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Topic

Can central bank FX interventions help achieving the Inflation-Targeting framework goal?

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Chama Sabbagh

Abstract

In this investigation, we provide insights into the crucial role of central banks' monetary strategy for achieving price stability. Particularly, we assess the impact of central bank foreign interventions in controlling inflation rates. To this end, we choose to employ a methodology based on the Structural VAR as it permits us to consider the interaction between monetary and exchange rate policies' components. We defined two different specifications where we modelled the contemporaneous effects between our variables in the presence and absence of the mixed policy. We contribute to the literature by inspecting the effectiveness of central bank interventions to attain the inflation objective in Tunisia, as our country is moving toward Inflation Targeting. We find that the money market rate responds instantly to an inflation shock. Furthermore, interventions are claimed to be effective in countering exchange rate deviations. However, there is little to gain in terms of inflation objective.

Keywords: Inflation targeting, FX interventions, Structural VAR, Monetary policy, Exchange rate policy, Price stability.

Résumé

Dans cette enquête, nous fournissons un aperçu sur le rôle crucial de la stratégie monétaire des banques centrales pour atteindre la stabilité des prix. En particulier, nous évaluons l'impact des interventions de la banque centrale de Tunisie dans le contrôle de l'inflation. A cette fin, nous avons choisi d'utiliser une méthodologie basée sur le VAR structurel car elle permet de considérer l'interaction entre les composantes des politiques monétaire et de change. Nous avons défini deux spécifications différentes où nous avons modélisé les effets contemporains entre nos variables en présence et en absence de la politique mixte. Nous contribuons à la littérature en inspectant l'efficacité des interventions de la banque centrale pour atteindre l'objectif d'inflation en Tunisie, étant donné que notre pays s'oriente vers le régime de ciblage d'inflation. Nous constatons que le taux du marché monétaire réagit instantanément à un choc d'inflation. En outre, les interventions sont censées être efficaces pour contrer les déviations du taux de change. Cependant, il y a peu à gagner en termes d'objectif d'inflation.

Mots clés: Ciblage d'inflation, Interventions de la banque centrale, VAR Structurel, Politique monétaire, Politique de change, Stabilité des prix.

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Abbreviations

ADF	Augmented-Dickey Fuller Test
CBT	Central Bank of Tunisia
DSGE	Dynamic Stochastic General Equilibrium
ERPT	Exchange Rate Pass-Through
FFIT	Full Fledged Inflation Targeting
FX	Foreign Exchange Interventions
GARCH	Generalized Autoregressive Conditional Heteroskedasticity
IMF	International Monetary Fund
IPC	Consumer Price Index
IPI	Industrial Price Index
IT	Inflation Targeting
LTD	Loan To Deposit
MTS	Monetary Targeting Strategy
NEER	Nominal Effective Exchange Rate
NFA	Net Foreign Assets
PP	Philips-Perron
REER	Real Effective Exchange Rate
SIT	Soft Inflation Targeting
SVAR	Structural VAR
TMM	Money Market Rate

INTRODUCTION

In order to look for economic and financial stability, central banks try to develop a variety of strategies based on a set of instruments. As time went on, monetary authorities have made several changes in the conduct of monetary policy and in accordance with predetermined objectives. Consequently, many changes have been observed in the monetary framework basis over time. Nowadays, different central banks introduce Inflation Targeting (IT) as their monetary regime. Despite of being requiring, IT has proved its efficiency in many emerging and developing economies. In the early 1980s, the economic situation in New Zealand was somehow difficult. Inflation rates were in rise, which pushed decision makers to operate some reforms with the objective to control inflation rates. Since this pioneer experience, many central banks learned from the New Zealander case and moved toward this regime. Indeed, it has captured the attention of researchers, as many countries were moving toward this framework. This fact should not be surprising. In fact, a variety of papers have praised this regime. For instance, Palomino (2012) demonstrated that an IT adoption contributed to improve public understanding of monetary policy and increased the credibility of central banks' actions. Consistent with this work, Bernanke, Laubach, and Mishkin (1999) claimed that IT should reduce inflation rates and their variability and enhance the transparency of how the monetary policy is conducted. In fact, many advantages may result from setting an IT regime. Adding to the credibility of central banks, a successfully implemented IT framework is a proof of having a sound banking sector and a well-developed financial market, which should result in reducing the risk (for instance, we cite country risk, sovereign risk and exchange risk, among others).

The Tunisian monetary authorities are not far from the international economic context. After the failure of the Monetary Targeting Strategy (MTS) that has been introduced as the main monetary framework in order to achieve price stability, a debate emerged inside the CBT about maintaining the MTS with some modifications or adopting IT. As it is perceived to be a wanting regime, Tunisia is trying to move toward IT as it displays a set of benefits in terms of economic stability and credibility. However, the main problem for Tunisia is that it does not satisfy the requirements of an IT framework. Consequently, a flexible version of this regime is proposed, where monetary authorities use the available instruments to achieve it. To maintain price stability,

central bankers use the interest rate as the main instrument for conducting monetary policy. Nevertheless, a stand of the literature showed the importance of the mixed policy. In other terms, exchange rate and monetary policies may yield to better results in terms of attaining the price stability objective. As the exchange rate policy constitutes one of the pillars that affect the monetary policy, monetary authorities should take into account the impact of exchange rate movements on monetary policy components. One of the ways that central bankers use to control exchange rate developments is the Foreign Exchange (FX) interventions. A number of studies have shown evidence of this fact. Tapia and Tokman (2004), Berganza and Broto (2012), and Viziniuc (2021) claimed that FX interventions contribute to impact both the level and the trend of the exchange rate, lessen exchange rate volatility and present benefits in the case of a particular financial shock.

In this respect, we might think that central bank interventions present a prominent additional tool for monetary policy and particularly to an IT framework. Indeed, wide literature has provided evidence of this fact mainly in emerging markets. Geršl and Holub (2006) concluded that interventions present the best supplementary tool to the conduct of the monetary policy in Czech Republic. In line with this idea, Canzoneri and Cumby (2014) claimed that FX interventions affect strongly inflation and output in an IT regime than do sterilized interventions. Finally, Ghosh, Ostry, and Chamon (2016) demonstrated that, in emerging countries, a mix of monetary and exchange rate policies should exacerbate positive effects mainly when targeting exchange rate through FX interventions in an IT context.

Intuitively, we think that interventions may help in achieving the price stability objective as Tunisia's monetary framework is moving toward a flexible IT. To this end, we conduct this study to investigate the effectiveness of FX interventions for inflation control. To the best of our knowledge, we are the first to provide answers to this issue. A lot of studies have focused on the transmission mechanism of the monetary policy in Tunisia along with the country's ability to move toward IT. However, there is no study that highlighted the effectiveness of FX interventions in the Tunisian context.

Our methodology is based on studying the interaction between monetary and exchange rate policies. For this reason, we choose to employ a Structural Vector Autoregressive (SVAR) where we propose two different specifications. In the first specification, we suggest that deviations in inflation and NEER are supposed to be faced mainly by the money market rate and FX interventions, respectively. In the second, we assume that interventions react instantly to shocks on inflation and money market rate.

The remainder of the thesis is outlined as follows: Chapter 1 presents the main concepts of this work related to monetary and exchange rate policies. Chapter 2 gives an overview of the conduct of the monetary policy in Tunisia and reviews the existing literature on the interplay between both policies, the role of FX interventions in

emerging markets and particularly in economies announcing IT as their main regime. In Chapter 3, we introduce the SVAR methodology and the equations characterising every variable of our model. The empirical analysis is carried out in the fourth chapter. Finally, we conclude our work by presenting a summary of the main findings and implications of our study.

THEORETICAL PART

Chapter 1

Inflation and Exchange rate Targeting

1.1 Introduction

The choice of the monetary strategy has been crucial for every central bank in order to achieve its objectives and namely the stability of economic indicators. To do so, many interesting alternatives may be discussed. While a large number of countries employed an Inflation-Targeting (IT) framework to reduce inflation rates and their variability as demonstrated by Bernanke, Laubach, and Mishkin (1999), others are still trying to calibrate their monetary policy in a way that contributes to attain the defined objectives because moving toward IT seems difficult in such circumstances.
Since the pioneer New Zealander experience of adopting an IT framework, many countries such as Canada and the United Kingdom, started to opt for several changes in the conduct of their monetary policy in order to set an IT regime. Thanks to its advantages, IT is spreading throughout the world. Nowadays, we count at least 27 countries who are IT adopters.
Actually, IT may have several benefits that push decision makers to opt for it. For instance, Fouejieu and Roger (2013), Thornton and Vasilakis (2016) and Balima, Combes, and Minea (2017) showed that IT contributes to reduce sovereign risk based on a Propensity Score Matching (PSM) methodology. Furthermore, Boughrara and Dridi (2017) claimed that IT has an important role in dropping the stock market volatility.
Economic stability is achieved not only through lessening inflation rates but also by controlling exchange rates. Most of the developing countries are implementing a flexible exchange rate regime. However, emerging economies that depend on international commerce should be vulnerable to exchange rate shocks (Samarina and De Haan (2014)). In this way, we think intuitively, that emerging countries wishing to adopt IT should target the exchange rate in order to make it beneficial to the central bank's future strategy.

Before going further in this research, we wish to present the most important concepts. As a matter of fact, we devote this chapter to introduce the IT concept as well as the exchange rate targeting and other related notions.

1.2 From Monetary Targeting to Inflation Targeting

Monetary policy is an important component of the economy. Central banks are generally responsible for carrying out this policy. They should cooperate with other authorities to achieve the desired objectives given the interdependence between different economic policies (in particular, fiscal policy). However, the core basis of a monetary policy has changed with the appearance of different monetary theories. First, we have been talking about the quantity theory of money. Such a theory insisted on the prices' variability control as a fundamental key to conduct the monetary policy. In 1950, Freidman claimed that the objectives of monetary policy are better met by targeting money supply's growth rate rather than by engaging in discretionary monetary policy. Consequently, monetarists emphasized on the importance of specifying monetary rules when the economy is growing, in order to avoid inflation. Through an overview of the monetary theories, we outline two types of rules, pre-determined and discretionary rules.

1.2.1 Rules and discretion in monetary policy

Should monetary policy be assessed by a determined rule or by authorities' discretion? A debate has been launched years ago to provide arguments of which one can be more suitable for a central bank policy.

According to Dwyer (1993), under **discretion**, a monetary authority is free to act following its judgment. For example, a central banker could make decisions concerning the interest rates on a case-by-case basis instead of allowing a set rule to determine interest rates or money supply. In a discretionary logic, the central bank intends to improve its response to shocks case by case taking into consideration different types of unpredictable shocks affecting the economy. Thus, the reaction of monetary authorities during the current period may vary from their last period reaction depending on whether the activity level is seen as insufficient. Nonetheless, it is possible to have rules that allow no discretion under any circumstances.

According to Bordes (1997), a **monetary rule** consists particularly in detecting the central bank reaction function that provides explanations of how the central bank may ensure the economic stability. A strong consensus prevails among economists that discretionary monetary policy generates economic instability. Furthermore, rule supporters believe that monetary targets often shift from predictions, producing a

time-inconsistent and unpredictable policy. This fact reduces the public confidence in the central bank policy presumed to be committed to achieving low inflation rates.
Rule supporters criticize discretionary policy because it is conducted on a period by-period basis without exploiting any possible connections between the policy choices made over time (McCallum, 1989). The advantage of decision making by rules is that it views policy not as a sequence of unrelated decisions but as a method to achieve optimal outcomes by following a consistent regime over a long period.

1.2.2 Instrumental and Targeting rules

According to McCallum (2004), an **instrument-based rule** is an equation describing instrument settings that depend on currently observed variables. As examples, we may cite the **Taylor rule** (1993). In fact, the central issue is the choice of observable variables in order to set a rule. Thus, analysts should choose them meticulously and announce, secondly, what variables did they selected. Actually, the purpose of instrument rules is to preserve inflation at the targeted value, without generating fluctuations in output (Svensson (1997)).
A general **targeting-based rule** is the specification of a central bank objective function, whereas a specific targeting rule is an optimal condition implied by an objective function together with a specified model of the economy.

1.3 Inflation Targeting

Since the New Zealander pioneer experience in adopting IT, many researches consider that this regime is the best remedy to high inflation rates. In the 1970s and 1980s, New Zealand had a very poor track record of price stability. Annual inflation had been around 10 to 15 percent and was considerably high. In this way, the adoption of IT has permitted decision makers to control inflation variability and regain economic stability. Nevertheless, the implementation of IT depends on a set of pre-requirements. For this reason, countries which are unable to meet all the prerequisites may opt for a Soft Inflation Targeting (SIT) instead of Full-Fledged Inflation Targeting (FFIT).

1.3.1 What is Inflation Targeting ?

Briefly, Inflation Targeting is a monetary policy where a central bank follows an explicit target for medium-term inflation rate and announces this inflation target to the public. Actually, as monetary authorities may maintain prices stability, economic growth should be ensured. The central bank uses interest rate as its main short-term monetary instrument.

1.3.2 Types of Inflation Targeting

The **Full-Fledged Inflation Targeting** (FFIT) characterizes countries with an average degree of credibility and clarity to be raised and a transparent framework allowing the central bank to achieve its objective. Countries that use this type of inflation control cannot achieve and maintain low levels of inflation without a clear commitment to price stability.
The **Soft Inflation Targeting** (SIT) qualifies a country that applies a relatively credible anti-inflationary policy. It is a monetary framework related to central banks which cannot achieve price stability due to the lack of key pre-requirements. This monetary regime is particularly designed for countries affected by shocks and characterized by weak financial institutions and unstable financial conditions.

1.4 The pre-requirements for IT adoption

1.4.1 The institutional conditions

The first prerequisite that central banks should consider is the independence. In literature, we distinguish two types of independence: political and economic independence from one side, and instrument-goal independence from another side. The latter concept is considered as the most widespread type in the economy. It is commonly admitted that central banks are more independent when they are goal-dependent, that is, when price stability is explicitly mentioned in the central bank chart.
An autonomic central bank should promote accountability to be able to answer the public and to present adequate solutions in case of strategy's failure. This fact should be accompanied with a good communication of its monetary policy in a regular and coherent way to the different operators in financial markets.
A good communication supposes that the central bank is transparent. A transparent monetary policy means that changes in short-term interest rates should not surprise the market. It is important that the central bank enhance its transparency to ensure a good implementation of the IT framework.

1.4.2 The economic conditions

Once we talk about transparency and accountability, it is essential to mention that if both of them are achieved, then, the central bank is able to conduct its monetary policy in an independent manner. In addition, IT implementation supposes certain flexibility in the exchange rate regime. When it comes to emerging market countries, the flexibility of the exchange rate might not be appropriate. Often, these countries are more concerned about this issue compared to advanced economies. According to

some economists (Mishkin (2004)), the flexibility condition may not be feasible without focusing on the exchange rate objective.
To carry out IT, it is relevant to have a well-developed financial market. Actually, the latter component is of a great importance to the central bank as it is a part of the monetary policy transmission mechanism. Indeed, the lack of indirect monetary instruments will slow the financial market, which will drop the monetary policy effectiveness, leading to a delay in impacting inflation rates. Moreover, the fear of financial instability is another important constraint that should be taken into consideration when implementing an IT strategy. In fact, it has been shown that the most serious economic contractions arise when there is financial instability (Mishkin (2001)).
Furthermore, safe and sound fiscal, as well as financial systems should be put in place before IT can even be attempted (Masson, Savastano, and Sharma (1997)). Fiscal dominance may deny the conduct of an independent monetary policy. Although we define fiscal dominance by the excess of fiscal policy pressures on the monetary policy, it is narrowly related to two other factors, mainly, a fragile banking system.
Finally, the methodological conditions are important to mention. After fulfilling all the pre-requirements, a central bank should undertake inflation rates forecast to determine the necessary actions to put into practice. As a matter of fact, these actions are possible only if the central bank possesses powerful models that reflect accurately the dynamics of the economy (Boughrara (2007)).

1.5 Foreign exchange rate: A concept to focus on

It is often perceived that the movement toward globalization, since 1980, has resulted in increasing the international trade. Consequently, commerce between different countries has developed enormously putting into spotlight the concept of exchange rate. Nowadays, the foreign exchange rate market has become the largest and the most dynamic market with no physical location and 24 hours a day of availability.
The purpose of this section is to identify the different concepts of the exchange rate and its determinants. Furthermore, we will try to detail the main types of exchange rates and focus afterward on the exchange rate equilibrium. Finally, we present the different exchange rate systems and describe their characteristics.

1.5.1 Foreign exchange rate: The concept

Foreign exchange rate may be defined as the price at which one currency can be converted into another. In other words, it presents the rate at which a firm may exchange one currency for another.

1.5.2 Types of exchange rates

In this subsection, we give a brief idea of the different types of exchange rates, namely, bilateral and effective exchange rates.

Bilateral Exchange rate

There are many ways to measure an exchange rate. The most common method is to calculate a bilateral exchange rate. In short, a bilateral exchange rate refers to the value of one currency relative to another. In this category, we may find the nominal and the real exchange rates.

Nominal Exchange Rate (NER) The nominal exchange rate is defined as the number of domestic currency units that can buy a unit of another foreign currency. A drop in this variable is seen as a nominal appreciation of the currency. The nominal exchange rate affects the capital flows between countries and impacts interest rates. It impacts other variables such as: investments, economic growth and people's welfare.

Real Exchange Rate (RER) The real exchange rate is defined as the ratio of the price level abroad and the domestic price level, where the foreign price level is converted into domestic currency units via the current nominal exchange rate.
Formally, it is expressed as follows:

$$R = \frac{E \times P'}{P}$$

Where the foreign price level is denoted as P', the domestic price level as P and E is the nominal exchange rate.

Effective Exchange Rate

Effective exchange rates compare a country's currency to a basket of other countries' currencies. Generally, we identify the basket of currencies by considering a country's major commerce partners. Thus, the effective exchange rate is called the trade-weighted index because the weights attached to other countries' currencies show the relevance of the national country's trade with these economies.

Nominal Effective Exchange Rate (NEER) According to the IMF, the NEER "is a measure of the value of a currency against a weighted average of several foreign currencies". If the NEER goes up, we may claim that the local currency has appreciated against the weighted basket of currencies of its trading partners.

Real Effective Exchange Rate (REER) With reference to the World Bank documentation, the real effective exchange rate "is the nominal effective exchange rate (a measure of the value of a currency against a weighted average of several foreign currencies) divided by a price deflator or an index of costs."

1.5.3 The concept of equilibrium exchange rate

Simply, the equilibrium exchange rate is the rate at which the demand for a currency and supply of the same currency are equal. The equilibrium exchange rate indicates that the price of exchanging two currencies will remain stable.
Driver and Westaway (2003) define three possible equilibrium exchange rates that differ according to the considered horizon of time. We may talk about:

- Short-term equilibrium concept, is defined as the exchange rate which would exist when its fundamental determinants are at their current settings after abstracting from the influence of random effects (for instance from the effect of asset market bubbles).
- Medium-term equilibrium concept, which is defined when the economy is at internal and external balance.
- Long-term equilibrium, which is defined as the point when stock-flow equilibrium is reached for all agents in the economy.

After presenting such a concept, it is interesting to examine different approaches to measure it. Although the Purchasing Parity Power (PPP) is the oldest method, researches have developed other methodologies over the years. Even when completed by a Balassa-Samuelson effect, the PPP theory still ignores many structuring factors in determining the equilibrium exchange rate. We may mention:

- The Fundamental Equilibrium Exchange Rate (FEER) (Williamson (1983)) and its recent developments (Cline (2008)).
- The Behavioural Equilibrium Exchange Rate (BEER) which is an econometric approach (Clark and MacDonald (1998)).
- The Natural Real Exchange Rate (NATREX) which tries to give a theoretical basis with a dynamic analysis (Stein and Allen (1997)).

1.6 Exchange rate determinants

Apparently, exchange rate movements are not random. Despite the global factors that may affect the rates, there are several determinants that induce the rates to fluctuate. As a consequent, we detail a number of factors deemed to influence the exchange rate.

Inflation and Interest rates Both variables are correlated with the exchange rate. Actually, as the interest rate is the key instrument for monetary policy, a rise in inflation will induce monetary authorities to increase interest rates. Thus, this fact generates the depreciation of the local currency. In other terms, increases in interest rates will induce the rates to go up, thereby attracting more foreign capital, which causes a rise in exchange rates.

Country's Current Account A country's current account describes the situation of the trade balance and earnings on foreign investment. It consists mainly of transactions related to exports, imports, debt, etc. A deficit in the current account is deemed to generate depreciation.

Government Debt Government debt is relative to the national debt of a government. Countries with public debts are not likely to acquire foreign capital. In this way, inflation should not be in rise. Foreign financial operators will sell their bonds in the open market if the market predicts government debt within a certain country. Thus, a drop in the value of its exchange rate will follow.

Political Stability and Performance A nation's political state and economic performance can impact its currency strength. A country with less risk in political turmoil periods is more attractive to foreign investors. Consequently, investors prefer countries with more political and economic stability. Increase in foreign capital, in turn, generates an appreciation in the value of its domestic currency. A country with sound financial and trade policy does not give any possibility for uncertainty in the value of its currency.

Recession In case of recession, monetary authorities are likely to reduce interest rates, decreasing the country's chances to acquire foreign capital. Thus, its currency weakens compared to other countries which means the depreciation of the exchange rate.

1.7 Exchange rate systems

The choice of an exchange rate regime depends on the ability of a country to face shocks. In other words, countries that depend enormously on international trade might be vulnerable to the consequences of theses shocks compared to developed economies. We present briefly the applied exchange rate regimes throughout the world.

1.7.1 The fixed exchange rate

A fixed exchange rate system is a currency system in which governments try to maintain a currency value constant against a specific currency or good. In a pegged exchange-rate regime, monetary authorities fix the value of their currency in terms of fixed weight of an asset, another currency, or a basket of other currencies. In this way, a country's central bank remains always committed to purchase and sell its currency at a pre-determined price.

1.7.2 The floating exchange rate

A floating exchange rate is an exchange rate regime where a currency's value is allowed to fluctuate according to the foreign exchange market. Floating regime are hard to apply in emerging markets where earnings from international commerce are considerably important. Advanced economies opt for floating regimes since their economies are able to absorb shocks' effects.

1.7.3 The intermediate regime

Intermediate exchange rate systems are related to pegged currencies with regards to some band or value, which is either fixed or periodically adjusted. These are three hybrid regimes. For instance, we may cite:

- **Crawling bands**: Local currency may fluctuate within a range specified by a band of fluctuation. This band may be determined either by international agreements or by a central bank's unilateral decision. Generally, the bands are adjusted in response to economic circumstances and shocks.

- **Crawling pegs**: A crawling peg is an exchange rate regime, primarily seen as a component of fixed exchange rate regimes. However, it permits gradual depreciation or appreciation in an exchange rate. The system is a method to fully utilize the peg under the fixed exchange regimes, as well as the flexibility under the floating exchange rate regime. In dealing with external pressure to appreciate or depreciate the exchange rate (such as interest rate differentials or changes in foreign exchange reserves), monetary authorities may undertake frequent exchange rate regime changes to ensure that economic shocks are minimized.

- **Pegged with horizontal bands**: This regime is equivalent to a system with crawling bands. The only difference is that this regime allows the currency to vary within a larger band[1] .

[1]Greater than one percent of the currency's value.

1.8 An overview of the different exchange rate regimes in Tunisia

A large body of the literature emphasized on the exchange rate as an important concept to focus on. As this latter policy influences the monetary policy, authorities had to undertake several changes to permit an advantageous mix of policies. Like most of the economies, Tunisia has experienced more than one exchange rate regime. From 1973 to 1991, Tunisia has adopted a fixed exchange rate regime. In 1970s, the instability of the French Franc has led Tunisian authorities to use the Deutsche Mark (DM) as a reference currency. As time went on, authorities have decided to expand the basket of currencies on which the Tunisian dinar was pegged. This fact concerned mainly currencies of competitor countries and in line with Tunisia's trade partners. In 1985-1986, the Tunisian economy was in a recession which pushed authorities to adjust the weight of the currencies forming the basket. Despite the authorities' efforts to protect the dinar, they were obliged to devaluate the currency by about 10%. At that time, the CBT had sought to stabilize macroeconomic indicators and Tunisia's competitiveness. As a matter of fact, it introduced a policy based on the maintenance of capital control such as partial convertibility of the currency.
In 1990s, the government has supported an environment that provides adequate conditions for companies to develop their competitiveness compared to international enterprises. In 1992, the CBT has decided to implement a more flexible exchange rate regime by targeting the Real Effective Exchange Rate (REER) through regular adjustments in the value of the nominal exchange rate. This policy has enabled authorities to create a sound non-inflationary economy particularly when lessening the inflation rates by 5% between 1991 and 2000. Since 2002, the CBT opted for more flexibility as the IMF advised. Consequently, authorities set a managed float exchange rate regime. Obviously, the Arab spring has brought many changes concerning the conduct of the exchange rate policy. From 2011 until now, the regime adopted in Tunisia is an intermediate system with crawling pegs.

1.9 Conclusion

In a nutshell, this chapter details the key concepts of this investigation. From monetary targeting, which is based on a set of monetary theories (the quantity theory of money, monetarism, etc.), to inflation targeting, the preferences and challenges of monetary authorities has changed enormously. To measure the effect of an exchange rate policy, we devote a second section to present different aspects related to the latter concept.

Chapter 2

The conduct of the monetary policy in Tunisia

2.1 Introduction

The central bank of Tunisia (CBT) was created in 1958 in order to achieve several objectives. While setting up the Tunisian dinar was its priority, the conduct of the country's monetary policy was also essential to ensure the financial and economic stability. The latter objective has become by the time the core issue of the CBT. Many changes were underwent to the monetary policy to mitigate shocks' effects on the economy.

The Monetary Targeting strategy (MTS) is the announced adopted framework by the Tunisian monetary authorities since 1980 in order to achieve price stability. The mission of the CBT consisted in that time in preserving the money value. In other words, it should reduce the inflation variability and support the government economic policies. This fact was in line with different academic researches that supported making price stability the long-term objective of a central bank (Svensson (1999); Bernanke, Laubach, and Mishkin (1999)).

Although many efforts have been put forward to ensure the success of the MTS, it was found to be wanting and there were several reasons behind its effectiveness. In 2002, a debate emerged inside the CBT on the appropriate monetary strategy to follow by the authorities. A first group was supporting a new version of the MTS, namely, MTS with some modifications. It was about providing further efforts on selecting the right intermediary aggregate and improving the financial system standing as well. The other group was defending a move toward Inflation Targeting (IT) framework. They argued that the CBT needed to improve its credibility to the financial operators and the public in general. They claimed that only adopting an IT regime, which would not be difficult seeing that it constitutes an extension of the MTS, could achieve this.

In this chapter, we give more details about the monetary strategy of the CBT as well as the IT framework. Then, we focus on the benefits of adopting an IT regime in an economy. Lastly, we provide a literature review on the relevance of an exchange rate targeting strategy in order to achieve the goal of price stability.

2.2 The conduct of the monetary policy since 1980

While the MTS was the monetary policy followed by the Tunisian authorities, several researches proposed the IT framework as a possible solution to the imperfections detected in the former strategy. In this section, we will try to describe the MTS conducted in Tunisia since 1980 as well as the IT regime alternative.

2.2.1 The Monetary Targeting Strategy: A controversial policy since 2003

As we announced before, the objectives of the CBT were primarily to preserve the financial stability by maintaining the value of the currency, supporting the government economic policies and ensuring the prices' stability. To this purpose, the CBT followed the MTS for approximatively 20 years. At that time, the monetary policy formulation has focused on the determination of the appropriate growth of M2 aggregate using the quantity theory of money. Its equation is expressed as follows:

$$M \times V = P \times Y$$

Where: M denotes the money supply M2, V is the velocity, P is the level of price and Y is the real GDP. The targeted M2 is obtained by placing the predicted values of the level of price, velocity and the real GDP. The estimation of M2 should enable the CBT to derive the credit expansion to the public sector that is deemed to be consistent with these projections. The amount of credit expansion is assessed through a separate calculation of the private sector credit needs. Finally, the CBT determines the amounts of liquidity to be distributed through the refinancing facilities by taking into account the projected net international reserves as well as the credit requirement of the agricultural sector.

Over this period, this monetary strategy has raised the attention of many academics and researches due to some limitations. According to Boughrara (2007), authorities have often missed the targeted values, and the gap between M2 targets and their realized values outstripped the 2% level in more than 60% of cases between 1987 and 2002. Moreover, this gap even exceeded 8% during the years 1988, 1996, and 1999.

2.2.2 The reasons behind the failure of the MTS

When monetary authorities started to opt for the MTS, many critics raised from the fact that the latter strategy seemed not to meet the targets in practice. Several explanations were advanced by the researches in this issue. To start with, the procedure employed by the CBT to estimate the targets was not based on a money demand function. It was based on the staff experience and its capacity to predict the targeted values which resulted in giving inaccurate figures. Second, government expenditure on food subsidies has pushed cereal and oil boards to borrow a large amount of money from banks between 1987 and 1996, which constituted a source of pressure on the economy. Furthermore, the CBT did not succeed in terms of the price stability objective as well as promoting the economic development. In fact, the CBT was unable to predict the possible evolutions in the economy. Consequently, it was difficult for the CBT to spread the necessary information permitting to align the expectations of the public to its own predictions. Actually, the financial system is composed mainly from the banking sector and the stock market. However, the latter component is not as developed as the former one. Unfortunately, such a sector was dominated for a long time by the phenomenon of the Non Performant Loans (NPL). In addition, the CBT received many requests from banks to obtain liquidity, which gives further arguments that it is not able to meet the fixed targets. It was even unable to publish its intermediate objectives in due course.

2.2.3 The IT regime: Is it the right alternative?

From 2002 until nowadays, the monetary authorities have opted for an IT regime, or even precisely, a flexible IT framework. Going back to 2002, a debate surged about the relevance of abandoning the MTS. IT supporters argued that this regime could be beneficial for Tunisia. In fact, they claim the necessity for the CBT to manage freely its instruments in order to gain more credibility. Moreover, IT framework does not promote the achievement of only one objective, the inflation one. By setting wide inflation target bands, long inflation target horizons, and explicit exemptions for supply shocks, monetary authorities can guarantee also the goal of output stabilization. In line with this idea, IT does not require to have the inflation goal as a permanent objective. A central bank can handle other internal issues without being exposed to shocks. In addition, announcing a future target may help the CBT to have clear long-term decisions, which improves its transparency to the public.

Actually, it was demonstrated that IT framework has other potential advantages. For instance, Lin and Ye (2009) employed a propensity score matching method to show that an IT policy has significant effects on lowering the inflation rates and their variability, consistent with the work of Bernanke, Laubach, and Mishkin (1999). Furthermore,

Balima, Combes, and Minea (2017) found that an IT adoption contributes to increase ratings and reduce the government bond yield spread, using also propensity score matching techniques, which leads to say that IT helps to reduce the sovereign risk and also the country risk (Fouejieu and Roger (2013)). Furthermore, Boughrara and Dridi (2017) showed that IT is beneficial since it has permitted to attract more foreign portfolio investment inflows.

2.3 The conduct of the monetary policy beyond the Arab spring

Before the revolution, the economic situation was approximatively stable. Actually, with the increase of Foreign Exchange (FX) inflows, the CBT could gain much in terms of Net Foreign Assets (NFA), which resulted in an expansion in the broad money by about an annual average of 20% in the period spanning between 2001 and 2010. As a matter of fact, the banking sector was in a liquidity surplus position and the inflation rates were in control. Although the economic situation was showing much stability, the revolution has pushed the monetary authorities to undertake fundamental changes in the conduct of the monetary policy. It is noteworthy to cite mainly three important phases after the revolution. We talk mainly about:

- **Opting for more flexibility in the exchange rate as banks were suffering from a liquidity deficit.**

While the liquidity position of the banking sector was positive before 2010, it became to draw a deficit in the imminent years. The revolution has resulted in FX outflows, which the monetary authorities have faced with growing sterilized FX interventions through liquidity injections.

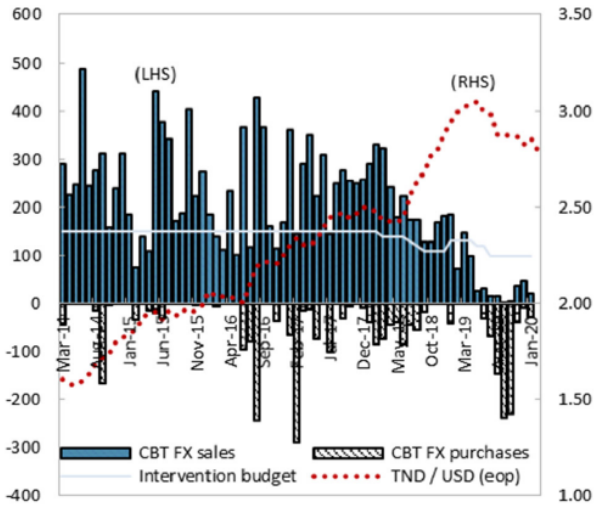

Figure 2.1: Monthly FX interventions between 2014 and 2020

To face the banking liquidity deficit, the CBT has lessened the reserve requirement by 10 percent. It has also fostered liquidity injections through 7-day main refinancing operations. In one year, the volume of refinancing grew up three times compared to 2011 seeing the fact of sterilizing the FX sales by the CBT.

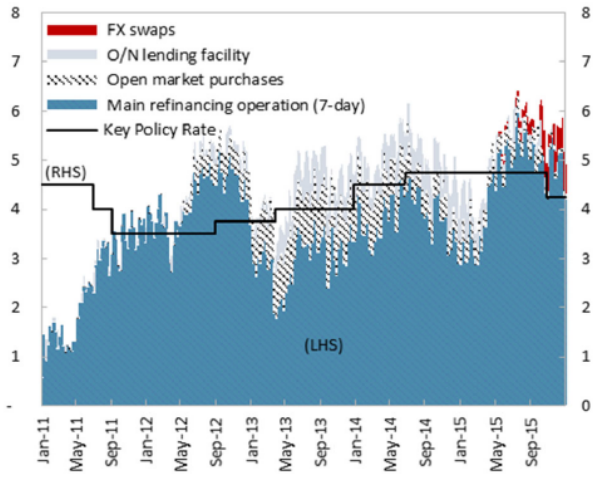

Figure 2.2: Open market operations between 2011 and 2015

- **The growing volume of refinancing by 2015 causing high inflation rates.**

By 2015, the economic situation showed much instability. The banking sector was suffering a lack of liquidity due to the terrorist attack. The solution was to expand the refinancing volume as a remedy to the economic slowdown (To the best of your knowledge, the latter variable has grown by 60% between 2017 and 2018). To this purpose, the CBT defined multiple objectives. However, regarding the phenomenon of inflation that started to rise, the CBT adjusted its key interest rate several times.

- **More strictness in terms of policy implementation in order to drop inflation rates.**

In 2016, the CBT has announced itself as an independent institution for conducting the monetary policy. The Law n°2016-35 assigns to the CBT the main objective of ensuring the prices' stability along with the economic development. Thus, the CBT has defined a rigorous macro prudential policy with more effective management of its instruments in order to attain the fixed goals. Actually, the CBT was tightening its policy more forcefully. The reduction of the refinancing volume was run through the contraction of the Loan To Deposit (LTD) ratio. In this way, the broad money deceased by almost 8% between 2017 and 2019.

2.4 The way forward: Moving toward Inflation Targeting

IT delivers an interesting set of advantages. However, it is requiring in terms of prerequisites. End, Khatat, and Kolsi (2020) claimed that Tunisia might have been progressed in fulfilling those conditions. Despite recent success in implementing an interest rate based monetary policy, Tunisia seems prepared to opt for an IT regime as it forged ahead mitigating inflationary rates through a set of operations on the interest rate. They argue that several requirements have been already in place such as, strengthening the communication to financial operators, building more competitive and regular FX sales and setting up an independent status with regards to the government. Nevertheless, other conditions are still to work on. It is mainly about being more credible, accountable and transparent by announcing medium term objectives and avoiding discretion in conducting the monetary policy. In addition, it is recommended to develop a strong model able to release relevant forecasts for inflation rates.

2.4.1 The instruments of the Tunisian monetary policy since 2016

With reference to the seventh article of the law n°2016-35, the CBT is responsible for ensuring the prices' stability as well as the economic development. In other words, the CBT should contribute to the creation of a sound and a non-inflationary economy. To this end, the CBT uses several tools to conduct its monetary policy. To attain the predefined inflation target, the CBT utilizes a main instrument, which is the interest rate. By adjusting the day-to-day interbank rate, the CBT could manage not only to

apply its strategy in an operational framework but also with regards to its future strategy. The short-term rates would affect the interest rate long-term structure helping the CBT to achieve its goals. The objectives of the central bank are realised through a meticulous process. The process begins by fixing the operational framework and its objectives.

With regards to the circular 2017-02, the CBT possesses all the necessary operations in order to implement its monetary policy. These tools are various and are the following: the reserve requirements[1] , operations upon CBT initiative[2] and operations upon banks' initiative[3] . The use of these tools has changed according to the requirements of each period.

2.5 Inflation Targeting and Foreign Exchange interventions effectiveness

As we said before, IT has been a widespread monetary policy framework since New Zealand paved the path for other countries to do so. As time went on, academics and researches emphasized on the importance of such a regime in reducing inflation and its variability from one hand (Bernanke, Laubach, and Mishkin (1999)) and in enhancing the credibility of central banks (Palomino (2012)) from another hand. Actually, IT regime is praised for being a shock absorber. Several studies argued that IT countries could get mitigated consequences of shocks thanks to the IT framework. Fratzscher, Grosse-Steffen, and Rieth (2020) showed that IT contributes to improve macroeconomic performance under crises or large natural disaster shocks. Using a sample of IT and non-IT countries and a set of quarterly data, they revealed that IT helps to lessen inflation, raise the potential output growth, and drop inflation variability compared to different monetary regimes.

Despite of the inflation goal, the IT regime offers also the possibility to have multiple objectives. In other words, monetary authorities may target the exchange rate within an IT framework. The question was should policymakers care about exchange rate movements under IT? To answer this question, we focus on the experience of some emerging countries.

[1] Obligatory deposits that banks have to give to the CBT in order to stabilize the money market rates and to guarantee the effectiveness of the CBT interventions.

[2] Those operations are put ahead to control the movements of the day-to-day interbank rate, manage liquidity and give an idea about the orientation of the monetary policy. We may distinguish four categories: Main refinancing operations, Longer-term refinancing operations, Fine tuning operations and Structural operations.

[3] Consists mainly of the standing facilities. They include marginal loan facility and deposit facility meant respectively to supply and withdraw liquidities on a day-to-day basis.

2.5.1 The interplay between exchange rate and monetary policies

Adopting an IT framework supposes a certain configuration in terms of exchange rate policy. Generally, IT supports a floating exchange rate regime. However, emerging economies could find difficulties moving from fixed exchange rate regimes to floating ones. Nevertheless, it remains a basic condition to opt for a Full-Fledged IT. Actually, the exchange rate policy constitutes one of the pillars that affect the monetary policy. Civcir and Akçağlayan (2010) studied at what extent could the exchange rate developments impact the monetary policy under IT. They found that shocks on exchange rate affected the interest rate during the period of IT adoption in Turkey. In this way, the exchange rate seems to be a relevant variable for the monetary policy. Nordstrom, Roger, and Stone (2009) emphasized on the importance of taking into consideration the exchange rate policy as it contributes to promote financial stability. If the latter policy is well managed, it may permit to absorb the shocks' effects and enhance the credibility of the conducted policy.

2.5.2 Exchange rate pass-through and inflation

The conduct of monetary policy requires that central bankers give a lot of attention to all the instruments that deemed to play a crucial role in the achievement of monetary policy goals, such as, the control of inflation variability. As we are discussing the interplay between both monetary and exchange rate policies, it is relevant to shed light on the impact of an exchange rate shock on inflation and other instruments volatility. Actually, a wide body of literature studied the Exchange Rate Pass-Through (ERPT) in emerging and advanced economies. Ca'Zorzi, Hahn, and Sánchez (2007) studied the ERPT in 12 emerging countries and found that the latter variable is higher than in advanced economies. In addition, for emerging markets with only one digit inflation and mainly in the Asian countries, pass-through to imports and consumer prices is found to be low and not very dissimilar from the levels of developed economies. The only explanation that we may get about developed countries having a low ERPT is that they present a model of sound and less vulnerable economies. Takhtamanova (2010) claim that the decline of the pass-through is due to the low inflation environment that has been recently achieved in many countries and particularly in a set of 14 of the OECD countries. Over the years, many academics has been interested in the ERPT's fluctuations after the subprime crisis.

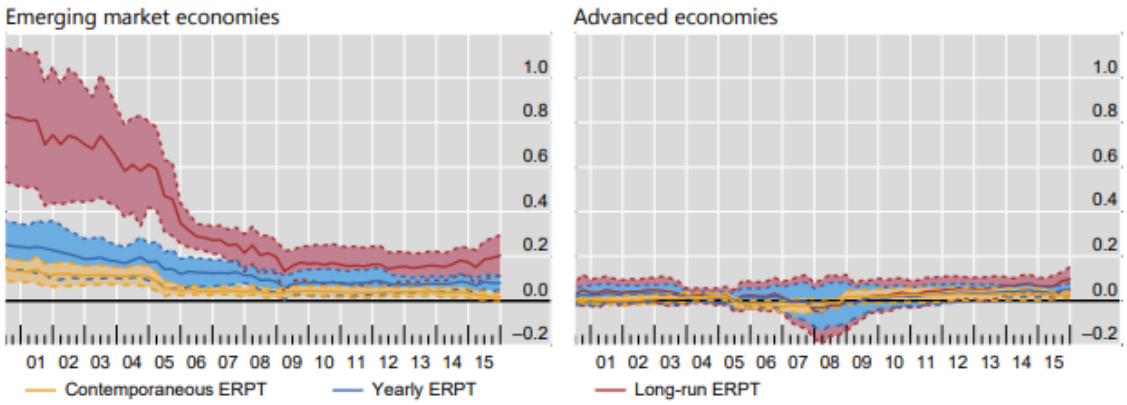

Figure 2.3: ERPT in Advanced and Emerging economies

The figure above depicts the most important changes in the ERPT for the period spanning from 2001 to 2015. A remarkable decline is observed for all the countries and particularly in advanced economies where the ERPT is negative in the end of 2007. However, some emerging economies could still have experienced stable or even increasing pass-through. In spite of the stable average results, different ERPT trends might prevail in some advanced economies.
Similarly, to other emerging countries, Tunisia has a high pass-through. According to the literature, the ERPT was around 0.12 before the revolution (Sanhedji et al. (2007)). However, after the Arab spring, the ERPT was found to be high (Guizani (2015)), which is different from other emerging countries that have experienced a decline in the ERPT in the same period.

2.5.3 The role of FX interventions in emerging economies

Monetary authorities manage the exchange rate policy by intervening in the foreign exchange market. The central bank purchases or sells currencies to influence or contain the excessive movements in the exchange rates. Unsurprisingly, policy making of the FX interventions in advanced economies differs from developing countries. A stand of researches focused on the effectiveness of FX interventions in emerging markets. Most of academics presume that undertaking FX interventions in developing countries would make a difference compared to developed countries, which operate with a floating exchange rate regime. Disyatat and Galati (2005) claimed that when foreign exchange market is not large and dominated by few financial operators, monetary authorities should provide guidance as the exchange rate is likely to be volatile. Indeed, exchange rate policies have to be managed in a way that permits policy makers to achieve their goals such as for East Asia when authorities were leaned toward ensuring export competiveness between 1980 and 1990. In addition, Tapia and Tokman (2004) argued that public announcements of the coming interventions by the central bank of Chile

are found effective in impacting both the level and the trend of the exchange rate. In line with this idea, Berganza and Broto (2012) used a sample of 37 emerging countries and a panel model to prove that in emerging IT countries, FX interventions have been more effective to lower exchange rate volatility, than in non-IT countries. In addition, Viziniuc (2021) created a small open economy model through a DSGE technique to investigate the implications of FX interventions on agents' welfare. He showed that FX interventions might be beneficial in case of financial shocks particularly when the level of currency discrepancy in the economy is high.
Thus, as documented by academics, FX interventions seem to play a key role in emerging countries. In this logic, what are the gains of emerging countries if they undertake FX interventions in an IT context?

2.5.4 Effectiveness of FX interventions under IT in emerging markets

Geršl and Holub (2006) shed light on the role of FX interventions in an IT regime in Czech Republic. Since 1998, the Czech National Bank (CNB) announced that IT had become the main monetary policy framework. However, the CNB was applying a mixed policy combining inflation and exchange rate objectives. Using different statistical tools, they showed evidence of the impact of FX interventions on the exchange rate and its volatility. Authors concluded that in small economies, it is better not to use excessively FX interventions. Nevertheless, they present the best additional instrument that helps an IT framework. Indeed, to ensure the effectiveness of these interventions, authors insisted on the fact that they should be communicated with the same credibility that does the conduct of the IT policy. Catalán-Herrera (2016) studied the influence of FX interventions on daily exchange rate returns of the Quetzal over the American dollar. He used a GARCH model because interventions are instrumented with a conditional expectation to interventions. Although it was not found a great evidence of this fact, the author showed that monetary authorities' interventions on the foreign market had a dampening effect on the volatility of daily returns under an IT regime.
In line with this idea, Adler, Lama, and Medina (2019) developed a small open economy model where the central bank opts for a flexible inflation targeting to analyse at what extent the FX interventions contribute to the IT goals in terms of credibility. They found that when the central bank is credible, FX interventions might stabilise potential output and inflation rates in response to foreign shocks. Consistent with this finding, Canzoneri and Cumby (2014) employed a DSGE model to investigate whether the performance of IT is improved when running FX interventions by monetary authorities. They showed that FX interventions affect strongly inflation and output

in an IT regime than do sterilized interventions. Ghosh, Ostry, and Chamon (2016) demonstrated that in emerging countries a mix of monetary and exchange rate policies should exacerbate positive effects mainly when targeting exchange rate through FX interventions in an IT context. Briefly, FX interventions should help the IT framework goals. Nevertheless, as Tunisia intended to opt for a flexible IT framework since 2003, we think intuitively, that FX interventions may provide more effectiveness in achieving the IT regime objectives. *Consequently, we contribute to the literature by inspecting in what way, FX interventions would help the CBT efforts in order to attain the inflation goal.*

2.6 Conclusion

In this chapter, we take a quick look at the different phases of the conduct of the Tunisian monetary policy by the CBT. Since 2003, the monetary authorities decided to opt for an IT regime. Although the IT framework offers the possibility to multiple objectives, we wonder if the exchange rate targeting policy might be relevant for better inflation control. As a large body of the literature proved the effectiveness of FX interventions in emerging countries, we aim to investigate at what extent may the CBT interventions in the foreign exchange market help in achieving the IT framework objectives.

EMPIRICAL PART

Chapter 3

Modelling the mixed policy

3.1 Introduction

Inflation Targeting (IT) has moved into spotlight since its adoption by the New Zealander Reserve Bank. As time went on, IT proved its efficiency in reducing inflation rates and their variability and improving other institutional aspects (we cite Bernanke, Laubach, and Mishkin (1999); Palomino (2012); among others). In this respect, we may think about other supplementary strategies that might enhance the central banks' objectives within an IT regime. For instance, a wide literature presented the benefits of central bank interventions. Geršl and Holub (2006) argued that interventions, when not used excessively, might be the best additional instrument to an IT framework. In addition, Ghosh, Ostry, and Chamon (2016) insisted on the importance of using a mixed monetary policy, combining IT and central bank interventions, in order to achieve the price stability goal.

The increased popularity of IT has pushed researchers not only to investigate about the relevance of adopting a mixed policy linking IT to other strategies but also to develop econometric tools. In fact, the use of simple macroeconomic models has become more requiring. As a matter of fact, academics have recourse to other advanced models proved to be more efficient in providing answers to these issues.

With the goal of inspecting the effectiveness of the central bank interventions in Tunisia, we draw on recent literature cited previously. We define equations of output, domestic inflation, foreign exchange interventions, nominal exchange rate and, Taylor rule as they permit us to present the characteristics of the Tunisian economy and determine the interactions between the different considered variables. Our aim is to investigate in what way may central bank interventions mitigate shocks' effects on the economy.

For this reason, a Structural Vector Autoregressive (SVAR) model is adopted to answer our main problematic. In this chapter, we devote an entire section to present

the interplay between the variables employed in our investigation through determining their possible equations. A second section details the characteristics of the SVAR as well as the impulse function.

3.2 Understanding the importance of combining central bank policies

For many academics and bankers, it is important to understand the interplay between exchange rate and monetary policies. Actually, policymaking should depend on a set of instruments. Thus, it is relevant to inspect the possible linkage between these instruments to ensure a better strategy. For instance, Civcir and Akçağlayan (2010) showed that exchange rate shocks affected the interest rate during the period of IT adoption. Moreover, Nordstrom, Roger, and Stone (2009) claimed the importance of well managing the exchange rate policy as it permits us to foster financial stability, absorb shocks' effects and improve the central bank credibility. Samarina and De Haan (2014) cite that many monetary authorities may target in the same time the stability in exchange and inflation rates. Consequently, a conflict may appear if we consider simultaneously both goals. To reduce inflation, central banks adopt some disinflation policies that require to stabilize the exchange rate using crawling bands. Once inflation is controlled, they abandon the SIT and migrate toward the FFIT.
For a small open economy, such as Tunisia, openness of the economy is a potential factor that affects the monetary policy choice. For instance, small economies depending on foreign trade are exposed to external shocks, which may influence the level of exchange rate. Hence, these countries should take into account this risk through fixing the right monetary policy.
To investigate the interplay between both policies, we have recourse to a **Structural Vector autoregressive (SVAR) model**. We detail the characteristics of the SVAR model in the next sections.

3.3 SVAR components

Before implementing the SVAR model, we should determine the interaction between its different variables in order to set the short-term restrictions. Consistent with many academics (Boughrara (2007); Ghosh, Ostry, and Chamon (2016); among others), the macroeconomic model is constructed mainly from equations related to output, domestic inflation, money market rate, nominal effective exchange rate and FX interventions.

3.3.1 Output equation

One of the main variables that we should consider is the output. Ghosh, Ostry, and Chamon (2016) supposed that the former variable may be described by the following equation:

$$y_t = \phi_y y_{t-1} - \phi_r r_t - \phi_e e_t + u_t^y \tag{3.1}$$

Where the dependent variable depends on e_t, the real exchange rate, r_t the real interest rate and the lagged output y_{t-1}. The parameters ϕ_y, ϕ_r and ϕ_e are strictly positive. In this respect, a shock on both rates should affect the variability of the output.

3.3.2 Foreign Exchange Interventions determinants

Adler, Lama, and Medina (2019) define central banks foreign exchange interventions as *"financial operations of the central bank entailing a purchase (sale) of a foreign currency denominated asset—or an equivalent derivatives transaction—and a sale (purchase) of a local currency asset."* A number of studies have investigated the different reasons that push the central bank to intervene in the foreign exchange market. Neely (2005) claimed that interventions happen probably to counter excessive exchange rate volatility. In other words, central banks intervene to limit the misalignment. Kim and Sheen (2018) studied the determinants of central bank interventions in Australia. Mainly, they considered five potential factors such as daily deviations of the exchange rate, the conditional volatility of daily exchange rates, the differentials between the U.S. and Australian overnight interest rates, a measure of the conditional profitability of past interventions, and reserve inventory considerations. Authors found that latter factors are deemed to explain the central bank behaviour related to interventions. Indeed, they showed that the Reserve Bank of Australia has responded to market disorderliness only when it is at a manageable level. This fact is consistent with leaning against the wind strategy. To assess the determinants of central bank interventions in Tunisia, we inspire from Neely (2005) and Kim and Sheen (2018) where interventions are described as follows:

$$I_t = c + \omega_1 I_{t-1} + \omega_2 \Delta S_{t-1} + \omega_3 (S_t - \overline{S_t}) + (R_t - R_{t-1}) + u_t^I \tag{3.2}$$

Where: I_{t-1} stands for the lagged intervention, ΔS_{t-1} is the lagged change in REER and $(S_t - \overline{S_t})$ represents the deviation of the REER from its targeted value. The targeted REER, $\overline{S_t}$, is calculated using an HP filter and $(R_t - R_{t-1})$ is the change in FX reserves

3.3.3 Domestic Inflation

The assessment of the inflation process is not the only concern for central banks in advanced economies, but it is one of the undoubtedly primary issues for all the central banks in emerging markets. According to many academics, economists and central bankers, the model of price change, is dominated by the called price Phillips-curve approach. In this respect, the inflation variability is strongly dependent on the degree of aggregate resource utilisation. To make it simple, we draw on several studies (we cite, Ghosh, Ostry, and Chamon (2016); Norman and Richards (2010); Ettlin (1997) and Makni (2019)) to explain inflation dynamics. Thus, we present the latter variable as follows:

$$\pi_t = \alpha_1 \pi_{t-1} + \alpha_2 \pi^e_{t+1} + \alpha_3 y_t + u^{\pi}_t \tag{3.3}$$

Where π_{t-1} is the lagged inflation rate, π^e_{t+1} is the expected inflation rate and y_t is the output.

3.3.4 Nominal effective exchange rate

Modeling exchange rate variability is of huge importance to researchers throughout the world. To counter the deviations of the REER from its target, the central bank intervenes in the forex market to influence the NEER. Actually, the latter variable may be expressed as :

$$NEER_{jit} = \sum_{i=1}^{k} w_{it} \times E_{it} \tag{3.4}$$

where E_{it} is the period average nominal exchange rate between the home country and each trading partner in period t, and w_{it} is the appropriate total trade weight for each trading partner. As the NEER equation includes the nominal exchange rate (NER), we choose to present also the NER equation. We draw on Makni (2019) who expressed the NER based on the Uncovered Interest rate Parity (UIP) in its forward-looking version. The nominal exchange rate may be written as follows:

$$NER_t = NER^e_t + \frac{-R_t + R^*_t + P^*_t}{4} + u^{NER}_t \tag{3.5}$$

Where: NER_t is the nominal exchange rate, NER^e_t is the expected nominal exchange rate in the next period. R_t is the domestic nominal interest rate, R^*_t is the foreign nominal interest rate. P^*_t is the risk premium.

3.3.5 Monetary policy rule

To construct the Taylor rule, we should assess the potential components expected to explain the interest rate's fluctuation. As we expect the effectiveness of FX interven-

tions in an IT framework, we may think that these interventions play an important role in stabilizing the exchange rate. For instance, Garcia, Restrepo, and Roger (2011) support the idea that advanced economies may have little to gain by including the exchange rate in the policy reaction function. However, other papers (Mohanty and Klau (2005); Aizenman, Hutchison, and Noy (2011)) claim that emerging market inflation targeters often include the exchange rate in their interest rate reaction function because the latter variable should have an impact on expected inflation. To this end, we suggest a Taylor rule specification that can be expressed as follows:

$$i_t = \beta_0 + \beta_1 i_{t-1} + \beta_2(\pi_t - \pi^e_{t+4}) + \beta_3(REER_t - REER_{t-1}) + \beta_4(z_t - z_{t-1}) + u^i_t \quad (3.6)$$

Where i_{t-1} is the lagged interest rate, π^e_{t+4} is the model-consistent projection of inflation four quarters ahead which assumed to be at the level of 4% drawing on Makni (2019), REER is the real effective exchange rate, and $(z_t - z_{t-1})$ is the change in output growth.

3.4 The Structural VAR

Now, we shift our interest to assess the effectiveness of FX interventions Tunisia. With reference to the literature, a simulation approach may be the most appropriate tool to answer our main question. However, as we intend to measure the magnitude of shocks in the presence of FX interventions, we choose to employ a Structural Vector Autoregressive (SVAR) as announced previously. Actually, the SVAR has been developed in 1968 by several researchers and academics such as, Bernanke, Sims and Blanchard and Watson consequently to the critics that arose from the fact that the VAR model's results yield to claim a particular economic structure that is difficult to reconcile with economic theory. Indeed, this technique allows the researcher to use economic theory to transform the reduced-form VAR model into a system of structural equations. The parameters are estimated by imposing contemporaneous structural restrictions. Thus, the crucial difference between atheoretical and structural VAR models is that the latter model yield impulse responses and variance decompositions that can be given structural interpretations. As time went on, an alternative structural VAR method, developed by Shapiro and Watson (1988), and Blanchard (1989), utilizes long-run restrictions to identify the economic structure from the reduced form. Such models have long-run characteristics that are consistent with the theoretical restrictions used to identify parameters. Moreover, they often exhibit sensible short-run properties as well.

3.4.1 SVAR Framework

The construction of the Structural VAR model is as follows:

$$A_0 X_t = D(L)X_t + Bu_t \tag{3.7}$$

Where: X_t is a $n \times 1$ vector containing economic variables, and u_t is a same dimension vector of mean zero structural innovations. A_0 is a matrix of structural coefficients is a non-singular matrix and is normalised to have ones on the diagonal. This matrix summarises the contemporaneous relationships between the variables of the model and is most commonly where identification restrictions are imposed. L is a lag operator and $D(L) = \sum_{i=1}^{n} L_i$ contains structural polynomials and B is supposed to be an identity matrix.
To the structural model, we associate the reduced form VAR representation expressed as follows:

$$X_t = C(L)X_t + \epsilon_t \tag{3.8}$$

Where ϵ_t is a vector containing the reduced-formed VAR residuals expressed as :

$$\epsilon_t = A_0^{-1} B u_t \tag{3.9}$$

Its covariance matrix is:

$$\Omega = E(\epsilon_t \epsilon_s^{'}) = A_0^{-1} \sum A_0^{'-1} \tag{3.10}$$

it is also characterized by $E(\epsilon_t) = 0, E(\epsilon_t / X_{t-1}) = 0, E(\epsilon_t \epsilon_s^{'}) = 0$
The identification of the SVAR model is done through the addition of other information to estimate A_0.

3.4.2 SVAR restrictions

The SVAR model requires the identification of a set of restrictions. To make it simple, we choose to consider only **short run restrictions**. As we consider the **B matrix as an identity**, short run restrictions cover only the simultaneous effect matrix. From the equation (3.8) determined above, we may write the reduced-formed VAR innovations as :

$$\epsilon_t = A_0^{-1} B u_t$$

with $S = A_0^{-1} B$
Restrictions on A_0 take the form of assumptions about the structure of contemporaneous feedback of variables in the SVAR. The number of restrictions is determined

regarding to the following equation:

$$n = \frac{k(k-1)}{2}$$

Where n is the number of restrictions and k is the number of endogenous variables used to construct the SVAR.

3.4.3 Impulse function analysis

The impulse responses to VAR shocks were derived mainly from the MA such as:

$$X_t = A_0^{-1} D(L) u_t \tag{3.11}$$

Impulse responses to structural shocks are formulated as follows:

$$\epsilon_t = A_0^{-1} B u_t$$

Where the use of ϵ_t rather than u_t points to an un-normalized form, i.e. the standard deviations of the shocks are absorbed into the diagonal elements of A_0. The MA representation for the VAR model is such:

$$X_t = C(L)\epsilon_t$$

Where: $C(L) = A_0^{-1} D(L)$

3.5 Data

3.5.1 Source

To produce this work, we employ data collected from the central bank database. To construct the SVAR, we use mainly, **quarterly data** related to Industrial production Index (IPI), Consumer Price Index (IPC), Nominal Effective Exchange Rates and (NEER), Money Market Rate (TMM) as a proxy for the central bank policy rate and FX interventions (FX). Our sample spans from the first quarter of 2010 to the fourth quarter of 2019.

As we intend to estimate the Taylor rule and intervention equations, we employ other variables such as, inflation rates, output growth, deviations of the REER from trend, changes in the REER and changes in FX reserves computed using the elementary variables presented previously. Data calculation details and presentation are displayed below.

Table 3.1: Variables' details

Variable	Definition
Inflation	Calculated based on the consumer price index as follows: $\frac{CPI_t - CPI_{t-1}}{CPI_{t-1}}$
Output Growth	Quarterly growth rates of the industrial production computed as follows: $\frac{IPI_t - IPI_{t-1}}{IPI_{t-1}}$
Foreign Exchange (FX) interventions	This variable present quarterly net interventions by the central bank. It is calculated as the difference between total sales and purchases of currencies.
Deviation of the REER from its target	Quarterly data related to the difference between the REER and its targeted value estimated by an HP filter
Changes in REER	Quarterly difference between the current REER and its past observation.
Changes in FX reserves	Quarterly difference between the current value of FX reserves and its past observation.

3.6 Conclusion

In this chapter, we presented the key tools to provide answers to the main issue of this study. Once we understand the interplay between exchange rate and monetary policies, we may move to focus on the relevance of FX interventions in Tunisia. To this end, we use the SVAR model to inspect the optimal central bank policy. Then, we estimate the effects of an inflation shock on the economy using different hypothesis in estimating the structural coefficient matrix.

Chapter 4

Evaluation of the two instrument monetary policy framework

4.1 Introduction

To conduct the monetary policy, central bankers choose a strategy to achieve the central bank announced objectives such as price and financial stability in compliance with their missions. To this end, many countries have opted for an Inflation-Targeting (IT) framework in order to reduce inflation rates and their variability. Recently, tremendous literature has focused on the benefits of such a framework as it helps to enhance institutional and economic indicators in a country (Bernanke, Laubach, and Mishkin (1999); Palomino (2012), and Balima, Combes, and Minea (2015)). It remains, however, relevant for the central banks to determine their optimal monetary policy. In other words, what are the additional instruments that monetary authorities may use in order to achieve their primary objective, namely price stability. The related literature has highlighted the role of foreign exchange (FX) interventions in the economy. For instance, Berganza and Broto (2012) used a sample of 37 emerging countries and a panel model to prove that in emerging IT countries, FX interventions have been more effective to lower exchange rate volatility, than in non-IT countries. In addition, Vizinuic (2020) investigated the implications of FX interventions on agents' welfare. The author showed that FX interventions might be beneficial in case of financial shocks, particularly when the level of currency discrepancy in the economy was high. Accordingly, we may think intuitively that FX interventions can help achieving price stability, which is the main objective of the central bank of Tunisia.

FX interventions have proven their efficiency in IT emerging markets. For instance, Canzoneri and Cumby (2013), Adler et al. (2019) and Ghosh, Ostry, and Chamon (2016) demonstrated how much interventions contributed to enhance the performance, credibility and macroeconomic stability in these countries. As we intend to

appraise the FX interventions effectiveness in the Tunisian economic context, we choose to make use of a prominent methodology based on the Structural VAR (SVAR). We analyse in this way the responses of the key macroeconomic variables (i.e. Industrial Production Index (IPI), Consumer Price Index (IPC), Money Market Rate (TMM), NEER and FX interventions) mainly to an inflation shock.
This chapter is outlined as follows. First, we highlight the necessary tests to characterize the study's variables. Second, we present and discuss the estimation results of the so-called Taylor rule as well as the main determinants of central bank interventions. Finally, we report the impulse function analysis provided by the SVAR model to answer our main question.

4.2 Descriptive Statistics

We present the descriptive statistics[1] of the main variables of this investigation. Our variables are the money market rate (TMM), the Nominal Effective Exchange Rate (NEER), the Industrial Production Index (IPI) as a proxy of the Tunisian output, the Consumer Price Index (IPC) and FX interventions (FX).

Table 4.1: Descriptive statistics of the main variables

	IPI	IPC	TMM	NEER	FX
Mean	94.71987	99.25284	4.987223	82.81050	516.4250
Median	94.41284	98.18415	4.711934	86.41243	572.0000
Maximum	101.5906	127.9158	7.849778	101.8369	1230.000
Minimum	85.31683	79.51656	3.236853	57.15311	-462.0000
Std. Deviation	3.652119	14.18037	1.248015	13.43987	323.9594
Skewness	-0.281841	0.402900	1.226228	-0.494092	-0.872513
Kurtosis	2.778590	2.093774	3.468380	1.982113	4.366335
Observations	40	40	40	40	40

Source: My own calculations based on Eviews software.

As provided by the table above, the money market rate varies between 3.2% and 7.8%. During the study period, the rise of this rate was due to the policy pursued by the monetary authorities based on controlling inflation rates and their variability as the money market rate moved along with the central bank policy rate. The NEER shows more fluctuating figures compared to the TMM. However, the output presents more variability with a 48-point difference between the highest observation and the lowest one. The social movements might explain this fact. The economic context has been impacted by the Arab spring pushing the production indices to drop. Indeed,

[1]Due to FX interventions data unavailability, we only consider the period spanning from 2010 to 2019, which results in using 40 observations.

the fragile political situation had led to claim uncertainty by Tunisia's partners, which deeply affected the level of production and productivity. The consumer price index has been in an increasing trend since the revolution. Inflation surged its highest score level during the last quarter of 2019, after which the central bank reacted to by rising its policy rate.

It stands out from Table (4.1) that the Kurtosis is higher than three only for TMM and FX. In other words, while most of the variables are platykurtic, TMM and intervention distributions are characterized by thick tails because they are leptokurtic. The Skewness coefficient is statistically different from zero for all the considered variables. It bears a negative sign for the IPI, NEER and FX and positive sign for the remaining variables. In this way, we can conclude that all the distributions are found asymmetric. Although, IPI, NEER and FX series are left skewed, others are right skewed. As we can remark, the Kurtosis and Skewness coefficients are different from those characterizing the normal distribution. Intuitively, we may claim that the considered distributions are not normal. We run the Jaque-Bera test to make sure of the non-normality of the distributions.

4.2.1 Normality Test

As we think that the distributions of the variables are non-normal, we run the normality test that is based on the following hypotheses:

H_0	the sample is normally distributed
H_1	the sample is not normally distributed

Table 4.2: Jaque-Bera Test

	IPI	IPC	TMM	NEER	FX
Jarque-Bera	0.611267	2.450930	10.38987	3.354340	8.186640
Probability	0.736657	0.293621	0.005545	0.186902	0.016684

Source: My own calculations based on Eviews software.

As we can see, the p-values are less than 5% for the TMM and FX, which justifies their non-normality at 5% and 10% levels. For the IPI, IPC and NEER, p-values are high which means the failure of the rejection of null hypothesis at all levels of significance. Thus, we may conclude that they present normal distributions.

4.3 Stationarity test

To answer our main question, we have recourse to the Structural VAR methodology. By and large, this econometric approach requires the stationarity of the variables used to implement it. To this end, we employ mainly the ADF test [2]. To check for the robustness of our results, we also run the PP test.

Table 4.3: ADF Test

	IPI	IPC	TMM	NEER	FX
ADF	0.6804	0.9763	0.8400	0.0001***	0.0285**

Notes: *, **, *** denote significance level at 1%, 5% and 10% respectively. We show estimation results where the model does not include a trend or an intercept. They are found to be insignificant for all the variables under all the levels.

First, we start by testing the stationarity of the considered variables in level. As shown in Table (4.3), all the variables have a unit root under all levels of significance except for the NEER and FX, that appear stationary at 5% and 10% levels.
The second step consists in testing the unit root for all the variables considering the first difference. The results of the different tests are displayed in the table below.

Table 4.4: ADF and PP Test

	D(IPI)	D(IPC)	D(TMM)	D(NEER)	D(FX)
ADF	0***	0***	0***	0***	0***
PP	0***	0***	0***	0***	0***

Notes: *, **, *** denote significance level at 1%, 5% and 10% respectively. We show estimation results where the model does not include a trend or an intercept. They are found to be insignificant for all the variables under all levels.

As we can remark, all the variables are stationary in the first difference. Consistent with the ADF test, the PP test leads to draw the same conclusions. Thus, the considered variables are integrated first order except for the NEER and FX.

[2] We report the P-values for the stationarity test.

4.4 Policies of the central bank

To ensure economic resilience, the central bank of Tunisia should conduct monetary and exchange rate policies in an optimal manner. In other words, it should take into consideration all the factors deemed to influence its reaction function in order to counter their movements by well managing its instruments. To this end, we start by examining the Taylor rule and the estimations of the intervention equations[3][4] to identify the possible interplays with the considered variables.

4.4.1 Interest rate rule

Several studies claimed that the Tunisian Taylor rule is deeply affected by movements in inflation and output growth (Boughrara (2007); Amiri and Talbi (2014), and Makni (2019)) However, our intuition leads us to consider the exchange rate deviations to specify the reaction function. As highlighted before, small open emerging economies, such as Tunisia, are financially vulnerable to global shocks. In this respect, including the exchange rate in their policy should present a source of benefits and another additional instrument to help achieving the monetary policy goal (Garcia, Restrepo, and Roger (2011)). We estimate the interest rate rule where the policy interest rate is supposed to depend on the deviations of inflation rate, change in output growth and REER from their targets, respectively. The estimation results are depicted in the Table (4.5).

Table 4.5: Taylor rule estimation

Variable	Coefficient	Standard Error	P-value
Constant	0.002097	0.030917	0.9462
Lagged TMM	0.536336	0.112434	0.0000
Deviation of inflation from its target	0.115885	0.066678	0.0879
Change in output growth	0.007505	0.006774	0.2728
Change in REER	-0.022231	0.015788	0.1648

Source: My own calculations based on Eviews software.

To estimate the Taylor rule, we include variables in the first difference to guarantee the accuracy of our results. Actually, we assess the relationship between the TMM and deviations of the inflation rate from its target, change in the REER and change in the output growth. Our results suggest that the money market rate is strongly dependent

[3]To estimate central bank policies, we choose to employ the REER as it is the variable to target for central banks.

[4]Estimations are done using OLS technique. All the variables employed in this section are stationary.

on its lagged observation as well as inflation movements. This observation is consistent with the economic theory. According to Bernanke, Laubach, and Mishkin (1999), the main instrument of an IT central bank is the interest rate, which is employed to limit inflation developments. The deviations of the inflation rate from its target pushes the money market rate to respond, as the coefficient is significant under 10% level. Put simply, this finding clearly demonstrated that the primary goal of the central bank is maintaining price stability. Surprisingly, the change in output growth is not a significant variable for the Taylor rule estimation. This result indicates that, during a context of deep recession, the central bank of Tunisia is well aware of the difficulty of containing the inflation and promoting the output simultaneously, it has privileged the first goal over the second one. In addition, the estimation of the Taylor rule may give us a glimpse of how the exchange rate policy contributes to the monetary policy. The change in REER is not significant under all levels suggesting that the latter variable is not supposed to influence the TMM. However, a more detailed analysis is necessary to a have a clear picture about the assessment of the monetary policy. For this purpose, we conduct a structural VAR investigation.

4.4.2 Foreign Exchange intervention

Turning to foreign exchange market interventions, the literature tells a lot about this variable. According to Neely (2005), Ghosh, Ostry, and Chamon (2016), and Kim and Sheen (2018), interventions should depend mostly on past interventions, change in REER, in reserves and deviations of the REER from the target and its lagged observation. Insofar as the considered variables are integrated same order to guarantee the accuracy of our estimations.

Table 4.6: FX interventions' equation

Variable	Coefficient	Standard Error	P-value
Lagged interventions	0.357945	0.148849	0.0220
Change in REER	261.3029	153.4376	0.0980
Deviation of the REER	294.9353	156.1786	0.0678
Lagged deviation of the REER	292.2234	155.5278	0.0691
Change in reserves	0.064279	0.033364	0.0627
Constant	514.3747	146.3311	0.0013

Source: My own calculations based on Eviews software.

Table (4.6) reports the estimation results of the central bank FX interventions regressed on exchange rate policy variables. Although interventions are revealed to

fluctuate in response to changes in the exchange rate policy determinants, the considered factors do not reflect huge relevance. Actually, past interventions seem to be the most important determinant in this equation because it appears statistically significant at 5% and 10% levels.
However, the remaining variables are only significant at the level of 10%. A positive change in REER affects positively the interventions. In other words, the central bank intervenes in the foreign exchange market to counter highly changes in REER, particularly when the misalignment is getting larger. A decrease in reserves are supposed to lessen interventions, which is consistent with the economic theory. Simply put, the central bank tends to reduce its interventions when the amount of international reserves is tightening.

4.5 Effectiveness of the Foreign exchange interventions in Tunisia

A large body of the literature praised the use of FX interventions within an IT framework (Ghosh, Ostry, and Chamon (2016); Adler, Lama, and Medina (2019)). Actually, FX interventions are demonstrated to be an efficient tool for lessening the exchange rate deviations and volatility (see among others, Disyatat and Galati (2005) ; Guimarães and Karacadag (2004)). However, it is relevant to assess their effectiveness in terms of inflation control. To this purpose, we consider a Structural VAR composed of the following variables: Industrial Production Index (IPI) as a proxy for the Tunisian output, Consumer Price Index (IPC) as a proxy for inflation, the Money Market Rate (TMM) because it is strongly dependent on the central bank policy rate, and the Nominal Effective Exchange Rate (NEER). All the variables are considered in their **first difference** to guarantee their stationarity and consequently yielding to better SVAR model results.
To answer our main question, we consider **two different specifications**. In the first specification, we assume that the monetary and exchange rate policies do not have contemporaneous effects on each other. That is, shocks on exchange rate components are not supposed to impact immediately the monetary policy components. We simulate a mix of policy in the second specification where we suppose the interaction between FX interventions, TMM and IPC to examine to what extent interventions may help achieving the price stability goal.

4.5.1 Preliminary tests

To construct the VAR, we should look for the optimal lag that permits us to get accurate results. We estimate a set of criteria such as Akaike information criterion (AIC),

Schwarz information criterion (SIC), Hannan-Quinn information criterion (HQ), sequential modified LR test statistic and Final prediction error (FPE).

Table 4.7: Lag Length criteria

Lag	Log Likelihood	LR	FPE	AIC	SC	HQ
0	-405.0658	NA	20582.97	24.12152	24.34598*	24.19807
1	**-368.5084**	**60.21228***	**10624.87**	**23.44167**	**24.78846**	**23.90096***
2	-341.8513	36.06550	10671.74	23.34419	25.81330	24.18623
3	-311.2840	32.36530	10195.45*	23.01671	26.60814	24.24149
4	-279.3673	24.40690	12783.44	22.60984	27.32360	24.21737
5	-246.5975	15.42109	32560.84	22.15279*	27.98888	24.14307

Notes: * Indicates the lag order selected by each criterion

Table (4.7) reveals the estimation results of the different criteria for a set of VAR constructions with a 5-lag maximum. Actually, we may observe that we get optimal criteria when we consider only **one lag**.
To confirm the relevance of using one lag to estimate the SVAR, we run the heteroskedasticity test on VAR residuals.

Table 4.8: Heteroskedasticity Test

Chi-square	Degrees of freedom	P-Value
140.3992	150	0.7012

My own calculations on Eviews software

Estimation results reveal that the p-value is high which indicates the failure of the rejection of null hypothesis at all levels of significance. Thus, VAR residuals do not show heteroskedasticity problem.
In this way, the conduct of the SVAR will be done using one lag. Consequently, the **SVAR(1)** model is defined as follows:

$$\begin{bmatrix} 1 & a_{12} & a_{13} & a_{14} & a_{15} \\ a_{21} & 1 & a_{23} & a_{24} & a_{25} \\ a_{31} & a_{32} & 1 & a_{34} & a_{35} \\ a_{41} & a_{42} & a_{43} & 1 & a_{45} \\ a_{51} & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} Dipi_t \\ Dipc_t \\ Dtmm_t \\ Dneer_t \\ Dfx_t \end{bmatrix} = \begin{bmatrix} a_{01} \\ a_{02} \\ a_{03} \\ a_{04} \\ a_{05} \end{bmatrix} + \begin{bmatrix} 1 & b_{12} & b_{13} & b_{14} & b_{15} \\ b_{21} & 1 & b_{23} & b_{24} & b_{25} \\ b_{31} & b_{32} & 1 & b_{34} & b_{35} \\ b_{41} & b_{42} & b_{43} & 1 & b_{45} \\ b_{51} & b_{52} & b_{53} & b_{54} & 1 \end{bmatrix} \begin{bmatrix} Dipi_{t-1} \\ Dipc_{t-1} \\ Dtmm_{t-1} \\ Dneer_{t-1} \\ Dfx_{t-1} \end{bmatrix} + \begin{bmatrix} u_t^{Dipi} \\ u_t^{Dipc} \\ u_t^{Dtmm} \\ u_t^{Dneer} \\ u_t^{Dfx} \end{bmatrix}$$

Where: Y_t presents the vector of endogenous variables ($Dipi_t Dipc_t Dtmm_t Dneer_t Dfx_t$). The vector u_t presents structural shocks. A_0 is the matrix of structural coefficients.

4.5.2 Two instruments, two targets

As said before, we suppose that the main instrument of the monetary policy is the interest rate. That is, exchange rate policy components do not have simultaneous effect on inflation and money market rate. In addition, if we run a shock on inflation, NEER and FX interventions may not respond immediately to this shock. The contemporaneous effect matrix A_0[5] should be designed to reflect these interactions. We suggest the matrix to be presented such as:

$$A_{01}X_t = \begin{bmatrix} 1 & a_{12} & a_{13} & 0 & 0 \\ a_{21} & 1 & a_{23} & 0 & 0 \\ a_{31} & a_{32} & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & a_{45} \\ 0 & 0 & 0 & a_{54} & 1 \end{bmatrix} \begin{bmatrix} Dipi_t \\ Dipc_t \\ Dtmm_t \\ Dneer_t \\ Dfx_t \end{bmatrix}$$

The **B matrix** is assumed to be defined as **an identity** for both specifications. Estimation results for the A_0 matrix are revealed below.

Table 4.9: Estimation of the structural coefficient matrix A_{01}

Element	Coefficient	Standard error	P-value
a_{21}	-0.013276	0.049869	0.7901
a_{31}	0.009063	0.050856	0.8586
a_{12}	-1.734577	0.399612	0.0000
a_{32}	2.220300	0.296014	0.0000
a_{13}	-2.085002	0.708321	0.0032
a_{23}	-3.909340	0.497864	0.0000
a_{54}	21.29853	0.082372	0.0000
a_{45}	0.000779	0.000579	0.1783

Source: My own calculations based on Eviews software.

Table (4.9) depicts the estimations of structural coefficients. As we can remark, inflation and money market rate have simultaneous effect on each other, which is consistent with the economic theory where the central bank controls inflation through its policy rate. In addition, the structural coefficient related to the FX interventions reaction to fluctuations in NEER seems highly significant, which supports the idea that the central bank try to limit the misalignment through its actions on the exchange rate using FX interventions.

[5]In this study, we estimate an over-identified SVAR model drawing on several researches such as Sims (1986), Gordon and Leeper (1994), Kim and Roubini (1999) and Brischetto and Voss (1999).

We present the **impulse reaction function**[6] due to shocks on inflation, money market rate and NEER to reveal the behaviour of the considered economic variables.

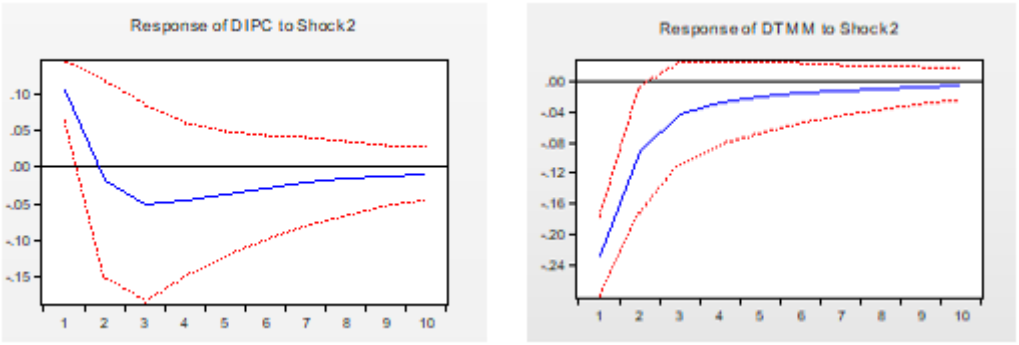

Figure 4.1: Responses of IPC and TMM to an inflation shock

As expected, fluctuations in inflation should lead the money market rate to respond immediately, within a quarter. The central bank of Tunisia has announced itself as in independent institution to conduct the monetary policy. This is one of the requirements for Tunisia to be an IT country in addition to focusing on inflation control as its primary objective. Thus, the following results seem to reflect economic reality because the main issue for the CBT is to achieve price stability. Therefore, an increase in inflation should lead the central bank policy rate to deviate from its normal level driving the money market rate to move either.

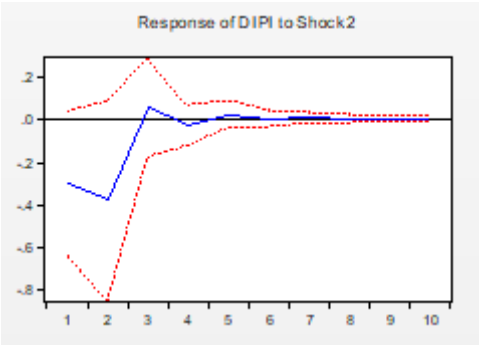

Figure 4.2: Response of IPI to an inflation shock

Indeed, the output responds immediately to an inflation shock as the rise of the money market rate creates a less attractive environment for investors, which ultimately depletes the industrial production index. We shift our interest to interpret movements in exchange rate policy components.

[6]Shocks 1, 2, 3, 4 and 5 correspond to shocks on output, inflation, money market rate, NEER and FX interventions, respectively.

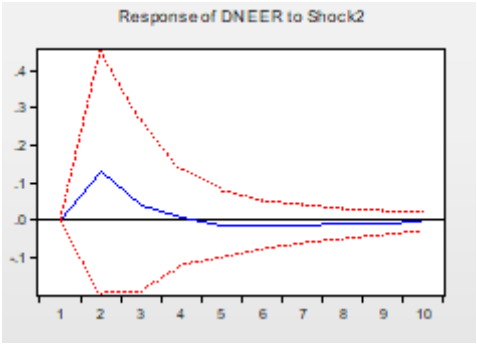

Figure 4.3: Response of NEER to an inflation shock

As we may see, the NEER does not respond instantly to the inflation deviation. It takes at least one quarter to observe the NEER response. As a country aspiring to adopt IT, the NEER does not figure among the key monetary policy instruments. However, it may be affected by changes in the central bank policy rate since the NEER depends from the nominal exchange rate whose equation is defined with regards to the Uncovered Interest Parity (UIP).
Moreover, we provide the results of **FX interventions** response, respectively, to inflation and NEER shocks.

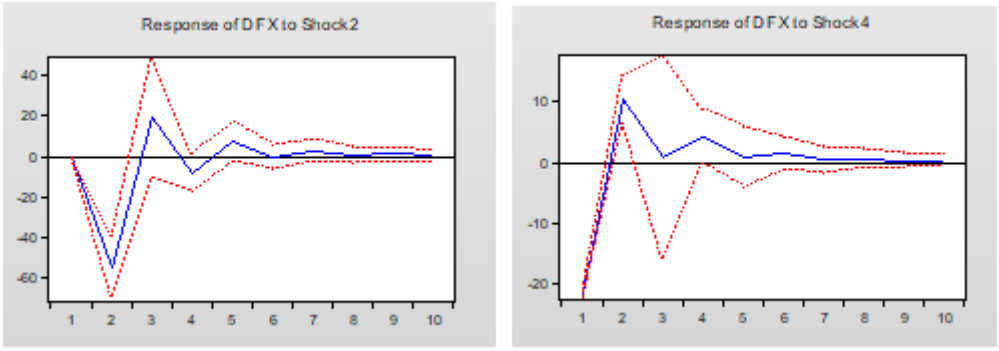

Figure 4.4: Responses of FX interventions to shocks on inflation and NEER

FX interventions promptly react only to a shock on NEER. This result is rather expected. When the REER deviates from its targeted value, the central bank intervenes in the foreign exchange market to contain the misalignment. It acts mainly on the NEER that transmits movement to the REER in order to get back to its equilibrium. Despite being effective for NEER developments, FX interventions seem to respond after one quarter to an inflation shock. Unfortunately, this finding can hardly be explained because of simultaneous effect and interplay between interventions and inflation. The only explanation that we may put forward is that interventions respond to gradual deviations in NEER.

4.5.3 Benefits of the mix policy

In this section, we propose a modification of the previous specification by suggesting an interaction between key instruments in monetary and exchange rate policies. In other words, we suppose that FX interventions present an interesting tool to the monetary policy to control inflation movements. For this purpose, we undertake several changes in the contemporaneous effect matrix, A_0, in a manner that reflects this possible interaction between inflation, money market rate and interventions. Structural coefficient matrix will be described as follows:

$$A_{02}X_t = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 \\ 0 & 1 & a_{23} & 0 & 0 \\ 0 & a_{32} & 1 & 0 & 0 \\ 0 & 0 & 0 & 1 & a_{45} \\ 0 & a_{52} & a_{53} & a_{54} & 1 \end{bmatrix} \begin{bmatrix} Dipi_t \\ Dipc_t \\ Dtmm_t \\ Dneer_t \\ Dfx_t \end{bmatrix}$$

In the table below, we provide estimation results of the structural factorization where B is an **identity matrix**.

Table 4.10: Estimation of the structural coefficient matrix A_{02}

Element	Coefficient	Standard error	P-value
a_{32}	2.229701	0.302387	0.0000
a_{52}	90.91332	0.384487	0.0000
a_{23}	3.955374	0.622938	0.0000
a_{53}	310.1792	0.753937	0.0000
a_{54}	39.82034	0.092340	0.0000

Source: My own calculations based on Eviews software.

With reference to the estimation results, we mainly notice that the structural coefficients a_{52} and a_{53} are highly significant, which suggests that central bank interventions are supposed to effectively respond to inflation and money market rate movements. More importantly, FX interventions react also to a shock in NEER, as the coefficient a_{54} is also statistically significant. This finding is of huge importance insofar as it presents interventions as the best instrument to control changes in the exchange rate. Furthermore, interventions seem to be a prominent tool for better monetary policy management. Unsurprisingly, we found that inflation and money market rate responses are significant, which confirms that Tunisia is moving toward an IT framework as it considers the central bank policy rate as the main component to counter inflation deviations.

To corroborate these estimation results, we shift to explore fluctuations in FX interventions and money market rate subsequent to an inflation shock.

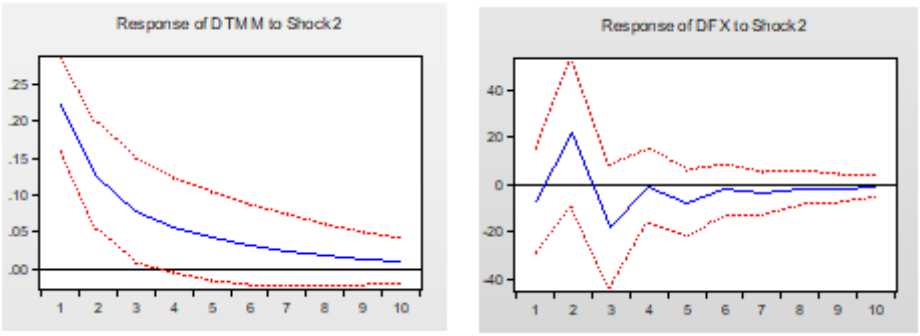

Figure 4.5: Responses of TMM and FX interventions to an inflation shock

As we predicted, the response of money market rate to an inflation shock is highly significant. The central bank tends to immediately react to inflation movements since monetary authorities announce that their main objective is to ensure price stability. Despite the use of the money market rate as the main instrument for the conduct of the monetary policy, the central bank still lacks another relevant supplementary tool to support its efforts . Although FX interventions instantly react to inflation deviations, their response remains almost insignificant. It takes one quarter for interventions to be involved in controlling inflation. More precisely, interventions' response is not explained only by the inflation shock. Interventions are supposed to respond to the exchange rate deviations brought about by the rise in the money market rate.

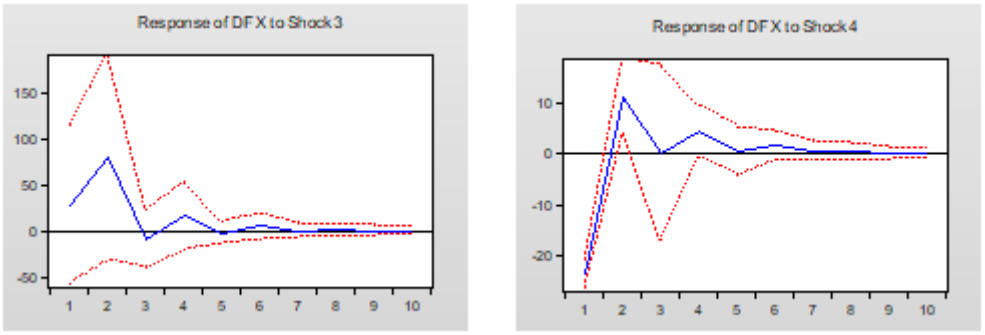

Figure 4.6: Responses of FX interventions to shocks on TMM and NEER

We reveal in the graphics above, the responses of FX interventions to money market rate and NEER shocks, respectively. The central bank interventions react to both instruments. Although, interventions promptly react to money market rate movements, their response was not really relevant compared to interventions' response to a shock on NEER. This finding confirms that the central bank of Tunisia has recourse to interventions, mainly to limit the exchange rate fluctuations from the targeted rates.

Briefly, the central bank of Tunisia needs to put forward much effort to ensure more effectiveness of its interventions in the foreign exchange market. In this perspective, Mihaljek (2005) shed light on the conditions of interventions' effectiveness for emerging economies central banks. It was found that interventions tend to be effective on average when central banks intervene less frequently with small amounts than those, which intervene less frequently in large amounts. Besides, half of the considered central banks claim the effectiveness of interventions to correct misalignment or to stabilise the exchange rate at a target level, particularly for those that operate with a fixed exchange rate regime. As the CBT deploys a non-floating regime, we think that interventions should mainly be used for these reasons.

It is also recognized that interventions should be conducted when the local currency is appreciating. Actually, if the exchange rate is depreciating due to weak economic fundamentals, interventions will not help stabilizing it for very long unless the central bank raises the interest rates. Indeed, the effectiveness is related to the well conduct of the monetary policy. For instance, interventions in the industrial countries seem to affect the exchange rate through the expectations channel than through the portfolio balance channel. To ensure the efficiency of expectations channel, interventions would need to signal future monetary policy. Interventions that change private agents' exchange rate expectations by giving signals about the future stance of monetary policy are argued to be the most effective ones. For this reason, the exchange rate and monetary policies should be conducted in a harmonious way.

Mohanty (2013) claimed that little has changed since the subprime crisis in terms of managing FX interventions. Although, there is no consensus about the effectiveness of central bank interventions in emerging markets, he points out that interventions are effective only if they tend to be consistent with the monetary policy strategy. Actually, inconsistency between the exchange rate and the monetary policies may damage the transmission mechanisms for monetary policy and prevent the success of interventions. For this reason, several central banks emphasized on the role of a good and transparent communication to guarantee that market perception is in line with the monetary policy stance. The author focused also on the importance of the monetary framework in the conduct of interventions. Despite of the increase of central bank intervention following the subprime crisis, persistent intervention might create risks for the economy due to its high costs of and the expansion of central banks' balance sheets. Moreover, interventions are still seen to be effective in moving the exchange rate in the desired direction and in reducing uncertainty about the future exchange rate. However, the impact of interventions is found to be only temporary and not persistent over time.

4.6 Conclusion

To sum up, this chapter aimed to provide evidence of the impact of central bank interventions on inflation control namely in Tunisia as our country is moving gradually toward the IT regime. Through reviewing the literature, we fixed the components of the Taylor rule as well as the determinants of foreign Exchange interventions. Estimation results showed that the interest rate rule is supposed to depend on inflation rather than changes in REER. FX interventions are found to move, precisely, due to deviations of the REER from its target. To provide more insights about this fact, we constructed a Structural VAR model where we considered two different specifications that permit us to test the interplay between monetary and exchange rate policies. We found that interventions might play an important role in limiting movements in the exchange rate. Nevertheless, interventions did not seem to provide much effectiveness in terms of inflation. Despite their instant reaction, the latter variable remained insignificant in controlling inflation.

MAIN FINDINGS, POLICY IMPLICATION AND CONCLUDING REMARKS

Since Inflation-Targeting (IT) moved into spotlight, many academics claimed that implementing this strategy in a successful way implies a high degree of exchange rate flexibility while defining a policy dedicated to ensure the sustainability of the economic growth. However, the former condition was considered as a hard challenge for a country that assumes its commitment to a credible IT regime. It was often recognized that emerging markets are reinforced to consider large exchange rate movements from their medium run equilibrium because neglecting these fluctuations is costly. Thus, central banks of emerging IT economies should operate with two policy targets: inflation and exchange rate. In this respect, a possible tension may be unavoidable between monetary and exchange rate policies. Despite of the conflict that might happen between both strategies, surveying recent literature may lead to draw different conclusions. Emerging market experiences showed that foreign exchange interventions may display a prominent tool that helps achieving price stability (Gersl and Holub, 2006; Canzoneri and Cumby, 2013; Gosh et al., 2016; Adler et al., 2019). **We contributed to the related literature through investigating one of the unexplored issues.** Since the central bank of Tunisia is gradually moving toward IT, we shed light on the effectiveness of FX interventions as a noteworthy tool to support inflation control.

To better understand the drivers of monetary and exchange rate policies, we first inspected, the determinants of central bank interventions as well as the factors suggested to influence the dynamic Taylor rule in Tunisia. Although changes in the Real Effective Exchange Rate (REER) matter, the interest rate rule seems to be impacted mainly by the inflation gap. Moving to FX interventions, the central bank of Tunisia seems to only react to deviations in the REER from its targeted rate.

Secondly, in order to answer our main question, a Structural VAR model was adopted. We defined two different specifications. In the first specification, we suppose that no interaction exists between both policies. That is, exchange rate policy uses the FX intervention as its key instrument to only limit deviations in the exchange rate. Besides,

the interest rate is considered as the main instrument to ensure inflation control. Then, we introduced a different specification where central bank interventions take part in achieving price stability. In other words, FX interventions were assumed to have a simultaneous effect on inflation and money market rate.

By and large, the central bank policy rate appeared to be the most effective instrument to control inflation as stipulates the IT regime. In addition, FX interventions seemed to be the main instrument to counter exchange rate deviations consistent with our intuition. However, there was little to gain in terms of inflation objective. Despite of reacting promptly to an inflation and money market shocks, FX interventions remained insignificant. To this end, the central bank of Tunisia needs to put forward a huge effort to ensure the efficiency of its interventions. However, we recognize the contribution of central bank interventions in stabilising the exchange rate. This fact should results in mitigating the imported inflation. Actually, inflation rates have been stable since the CBT increased its actions on its policy rate. Nevertheless, it is noteworthy to say that forex interventions played an important role to control this type of inflation.

In this study, we did not present FX intervention as the best tool to support the monetary strategy. However, we praised its role in helping achieve price stability. The central bank of Tunisia should define a meticulous approach to ensure the efficiency of the mixed policy. This fact is related enormously to the requirements of the IT regime. As the central bank keeps enhancing its credibility, it will be able to anticipate the expectations of financial agents. In this way, the central bank may guarantee the effectiveness of all its different instruments in order to achieve economic stability. Thus, the key ingredient to the success of a central bank is to ensure a good and transparent communication.

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Appendices

Preliminary Tests

Date: 11/24/21 Time: 00:31
Sample: 2004Q1 2019Q4

	IPI	IPC	TMM	NEER	FX
Mean	94.71987	99.25284	4.987223	82.81050	516.4250
Median	94.41284	98.18415	4.711934	86.41243	572.0000
Maximum	101.5906	127.9158	7.849778	101.8369	1230.000
Minimum	85.31683	79.51656	3.236853	57.15311	-462.0000
Std. Dev.	3.652119	14.18037	1.248015	13.43987	323.9594
Skewness	-0.281841	0.402900	1.226228	-0.494092	-0.872513
Kurtosis	2.778590	2.093774	3.468380	1.982113	4.366335
Jarque-Bera	0.611267	2.450930	10.38987	3.354340	8.186640
Probability	0.736657	0.293621	0.005545	0.186902	0.016684
Sum	3788.795	3970.113	199.4889	3312.420	20657.00
Sum Sq. Dev.	520.1809	7842.232	60.74412	7044.575	4093038.
Observations	40	40	40	40	40

Date: 11/24/21 Time: 08:45
Sample: 2004Q1 2019Q4

	DINF14	DEV_REER	D_REER	LAG_REER	DIR	DGROWTH
Mean	0.076221	-0.082371	-0.500009	-0.500009	287.1241	0.002615
Median	0.068947	-0.463080	-0.733659	-0.733659	196.8337	-0.261575
Maximum	0.984570	6.805830	4.593939	4.593939	4567.459	12.83232
Minimum	-0.982276	-5.938816	-5.959864	-5.959864	-2410.640	-15.40983
Std. Dev.	0.447316	2.623500	1.887327	1.887327	1213.737	4.477203
Skewness	-0.226700	0.674606	0.223483	0.223483	0.948464	-0.157092
Kurtosis	2.472878	3.695391	4.673619	4.673619	5.305885	5.515896
Jarque-Bera	1.188429	5.663856	7.376914	7.376914	21.91713	15.80326
Probability	0.551996	0.058899	0.025011	0.025011	0.000017	0.000370
Sum	4.497036	-4.859918	-29.50052	-29.50052	16940.32	0.154289
Sum Sq. Dev.	11.60531	399.1996	206.5961	206.5961	85443114	1162.630
Observations	59	59	59	59	59	59

Stationarity Test

Null Hypothesis: IPI has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.004878	0.6804
Test critical values:	1% level	-2.602794	
	5% level	-1.946161	
	10% level	-1.613398	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IPI)
Method: Least Squares
Date: 11/24/21 Time: 00:49
Sample (adjusted): 2004Q3 2019Q4
Included observations: 62 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IPI(-1)	2.13E-05	0.004359	0.004878	0.9961
D(IPI(-1))	-0.294074	0.122986	-2.391114	0.0200

R-squared	0.087020	Mean dependent var	0.028234
Adjusted R-squared	0.071803	S.D. dependent var	3.357131
S.E. of regression	3.234359	Akaike info criterion	5.217265
Sum squared resid	627.6648	Schwarz criterion	5.285882
Log likelihood	-159.7352	Hannan-Quinn criter.	5.244206
Durbin-Watson stat	2.161466		

Null Hypothesis: IPC has a unit root
Exogenous: None
Lag Length: 4 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		1.680247	0.9763
Test critical values:	1% level	-2.604746	
	5% level	-1.946447	
	10% level	-1.613238	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IPC)
Method: Least Squares
Date: 11/24/21 Time: 08:25
Sample (adjusted): 2005Q2 2019Q4
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
IPC(-1)	0.002815	0.001675	1.680247	0.0987
D(IPC(-1))	0.235620	0.129891	1.813986	0.0752
D(IPC(-2))	0.245478	0.134424	1.826146	0.0734
D(IPC(-3))	-0.040994	0.133771	-0.306447	0.7604
D(IPC(-4))	0.379281	0.129821	2.921579	0.0051

R-squared	0.660889	Mean dependent var	1.030362
Adjusted R-squared	0.635770	S.D. dependent var	0.561093
S.E. of regression	0.338628	Akaike info criterion	0.753109
Sum squared resid	6.192122	Schwarz criterion	0.929171
Log likelihood	-17.21671	Hannan-Quinn criter.	0.821837
Durbin-Watson stat	2.004763		

Null Hypothesis: TMM has a unit root
Exogenous: None
Lag Length: 1 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		0.584618	0.8400
Test critical values:	1% level	-2.602794	
	5% level	-1.946161	
	10% level	-1.613398	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TMM)
Method: Least Squares
Date: 11/24/21 Time: 00:52
Sample (adjusted): 2004Q3 2019Q4
Included observations: 62 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
TMM(-1)	0.003469	0.005934	0.584618	0.5610
D(TMM(-1))	0.514809	0.112552	4.573963	0.0000

R-squared	0.264362	Mean dependent var	0.045475
Adjusted R-squared	0.252102	S.D. dependent var	0.263136
S.E. of regression	0.227563	Akaike info criterion	-0.091054
Sum squared resid	3.107093	Schwarz criterion	-0.022436
Log likelihood	4.822663	Hannan-Quinn criter.	-0.064113
Durbin-Watson stat	1.864598		

Null Hypothesis: NEER has a unit root
Exogenous: None
Lag Length: 2 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.236242	0.0001
Test critical values:	1% level	-2.603423	
	5% level	-1.946253	
	10% level	-1.613346	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(NEER)
Method: Least Squares
Date: 11/24/21 Time: 08:19
Sample (adjusted): 2004Q4 2019Q4
Included observations: 61 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
NEER(-1)	-0.010491	0.002476	-4.236242	0.0001
D(NEER(-1))	0.398208	0.119957	3.319591	0.0016
D(NEER(-2))	-0.402714	0.124307	-3.239663	0.0020

R-squared	0.221403	Mean dependent var	-0.985132
Adjusted R-squared	0.194554	S.D. dependent var	1.619001
S.E. of regression	1.452998	Akaike info criterion	3.633065
Sum squared resid	122.4499	Schwarz criterion	3.736879
Log likelihood	-107.8085	Hannan-Quinn criter.	3.673751
Durbin-Watson stat	1.875887		

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

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.778775	0.0285
Test critical values:	1% level	-4.211868	
	5% level	-3.529758	
	10% level	-3.196411	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FX)
Method: Least Squares
Date: 11/24/21 Time: 08:22
Sample (adjusted): 2010Q2 2019Q4
Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
FX(-1)	-0.564775	0.149460	-3.778775	0.0006
C	676.8798	218.3456	3.100038	0.0037
@TREND("2004Q1")	-8.734077	4.014296	-2.175743	0.0362

R-squared	0.301567	Mean dependent var	-9.487179
Adjusted R-squared	0.262765	S.D. dependent var	314.3768
S.E. of regression	269.9314	Akaike info criterion	14.10802
Sum squared resid	2623066.	Schwarz criterion	14.23598
Log likelihood	-272.1063	Hannan-Quinn criter.	14.15393
F-statistic	7.771986	Durbin-Watson stat	2.095425
Prob(F-statistic)	0.001564		

Null Hypothesis: D(FX) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=9)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-9.647358	0.0000
Test critical values:	1% level	-2.627238	
	5% level	-1.949856	
	10% level	-1.611469	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(FX,2)
Method: Least Squares
Date: 11/24/21 Time: 08:22
Sample (adjusted): 2010Q3 2019Q4
Included observations: 38 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(FX(-1))	-1.405087	0.145645	-9.647358	0.0000

R-squared	0.715497	Mean dependent var	-6.473684
Adjusted R-squared	0.715497	S.D. dependent var	524.6334
S.E. of regression	279.8335	Akaike info criterion	14.13223
Sum squared resid	2897351.	Schwarz criterion	14.17532
Log likelihood	-267.5124	Hannan-Quinn criter.	14.14756
Durbin-Watson stat	2.009733		

Null Hypothesis: D(IPI) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-10.61568	0.0000
Test critical values:	1% level	-2.602794	
	5% level	-1.946161	
	10% level	-1.613398	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IPI,2)
Method: Least Squares
Date: 11/24/21 Time: 00:49
Sample (adjusted): 2004Q3 2019Q4
Included observations: 62 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IPI(-1))	-1.294053	0.121900	-10.61568	0.0000

R-squared	0.648792	Mean dependent var	-0.033015
Adjusted R-squared	0.648792	S.D. dependent var	5.412734
S.E. of regression	3.207739	Akaike info criterion	5.185007
Sum squared resid	627.6651	Schwarz criterion	5.219316
Log likelihood	-159.7352	Hannan-Quinn criter.	5.198478
Durbin-Watson stat	2.161453		

Null Hypothesis: D(IPC) has a unit root
Exogenous: Constant, Linear Trend
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.875242	0.0000
Test critical values:	1% level	-4.113017	
	5% level	-3.483970	
	10% level	-3.170071	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(IPC,2)
Method: Least Squares
Date: 11/24/21 Time: 10:20
Sample (adjusted): 2004Q3 2019Q4
Included observations: 62 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(IPC(-1))	-0.757426	0.128918	-5.875242	0.0000
C	0.164625	0.095348	1.726570	0.0927
@TREND("2004Q1")	0.018977	0.003972	4.777101	0.0000

R-squared	0.369804	Mean dependent var	0.033595
Adjusted R-squared	0.348442	S.D. dependent var	0.434996
S.E. of regression	0.351125	Akaike info criterion	0.791831
Sum squared resid	7.274054	Schwarz criterion	0.894757
Log likelihood	-21.54675	Hannan-Quinn criter.	0.832242
F-statistic	17.31084	Durbin-Watson stat	2.088091
Prob(F-statistic)	0.000001		

Null Hypothesis: D(TMM) has a unit root
Exogenous: None
Lag Length: 0 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-4.322631	0.0000
Test critical values:	1% level	-2.602794	
	5% level	-1.946161	
	10% level	-1.613398	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(TMM,2)
Method: Least Squares
Date: 11/24/21 Time: 00:54
Sample (adjusted): 2004Q3 2019Q4
Included observations: 62 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(TMM(-1))	-0.468986	0.108496	-4.322631	0.0001

R-squared	0.234487	Mean dependent var	-0.000164
Adjusted R-squared	0.234487	S.D. dependent var	0.258684
S.E. of regression	0.226332	Akaike info criterion	-0.117632
Sum squared resid	3.124792	Schwarz criterion	-0.083323
Log likelihood	4.646579	Hannan-Quinn criter.	-0.104161
Durbin-Watson stat	1.875420		

Null Hypothesis: D(NEER) has a unit root
Exogenous: None
Lag Length: 2 (Automatic - based on SIC, maxlag=10)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-2.933132	0.0040
Test critical values:	1% level	-2.604073	
	5% level	-1.946348	
	10% level	-1.613293	

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

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(NEER,2)
Method: Least Squares
Date: 11/24/21 Time: 08:20
Sample (adjusted): 2005Q1 2019Q4
Included observations: 60 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
D(NEER(-1))	-0.429212	0.146332	-2.933132	0.0048
D(NEER(-1),2)	0.056198	0.133885	0.419748	0.6762
D(NEER(-2),2)	-0.330420	0.124594	-2.651972	0.0103

R-squared	0.381831	Mean dependent var	0.061797
Adjusted R-squared	0.360141	S.D. dependent var	1.932328
S.E. of regression	1.545692	Akaike info criterion	3.757527
Sum squared resid	136.1823	Schwarz criterion	3.862244
Log likelihood	-109.7258	Hannan-Quinn criter.	3.798488
Durbin-Watson stat	2.159065		

Taylor rule and FX intervention equations

Dependent Variable: DTMM
Method: Least Squares
Date: 11/17/21 Time: 15:54
Sample (adjusted): 2005Q2 2019Q4
Included observations: 59 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.002097	0.030917	0.067811	0.9462
DTMM(-1)	0.536336	0.112434	4.770238	0.0000
DINF14	0.115885	0.066678	1.737988	0.0879
DGROWTH	0.007505	0.006774	1.107922	0.2728
D_REER	-0.022231	0.015788	-1.408156	0.1648

R-squared	0.354562	Mean dependent var	0.047788
Adjusted R-squared	0.306752	S.D. dependent var	0.269647
S.E. of regression	0.224512	Akaike info criterion	-0.068834
Sum squared resid	2.721912	Schwarz criterion	0.107228
Log likelihood	7.030613	Hannan-Quinn criter.	-0.000107
F-statistic	7.416022	Durbin-Watson stat	1.950602
Prob(F-statistic)	0.000078		

Dependent Variable: FX
Method: Least Squares
Date: 11/24/21 Time: 08:40
Sample (adjusted): 2010Q2 2019Q4
Included observations: 39 after adjustments

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	514.3747	146.3311	3.515144	0.0013
FX(-1)	0.357945	0.148849	2.404762	0.0220
LAG_REER	261.3029	153.4376	1.702992	0.0980
DEV_REER	294.9353	156.1786	1.888449	0.0678
DEV_REER(-1)	292.2234	155.5278	1.878915	0.0691
DIR	0.064279	0.033364	1.926633	0.0627

R-squared	0.439503	Mean dependent var	525.3590
Adjusted R-squared	0.354579	S.D. dependent var	323.1638
S.E. of regression	259.6236	Akaike info criterion	14.09698
Sum squared resid	2224346.	Schwarz criterion	14.35291
Log likelihood	-268.8911	Hannan-Quinn criter.	14.18881
F-statistic	5.175267	Durbin-Watson stat	2.212738
Prob(F-statistic)	0.001295		

VAR construction Tests

VAR Lag Order Selection Criteria
Endogenous variables: DIPI DIPC DTMM DNEER DFX
Exogenous variables: C
Date: 11/24/21 Time: 08:46
Sample: 2004Q1 2019Q4
Included observations: 34

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-405.0658	NA	20582.97	24.12152	24.34598*	24.19807
1	-368.5084	60.21228*	10624.87	23.44167	24.78846	23.90096*
2	-341.8513	36.06550	10671.74	23.34419	25.81330	24.18623
3	-311.2840	32.36530	10195.45*	23.01671	26.60814	24.24149
4	-279.3673	24.40690	12783.44	22.60984	27.32360	24.21737
5	-246.5975	15.42109	32560.84	22.15279*	27.98888	24.14307

* 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 Residual Heteroskedasticity Tests (Levels and Squares)
Date: 11/24/21 Time: 08:48
Sample: 2004Q1 2019Q4
Included observations: 38

Joint test:

Chi-sq	df	Prob.
140.3992	150	0.7012

VAR structural estimates

Structural VAR Estimates
Date: 11/05/21 Time: 11:29
Sample (adjusted): 2010Q3 2019Q4
Included observations: 38 after adjustments
Estimation method: Least squares via Gauss-Newton (analytic derivatives)
Convergence achieved after 7 iterations
Structural VAR is over-identified

Model: Ae = Bu where E[uu']=I

A =

1	C(3)	C(5)	0	0
C(1)	1	C(6)	0	0
C(2)	C(4)	1	0	0
0	0	0	1	C(8)
0	0	0	C(7)	1

B =

1	0	0	0	0
0	1	0	0	0
0	0	1	0	0
0	0	0	1	0
0	0	0	0	1

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	-0.013276	0.049869	-0.266211	0.7901
C(2)	0.009063	0.050856	0.178208	0.8586
C(3)	-1.734577	0.399612	-4.340654	0.0000
C(4)	2.220300	0.296014	7.500664	0.0000
C(5)	-2.085002	0.708321	-2.943583	0.0032
C(6)	-3.909340	0.497864	-7.852218	0.0000
C(7)	21.29853	0.082372	258.5668	0.0000
C(8)	0.000779	0.000579	1.346142	0.1783

Structural VAR Estimates
Date: 11/07/21 Time: 13:02
Sample (adjusted): 2010Q3 2019Q4
Included observations: 38 after adjustments
Estimation method: Least squares via Gauss-Newton (analytic derivatives)
Convergence achieved after 15 iterations
Structural VAR is over-identified

Model: Ae = Bu where E[uu']=I

A =

1	0	0	0	0
0	1	C(3)	0	0
0	C(1)	1	0	0
0	0	0	1	0
0	C(2)	C(4)	C(5)	1

B =

1	0	0	0	0
0	1	0	0	0
0	0	1	0	0
0	0	0	1	0
0	0	0	0	1

	Coefficient	Std. Error	z-Statistic	Prob.
C(1)	2.229701	0.302387	7.373672	0.0000
C(2)	90.91332	0.384487	236.4534	0.0000
C(3)	3.955374	0.622938	6.349550	0.0000
C(4)	310.1792	0.753937	411.4128	0.0000
C(5)	39.82034	0.092340	431.2365	0.0000

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