary and permanent shocks, we should first extract the latter of the two components. A filter generally applied is that of Hodrick-Prescott. The figure below joins the observed REER and the estimated equilibrium presented by the permanent component of the fundamentals (REEReq):

Figure 6: Evolution of the REER around its equilibrium path

Source: Own construct

This first figure already hints at the existence of misalignment between the two series. We then employ the generated series to estimate the degree of misalignment, obtained from the difference between the actual observed REER and its estimated equilibrium values. Our estimates are shown in the figure below:

Figure 7: Estimated REER misalignment in Tunisia (Appendix 7)



Source: Own construct

A first overall examination of the estimated misalignment as presented by the above figure allows us to conclude that the Tunisian dinar has underwent several phases of undervaluation and overvaluation throughout the study period. The observation of these distortions also allows us to identify:

- A first noticeable peak around the first quarter of 2002 of 5.5%;
- A first trough at the end of the fourth quarter of 2013 of -3.9%;
- A second and higher peak at the end of 2015 of 8.3%;
- And a second lower trough at the first quarter of 2019 reaching -14.4%.

Through a more detailed analysis of the obtained results, it can be seen that for the first year in our sample, **year 2000**, the real exchange rate was almost at its equilibrium level. This first observation can find its explanation in past historical facts as the country experienced significant economic changes. In fact, following a lengthy period of a quasi-nominal peg to French franc, Structural Adjustment Policies (SAP) were implemented as authorities sought to remediate productivity and optimize resource allocation to boost and preserve the country's competitiveness on international scales. The Dinar's value was hence left to depreciate by almost 40% before the crawling peg regime was adopted via a reference representative basket of currencies including the euro and the dollar (Dropsy & Grand, 2008). This real effective exchange rate targeting combined with a prudent policy of capital account liberalization and sound monetary and fiscal policies helped Tunisia to efficiently preserve competitiveness and

shield the national currency from disturbances which have reached those of other emerging countries as the international exchange markets showed some large fluctuations. The Tunisian dinar was hence able to evolve in harmony with its fundamental determinants.

Nonetheless, as the process of economic and financial liberalization continued, such exchange rate regime proved to be rather problematic and quite complex as it called for a proper resource allocation and appropriate exchange supply level while capital inflows and outflows' volatility increased. In front of such challenges, and under the IMF's recommendation to further sustain the country's international competitiveness, the Dinar was granted additional flexibility as fluctuation bands were widened starting from **year 2001**. The continuous efforts to promote exports and the pursuit of a flexible exchange rate policy have allowed the Tunisian economy to maintain its competitiveness, as proved by the high growth in exports achieved which passed from 14.9% to 18.7% in 2001, and this despite an international situation that became particularly difficult following the 9/11 events. Additionally, Tunisia's success in maintaining general macroeconomic balances encouraged foreign capital inflows, particularly in the form of foreign direct investments (excluding privatizations). These factors can hence explain the overvaluation peak of 5.5% suggested by our estimations, following which this upward deviation persisted up until the **end of 2004**, though with lower levels. This backward trend can be attributed to the international climate deterioration due to increased geopolitical tensions and submerging repercussions of terrorism activities which spillover degree among countries was more or less proportional to their degree of openness, especially that the greatest impacts was felt on the level of tourism, international trade and incoming foreign investments.

For the two following years, we can say that the real exchange rate of the dinar was pulled back down yet kept stuck to its equilibrium level before turning into a slight undervaluation mid-**2007 and throughout 2008**. As this period was marked by one of the greatest crisis in the history, Tunisia's increasing liberalization degree couldn't have kept it untouched. In fact, the Global Financial Crisis which busted during that period brought significant disturbances to the world's economy and financial systems leading to monetary instability mainly due to an unmatched rise in oil prices which reached a record of 134 dollars, and the increase in debt costs, leading to the relative depreciation of the Dinar. However, despite the magnitude of this crisis, the economic activity within Tunisia managed to keep a satisfying pace within a nationally maintained internal and external balances, as a growth rate of 4.6% was recorded in 2008. The reduced impact can be attributed to the efforts of the CBT's monitoring unit which allowed some proactive actions, increased protection of exchange reserves via more rational

international investments, the support destined to maintain the Tunisian exporters' competitiveness as well as significant inflows of direct foreign investment as a result of engaged reforms and improvements to the business climate.

Moving further, it would be necessary to mention that the end of the first decade of the 21st century marked the parallel end of real exchange rate targeting in Tunisia, as it moved toward a more flexible exchange rate regime.

In fact, this second decade was welcomed with the Jasmine Revolution as a starting flame for successive Arab Spring movements. Needless to say, **in 2011**, the instability that has tainted the political and economic environments hindered the productive and exporting capacities of key economic sectors, mainly that of extractive and chemical industries, while tourism and international transport activities plunged, leading to a negative real growth rate of -1.8%. In tandem with the deterioration of trade terms, large foreign exchange outflows have also been witnessed and proved to be rather persistent. The CBT hence leaned on the depreciation of the Dinar while maintaining the necessary level of intervention on the exchange market. The undervaluation suggested by our estimations hence finds its explanation in the concomitant work of all these factors.

The trough of 3.9% undervaluation remarkable at the **end of 2013** can be attributed to the unfavorable internal and external environments, which main features included a "chaotic democratic transition" process, a net decline in foreign direct investment inflows, a current account deficit equivalent to 8.3% of GDP and a persistent high inflation rate. All together, these factors managed to put extra pressure on exchange supply which fell to 106 days of imports compared to 119 a year before.

The **third quarter of 2014** marked the start of an appreciation process of the Dinar which was carried on for about a year and half, leading by that to its overvaluation by 7.4% by **march 2016**. According to the figure (6) , this overvaluation comes from the joint effects of the decrease in required equilibrium level while the observed REER followed an upward trend. In fact, the period in question was the target of several shocks counting new terrorism movements and social upheavals, which consequently, had repercussions on tourism as well as the deceleration of the European partner's demand as it struggled with a sharp decline in its growth rates. Despite these facts, the exceptional performance of the agriculture sector as well as the increase of 8.8% in foreign direct investment and the consolidation of exchange reserves up to 128 days of imports as a consequence of external resources mobilization stood in favor of the

Tunisian dinar and the economy's medium-term potentials, as its value against the euro increased by 2%. Parallel to such circumstances, the CBT decided for the first time not to intervene on the foreign exchange market as it switched to a more flexible exchange regime. By such decision, the CBT answered the IMF's suggestions to further liberalize the national currency, as it believed it would enhance Tunisian exports and stimulate the growth of the economy.

Within few months, this overvaluation was eliminated and a considerable decline in the value of the currency can be observed. For three consecutive years **(2016Q1 to 2019Q1)**, the Tunisian dinar plummeted, trading its overvaluation for an undervaluation which deepened down to -14.8%. This sharp decline can find its origin in the hard deceleration of the national productivity, the poor performance of exports as they lacked in volume and attractiveness while imports made proof of an accelerated pace, and the slippage in inflation rates which reached 7.3% by the end of 2018 against 6.4 in 2017 and 4.2% in 2016. In addition, the consequences of rumors in regard with the depreciation of the dinar ended up spreading fear and mistrust among investors and feeding speculation activities, which accelerated the currency's fall. In front of such circumstances, the CBT chose to intensify the refinancing global volume despite its consequences on exchange reserves in order to maintain the stability of the financial system and the capacity of both traders and the state to honor their settlement schedules, before proceeding to an increase in its policy rate at the start of 2018.

The downward trend followed by the REER lasted up until the first quarter of 2019, following which misalignment started shrinking as the REER sought to find its equilibrium level back. In fact, during **year 2019**, the equilibrium fundamentals were kept under control. The country knew a rise in its tourism revenues of 35% compared to the previous year, parallel to an increase in current transfer of 15% and a retreat in imports. The CBT's action of rising its policy rate seemingly helped sustain the low exchange reserves. The Dinar hence picket an upward appreciating trend towards its equilibrium as it increased in value by 9.1% against the euro and 7% against the USD.

As for the last two years of **2020 and 2021**, the Dinar has kept a slight undervaluation of 2% on average. As the Covid-19 halted trade on international scales and a sharp decline in oil prices was recorded, the country's export revenues generated by international olive oil sales while imports fell back, as well as the rise in current transfers' inflows helped ease the current deficit and hence reinforce the exchange supply which rose from 112 days of imports to 162 days. This helped maintain the dinar's value at a stable state during this period before knowing a slight

undervaluation **mid-2021** as an early consequence of the news in regard with the depreciation of the country's sovereign notation, as well as the weight of the debt the country had to face.

Conclusion:

The sections of this chapter were dedicated to the estimation of the exchange rate equilibrium level of the Tunisian dinar, based on which we tried to assess the misalignment degree of its real effective value. For this purpose, we employed a Vector Error Correction Model as we followed the BEER approach developed by **Clark & McDonald (1998)**, being most suited for a small open economy like Tunisia. The retained fundamentals counted the terms of trade, the trade openness, the relative productivity and the government expenditures. Just like it has been proven but several studies interested in the Dinar currency, this latter did not stick to its equilibrium level for the major part of the study simple. A detailed analysis of this misalignment found its origin in three main sources:

First, there are the unstoppable and recurrent changes in decisive fundamentals, both internal and external, which keep reshaping the equilibrium path for the dinar as, like sustained by the literature, it is a considerably dynamic trajectory which absorbs and reflects the characteristics of the economic environments and their conjectures, were they national or international. Such was the case for periods through which changes in the international demand, raw material prices, local competitiveness and productivity as well as current and budget deficits suggested different equilibrium levels for the dinar REER as it evolved in time.

Second, there are the authorities' policies relative to exchange rate regimes and decisions in regard with their interventions on the exchange market and direct orchestration of the currency's value. In this context, we showed how switching between exchange rate regimes and the CBT's refrain from directly orienting the evolution of the Dinar had undeniable consequences on the misalignment separating its REER from its equilibrium level as its increasing degree of floating gave it an extra range to freely bounce above and below its suggested equilibrium level.

Last, it is crucial to mention the role of unpredictable events and sudden shocks in swaying the exchange rate to change path and pace. Such was the case for the Tunisian dinar following unforeseen terrorist attacks and harmful rumors which altered its evolution against all wills, policies and natural balances.

PART-II

Exchange rate movements and pass-through to inflation

Chapter 1: The exchange rate pass-through and inflation

Introduction:

The discussions carried out in the previous chapters captured the general importance of the exchange rate behavior for the overall performance of economies in the middle of a never ending shifts in international policies and economic mutations. As it has been proven through the continuous efforts of the CBT as it sought to contain the consequences of a long series of events and keep them under control, we chose, in this chapter, to scope the implications of the exchange rate behavior on inflation.

As emphasized by literature, in open economies, exchange rate fluctuations condition deeply the behavior of inflation. Being one of the main factors which intervene in setting trade patterns and adjusting investment attractiveness, the exchange rate would hence have considerable implications in regard with costs and prices. These implications are usually transmitted to prices though what is known as the "exchange arte pass-through".

However, many studies have proven that, despite the intense changes in exchange rates recorded during the 90s, the subsequent effect on price levels within small economies was rather weak. For this, solving this puzzling effect and assimilating the determinants of pass-through magnitude had proven to be crucial especially for monetary authorities in order to conduct the appropriate monetary policy. In this context, the present chapter will be divided into two sections:

The first section will be dedicated to put extra light on the inflation phenomenon. Understanding the meaning of inflation as well as its different forms and origins and the tools employed by authorities to keep it under control will hence be discussed under this section.

Following that, a second section will introduce the pass-through concept. Its subsections will dive into the different levels of the exchange rate pass-through, its magnitude as well as its determinant, as it draws the link between exchange rate movements, misalignment and inflation rates.

Section 1: The inflation phenomenon:

I- Overview of the inflation phenomenon:

1- Inflation defined:

It was around the end of the 19th century that economists started employing the concept of inflation to refer to an economic aspect. On its very first appearance, this concept represented as a purely monetary phenomenon as inflation was believed to be generated by the evolution of a nation's money supply. Back at that time, inflation was defined as "the process of making addition to currencies not based on a commensurate increase in the production of goods" (FED, 1919), and as a consequence, a phenomenon which led to rise in prices.

With time, clearer distinction between the meanings of "currency" and "money" was installed leading to a shift in meaning. What was once a word that described a monetary cause now describes a price outcome (Michael F. Bryan, 1997). Today, inflation "measures how much more expensive a set of goods and services has become over a certain period, usually a year." (IMF, 2022). It is also referred to as "the loss of purchasing power of the currency that results in an increase general and sustainable prices." (INSEE, 2022). What could be purchased with one unit of money will require more to be bought.

The most frequent method used to calculate inflation rates is the consumer price index. This index measures inflation by comparing the change in the prices of a fixed basket of goods and services, through a given period of time. This basket represents a combination of a given country's most acquired products by households, each being allocated a specific weight reflecting its importance in the recurrent consumption behavior of the country's citizens.

$$CPI_t = \frac{C_t}{C_0} * 100 \qquad (30)$$

Where CPI_t refers to the consumer price index in current period, C_0 is the general cost required a acquire the above defined basket of goods in base period, and C_t the cost of the same basket but in current period.

2- Sources of inflation:

2.1- Demand-pull inflation:

This type of inflation is generated by the gap observed between aggregate supply and demand levels of goods and services. More precisely, it is due to current demand levels outweighing those of the supply.

This disproportion can be the result of several economic dynamics:

- A blooming economy: Within a country showing signs of economic growth and dropping rates of unemployment, an appreciation in in general income takes place. Economic agents allow themselves to spend more leading their demand level to rise. Yet, supply levels might fail to follow, given that current capitals invested in production might not be suitable for such quantities. The succession of demand hence bids up prices, setting ground for inflation.
- An increase of money in circulation: The level of circulating money within an economy is monitored by the monetary authorities, generally the central bank, who makes use of the instruments under its control to either facilitate or restrict access to money through banks. In fact, in order to simulate economic activity for example, a central bank might decide to reduce its policy interest rate, and by that lighten banks' costs to access financial resources allowing them to reduce their interest rates on loans, and hence an increase in demand leading to higher inflation.
- Expectations regarding inflation: Economic agents might have their own readings regarding inflation's future trajectory. Since their major concern is the purchase power of what they earn, they prefer to buy when prices are considered lower. For that, when their expectations regarding inflation levels are pessimistic, they increase their purchases through higher a demand, simulating prices to rise.
- Tax policies and government expenses: Tax policy can influence the inflation rates within an economy. In fact, when the government decides a tax increase to reinforce its incomes, it either rises tax cuts or includes additional income categories or agents who have been so far relived from this obligation. As due tax increases, agents' income is reduced, limiting by that their consumption capacity, and consequently their demand level.

2.2- Cost-push inflation:

This form of inflation is observed when general prices of goods and services rise, not due to an increase in demand levels, but in the costs needed to keep the same level of supply on the market, such as wages and raw materials prices. These extra charges weighting heavy on production entities will need to be covered for these latter to maintain an adequate level of profitability. For that, they are passed to the consumer who will need to pay more to acquire the same amount of goods.

2.3- Built in inflation:

In hopes to counterbalance rising living costs, workers might ask for higher wages, an extra charge that will be included in products prices for firms to be able to cover it, and thusly and additional increase in living costs. As a consequence, this phenomenon is also referred to as "the wage-price spiral".

2.4- Imported inflation:

As its name suggests, imported inflation refers to the sustainable increase in aggregate product prices due to an increase in the costs of imported elements, which include raw materials, services or even finished products themselves destined to be traded on local markets. In the case of an open economy, consumption baskets represent a combination of imported goods as well as locally produced goods which production process might include imported elements. As a consequence, when the share of imported products in the is important in the reference basket, an increase in their cost implies an increase in the cost of the basket as a whole. In case demand levels do not fall back, it stimulates the rise in living costs even further.

3- Types of inflation:

- Creeping inflation: Creeping inflation is when there is a steady but slow increase in aggregate expenditures over a certain period of time. It is a gentle increase in prices and hence is also known as "Mild inflation". The level of such increase is usually limited to a maximum of 2% per annum.
- Walking inflation: This type of inflation shows a single-digit level falling between 2% and less than 10% per year. Such levels are considered to be alarming and call for governmental control to prevent it from passing to the next level.

- Galloping inflation: Also known as « running inflation », this type is associated with rates which go beyond 10% up to around 20% per annum. Such rates put pressure on different types of consumers since their income would find difficulties in keeping up with the prices' plummet. Countries which experience high inflation rates are potentially subject to major changes in inflation behavior. In fact, from the one side, such situation can increase chances for loss of control over inflation which might lead to hyperinflation. From the other side, if actions are taken to attenuate this situation, inflation rates might fall **(Choudhri and Hakura, 2001)**.
- Hyperinflation: The sharpest among all types is the hyperinflation. At this stage, the increase of prices is out of control, and is sometimes unmeasurable, leading to the erosion of the local currency value.
- Stagflation: Another form which can be taken by an inflationary behavior is known as the "stagflation". This is when the economic environment shows a continuous increase in prices even though its economic growth is slowed down and unemployment rates are high.

II-Monetary policy and the fight against inflation:

1- Monetary policy explained:

The European Central Bank defines the monetary policy as "the decisions taken by central banks to influence the cost and availability of money in an economy." The monetary policy is hence of a macroeconomic aspect and assembles the set of instruments used by a monetary authority of a nation, usually its central bank, as it seeks to achieve and maintain economic and prices stability.

However, monetary authorities do not really have a direct and immediate control on existing economic variables such as economic growth, employment or even inflation… aside from that, these variables are characterized by a considerable time-delay in their responses to changes and interventions in the economic environment. For that, central banks turn to dividing the whole process into three main categories of targets: operational targets, intermediate targets and a final target.

- Operational targets:

For a smoother manipulation of macroeconomic variables, central banks bring changes to elements which are under their direct control through the employment of a number of tools at its disposal. Two main variables may be mentioned: interest rates and money supply.

- Intermediate monetary policy targets:

Intermediate targets are also economic variables which policymakers intend to influence. However, these targets cannot be directly manipulated as they are out of the central bank's control range. Their importance, however, resides in two main facts:

- their reaction time to changes affecting the economic environment, which exceeds the time needed by final targets to attain their sought levels;
- their correlation with the final objectives as they stimulate and influence their movement toward the predefined levels.

Based on its previsions regarding the evolution of macroeconomic factors, a central bank may decide on an expansionary monetary policy, through which it reduces of its interest rates as it seeks to ease access to money and stimulate currency in circulation with the aim of encouraging consumption and investment, or a contractionary monetary policy where it aims for the opposite.

- Final monetary policy targets:

The ultimate objective of a monetary policy is a quantitative specification of the macroeconomic variable on which a central bank seeks to have an influence and readjust the way it is progressing. This is usually achieved on a medium to long term. The final objective of a monetary policy might differ from a country to another. The main objectives a monetary authority might seek include high employment, economic growth, interest-rate stability, financial markets' stability and foreign exchange markets' stability (FED), however, the most commonly perused objective has to be prices stability. Through this latter, central banks seek to ensure an adequate level of inflation through which domestic currency's purchasing power is maintained.

2- Instruments of the monetary policy:

The intervention of central banks to assume their responsibilities when it comes to maintaining prices stability is done mainly through the use of a number of channels.

2.1- The interest rate channel:

Being the higher monetary authority in the monetary system, the central bank controls what's known as the "policy interest rate". Defined as the rate at which commercial banks would be charged for receiving loans or remunerated for their deposits, this rate has a great influence on interest rates used by banks in their relationship with their clients, and hence on these latter's consumption and investments behavior. The mechanism behind this is that an increase in the policy interest rate increases commercial banks' resourcing costs, were they loans or clients' deposits. To cover their rising costs, banks tend to increase their own interest rates charged to their clients in order to maintain their profit margin, which discourages consumers and investors from turning to banks for loans. The decrease in demand and the preference to turn to saving generated by this mechanism influence general prices as they refrain from increasing.

2.2- The exchange rate channel:

The exchange rate is considerate to be a key fragment in a country's international relationships and its macroeconomic equilibrium. As a matter of fact, the evolution of exchange rate's level conditions every country's economic performance, as it impacts the domestic prices on local markets. Undesirable exchange rate evolutions are hence capable of generating inflationary pressures and disturbing the well sought price stability.

Central banks play a major role in eliminating, or at least reducing, such threat through its capacity of manipulating interest rates. In fact, from its position on the top of the monetary system, a central bank might identify a need to stimulate the economic activity. An objective that might be achieved if it succeeds to generate a certain depreciation of the local currency. The disposal of a policy interest rate under its control allows it to induce interest rates to fall down, leading by that to encourage demand on local goods and services, both from inside and outside the country. This shift from foreign goods reinforces the economy's competitiveness on the international scale and helps adjust eventual external trade imbalances.

However, from a second angle, reducing interest rates dims the attractiveness of the local currency since investing capitals in the country in question becomes less remunerating. The demand on local currency decreases leading its value, compared to foreign ones, to fall down.

2.3- The credit channel:

This channel allows central banks to control the economic activity through adjusting the availability and terms of bank loans. In accordance with her readings of the economic environment and inflation objectives, the central bank either facilities or limits access to financial resources, affecting by that the level of currency in circulation. When the forecasts regarding inflation levels are worrisome, the central bank would try to reduce the money supply available in the economy in order to limit consumption, decelerating by that inflation growth, and vice versa.

2.4- Transmission through anticipations channel:

For all the above channels to be efficient, and for the central bank to be able to accomplish its mission of maintaining prices stability through its monetary policy, this latter need to have a certain level of credibility. Such feature will allow the monetary authority to influence economic agents' forecasting and adjust their behavior according to the sought finalities. For this to be concrete, central banks need to make proof of a certain degree of transparency by giving a realistic overview on the economic situation and building its monetary policy on solid pillars. It is only when agents' anticipations are correctly anchored that monetary policy can gain in credibility and achieve sought goals.

Section 2: The exchange rate pass-through:

Among the instruments a central bank may put into action to control the evolution of the inflation rate in an economy is the exchange rate channel. This channel connects adjustments brought to interest rates to the overall economic activity through the influences left on goods prices. The understanding of this channel's underlying mechanism proves to be crucial for applied monetary policies to be correctly structured and led. It is also of a great importance since its implications reach up to several other macroeconomic aspects. However, the importance of these implications depend on the extent to which exchange rate movement affect prices on local market. Traditional literature has been concerned by these issues and hence have risen debates concerning its determinants and magnitude.

I- Exchange rate pass-through and related basic fundamentals:

1- Exchange rate pass-through definition:

In their definition of the concept, **Goldberg and Knetter**'s (1997) describe the exchange rate pass-through (ERPT) as "the percentage change in local currency import prices resulting from a one percent change in the exchange rate between the exporting and importing countries." In other words, the ERPT refers to the phenomenon by which exchange rate variations are transmitted to prices of imported goods when expressed in another currency, usually a local one.

Originally, this phenomenon hence only referred to changes in the imported goods prices as a consequence of exchange rate variation. However, later studies proved that such variations impact other sorts of price measures such as consumer prices and producer prices. To take that into consideration, ERPT is now used to refer to changes in domestic prices as a whole, that is the prices at which products trade on a local market. In another attempt to define the same phenomenon, this time from a statistic angle, was that of **Pinshi et Sungami** (2020) who presented it as the exchange rate elasticity of import prices, which can be extended to production prices as well as consumer prices.

2- Transmission of exchange rate fluctuations:

The mechanism converting changes in currency prices into an increase or a decrease in domestic prices has been subject to several decomposition attempts as documented by existing literature. Studies within this field converge towards the distinction between two consecutive steps commonly known in economic literature as the pass-through stages. These stages hence conduct exchange rate variations to domestic prices either directly through increases or decreases in displayed prices, or indirectly through the stimulation of wages and demand levels.

2.1- **Transmission stages:**

The transmission of exchange rate fluctuations to domestic prices follows two consecutive stages:

- **First stage pass-through:** Through this stage, the observed appreciation or depreciation of a given currency is channeled to import prices;
- **Second stage pass-through:** Moving on with the mechanism, changes in import prices are transmitted to consumer prices. Consequences of the first stage outcomes are hence reflected in the general domestic prices, as supply on the local market and the

consumption basket contain both imported products and goods made out of imported components.

2.2- Transmission channels:

Throughout the explained stages of exchange rate pass-through to prices, a more detailed decomposition has been the attempt of a large number of studies. The identified linkage which runs from fluctuations in currency values to domestic consumer prices can be attributed to the work of **Dornbusch (1987)** who based its studies on industrial organization models. Inspired by this latter, **McCarthy (1999)** identifies the leading process of the distribution chain of pricing according to which exchange rate fluctuations are reflected first in import prices, then in domestic producer prices before affecting consumer prices. A parallel effect however was also identified. In fact, changes in exchange values would imply a reaction from consumers translated in demand levels as well as adjustments in production and selling policies which seeming play a crucial role in the product pricing. Hence, as agreed upon by literature, the impact of exchange rate movements is generally transmitted to domestic prices via two channels:

2.2.1- The direct channel:

The direct channel refers to the direct impact exchange rates are likely to have on products' prices on local markets. It hence implies a straight impact of exchange rates fluctuations on consumer prices. This can be portrayed by the example where a depreciation of a local currency leads to an increase in costs of imports, were they finished products or inputs destined for production. This observation allows the identification of two manners through which pass-through reaches domestic prices. Repercussions on consumer prices would hence be felt as rising costs would have to be covered by higher market prices for traders and producers to maintain a proper level of profitability. This direct channel thusly has two sub-channels:

- The first is the "cost channel" which represents the pass-through of imported inputs to domestic producer prices:

  This sub-channel hence transmits the recorded movements of the value of a currency to the prices of imported raw and intermediate materials and services necessary for the production process and which will ultimately be transmitted to the consumer prices within the importing economy. In fact, a depreciation in the local currency capable of

generating supplementary import and production costs would call for an increase in prices in order to cover this additional expenditure and vice versa;

- The second is the "consumption channel" which represents the pass-through of exchange rates to import prices:

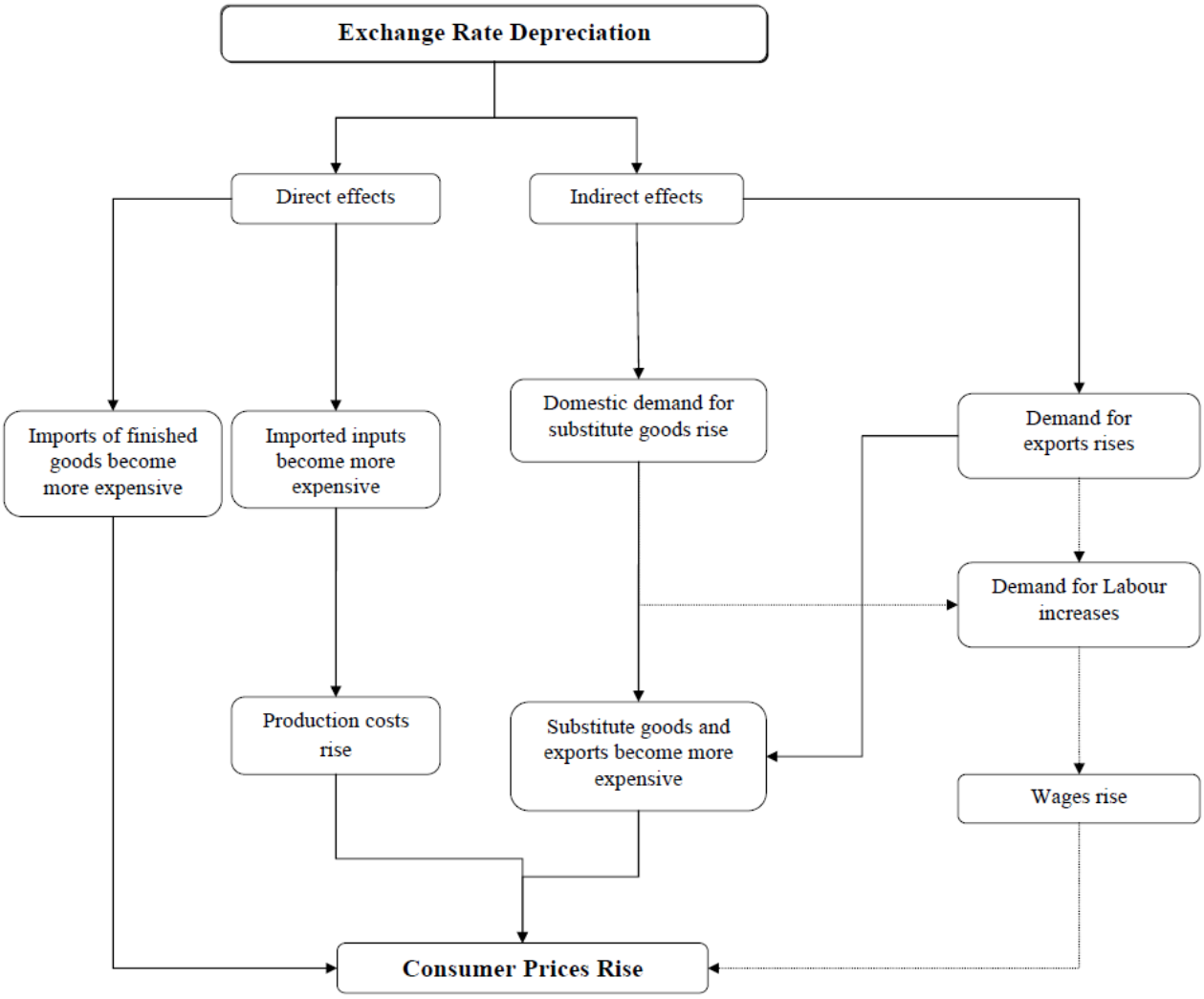
  This sub-channel establishes a direct link between the exchange rate fluctuations and imported final goods and services destined to the local market, and which will have straight repercussions on the level of prices in the importing economy.

2.2.2- The indirect channel:

Opposite to the direct channel, the indirect channel transmits changes of the exchange rate to domestic prices following a series of steps.

Considering the case of a domestic currency depreciation again, acquiring goods from the local market becomes cheaper, leading by that to an increase in demand levels, both foreign and domestic, as they became more competitive. On the one hand, **LaFlesh (1996)** describes how in front of such high demand levels coming from expenditure switching effect, local prices usually tend to increase to consequently generate inflationary pressures. On the other hand, as reaffirmed by **Kahn (1987)** and **Rincon & Rodrigez (2016)**, in order to meet with rising demand levels, production entities and firms would seek to reinforce their working capacities through increasing output and eventual additional recruitment from labor markets, especially within the export oriented sector. Such actions are consequently synonym to an additional distribution of wages. Such heavier costs would hence be a reason to charge higher prices for selling goods.

Figure 8: Exchange rate transmission mechanism



Source: LaFleche (1996)

1- Magnitude of exchange rate pass-through:

Being defined as the degree of transmission of exchange rate fluctuations to domestic prices, the exchange rate literature is considerably rich with studies seeking to assess the magnitude of its pass-through. Theoretically, this pass-through can either be complete or incomplete.

- Complete exchange rate pass-through:

The complete exchange rate pass-through implies a complete transmission of exchange rate variation to domestic prices. In other words, if a foreign currency increases in value, the initial amount of money needed to purchase imported goods from a local market would increase by the same percentage when expressed domestic currency and vice versa. The transmission is hence said to be "one-to-one". Yet even though this hypothesis is actually coherent with the

very first laws of exchange rate like the law of one price and the PPP, it remains theoretical as it requires the validity of a certain number of hypotheses to be discussed under the following title.

- Incomplete exchange rate pass-through:

Deeper examinations of the actual transmission degree to prices have been conducted short after the Bretton Woods era reached its end. In front of a considerable swing in the Japanese yen, the US import prices were not proportionally affected. In their attempts to find a proper explanation, economists studies commonly reach the conclusion stating that import prices typically change by a smaller degree compared to the exchange rate between the exporting and importing country **(Golberg & Knetter, 1996).**

Muted price response has been attributed to a number of economic aspects, considered to represent transgressions against the complete exchange rate pass-through.

On the one hand, **Krugmen (1987)** considers the existence of trade costs which need to be added to the general costs of production, departing with that from the low of one price theory. An increase in the value of a domestic currency makes imports cheaper leading by that to a higher domestic demand on foreign products. The increase in marginal transport costs will hence restrain prices from falling proportionally but rather in a smaller degree. Furthermore, he emphasizes on the pricing to market strategy through which traders chose to lower their prices to maintain their competitive position, limiting by that the transmission of exchange rate variation.

3- Pass-through determinants:

The underlying linkage transmitting transformations in exchange rates to domestic prices is a rather detailed net of dynamics.

Among the Pass-through literature, studies interested in the determination of factors of influence on the transmission degree of currencies fluctuations to domestic prices are considerably numerous and quiet various. Behind this variety lies a certain level of uncertainty in regard to what could explain this imperfection characterizing the transmission process. The result of these studies led to the classification of identified factors into two main categories:

- Macroeconomic factors;
- Microeconomic factors.

3.1- Microeconomic factors:

The very first studies that were carried out on exchange rate pass-through were conducted from a rather microeconomic angle. The main factors which were identified include:

3.1.1- Trade composition of imports:

Several studies have shown that the magnitude of exchange rate pass-through varies according to the composition of the import price index. In fact, consumption baskets present different characteristics as their composition differs between countries. Nevertheless, they always consist of a particular combination of imported and locally produced goods. The ERPT's transmission degree will hence depend on:

- The share of imported goods found within the consumption basket;
- The responsiveness of domestic goods which production includes imported elements.

Within this context, when the import share is considered rather important in a given local economy, domestic prices are expected to closely follow the movements of currency prices. **(Feinberg ,1986).** From a second but similar angle, **Neves and Rebelo (2000)** provide evidence supporting the fact that the extent of variations' transmission is also limited by citizens' consumption behavior referred to as "import penetration" following which the more citizens favor domestic products, the smaller the ERPT to domestic prices will be.

Furthermore, **Campa and Goldberg (2005)** put additional emphasis on the role played by this factor through distinguishing between goods based on their sensitiveness to changes in exchange rates. In fact, they proved how allocating lesser share to highly sensitive goods like energy against a greater portion less sensitive goods like manufactured products can reduce the exchange rate pass-through to general domestic prices.

3.1.2- Price adjustment costs:

A second element which can explain the incomplete transmission of exchange rate variations to prices are the price adjustment costs. Responsiveness degree of prices to changes in exchange rates is mainly submitted to two factors:

- Firms' price policies through which they decide on the frequency and reactivity of price adjustments implied by internal and external events: In fact, aside from supplementary costs which would be generated by price-adjustment procedures, firms do not usually proceed to an immediate nor frequent reassessment of their prices, however such process

is rather of a staggered pace. Because of that, when prices expressed in local currency are considerably rigid, the exchange rate pass through would be rather low.

- Estimations regarding exchange rate variation persistence through time: in fact, if variations are expected to be temporary, the benefit/cost ratio would turn out discouraging, leading to a null ERPT.

3.1.3- Pricing policies:

Several studies proved the importance of this factor in the determination of the exchange rate pass through to traded goods' domestic prices. **Krugman (1987)**, for instance, brings to light the pricing-to-market strategy, defined as the "positive correlation between the value of a country's currency and the relative price of its imports" **(Kasa, 1992)**. This phenomenon can be explained by the fact that, when an exporting country's currency appreciates, repercussions would be that its exporting prices would increase. However, when the exchange rate variation is considerate high enough to damage its competitiveness on international scales, **Krugman (1987)** and **Dornbusch (1987)** explained that exporting firms might choose to protect their position as well as their market share **(Hooper & Mann, 1989; Froot & Klemperer, 1989)** by reducing their mark-ups and thus their prices when converted in the importer currency. This reduction is hence one of the microeconomic factors which limits the transmission of such fluctuations to domestic prices.

3.2- Macroeconomic factors:

Although the debate concerning microeconomic determinants is still open, much recent studies have shifted their interest towards the macroeconomic level.

3.2.1- Monetary policy and inflation persistence:

Characteristics of existing monetary policy is commonly considered to be of a great influence on the degree to which domestic prices are found submitted to exchange rate volatility effects.

As a starting point, a hypothesis was considered, and later on confirmed, suggesting that an environment characterized by low or stable inflation rates usually limits the transmission of exchange rate changes to firms. **Taylor (2000)** was among the first to suggest and study this proposal. He explains that the tunnel leading from exchange rate variations to domestic prices has firms' behavior and monopolistic competition as main pillars. As firms' modus operandi

implies setting their products' prices in advance, he further explains how these prices are rather quite responsive to increases in cost levels when they are expected to last for a considerable period of time. When this increase finds its origins in local currency depreciation, the conclusion which can be made is that inflationary environment increases the exchange rate pass-through. From an opposite angle, his examinations affirmed that predictions regarding low inflation levels reduce the pass-through transmission, as firms refrain from adjusting their prices given a loss in their pricing power.

However, for such predictions to be solid, it is believed that they need to be backed by a credible and transparent monetary policy. **Gagnon and Ihrig (2004)** provide evidence sustaining that anti-inflationary actions and credibility of the monetary authority are key fragments in the attenuation of volatility pass-through to domestic prices. Inflation hence becomes an indirect way through which monetary policy exerts its influence on such variations. This monetary policy, however, needs to pursue lower inflation levels.

According to the **IMF (2016)**, a credible and predictable monetary policy is one that establishes "closer coordination among forecasters regarding the future path for inflation, since agents have a common understanding of how the central bank will react to any given shock". To achieve the appropriate level of coordination among forecasters, **Capistrán and Ramos-Francia (2010)** suggest the adoption of an inflation-targeting policy in order to transmit a better-anchored inflation objectives.

3.2.2- Exchange rate regime:

The question of whether or not the adopted exchange rate regime within a country, in comparison to those of its trading partners, intervenes in the determination of the pass-through degree has also been examined.

To start with, **caramazza (1986)** sustained the fact that the choice of an exchange rate regime will have considerable consequences on prices' responsiveness to currencies' value fluctuations. On the one hand, based on works of **Marazzi & al. (2005)**, when a given economy increases its imports from another adopting a fixed exchange rate, the pass-through affecting its local prices will tend to decrease.

On the other hand, **Bussiére, Delle chiaie & peltonen (2013)** indicate that when an economy, from its side as an importer, is known for its stable exchange rate regime, exporters might choose to adjust their prices adequately in a way that exchange rate changes wouldn't be fully transmitted to the importer's domestic prices.

3.2.3- Economy openness:

The openness degree of the country also takes part in the determination of the exchange rate pass-through as it is one of the factors which reflect the extent to which changes in international markets can have repercussions on the economy in question. Opposite to a closed economy who stands in the shadows from international events, the more an economy trades with the rest of the world, the more its prices would be subject to exchange rate fluctuations.

Additionally, this measurement has an indirect influence on how inflation impacts ERPT. As explained by Razin and Yuen (2001), inflation's sensitivity is partially determined by the degree of an economy's openness, as it represents the share of imported prices within the consumption basket.

II- Why it is important to assess the exchange rate pass-through:

1- Exchange rate pass-through and related facts:

The existing rich literature treating of exchange rate pass-through underlines the importance of pass-through assessment. The above described mechanism involves a wide range of economic factors, and its outputs are of a great influence on countries' economic performances, both on national as well as international scales.

In fact, the motivation behind the determination of the exchange rate pass-through might be explained by the repercussions it might have on decision making processes such as the establishment of monetary policies, the selection of an exchange rate regime, the adjustment of trade balance or even international transmission of shocks.

For instance, when exchange rate pass-through is considered to be high, it risks an increase in inflationary pressures, as increasing import costs will transform into an increase in domestic prices. This depreciation would hence have serious implications as it brings disturbance to pre-established forecasts as well as existing monetary policy. One of the major players which holds fundamental keys to thwart this is the central bank. This latter, needs to be able to assess the potential magnitude of the exchange rate pass-through to the economy, in order to be able to draw the monetary policy it sees fit to avoid an undesirable and damaging evolution in the inflation rate, as well as orientate its movement to respect the desired level.

Aside from that, as explained in the previous chapter, in order to be able to activate the appropriate instruments at its disposal at the appropriate time, a central bank needs to be able

to forecast inflation trajectory through building mid-term and long-term projections. The calculation of the importance and speed of exchange rate pass-through would allow proper estimation of the inflation's future path.

Another use might be made out of the calculation of exchange rate pass-through is the determination of external adjustment. It goes without saying that the quotation of a currency against the rest of the world's legal tenders is a key determinant of a country's trade balance, that is why consequences of movements in exchange rates cannot be ignored. In fact, two opposite cases can be considered: An increase in a foreign currency value compared to a local one will shift demand from imported goods to locally produced ones. As a consequence, the higher the pass-through is, the more domestic goods would attract demand, adjusting by that external imbalances. However, if the pass-through is estimated to be weak and slow, exchange rate variations would not be considerate that noticeable on demand levels, and hence would not be able to adjust external imbalances.

We should also bring up the impact of exchange rate pass-through on the extent of monetary shocks effect. These latter are known to generate disturbances among the economic features of a country. In fact, when the pass-through is considered high enough, monetary shocks generated by the local currency's depreciation would stimulate demand of domestic products, leading production entities to intensify their activity to be able to follow, while foreign countries would experience the opposite.

Last but not least, the magnitude of exchange rate pass-through provides a criterion allowing to distinguish, and hence to choose, between exchange rate regimes **(Corsetti and Pesenti, 2005; Devereux and Engel,2003; Obstfeld and Rogoff, 2000)**. In fact, when the pass-through is considered to present high levels, local currency depreciation is more likely to lead to an increase of demand on local products. Such pass-through would need the adoption of a flexible exchange rate to be able to transmit currency fluctuations to domestic prices. On the contrary, when exchange rate pass-through is low, a flexible exchange rate wouldn't present any advantage as fluctuations' theoretical impact would not really be reflected through prices.

2- Inflation and currency misalignment:

As previously explained, a currency's value can be misaligned with its equilibrium level either due to natural reasons, or deliberately as induced by authorities' decisions. However, literature agrees that real exchange rate misalignment is capable of causing severe welfare and

efficiency costs as well as generating economic vulnerability **(Pfefferman 1985; Edwards, 1989; Jongwanich, 2009)**.

2.1- In case of currency overvaluation:

Pfefferman (1985), Kaminsky & al. (1997) and Razin & Collins (1997) consider cases of overvaluation to be a sign of inconsistency in macroeconomic policy decisions. In fact, repercussions of overvaluation are as undeniable as they are considerably pervasive. A starting point for the analysis might be the eventual consequences overvaluation is likely to have on resources allocation between sectors and, consequently, over the aggregate output-inflation tradeoff **(Frankel, 1985)**: As an overvalued currency means that its acquirement is considered expensive, a local country's exports destined to the rest of the world would be perceived costlier which decreases their competitiveness on international markets. Such case hence undermines the profitability of any dynamic export sector considered as one of the core generators of development as it boosts the economy's production and employment, and feeds foreign exchange' reserves.

While exchange supplies slow down, imports become cheaper. Yet this drop in import prices does not systematically mean a reduction in the prices displayed on the local market **(Pfefferman, 1985).** A possible scenario would be a demand shift from imported goods to non-tradable goods. However, such shift might prove rather limited, as the overvaluation of the local currency holds back the production of import substitutes. For such reasons, currency overvaluation is usually followed by strengthened exchange and trade controls **(Edwards, 1989)**.

Literature also emphasizes on the disastrous impact overvaluation is likely to have on agriculture especially for developing economies to which this sector is an important source of employment. As repercussions would generate supplementary needs for foodstuffs, additional pressure would be put on imports and thus on the balance of payment. **(World bank, 1984; Pfeffermann, 1985).**

In front of a destabilized balance of payment, a government might try to ease the existing pressures by contracting debts. As it might lighten import pressures temporarily, a persisting and deepening deficit risks deepening the debt-servicing burden, rising risks of currency crisis. As **Stein and Allen (1995)** sustain these eventual implications of overvaluation, they argue that a persistent overvaluation within a country is a signal for crisis. As a sign of unfavorable

macroeconomic conditions, an overvalued currency makes it an appealing target for speculative attacks, massive capital flight **(Cuddington, 1986)** and, ultimately, possible currency crisis.

Central banks might choose to keep their country's currency overvalued as part of their macroeconomic monetary policy as they seek to control the evolution of inflation rates. Since an appreciation of a local currency's value makes imports cheaper, their strategy would aim to encourage the import sector via maintaining their currency overvalued. In fact, cheaper imports would benefit from an enhanced competitiveness vis à vis non-tradable goods. Such strategy helps keep a low level among general prices. However, critics have been made as of the effectiveness of such strategy. **Pfeffermann (1985)** argues that overvaluation does not really help curb inflation. He explains that, from one side, as the exchange rate pass-through implies, cheaper imports prices can only have a significant impact on inflation levels if their share in the average consumption basket is itself significant. Furthermore, he adds that even if such strategy does help contain inflation, a new wave of inflationary pressures would be inevitable as the unavoidable subsequent devaluation of the currency would push prices higher again.

2.2- <u>In case of currency undervaluation:</u>

At the other end of the spectrum, some countries are found opting for an undervaluation of their currencies. Indeed, some countries set up policies destined to maintain a permanently undervalued currency with the prime aim of boosting their competitiveness on international markets through enhancing exports **(Gala, 2008; Holtemöller and Mallick, 2013)**. In fact, as an undervalued currency would mean that foreign purchasers can spend less to acquire the same quantity, local sellers should gain in terms of competitiveness against other foreign sellers on the same market. **Couharde and Sallenave (2013),** who sustained this policy for export led-growth countries, argues that such orientation is likely to generate rather limited gains when currency undervaluation is considered small or excessive.

However, such policies have been the target of many critics. From the one side, **Haddad & Pancaro (2010)** evoke the question of the capacity of advanced countries' markets to carry out the absorption of developing countries' exports as their weight tend to get heavier, from the other hand, there is the impact of these strategies on the additional costs they generate for local producers especially when the undervaluation is maintained for a prolonged period of time. In this context, while growth rates might be enhanced through an undervalued currency strategy, (**Calvo et al., 1995; Haddad and Pancaro, 2010; Chen, 2017; Grekou, 2018a)** argued that

undervaluation might lead to an up rise in inflation rates through several channels. From his side, **Rodrik (2008)** supports this idea by explaining that the eventual expansion of the tradable sector following undervaluation would end up overheating the local economy, leading by that to additional inflation pressures. For **Chen (2017)**, exchange rate undervaluation puts extra pressure on local firms, as they increase the cost of imported inputs and machinery. Rising prices in order to cover new costs hoisting by that cost-push inflation.

Ghei and Pritchett (1999) discussed what they called "The import compression syndrome". While the devaluation of a currency might be a tool against imports, it is generally followed by softer trade barriers which encourage imports. He adds, however, that the import reducing impact is generally not that significant.

For this, while currency appreciation might be considered as a "negative externality" since it technically causes countries to export inflation to the rest of the world through trade operations **(Oudiz & Sachs, 1984)**, a currency depreciation has also been considered by some as the actual "negative externality" as it promotes exporting unemployment.

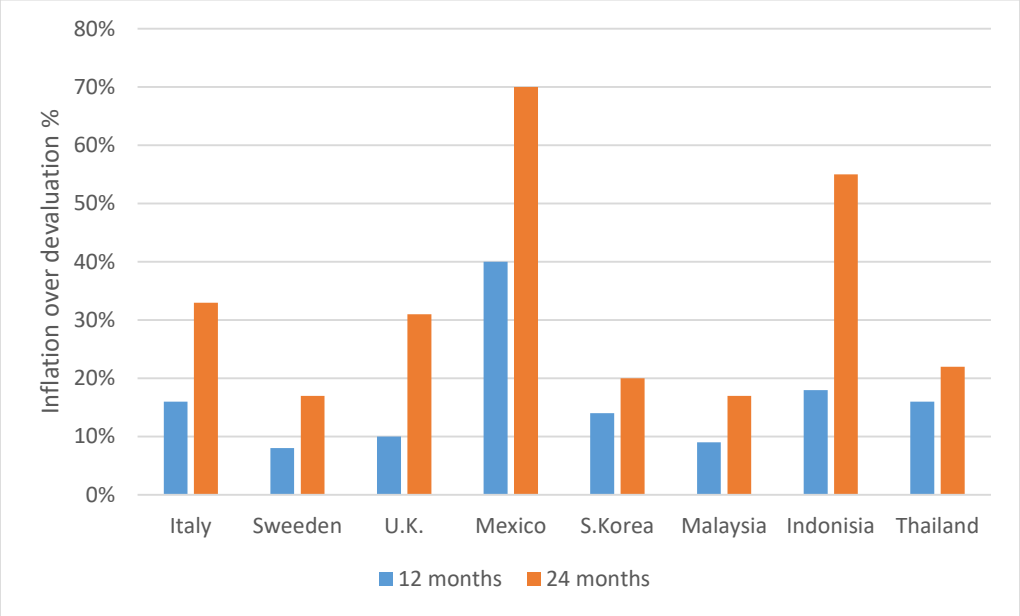
3- Literature review on exchange rate and inflation:

3.1- Existing empirical literature:

Even though questions around the exchange rate pass-through have long been a driver behind theoretical examinations, the unexpected reaction of inflation rates following currency crises and consequent large depreciations which have characterized the 90's fueled economists' will to further assess and understand the mechanism behind it. To consolidate these theoretical approaches, various empirical studies adopted the matter of exchange rate pass-through to prices with the aim of bringing quantified evidence to either support or adjust theoretical beliefs.

One of the most prominent observations which inspired empirical studies consisted in the magnitude and speed of shocks transmission to prices following the fall of the Bretton woods system. The measuring of the evolution of inflation rates following the depreciation of currencies confirmed the incomplete and low observed pass-through to prices even for small open economies in which imported final and intermediate goods presented a great share in consumption indices. The graphic below established by **Goldfajn and Werlang (2000)** demonstrate how low the pass-through was in a number of countries (With the notable exception of Mexico) after currency depreciations due currency crisis.

Figure 9: Pass-through: Effect of devaluation on inflation (%)



Source: Goldfajn & Werlang (2000)

Cunningham & Haldane (1999) considered the cases of 20% currency depreciation and appreciation in the United Kingdom. They noticed that neither were able to considerably shift price indices from their 2.5% trend.

The degree of estimated pass-through values was mainly explained by the overvaluation of the RER and the initial inflation level, with the first being the most robust determinant. Considering two sub-periods, the impact of a 10% nominal depreciation on the short run was estimated to cause a mere 1.24% of inflation, while an overvaluation of 10% pulled it down by 1.21%. In lapse of 12 months, these coefficients jumped to 73% and 11.8% consecutively. A worth mentioning fact by **Goldfajn and Werlang (2000)** states that, in the case of a devaluation which does not exceed the level of observed overvaluation would not have severe consequences on inflation as it pulls the nominal rate back toward its equilibrium.

From his side, **Calvo et al. (1995)** were able to extract evidence which sustained the fact that an undervaluation strategy can only be accompanied by acceleration in inflation rates, as it has been proven through their intertemporal optimizing model applied for Brazil, Chile, and Colombia.

Empirical evidence also corroborates the differences in pass-through magnitude between countries. Just like the above table which have hinted at the fact that the degree of pass-through is generally higher in developing and emerging countries compared to that of developed

countries, an application of three different VAR models by **Ca'Zorzi, Hahn & Sanchez (2007)** returned results in favor of this observation.

Considering the question of different pass-through magnitudes between short and long-run, **Campa & Goldberg (2001)** adopted the case of OECD countries. They were able to prove that, as a cross-country average, import prices in local currencies were affected up to 0.46 percent under the impact of exchange rate fluctuations in the short run, while the coefficient reached 0.65 percent over the long-run. Followed by **Campa et al. (2005)** who sought to estimate the exchange rate pass-through both on the short and the long run, they were able to conclude that the level of the pass-through is quite lower on the short run. This result was attributed to the stickiness of prices on the short run as prices do not adjust immediately following movements in inflation rates.

A sample of 74 developed, developing and emerging countries combined helped reexamine the same phenomenon. The generated results reaffirmed a low pass-through observed on the short run, but which increases as time period expends.

Table 11: Comparing exchange rate pass-through between 6 and 12-month periods

Months	Developed countries	Emerging countries	Other developing countries	OECD	Non OECD
6	0.245	0.394	0.340	0.113	0.471
12	0.605	0.912	0.506	0.188	0.754

Source: Goldfajn & Werlang (2000)

T**aylor's (2000)** suggestion that economies with low inflation rates would experience low exchange rate pass-through to CPI caught the attention of **Choudhri and Hakura (2001)**, a test was conducted by these latter for a period from 1979 to 2000 using a sample of 71 economies. While the average pass-through within low inflation countries was estimated at 0.16 on the long run, moderate inflation countries showed an average of 0.35 and high inflation counties 0.56.

Different pass-through coefficients were also obtained by **Webber (1999)** who examined the case of nine countries of the Asia-pacific with results ranging from 26% in Australia to 109% in Pakistan. In the same context, the work of **Devereux and Yetman (2003)** shows that there is a positive relationship between the average inflation rates and the pass-through magnitude. however, he indicates that this relationship is not linear because the impact degree follows the evolution of inflation under a "defective" dynamic.

For the question of the prices chain, **Taylor (2000)** from its part also pointed out the decline in pass-through magnitude to consumer prices during the past few years, as he suggests that the increased level of monetary policy credibility and a low level of inflation help better anchor expectations in regard to inflation evolution. An **IMF (2016)** study sustained his findings as it obtained evidence proving that general price stability and sufficient monetary policy credibility is capable to minimize exchange rate pass-through to consumer prices. Another study would be that conducted by **MacCarthy (2000)** who followed the exchange rate pass-through through the whole distribution chain as he included oil prices, output gap and money supply to further adjust his VAR model. For a set of industrialized economies, he found that the impact is far larger on import prices than on consumer prices, with implications getting heavier with the greater share of imports.

Another matter concerning the symmetry of the pass-through has also been risen in a number of studies. **Campa & Sebastia-Barriel (2006)** examined the non-linearity in the response on import prices to exchange rate movements in European countries. Obtained results were in favor of the asymmetric reaction of prices to exchange rate movements, as a depreciation of a local currency had a more pronounced effect on inflation rates than that of an appreciation. Yang **(2017), Pollard & Coughlin (2003) and Delatte & Villavicencio (2012)** who were also intrigued by this same question, were able to collect alibi in favor of these findings, each within the case of his study sample.

3.2- Pass-through in Tunisia: existing empirical studies:

Prior to any farther analysis of the Tunisian case, an overview of the existing empirical literature would be appropriate in order to have a thorough examination of previously carried studies in regard with exchange rate and inflation in Tunisia.

A first mentionable study would be that of **Choudhri and Hakura (2001)** who included Tunisia among their sample of low inflation countries as they considered the period covering 1979 to 2000. The obtained results suggested a pass-through of 0.1 on the long run, as they supported the fact that a low-inflation environment implies a low exchange rate pass-through.

Barhoumi (2006) constructed a model using the nominal exchange rates, countries' openness and inflation. A panel estimation technique employed to a sample covering 1980 to 2003 counting 24 developing countries including Tunisia proved that exchange rate pass-through to import prices on the long run is lower within countries applying higher tariff barriers and floating exchange regimes. With Tunisia being classified among the countries with high trade

barriers, low inflation rates and a floating exchange regime, the pass-through magnitude was estimated at -0.32%.

In another attempt to estimate the exchange rate pass-through, **Dahem.A and Siala.F (2016)** relied on an SVAR model for quarterly data from 2000 to 2015. The model returned a pass-through of 0.2 observed after 2011.

Charfi F and Kadria M (2016) employed an SVAR model considering MPI, PPI and CPI to assess the exchange rate pass-through in Tunisia using a sample of monthly observations covering the period from 2000 to 2013. The exchange rate pass-through, which was also incomplete, seemed the highest for MPI, and lowest for CPI.

More recent attempts to assess the exchange rate pass-through in Tunisia allowed to take into consideration the latest changes and events which have had a major impact on the economic environment both locally and internationally.

For a sample of observations covering the period from 2007 to 2019, **Karchi.S (2020)** retained the CPI, PPI, NEER and money supply (M2). Results indicated that a depreciation of the nominal exchange rate implied a pass-through of 0.12% observed in a matter of 4 lags. This delay has been attributed to the late response of firms and administrated prices of imported goods to exchange rate shocks.

As the spread of the COVID-19 pandemic represented a global event which repercussions on the world's economy cannot be denied, **Elloumi (2022)** adopts an SVAR approach to investigate the eventual impact of the changes induced by the pandemic on the pass-through to domestic prices. Through making use of the MPI, ISPI, CPI, XPI and the EUR/TND parity, an average pass-through of 0.9% was achieved.

Baghdadi, Zarzoso & Medini (2022) relied on monthly data covering the period from 2018 to 2020 to evaluate the pass-through of the COVID-19 shock on a list of prices. The estimated pass-through into prices proved to be significant as bread and cereals' prices increased by 0.431, fish and seafood rose by 0.461, and fruit rose by 0.565. for milk, cheese, and eggs a pass-through of 0.365 was obtained while oil and fats received 0.432, and vegetables 0.578. Similar values were found for manufacturing products as the pass-through for all products, reached about 0.573, and 0.623 for domestic appliances. A general overall pass-through of 0.5 was hence attributed to that period of study.

Conclusion:

As stated by Svensson (1987), The inflation and exchange rate relationship has always been one of the fascinating topics for economists. This is mainly due to the vital importance it occupies, mainly in the case of emerging countries. As out-of-control inflation rates can have destructive implications on a given economy's position in the middle of international markets as well as its general welfare and the well-being of its citizens, authorities should be in a position which allows them to employ the appropriate tools at the appropriate time. For this, a continuous observation of inflation rates evolution as well as its main determinants needs to be carried out. In this context, theoretical literature proved how crucial it is to keep exchange rates under the scope, even within floating regimes, and to assimilate its behavior since this latter has sever implications when it comes to the inflation state within an economy.

For this purpose, literature agrees upon the fact that exchange rate pass-through to prices should be deeply analyzed given its particularities which tend to shift shapes between developed and developing economies, and from short-run and long-run. A set of microeconomic determinants has also been identified and which intervenes significantly in the calibration of the pass-through magnitude such as pricing policies and prices adjustment costs which condition producers and traders' decisions as well as the share occupied by imports in the average consumption basket… A second set of macroeconomic factors include the prevailing monetary policy, the adopted exchange rate regime as well as the economic openness degree and inflation rates themselves.

Aside from exchange rate fluctuations, the position of a currency compared to its equilibrium level has also been proven to have undeniable consequences on inflation, especially in the case of severe rates' shifts and trends. Several factors such as macroeconomic policies and trade restrictions influencing the misalignment of a local currency are capable of having adverse consequences on inflation rates and thus need to be delicately defined.

To further understand the role played by the exchange rate in the Tunisian case, the following chapter will try to assess the pass-through magnitude to the chain of prices. We will later check if the REER misalignment, as estimated in chapter 2, has any eventual implication on inflation rates in Tunisia.

Chapter 2: Exchange rate pass-through and misalignment in Tunisia

Introduction:

Following what have been presented in the previous chapters, we can now focus on the exchange rate pass-through and the eventual misalignment's impact on inflation in Tunisia. However, before proceeding to any further empirical estimations, it would be more appropriate to have a preliminary overview on the inflation dynamic in the country throughout the past few years, especially that it has been responding to the influence of a heavy list of disturbing and unpredictable events.

For this purpose, the first section will be dedicated to have a historical overview on the evolution of the monetary policy framework of the central bank of Tunisia as well as the tools at its disposal, before moving on to an overall look on inflation's determinants and its historical rates throughout the past couple of decades.

The second section will later on undertake the estimation of the exchange rate pass-through to the consecutive levels of the chain of prices as well as the assessment of whether or not the previously brought to light misalignment is capable of having any impact of inflation in Tunisia.

Section 1: Some stylized facts from Tunisia:

I- The monetary policy in Tunisia:

1- A historical overview:

An examination of the monetary policy history in Tunisia shows that the mentioned policy had to undergo a certain number of mutations implied by the changes in the macroeconomic environment features.

Since the 20th century, the monetary policy conducted in Tunisia was a discretionary policy, that is a policy which was based on the Central Bank's judgment and analytical studies as a monetary policy maker. The nature of this policy can be explained by the rather ambiguous definition of the Central Bank's main mission during that time and which, according to the law

N° 58-90 establishing and organizing the CBT, consisted in preserving the internal and external value of the national currency, and by the absence of a robust and reliable analytical framework to better shape and conduct the monetary policy. Via such policy, the Central Bank included in its aim range numerous targets counting the preservation of the country's financial system's stability, the protection of its economic activity, containing inflation and maintaining the country's external position. Within this orientation, the Central Bank would publish yearly objectives in regard to money supply, while taking into consideration the governmental macroeconomic objectives and previsions. Considered to be highly influenced by these latter, the CBT's judgments regarding inflation and its eventual future evolution were merely indicative and could not be fully relied upon to adequately operate its policy rate.

Later on, in 2006, the amendment of the Central Bank's status brought changes to the mainly pursued objective by switching its target from money supply growth to preserving prices stability. This transaction consequently called for a structural innovation of the bank's underlying system which now provides advanced analysis and previsions in regard to inflation and its future trajectory, on short and medium run.

While the overall performance of the monetary policy allowed the CBT to respect its obligations in regard with inflation control, a lack in credibility and an unclear anchoring of anticipations was diagnosed. A remedy to this issue was applied through the newest status of the Central Bank as its latest amendment in 2016 announced the monetary authority's independence from every other parties in working on its goals, carrying out its missions and managing its resources. It also became more forward, transparent and clear in the announcement of its previsions and objectives in terms of inflation rates in order to allow better anchoring of agents' anticipations and reinforce their trust.

2- The CBT's monetary policy tools:

On the local market, prices of goods and services are left to be freely determined by the continuous confrontation between supply and demand. Exceptions, however, still exist as the legislation proclaims a list among these products to be administered. In this context, it is worth mentioning that, in 2021, the consumer price index in Tunisia is shared between both, with a share of 73.5% occupied by unregulated products while 26.5% is occupied by administered products. While the movements of both types of prices contribute to the evolution of inflation rates, it is only on the former category that the CBT can exert an influence.

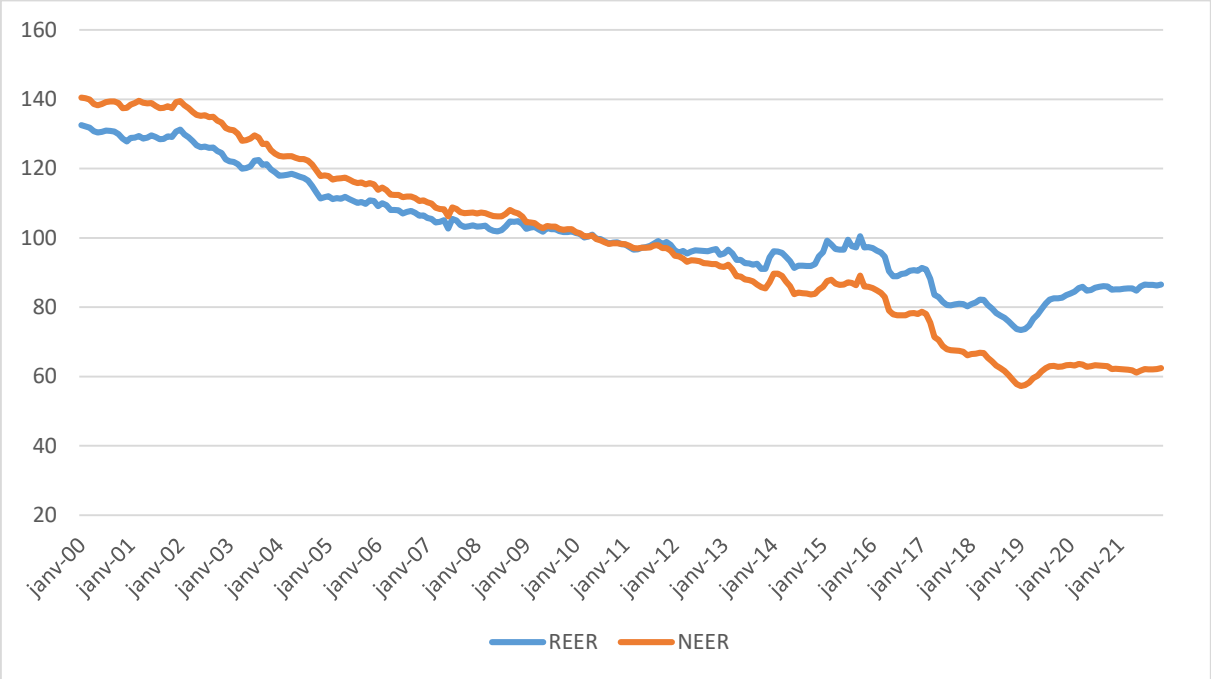
In order for the CBT to accomplish its main mission of maintaining the stability of prices, a set of tools is as its disposal. Among these tools, the CBT has to delicately choose what and when employ each one of them in order to achieve the best results. It is in the context that central bank of Tunisia adopts the "Forward Looking" rule. As it changed its main target from money supply growth to stable price levels, the central bank of Tunisia works to build appropriate previsions in regard with inflation's future evolution. Such previsions will give enough range to employ the right instrument following the right strategy. The set in question counts mainly its policy rate though which the CBT influences the cost of credits and hence the money in circulation, along with required reserves which represent the minimum deposit level banks are forced to have in their accounts held by the CBT, and open market operations through which the central bank trades securities for money in order to increase or decrease the supply of money within the banking system.

II-The evolution of inflation in Tunisia:

1- A preliminary insight on the nominal exchange rate of the Tunisian dinar:

Considering the dinar from a more reflective perception then earlier, the figure below shows the evolution of the Tunisian nominal effective exchange rate compared to its real effective exchange rate during the last 21 years.

Figure 10: Evolution of the REER and the NEER in Tunisia between 2000 and 2021



Source: Own construction

According to the above figure, between 2000 and 2003, the two series kept a stable relationship as they seem to have followed parallel movements during that period. However, their relationship changed shape. Though both values have been following a downward trend up to 2019, it is clear from the graph that the NEER levels depreciated with a faster pace than that of the REER. An identifiable intersection point around the start of 2011 marked the moment when the NEER value of the dinar fell below that of the REER.

Building up from what has been developed in the previous chapter, as the CBT brought some flexibility to its currency at the start of the 20th century, the NEER has hence known an overall depreciation of 35% from 2000 to 2010. The bust of the revolution in 2011 and what it has for consequences on several levels from tourism to foreign investment attractiveness among others has accelerated this deterioration, leading the Tunisian NEER to lose extra 30% of its value against the USD and 18% against the euro within the three following years only. Nevertheless, this depreciation can be witnessed picking up the pace as the end of 2016 was marked by depreciation which reached 8.5% for the NEER against 6.2% for the REER, before falling even harder in 2017 by 15.1% against 11.5% for the REER.

This harder depreciation in the NEER compared to the REER can mainly reflect an inflation pace which is faster and more pronounced in Tunisia compared to the average inflation level of its main trading partners, as well as quite fluctuating terms of trade and volatile capital flows.

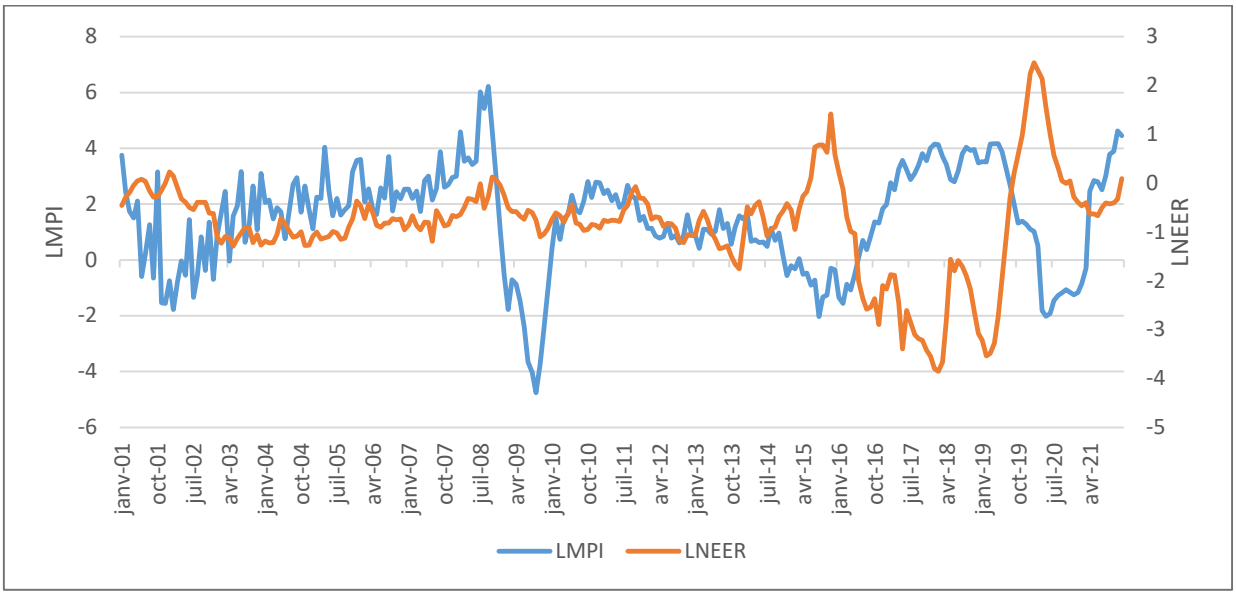
2- Evolution of inflation in Tunisia:

As the pass-through to domestic prices follows the succession of prices within the distribution chain, we will be having a general look on the evolution of these levels, in order.

2.1- The evolution of the import price index in Tunisia:

Our analysis of the prices chain would start at the level of import prices, for which a proxy named “the Import price index” (MPI) helps follow their evolution through time. The figure below hence shows the average annual evolution of this variable from 2000 to 2021 along with that of the NEER:

Figure 11: Compared evolutions of the LMPI and the LNEER



Source: Own construction

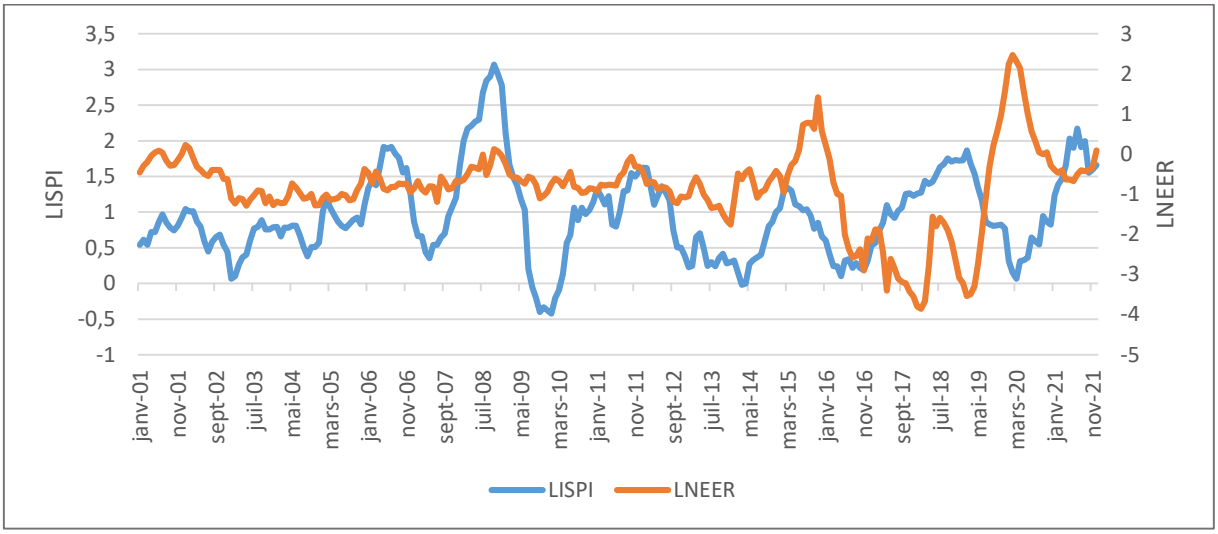
It can be seen from the figure above that the MPI followed an increasing trend up until 2008 characterized by a high volatility, before plunging deeply following the subprime crises which busted in 2008, leading by that to extremely lower world prices.

Import prices found back their levels later on. Following 2016, the index showed a consistent increase crease before falling again following the bust of the COVID-19 pandemic. Once the pandemic controlled, the MPI found back its level through a sharp increase of 12.6% in 2021 against -4.3% a year before. Such increase has been the consequence of a substantial rise in the prices of mines and phosphates (29.3% against -6.5%), the agricultural and agro-food sector (20.3% against -0.2%), that of energy (17.7% against -23.0%), as well as and textiles, clothing and leather (7.6% against -1.6%). Considerable consequences on the consumer price index are hence awaited.

2.2- The evolution of the industrial selling price index in Tunisia:

As the import prices later on influence the industrial selling prices as they are taken into consideration in the determination of costs, the below figure will hence show the annual average evolution of industrial selling prices during the period from 2000 to 2021 along with that of the NEER:

Figure 12: Compared evolutions of the LISPI and the LNEER



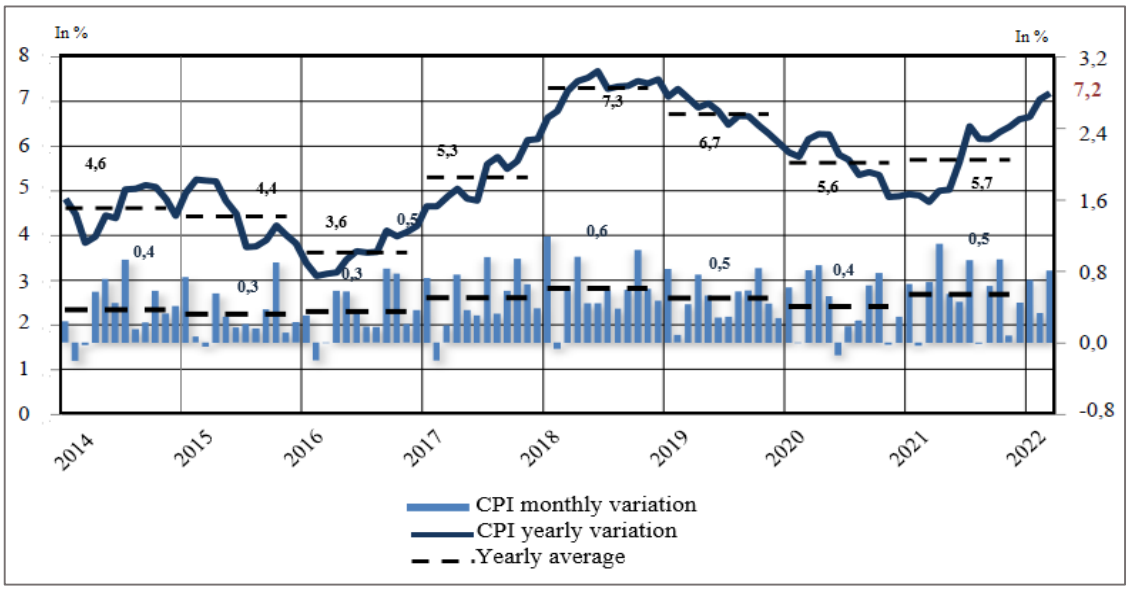
Source: Own construction

The industrial price index seems to have followed a similar trend during the first decade, as selling prices have been following an overall upward trend, which was pulled down to negative levels around mid-2008 under the shock of the subprime crisis. For the rest of the ISPI seem to have followed an almost parallel behavior, reflecting the shock of the pandemic in 2019, following which a notable increase was recorded as the nation and international economic activities started to find its paces back, however with different degrees. Such increase was estimated at 9.3% against 2.3% a year back. This increase mainly finds its origin in more costing chemical productions (28.6% against -7.6%), of manufacturing industries (11.5% against 2.5%) and mechanical and electrical products (13.5% against 6.2%).

2.3- The evolution of the consumer price index Tunisia:

Inflation in Tunisia has shown significant changes in its movements throughout the past years. This fact is not surprising given the long list of past events which took place both in Tunisia and all around the world, and which called for the adoption of necessary measurements and the adjustment of some preexisting policies. The evolution on inflation rates are presented in the below figure:

Figure 13: Monetary trend in headline inflation in monthly variation and in annual shift



Source: BCT (2022)

During the first decade of the 21st century, inflation rates were contained below the world's average level **(Moulay, 2012)**. In fact, the monetary and exchange rate policies followed by the central bank, sustained by fiscal discipline, succeeded to maintain the inflation rate at an average of 3.4% **(Khatat, End & Kolsi, 2020)**.

Following the 2011 events, the deterioration of economic indicators and the disturbances brought to the economic functioning started to fuel inflation. The central bank which have decided upon an expansionary monetary policy was also confronted by the need of reconstituting foreign supply and standing against increasing trade deficit. The exchange rate was hence allowed extra freedom, as we explained earlier. Altogether, and given the considerable openness degree of the Tunisian economy, the depreciation of the dinar during that period pulled inflation up to 6.1%.

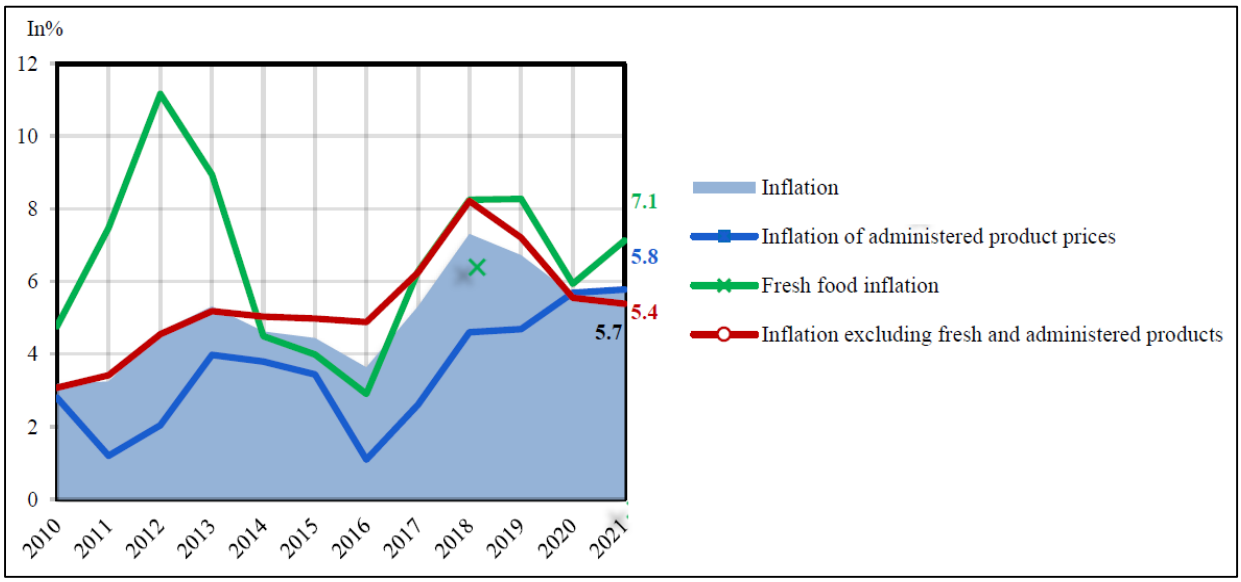
While these rates slowed down following appropriate measures, mid-2016 marked the beginning of a new upward trend which persisted for three successive years as the consumer price index underwent some rather radical changes in its dynamic mainly due to consecutive supply shocks resulting essentially from heavier imposed taxes and a further depreciation of the Dinar. A first record of 7.8% was hence reached in June of 2018, and the year was marked with an average of 7.5%.

Concerned by such rates, the Central Bank of Tunisia adopted a restrictive monetary policy and raised its policy rate by 100 points at the start of 2019. By 2020, the Covid-19 pandemic

dramatically spread worldwide. Measures taken to flatten its spread pulled back the levels of demand, which resulted in prices dropping, mainly those of energy. Inflationary pressures hence halted during the following two years and inflation in level stepped back from 7.1% at the start of 2019 to 4.9% by the end of 2020. This fallback was also supported by the good performance of the Dinar against the main international currencies as well as the drop both in observed demand and in raw material prices, which reflected mainly on core inflation, despite the continuous increase in administrated prices.

Few months into 2021, the recovery of global demand inspired inflationary pressures to resume. The rebound of raw material and international transport prices which were transmitted through production chains fueled a new series of supply shocks, to which was added the implications of monopolistic situations and parallel trade. The evolution of inflation can be explained by the behavior of its main components as follows:

Figure 14: Trend in the main components of inflation (in annual shift)



Source: BCT (2022)

• For core inflation, which represents the variation in the price index while omitting the fresh food and administered products inflation components, a deceleration was observed as it passed from 5.6% in 2020 to 5.4% in 2021. This slight decrease finds its origins in the easing of pressure on numerous components of the consumer prices, faced by the opposite effect of a remarkable increase in imported raw materials' prices and freight costs.

• For administered products, a slight increase from 5.7% to 5.8% was recorded, as the increase in prices of products like milk, sugar and pump were slowed down by a fallback in prices of coffee services and transport fees.

• As for fresh food products, a general increase from 5.9% in 2020 to 7.1% in 2021 participated hugely in the increase of inflation rates, as a response to increasing import costs.

An examination of prices during 2022 confirmed that higher levels of inflation continued to be exceeded as disturbances in supply chains persisted and prices of commodity products, especially of energy and cereals, continued to rise stimulated by the repercussions of the still ongoing war between Russia and Ukraine. A new record level of 9.8% was breached in the third quarter of 2022, while core inflation touched 8.5% as of September 2022. Such levels are considered to be the highest to ever be recorded during the past three decades.

Section 2: empirical assessment of the exchange rate pass-through:

Before diving into empirical analysis, we will first be introducing the selected variables which will build our model, as well as the signs of the theoretical relationships linking them together, before moving on to the concrete computing of the impact some might have on the others.

I- Variables definition and sources:

1- Introducing the selected variables:

For the selection of the variables to be included in our model, we were inspired by the existing studies within this matter. Based on our observations, the most used variables for the determination of the exchange rate pass-through usually include: the import price index, the industrial selling price index, the consumer price index, the foreign consumer price index, the money market rate, the money supply, Oil prices, output gap…

After some considerations, and given the small number of observations obtained following the splitting of our sample into two sub-periods, our choice fell on the following variables:

- **The nominal effective exchange rate:**

Since we seek to estimate the exchange rate pass-through quantifying the impact of exchange rate changes on prices, an exchange rate variable needs to be employed. As previously defined, the nominal effective exchange rate (NEER) is a weighted rate which estimates the value of a domestic currency against a basket of a given combination of foreign currencies without being an adjusted by any inflation differential. For this, existing empirical literature employs the NEER rather than the REER in the estimation of the exchange rate pass-through.

- **The import price index:**

The import price index (MPI) is a measurement of changes in the prices of imports of merchandise brought from abroad. Since the exchange rate defines the relative value of the currency with which imports will be brought, the higher the value of the local currency, the cheaper the imports and the lower the import price index would be. The sign is hence expected to be negative. This index represents the first level in the chain of prices. It is hence directly affected by changes in the exchange rate and is expected to receive the largest impact compared to the rest of the chain.

- **The industrial selling price index:**

The industrial selling price index (ISPI) represents a measurement of changes in prices of manufactured and later on sold products in the domestic markets, during the first step of its commercialization. This index has an important place within the chain of prices. Since the industrial products include a part of imported products, it is positioned after the MPI. The impact of an increase in the value of a local currency would hence decrease the ISPI with a lesser degree compared to the MPI.

- **The consumer price index:**

The consumer price index (CPI) is a measurement of the evolution of local prices paid by consumers in order to purchase a theoretical consumption basket of the weighted goods and services which characterize the average consumption habits of the consumer. The annual evolution of this index gives an estimation of inflation rate. It is also positioned at the third and last level of the prices chain. As a share of these prices is occupied by industrial products, the impact of an increase in the local exchange rate would decrease the CPI, however with a lesser degree compared to the ISPI.

- **The money market rate:**

Another variable widely used in the estimation of the exchange rate pass-through seems to be the money market rate (MMR). Being a target through under the influence of central banks, this variable is generally included to assess the impact of the monetary policy decisions on inflation as it conditions the accessibility to money supply by economic agents.

- **The exchange rate misalignment:**

Being the difference between the observed real exchange rate and the equilibrium level, this variable to be denoted (MIS) has been estimated by a VECM model within the previous first part of this thesis. This variable will not be included at first. Its impact will later on be assessed throughout a second estimation.

Theoretically, an overvalued local currency is expected to reduce prices index as it makes imports cheaper while an undervalued currency has the opposite impact.

2- Series description and data sources:

The following table regroups the variables' series and the notations to be employed in the model:

Table 12: variables selected for the study

Variable	Notation
Nominal effective exchange rate	NEER
Import price index	MPI
Industrial selling price index	ISPI
Consumer price index	CPI
Money market rate	MMR
Exchange rate misalignment	MIS

Source: Own construction

Since 2011 marked a pivotal point as Tunisia switched toward a more flexible exchange rate regime, we thought about splitting our sample into two sub-periods before moving on with the tests. The first sample period will hence cover 2000Q1 to 2010Q4 while the second will cover 2011Q1 to 2021Q4. For the NEER, the import price index, the industrial selling price index, the consumer price index and the money market rate, they were all collected from the Central Bank of Tunisia's data quarry. The exchange rate misalignment, however, was estimated within the second chapter of the first part.

3- Some statistical preliminaries:

Variables were transformed before being used in our model. First, a logarithmic transformation was applied to the variables of use. Second, to avoid multi-collinearity which might be induced by the integration of both the NEER and the misalignment, we modeled our series in first difference. The variables have proved to be stationary (Appendix 8-9), a necessary condition to be able to use the VAR method. As for the length criteria, 1 lag has been applied (Appendix 10). The results of our analysis have also proven to robust to proceed with the VAR estimation (Appendix 11).

Given the characteristics of the VAR of not taking into consideration the asymmetry of variables reactions, we will be considering, for the rest of our work the hypothesis of the symmetric impact of overvaluation and undervaluation on inflation.

4- Model and methodology:

For the examination of the exchange rate pass-through to domestic prices in Tunisia, we chose to follow the steps of **McCarthy (2000)** who adopted the vector auto-regression (VAR) methodology using a Cholesky decomposition.

Within the field of economics, VAR models were made popular by **Sims (1980)**[4]. While univariate autoregressive models represent a single equation model where a current value would be explained by its own lag solely, VAR models are n-equation models where each variable would be expressed as a linear function of its own past values, the past of all other variables being considered, and a serially uncorrelated error term. This methodology is hence frequently used and considerably adopted for the analysis of multivariate time series, and is considered particularly effective in capturing the dynamic behavior of financial and economic time series and building forecasts.

Within the context of the exchange rate pass-through, such methodology can be found frequently adopted by empirical works like **McCarthy (2000), Leigh and Rossi (2002), Hahn (2003), Belaish (2003), Faruqee (2006) and Ito and Sato (2006)**. This choice would be found explained by the fact that VAR models help to go beyond the direct relationship between exchange rates and single prices, to capture the underlying simultaneous relationships between the variables and the exchange rate shocks at the different levels forming the pricing chain **(Jimborean, 2011)**.

[4] Christopher Sims (1980): Macroeconomics and reality

If we consider a (n x 1) vector of stationary time series variables which we denote $Y_t = (y_{1t}, y_{2t}, \dots, y_{nt})$, then, for a chosen p number of lags, a representation of a general VAR(p) would have the following form:

$$\begin{pmatrix} y_{1t} \\ \vdots \\ y_{nt} \end{pmatrix} = \begin{pmatrix} c_1 \\ \vdots \\ c_n \end{pmatrix} + \begin{pmatrix} \pi_{11}^1 & \cdots & \pi_{1n}^1 \\ \vdots & \ddots & \vdots \\ \pi_{n1}^1 & \cdots & \pi_{nn}^1 \end{pmatrix} \begin{pmatrix} y_{1t-1} \\ \vdots \\ y_{nt-1} \end{pmatrix} + \cdots + \begin{pmatrix} \pi_{11}^p & \cdots & \pi_{1n}^p \\ \vdots & \ddots & \vdots \\ \pi_{n1}^p & \cdots & \pi_{nn}^p \end{pmatrix} \begin{pmatrix} y_{1t-p} \\ \vdots \\ y_{nt-p} \end{pmatrix} + \begin{pmatrix} \varepsilon_{1t} \\ \vdots \\ \varepsilon_{nt} \end{pmatrix} (31)$$

Or also:

$$Y_t = c + \pi_1 y_{t-1} + \pi_2 y_{t-2} + \cdots + \pi_p y_{t-p} + \varepsilon_t \; ; t = 1, \dots, T \quad (32)$$

Where π_i are the (n x n) matrices of coefficients, c is a vector of constants and ε_t refers to the white noise vector. Specifically, the reduced-form VAR(p) can be written as follows:

$$Y_t = \Pi(L) Y_{t-1} + \varepsilon_t \quad (33)$$

With Π being the matrix polynomial of degree p in the lag operator L. Note here that, for the white noise vector ε_t we have:

$E(\varepsilon_t) = 0$;

$$E(\varepsilon_t \varepsilon_\tau{}') = \begin{cases} \Omega \; for \; t = \tau \\ 0 \; otherwise \end{cases}$$

Ω being an (n x n) symmetric matrix.

Within the context of our study, a first difference VAR model was chosen for our analysis. The identification of the structural shocks of this model is achieved by applying a Cholesky decomposition. The Cholesky decomposition leads to the decomposition of the variance covariance matrix **Ω** of the reduced form residuals into a lower triangular matrix S and an upper triangular matrix S'. Thus the n(n−1)/2 economic restrictions, necessary to identify the structural model, are imposed as zero restrictions on the matrix S, that links the reduced form and the structural residuals **(Hahn,2003)**. These restrictions indicate that some structural shocks do not have a contemporaneous influence on some of the variables. For this reason, a proper ordering of the variables is necessary. To put it simple, according to their placement, variables will respond contemporaneously to shocks from the variables placed ahead of them, but not to shocks of those placed behind them.

After the examination of the existing literature, we decided in favor of the following ordering within our baseline model: first we include the monetary authorities' instruments given their

proactive feature which will be influencing the rest of the series. We hence find the money market rate in the first place followed by the NEER. The Rest of the variables, as they represent a predetermined chain will hence keep their order. The NEER will hence be followed by the import price index, then the industrial selling price index and lastly the consumer price index.

Hence, in this spirit, our model can be written as follows:

$$Y_t = (dlnMMR_t, dlnNEER_t, dlnMPI_t, dlnISPI_t, dlnCPI_t)$$

Using this ordering in the Cholesky decomposition the relationship between the reduced form residuals ε_t and the structural shocks of the model can be written as follows:

$$\begin{pmatrix} \varepsilon_t^{MMR} \\ \varepsilon_t^{NEER} \\ \varepsilon_t^{MPI} \\ \varepsilon_t^{ISPI} \\ \varepsilon_t^{CPI} \end{pmatrix} = \begin{pmatrix} S_{11} & 0 & 0 & 0 & 0 \\ S_{21} & S_{22} & 0 & 0 & 0 \\ S_{31} & S_{32} & S_{33} & 0 & 0 \\ S_{41} & S_{42} & S_{43} & S_{44} & 0 \\ S_{51} & S_{52} & S_{53} & S_{54} & S_{55} \end{pmatrix} \begin{pmatrix} u_t^{MMR} \\ u_t^{NEER} \\ u_t^{MPI} \\ u_t^{ISPI} \\ u_t^{CPI} \end{pmatrix} \quad (34)$$

At a later step, we will be introducing the misalignment variable to assess its impact on the CPI. The model will hence have the following form:

$$Y_t = (dlnMMR_t, dlnNEER_t, dMIS_t\ , dlnMPI_t, dlnISPI_t, dlnCPI_t)$$

- Estimates of the pass-through coefficients:

Impulse response functions were employed as we tried to assess the impact of exchange rate movements on the prices chain. For each study period, we present the orthogonalized impulse response functions for the import prices, the industrial selling prices and the consumer prices to a one standard deviation innovation brought to the nominal real exchange rate.

Following **Leigh and Rossi (2002)**, the determination of the pass-through coefficients uses the cumulative response functions. Each coefficient would hence be obtained by dividing the cumulative impulse response of a given price index to a 1% NEER shock after *j* periods by the cumulative response of the NEER to a 1% NEER shock after the same *j* periods, as represented through the following formula:

$$PT_{t,t+j} = \frac{\Delta\%P_{t,t+j}}{\Delta\%E_{t,t+j}} \quad (35)$$

Where $PT_{t,t+j}$ stands for the pass-through coefficient, $\Delta\%P_{t,t+j}$ is the percentage change of the price levels j periods after the shock, and $\Delta\%E_{t,t+j}$ is the percentage change of the exchange rate after the same period.

Each obtained coefficient would hence give an estimation of prices' adjustments magnitude while taking into account the disturbances brought to the other variables in the model.

II-Empirical results:

In what follows, we will be presenting the main results obtained from the previously specified VAR model. Since the focus is on the effects of exchange rate shocks on inflation, and hence on prices, the other response functions will not be reported.

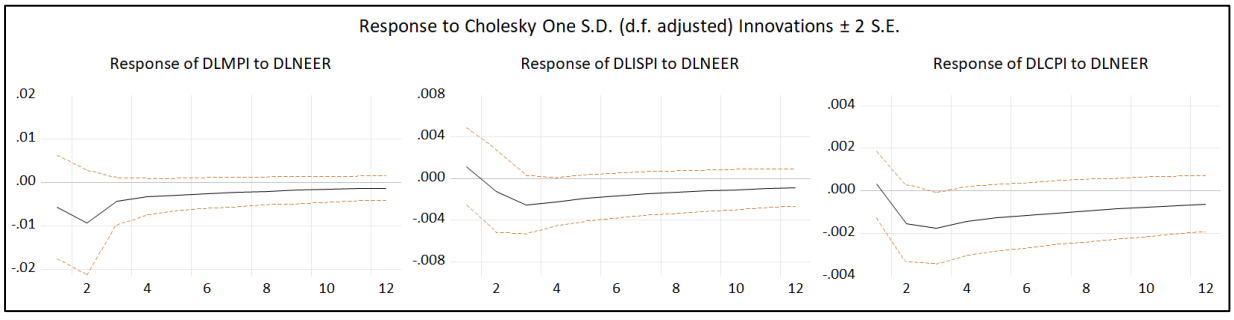
1- Before the 2011 revolution:

1.1- Without including misalignment:

- Impulse response functions:

As we proceeded, we tried to estimate the exchange rate pass-through to the different prices relative to the first period in our study, that is the period going from 2000Q2 to 2010Q4. The following set of figures hence traces the pass-through of a 1% shock brought to the NEER into the different levels of the chain of prices:

Figure 15: Responses of prices indexes to Cholesky 1% shock to DLNEER (before 2011)



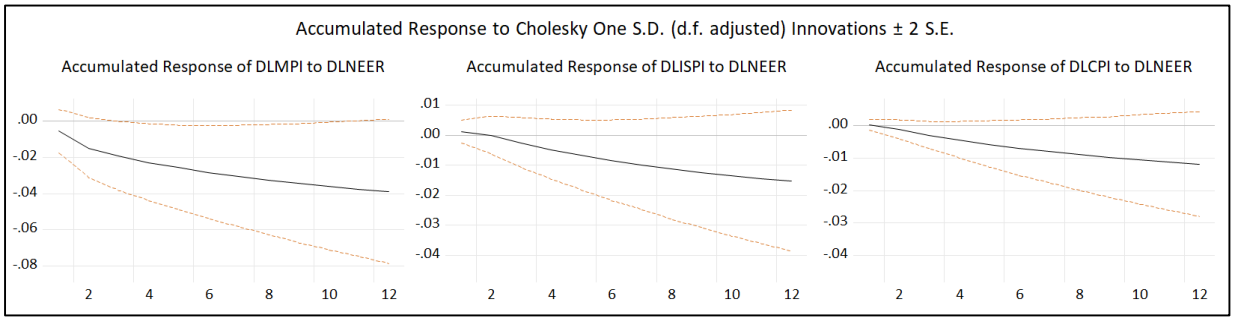
Source: E-views 12

As indicated by the confidence bonds in orange, the response is significantly different from zero at 5%. It is clear from the first set of graphs that the initial impact of the shock on the import prices is, as expected, of a negative sign, reaching its maximum around the second trimester, with the most of it being received within about two years. In other words, a 1%

appreciation of the NEER would lead to a decrease in import prices, followed by a similar but less pronounced behavior in the industrial selling prices and then in consumer prices.

To estimate the exchange rate pass-through to the different prices, we generated their accumulated responses to a 1% choc brought to the NEER value presented by the figure below:

Figure 16: Accumulated responses of prices indexes to Cholesky 1% shock to DLNEER (before 2011)



Source: E-views 12

From these responses, we compute the exchange pass-through to the different prices by the application of equation (35). Results are grouped within the following table:

Table 13: ERPT to prices magnitude on the short-run and the long-run (before 2011)

	Short run	Long run
MPI	-0.6	-1.7
ISPI	-0.2	-0.6
CPI	-0.1	-0.52

Source: Own calculations

From the second set of graphs, we can notice that the magnitude of the exchange rate pass-through increases with time as, for the three levels of the prices chain, the pass-through on the short run seems to be smaller than that on the long run, an observation which corroborates with the theoretical and empirical literature. the above graphs also hint at the absorption of the exchange rate shock throughout the prices chain.

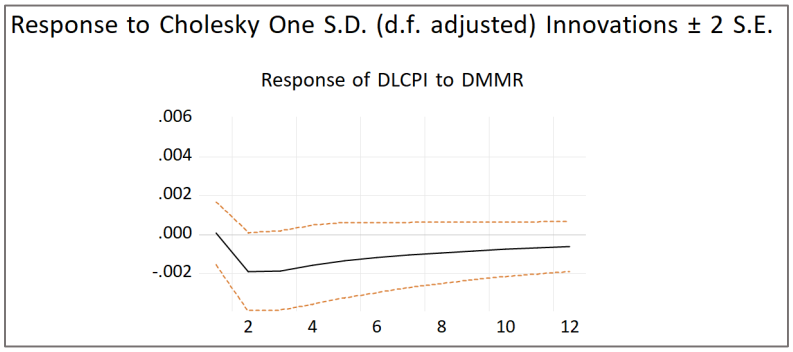
The cumulative response functions were also used to quantify the magnitude of the pass-though. The application of **Leigh and Rossi's (2002)** formula suggests a high direct pass-through to import prices as the obtained coefficient goes from -0.6% on the short run to a maximum of -1.7% on the long run. Our findings corroborate with those of **Helali, Kalai and Boujebane (2014)** who obtained a pass-through to import prices of 1.3% for the pre-revolution

period in Tunisia. **McCarthy (2000)** seemingly obtained coefficients surpassing 1% in the case of some countries in his sample. His supplementary tests explained such strong pass-through mainly by a small volatility in exchange rates, a modest competitiveness and a small volatility in GDP. As such have been the characteristics of Tunisia prior to the revolution, which also marked the switching towards a more floating exchange rate, we can hence adopt this explanation to which we must add the high increase in import prices which have been recorded during that past period parallel to which import levels and exchange rate followed smaller fluctuations.

As the shock continues its path through the rest of the chain, the coefficients seem to fall, and the exchange rate pass-through proves to be incomplete. In fact, only -0.2% reaches the selling prices index on the short run before turning into -0.6% on the long run, this latter showing a delay in its response which can be attributed to prices' stickiness. Moving on, only -0.1% of impact hits the consumer price index on the short run before reaching -0.52% on the long run, and which can be attributed to the significant share occupied by imported goods, mainly of raw materials at base, in the composition of the average consumption basket.

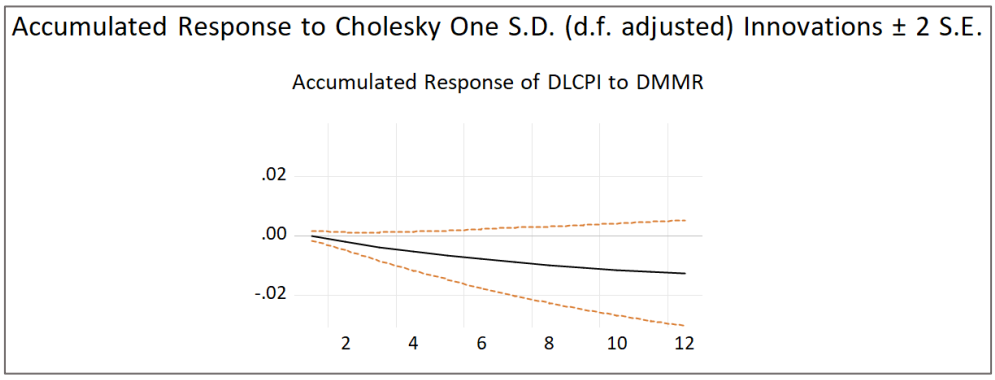
When the situation calls for authorities' intervention, containing upward trends of inflation might require the central bank to adjust its policy rate through rising it by the necessary points. The figure below shows the response CPI might have when the MMR receives a positive shock of 1%:

Figure 17: Response of DLCPI to a 1% shock to DMMR



Source: E-views 12

Figure 18: Accumulated response of DLCPI to a 1% shock to DMMR



Source: E-views 12

According to the accumulated response showed above, a positive shock of 1% to the MMR would pull CPI down as prices on the local market get lower. The overall impact was estimated at -4.4% achieved within 10 periods, that is 2 years and a half. This can be explained by the fact that an increase in MMR would tend to discourage bank clients from getting further credits while encouraging them to increase saving. As the money in circulation falls, demand on products falls back which calls suppliers and sellers to reduce prices.

- Variance decomposition:

While the pass-through coefficient might indicate the eventual impact of exchange rate shocks on the movements of the different prices, it does not indicate the degree to which such shocks are actually contributing to these movements. In order to reinforce impulse results, **Taylor (2000)** suggests proceeding to variance decomposition which is a step capable of providing additional information in regard with the contribution of exchange rate shocks to inflation throughout the study sample. We thus use the Cholesky variance over 10 periods because the impulse responses seem to tend back to their equilibrium level after 10 periods. The below table reports the percentage of the CPI forecast variance attributable to the various shocks:

Table 14: Variance decomposition of DLCPI (before 2011)

Period	S.E	DMMR	DLNEER	DLMPI	DLISPI	DLCPI
1	0,52%	0,02%	0,31%	4,04%	3,84%	91,79%
2	0,66%	8,32%	5,46%	6,35%	6,52%	73,34%
4	0,83%	13,91%	10,75%	4,10%	11,62%	59,63%
6	0,91%	15,17%	12,23%	3,47%	13,68%	55,45%
8	0,97%	15,71%	12,98%	3,17%	14,63%	53,52%
10	0,99%	16,01%	13,38%	3,00%	15,14%	52,46%

Source: E-views 12

The results in the above table show that the MMR and PPI variables' contributions to the CPI exceed that of the NEER. In fact, while the NEER contributed to the CPI variation by up to 13.38%, the ISPI variable's participation reaches 15.14% and that of the MMR reaches 16.01%. These results are not surprising since, prior to the revolution period, the Central Bank of Tunisia used to apply an exchange rate targeting policy within a de facto stabilized arrangement regime. Hence, the exchange rate's almost negligible variability back then played a minor role in both stimulating or easing inflationary tensions measured by the CPI. In the meantime, the monetary policy of the central bank of Tunisia used to focus on monetary targeting, in which the monetary market rate (MMR), along with the rest of the conventional instruments at CBT's disposal, played the main role in maintaining rates of inflation contained.

From its side, the level of the IPSI can be attributed to the quite important share occupied by imported elements in the composition of products taking part in the average Tunisian consumer basket.

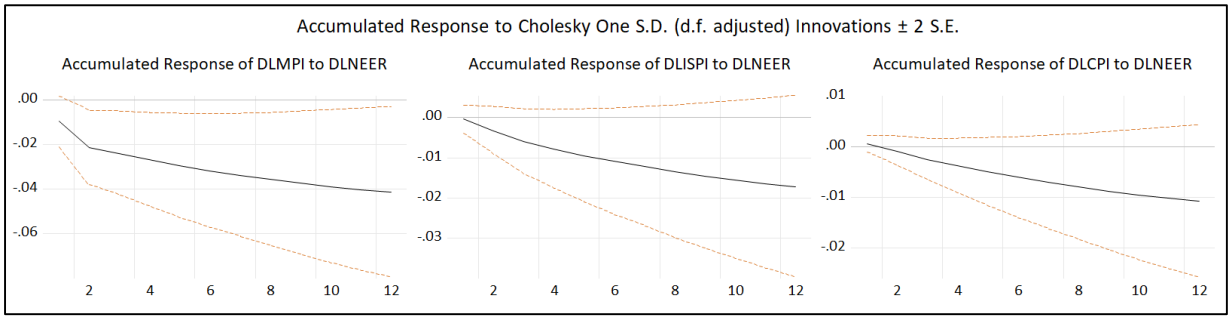
Last but not least, some focus should be accorded to the CPI's own role in fueling its own variance. On the short run, CPI levels explain up to 91.79% of their own behavior. While its influence decreases with time, it does not break the level of 52% even after 10 periods. This phenomenon is referred to as the "Inertial Inflation" following which agents' expectations of the future inflation level inspire their consumption behavior and hence might even push it to rise even higher. When higher price levels in the future are expected, consumers' time preference might increase and so they tend to accomplish their purchases on the short run rather than the long run. However, increase in demand can only push prices to get even higher, leading by that the inflation maintaining or even fueling its own rates.

1.2- Considering misalignment before the revolution:

Moving on with our experimentations, we will be including the misalignment we estimated in the second chapter of the first part into our model. The objective is to see whether or not the misalignment of a currency has any impact on the level of the final prices composing the consumption basket.

Prior to focusing on misalignment, we examined the subfigures relative to the exchange rate pass-through to prices. These subfigures are plotted in the figure below:

Figure 19: Accumulated responses of prices indexes to Cholesky 1% shock to DLNEER (before 2011-with misalignment)

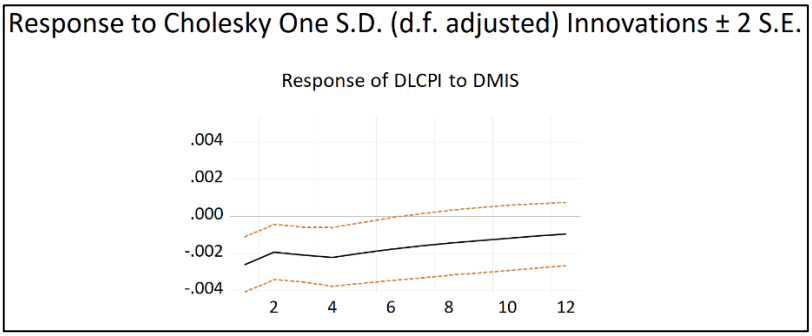


Source: E-views 12

Our first observation would be that integrating the misalignment variable did not alter the generally accepted fact that the exchange rate pass-through decreases as its impact advances through the prices channel. While the pass-through seems, again, to be complete reaching about -1.8%, the industrial selling prices index seems to receive -0.8% while the pass-through to domestic prices is of -0.55%, slightly higher than the -0.52% estimated without the misalignment variable.

As we move on, the below figure shows the impact a 1% shock to the misalignment variable is likely to have on the CPI:

Figure 20: Response of DLCPI to a 1% shock to the misalignment variable (before 2011)



Source: E-views 12

From the figure above, the consumer price index seems to adopt a similar behavior after a 1% shock brought to the currency's misalignment and which translates into a 1% supplementary overvaluation. In other words, following this shock, the consumer price index immediately responds by a decrease of about -0.26%. The sign of this reactions is not surprising. In fact, as theory implies, an overvaluation of a currency helps decrease import costs as their prices, converted into the local now more valuable currency, become cheaper. As these imports take

part in the manufacturing of locally produced goods, later on participating in the final consumer basket, the CPI would thus be expected to retreat.

- Variance decomposition:

We also examined the contribution of each of the variables within the model in his second form to estimate to which degree misalignment contributes to IPC variations. The variance decomposition of the DLIPC is detailed in the table below:

Table 15: Variance decomposition of DLCPI (before 2011-with misalignment)

	S.E.	DMMR	DLNEER	DMIS	DLMPI	DLISPI	DLCPI
1	0,01%	0,17%	1,15%	25,02%	1,27%	0,04%	72,35%
2	0,01%	7,29%	5,70%	24,66%	6,42%	0,87%	55,05%
4	0,01%	11,80%	10,17%	30,09%	4,47%	3,03%	40,44%
6	0,01%	12,98%	11,54%	33,24%	4,03%	3,94%	34,27%
8	0,01%	13,46%	12,25%	34,73%	3,81%	4,39%	31,36%
10	0,01%	13,71%	12,65%	35,54%	3,69%	4,64%	29,77%

Source: E-views 12

According to the results, misalignment contributes by up to 35.5% to consumer prices' variance, while the contribution of the NEER stands at 12.6%. We might hence conclude the misalignment strategy which have been followed prior to the revolution had a considerable influence on inflation's behavior.

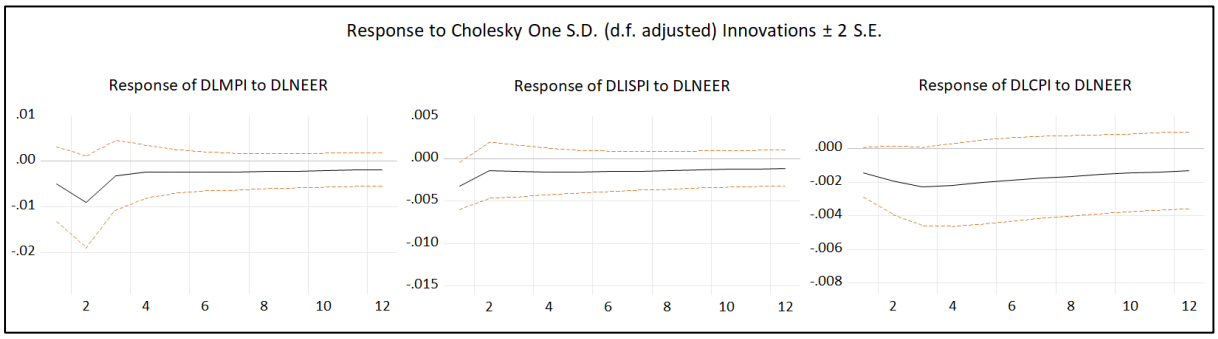
2- After the 2011 revolution:

2.1- Without including misalignment:

- Impulse response functions:

As the Arab Spring era marked a transition point in the monetary policy as well as several features in the economic landscape in Tunisia, we will be moving to the study of the exchange rate pass-through at the aftermath of January 2011's events. We will hence proceed to the same examinations this time, however, for the period from 2011Q1 to 2021Q4. The following set of figures will hence trace the pass-through of a 1% shock brought to the NEER into the different levels of the chain of prices:

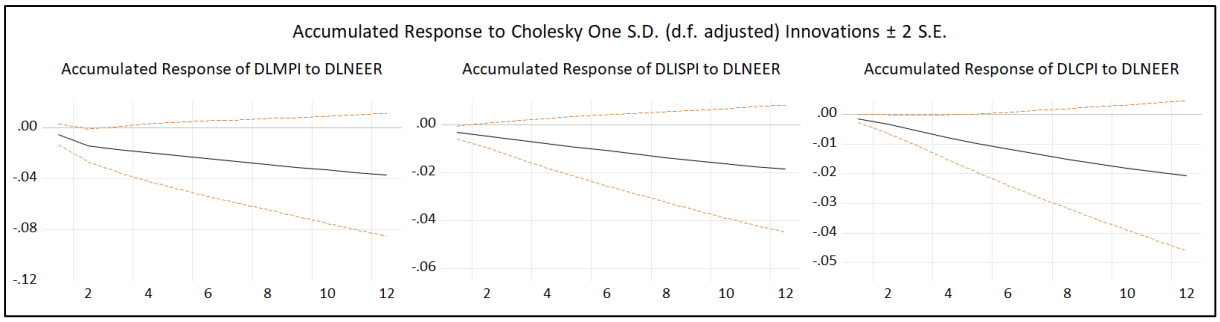
Figure 21: Responses of prices indexes to Cholesky 1% shock to DLNEER (after 2011)



Source: E-views 12

Seemingly to the previous period, the first impact of a 1% shock to the NEER variable has a generally negative impact on the prices composing the chain. Most of the transmission takes about 10 periods to approach its maximum as it gets absorbed through the consecutive levels of the chain.

Figure 22: Accumulated responses of prices indexes to Cholesky 1% shock to DLNEER (after 2011)



Source: E-views 12

Once again, we employ accumulated responses to assess the pass-through of exchange rate movements to the different levels of the prices chain.

Table 16: ERPT to prices magnitude on the short-run and the long-run (after 2011)

	Short run	Long run
MPI	-0.42	-0.6
ISPI	-0.16	-0.32
CPI	-0.15	-0.36

Source: Own calculations

From what has been returned by the estimations, the pass-through magnitude decreased compared to that observed prior to the revolution. The pass-through to import prices presents

the sharpest fall as the coefficient stands at -0.15% on the short run followed by -0.6% after 12 periods. It is hence no longer complete.

Seemingly, the pass-through to ISPI now stands at -0.32% while the pass-through to CPI seems to be of 0.36%. This last observation, however, stands against common perceptions concerning exchange rate pass-through as they imply a decreasing magnitude of the pass-through along the chain of prices.

Following such observation, a possible explanation might reside within the employed series relative to the CPI. In fact, the latter index's behavior has been considerably influenced by the general functioning of the Tunisian economy during the last decade. We might mention in this context the lax and lenient nature of the monetary policy which has been applied during the first few years of our sample. As a matter of fact, with the aim of avoiding a threatening credit crunch, the successive decreases of money market rates which were kept at some rather low levels compared to what the rates of inflation would have called for, pulled them down to an average record of 3.3%. Accompanied by refinancing operations, it altogether led to a record upraise in broad money of 22.5% in front of which stood the continuously depreciating dinar, however of a smaller pace, as it made imports costlier.

While a more restrictive policy has later on been applied, it still needed sometime to bring necessary adjustments. Yet still, few months into 2015, unpredicted terrorist attacks have disturbed the country forcing its economy to slow down. A new expansionary monetary policy was decided as it sought to support credit growth and to accommodate demand for money and exchange. A new wave of intensified refinancing operations has then followed, reaching a peak of about 17 billion dinars between mid-2017 to mid-2018, as a record of 60% increase was registered. This however led to produce some adverse consequences as the increased capacity of banks to subscribe to treasury bonds ended up financing salaries, and hence common consumption, rather than investment and production which remained overall plagued.

If we add to all of that a certain number of political and social decisions which have translated into several unjustified recruitments and unproductive rise in wages, we might explain the unusual response of the CPI series as the inflation's normal behavior during this period has been disturbed.

- Variance decomposition:

Moving on to the variance decomposition, the below table reports the percentage of the CPI forecast variance attributable to the various shocks:

Table 17: Variance decomposition of DLCPI (after 2011)

Period	S.E.	DMMR	DLNEER	DLMPI	DLISPI	DLCPI
1	0,005%	7,30%	7,61%	0,01%	11,20%	73,88%
2	0,007%	4,10%	11,97%	4,70%	12,03%	67,20%
4	0,010%	2,45%	18,00%	5,00%	21,41%	53,14%
6	0,011%	1,85%	19,42%	5,12%	26,56%	47,05%
8	0,012%	1,54%	19,88%	5,23%	29,34%	44,01%
10	0,013%	1,36%	20,09%	5,31%	30,98%	42,26%
12	0,014%	1,25%	20,22%	5,36%	32,02%	41,16%

Source: E-views 12

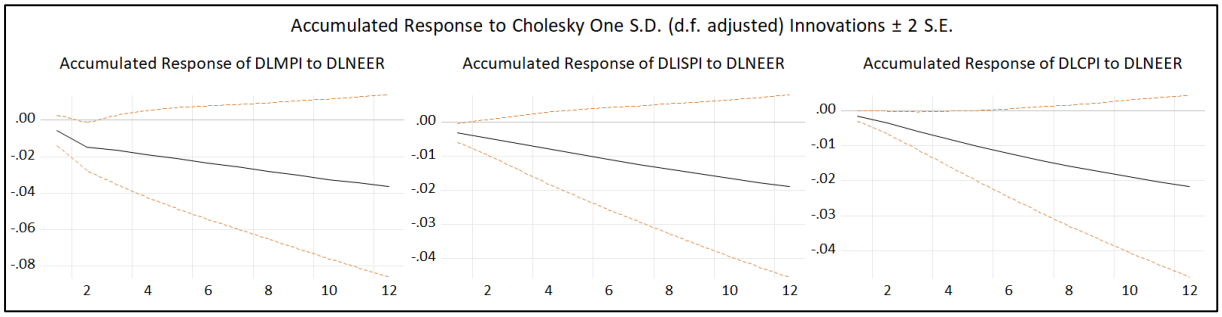
According to the above table, the participation of the NEER to the variance of IPC value rose to 20.3% after standing at 13.3% before the revolution. This increase finds its origins in the changes brought to the exchange rate regime after the events of 2011, following which the dinar was granted supplementary degrees of freedom as the CBT adopted the floating regime and gave up on exchange rate targeting. As the NEER presented higher volatility itself, its contribution to that of the IPC rose.

The MMR's participation, from its side, fell. While its impact kept a more or less similar level reaching 7.3% on the short run, its contribution seems to be limited on the long run as it merely exceeds 1.3%. In fact, as the period that followed the revolution underwent a long series of unpredictable events, the central bank's intervention via its policy rate would succeed to contain the adverse evolutions of inflation rates on the first few trimesters, before new unforeseen shocks alter the economic environment's characteristics again and spread new uncertainties among economic agents.

2.2- Including misalignment post-revolution:

Again following the same steps as in the previous tests, we introduced the misalignment variable to our model relative to the second subsample. Estimations of the impact of a 1% shock to the NEER variable are plotted in the figure below:

Figure 23: Accumulated responses of prices indexes to Cholesky 1% shock to DLNEER (after 2011-with misalignment)

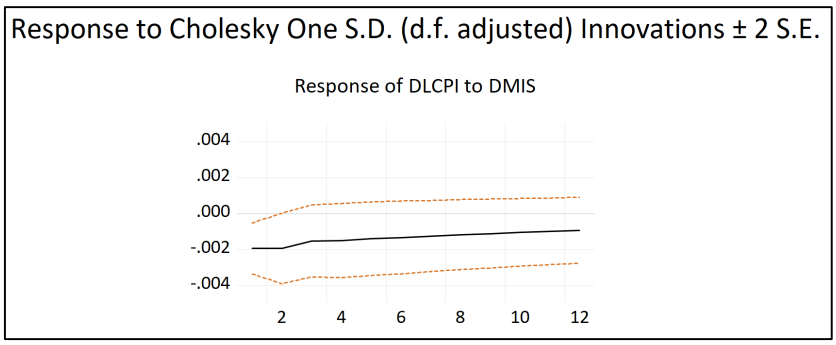


Source: E-views 12

From the figure above, the inclusion of the misalignment variable did not bring any changes to the reaction of the prices found through the previous test, with the pass-through to import prices reaching -0.68%, followed by -0.36% reaching the industrial selling prices before transmitting -0.38% to consumer prices, a pass-through slightly higher to the one returned by the previous test and which stood at -0.36%.

Moving on to focus on the misalignment variable, the below figure shows the impact a 1% shock to the misalignment is likely to have on the CPI:

Figure 24: Response of DLCPI to a 1% shock to the misalignment variable (after 2011)



Source: E-views 12

While the CPI variable showed an immediate response of -0.26% prior the revolution, the impact of the Dinar's misalignment seems to have slightly decreased after the revolution as, on impact, an overvaluation shock of 1% now leads to a fall in general consumer prices of -0.2%. The converse would also imply that an undervaluation shock of 1% would lead to consumer prices getting higher by 0.2%.

- Variance decomposition:

Table 18: Table 16: Variance decomposition of DLCPI (after 2011-with misalignment)

Period	S.E.	DMMR	DLNEER	DMIS	DLMPI	DLISPI	DLCPI
1	0.005%	5.59%	7.46%	13.93%	1.72%	6.49%	64.79%
2	0.006%	3.16%	11.84%	14.90%	10.75%	7.53%	51.78%
4	0.009%	1.94%	18.57%	12.33%	11.58%	15.77%	39.78%
6	0.011%	1.52%	20.00%	11.38%	11.97%	20.37%	34.74%
8	0.012%	1.29%	20.44%	10.90%	12.23%	22.85%	32.27%
10	0.013%	1.15%	20.64%	10.62%	12.40%	24.31%	30.86%

Source: E-views 12

As the variance decomposition shows above, the misalignment's contribution to the variance of the CPI fell back, as it now participates by 13.9% only on the short run against 10.6% on the long run.

Conclusion:

This last chapter has first set out the stylized facts concerning the monetary policy and inflation behavior in Tunisia. It has also been dedicated to estimate the exchange rate pass-through before and after the January 14th 2011 revolution and its transmission throughout the chain of prices, as well as an assessment of the eventual impact exchange rate misalignment is likely to have on consumer prices as a prime element in the appraisal of inflation levels.

For this purpose, we were inspired by the studies in the field of pass-through to apply a VAR model capable of capturing the underlying simultaneous relationships linking the variables and the exchange rate shocks at the different levels of the pricing chain.

Our estimations returned a fairly significant pass-through to consumer prices reaching up to -0.52% before the revolution and -0.36% after the said event. This can be attributed to the increased level of freedom granted to the exchange rate which helped reduce the degree of submission to sharp increases in import prices as it was witnessed through the complete pass-through to import prices obtained during the first decade of the sample.

The pass-through also proved to be decreasing as it is transmitted through the chain levels, given the rigidity of prices and the important share of administered products within the consumption basket.

An exception has, however, been noticed in the second sub-period of the sample as consumer prices seemed to be more responsive to exchange rate fluctuations than the industrial selling prices. This can find an explanation in the adopted behavior of the CPI throughout that period. The lax monetary policy which led to record low levels of policy rates, along with refinancing operations which led to an unprecedented increase in the money in circulation of about 60% were joined by a number of inconsistent political and social decisions as they, altogether, pulled up inflation rates despite the decrease in import prices.

The misalignment itself seems to have a quite important impact on consumer prices as a 1% positive (negative) shock would be answered by a -0.2% decrease (0.2% increase) in the CPI.

Its inclusion in the model also returned higher levels of pass-through to the consecutive chain prices without disturbing its transmission through the different levels.

General conclusion

Throughout the past five decades, the exchange rate economics has undergone an accelerated expansion both on the theoretical and the empirical levels. Such expansion resulted from a deep aspiration to assimilate the concept of the exchange rate, fueled by the numerous historical events which have marked the epoch from the demise of the Bretton Woods System to the multiple exchange rate crisis which have brought severe damage to several economies around the world.

Nonetheless, despite the large steps which have been made in the understanding of the exchange rate, this concept still maintains some puzzling aspects, for which no final answers have been achieved yet.

Within this context, our thesis was interested in the question of exchange rate pass-through to prices and the eventual consequences its misalignment might have on the inflation's behavior.

For this purpose, our work was organized under two main parts. The first of both was devoted to the misalignment concept, while the second made use of the latter's output within the context of the exchange rate pass-through.

The first chapter within Part-I discussed the different theoretical concepts of the exchange rate, their empirical measurement, and the linkage between them as it was believed to be necessary before developing the equilibrium exchange rate concept and the multiplicity of approaches underpinning it as a fundamental step to extract misalignment. Under this point, we evoked a number of approaches which were developed as an attempt to draw the appropriate equilibrium path, emphasizing by that that no consensus was really made as for which approach would be the most appropriate. Among these latter, we chose to dive into the fundamental, the behavioral and the natural exchange rate approaches (also referred to as FEER, BEER and NATREX), as they are the most popular among the existing studies.

The second chapter within Part-I was dedicated to the estimation of the extent of the Tunisian Dinar's misalignment. For this purpose, we chose to adopt the BEER approach as it seems to be the most appropriate for the case of small economies, such as Tunisia. Through the application of a VECM model, we were able to generate a long run relationship defining an approximate equilibrium path for the Tunisian currency. The comparison between the observed

real rate and its equilibrium showed how the former kept alternating between states of undervaluation and overvaluation. As the few past decades witnessed a number of events which went into Tunisia's history, we were able to attribute such behavior to three main factors: (1) the unstoppable and recurrent changes in decisive fundamentals, both internal and external, which kept bringing changes to the equilibrium path, (2) the authorities' policies relative to exchange rate regimes and decisions in regard with their interventions on the exchange market and direct orchestration of the currency's value, (3) and the unpredictable events and sudden shocks capable of altering the exchange rate's path and pace.

As we moved to Part-II, we dedicated its first chapter to draw the link between exchange rate movements and inflation's behavior. It hence started by presenting the theoretical concepts related to the inflation phenomenon and the role played by monetary authorities as frontline agents responsible for keeping its rates under control. It later on developed the exchange rate pass-through concept since it is the channel through which exchange rate fluctuation are transmitted to the consecutive levels of the prices chain. Within this context, the existing literature interested in the particular impact of exchange rate misalignment seems to agree that, in most cases, both undervaluation and overvaluation are capable of leading, for a final result, to extra inflationary pressures.

The second and last chapter of Part-2 consisted in an empirical application interested in the Tunisian Dinar. After giving a general overview of the evolution of inflation in Tunisia, we first tried to assess the exchange rate pass-through to the consecutive chain prices. We were hence inspired to apply a VAR model using a Cholesky decomposition as it seems to be frequently applied by the existing studies. Our sample covering the past 21 years was divided into two subsamples given the pivotal point of the 2011 revolution.

Prior to the revolution, results suggested a complete pass-through to import prices which might be attributed to the small volatility in exchange rates and a modest competitiveness (**McCarthy, 2000)** against high record levels of world prices. The pass-through later on decreases as it is transmitted through the chain to stand incomplete at -0.52 when it reaches consumer prices.

After the revolution, the pass-through to import prices becomes incomplete and gets farther absorbed until only -0.36 reaches consumer prices. This incomplete pass-through is attributable to price rigidity and pricing policies as well as the important share of administrated products of almost 30% within the consumption basket.

While the inclusion of the predetermined Dinar misalignment slightly increases the results of the pass-through, a positive shock brought to this variable seems to have a significant impact of about -0.2% on consumer prices (and vice versa). Given these results, misalignment cases need to be carefully handled, especially in the presence of an important exchange rate pass-through. The correction of such cases will also call for a delicately conceptualized policies in order to avoid unleashing extra inflationary pressures and losing in terms of credibility.

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Appendices:

Appendix 1: Results of ADF stationarity tests:

- Applied at level:

Null Hypothesis: LREER has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.580415	0.4881
Test critical values:	1% level	-3.509281	
	5% level	-2.895924	
	10% level	-2.585172	

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

Null Hypothesis: LPRO has a unit root
Exogenous: Constant
Lag Length: 9 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.334952	0.9787
Test critical values:	1% level	-3.516676	
	5% level	-2.899115	
	10% level	-2.586866	

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

Null Hypothesis: LGEX has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.779565	0.3882
Test critical values:	1% level	-3.510259	
	5% level	-2.896346	
	10% level	-2.585396	

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

Null Hypothesis: LOPN has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.232005	0.9292
Test critical values:	1% level	-3.510259	
	5% level	-2.896346	
	10% level	-2.585396	

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

Null Hypothesis: LTOT has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.481737	0.0108
Test critical values:	1% level	-3.507394	
	5% level	-2.895109	
	10% level	-2.584738	

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

- Applied at first difference:

Null Hypothesis: D(LREER) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.321860	0.0000
Test critical values:	1% level	-3.509281	
	5% level	-2.895924	
	10% level	-2.585172	

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

Null Hypothesis: D(LGEX) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-23.34609	0.0001
Test critical values:	1% level	-3.510259	
	5% level	-2.896346	
	10% level	-2.585396	

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

Null Hypothesis: D(LOPN) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.761463	0.0000
Test critical values:	1% level	-3.510259	
	5% level	-2.896346	
	10% level	-2.585396	

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

Null Hypothesis: D(LPRO) has a unit root
Exogenous: Constant
Lag Length: 8 (Automatic - based on SIC, maxlag=11)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.893541	0.0507
Test critical values:	1% level	-3.516676	
	5% level	-2.899115	
	10% level	-2.586866	

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

Appendix 2: Results of PP stationarity tests:

- Applied at level:

Null Hypothesis: LREER has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-1.542389	0.5076
Test critical values:	1% level	-3.507394	
	5% level	-2.895109	
	10% level	-2.584738	

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

Null Hypothesis: LGEX has a unit root
Exogenous: Constant
Bandwidth: 5 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-9.455963	0.0000
Test critical values:	1% level	-3.507394	
	5% level	-2.895109	
	10% level	-2.584738	

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

Null Hypothesis: LPRO has a unit root
Exogenous: Constant
Bandwidth: 18 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-0.465609	0.8918
Test critical values:	1% level	-3.507394	
	5% level	-2.895109	
	10% level	-2.584738	

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

Null Hypothesis: LOPN has a unit root
Exogenous: Constant
Bandwidth: 27 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		0.073300	0.9619
Test critical values:	1% level	-3.507394	
	5% level	-2.895109	
	10% level	-2.584738	

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

Null Hypothesis: LTOT has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.219191	0.0222
Test critical values:	1% level	-3.507394	
	5% level	-2.895109	
	10% level	-2.584738	

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

- Applied at first difference:

Null Hypothesis: D(LREER) has a unit root
Exogenous: Constant
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.477736	0.0000
Test critical values:	1% level	-3.508326	
	5% level	-2.895512	
	10% level	-2.584952	

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

Null Hypothesis: D(LPRO) has a unit root
Exogenous: Constant
Bandwidth: 85 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-23.70937	0.0001
Test critical values:	1% level	-3.508326	
	5% level	-2.895512	
	10% level	-2.584952	

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

Null Hypothesis: D(LOPN) has a unit root
Exogenous: Constant
Bandwidth: 8 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-17.40430	0.0001
Test critical values:	1% level	-3.508326	
	5% level	-2.895512	
	10% level	-2.584952	

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

Null Hypothesis: D(LTOT) has a unit root
Exogenous: Constant
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-12.61751	0.0001
Test critical values:	1% level	-3.508326	
	5% level	-2.895512	
	10% level	-2.584952	

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

Appendix 3: Results of KPSS stationarity tests:

- Applied at level:

Null Hypothesis: LREER is stationary
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		1.117740
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Null Hypothesis: LGEX is stationary
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.281931
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Null Hypothesis: LPRO is stationary
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.986552
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Null Hypothesis: LOPN is stationary
Exogenous: Constant
Bandwidth: 7 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		1.163017
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Null Hypothesis: LTOT is stationary
Exogenous: Constant
Bandwidth: 6 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.759900
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

- Applied at first difference:

Null Hypothesis: D(LREER) is stationary
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.146906
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Null Hypothesis: D(LGEX) is stationary
Exogenous: Constant
Bandwidth: 13 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.206961
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Null Hypothesis: D(LPRO) is stationary
Exogenous: Constant
Bandwidth: 15 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.315673
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Null Hypothesis: D(LOPN) is stationary
Exogenous: Constant
Bandwidth: 22 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.186526
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Null Hypothesis: D(LTOT) is stationary
Exogenous: Constant
Bandwidth: 10 (Newey-West automatic) using Bartlett kernel

		LM-Stat.
Kwiatkowski-Phillips-Schmidt-Shin test statistic		0.267137
Asymptotic critical values*:	1% level	0.739000
	5% level	0.463000
	10% level	0.347000

*Kwiatkowski-Phillips-Schmidt-Shin (1992, Table 1)

Appendix 4: VAR lag order selection criteria :

VAR Lag Order Selection Criteria
Endogenous variables: LREER LTOT LPRO LOPN LGEX
Exogenous variables: C
Date: 01/01/23 Time: 09:07
Sample: 2000Q1 2021Q4
Included observations: 80

Lag	LogL	LR	FPE	AIC	SC	HQ
0	379.6519	NA	5.89e-11	-9.366297	-9.217421	-9.306608
1	644.3239	489.6432	1.47e-13	-15.35810	-14.46484	-14.99996
2	709.6055	112.6107	5.42e-14	-16.36514	-14.72749*	-15.70856
3	756.3997	74.87083	3.20e-14	-16.90999	-14.52797	-15.95497*
4	792.0959	52.65181	2.54e-14*	-17.17740	-14.05099	-15.92393
5	806.8066	19.85952	3.49e-14	-16.92017	-13.04937	-15.36825
6	825.5990	23.02068	4.46e-14	-16.76498	-12.14980	-14.91462
7	847.3849	23.96442	5.52e-14	-16.68462	-11.32506	-14.53582
8	893.4791	44.94186*	3.94e-14	-17.21198*	-11.10803	-14.76473

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 5: Verifying the existence of at least one cointegration equation

Date: 01/01/23 Time: 09:37
Sample (adjusted): 2002Q2 2021Q4
Included observations: 79 after adjustments
Trend assumption: Linear deterministic trend
Series: LREER LTOT LPRO LOPN LGEX
Lags interval (in first differences): 1 to 8

Unrestricted Cointegration Rank Test (Trace)

Hypothesized No. of CE(s)	Eigenvalue	Trace Statistic	0.05 Critical Value	Prob.**
None *	0.441934	79.21936	69.81889	0.0074
At most 1	0.160545	33.14034	47.85613	0.5491
At most 2	0.135339	19.31513	29.79707	0.4704
At most 3	0.092397	7.827119	15.49471	0.4840
At most 4	0.002127	0.168194	3.841465	0.6817

Trace test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegration Rank Test (Maximum Eigenvalue)

Hypothesized No. of CE(s)	Eigenvalue	Max-Eigen Statistic	0.05 Critical Value	Prob.**
None *	0.441934	46.07902	33.87687	0.0011
At most 1	0.160545	13.82520	27.58434	0.8345
At most 2	0.135339	11.48801	21.13162	0.5986
At most 3	0.092397	7.658925	14.26460	0.4144
At most 4	0.002127	0.168194	3.841465	0.6817

Max-eigenvalue test indicates 1 cointegrating eqn(s) at the 0.05 level
* denotes rejection of the hypothesis at the 0.05 level
**MacKinnon-Haug-Michelis (1999) p-values

Unrestricted Cointegrating Coefficients (normalized by b'*S11*b=I):

LREER	LTOT	LPRO	LOPN	LGEX
-70.30404	-72.48689	10.72138	-14.34712	20.53371
78.06172	-12.03865	-22.42410	26.44407	-24.97351
10.17803	0.722456	-32.12941	-9.997346	-33.41035
36.18319	45.22497	6.992753	20.06939	11.18442
-78.62147	-11.71062	19.06039	-26.61588	1.905508

Unrestricted Adjustment Coefficients (alpha):

D(LREER)	0.008142	0.000613	-5.27E-05	-0.001316	-3.70E-05
D(LTOT)	-0.004062	0.000948	-0.002321	-0.002490	0.000607
D(LPRO)	0.005858	-0.002006	-0.000343	-0.005635	-0.000605
D(LOPN)	-0.009283	-0.008379	0.008677	-0.000432	0.000572
D(LGEX)	-0.019577	0.025333	0.011115	-0.002112	0.000436

1 Cointegrating Equation(s): Log likelihood 911.5954

Normalized cointegrating coefficients (standard error in parentheses)

LREER	LTOT	LPRO	LOPN	LGEX
1.000000	1.031049	-0.152500	0.204072	-0.292070
	(0.18872)	(0.08989)	(0.04678)	(0.10644)

Adjustment coefficients (standard error in parentheses)

D(LREER)	-0.572439
	(0.11869)
D(LTOT)	0.285580
	(0.20240)
D(LPRO)	-0.411852
	(0.27960)
D(LOPN)	0.652615
	(0.40996)
D(LGEX)	1.376346
	(0.85964)

2 Cointegrating Equation(s): Log likelihood 918.5080

Normalized cointegrating coefficients (standard error in parentheses)

LREER	LTOT	LPRO	LOPN	LGEX
1.000000	0.000000	-0.269727	0.321234	-0.316296
		(0.13044)	(0.07427)	(0.16745)
0.000000	1.000000	0.113697	-0.113633	0.023497
		(0.14365)	(0.08178)	(0.18440)

Adjustment coefficients (standard error in parentheses)

D(LREER)	-0.524608	-0.597589
	(0.17704)	(0.12383)
D(LTOT)	0.359572	0.283035
	(0.30199)	(0.21123)
D(LPRO)	-0.568482	-0.400484
	(0.41636)	(0.29123)
D(LOPN)	-0.001453	0.773747
	(0.59526)	(0.41636)
D(LGEX)	3.353904	1.114101
	(1.20773)	(0.84474)

3 Cointegrating Equation(s): Log likelihood 924.2520

Normalized cointegrating coefficients (standard error in parentheses)

LREER	LTOT	LPRO	LOPN	LGEX
1.000000	0.000000	0.000000	0.441924	-0.039779
			(0.04075)	(0.10756)
0.000000	1.000000	0.000000	-0.164507	-0.093062
			(0.03439)	(0.09078)
0.000000	0.000000	1.000000	0.447453	1.025174
			(0.09711)	(0.25633)

Adjustment coefficients (standard error in parentheses)

D(LREER)	-0.525144	-0.597627	0.075249
	(0.17787)	(0.12384)	(0.06846)
D(LTOT)	0.335954	0.281359	0.009751
	(0.30073)	(0.20937)	(0.11574)

D(LPRO)	-0.568482	-0.400484		
	(0.41636)	(0.29123)		
D(LOPN)	-0.001453	0.773747		
	(0.59526)	(0.41636)		
D(LGEX)	3.353904	1.114101		
	(1.20773)	(0.84474)		

3 Cointegrating Equation(s): Log likelihood 924.2520

Normalized cointegrating coefficients (standard error in parentheses)

LREER	LTOT	LPRO	LOPN	LGEX
1.000000	0.000000	0.000000	0.441924	-0.039779
			(0.04075)	(0.10756)
0.000000	1.000000	0.000000	-0.164507	-0.093062
			(0.03439)	(0.09078)
0.000000	0.000000	1.000000	0.447453	1.025174
			(0.09711)	(0.25633)

Adjustment coefficients (standard error in parentheses)

D(LREER)	-0.525144	-0.597627	0.075249
	(0.17787)	(0.12384)	(0.06846)
D(LTOT)	0.335954	0.281359	0.009751
	(0.30073)	(0.20937)	(0.11574)
D(LPRO)	-0.571974	-0.400732	0.118823
	(0.41827)	(0.29121)	(0.16098)
D(LOPN)	0.086861	0.780016	-0.190420
	(0.57879)	(0.40297)	(0.22276)
D(LGEX)	3.467037	1.122132	-1.135102
	(1.19796)	(0.83404)	(0.46106)

4 Cointegrating Equation(s): Log likelihood 928.0815

Normalized cointegrating coefficients (standard error in parentheses)

LREER	LTOT	LPRO	LOPN	LGEX
1.000000	0.000000	0.000000	0.000000	-0.548789
				(0.45473)
0.000000	1.000000	0.000000	0.000000	0.096418
				(0.17519)
0.000000	0.000000	1.000000	0.000000	0.509796
				(0.53643)
0.000000	0.000000	0.000000	1.000000	1.151803
				(0.97438)

Adjustment coefficients (standard error in parentheses)

D(LREER)	-0.572755	-0.657135	0.066048	-0.126497
	(0.18648)	(0.14421)	(0.06889)	(0.06271)
D(LTOT)	0.245872	0.168766	-0.007658	0.056578
	(0.31461)	(0.24330)	(0.11622)	(0.10580)
D(LPRO)	-0.775868	-0.655577	0.079419	-0.246770
	(0.42992)	(0.33247)	(0.15882)	(0.14457)
D(LOPN)	0.071238	0.760490	-0.193439	-0.183802
	(0.61180)	(0.47313)	(0.22601)	(0.20574)
D(LGEX)	3.390608	1.026604	-1.149872	0.797271
	(1.26580)	(0.97889)	(0.46762)	(0.42567)

Appendix 6: Estimation of the Long-run and the Short-run relationships

Vector Error Correction Estimates
Date: 01/01/23 Time: 09:25
Sample (adjusted): 2002Q2 2021Q4
Included observations: 79 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
LREER(-1)	1.000000
LTOT(-1)	1.031049 (0.18872) [5.46344]
LPRO(-1)	-0.152500 (0.08989) [-1.69652]
LOPN(-1)	0.204072 (0.04678) [4.36270]
LGEX(-1)	-0.292070 (0.10644) [-2.74387]
C	-8.751040

Error Correction:	D(LREER)	D(LTOT)	D(LPRO)	D(LOPN)	D(LGEX)
CointEq1	-0.572439 (0.11869) [-4.82284]	0.285580 (0.20240) [1.41098]	-0.411852 (0.27960) [-1.47299]	0.652615 (0.40996) [1.59189]	1.376346 (0.85964) [1.60108]
D(LREER(-1))	0.536908 (0.14810) [3.62531]	-0.161755 (0.25254) [-0.64050]	0.533219 (0.34887) [1.52840]	-0.593142 (0.51153) [-1.15954]	0.480804 (1.07262) [0.44825]
D(LREER(-2))	-0.027213 (0.15314) [-0.17770]	-0.175870 (0.26113) [-0.67349]	0.168985 (0.36074) [0.46844]	-0.316831 (0.52893) [-0.59900]	0.495917 (1.10910) [0.44714]
D(LREER(-3))	0.317490 (0.14935) [2.12583]	-0.064264 (0.25467) [-0.25234]	0.053785 (0.35182) [0.15288]	-0.455184 (0.51585) [-0.88240]	0.774179 (1.08166) [0.71573]
D(LREER(-4))	0.230578 (0.15167) [1.52028]	-0.064756 (0.25863) [-0.25038]	0.210184 (0.35728) [0.58829]	-0.948772 (0.52386) [-1.81112]	1.134475 (1.09846) [1.03279]
D(LREER(-5))	0.099431 (0.15589) [0.63784]	-0.259976 (0.26582) [-0.97802]	-0.064039 (0.36722) [-0.17439]	1.440035 (0.53843) [2.67452]	2.535934 (1.12901) [2.24616]
D(LREER(-6))	0.056008 (0.17999) [0.31117]	-0.165012 (0.30693) [-0.53763]	0.081133 (0.42400) [0.19135]	-0.952302 (0.62169) [-1.53180]	1.135973 (1.30360) [0.87141]

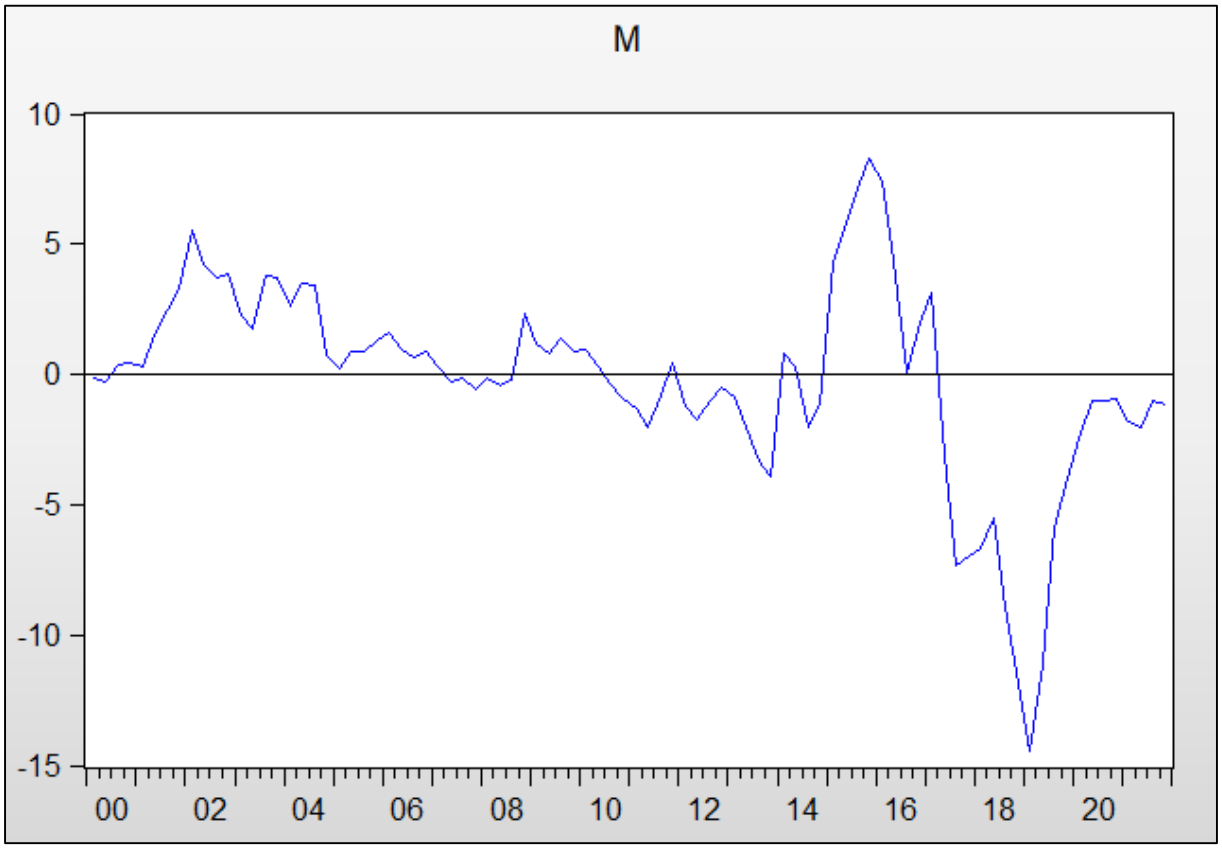
D(LREER(-7))	0.300357	-0.387423	0.376941	0.554066	-1.260718
	(0.16780)	(0.28614)	(0.39528)	(0.57958)	(1.21530)
	[1.78995]	[-1.35397]	[0.95359]	[0.95598]	[-1.03737]
D(LREER(-8))	-0.033957	0.236191	-0.859221	-0.291435	2.095318
	(0.16105)	(0.27462)	(0.37937)	(0.55625)	(1.16637)
	[-0.21085]	[0.86007]	[-2.26486]	[-0.52393]	[1.79644]
D(LTOT(-1))	0.553831	-0.592419	0.455450	-0.637051	-1.289768
	(0.14399)	(0.24553)	(0.33918)	(0.49732)	(1.04282)
	[3.84644]	[-2.41286]	[1.34279]	[-1.28096]	[-1.23681]
D(LTOT(-2))	0.687745	-0.466396	0.672715	-0.829004	-0.845040
	(0.14257)	(0.24311)	(0.33584)	(0.49243)	(1.03255)
	[4.82398]	[-1.91846]	[2.00307]	[-1.68351]	[-0.81840]
D(LTOT(-3))	0.453205	-0.237584	0.292136	-1.263272	-0.789840
	(0.13325)	(0.22722)	(0.31390)	(0.46025)	(0.96507)
	[3.40114]	[-1.04561]	[0.93068]	[-2.74478]	[-0.81843]
D(LTOT(-4))	0.358814	-0.195074	0.215761	-1.098912	0.049696
	(0.13704)	(0.23368)	(0.32282)	(0.47334)	(0.99252)
	[2.61830]	[-0.83477]	[0.66836]	[-2.32163]	[0.05007]
D(LTOT(-5))	0.325604	-0.223588	0.250321	-0.786833	-1.422470
	(0.14150)	(0.24129)	(0.33333)	(0.48874)	(1.02482)
	[2.30106]	[-0.92664]	[0.75097]	[-1.60992]	[-1.38801]
D(LTOT(-6))	0.324959	-0.706378	0.326215	-0.711309	-0.621212
	(0.13802)	(0.23535)	(0.32512)	(0.47670)	(0.99958)
	[2.35450]	[-3.00143]	[1.00337]	[-1.49214]	[-0.62147]
D(LTOT(-7))	0.410096	-0.318017	0.339496	-0.741543	-0.884757
	(0.12662)	(0.21592)	(0.29829)	(0.43736)	(0.91708)
	[3.23867]	[-1.47283]	[1.13816]	[-1.69550]	[-0.96475]
D(LTOT(-8))	0.388238	-0.460879	0.359123	-0.450109	-0.237926
	(0.10781)	(0.18383)	(0.25396)	(0.37236)	(0.78079)
	[3.60123]	[-2.50704]	[1.41411]	[-1.20879]	[-0.30472]
D(LPRO(-1))	0.095866	0.066004	-0.162305	-0.328730	-0.490343
	(0.07140)	(0.12176)	(0.16821)	(0.24663)	(0.51715)
	[1.34257]	[0.54208]	[-0.96492]	[-1.33289]	[-0.94817]
D(LPRO(-2))	0.050566	0.100792	-0.088604	0.041621	-1.084639
	(0.07700)	(0.13130)	(0.18138)	(0.26595)	(0.55766)
	[0.65672]	[0.76766]	[-0.48850]	[0.15650]	[-1.94500]
D(LPRO(-3))	0.045868	-0.066265	-0.048819	0.077564	-0.454234
	(0.08141)	(0.13882)	(0.19177)	(0.28118)	(0.58959)
	[0.56344]	[-0.47735]	[-0.25457]	[0.27585]	[-0.77042]
D(LPRO(-4))	-0.021641	0.022829	0.153453	-0.302148	-0.955301
	(0.08101)	(0.13814)	(0.19084)	(0.27981)	(0.58673)
	[-0.26713]	[0.16526]	[0.80410]	[-1.07982]	[-1.62818]
D(LPRO(-5))	0.161248	0.029646	0.165560	-0.194572	-1.028266
	(0.08429)	(0.14373)	(0.19856)	(0.29113)	(0.61047)
	[1.91303]	[0.20626]	[0.83381]	[-0.66833]	[-1.68439]

D(LPRO(-6))	0.116434	-0.115210	0.172588	-0.544477	-0.856350
	(0.07946)	(0.13550)	(0.18718)	(0.27445)	(0.57549)
	[1.46531]	[-0.85027]	[0.92203]	[-1.98385]	[-1.48803]
D(LPRO(-7))	-0.032995	-0.080762	-0.062886	0.379582	0.195203
	(0.08551)	(0.14581)	(0.20143)	(0.29535)	(0.61931)
	[-0.38586]	[-0.55387]	[-0.31219]	[1.28520]	[0.31520]
D(LPRO(-8))	0.016370	-0.111457	0.673569	-0.057607	-1.206485
	(0.08204)	(0.13989)	(0.19325)	(0.28335)	(0.59415)
	[0.19955]	[-0.79675]	[3.48546]	[-0.20331]	[-2.03060]
D(LOPN(-1))	0.120812	-0.017013	0.044807	-0.206594	0.391481
	(0.05538)	(0.09443)	(0.13045)	(0.19127)	(0.40106)
	[2.18165]	[-0.18017]	[0.34348]	[-1.08013]	[0.97611]
D(LOPN(-2))	0.076191	-0.214995	0.009545	-0.083670	-0.233072
	(0.04878)	(0.08318)	(0.11490)	(0.16848)	(0.35327)
	[1.56202]	[-2.58482]	[0.08307]	[-0.49663]	[-0.65975]
D(LOPN(-3))	0.096046	-0.209937	0.121756	-0.528243	-0.018371
	(0.04900)	(0.08355)	(0.11542)	(0.16924)	(0.35486)
	[1.96023]	[-2.51268]	[1.05488]	[-3.12135]	[-0.05177]
D(LOPN(-4))	0.200666	-0.038488	0.154161	-0.030758	0.231438
	(0.05049)	(0.08609)	(0.11893)	(0.17438)	(0.36566)
	[3.97453]	[-0.44705]	[1.29620]	[-0.17638]	[0.63293]
D(LOPN(-5))	0.084806	-0.171756	0.072636	-0.277057	0.560562
	(0.04857)	(0.08282)	(0.11442)	(0.16776)	(0.35177)
	[1.74605]	[-2.07378]	[0.63484]	[-1.65150]	[1.59354]
D(LOPN(-6))	0.023416	-0.061370	-0.029231	-0.200892	0.710347
	(0.04039)	(0.06887)	(0.09514)	(0.13949)	(0.29250)
	[0.57980]	[-0.89113]	[-0.30726]	[-1.44015]	[2.42854]
D(LOPN(-7))	0.092325	0.059937	0.111552	0.028408	0.579614
	(0.04348)	(0.07415)	(0.10243)	(0.15019)	(0.31492)
	[2.12327]	[0.80836]	[1.08906]	[0.18915]	[1.84050]
D(LOPN(-8))	0.001758	-0.169447	0.114902	-0.232315	0.051944
	(0.04837)	(0.08249)	(0.11395)	(0.16708)	(0.35034)
	[0.03634]	[-2.05424]	[1.00834]	[-1.39045]	[0.14826]
D(LGEX(-1))	-0.176279	0.103279	-0.182751	0.188880	-0.608312
	(0.03830)	(0.06531)	(0.09022)	(0.13229)	(0.27739)
	[-4.60258]	[1.58137]	[-2.02556]	[1.42780]	[-2.19300]
D(LGEX(-2))	-0.164625	0.117203	-0.150655	0.322092	-0.841354
	(0.04159)	(0.07092)	(0.09797)	(0.14365)	(0.30121)
	[-3.95838]	[1.65265]	[-1.53778]	[2.24225]	[-2.79327]
D(LGEX(-3))	-0.129494	0.036965	-0.131458	0.236430	-0.787014
	(0.04401)	(0.07504)	(0.10366)	(0.15199)	(0.31871)
	[-2.94271]	[0.49262]	[-1.26814]	[1.55554]	[-2.46939]
D(LGEX(-4))	-0.086452	0.041835	-0.066779	0.112242	-0.443271
	(0.04527)	(0.07720)	(0.10665)	(0.15637)	(0.32788)
	[-1.90959]	[0.54191]	[-0.62617]	[0.71780]	[-1.35191]

D(LGEX(-5))	-0.040613	0.007974	0.005069	-0.028469	-0.191243
	(0.03985)	(0.06796)	(0.09389)	(0.13766)	(0.28865)
	[-1.01901]	[0.11734]	[0.05399]	[-0.20681]	[-0.66254]
D(LGEX(-6))	-0.052971	-0.016034	-0.008671	-0.129682	-0.039659
	(0.03407)	(0.05809)	(0.08025)	(0.11767)	(0.24674)
	[-1.55485]	[-0.27599]	[-0.10805]	[-1.10208]	[-0.16073]
D(LGEX(-7))	-0.064771	-0.007483	-0.033371	-0.078165	-0.003229
	(0.02858)	(0.04873)	(0.06732)	(0.09870)	(0.20697)
	[-2.26654]	[-0.15357]	[-0.49572]	[-0.79191]	[-0.01560]
D(LGEX(-8))	-0.065171	0.033584	-0.054401	-0.057708	0.263178
	(0.01990)	(0.03393)	(0.04687)	(0.06872)	(0.14411)
	[-3.27539]	[0.98984]	[-1.16065]	[-0.83970]	[1.82630]
C	-0.007971	0.008432	-0.011286	0.028005	-0.019963
	(0.00275)	(0.00469)	(0.00647)	(0.00949)	(0.01991)
	[-2.89998]	[1.79894]	[-1.74296]	[2.94985]	[-1.00278]
R-squared	0.727508	0.631515	0.871138	0.838839	0.937905
Adj. R-squared	0.425558	0.223194	0.728345	0.660255	0.869097
Sum sq. resids	0.008331	0.024226	0.046233	0.099394	0.437017
S.E. equation	0.015006	0.025588	0.035349	0.051830	0.108680
F-statistic	2.409363	1.546615	6.100705	4.697174	13.63075
Log likelihood	249.6119	207.4503	181.9228	151.6894	93.19447
Akaike AIC	-5.255998	-4.188616	-3.542349	-2.776948	-1.296063
Schwarz SC	-3.996291	-2.928909	-2.282643	-1.517242	-0.036356
Mean dependent	-0.005226	-0.000509	-0.008013	0.015513	0.004152
S.D. dependent	0.019799	0.029032	0.067821	0.088920	0.300382

Determinant resid covariance (dof adj.)	2.90E-15
Determinant resid covariance	6.53E-17
Log likelihood	911.5954
Akaike information criterion	-17.63533
Schwarz criterion	-11.18683
Number of coefficients	215

Appendix 7: Misalignment output in Tunisia



Appendix 8: Results of ADF stationarity test:

- Applied to variables between 2000Q1 and 2010Q4:

Null Hypothesis: DLNEER has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.129278	0.0001
Test critical values:	1% level	-3.600987	
	5% level	-2.935001	
	10% level	-2.605836	

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

Null Hypothesis: DMMR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.132901	0.0023
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: DLMPI has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-6.314318	0.0000
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: DLISPI has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.581373	0.0006
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: DLCPI has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.018591	0.0002
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: DMIS has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.347778	0.0193
Test critical values:	1% level	-3.610453	
	5% level	-2.938987	
	10% level	-2.607932	

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

- Applied to variables between 2011Q1 and 2021Q4:

Null Hypothesis: DLNEER has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.176315	0.0001
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: DMMR has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.694188	0.0076
Test critical values:	1% level	-3.592462	
	5% level	-2.931404	
	10% level	-2.603944	

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

Null Hypothesis: DLMPI has a unit root
Exogenous: Constant
Lag Length: 9 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.840957	0.3551
Test critical values:	1% level	-3.639407	
	5% level	-2.951125	
	10% level	-2.614300	

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

Null Hypothesis: DLISPI has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.827153	0.0053
Test critical values:	1% level	-3.592462	
	5% level	-2.931404	
	10% level	-2.603944	

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

Null Hypothesis: DLCPI has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.588915	0.0102
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: DMIS has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.392873	0.0001
Test critical values:	1% level	-3.600987	
	5% level	-2.935001	
	10% level	-2.605836	

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

Appendix 9: Results of PP stationarity test:

- Applied to variables between 2000Q1 and 2010Q4:

Null Hypothesis: DLNEER has a unit root
Exogenous: Constant
Bandwidth: 4 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.149161	0.0000
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: DMMR has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.103052	0.0025
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: DLMPI has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.329519	0.0000
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: DLISPI has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.565663	0.0007
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: DLCPI has a unit root
Exogenous: Constant
Bandwidth: 12 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.901273	0.0002
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: DMIS has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-6.472154	0.0000
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

- Applied to variables between 2011Q1 and 2021Q4:

Null Hypothesis: DLNEER has a unit root
Exogenous: Constant
Bandwidth: 14 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.010203	0.0032
Test critical values:	1% level	-3.592462	
	5% level	-2.931404	
	10% level	-2.603944	

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

Null Hypothesis: DMMR has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.619170	0.0093
Test critical values:	1% level	-3.592462	
	5% level	-2.931404	
	10% level	-2.603944	

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

Null Hypothesis: DLMPI has a unit root
Exogenous: Constant
Bandwidth: 3 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.097355	0.0001
Test critical values:	1% level	-3.592462	
	5% level	-2.931404	
	10% level	-2.603944	

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

Null Hypothesis: DLISPI has a unit root
Exogenous: Constant
Bandwidth: 2 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-3.877720	0.0046
Test critical values:	1% level	-3.592462	
	5% level	-2.931404	
	10% level	-2.603944	

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

Null Hypothesis: DLCPI has a unit root
Exogenous: Constant
Bandwidth: 1 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-5.546492	0.0000
Test critical values:	1% level	-3.592462	
	5% level	-2.931404	
	10% level	-2.603944	

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

Null Hypothesis: DMIS has a unit root
Exogenous: Constant
Bandwidth: 12 (Newey-West automatic) using Bartlett kernel

		Adj. t-Stat	Prob.*
Phillips-Perron test statistic		-4.313765	0.0014
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Appendix 10: VAR lag order selection criteria

- For the period between 2000Q1 and 2010Q4:

VAR Lag Order Selection Criteria
Endogenous variables: DMMR DLNEER DLMPI DLISPI DLCPI
Exogenous variables:
Date: 01/01/23 Time: 13:03
Sample: 1 43
Included observations: 39

Lag	LogL	LR	FPE	AIC	SC	HQ
1	496.9076	NA	2.14e-17	-24.20039	-23.13401*	-23.81778*
2	514.3746	25.97655	3.32e-17	-23.81408	-21.68131	-23.04886
3	541.5357	33.42901	3.45e-17	-23.92491	-20.72575	-22.77708
4	585.0606	42.40892*	1.85e-17*	-24.87490*	-20.60936	-23.34446

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

VAR Lag Order Selection Criteria
Endogenous variables: DMMR DLNEER DLMPI DLISPI DLCPI DMIS
Exogenous variables:
Date: 01/01/23 Time: 13:03
Sample: 1 43
Included observations: 39

Lag	LogL	LR	FPE	AIC	SC	HQ
1	489.8680	NA	3.19e-18*	-23.27528	-21.73969*	-22.72432*
2	511.4159	29.83554	7.45e-18	-22.53415	-19.46296	-21.43223
3	544.3896	35.51014	1.21e-17	-22.37895	-17.77217	-20.72608
4	603.1610	45.20877	8.15e-18	-23.54672*	-17.40434	-21.34288

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

- For the period between 2011Q1 and 2021Q4:

VAR Lag Order Selection Criteria
Endogenous variables: DMMR DLNEER DLMPI DLISPI DLCPI
Exogenous variables:
Date: 01/01/23 Time: 13:05
Sample: 1 44
Included observations: 40

Lag	LogL	LR	FPE	AIC	SC	HQ
1	547.0166	NA	3.20e-18	-26.10083	-25.04528*	-25.71918*
2	579.0854	48.10314*	2.36e-18*	-26.45427	-24.34317	-25.69096
3	604.0960	31.26324	2.70e-18	-26.45480	-23.28815	-25.30984
4	630.8753	26.77927	3.34e-18	-26.54376*	-22.32156	-25.01715

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

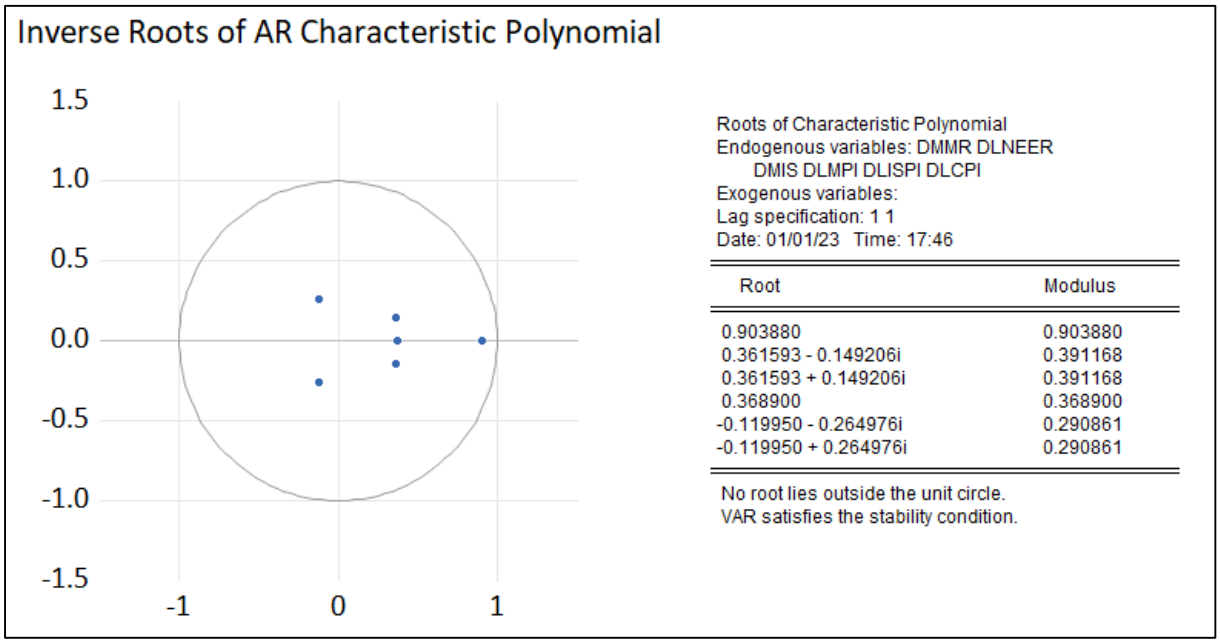
VAR Lag Order Selection Criteria
Endogenous variables: DMMR DLNEER DLMPI DLISPI DLCPI DMIS
Exogenous variables:
Date: 01/01/23 Time: 13:06
Sample: 1 44
Included observations: 39

Lag	LogL	LR	FPE	AIC	SC	HQ
1	503.7773	NA	1.56e-18	-23.98858	-22.45299*	-23.43762*
2	546.7095	59.44447*	1.22e-18	-24.34407	-21.27288	-23.24216
3	585.4634	41.73504	1.47e-18	-24.48530	-19.87852	-22.83243
4	642.0598	43.53568	1.11e-18*	-25.54153*	-19.39915	-23.33769

* indicates lag order selected by the criterion
LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion

Appendix 11: Stability tests for both periods

- Applied to variables between 2000Q1 and 2010Q4:

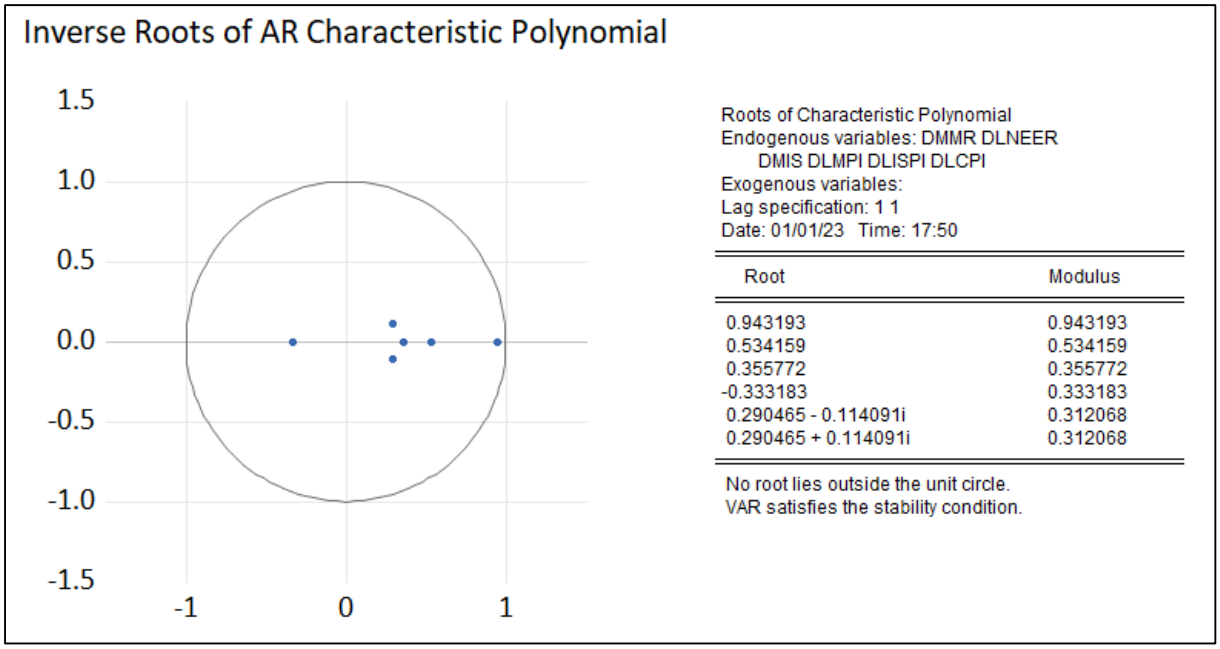


Roots of Characteristic Polynomial
Endogenous variables: DMMR DLNEER DMIS DLMPI DLISPI DLCPI
Exogenous variables:
Lag specification: 1 1
Date: 01/01/23 Time: 17:46

Root	Modulus
0.903880	0.903880
0.361593 - 0.149206i	0.391168
0.361593 + 0.149206i	0.391168
0.368900	0.368900
-0.119950 - 0.264976i	0.290861
-0.119950 + 0.264976i	0.290861

No root lies outside the unit circle.
VAR satisfies the stability condition.

- Applied to variables between 2011Q1 and 2021Q4:



Roots of Characteristic Polynomial
Endogenous variables: DMMR DLNEER DMIS DLMPI DLISPI DLCPI
Exogenous variables:
Lag specification: 1 1
Date: 01/01/23 Time: 17:50

Root	Modulus
0.943193	0.943193
0.534159	0.534159
0.355772	0.355772
-0.333183	0.333183
0.290465 - 0.114091i	0.312068
0.290465 + 0.114091i	0.312068

No root lies outside the unit circle.
VAR satisfies the stability condition.

Table of contents

Abstract

In the light of the tight relationship between exchange rate movements and inflation known as the "exchange rate pass-through", the misalignment between the observed exchange rate and its equilibrium state is believed to have a considerable impact on prices. In this thesis, we examine the impact of such misalignment on consumer prices in Tunisia. First, an estimation of the Tunisian equilibrium exchange rate following the BEER approach via a Vector Error Correction Model allowed the identification of overvaluation and undervaluation phases throughout the past 21 years. The obtained output was later on employed within a VAR model as we estimated the exchange rate pass-through to prices within the distribution chain in general as well as its direct impact on consumer prices in particular. Considering the 2011 revolution a transitioning point, splitting the study period into two subperiods allowed the identification of changes in the behavior of prices within the chain as well as a decreased pass-through. Misalignment from its side showed a fair impact on consumer prices, with a slight retreat following 2011.

Keywords: Misalignment, exchange rate pass-through, BEER, VECM, VAR, inflation, distribution chain

Résumé

Compte tenu de la relation étroite entre les mouvements du taux de change et l'inflation connue sous le nom du « pass-through du taux de change », le mésalignement du taux de change réel observé par rapport à son état d'équilibre risque d'avoir des répercutions indéniables sur les prix. Dans ce mémoire, nous examinons l'impact des mésalignements de taux de change sur les prix à la consommation en Tunisie. D'abord, une estimation du taux de change d'équilibre tunisien suivant l'approche BEER via un modèle VECM a permis l'identification de phases de surévaluation et de sous-évaluation au cours des 21 dernières années. Ce résultat a ensuite été utilisé dans un modèle VAR pour estimer le pass-through du taux de change sur la chaine des prix en général ainsi que son impact direct sur les prix à la consommation en particulier. En considérant la révolution comme un point de transition, la division de la période d'étude en deux sous-périodes a permis d'identifier des changements dans le comportement de la chaine des prix ainsi qu'une diminution du niveau du pass-through. Le mésalignement, de son côté, a montré un impact non négligeable sur les prix à la consommation, avec un léger recul après 2011.

Mots clés : Mésalignement, Pass-through du taux de change, BEER, VECM, VAR, inflation, chaine des prix.