INSTITUT DE FINANCEMENT DU DÉVELOPPEMENT DU MAGHREB ARABE

معهد تمويل التنمية
للمغرب العربي

End of Studies Project

Topic :

Management of Foreign Exchange Reserves : A focus on the Central Bank of Tunisia

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BCT

Scholium

"The reserve currency role seems to add prestige to an area and some people."

Robert C. Solomon

ACKNOWLEDGEMENTS

This work is carried out within the framework of the end of studies project of the Institute of Financing the Development in Arab Maghreb. It has benefited from the guidance and the assistance generously offered by a wide range of people. Therefore, I wish to acknowledge my regard to them.

*First and foremost, I would like to thank **God** Almighty for giving me the strength, knowledge, ability and opportunity to undertake this research study and to persevere and complete it satisfactorily. Without his blessings, this achievement would not have been possible.*

*I would like to express my recognition to my main supervisor professor **Dorra HMAIED** for her valuable assistance and her constructive advices during this journey.*

*I am deeply indebted to **the administration of IFID** for providing wholehearted encouragements and guidance seeking to come up with the best professional training in the field. Therefore, I must also thank the set of teachers and trainers for providing precious enlightenments, sharing their experiments, and giving inspiration in my quest of knowledge.*

I would like to express my gratitude to the head of the Department of the Management of Foreign Exchange Reserves and Markets Mr. ***Bechir TRABELSI****. Without his great help, this work would never have seen the light. Thanks to him, I have had been involved in a project held by the Central Bank of Tunisia. I owe to his respect the precious time given to me to discuss my results and the valuable suggestions provided by him.*

I am deeply thankful to Mrs. ***Houneida HARZALLAH*** *for her guidance and precious time devoted to me along my final internship in the Central Bank of Tunisia. In this regard, I am most grateful to all the persons who belong to the concerned department for their friendliness and encouragements.*

I would also to express my deepest appreciation to Mr. ***Dhafeur HMAISSIA*** *who showed boundless support and encouragement during my journey toward this degree. Moreover, I would like to extend my deepest gratitude to the staff of the Central Bank of Tunisia for their heartfelt support and their invaluable guidance during different internships that subscribe to my studies in IFID*

Finally, I have a great pleasure in acknowledging my gratitude to the ***members of the jury*** *for agreeing to evaluate my work.*

DEDICATION

Nobody has been important to me in the pursuit of this journey than my family; I would like to express my heartfelt gratitude to them for their unconditional love and support.

Special thanks to the pearl of my world; to my father, the one who taught me the value of hard work with my own deeds. The one who let me feel secure and give me the recognition every daughter desperately needs and the courage to go out and explore the world.

I would like to thank you and I know it would never be enough.

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LIST OF ABBREVIATIONS

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
BRICs	Brazil, Russia, India and China
CBT	Central Bank of Tunisia
CCAPM	Consumption Capital Asset Model
COFER	Currency Composition of Foreign Exchange Reserves
DW	Durbin test
ECB	European Central Bank
EFF	Extended Fund Facility
EUR	Euro
FPE	Final Prediction Error information criterion
FX	Foreign Exchange
GBP	Sterling pounds
GDP	Gross Domestic Product
HQ	Hannan-Quinn information criterion
ICT	Information and Communication Technology
IPFER	Investment Policies for Foreign Exchange Reserves
IMF	International Monetary Fund
IR	International Reserves
JPY	Japanese Yen
LR	likelihood ratio Information criterion
NIS	National Institute of Statistics
OLS	Ordinary Least Squares
PPA	Purchasing Power Parity
RAMP	Reserves Advisory and Management Program
RBA	Reserve Bank of Australia
REER	Real Effective Exchange Rate
RMB	Chinese Renminbi
TMM	Tunisian Money Market rate
SWIFT	Society for Worldwide Interbank Financial Telecommunication
SDR	Special Drawing Rights

SUR	Seemingly Unrelated Regression
US	United States
USA	United States of America
VECM	Vector Error Correction Model
VIF	Variance Inflation Factors

INTRODUCTION

The foreign exchange reserves management is generating a considerable interest among the various issues that are being faced by a great number of central banks around the world (Roger, 1993). It is considered as a key tool detained by authorities in drawing the monetary and exchange rate policies. Nevertheless, if these national external holdings are poorly managed, the national economic policy will be jeopardized; hence, severe damages will touch national balances besides financial losses that will burden assets themselves. Nugée (2000) emphasized this belief through stating: "… *the management of official reserves assumes a doubly important role for the authorities: in many cases not only is a large amount of money at stake, but also significant elements of national economic policy*." This concern draw the attention especially aftermath of the Asian crisis in the late of 1990s; East Asian Economies had gone through a rough time because of lack of liquid foreign assets to face financial markets havoc. In the wake of this crisis, the level of foreign exchange has risen dramatically reflecting a growing need of self-insurance against crisis (Allen and Hong, 2011). This assumption has been confirmed in 2008-2009 global financial crisis since countries showing high level of reserves better resisted to the aftereffects of this global turmoil; Brazil and Mexico has drawn the best examples. To further illustrate, according to the International Monetary Fund, the value of foreign exchange reserves has grown from 1 389 816, 59 million dollars in 1995 to 11 441 121, 34 million dollars in 2017, although the investment environment for central banks is characterized by low returns on main reserves assets.

All these considerations emphasized the vitally important role of international reserves management in cushioning the effects of crises, as well as to keep the economic aggregates balanced. Correspondingly, central issues about two important aspects must be solved; the needed amount and the currency composition of foreign exchange reserves that shall be held by authorities (Roger, 1993). Within the framework of these interrogations, the present investigation broaden current knowledge about the Tunisian foreign exchange reserves. The latter arouse widespread concerns especially in last years. In fact, the level of foreign exchange reserves was always above the international benchmark of three months imports providing a safety cushion, as well as playing the role of a guarantee for external borrowers. However, in last years, the worsening external deficits have eroded foreign exchange reserves to reach critical levels questioning the capacity of Tunisia to meet external liabilities. Following this

insight, we aim to understand the demand of international reserves of Tunisia by highlighting the most important influencing factors. On that understanding, we seek to define the function demand of main currencies in order to define adequate composition. The latter aims to ensure the best use of foreign holdings in a context of reserves drain. We believe that these issues are a topic of current interest since understanding the foreign exchange reserves management in these crucial circumstances would strengthen the respect and the confidence of the public in official policies. Despite the importance and the urgent need to deal with those two aspects, to the best of my knowledge, few are researchers that addressed questions about the management of foreign exchange reserves of Tunisia; hence, our work is considered the pioneer that deals with those both aspects.

Within this intriguing context, we try to draw the landscape of foreign exchange reserves of Tunisia by responding to these following detailed research questions:

1) *What are the most influential factors on the demand of Tunisian foreign exchange reserves?*
2) *How the Central Bank of Tunisia manages the currency composition of its foreign exchange reserves?*

Responding to these questions starts by highlighting the determinants of the level of foreign holdings by dressing the long run relationship as well as defining the speed of adjustment to ensure the return to equilibrium with its major determinants; this question would be answered thanks to monetary approach to balance of payments theory. Yet, a rigorous management of foreign exchange reserves is not restricted on defining the amount, choosing the appropriate form is also important since it ensures the optimal use of these national foreign funds. Therefore, it is pivotal first to gain a deeper understanding on how basis Central Bank of Tunisia manage such currency composition. This goal can be achieved thanks to three undelaying approaches; firstly, the mean-variance theory that consider the Central Bank as an investor that seeks income generation; secondly, the transaction cost theory justified by the exceptional statute of the central bank as an investor; and finally, the intervention approach based on initial motives of holding reserves.

In order to shed the light on Tunisian foreign exchange reserves management and get a better understanding of the most influential factors that shape the management of foreign holdings, our study will be outlined as follows.

The first chapter provides an overview on foreign exchange reserves and its management; it underlines the motives of holding international reserves and the importance of an appropriate framework that serve to conduct a successful management of reserves. The latter will serve to settle the best practices that will preclude the speculative behavior. Moreover, we will draw the attention to the perpetual conflict between the leading reserves currencies to have the position of supremacy. Afterwards, we will exhibit the actual trend of the currency composition of foreign exchange reserves.

In the second chapter, we propose to settle our theoretical framework and exhibit in detail the empirical literature review. This part will establish the background for our empirical analysis that will be conducted in the later chapter. For our first research question, the theoretical body referred to two approaches: The theory of optimal international reserves and the monetary approach to balance of payments. Turning to the second research question that is underlying by mean-variance approach, the transaction cost approach, and the intervention approach. These methods have the privilege on questioning the statute of the central bank as an investor that run a national wealth.

Our third chapter will focus on the Tunisian foreign exchange reserves management. In our empirical investigation, we seek to define the determinants of the level of foreign holdings detained by the Central Bank of Tunisia, as well as to spell out the currency composition of these foreign holdings in the aim of compiling the currency demand functions relative to the main reserves currencies. Subsequently, a comparison between the estimated composition and the existing one will take place. The results of this chapter will cast the light on the statute of the Central Bank of Tunisia and its priorities in reserves management.

CHAPTER I:

FOREIGN EXCHANGE RESERVES COMPOSTION AND MANAGEMENT: AN OVERVIEW

CHAPTER I: FOREIGN EXCHANGE RESERVES COMPOSITION AND MANAGEMENT: AN OVERVIEW

Introduction

Foreign exchange reserves management is a crucial subject, which has started generating a considerable interest among the range of issues that faces many central banks. Elementary questions about the amount and the form of reserves have become so pressing because of the growing accumulation of reserves assets by several countries. Responding to these questions is not obvious neither conclusive; foreign exchange reserves is a complex and time-consuming business. It seeks clear objectives, adequate organizational framework, effective control systems, and open and transparent communication about different constraints faced. To outline its importance, if foreign exchange reserves were conducted openly and successfully, the public's respect and confidence in official policies would greatly strengthen.

In the light of these considerations, in this chapter, we will try to respond to different ambiguities that are related to foreign exchange reserves management by the guardianship authority. Hence, we will start by defining foreign exchange reserves and the motives of detention. Then, we will shed the light on the principles, the best practices and the appropriate framework that are highly recommended to conduct a successful management of foreign currency holdings. Finally, we will focus on the currency composition of foreign exchange reserves; starting by exposing the history of this field especially the perpetual conflict in the aim of being the leading currency, afterwards, we will display the actual trend of the currency composition of foreign exchange reserves.

Section 1: Generalities on foreign exchange reserves

1- Definition of foreign exchange reserves

Foreign exchange reserves are well known as the national assets denominated in different foreign currencies and one of the most important elements that guarantee the liabilities of each country in international financial markets. In the lights of its momentousness, the definition of foreign exchange reserves is a crucial step to estimate it. Fortunately, no disagreement exists on what could be since all the central banks around the world refer to the definition provided by the International Monetary Fund (IMF).

The term of foreign exchange reserves is generally understood as the total country's foreign currency deposits and bonds owned by monetary authorities. Yet, this term often indicates the sum of a country's gold holdings, convertible foreign currencies detained in its banks, Special Drawing Rights (SDR) and exchange reserve balances with International Monetary Fund (Nasdaq.com).

International Monetary Fund (1993) defines international reserves (IR) as those external assets that are rapidly available and managed by monetary authorities in order to finance balance of payments requirements. IR is used, also, to affect currency exchange rate through intervention in exchange markets. Finally, they are serving as a basis point for borrowing and maintaining confidence in the currency and the economy.

International Monetary Fund (2013) has made a group of criterion that must be respected in order to be classified as a reserve asset, which are published in its "*International Reserves and Foreign Currency Liquidity Guidelines for a Data Template* ". A reserve asset has to be a claim on a nonresident or in gold bullion of significant purity. It insisted on the liquidity criteria, this asset must be detained or effectively controlled by the guardianship authority, rapidly available in emergency cases and denominated in convertible foreign currency used freely to settle transactions around the world. Unfortunately, not all the elements of reserve assets' definition can be applied objectively because some of them need an informed judgment. The guidelines of 2013 provide this example; "*determining whether a claim is on a nonresident usually can be determined objectively. However, determining whether a claim is sufficiently liquid to qualify for reserve asset classification is partly judgmental*".

2- Motives of holding a foreign exchange reserves

A growing body of literature has investigated the motives of holding foreign exchange reserves. These motives have been distinguishing based on the empirical review perception toward the central banks. Starting from considering the guardianship authorities as an investor, then underscoring its role to finish by the recap presented in the IMF (2013).

2-1- The Central Bank as an investor

This approach is based on assimilating central banks reserves to individual normal holdings, as well as the central banking authority to normal investor, with some vigilance (Roger, 1993). Those motives are essentially transaction, precaution and investment.

- Transaction needs: This motive differs from developing countries to developed ones. The latter has access to international capital markets; consequently, this use of international reserves becomes a minor priority. However, this is not the case for developing countries. In such cases, they refer to reserves instead of borrowing to finance current accounts deficits. This motive is taken into consideration thanks to studies that used IMF confidential data (Dooley et al., 1989; Eichengreen and Mathieson, 2000.; Heller and Knight, 1978) or publicly available aggregates (Chinn and Frankel, 2007, 2008) and they proved the substantial role of central banks currency choices.

- Intervention needs: This is so far the most important need and that corresponds to precaution motive. Detaining international reserves allow central banks to implement monetary policy and to enhance confidence in national currency.

- Wealth diversification and investment needs: This motive does not focus on reserves accumulation, but on reserves currency composition. This role is emphasized by the obligation of the central bank to manage external currency positions. Actually, the guardianship authority looks to maximize return for a given amount of risk except they have a smaller appetite to risk, contrary to normal investors.

2-2- Precautionary versus Mercantilist views

This category of distinction focuses on the main role of holding foreign exchange reserves that differs from one country to another. Those motives provide some sort of a guideline in order to determine the adequate level (Aizenman and Lee, 2005; Ranciere and Jeanne, 2006). For instance, the existing literature conducted mainly by (Aizenman and Marion, 2003; Aizenman and Lee, 2005; Kim et al., 2007) allocates the different motives into two groups; namely mercantilist and precautionary motives.

- ***Precautionary motive***: This motive outlines the defensive role of international reserves against harmful effects of potential random shocks to the country's external balances. This opinion is confirmed by Aizenman and Lee (2008); they suggest hoarding foreign exchange reserves so that the monetary authority would be able to cushion the impact of a sudden lack of foreign currency in the future. This self-insurance motive emphasize; First, on the well-known role of the foreign exchange reserves to maintain investor confidence and to protect the country from currency crisis as it is mentioned by Fisher

(2001). Second, on the collateral role as a guarantee for external liabilities as treated by De Beaufort Wijnholds and Kapteyn (2001).

- ***Mercantile motive***: This motive is a well-known contender to precautionary view. As mentioned by Dooley, Folkerts-landau and Drive (2003), the accumulation of international reserves is instigated by worries about export competitiveness, especially in the context of China. The groundbreaking explication is that hoarding foreign currency reserves impede and tone down appreciation, with ultimate aim to enhance export growth. However, this motive is debatable since this interpretation is valid only to the most East Asian countries during special circumstances. Moreover, this policy conducted negative effects on trading partners.

2-3- Motives as perceived by the IMF

The IMF (2013) summarized the different motives that may encourage countries to hold international reserves. The rationale of detaining foreign currency reserves is justified by different objectives, which are:

- The intervention need to support the national currency; the central bank authority looks after supporting and maintaining confidence in its policies for the sake of monetary and exchange rate management.
- The self-insurance motive against potential vulnerabilities; the primordial role of foreign currency reserves is absorbing shocks during times of crisis, or when access to borrowing becomes curtailed.
- The notoriety of the country in financial markets; foreign exchange reserves work as a guarantee to foreign funders. In other words, IR provides a level of confidence that a country can meet its current and future external engagements.
- The backing of domestic currency by external assets, thereby governments are assisted to meet foreign exchange needs and external debt obligations.
- Reserves of foreign exchange currency serve as safety cushion in case of national disasters or emergencies.

This panoply of motives subscribe into the same logic, which is the guarantee to meet up liabilities in normal or urgent circumstances. The level and their composition are the key parameters to keep the notoriety of the country.

3- Measures of adequacy

The adequacy of reserves level is among the most widely investigated question since they proved their efficiency in times of turmoil. The nineties were characterized by the presence of many financial crises that resulted in the accumulation of a massive level of international reserves (Green and Torgeson, 2007). Consequently, questions about the adequate level of reserves, that serve to cushion the impacts of crises, were attracting a widespread interest. Common minimum thresholds that ought to be respected were necessary to adopt, in particular the Greenspan-Guidotti rule. The latter has identified three metrics that has the privilege of being simple and transparent (International Monetary Fund, 2011), which are:

3-1- Import Coverage Ratio

This measure is defined as the number of months imports during which a country can honor its external engagements when the balance of payments inflows cease; this assumption seems drastic, yet, plausible for the poorest country (International Monetary Fund, 2011). Usually, this benchmark is defined as three months coverage of *prospective* imports.

3-2- Reserves to broad money

This measure is not considered a firmly based metric despite the fact that it proved its utility for countries threatened by potential capital flights (Green and Torgeson, 2007). The appropriate level is in the interval of 5% and 20% based on the exchange rate arrangement. This indicator is a scale of the confidence of external parties in the domestic currency; when this ratio increases, their confidence rises (Green and Torgeson, 2007)**.**

3-3- Reserves to short term debt

This measure is among the benchmarks that are widely used in capital markets as described by Fisher (2001)**.** This Greenspan-Guidotti rule defines the adequate level of reserves as the amount that is able to cover 100 percent of short-term debt. However, this metric is criticized because countries require a higher level of reserves for other reasons besides debt as the size and the currency composition of total external debt, and exchange rate arrangement (Kumail et al., 2011).

Table I.1:Conventional criteria of foreign exchange reserves adequacy

Criteria	Benchmark value
Import coverage ratio	Three months imports
Reserves to broad money	[5%; 20%]
Reserves to short term debt	100%

Source: International Monetary Fund (2011)

Section 2: Foreign Exchange Reserves management in Central Banks

1- Central Bank: an exceptional investor

The status accorded to central banks around the world as a monetary authority and the first responsible for the management of foreign exchange reserves, draw an exceptional investment profile for them. Opposing to normal investors, the guardianship authority is characterized with a high-risk aversion and an ultimate desire to have *available* and *liquid* assets especially during periods of crisis. Indeed, the allocation of international reserves is done according two principals:

- Wealth preservation; this standard aims protecting detained reserves against volatility in terms of the home currency. Consequently, authorities proceed, first, to diversification across many currencies, second, to invest in high-quality assets that offer stable returns. Therefore, *ceteris paribus*, the central bank ensures that the value of reserves is maintained and available in case of necessity.

- Liquidity preservation; defined by Gintschel and Scherer (2004) as the capacity to meet the country's need in the short run by holding sufficient reserves. They insists on the fact that the more adequate the structure of international reserves to these payment imbalances, the less credit risk present the country.

Regarding those two approaches, the existing literature on currency allocation (Ramaswamy, 1999; Scherer, 2002; Boorman and Ingves, 2008) focused on the optimization of the foreign exchange reserves currency composition considering either one of those principals.

2- Reserve management objectives, scope, and strategy coordination

The ultimate reason for detaining reserves is to protect the country against rainy days and to cushion unpredictable crisis. However, objectives, practices and trends may differ within reserve management regarding circumstances of each country.

2-1- Objectives: Liquidity, return and safety

The last decades witnessed unprecedented growth in global reserves size. This fact boosted many authors to treat reserves management subject since these "public funds" must be ran prudently and safely. As pointed by Morahan and Mulder (2013), whom investigated reserves management practices, they proved that reserves managers are obliged to take decisions that may influence their choices, yet, they must ensure these vital goals, which are:

- Liquidity: this goal is motivated by the sudden need that may arise.
- Capital preservation: it is fully justified by the nature of reserves; they represent the national deposit.
- Income generation: it aims to take profit from reserves size and minimize the cost of detaining foreign holdings.

The recent global financial crisis has sharply changed the hierarchy of objectives followed by reserves managers. Objectives priority has shifted from returns to liquidity; whereas earlier studies focused on return generation (Rigaudy, 2000)**,** the more recent-ones highlighted the emergence of liquidity as a primary objective for foreign holdings management (Hansen, 2009).

According to International Monetary Fund (2013), reserves management objectives are very sensitive to official economic policies and specific circumstances. Consequently, in the aim of ensuring the availability of reserves at the times of crisis, the hierarchy of objectives are organized as follow; liquidity comes on the top of the hierarchy of objectives. Capital preservation is in the second place and it aims to protect assets values by controlling different risks. Finally, return generation comes at the last place, although investments incomes ensure minimizing the carrying costs of reserve assets. Hence, it is highly recommended to achieve an acceptable level of investment with the condition of defining adequate level of liquidity and clear risk constraints.

In sum, reserves managers are highly recommended to seek the preservation of reserves value, within a prior defined prudent risk limits, so that they ensure availability of reserves when they are needed. Therefore, their priority is liquidity and safety before incomes or cost considerations. They are in a permanent trade-off between risks and returns when they set reserves management priorities.

2-2- Scope

Reserves management field, as defined by International Monetary Fund (2013), is the official public sector foreign assets controlled by monetary authorities and available in case of need. It may include the management of liabilities and the utilization of derivative financial instruments. In the latter respect, nowadays many central banking authorities use derivatives in the aim of diversification, improving liquidity or hedging against different risks.

2-3- Strategy coordination

Reserves management strategies are not elaborated independently of the external circumstances (International Monetary Fund, 2013). In fact, they should be coherent with the country's or the

union's specific stratagem, especially those related to monetary and exchange arrangements[1]. In the context of free float regime, the reserve management entity has a greater liberty in structuring its portfolio, contrary to fixed exchange rate and intermediate exchange rate regimes.

Moreover, the guidelines of the IMF insist on evaluating alternative reserve management strategies and their reserves implications in order to identify reserves adequacy. They outline the necessity to take into consideration strategies adopted to manage external debt, mainly if the latter and reserve management are entrusted in the same authority, so that external vulnerabilities are curtailed and clear signals are sent out to subnational authorities. Finally, IMF (2013) points out the importance of diversification in order to guarantee the precautionary need and improve the risk-return profile of the portfolio.

3- Governance and Institutional framework

The governance structure is the corner stone for a prudent reserves management; it is established to ensure accountability and to rule out speculative behavior. Weak or risky reserves management practices may cause considerable reputational or monetary losses. As example, Asian central banks were engaged in speculative investments in the 1990s that result into losing 90 percent of funds invested in some instances (Rigaudy, 2000).

In the lights of above considerations, the governance structure must provide policies and guidelines to conduct reserves management; they contain recommendations about tranching and currency composition of reserves, risk management, performance measurement and external management program.

3-1- International recommendation

a) Legal foundation

The International Monetary Fund (2013) recommends; "*Sound institutional and governance arrangements should be established through a legislative framework that clearly establishes the reserve management entity's responsibilities and authority*." In other words, reserves management should operate through an institutional framework. The latter must contains clear identification of responsibilities in the aim of ensuring good governance and accountability as

[1] IMF guidelines distinguishes three regimes ; firstly, free float regime in which authorities are committed not to operate in foreign exchange market; secondly, secondly, fixed exchange rates regime in which authorities intervene often in foreign exchange market; and last intermediate exchange rate regimes that demand the intervention of authorities in favor of the arrangement.

well as ensuring effective and efficient reserves management. Appropriate documentation and clear legislation coupled with public disclosure improves transparency and accountability.

b) Internal governance and organizational structure

Given the importance of internal governance and organizational structure, they must be steered by the principals of clear allocation. In fact, to ensure a well-defined organizational structure from the very top to operational levels of reserves management entity, different responsibilities and accountabilities must be separated and guided by clear objectives, as well as clear rules for authority delegation. The IMF (2013) suggests that the latter must be complemented by committee structure to ease decision-making.

The investment management is the central core of reserves management activities; it is subsequent activities that include the initiation of reserve transactions (front office), the control of risk limits (middle office) , the arrangement of transactions settlements (back office), and the maintaining of financial accounting records (accounting department). However, these operational activities are held in the spectrum of reserves management strategies.

The implementation of investment strategies is generally delegated to investment committee; it is generally headed by board member or high-ranking responsibility of reserves management (International Monetary Fund, 2013). It is in charge of detailing the operational side of reserves management, implementing investment strategy and portfolio benchmarks, and reviewing performance regularly. It may assess the inclusion of new investments procedures or the inclusion of new instruments based on the ability of existing staff and systems to handle with these new proposals.

A good governance structure must ensure the separation between the investment management and risk control activities. This separation has the advantage of easing the identification, monitoring and management of different risks. Within the risk control operational framework, reserves management entity have to identify different risks, setting up appropriate systems of guidelines and limits, establishing risk management measures to guarantee daily controls.

Moreover, in designing the governance structure, it is crucial to take into account the interaction between reserves management and other functions of central banks so that they avoid unwanted signaling effects. However, challenges may arise and reserves management activities may interfere in other central bank operations; International Monetary Fund (2013) provides this example of a potential interference "… *this may occur when the reduction of exposures to*

certain counterparties or issuers in crisis situations is assessed differently from an investment of financial stability perspective." Therefore, governance structures must make an early identification of these potential interferences and address them to the right hierarchical levels.

The appropriate governance structure is highly related by the role played by the staff of reserves management. In the regard of the latter, they ought to be qualified and well trained; first, they should have the required knowledge about market practices and instruments, this must be coupled to procedures that ought to be followed for settlement, resolution of disputes or differences based on sound business practices. The staff must be aware of different risks, as well as control system in which they operate, otherwise the failure can cause significant financial losses and may blacken the reputation of reserves management unit. In the light of these considerations, staff must be subject to a code of conduct to allay different concerns about the potential danger of personal financial interests, in addition to resolve probable conflict of interest. However, to ensure the efficacy and the efficiency of staff, they must be supported by reliable information and reporting systems. In addition, the governance structure has to provide business continuity policies in order to mitigate risks related to failures in operating systems, or even calamitous events. Finally, to ensure the assessment of different procedures and monitoring systems, an independent internal audit has to check compliance with the institutions policies and guidelines and report it to the Board or the top management.

3-2- The Central Bank of Tunisia organizational structure

According to the status of the Central Bank of Tunisia of 25 April 2016, the management of foreign reserves is within its purview. The governance of the Central Bank of Tunisia is assumed by the Governor suggested by the President of the Republic and nominated by Assembly of Peoples' Representatives, Board of Directors, and a censor who is appointed by decree, respectively.

In the Central Bank of Tunisia, strategic decisions on overall objectives and principles of reserves management policies as well as the different guidelines related to operational framework are ran by the Governor on the proposal of concerned departments. The main role of managers of reserves managers is ensuring the adequate application of operational guidelines; hence, senior managers are kept informed of all deals done daily and the Governor weekly.

The Central Bank of Tunisia is aligned with international recommendations about organizational structure: There is an explicit separation among front office, back office (each of them is related to an independent department), and the entity of SWIFT. Tracking treasury orders is checked immediately by the back office. The Central Bank of Tunisia adopts prudent management since all the limits (credit limits, permissible instruments, etc.) are controlled by the chief dealer, the back office, senior management, the banking relations departments, and the Governing Board through frequent reporting.

4- Reserve management guidelines

Foreign exchange reserves represent the foreign public fund detained by a nation; therefore, its management practices and policies reinforce the prudence and risk aversion in different investment activities to avoid potential losses and keep them to meet different needs. Regarding to their importance, governments and the guardianship authority are in perpetual trial to strengthen their reserves management framework in order to help the country to increase its resilience to financial crisis. To ensure these objectives, the central banking authorities are trying to provide different supporting systems and processes in favor of its staff, ensure transparency and accountability and follow the best practices in the field.

4-1- Systems and processes

Reserves management is a crucial mission that requires supporting systems to ensure reserves management and to meet fixed objectives. They are often market information systems that guarantee a permanent access to information connected to different financial markets around the world, portfolio management systems for the need of analytics and reserves management, in addition to accounting systems. Information and Communication Technology (ICT) systems are mainly Bloomberg, Reuters or both to ensure the management process, yet some central banks develop their internal systems. The *IMF guidelines (2013***)** highlight the importance of these systems to keep reserves managers aware of potential risk, and thus, mitigating the impact of a potential financial crisis.

4-2- Transparency and accountability

Transparency and accountability are vital requirements in reserves management; consequently, the international norms recommend pursuing clarity of objectives, roles, and reserves management practices. Moreover, they insist on the availability of information to the public and demand strongly to communicate statistics about foreign exchange reserves on a regular basis, as well as the disclosure of general principles for internal governance. In an international

level, these main issues are treated by the *IMF's Code of Good Practices on Transparency in Monetary and Financial Policies: Declaration of Principles*; this code looks for enhancing transparency practices for central banks in their conduct of monetary and financial policies. In doing so, it provides a plethora of recommendations concerning transparency practices related to foreign exchange policies, reserve management, and foreign exchange market operations. Its ultimate goal is to promote to transparency thanks to accountability.

4-3- Best practices

The existing literature outlined the role played by best practices to improve the country's resilience to external shocks; these practices are supportive, but not substitutive, to a sound macroeconomic management. Moreover, inappropriate fiscal, monetary exchange rate, or financial policies may endanger reserves management. Hence, central bank authorities around the world may refer to the *Guidelines* provided by the IMF; they are meant for voluntary application and may be useful in the context of technical assistance.

Regard to the importance of the best practices, many surveys showed that the majority of central banks are part of World Bank's Reserves Advisory and Management Program (RAMP). The latter aims building human capital and establishing sound investment management. In the line with the international recommendations concerning the composition of reserves, many central banks proceed by tranching reserves according to objectives; we distinguish three tranches of working capital, liquidity and investment.

Section 3: The Composition of Foreign Exchange Reserves; History and Trends

The last century witnessed subsequent leading currencies that had lost their dominant status or sharing global status (Lindert, 1969), and others were appearing as leading currencies reflecting influential political and economic positions. Therefore, in this part, we will trace the historical evolution of the central bank reserves composition starting from the 19th century, when central bank reserves appeared, followed by the different events that marked the 20thcentury especially the two World Wars. In fact, the World War II was a determining event after which the change in geopolitical forces affected the size and the pace of reserves accumulation, as well as the degree of concentration and the distribution of foreign currency reserves that shifted drastically. The need to diversification became urgent for greater part of central banks around the world to protect them against different potential crisis. In the light of those considerations, perpetual contentions between different currencies to keep the leading position have existed.

1- Foreign exchange reserves history

1-1- The history of foreign exchange reserves in the international monetary system

a) The early history of foreign exchange reserves

Our starting point is the mid of the 19th century were reserves, or to be more precise "reserve", are the coins and bars made of precious metals mainly silver and gold. In fact, the issues related to foreign assets holdings seemed rudimentary compared to today. For further explanations, foreign currency reserves were a minor component of central bank balance sheets, and the central bank as public institution did not exist. The majority of them were privately owned government- chartered companies. In addition, the reserves were detained in the form of bullion housed domestically or abroad. The detention of the so-called "reserve" was for monetary purpose; it was a counterparty to the circulation of banknotes. However, this reserve was a zero interest-yielding asset.

This period was characterized by the volatility of commodity prices, hence, many questions raised about the prospect of a central bank running monetary policy in the absence of appropriate rules (Eichengreen and Flandreau, 2014). Therefore, the central bank's mandate was to target inflation and to preserve the value of domestic currency. To do so, two contender views appeared; on the one hand, the Currency school, which confirmed that monetary and banking systems would be most resilient if the creation of the money was tied to specie reserves, the supporters of this school defended the introduction of quantitative targets. On the other hand, the Banking school defended the flexibility of monetary system, as well as limiting the intervention of central banks to mitigate the liquidity needs of the banking and financial systems.

According Eichengreen and Flandreau (2014), the practice of holding foreign exchange bills was the routine in banking circles since the commercial revolution of 15th and 16th century. Thus, every financial center had an active market for bills denominated in foreign currency. Foreign exchange yield were positive in the banking sector, but bullion was zero-yielded. Since the majority of early central banking were owned by private investors, the profit motive became dominant. However, foreign exchange currency was not considered a part of the statutory reserves of central banks because they faced resistance from banking system fearing competition. For them, the role of central banking authority is limited to intervene in order to guarantee liquidity market or during crisis, but not welcomed as a competitor. Moreover, the dominance of this market worked in favor of other banks.

The second explanation presented by the authors was the incapacity of the early central banks to access to information; the management of foreign currency reserves requires information about foreign correspondents, foreign signatures etc..., something that was not the comparative advantage of central banks. Finally, the last argument was the hesitation of law and policy makers to give central banks discretion of risk taking, since they were responsible for the convertibility of the currency. They justified this answer by the eventuality of jeopardizing the value of the currency due to an excessive risk. Thus, profitability was sacrificed for the sake of transparency, security and predictability.

However, the National Bank of Belgium was the first exception (Conant, 1915; Ugolini, 2010, 2012)**.** Founded with the ultimate aim to stabilize the Belgian franc, it engaged from the beginning in the practice of holding foreign exchange reserves. In fact, 1872 was a pivotal date since the statute was modified in order to consider foreign exchange currency as part of its official reserves.

b) The Rise of official reserves before World War I and the appearance of key currencies.

The accumulation of foreign exchange reserves, as opposed to gold and silver, was on a permanent expansion during the period that preceded World War I. This phenomenon was fully justified by the expansion of international trade associated by the market liquidity need, and combined with the stability provided by gold standard (Lindert, 1969)**.**

Thus, the detention of foreign exchange currencies led to the concentration on a handful of currencies named by Lindert "key currencies", which are the pound sterling, the French franc and German mark in descending order of importance, but we have to note that those currencies had exhibited stability in terms of gold. Eichengreen and Flandreau (2014) explained the schema by referring to three arguments

(i) These currencies are the most liquid because they were traded the most in foreign exchange markets.

(ii) The growth of overseas lending; There were an increasing number of bond issuance on behalf of foreign and colonial borrowers in London, Paris and Berlin. These bonds were predominantly denominated in the currency of the lending country (Flandreau and Sussman, 2005).

(iii) The desire to strengthen diplomatic alliances; mainly the French and German governments were satisfied by seeing domestic capital flow to potential allies through their central banks.

This era was characterized by the appearance of the pound sterling as the leading currency; hence, it dominated the composition of international reserves, although French franc was a significant rival. The geopolitical events had given the best explanation; in fact, this epoch defined the United Kingdom as an imperial power that controlled the international trade.

1-2- The rise and the fall of Genoa

The twenties and the thirties were crucial decades for foreign exchange reserves management led by central banks. This period witnessed the rise of the so-called gold-exchange standard, instead of gold standard, and its fall.

a) The after World War I

The situation of reserves differed dramatically compared to prior to 1913; the foreign exchange reserves that had had only 10 percent of the total reserves of central banks and governments (Eichengreen and Flandreau, 2014), became actively demanded by governments to supplement gold. This period, which followed the World War I, knew an increasing level of inflation combined with a considerable inelasticity of gold supplies. Hence, many countries expressed their fear that would be a global gold shortage. As a solution, they preconized the shift towards accumulating foreign exchange as reserve assets as expressed in the two postwar monetary conferences sponsored by the League of nations, in Brussels in 1920 and Genoa in 1922. In the lights of the above considerations, many central banks, especially those in central Europe and Latin America, were restructured or established in order to be allowed to hold foreign exchange as part of their reserves.

The proposition of replacing the gold standard, when a country ties the value of its money to the amount of gold it possessed, with the gold exchange standard [2]was motivated by the economic aftermath of the war, as well as, the British concerns about regaining its position as a monetary center. The British fears were fully justified; the measures of austerity that were obliged to adopt enfeebled its position and created a marketing opportunity for U.S. financial institutions.

[2] It is defined as the monetary system under which a nation's currency is pegged to the U.S. dollar at a stable rate of exchange, but the U.S. dollar is pegged to gold. Hence, a country have the possibility to maintain parity to gold without the obligation to maintain the amount of gold reserve as it is detained in gold standard.

The Genoa conference offered an answer to after-war interrogations; by replacing the gold standard by gold exchange standard, they attempted to systemize the way foreign exchange reserves were managed, and codifying the ad-hoc practices. Resolution n°9 of the report of the Financial Commission of the Genoa Conference announced that the end of the convention would be to "*centralize and coordinate the demand for gold, and so avoid those wide fluctuations in the purchasing power of gold which might otherwise result front the simultaneous and competitive efforts of a number of countries to secure metallic reserves*." In addition, resolution n°11 declared that the "*maintenance of the currency at its constant gold value must be assured by the provision of adequate gold reserve of approved assets, not necessarily gold*."

In 1928, the interwar gold-exchange standard reached its peak; in fact, the share of foreign exchange in the combined gold and foreign exchange reserves of 28 European countries was altogether 42 percent, besides their central bank statutes had been changed in order to authorize to them to hold foreign exchange as a component in their reserves (Eichengreen and Flandreau, 2014). However, the agreement fell apart subsequently like so many other expert recommendations of the time although its ideas had an enduring impact**.**

b) The Sterling Area

Although Sterling pound had been considered as a dominant currency in foreign exchange reserves until after World War II, many authors considered the United States dollar as a rival since the twenties (Eichengreen and Flandreau, 2014). They justified this assumption by the improvement of New York financial markets, the creation of Federal Reserve System, which worked actively to stabilize and to guarantee the liquidity of U.S. dollar market. To promote to the American dollar as a leading currency by developing the dollar denominated bonds market; U.S. commercial banks were authorized for the first time to branch abroad under the provisions of Federal Reserves Act (Chitu *et al.*, 2012).

However, the credibility of the dollar's peg to gold had been questioned due to sterling's collapse (Accominotti, 2009). Given the clouds over the dollar and currencies of the gold bloc, pegging to sterling became attractive, therefore, the desire to detain the British currency increased. In the midst of the general recess of foreign exchange reserves, sterling took the opportunity to expand its position in central banks reserves and to be the leading currency.
The sterling area provided a relatively favorable combination of stability and flexibility, despite the fact, that there were some countries skeptical to diversification during the twenties.

1-3- The Bretton Woods System1945-1973

The Bretton Woods system was defined as the lineal descendent of the gold-exchange standard established in Genoa. It was the best representation of the global coordination; its main outputs were establishing the U.S. dollar as the global currency and giving birth to the World Bank and the International Monetary Fund as the two global organizations that monitor the new system. Thanks to Bretton Woods, the United States of America was nominated to be the dominant power and the only country with the ability to print dollars.

a) The Bretton Woods agreement

The Bretton Woods agreement was the result of the international monetary conference by the World War II at Bretton Woods, New Hampshire in 1944, and which gathered the Allied nations. Although the sterling pound was the most held foreign currency at the early of the Bretton Woods era, the new agreement announced that their central banks would maintain fixed exchange rates between their currencies and the dollar. In fact, the new key currency is considered the U.S. dollar that was convertible to gold, but the other currencies were convertible into dollars. The choice of the dollar was fully justified by the fact that the dollar was freely traded in deep and liquid markets accessible to international investors, institutional as well as private. The new process that would be followed by these countries consisted on buying a given currency in foreign exchange markets if its value became too weak compared to dollar; consequently, the supply would decreases causing the raise of the price. However, in the opposite case, the bank would print more to increase the supply and lower the price.

The principal decision, that the International Monetary conference came up in order to increase the monetary and economic integration, was avoiding any trade warfare; for further explanations, it was prohibited to lower the value of a given currency for the aim of increasing trade. However, the adjustment of the currency was allowed only to rebuild after a war or to protect their economy if a foreign direct investment threatened to destabilize it.

The obvious question to answer is; *why this new arrangement was needed?* The consequences of the World War I and the economic difficulties after war had given the response; until the World War I, most the countries were on the gold standard era, but they left it so they could print the money needed to afford the cost of their wars. Thus, they suffered hyperinflation and the value of the currency decreased drastically. For example, people needed wheelbarrows brimful of cash to have only a loaf of bread. After war, countries returned to the gold standard era. Nevertheless, after the 1929 stock market crash and the raise of interests by the Federal

Reserves, investors focused on commodities and forex trading causing a dramatic raise in the price of gold. Then, there was no wonder counties looked for abandoning the pure gold standard. As a solution, the Bretton Woods system gave these countries more flexibility and less volatility, than one standard at all.

b) The raise of U.S dollar

World War II changed drastically the geopolitical forces around the world, and Bretton Woods System was the consequence. It was driven mainly by a wartime compromise between the United States and the United Kingdom. On financial level, this new system gave rise to new opinions on international liquidity (Ritschl, 2008). The compromise between the two leading forces was mainly ending the trade preferences for British goods for the sake of financial aid from United States of America and acknowledgment to reach full employment. The after World War II marked the United States of America as the prevailing military power and the strongest country economically and financially, hence, it had the best bargaining position. As a result, the agreement establishing the International Monetary Fund was influenced by US views.

In the lights of the above considerations, U.S. dollar was the new leading currency. The United States fixed the value of the dollar in terms of gold; consequently, one troy ounce of gold was valued to $35. On the other hand, the other members of IMF ought to define the value of their domestic currency according to "the par value system" in terms of U.S. dollar or gold. The situation of many European countries conducted the U.S. dollar to be a dominant currency, the majority of them were suffering from debt problems, and thus, they were obliged to send important amounts of gold to the United States to delay payment or to receive offsetting American aid.

c) The collapse of Bretton Woods System

The 1971 was a determining year for the Bretton Woods System; the United States of America was suffering from a combination of inflation and recession. This situation was partly explained by the role played by U.S. dollar as a global currency. To resolve the problem, President Richard Nixon launched the deflation of the dollar's value in gold by revaluating the dollar to 1/38 of an ounce of gold, then 1/42 of an ounce. However, this plan backfired since it created a run on the U.S. gold reserves and the devaluation of U.S. dollar. In 1973, the dollar was a subject of heavy pressure in financial market; hence, Nixon announced the detachment of the value of dollar from gold. Without price controls, the value of gold quickly raised to the level of $120

dollar per ounce. The Bretton Woods system was over in favor of the current system of floating exchange rate.

Since the collapse, IMF members have been free to choose any form of exchange arrangement they want, except pegging currency to gold. The exchange arrangement may be according to IMF "*allowing the currency to float freely, pegging it to another currency or to a basket of currencies, adopting the currency of another country, participating in a currency bloc, or forming part of a monetary union*."

During the period of Bretton Woods System, preliminary research on the composition of reserves saw the light. The first researches focused on the choice between gold and U.S. dollar (Kenen, 1994) owing the fact that they were the preponderant components. Yet, the issue of problem composition stole the spot of light after the crisis of the dollar standard, which took place in 1971 after the demonetization of gold and the Bretton Woods system collapse. Hence, central banks around the world focused on diversifying their stock of international reserves. Such process was boosted by the appearance of new currencies called "*vehicle currencies*" and that served as international means of payment. However, the U.S. dollar maintained its position as a leading currency because it guaranteed the first consideration in reserves accumulation, which is liquidity at that time. On the other side, there were urgent interpellation to diversify international reserves; (Eichengreen, 2005) wrote, "*It may pay to hold reserves in the most liquid market, which tends to be the market in which everyone else holds reserves, but market liquidity is not all that matters. It may worth tolerating a bit less market liquidity in return for the benefits of greater diversification…"*

Table I.2 introduces different key events to foreign reserves since World War II until the collapse of Bretton Woods System as summarized by (Kwon, 2018).

Table I.2:Key events to foreign reserves since World War II until the collapse of Bretton Woods

Date	Event
1946	- IMF started operating; most of members are independent noncommunist countries. - Bretton Woods System based on pegged exchange rate arrangement launches.
1946 – 1975	- New independent states with national Central Banks adhere the IMF.
1949	- Pound Sterling and other Western European currencies are devaluated.
1950	- European Payments Union enhances the convertibility of member currencies.
1958	- EPU members move to current account convertibility. - EPU dissolves.
1961	- Central Bank "gold pool" is established in order to keep market price near official price of $35 per troy ounce.
1967	- Devaluation of pound sterling and currencies linked to it.
1968	- Market price of gold moves above the official price since the end of Central Bank "gold pool".
1969	- IMF creates Special Drawing Rights (SDR)
1971	- United States of America devaluates its currency and abandons gold standard - Bretton Woods System effectively ends.
1972	- Pound Sterling floats and many currencies no longer pegged to it.
1973	- **Final collapse of Bretton Woods System** - The majority of advanced economy currencies float - The rise of oil price caused an extensive accumulation of reserve by oil exporters.

Source: "Trends in the Accumulation of Net Foreign Reserves since World War II", Austin Kwon, 2017

1-4- The raise of Euro as a competing currency

Until now, the U.S. dollar is the leading currency. Nevertheless, this dominance did not prohibit the emergence of the euro as a credible contender (Chinn and Frankel, 2007) since the euro currency has the same advantage as the dollar, which is the liquidity of Euro denominated bond markets.

a) The introduction of the Euro

The first appearance of Euro took place in 1999. First, it was launched as a currency for electronic payments. Yet, old currencies were used in cash only. As it was the currency that aimed to unify the Europe, eleven nations used it immediately; they were France, Germany, Italy, Spain, Portugal, Belgium, Luxembourg, Finland, Austria, and Netherlands. The emission of euro banknotes was in 2002. The management of the Euro is attributed to the European Central Bank. However, the management is shared by the Eurozone members because each country have to set its own fiscal policy that affects the euro's value.

b) The Euro as a "competitor" to U.S. dollar

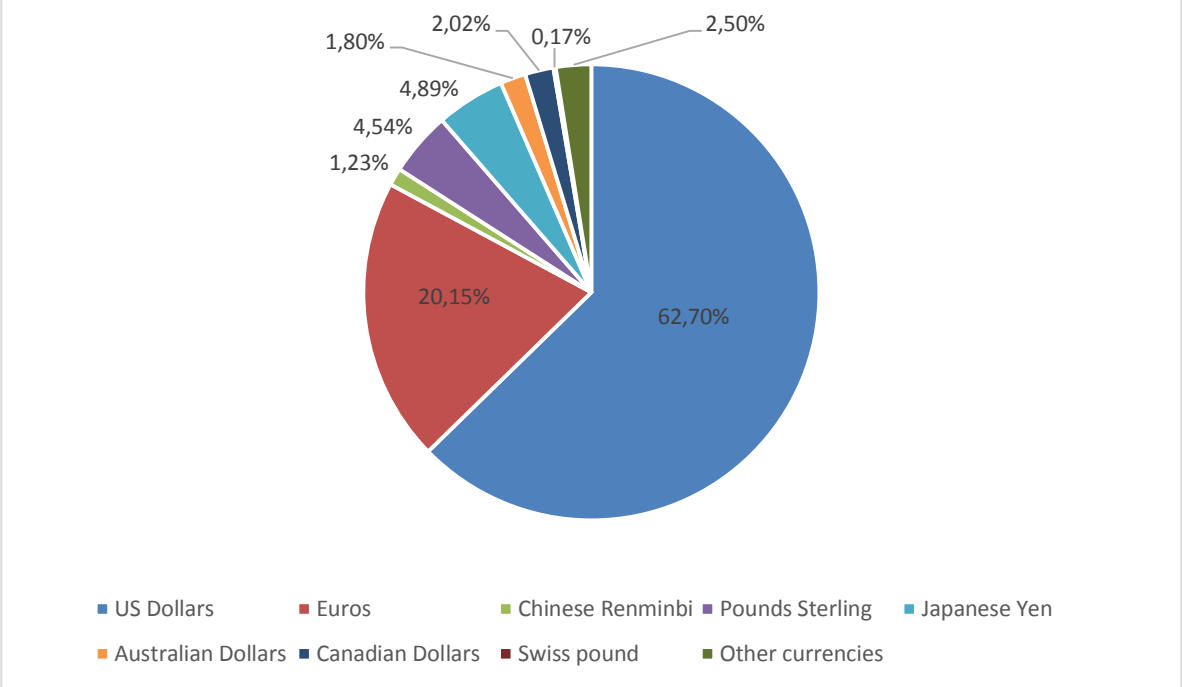
Historically, every time U.S. dollar experiences a period of depreciation, the question of whether the American currency might lose its supremacy raises. Before the issuance of the Euro, the answer to this question were negative arguing this position by the absence of a plausible alternative. For example, (Eichengreen and Frankel, 1996) declared: "*It is unlikely that some other currency will supplant the dollar as the world's premier currency… There is no plausible alternative for the number one position*". However, the same authors acknowledged "*the possibility of a single currency coming into use throughout Europe, which would indeed pose a challenge to the supremacy of the dollar if it was to happen*".

Soon after its debut, the Euro was defined as a "vehicle currency"; it was gained thanks to its use as intervention currency, as invoice currency in cross-border financial transactions, and as a currency domination of bonds. Consequently, the creation of the Euro announced a new and increasingly powerful contender for the dollar as the leader of international monetary system. Historically, on the eve of launching the new European currency, the winner of economics Nobel price, Mundell (2000), announced: " *The introduction of the Euro will represent the most dramatic change in the international monetary system since President Nixon took the dollar off gold in 1971 and when the era of flexible exchange rates began… the euro is likely to challenge the position of the dollar, and hence this may be the most important event in the history since the dollar took over from the pound the role of dominant currency in World War I*".

According to the available data, the share of the Euro in foreign exchange reserve held by emerging market central banks has increased steadily. Consequently, some authors claimed that Euro has become a strong rival for the dollar as reserve currency (Chinn and Frankel, 2007).

Based on European Central Bank (2017), the stabilization of the share of the Euro in foreign currency holdings proves that the role of Euro as an official store of value remained resilient to the various shocks witnessed in the last years. Consequently, the Euro stay "unchallenged" as the second reserve currency around the World. . The latest publication of IMF confirms this vision with marginal presence of other convertible currencies.

Figure I.1: World-Allocated Reserves by Currency for 2017Q4



Source: IMF/Currency Composition of Foreign Exchange Reserves (COFER)

1-5- The global financial crisis and the internationalization of Chinese Renminbi

The global financial crisis of 2007-2008 has been a challenging event to foreign exchange reserve managers around the world. This event underscored the preliminary motive of detaining foreign currency holdings, namely the defensive role against harmful shocks. The guardianship authorities were obliged to mobilize funds, in liquidity portfolio, as well as investment portfolios to mitigate to impact of this crisis on their economies.

a) The situation of the leading reserve currency in the turmoil

During the financial crisis, the solidity and the stability of the American financial system were questioned and the U.S. currency was at the epicenter of the turmoil. The dollar depreciated

until July 2008 when the financial crisis turned into a global phenomenon. However, the position of the dollar as the first reserve currency is maintained despite a little change in the allocation of U.S. dollar in total exchange reserves.

The persistence of the U.S dollar as a leading currency is thanks to the intervention of the Federal Reserve. The latter played a substantial role in shoring up the dollar liquidity, it even extended to lending directly American subsidiaries of foreign financial institutions (Eichengreen and Flandreau, 2014).

b) The internationalization of Chinese Renminbi

After the global financial crisis, People's Republic of China became conscious how the international monetary system is fragile and how far the U.S. dollar is dependent. Hence, China proceeded on the internationalization of Chinese Renminbi (RMB) in 2009. This decision was motivated by a strong desire to replace U.S. dollar as the leading reserve currency since it would give it more control on its economy. However, before gaining the status of "global reserve currency", RMB should succeed as a reserve currency. In other words, it is necessary to provide a liquid and deep market for Chinese Renminbi denominated bonds, as well as accessible to foreign and local investors whether they are institutional or private. The establishment of dim sum bond[3] market and the prosperity of the Chinese cross-border trade worked in favor of this ambition. Moreover, many countries use the Chinese Renminbi as a currency settlement in their bilateral trade with China. As a result, it became the eighth-most-traded currency in 2013 (SWIFT, 2013). On October 1, 2016, the IMF added the Chinese Renminbi to its Special Drawing Rights Basket.

Despite the upward trend of cross-border trade, The RMB still suffers from many deficiencies stopping it from being a desirable currency: there are barriers on inflows and outflows of capital; domestic financial markets are not developed; and the RMB denominated bond market is not liquid enough. Hence, the exclusion of the dollar from its current leading position seems a long process.

To conclude, the foreign exchange reserves composition, as communicated by IMF/COFER, presents the absolute domination of US dollar, followed by Euro. This aggregate representation is motivated by different motives as explained above. Every Central Bank around the world looks for an optimal composition based on the specificity of its management and needs.

[3] Dim sum bonds are securities issued outside of China bur denominated in Chinese Renminbi.

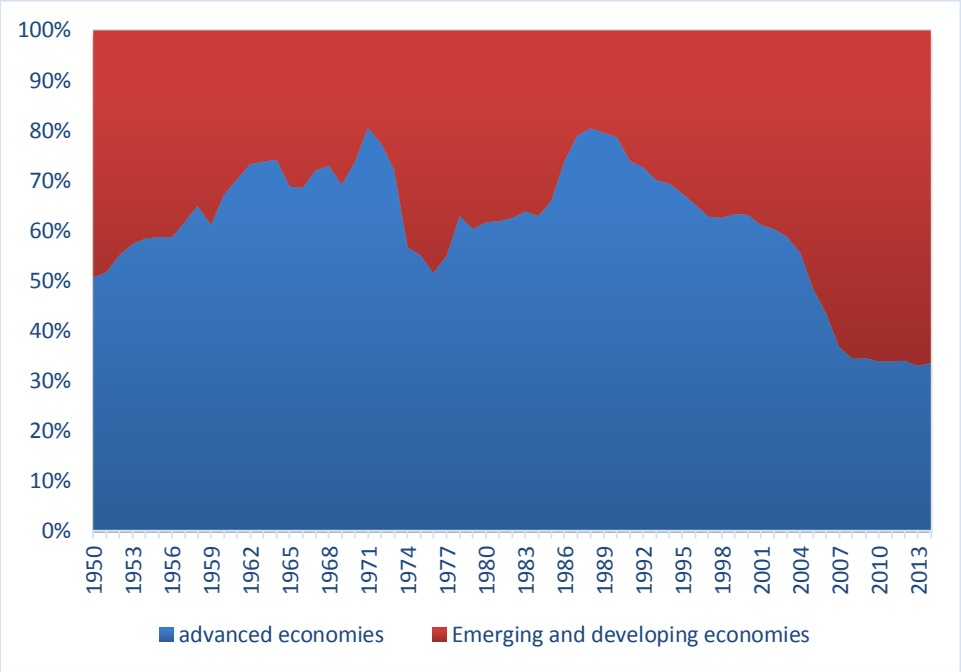
2- Foreign Exchange Reserves trends

2-1- Where Reserves are held?

After the World War II, a considerable part of reserves was detained by developed countries. However, a shift occurred in the 1970s in favor of the Middle East countries since they accumulated heavy foreign reserves thanks to the rise of oil prices. Moreover, The Asian crisis that touched their financial markets in the 1990s and early 2000s pushed many emerging countries to accumulate foreign currency reserves in order to be protected against potential crisis in the long term.

The total reserves estimated in 2016 levelled at $12.1 trillion, where advanced countries get the lion's share with 43%, while developing Asia countries held 34% of reserves Kwon (2018).

Figure I.2: Reserve Shares by the degree of development of the economy, Foreign exchange

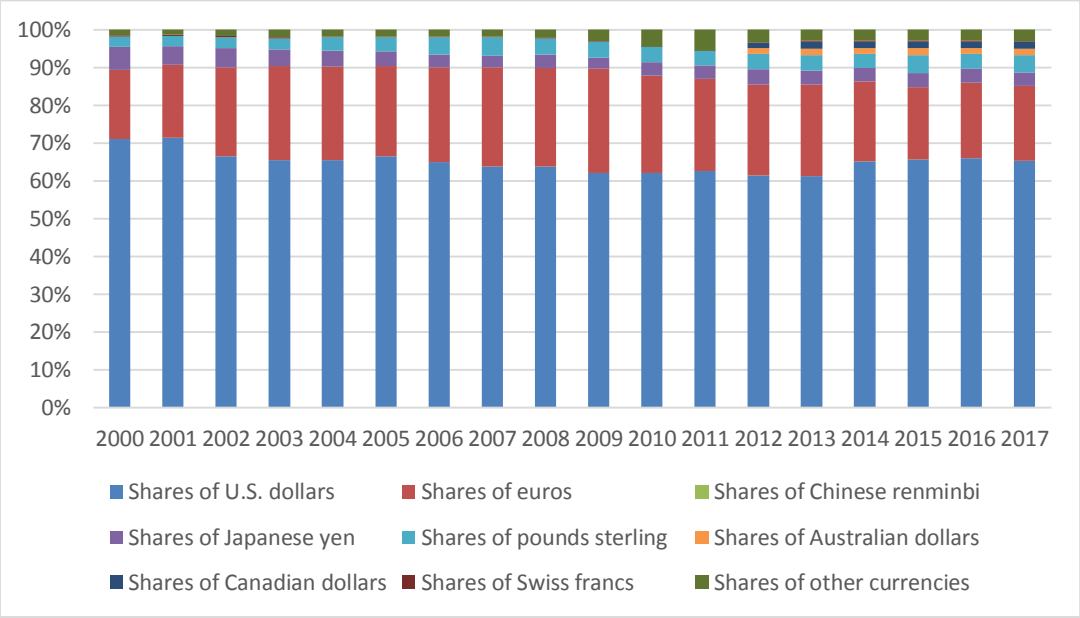


Source: IMF data

2-2- The actual composition of Foreign Exchange reserves

The actual composition of foreign exchange reserves at an international level shows the presence of U.S. dollar as a leading currency although it witnessed a light decrease from 71.31% of total foreign reserves to 65, 27% in 2017. Euro comes in the second place at the level of 19.89% in 2017.

Figure I.3: World Currency Composition of Foreign Exchange Reserves

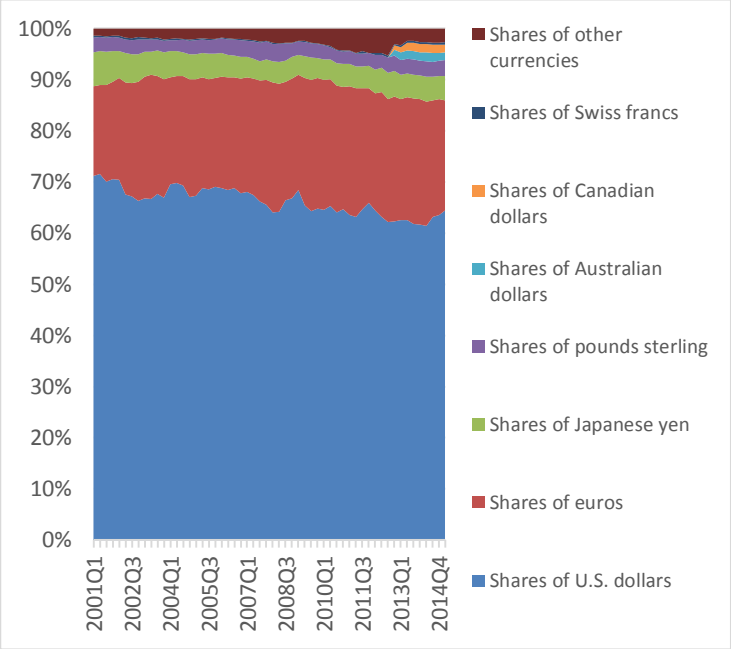


Source: IMF Data 7/16/2018

In order to investigate the differences that could exist between different regions in detaining foreign exchange reserves, we make a comparison between advanced countries and emerging countries based on data availability. We used quarterly data available on IMF data platform from 2001 to the first trimester of 2015.

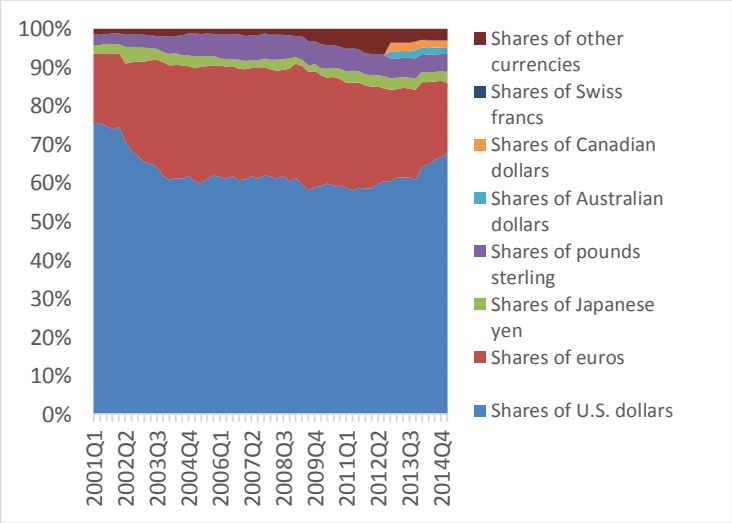
Generally, the order of currency's shares is maintained with the dollar as the dominant currency. Moreover, the guardianship authorities subscribed to the diversification last years. However, the sterling pound share seems to be important in the composition of foreign exchange reserves of the emerging and developing countries, which may be explained by historical events since the United Kingdom was the power that colonized the majority of these countries.

Figure I.4:Advanced Economies Currency composition of Foreign Exchange Reserves Evolution



Source: IMF Data July 16th, 2018

Figure I.5: Emerging and Developing Economies Currency Composition of Foreign Exchange Reserves Evolution



Source: IMF Data July 16th,2018

Advanced economies show a stable share composition for the different reserve currencies. Albeit the US dollar is the dominant, its share decreased slightly from 71.2% in the first quarter of 2001 to 64.4% in the same period of 2015. The Euro showed a slight rise of 4.12% for the same period. However, the part of other currencies, except the pounds sterling and Japanese yen, increased from 1.75% to 6.17% in the same period.

Emerging and developing countries respected the same hierarchy of reserve currencies. However, the share of U.S.D decreased at its lowest level at 58.14% of the total FX reserves during the period of financial crisis. The Euro's share followed an upward trend at the beginning of its launch but it reversed the tendency the last years. It is explained by the different political and economic issues witnessed in Europe last years (European sovereign debt crisis, Brexit, in some Euro areas) (European Central Bank, 2017)

Conclusion

This chapter paved the way to understand the spirit that encounters foreign exchange reserves management. Starting by exhibiting different generalities about foreign exchange reserves and outlining their importance, since they play a major role to guarantee the stability of the country in normal contexts as well as in the time of turmoil. Subsequently, we focused on foreign exchange reserves management in central banks; we highlighted the special profile of the central bank and presented their ultimate objectives, which are liquidity and wealth preservation. In the same section, we called attention to the importance of reserves management strategy, the governance and institutional framework, and best practices guidelines in developing an efficient management so that the responsible entity would have the ability to cushion unpredictable crisis. Finally, we converged to the currency composition of foreign exchange reserves history, in which we focused on the rivalry between different leading currencies. In addition, we presented the actual trend of the currency composition of foreign exchange reserves evolution in the world as well as comparing those related to advanced economies and emerging and developing economies.

This chapter offered a deeper understanding of different principles that guide the manner in which central banks manage their foreign exchange reserves. However, there is a need to figure out the main determinants that affect them. A growing body literature has served as the main conceptual frameworks for investigations in this field. They have been useful to identify factors that might affect foreign currency holdings. However, the empirical studies has been limited because of the confidentiality of data. Hence, most works used aggregated data or data relative to groupings of countries. In the next chapter, we seek for introducing the theoretical frameworks by presenting in details different approaches.

CHAPTER II: THEORETICAL FRAMEWORK AND EMPIRICAL LITERATURE REVIEW

CHAPTER II: THEORETICAL FRAMEWORK AND EMPIRICAL LITERATURE REVIEW

Introduction

The optimal management of foreign exchange reserves urged central banks to respond to two preliminary aspects of reserves managements, which are the global demand of foreign holdings and the adequate form to detain. The first aspect enjoys a growing body of literature; the onset approach focused on the difference between the optimal level and the existing holdings. The latter paved the way to the appearance of the monetary approach to balance of payments. However, defining the adequate form is as important as determining the level. Therefore, the unanimity of central banks around the world have subscribed to a mechanism of reserves' diversification among different currencies since it can shelter them from risk events. Depending on objectives already defined, the guardianship authority may refer to either one of these theories to determine the convenient composition of foreign exchange reserves; the mean-variance theory, the transaction theory or the intervention-oriented approach. The existing literature focused on the two first theories as main determinants of the currency composition of foreign exchange reserves; however, the intervention need was mainly treated as a component in different. In this part, we try to review the literature in order to outline different arguments presented by each theory. In this part, our ultimate aim is to respond to these questions: Firstly, "*What are the main influential factors that defines the demand of international holdings for a country?"* As evocated, we will start by the theory of optimal level, then the monetary approach to balance of payments. Secondly, *"What are the main theoretical determinants that underlie the composition of foreign exchange reserves in previous researches?"* for this aspect, we will start by the mean-variance theory first for ease of explanation and historical considerations.

Section 1: The determinants of the demand of foreign exchange reserves

Theoretical framework

1- Theory of optimal international reserves

1-1- Cost benefit approach

This approach was established in the aim of determining the optimal level of international reserves by (Heller, 1966). According to this approach, authorities are in perpetual trial to make compromise between the cost of adjustment policies that keep the equilibrium of the balance of payment under a pegged exchange rate arrangement, and the cost of holding reserves. He

outlined that central banks would ask for reserves until their marginal benefit is equivalent their opportunity cost.

The pioneering work that is considered as a reference in this approach is elaborated by Heller (1966), and brought to light the buffer stock model. The latter was built under implausible hypotheses that are mainly:

i) Fixed exchange rate arrangement
ii) No capital flows
iii) Broad money can only be adjusted by using international reserves, as well as cannot be influenced by economic policy.
iv) The adjustment of the exchange rate arrangement is excluded

The results of this model were striking since they differed from the optimal level of reserves. However, the buffer stock model served to shed the light on the determinants of the optimal level and their predicted impact. Consequently, it has become the reference for subsequent empirical investigations (Bahmani-Oskooee and Brown, 2002; IMF, 2003).

Building on Heller's model findings, the optimal level of foreign holdings raises the reserves become more volatile under a pegged exchange rate arrangement; yet, it drops with marginal propensity to import and the opportunity cost.

To conclude, the cost benefit approach modeled by the buffer stock model is valid in the post Bretton Woods period as well as before according to Flood and Marion (2002)**.** Nonetheless, this model captures only a small part of reserves movements and fails to make clear cross-country changes.

1-2- Utility maximization approach

Clark (1970) was the pioneer who proposed the present approach that has had referred to the utility maximization to deal with the optimal level of reserves and its speed of adjustment. The defined function, called the social welfare function, is dependent positively with income, and negatively with income variability. This assumption is justified by the fact that the detention of a high level of reserves would increase the opportunity cost, and consequently, would decrease income. The hypothesis adopted by Clark (1970) to conduct his analysis guarantee that the country would never suffer from a permanent balance of payments deficits. They are mainly:

i) The size of the country is small, and the import prices are constant.
ii) The balance of payments is in equilibrium

iii) The country adopts a pegged exchange rate arrangement, and fixed the exchange rate at the level of equilibrium.

iv) Export prices are constant, and the economy is assumed to be in less than full employment level.

v) Due to the changes in the level of reserves, random disturbances outside the economy would appear.

According to Clark (1970), the accumulation of reserves is motivated by the desire of avoiding the cost of adjustment; He believes that reserves help to face the exceptional deficits of the country's balance of payments.

The main findings proposed by this approach have given a glimpse on the potential determinants. It has been proven that the optimal level of international reserves increases with the GDP per capita and country's balance of payments shocks, yet, it decreases with the marginal propensity to import and the opportunity cost. According to him, balance of payments disturbances are solved whether by financing it from reserves or by adopting government policies to adjust the economy. However, both of them imply costs. Clark stressed more on the reserves accumulation since it helps to reach other goals besides reducing the balance of payments deficits. Among these objectives is mainly the possibility that the country might become illiquid.

To sum up, the cost benefit approach, as well as the utility maximization approach lead up to define the determinants of optimal level of reserves although they referred to different modeling strategies. However, this theory arouses criticism according to Badinger (2004) for various reasons; on one hand, it ignores the implications of monetary approach to balance of payments. On the other hand, the great number of works use cross sectional data, which eliminate the individual characteristics of economies.

2- The monetary approach to balance of payments

Contrary to the traditional theory built on the optimization of the international reserves, the monetary approach to the balance of payments aimed to explain the demand of foreign exchange reserves. The main empirical investigations that called for this approach are mainly related to Heller and Khan (1978), Edwards (1985), Eichengreen and Mathieson (2000),Lane and Burke (2001), Aizenman and Marion (2003), IMF (2003), Romero (2005), Prabheesh et al. (2007), Obstfeld et al. (2010) and Gantt (2010).

According to IMF (2003), the influencing factors on the level of international reserves can be categorized into five groups, which are; economic size, current account vulnerability, capital account vulnerability, exchange rate flexibility, and opportunity cost.

2-1- Economic size

This determinant is considered a scale indicator; since it is assumed that if the economy is large, the required level of reserves will be higher. These holdings would serve as a buffer to curb the balance of payments fluctuations. The set of proxies used to measure this indicator are usually population of the country, real GDP per capita, and GDP (Aizenman and Marion, 2003; IMF, 2003; Obstfeld et al., 2010).

Aizenman and Marion (2004) conducted a cross country investigation of 122 developing countries for the period between 1980 and 1996. The estimated international reserves demand functions revealed an increasing function with population and GDP per capita.

Nevertheless, the study conducted by Obstfeld et al. (2010), relative to the period between 1980 and 2004, showed that the GDP is an insignificant determinant for the demand function of international reserves.

2-2- Current account vulnerability

This indicator reflects the trade openness of the country and its exposure to external shocks. It is usually measured by the ratio of import to GDP, the ratio of trade to GDP, or the ratio of current account to GDP (IMF, 2003). Preliminary works held by Heller (1966) and Clark (1970) has proven the importance of propensity to import in determining the changes of reserves level. The finding has motivated many researchers to test the effects of current account vulnerability highlighting the positive correlation between the level of foreign exchange reserves and the current account vulnerability in the long run relationship (Frenkel, 1976).

Aizenman and Marion (2003) conducted a research of the demand of reserves holdings in Far East countries for the period between 1980 and 1996. They found that reserves are the result of international transactions mainly.

Prabheesh, Malathy, and Madhumati (2007) research focused on the level of international reserves detained by India from 1983 to 2005. Their results confirmed the theoretical assumption since the long run foreign holdings are an increasing function of current account vulnerability.

2-3- Capital account vulnerability

In the existing literature, this indicator reflects the financial openness of the country and its exposure to residential capital flights. The different metrics used in empirical researches to test the capital vulnerability are mainly; ratio of capital account to GDP, ratio of short term external debt to GDP, and the ratio of broad money to GDP according to IMF (2003)**.** Empirical investigations that have taken into consideration the capital account vulnerability have stressed on its positive impact on the long run foreign exchange reserves. Prabheesh, Malathy and Madhumati (2007) findings proved that the accumulation of international reserves behavior of India is strongly influenced by the capital account vulnerability indicating the precautionary motive.

Empirical investigations held by Obstfeld et al. (2010)emphasized on the effect of financial openness in forecasting the demand of foreign exchange reserves. Moreover, the work held by Gantt (2010)**,** using broad money as an indicator for capital vulnerability, confirmed the previous findings thanks to an investigation that covered 50 countries for the period 1977 and 1991.

2-4- Exchange rate flexibility

Among the motivations that encourage the accumulation of foreign exchange reserves is the intervention need in the aim of smoothing the exchange rate fluctuations. Hence, exchange rate flexibility is considered a crucial determinant for foreign holdings level; in fact, when an exchange rate arrangement classified as flexible, the demand for international reserves would be reduced because the guardianship authority is no longer in need for a large supply of reserves to deal with a fixed exchange rate. Therefore, the demand of foreign holdings is a decreasing function with exchange rate flexibility. This indicator is usually measured by the actual volatility of the exchange rate (Aizenman and Marion, 2003; IMF, 2003; Prabheesh et al., 2007). The investigation held by Jiang (2018)**,** to explore the reasons of the accumulation of foreign exchange reserves of Hong Kong for the period between January 2000 and November 2007, proved that the long run demand of reserves is negatively correlated with the exchange rate flexibility, and highlighted the need of the Hong Kong monetary authority to hold a high level of reserves for needs of intervention.

2-5- Opportunity cost

The pioneer investigations that evocated the importance of opportunity cost in determining the demand of foreign exchange reserves belong to Heller (1966) and Frenkel and Jovanic (1981).

According to these authors, it is defined as: "*The difference between the yield on reserves and the marginal productivity of an alternative investment*." However, this formula was hard to apply and reflected measurement problems since a great part of empirical investigations were not able to confirm a significant effect of this indicator due to measurement problems. Ben-Bassat and Gottlieb (1992) have proposed to assess the opportunity cost as the interest rate differential between the domestic interest rate and the US treasuries in the aim of capturing the effect. Nonetheless, he emphasized that the best metric to evaluate this indicator is the difference between the yield on international reserves and the highest possible marginal productivity given from an alternative investment in fixed yield asset.

Khan and Eatzaz (2005) proposed another measure while conducting a study on the demand for international reserves of Pakistan covering the first quarter of 1982 to the second quarter of 2003. They referred to the domestic interest rate to measure the effect of opportunity cost. The latter proved to be significant in explaining the demand of international reserves in Pakistan.

All these studies confirmed the existence of a negative relationship between the demand of international reserves and the opportunity cost despite the being of a variety of measurements. They propose that the greater the interest rate differential or the domestic interest rate, the lower the demand for international reserves to face outflows. Yet, this assumption should be coupled by information about political stability and investment environment (Khan and Eatzaz, 2005; Chowdhury et al., 2014).

Table II.1:Empirical determinants and the proxy of measurement

Determinant	**The proxy of measurement**
Economic size	Population, per capita GDP, and GDP
Current account vulnerability	Ratio of import to GDP, Ratio of trade to GDP, Ratio of current account deficit to GDP
Capital account vulnerability	Ratio of capital account to GDP, Ratio of short term debt to GDP, and ratio of broad money to GDP
Exchange rate flexibility	Standard deviation of exchange rate
Opportunity cost	Interest rate differential, domestic interest rate

Source: Prabhesh, Malathy and Madhumati (2007)

Section 2: The currency composition of foreign exchange reserves theoretical framework

1- Mean-variance theory

1-1- Overview

The mean variance model developed by Markowitz (1952) and Tobin (1958) defines different insights on how a private investor could construct a financial portfolio. The standard model assumes that an investor with a given wealth can select among different assets based on their risk aversion and the anticipated risks and returns. The investor may maximize its anticipated returns for a specific level of risk. Otherwise, minimize the risk given a fixed return. Beck and Rahbari (2011) favored the minimization of the variance of portfolio returns based on a plethora of theoretical and real world consideration. On the one hand, central bank is considered a conservative investor that places its assets in short term foreign debt; on the other hand, the finance literature has proved that the impact of estimation errors on optimal portfolio weights is less for the estimation variances and covariance than for expected return.

This approach had attracted central bankers or rational governments since they tend to be more transparent about the use of international reserves as they are considered part of the national savings. In fact, the ability to trade-off between returns and risk was the real motive since it subscribes to the interest of wealth preservation. The use of this theory is based on assigning different weights to different currencies based on their returns dependence, and consequently the risk is diminished.

1-2- The empirical studies on the mean-variance theory

The main pitfall that encountered researches on the currency composition of foreign exchange reserves relative to individual countries is the confidentiality of data. Hence, we find most investigations on individual countries focus on the optimal currency composition of foreign holdings rather than discussing its actual composition and knowing its determinants. In the light of these considerations, the mean-variance theory has become the prevailing method in innumerable studies.

Giving a large panorama of past to present empirical studies that referred to the mean-variance theory, only four works have marked research on the application of this theory for central bankers. The issue, which faced the majority of them, is lack of the appropriate data that serves to the evaluation of the composition of foreign exchange reserves.

a) Ben-Bassat (1980)

Preliminary application of the mean-variance theory to determine the composition of foreign exchange reserves was conducted by Ben-Bassat (1980) in order to select an optimal currency reserves portfolio for Israel, and for semi-industrial and developing country's groups. In an effort to apply the theory, the researcher used monthly data of the currency composition of foreign exchange reserves of Israel, semi industrial and developing groups of countries during the period between 1972 and 1976. He stressed on the influence of profit considerations on the allocation of reserves and semi-industrialized countries; the author considered, the international reserves are very sensible for profit considerations. Hence, it was beneficial to proceed by the mean-variance theory for those countries. Ben-Bassat (1980) defended this assumption since they have not an impact on international monetary stability; moreover, their exchange rates were administrated.

The key contribution afforded by Ben-Bassat (1980) was the estimation of the portfolio holdings' efficiency curve relative to the Bank of Israel during 1972 and 1976, which corresponded to the efficiency frontier of the import currency basket of Israel. The different shares of currencies were obtained through the resolution of the "minimax criterion" of the mean variance theory. Moreover, he highlighted the similarity of the optimal combination of currency composition to the actual composition of Israeli import basket. The latter was explained by two reasons; first, hedging against exchange rate of import currencies fluctuation; second, the fluctuation of exchange rate was the prevailing element in the total variance in this period. However, a difference in the efficiency curve in terms of U.S. dollar was noticed since it was not the same comparing to those in import terms. The latter outlined that the specification of the central bank target currency and its practical importance.

Concerning the different groups, it was proven that the return and the risk of each currency coupled with their currency structure of their imports played a determinant role in the composition of foreign exchange reserves. However, estimating the efficient portfolio of each country by the level of development highlighted that profit considerations played a greater in semi-industrial and developing countries than in industrial ones.

Finally, he pointed out that the distribution of reserves currency around the world might affect the demand of central banks for the various currencies.

b) Dellas and Chin (1991)

In their cutting edge paper published in the "*Journal of International Money and Finance* (1991)", Dellas and Chin study used monthly data of the foreign exchange reserves of the Central Bank of the republic of Korea from 1980 to 1987. Their working paper is considered the pioneer since they used individual country data of portfolio reserve possession and the actual shares of currencies used for import payments instead of import shares by country of origin. This helped to fill the gap that marked previous studies such as those conducted by Dellas (1989) and Heller and Knight (1978). In fact, those authors referred to the mean-variance model to respond to foreign exchange reserve question, but their results were debatable because of specific country's data shortage and they were obliged to use group-aggregated data. This contribution permitted to calculate accurately the consumer price index so that results were more valid.

This contribution turned out to be well grounded since it made the difference between the two measures conducted in this work. Those measures are mean-variance model, constructed under the hypothesis that exchange rates follow a random walk, and the Consumption Capital Asset Model (CCAPM) with imports was used instead of consumption level. Hence, accurate data on import currencies was recommended.

Dellas and Chin (1991) focused only on four currencies since they represent 97% of the entire official Korean portfolio, which are the U.S. dollar, the pound sterling, the deutschemark and the Japanese yen. They referred to the importance of currency in trade transactions as weight to construct the consumer price index with adjustment to oil imports denominated in USD, based on the assumption that foreign reserves are detained to finance imports (Frankel and Engel, 1984)**.**

Proceeding through two different methods is an attempt to figure out a better quantitative framework that serves the currency composition of foreign exchange reserves. However, the estimated efficient composition of Korean currency reserves during this period was analogous to the actual currency portfolio; therefore, this result was in favor of the mean-variance model as the most plausible approach used by central banks. Therewith, the contender model (CCAPM) was inconclusive although the data did not reject it; this is due to the feebleness of the test.

Despite the fact that this work confirmed the assumption of the use of the mean-variance model by monetary authorities, it was unable to capture its role since they used the gross foreign

reserves instead of net position[4]. The authors admitted this deficiency and they explained by the lack of monthly data of debt.

c) Petursson (1996)

Petursson (1996) referred to the mean-variance portfolio management of Markowitz to compute the optimal composition of foreign exchange reserves detained by the Central Bank of Iceland and based on data for the period between 1987 and 1993.

The considerable contributions of his paper was the application of ARMA process in order to calculate the expected return and the integration of the utility function to fix the optimal currency composition of foreign exchange reserves. To proceed so, he replaced the assumption considering the random walk of the exchange rate by ARMA model, which is a huge jump toward the reality. In spite proving the superiority of the random walk model, the incorporation of the utility function, a corner stone in the portfolio theory, is a revolutionary step since it offered the possibility to adjust coefficients and enhance the flexibility of the model.

d) Papaioannou, Portes and Siourounis (2006)

Papaioannou, Portes, and Siourounis (2006) investigated the growing concern about the diversification of the central bank foreign currency holdings focusing on diversifying assets denominated in U.S. dollar to those denominated in Euro. This research question has risen because there was a debate among academics to find out whether different central banks around the world faced "concentration risk" of foreign exchange reserves on U.S. dollar. To do so, they conducted a study using data relative to the BRICs (Brazil, Russia, India and China) for the period 1995-2005. Their paper aimed to study the impact of euro in reserves allocation and the possibility to be an alternative to the dollar. The methodology followed by the authors is similar to those pursued by Ben-Bassat (1980)and Dellas and Chin (1991). However, Papaioannou et al. (2006) added transaction costs and other constraints, which are assumed suitable for the special profile of central banks.

In establishing their empirical framework, Papaioannou et al. (2006) started by considering a representative central bank. Then, they made suppositions about the expected returns of currencies, and the structure of the variance and covariance matrix of different currency returns. In fact, authors applied the dynamic conditional correlation multivariate GARCH (DCC-GARCH). Hence, it permitted a better optimal composition since evidence proved that in

[4] The difference between assets and liabilities, which are the external debt.

volatile periods, financial markets deviate from what normal distribution anticipate. This contribution was cogent because conclusions that were based on multivariate normal distribution were doubtable and problems might consequent of decisions built upon them.

These assumptions served to estimate the optimal composition of foreign exchange reserves based on a mean-variance model and considering for the first time the rebalancing costs and other factors that represent the management specificity of central banks. In the regard of the latter, it included; (1) the financial market stability by providing liquidity to markets behaving abnormally; (2) detaining an important portion of foreign exchange reserves in currencies of its foreign debt; (3) the adequate composition in currencies that enable it to honor international trade needs, and (4) a composition that serves as an anchor currency in order to have a fixed exchange rate.

The elaborated model offered the possibility to estimate optimal foreign exchange reserves composition of the chosen emerging economies, and then compared it by the existing portfolio. Ergo, the authors made these three important conclusions;

(i) If we consider the U.S. dollar as the reference for the risk free currency, the optimizer may correspond to a large share of U.S. dollar in foreign reserves.

(ii) The actual observed euro share in reserves holdings are much higher the weight of Euro estimated in the optimal portfolio. Papaioannou et al. (2006) suggested that Euro might already enjoy an enhanced role as an international reserve currency.

(iii) Many factors may likely work in favor the rise of the optimal euro shares such as; (1) Growth in issuance of euro-denominated securities, (2) the increase of the euro zone trade with the key emerging markets, (3) and the growing use of euro as a currency peg.

To conclude, Papaioannou et al. (2006) considered the mean-variance model convenient to use it in the currency composition of foreign exchange reserves among different currencies. However, the guardianship authority ought to make modification in order to befit to the specificity of each country.

1-3- Critics addressed to the mean-variance theory

a) Deficiencies of the mean-variance theory mathematically

In spite of the success of the mean-variance model in the portfolio management, it faced many critics concerning its assumptions of the asset returns distributions and the utility functions forms. The mean-variance method is based only on the two first moments of the utility function

and assumes that the asset returns follow Gaussian distributions. However, there is growing findings that proves that many financial market series are far away from Gaussian distributions. Moreover, the mean-variance model neglects the asymmetry and the fat-tail features that characterize the financial market data (Kraus and Litzenberger, 1976).

b) Vine-Copula as a successor

The Copula has the credit to detect the asymmetry in return series unlike the mean-variance analysis, which is based on Gaussian distribution. This new theory has been a subject for many developments in recent years (Genesta et al., 2009). The most important advantage of the Copula theory, compared to the mean-variance theory, is its ability to incorporate the skewness and the kurtosis both in marginal and in dependence (Zhang et al., 2015).

Zhang et al. (2015)applied the Copula theory on foreign exchange reserves of China in order to have the optimal currency composition. They used the interest rate of the currency-issuing country and the exchange rate of the foreign currency to the currency of the home country relative to twelve currencies based on their importance in China's trade and financial transaction. The data sample has a daily frequency for the period 1 January 1999 - 31 December 2009.

This method offered the possibility to investigate the asymmetry fat tails and the complex dependence structure in distributions of currency returns. Authors underlined the fact that central banks have achieved significant gains in expected economic value just from switching from mean-variance to copula modelling. The most important finding that this approach offered to People's Bank of China more space for international currency diversification, although the U.S. dollar remained keeping the leading position.

c) Deficiencies of the mean-variance in the currency composition of foreign exchange reserves

The main pitfall of the mean-variance theory, which had been mentioned by economists including Heller and Knight (1978), Dooley, 1987, Dooley et al. (1989) and Lizondo and Mathieson (1987), is that focused on wealth preservation and fail to explain the spirit that guided the currency composition of foreign exchange reserves. These authors suggested the presence of other factors able to explain the management of reserve assets especially the ones related to precautionary and transactional needs; Thus, this theory is not applicable to manage foreign exchange reserves (Dooley, 1987).

Shi and Nie (2017) outlined major issues faced in order to use the mean-variance model by central banks, which are:

- The choice of reference currency
- The estimation of asset returns
- The estimation of variance-covariance matrix

Moreover, they questioned numerous studies that are fundamentally achieved within a framework of a single period static mean-variance model, which is contradictory to the currency composition management goals. As a matter of fact, centrals banks look for protecting against the risk of exchange rate volatility, therefore, the empirical framework should be a dynamic adjusting process. This problem has drawn the attention, and thanks to the development of econometric methods, some authors referred to these dynamic model such as continuous-time models (Zhou and Li, 2000) and dynamic optimum models under imperfect markets (Basak and Chabakauri, 2010) .

These deficiencies were relative to the specificity of the central bank as a public investor and a concerned authority that manages the foreign exchange reserves. Despite the obligation to preserve this national wealth, the monetary authority must meet numerous transactional needs according to mercantilists. Therefore, the transaction theory appear as a fully justified contender to the mean-variance theory. In the next part, we will expose the plethora of contributions that defended the transaction theory.

2- Transaction cost theory

2-1- Overview

Although the mean-variance approach proved its efficiency in explaining the behavior of the foreign exchange reserves composition among different currencies, many academics would seem to suggest that this explanation is insufficient. The presented arguments that outlined the drawbacks were mainly related to the status of the central bank as a public institute; in other words, central banks are not private investors seeking the full optimization only, they have other considerations related to market transaction activities such as financing international trade, honoring external debt, purchasing and selling foreign currencies, and similar factors.

Heller and Knight (1978) have the merit to make preliminary researches proving that transaction needs have an impact in determining the foreign exchange reserves composition. According to Dooley et al. (1989), the transaction theory suggests that the convenient foreign exchange reserves composition is probably independent of the optimal distribution of net wealth

across currencies. In other words, the most important currencies that accommodate the international transaction purposes of a country will constitute the largest shares in a foreign exchange reserve portfolio relative to this country. Therefore, the most pertinent question that now arises is "*Which are the most significant transaction factors that have a determinant role in the composition of a country's foreign reserves among different currencies?"* The first temptation done by Dooley et al. (1989) was based on the traditional mean-variance model in which they incorporated transaction costs. Then, an empirical model derived the impact of the transaction factors that found to be significant. Moreover, this work was endorsed by a study conducted by Eichengreen (1998). The latter chose a group of transaction factors based on historical and institutional evidence. They supposed to be the most influent in the management of currency composition of international reserves detained by a central bank. The transaction theory became present in different empirical works treating the currency composition of foreign reserves in the light of the above considerations. In the next part, we will expose different determinant variables that influence strongly currency shares in foreign exchange reserves detained by central banks.

2-2- Determinants to the currency composition of foreign exchange reserves

The existing literature about reserves management established a common recognition that the currency composition of foreign holdings is largely determined by reserves usage included those of Heller and Knight (1978), Dooley et al. (1989), Eichengreen (1998),Eichengreen and Mathieson (2000), Chinn and Frankel (2007) and Hatase and Ohnuki (2009) etc…

However, the confidentiality of data relative to currency composition for individual countries obliged researchers to conduct their work in a global level in the aim of finding the determinants of actual currency composition of foreign exchange reserves. Hence, they used IMF aggregated data and they regressed different currency shares on a macroeconomic, financial, and trade variables. These regressions usually disregard the global overall level or for countries in the group. Hence, in the following part, we will enumerate the different impacting variables as defined by the existing literature.

a) Factors related to the country

i. The country's international trade currency composition

The international trade currency structure is considered a pivotal determinant variable in the composition of foreign exchange reserves; the level and the composition of foreign currency holdings is sorely dependent by the country's trade patterns. As defined by mercantilists,

detaining foreign exchange reserves serve to enhance exports, then, its composition is quite sensible to exports flows. Moreover, the common usage of reserves is primordially financing imports; hence, the composition of foreign holdings should reflect imports structure in order to mitigate exchange rate risk.

Heller and Knight (1978) were the pioneer who proved this relationship by trying to explain variations of different shares, which are U.S. dollar, pound sterling, deutsche mark, French franc and other reserves currency. They used individual country data from 76 countries over the period between 1970 and 1976 in a cross sectional time series regression. They concluded if the reserve center was an important trading partner, the proportion of that currency in foreign exchange reserves would increase.

Dooley et al. (1989) subscribed to the same assumption by using confidential data from International Monetary Fund on the currency composition of foreign exchange reserves relative of each country. They combined from individual data into separate cross-country time series to get groupings of industrialized and developing countries during the period 1976 to 1985. The use of groupings instead of aggregated group data is justified by the desire of observing the currency preferences of each country. Their empirical work consisted on combining the mean variance approach and the transition approach, and they took the ratio of transactions in a given currency to the total transactions.

Hatase and Ohnuki (2009) studied this relationship focusing on the structure of foreign exchange reserves of japan during the interwar period. Results confirmed the previous works, they claimed that trade structure strongly affected the shifts of reserves currency. According to archival evidence, authorities took into consideration the expected trade flows while allocating their currency portfolio.

To sum up, there is no disagreement about the positive sign between the share of a currency in international trade and its share in foreign exchange reserves in the existing empirical studies. This is explained by using the currency as invoice trade, hence it is considered as a vehicle currency that affected reserves currency holdings.

ii. Currency composition of external debt

The preliminary motive of holding foreign exchange reserves is to meet external engagements if there is a temporary shortfall in export earnings or temporary closing of access to international capital markets. Therefore, the currency composition of external debt, chiefly the composition

of the short-term debt, is considered by theoretical framework as an essential determinant of the currency composition of holdings.

Eichengreen and Mathieson (2000) used the model elaborated by Dooley et al. (1989) to know if Euro would be dominant and become the leading currency in international reserves. The IMF data used are relative to 84 emerging and transition countries for the period between 1979 - 1996, which is longer than the cross-sectional time series data adopted by Dooley et al. (1989). However, they provided more evidence that debt-servicing payment has an important impact on the composition of foreign currency reserves (Heller and Knight, 1978; Dooley et al., 1989; Soesmanto, Selvanathan, and Selvanathan, 2015).

Moreover, the investigation done by Hatase and Ohnuki (2009) on the currency composition of Japan during interwar period confirmed the theoretical framework. Authors confirmed that this result was expected because of historical reasons; during that period, Japan was over burdened by debt servicing, therefore, authorities chose the currency that offered more favorable conditions for denomination. Those conditions were mainly the capacity markets of raising the required funds with fewer taxes and less regulation.

All the investigations were fully justified by the fact that many countries use international currencies to denominate significant amounts of bond issuance to take profit of the depth and the liquidity of their markets. For example, governments and private agents in markets outside the United States of America issue a significant amount of dollar-denominated debt.

iii. The incumbency advantage and network externalities

The incumbency advantage was treated for the first time by Eichengreen (2005) as an explanatory variable for the composition of foreign currency holdings. Indeed, after surveying historical and institutional evidence on holdings of international reserves for the whole 20thcentury, he noticed that central banks were like enough to maintain holding their reserves in the currency that is already dominant, the case of U.S. dollar over the current period. This thought is fully justified because it pays central banks to hold their foreign exchange reserves in a currency for which markets are liquid, and it is used for settlement of international trade for over than fifty years. The latter worked in favor of U.S. dollar since this long period of use offered to it the opportunity to develop network externalities and dependency of international reserves to it.

The core question research that Eichengreen (1998) treated was the potential impact of the introduction of the Euro on the management of foreign exchange reserves conducted by central

bankers. Hence, he used aggregated data on the currency composition of total global holdings of reserves, focused mainly on US dollar, the pound sterling and Japanese yen for the period between 1971 and 1995, and proceeded by Seemingly Unrelated Regressions (SUR) as quantitative method. In term of the model, he used the lag of the dependent variable to represent the role played by "incumbency advantage" in determining the composition of the foreign exchange reserves.

Findings proved his hypothesis; the development of the incumbency advantage of each reserves currency is a major factor to guarantee the dominance of a principal reserve currency, then, influencing the composition of foreign currency holdings.

Moreover, the research conducted by Chinn and Frankel (2007) worked in favor of previous result proving that incumbency advantage was determinant in explaining the currency composition of international holdings. His work was based on IMF annual data on global aggregate on foreign exchange reserves for the period from 1973 to 1998.

To summarize, if the incumbency advantage effect is considered significant, the relationship between the share of the U.S. dollar in international holdings and the trading size would be most significant, but it would be less applicable for other currencies.

c) Factors related to the home currency country

i. Trading volume of the home currency country

Trading volume is an indicator about the weight of the home currency country in the world economy. Therefore, it is an important determinant of the foreign currency holdings; if the currency country increases its trade volume with the rest of the world; other countries will have the desire to detain more of that country's currency as their reserves for trade payment purposes. The usage of trading volume as explanatory variable was treated for the first time by Eichengreen (1998).

Eichengreen (1998) investigated the impact of introducing Euro on the management of foreign exchange reserves conducted by central bankers. Hence, his research referred to aggregated data on the currency composition of total global holdings of reserves and focused mainly on U.S. dollar, the pound sterling and Japanese yen for the period between 1971 and 1995. He used as proxy the share of each currency country in the global exports. He confirmed that if a country increases its international trade volume with the rest of the world, other countries would have tendency to hold more of its currency for import settlement needs.

ii. Size and growth of the economy of the home currency country

In the regard to the history of the composition of foreign currency holdings presented above, it must be considering the use of the currency in terms of international status obvious. In other words, if the currency country has a large share in international output and its economy grows, the importance of its currency increases and becomes more significant as reserve currency for other countries. Empirical studies conducted by Eichengreen (1998) and Chinn and Frankel (2007) have confirmed the determinant role of this factor.

The first thoughts considering trade size and relative economic currency sizes as explanatory variables was based on earlier studies conducted by Eichengreen and Frankel (1996), which presented indications on the existence of a competition between U.S. dollar and Euro at that time. This assumption was founded on considerations that the economic size and the international trade of the Unified European countries would be more substantial than those of the United States of America (USA). However, with the regard to the main question whether Euro would overtake the dollar as primary reserve currency; the main conclusion of Chinn and Frankel (2007) emphasized on the importance of this explanatory variable. The explanation provided is the euro may become the dominant reserve currency, but it mainly depends; on one hand, whether other European countries would join the Eurozone so that become larger than the American economy, and on the other hand, whether, American policy maker decisions would decrease the confidence in the value of the U.S. dollar by means of inflation or depreciation.

iii. Inflation rate of the home currency country

The inflation is ultimately linked to Purchasing Power Parity (PPA), which states that the exchange rate between two countries is equal to the ratio of the currencies' respective purchasing power. Hence, the inflation of currency country has been seen as a potential determinant of different currencies' shares in foreign exchange reserves. The empirical literature found the inflation rate of currency country is a significant determinant of the currency shares in central bank reserves portfolio (Chinn and Frankel, 2007, 2008). The relationship is negative between the inflation of the currency country and its shares in foreign exchange holdings since the value of the currency would decrease threatening the objective of wealth preservation.

2-3- Mean-variance theory versus Transaction cost theory

The management of the currency composition of foreign exchange reserves is a crucial topic despite the fact that is poorly investigated. This specific area still unclear due the confidentiality of data and the specificity of the central bank. As mentioned previously, these shortcomings guided many investigations along two directions: Researches on the optimal composition of foreign exchange reserves on individual level and studies on the determinants of the currency composition of foreign exchange reserves on a global level or groupings of countries. Concerning the latter, Shi and Nie (2017) declared that main findings might be very challenging to apply on individual countries. Hence, in this perpetual work to understand the main influencing factors on the currency composition of foreign exchange reserves, two contender theories appeared, which are the mean-variance theory and the transaction cost theory. As explained above, such of them has its perception for the central bank authorities, goals for detaining foreign currency holdings, advantages and limitations.

First trials to understand the management of currency composition of foreign exchange reserves appealed the mean-variance theory. The latter was a relevant approach to any portfolio manager that aims to diversify its portfolio and realize wealth optimization. Central banks authorities are not an exception since they aim to preserve this national wealth by definition. However, economists have noted that empirical studies to verify the pertinence of using the mean-variance theory to foreign exchange reserves are probably to face numerous practical issues. The main assumption, which authors referred to, is limiting the role of central banks to construct optimal portfolio that will preserve or maximize their wealth; in other words, the determinants factors would be the return and the risk associated to holding assets denominated in different currencies. The existing empirical studies confirmed this hypothesis although many critics.

Conversely, transaction theory has another perception to the role of the central bank. In fact, the monetary authorities are considered the responsible of managing the national wealth that serves mainly to meet external engagements. Therefore, the transaction approach debates that currency shares in foreign exchange reserves ought to reflect the most important to accommodate the country's various international transaction needs. The latter might include financing foreign trade, honoring foreign debt engagements, and other factors. At variance to the mean-variance theory, this theory defends that the actual currency composition of foreign exchange reserves might be independent to the optimal diversification of net wealth across different currencies. The next table will summarize this comparison between those two contender theories

Table II.2:Mean-variance theory versus transaction theory

Indicator	Mean-variance theory	Transaction theory
The role of the guardianship authority	- Central bank is an institutional investor in order to preserve the wealth.	- Central bank manages foreign currency holdings in order to meet the country's liabilities.
Main assumption	- The currency composition of foreign exchange reserves meets the optimal portfolio.	- The desired currency composition of foreign exchange reserves is independent from optimal distribution of net wealth across currencies.
Main currency composition determinant factors	- The return of holding assets denominated in different currencies. - The volatility of holding assets in the different currencies	- Foreign trade; exports and imports - Foreign debt servicing - Incumbency advantages and network externalities. - Trading volume of currency country - Size and growth of currency country - Inflation rate in the currency country
Limitations and difficulties	Dooley (1987) and Dooley et al. (1989) identified three difficulties; which are: - Mean-variance theory fits more the wealth of net holdings of a financial instrument. Meanwhile, the currency composition of foreign exchange data refers only to gross holdings. - To be useful, this approach should include decisions regarding all the financial positions. However, foreign currency holdings are only a small subset of a variety of potential assets and liabilities that may be managed by central bankers. - Mean-variance approach is more intuitive if it is applied to individual countries. However the confidentiality restrictions has limited data to groupings of countries.	- The confidentiality of data has restricted studies on the determinants of the currency composition of foreign exchange reserves to IMF researchers, or investigating on a global level. - The findings based on a global level may face difficulties while applying it to individual countries (Shi and Nie, 2017).

Source: Own construction

3- The intervention approach

The existing literature about transaction theory has taken into consideration intervention needs in its process to understand the determinants of currency composition of foreign holdings. According to mercantilist motive, reserves are accumulated to maintain a low exchange rate for trade and to guarantee competitiveness (Gamage, 2016). Therefore, the existing literature have always outlined the role played by the intervention needs as one of the most determinant factors of the composition of foreign currency holdings. Central banking authorities use foreign exchange reserves to mitigate or amplify changes of their domestic currency value in the international exchange market. This type of purposes belongs; on one hand, to countries with a very open goods and capital market in the aim of restoring market function in times of stress (Blanchard et al., 2015). On the other hand, countries with a peg currency or a peg basket of currencies in order to intervene in foreign exchange market to guarantee that the exchange rate is not too far from its targeted rate. In other words, foreign exchange reserves serves to hedge the country against the exchange rate risk that will otherwise manifest in the settlement of imports. Consequently, choosing a particular reserves distribution assumes that the major motivation for holding reserves is to finance imports, which has been questionable by Ramaswamy (1999) at least for many monetary authorities. In the same context, Obstfeld and Rogoff (1995) insist on the importance of reserve holdings to protect exchange rate against speculative attacks.

These intervention can be categorized into sterilized intervention and unsterilized intervention. The common point between the two methods is both are based on buying or selling foreign currencies or bonds denominated on those currencies in the aim of increasing or decreasing the domestic currency in the foreign exchange market. However, sterilized transactions are conceived to influence exchange rates without changing monetary base, opposing to non-sterilized transactions, which affect the monetary base[5].

An additional consideration draws our attention to the role of exchange rate in determining the composition of foreign currency reserves, which is the tradeoff between the two competing central bank objectives. The latter are mainly; firstly, transaction costs that are encouraging the authorities to concentrate its holdings in a single foreign currency. Secondly, the obligation to

[5] "*Sterilized transactions are designed to influence exchange rates without changing the monetary base by buying or selling foreign currency denominated bonds while simultaneously buying and selling domestic currency bonds to offset the amount. Non-sterilized transactions involve simply buying or selling foreign currency bonds with domestic currency without the offsetting transaction*" (the balance.com)

proceed to diversification to minimize the risk. One of the most important risk is the exchange rate movements between different currencies that denominate reserves.

3-1- The impact of exchange rate regime

According to IMF (2016), exchange rate arrangements are classified into three main regimes that can be divided into subgroups, which are (1) hard pegs, (2) soft pegs, and (3) floating regimes.

Table II.3:Classification of exchange rate arrangements

Type	Categories				
Hard pegs	Exchange arrangements with no separate legal tender	Currency board arrangement			
Soft pegs	Conventional pegged arrangement	Pegged exchange rate within horizontal bands	Stabilized arrangement	Crawling peg	Crawl-like arrangement
Floating regimes (Market-determined rates)	Floating	Free Floating			
Residual	Other managed arrangement				

Source: *IMF annual report on exchange arrangements and exchange arrangements, 2016*

A growing body of literature has investigated the influence of the exchange rate arrangement on the scale of exchange market transactions undertaken by authorities since foreign currency holdings are mainly used as a tool of monetary and exchange rate policy. Generally, central banks adopted fixed exchange rate regime or with managed exchange rate regime require detention of large amounts of foreign exchange reserves in order to defend their exchange rate against undesirable pressure on domestic currency (Obstfeld and Rogoff, 1995). Moreover,

those who are using managing floating regime act alike. Even, countries adopting floating regimes hold reserves for optional intervention or a potential change in policy. Hence, the choice of the exchange rate arrangement influences the composition of foreign exchange reserves.

Preliminary work done by Heller and Knight (1978), which was carried out on individual country data relative to 76 countries over the period between 1970 and 1976, took into consideration the exchange rate arrangement to explain variations of different currency shares. Their findings proved that if a country fixed its exchange rate to a given currency, or if the reserve center was an important trading partner, the proportion of that currency in foreign exchange reserves would increase.

Dooley et al. (1989) used an adapted version of this dataset to test the impact of exchange rate regime on different currency shares. They identified an empirical relationship between the currency composition and exchange rate arrangement. The latter was important in explaining the composition of foreign currency holdings both in the group of industrial and in the group of developing countries.

Moreover, results found by Eichengreen and Mathieson (2000) was in favor of the previous researches testing the impact of the exchange regime despite the fact that the data belong to 84 emerging and transition countries for the period between 1979 and 1996. The period is longer than the cross-sectional time series data adopted by Dooley et al. (1989).

Finally, Beck et al.(2008) confirmed previous findings. They conducted their research by estimating dollar and Euro shares for 24 emerging countries for the period between January 1993 to December 2005. Results highlighted that countries with fixed exchange rate or tightly managed float tend to have optimal shares of U.S. dollar since it is the leading international currency. However, those adopting flexible exchange rate tend to have more diversification in their portfolios.

3-2- The impact of currency movement

The initial motive of detaining international reserves is to mitigate the undesirable evolution of exchange rate, hence protecting the domestic currency against speculative attacks. Currency movement plays a major role in identifying foreign exchange reserves. Chinn and Frankel (2007) considered rate volatility as an important factor in determining the currency composition of reserves globally.

Truman and Wong (2006) used data relative to 30 countries for the period between 2001 and 2005 to shed the light on the impact of exchange rate movement on the management of foreign currency portfolios detained by central banks. His results proved that portfolio diversification still limited to date. Although, there are beliefs that reserve diversification might enhance foreign exchange market volatility and exchange rate movements, they argued that policymakers might intervene to smoothen these changes by rebalancing their portfolios, and since they act in their national interest.

Lim (2007) looked into the impact of the past exchange rate movement on aggregated currency shares of foreign exchange reserves using COFER data for 1999Q1 to 2005Q4. He documented currency diversification in response to exchange rate volatility. He proved that portfolio rebalancing might be the prevailing dynamic allocation strategy in the management of reserves portfolio; In other words, exchange rate volatility changes the optimal combination of currencies using portfolio rebalancing. From this perspective, he denied that portfolio diversification might cause pressure on foreign exchange markets; conversely, such process would stabilize the market. He also suggested that results might support the opinion that that optimal reserve portfolio have changed over time, however, reserves managers implemented the change progressively.

Likewise, Chiou and Hseu (2008) conducted an investigation using the daily fluctuations of the exchange rate as a major factor to estimate the optimal holdings of foreign currency composition. The data were relative to groups of industrial and developing countries for the period between 1995 and 2001. The conclusion was confirming the initial theoretical basis; the exchange rate fluctuation played a crucial role in the manner of the composition of foreign exchange reserve within these countries.

Hatase and Ohnuki (2009) confirmed this relationship using Japan's foreign exchange reserves; they found that the stability of potential reserve currencies strongly affects the shifts of reserve currencies.

Finally, Ito, Mccauley, and Chan (2015) used data relative to six Eastern European countries for the period from 1997 to 2013. Their findings confirmed that currency fluctuations drove the change of currency composition of foreign currency holdings.

3-3- The impact of the financial market of the currency

The international status of a currency is strongly linked to the liquidity and the depth of their capital and money markets. In regard of the latter, they must be accessible to institutional and

private investors, free from the intervention of authorities, and well developed. Therefore, these markets may handle a large number and range of transactions. In fact, the U.S. dollar has more advantage than the Euro thanks to the "Wall Street" financial market. The New Yorker market is far more sophisticated than its counterpart in Frankfurt. Historically, the pound sterling was the dominant during its era thanks to the development of London financial market at that time Eichengreen (2005).

Chinn and Frankel (2007) highlighted the importance of a strong central bank and well-developed financial sector to counterbalance the impacts of political influence and the fluctuations of the trade sector. Authors admitted facing difficulties in finding an appropriate proxy available for all the financial centers; for this reason, they used foreign exchange turnover in respective financial markets over the period 1973 to 1998: New York, London, Frankfurt, Zurich. This measure has the advantage of capturing the preeminence of some financial markets regardless of the small role played by its currency such as pound sterling, as well as reflecting all kinds of international transactions.

3-4- Confidence in the value of the currency

Central banks around the world insist on wealth preservation as vital objective; hence, it is substantial to guard the confidence that the value of the currency will be stable and will not be inflated in the future. This assumption is fully justified since this leading currency is used a form in which to detain assets, then, it is important to ensure that its value would not fluctuate sharply. As an example, the dominance of the dollar in the 1990s is due to the good performance of U.S. inflation during the same period. However, Chinn and Frankel (2007) drew the attention to the U.S. current account deficit that may be a source of pressure on the value of the dollar; therefore, these fears could cause the unattractiveness of the American currency. This judgment was based on effects of Asian crisis in the late 1990s; many Asian currencies lost their value since investors lost their confidence in the economic systems. The latter was due to a large foreign debt and current account deficits.

3-5- The impact of the level of intervention

The level of intervention is strongly correlated to foreign exchange rate volatility and the exchange rate regime. However, the central bank as a regulator has two means of intervention to mitigate exchange rate movement; which are:

- Interest rate; although its efficiency, this process might cause inflation

- Foreign exchange reserves; that might be non-sterilized causing changes on monetary base or sterilized approach.

Central bank interventions in foreign exchange reserves have been always seen with skepticism by academics although it is well mastered by authorities (Fratzscher et al., 2018). Countries could use sterilized intervention operations since it is independent from monetary policy action, however, that appeal the usage of foreign currency holdings. This approach has been confirmed to be efficient to stabilize the exchange rate during the period of turmoil in financial market, or when interventions are large.

The existing literature that might use the intervention level, as explanatory variable, are restricted due to the confidentiality of data. Moreover, the choice of appropriate proxy has been always challenging; as an example, many researchers used the changes in international reserves as a proxy thanks to the correlation between both of them, however, it has been doubted since they were not strongly correlated (Neely, 2000).

Soesmanto et al. (2015) used the level of intervention in foreign exchange market held by Reserve Bank of Australia (RBA) to determine the most important factors that influence the currency composition of foreign exchange reserves of Australia. They referred to monthly data relative RBA's shares of reserve currencies, mainly, U.S. dollar, euro, yen and other currencies during the period March 2000 to September 2012, and use them in the SUR model. Results underlined the theoretical framework by proving a positive relationship between a currency share and the level of intervention in foreign exchange market especially for U.S. dollar and euro.

In brief, empirical findings of exceptional studies that used confidential data proved the importance of intervention level on the currency composition of foreign exchange reserves. Nevertheless, researchers failed to have a perfect proxy that might be used to reflect the intervention level for other studies. Hence, researchers referred to other explanatory variables that might encounter intervention needs such as exchange rate volatility, exchange rate regime, and the confidence in the value of the currency, which proved their explanatory power.

Conclusion

This chapter exhibited different approaches that guided the definition of the demand of international reserves, as well as its currency composition. As stated in this chapter, a growing body of literature has undertaken those two aspects. The confidentiality of data and the sensibility of this field were considered among the most serious impediments to broaden

knowledge, especially in the currency composition aspect. Indeed, these barriers guided researches into two directions; the first one ,which appealed the mean-variance theory, focused on the optimization approach in order to determine the optimal currency composition of foreign exchange reserves. However, this approach was criticized for many reasons, which the specificity of the central bank as an investor is the most important. The second direction that aimed the identification of determinants of the currency composition of foreign exchange reserves called for the transaction cost theory. In the respect of the latter, the central bank was perceived as a public institute that manages foreign exchange reserves given a panoply of considerations related the country's external engagements such as financing international trade, honoring external debt, and similar factors. These two theories were perceived as contenders because of their initial hypothesis, but both of them proved their efficiency in explaining the currency composition of foreign holdings. The theoretical framework has not been limited on those two approaches; the intervention need seemed a plausible determinant. The intervention approach was correlated to the exchange rate regime, the exchange rate volatility, the financial market of the currency, the confidence in the value of the currency, and the level of intervention done by the guardianship authority to affect the exchange rate. Empirical studies done on groupings of countries proved that the majority of explanatory variables exhibited above are significant. However, researches on individual countries are very limited due to the confidentiality of data.

In this investigation, we aim to identify the main determinants that affect the level of Tunisian foreign holdings and its currency composition. The management of foreign exchange reserves holdings is within the purview of the Central Bank of Tunisia. Different approaches will be called for in the aim of determining the most influential factors on the level of international reserves, besides the demand function of different principal currencies composing the foreign exchange reserves.

CHAPTER III:

FOREIGN EXCHANGE RESERVES LEVEL AND COMPOSITION: A FOCUS ON THE CENTRAL BANK OF TUNISIA

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Introduction

The foreign exchange reserves management is interestingly becoming an urging matter to deal with. Facing the array of motives that emphasize the greatness of foreign exchange reserves in protecting the country in rainy days, they are a subject of several recommendations instituted by the IMF. In the light of these concerns, a rigorous management bespeaks a clear definition of the objectives that are mainly; liquidity, wealth preservation, and income generation. These objectives ought to be established within an appropriate institutional and governance framework as defined by the IMF guidelines. Indeed, they serve to settle best practices and policies in the aim of reinforcing the prudence and the risk aversion. Nevertheless, preliminary questions about the determinants of the level and the currency composition of a country's foreign holdings still so pressing. Responding to these interrogations is attracting a widespread interest due its usefulness in shaping the reserves managements, and enhancing the resilience of the country in crises. Concerning the demand for international reserves, the theoretical body that has investigated the optimal level as well as the determinants referred to two approaches, which are: i) the demand of reserves are explained by the divergence between the existing level and the desired one. ii) The demand of reserves is due to reasons related to monetary approach to balance of payments. Defining an adequate level is not enough to minimize risks, therefore, central banks around the world subscribed to a process of diversification between the leading reserves currencies. Catering for this issue is coupled to priorities fixed by the reserves management unit; hence, the theoretical framework called for the mean-variance approach, the transaction approach, and the intervention approach.

To the best of my knowledge, the Tunisian foreign exchange reserves were not a subject of these interrogations although the rising concerns about its evolution in last years. Therefore, the aim of our investigation is to define the determinants of the level of Tunisian foreign exchange reserves, as well as establishing the currency demand functions that elucidate its currency composition. This chapter is organized as follows; the first section gives a brief overview on the role of the Central Bank of Tunisia in managing the international reserves. The second section is an empirical investigation on the determinants of the level of foreign exchange

reserves. The third section defines the currency composition determinants in two steps; firstly, we will use only the mean- variance approach to question the statute of Central bank as an investor. Secondly, we will test different approaches more formally in the aim of determining the currency demand function relative to the main currencies that will serve to define the adequate structure.

Section 1: Central Bank of Tunisia as the relevant authority

1- Presentation of the Central Bank of Tunisia

The Central Bank of Tunisia (CBT) was formed two years after the independence; it was created thanks to the promulgation of the law n°1958-90 of 19 September 1958, which governs its creation and organization. In the same year, the Tunisian Dinar was brought into being as a domestic currency by the act n°1958-109. However, the disconnection of the Tunisian Dinar from French franc took place only on 30 December 1958.

2- Central Bank of Tunisia and foreign exchange reserves management

The present investigation focuses on the role assumed by the Central Bank of Tunisia in the management of the country's international reserves, especially those detained on foreign currencies. As mentioned previously, the monetary authority is trying to be aligned with international recommendations; it presents a governance and institutional framework that boosts the transparency and accountability, as well as subscribing to the recommended policies in reserves management.

2-1- Legal framework of international reserves management

Foreign exchange reserves management is accorded to the Department of Reserves Management and Markets. Until 2011, reserves management was regulated by a set of notes and guidelines. However, following this date, a document entitled Investment Policies for Foreign Exchange Reserves (IPFER) has been adopted by the Board of Directors of the CBT. This document has responded to the need of a strong institutional and governance framework that outlines the general principles of reserves management, different responsibilities, strategic asset allocation, eligible investments and risk limits.

2-2- Risk and Investment committee

Risk and investment committee plays a pivotal role in ensuring good governance, accountability and oversight on the management of foreign exchange reserves. It defines the investment policy

given panoply of objectives: to do so, it identifies and assesses different potential risks, as well as implementing different control measures. These different guidelines are included in the Investment Policies for Foreign Exchange Reserves. The review and the regular control of respect of this document are assumed by the head of the department of reserves management and markets. In the respect of the latter, he has the terms of references to implement the corrective measures in case of problems.

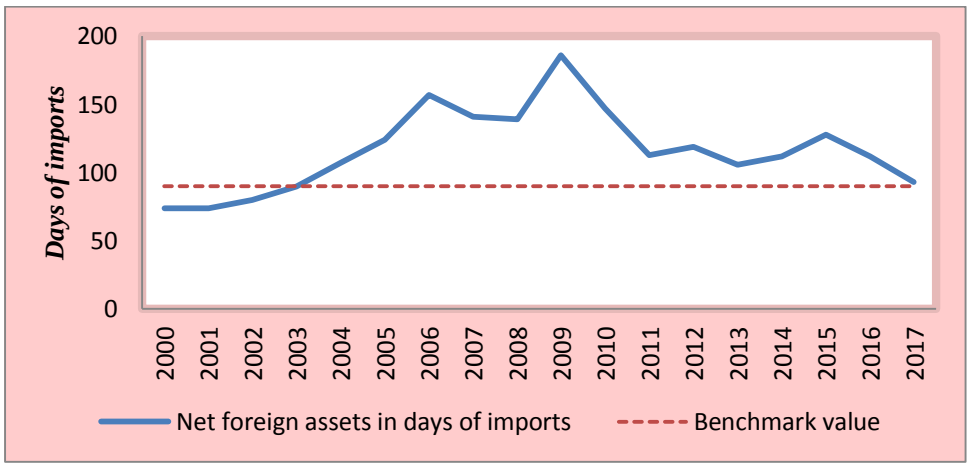
3- Overview on foreign exchange reserves of Tunisia

Foreign exchange reserves are very important for Tunisia to keep the stability of the monetary and the economic system, as well as protecting it against reputational risk. Foreign holdings detained by the CBT are not an exception: Thanks to them, Tunisia has met its foreign engagements, guarded the confidence in the monetary and exchange rate policies of the government, and absorbed distress in the time of the turmoil. To shed the light on their importance, we will overview their evolution over time, as well as outlining the standards followed by authorities.

3-1- Tunisian foreign exchange reserves evolution

The accumulation of foreign holdings is perceived as an efficient monetary tool that has the capacity of stabilizing the most vulnerable factors as the exchange rate, debts, and balance deficits since the East Asian crisis of 1997 (Kumail et al., 2011). Due to this relationship, Tunisian foreign exchange reserves witnessed many reversals as shown in the following graph.

Figure III.1:Net assets in foreign currency evolution (in days of imports)



Source: Central Bank of Tunisia annual reports

Tunisian foreign exchange holdings underwent an episode of prosperity thanks to manufactured good exports, and the increasing of the competitiveness of the country, which is coupled with

the depreciation of the domestic currency. However, the level of foreign holdings experienced a slight decline in 2007 and 2008 because of the international financial crisis. In these two years, Tunisia endured relatively well the international crisis thanks to the existing restrictions imposed on capital movements. In 2009, foreign holdings reached a peak of 186 days of imports although the international context was difficult, especially for the Industrialized European countries qualified as the first partners to Tunisia. In actual fact, Tunisia realized a growth rate of 3.1%, and decreased its current deficit by 2.8% (in percentage of GDP). This outcome is achieved thanks to a great agricultural crop, and the boosting in tourists arrival from Libya and Algeria, who replenished the gap caused by European tourists burdened by global recession. Since 2009, Tunisia has witnessed a reversal in tendency, which has been accentuated subsequent after 2011 to reach in 2017 the level of 90 days of imports, and 78 days, in the first trimester of 2018, dwindling under the benchmark value of three months of imports. This situation is explained mainly by the severe slowdown of exports, the increasing social protests, and political issues that questioned the security of the country; all these factors deteriorated the external balances, hence the mobilization of important amounts of foreign holdings to meet external engagements took place.

3-2- Tunisian foreign exchange reserves management

Although the Central Bank's net foreign currency assets continue to plummet in these crucial circumstances, reserves management unit is in perpetual work to optimize the existing foreign holdings given a set of objectives and strategies. In fact, the main objectives privileged are:

- *Wealth preservation*: which consist on minimizing the risk given a fixed level of return. The most challenging risks are market risk and credit risk.
- *Liquidity*: This objective is the most challenging one since the CBT is obliged to meet country's external obligations. Hence, it has to provide liquidity in any time with the lowest cost.
- *Maximizing the return*: Given the two previous objectives, the CBT, as a public investor, ought to invest these foreign holdings to get profit from different eventual movements of the market, yet we have to mention that central bank is not a normal investor since the security of the investment is a determinant criterion.

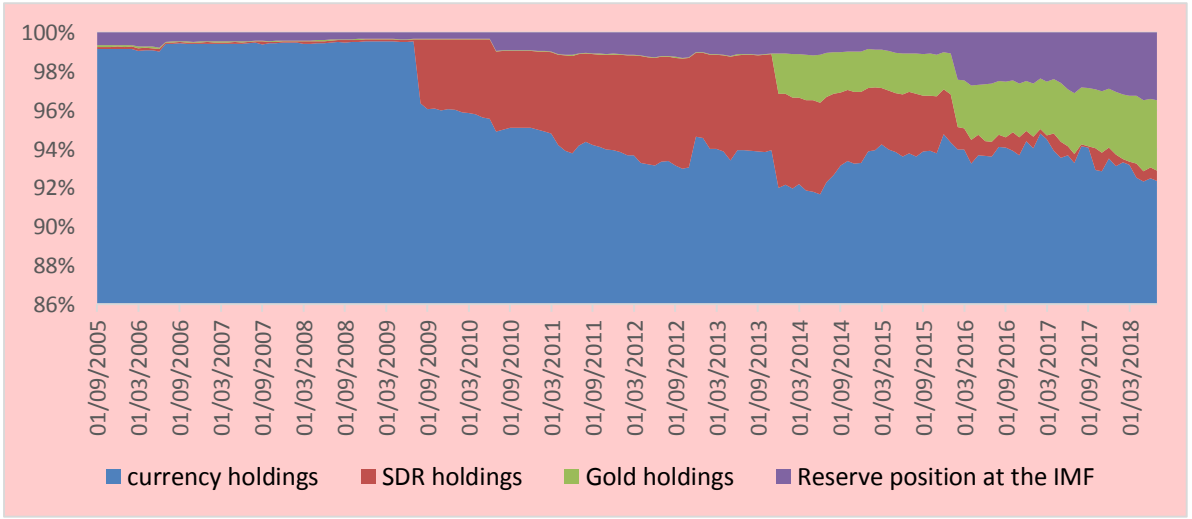
These objectives can be met thanks to the tranching and the diversification among different currencies and instruments. The tranching process aims to divide foreign holdings into three parts, which are:

- *Working capital tranche*; that serves to meet the country's liabilities for a period of one month.
- *Liquidity tranche*; that aims honoring the country's engagements during one year. In fact, this tranche serves to replenish the working capital tranche.
- *Investment tranche*; which is meant mainly to generate returns; foreign holdings detained are used in placements for a period beyond one year.

Usually, these tranches are revised annually unless exceptional events requiring immediate adjustments. Moreover, these tranches are a subject of a process of diversification among different currencies; Reserves management unit seeks for identifying the optimal composition of foreign exchange reserves by minimizing the loss caused by the volatility of some currencies and by respecting the currency structure of external engagements. This work calls for a rigorous risk management; it consists on fixing the investment horizon, the tolerated risk margin, the allowed investment instruments as well as defining risks to which the reserves managers are likely to face as credit risk, market risk and operational risk.

In the light of its importance, the composition of international reserves is considered crucial to optimize the use of foreign exchange reserves; the composition of Tunisian foreign holdings has witnessed a perpetual change due to local and international circumstances. The following graph shows these alterations.

Figure III.2:The evolution of different components of International



Source: Central Bank of Tunisia

We notice that the currency holdings have the share of the lion in the composition of Tunisian international reserves with an average of 96%. In fact, they were stable at the level of 99.5% of total gross reserves until 2009, when around 3% have shifted in favor of SDR. This displacement, which took place in August 2009, subscribed to a general allocation of SDR implemented by the IMF. The latter aimed to protect countries suffering from liquidity problems from deflation risk (International Monetary Fund, 2009). The size of allocation was appropriate to keep Tunisia from inflationary risk since it exhibits 3% of total reserves as recommended by the IMF. Consequently, the currency holdings share has ranged from 96.35% to 92.39% since 2009.

In December 2013, The Gold holdings jumped from 0.03% in previous month to around 2%. This consolidation is justified by both international and national circumstances; Firstly, during that period, world economy did not heal yet and it has considered a period of turmoil in international financial markets; hence, the gold, which is considered a safe haven asset thanks to its characteristics as a shield against unforeseen crisis, high liquidity and value preservation, was called for by the majority of central banks around the world. Moreover, the boom of sovereign default in euro zone during this era, pushed authorities to acquire gold to enhance confidence in the stability of Tunisian financial system. However, the level of DTS has been shrunk in favor of reserve position in the IMF because of the Extended Fund Facility (EFF) arrangement requested by Tunisia.

Section 2: Empirical investigation on the determinants of Tunisian Foreign exchange reserves

Tunisian foreign exchange reserves level is among the most important economic indicators that draw the attention of the public. Its degrading level arouses a number of questions about the reasons that stand behind this shrunk. In the light of this intriguing issue, we judged the exigency of determining the influencing factors on the level of foreign holdings. In the following, we will exhibit our empirical investigation that deals with this issue.

1- Data definition and sources

In our investigation, we use quarterly time series data for the period between the fourth quarters of 2005 to first quarter of 2017 relative to five variables, which are; the gross foreign reserves in % of GDP without gold, current account deficit in % of GDP, capital account deficit in % of GDP, standard deviation of exchange rate, interest rate differential. All the data relative to this

part are publicly available and collected from the Central Bank of Tunisia statistics, National Institute of Statistics (INS), and the IMF database.

The dependent variable

Gross foreign exchange reserves: it represents the dependent variable that we aim to explain. It is calculated as the whole gross reserves minus gold since the latter is not considered as an intervention asset (Jiang, 2018). This variable is expressed in % of GDP. The gross reserves are available in CBT statistics, while the GDP is published by the INS.

The explanatory variables

Current account in % of GDP: This ratio represents the current account vulnerability as defined by (IMF, 2003). It aggregates the sold relative to merchandises, services including tourism, remittance, and current transfers. The current account deficit is available on quarterly basis and published by the CBT, yet, this variable is expressed in % of GDP.

Capital account in % of GDP: this ratio represents the capital account vulnerability according to (IMF, 2003)**.** It gathers the sold relative to capital transaction, direct investments, portfolio investments, and other investments. The capital account deficit is published in quarterly basis by the CBT. However, we expressed it in % of GDP.

Standard deviation of Real Effective Exchange Rate (REER): we referred to this variable to express the exchange rate flexibility. The REER is an index that expresses the weighted average of Tunisian dinar exchange rate given a basket of main currencies. However, the effect of inflation is taken into consideration, as well as the balance of payment to determine the weight. The proxy of exchange rate flexibility is calculated as the rolling standard deviation of two quarters of real effective exchange rate(Aizenman and Marion, 2004; Prabheesh et al., 2007). The latter is available in IMF data.

Interest rate differential: It is calculated as= $\frac{(1+money\ market\ rate\ in\ Euro\ zone)}{(1+domestic\ money\ market\ rate)}$. The choice of Euro zone interest rate is explained by the fact that the structure of foreign direct investment is dominated by the European Union with an average of 84% according to the annual report of CBT, on one hand, and its being as the first trade partner for Tunisia, on the other hand.

According to literature review, the population and per capita GDP might be potential determinants of the level of Tunisian of foreign exchange reserves since both are proxies to the size of the country. Unfortunately, they are only available on annual basis, which stands against taking them into consideration.

2- Variables description

This research work aims to identify the influencing factors on the level of foreign exchange reserves of Tunisia. Therefore, we started by the descriptive statistics to both dependent variable and potential explanatory variables.

The table III.1 shows that the average ratio of gross reserves in % of GDP is 68.9712, which is near the value of median. This result proposes that the variable is normally distributed, which confirmed by Jarque-Bera normality test. The range calculated (Max-Min=42.63586) coupled with the standard deviation exhibited by this variable are important suggesting that during the period of sample the level of Tunisian foreign holdings is not stable over time. The Tunisian foreign holdings witnessed a period of growth thanks the increasing competitiveness of Tunisian exports. However, 2011 was a pivotal date after which the social turmoil caused a sharp decrease in tourism income and export activities. Hence, the external balance of the country deteriorated.

Concerning the regressors, on one hand, only the current account ratio, as well as the interest rate differential proved to be normally distributed, and on the other hand, capital account ratio, and exchange rate flexibility are not normally distributed. In fact, both capital account ratio and exchange rate variability are exhibiting a positively high skewness coupled with a leptokurtic form.

Concerning the dispersion, both current account ratio and capital account ratio present important variability since the standard deviations are 3.6986 and 6.1717 successively. This variability can be explained by the fact that Tunisian current account is in permanent deficit, yet, it has worsen after 2011 due political and social instability. The capital account has also witnessed a high variability after the revolution due essentially to the volatility of foreign direct investment. In fact, the social instability and political problems appeared after 2011 caused the lack of confidence and visibility for foreign investors.

Exchange rate volatility is considered important, which is explained by the exigency of the CBT to cope with national and international circumstances. The sharp decline of the Euro against

USD in 2000 and 2001, as well as the urgent need to guard the competitiveness of Tunisian companies faced the increasing openness of the economy[6] pushed authorities to opt for the depreciation of the REER. However, this approach has been disused in 2008 in favor of stabilizing the real exchange rate. In 2014, Tunisia subscribed to a more flexible exchange regime due to the increasing current account deficit.

Interest rate differential showed a little variability due to that fact that the Tunisian monetary Market rate (TMM) is known to be of low volatility due to strong presence of the Central Bank of Tunisia, for example, since 2000, it has changed once in 2006. However, in February 2009, the CBT encouraged the banking sector to be part of the monetary policy by establishing facilities and the corridor, which helped the TMM to be more flexible (Lajmi, Moez and El Khadhraoui, 2014). The TMM increasing variability is witnessed after the revolution but not in higher pace during the period of sample. The domestic interest rate variability on the northern shore of the Mediterranean is known to be stable over time with a rate fluctuating around a zero.

[6] This period is characterized mainly by the phasing out of quotas under multi-fiber agreement and the launching of the second phase of Association Agreement with European Union.

Table III.1:Descriptive statistics

	Gross reserves	Transaction current account	Capital current account	Exchange rate volatility	Interest Rate Differential (IRD)
Mean	68.9712	-6.149271	7.190517	1.144110	0.966944
Median	67.4491	-6.576378	6.836978	0.948599	0.962753
Maximum	91.3701	1.113563	31.40991	3.948651	0.991033
Minimum	48.7342	-13.74557	-5.233719	0.180721	0.953021
Standard Deviation	10.8938	3.698672	6.171722	0.868254	0.012092
Skewness	0.32685	0.128666	1.217280	1.498170	0.632611
Kurtosis	2.24937	2.165836	6.933200	4.793827	2.045313
Jarque-Bera	1.89896	1.460596	41.01119	23.37540	4.815073
Probability	0.38694	0.481765	0.000000	0.000008	0.090037
Sum	3172.676	-282.8664	330.7638	52.62906	44.47943
Sum sq.dev	5340.356	615.6078	1714.057	33.92389	0.006580

3- Multicollinearity tests

The next step is to check that our exogenous variables are free from multicollinearity. The latter is defined as the existence of a strong relationship between explanatory variables in a model. According to econometrics, it is crucial to verify the absence of multicollineairity, otherwise, results would be biased and misleading. In the light of this consideration, we will start with the correlation matrix between different potential explanatory variables in order to test collinearity between different independent variables. For the needs of our estimation, regressors that would be taken into consideration must be free from dual collinearity; hence, their correlation coefficient ought to be lower than |0.8| according to Gujarati (1995). The following table represents the correlation matrix of our exogenous variables.

Table III.2:matrix of correlation

	Current account ratio	**Capital account ratio**	**Exchange rate flexibility**	**Interest Rate Differential**
current account ratio	1.0000	-0.1065	-0.4319	0.6160
Capital account ratio	-0.1065	1.0000	0.1579	-0.1548
Exchange rate flexibility	-0.4320	0.1579	1.0000	-0.5411
Interest Rate Differential	0.6160	-0.1548	-0.5411	1.0000

The Table III.2 indicates that our independent variables are free from collinearity between each pair of variables; hence, we will take all of them into consideration in our investigation. However, this preliminary judgment must be confirmed by testing multicollinearity between different regressors using Variance Inflation Factors (VIF). In this test, null hypothesis indicates the absence of multicollineary and it is adopted only if VIF is lower than 10 according to Gujarati (1995). The table III.3 shows the result of the VIF test.

Table III.3:Variance Inflation Factors test (VIF)

	Coefficient variance	VIF
Current account ratio	0.2129	4.6360
Capital account ratio	0.0647	2.4492
Exchange rate flexibility	3.9682	3.4542
Interest rate differential	12.3993	4.9772

Based on both matrix of correlation and VIF test, we confirm that our exogenous variables are free from multicollienarity and we have the ability to take all of them in the same model in the aim of explaining the level of Tunisian foreign exchange reserves.

4- Empirical methodology

Dealing with times series data requires preliminary test to identify the model that we would deal with; which is the Augmented Dickey-Fuller for unit root test (Dickey and Fuller, 1981) to verify if variables were stationary or not. Granger and Newbold (1974) highlighted the risk of using non stationary variables in ordinary regression; the latter would be a spurious model causing questionable results although it might produce significant coefficients.

If variables are stationary we will use Ordinary Least Squares to estimate our model. However, if variables are not stationary, which is the case of the majority of series, long run equilibrium between different variables could be identified thanks to co-integration test (Engle and Granger, 1987)**.** This result suggests the presence of an error correction system modeled by Vector Error Correction Model. The latter represent short run dynamics, especially the speed of adjustment mechanism to its equilibrium level.

Equation 1: General form of VECM

$\Delta X_t = c + \beta X_{t-1} + \gamma_1 \Delta X_{t-1} + \cdots + \gamma_{p-1} \Delta X_{t-p+1} + \varepsilon_t$, where X_t the vector of non-stationary variables and p is number of lag suggested by Lag length criteria.

The most important parameter in the VECM is the coefficient of error correction term that measures the speed of adjustment of foreign exchange reserves to its equilibrium level. The latter must be negative and significant to highlight the presence of correction mechanism.

5- Empirical findings

Augmented Dickey-Fuller test for unit root is the most crucial step that will decide the approach that will be adopted. The preliminary ranges of choices are ordinary regressions if the variables turned out to be stationary over time, otherwise, we will refer to the Cointegration approach to define a long run equilibrium and the Vector Error Correction Model to define the speed of adjustment.

5-1- Augmented Dickey-Fuller test for unit root

Thanks to Augmented Dickey-Fuller (ADF), we tested the stationarity of existing series. Hence, the null and alternative test hypotheses are:

H_0: The variable has a unit root

H_1: The variable is stationary

The results presented in the table III.4 proved the acceptance of the null hypothesis of unit root for all variables. However, their first differences are stationary; therefore, all the variables are integrated at the level of one.

According to the table III.4, all the variables are not stationary, as well as having the same order of integration, we can use the co-integration technique to confirm the existence of a long run equilibrium relationship between the level of gross reserves, the current account ratio, the capital account ratio, the exchange rate flexibility, and interest rate differential.

5-2- Selection of the Lag length

In the aim of estimating the long and the short term relationship between different variables, a prior determination of the model order is required. To do so, we refer to Lag length criteria as Likelihood Ratio (LR) test statistic, Final Prediction Error (FPE), Akaike Information Criterion (AIC), and Hannan-Quinn information criterion (HQ). The optimal lag length is the one which minimizes the information criteria (Gutierrez et al., 2009). Schwarz information criterion and Hannan-Quinn information criterion offered the minimal lag length, which is one lag as shown in the appendix I.3.

Table III.4:Augmented Dickey-Fuller results for a unit root on the level and first difference of the series

Variables	ADF test at the level			ADF test at first difference			Status
	t-statistic	Critical value at 5%	Decision	t-statistic	Critical value at 5%	Decision	
Gross foreign exchange reserves	-1.699635	-2.929734	Non-stationary	-5.667889	-2.929734	Stationary	I(1)
Current account ratio	-0.809344	-2.929734	Non-stationary	-8.777101	-2.929734	Stationary	I(1)
Capital account ratio	-0.994854	-2.929734	Non-stationary	-9.062504	-2.929734	Stationary	I(1)
Exchange rate volatility	-0.258214	-2.929734	Non-stationary	-7.573199	-2.929734	Stationary	I(1)
Interest rate differential (ird)	-1.615538	-2.929734	Non-stationary	-3.674447	-2.929734	Stationary	I(1)

5-3- Cointegration Result

The Johansen co-integration test proved the existence of a stable relationship among gross foreign exchange reserves, and different explanatory variables, hence the disequilibrium error would tend to be stationary and has a zero as a mean. The co-integration equation that expresses the long run dynamic is:

Equation 2: Long term dynamic equation

$$R_t - 23.20108 * TC - 19.50335 * Cap + 28.51766 * volt\_rate + 2193.683 * ird - 2225.236 = \varepsilon_t$$

Based on the co-integration test, the equation defined above would be valid if ε_t is stationary; hence, the test for co-integration, exhibited in table III.5, validate the previous assumption.

Table III.5:test for Cointegration

	t-statistic (ADF)	**Critical value at 5%**	**Results**
Residuals ε_t	-7.401558	-2.928142	Reject H_0
Conclusion	The residuals of the long run equilibrium do not have a unit root. Therefore, gross foreign exchange reserves, current account ratio, capital account ratio, exchange rate volatility, and interest rate differential are co-integrated.		

Therefore, the long run equilibrium equation that explains the level of gross foreign exchange reserves is:

Equation 3: The long run equilibrium of foreign exchange reserves

$$R_t = \underset{}{2225.236} \underset{[-6.64494]}{+23.2 * TC_t} \underset{[-7.02917]}{+19.5 * cap_t} \underset{[\ 4.40363]}{-28.52 * volt\_rate_t} \underset{[\ 4.32851]}{-2193.683 * ird_t}$$

The T-static in the parentheses indicates that the chosen variables are explanatory at 5 % level, which confirms the theoretical framework. In the light of this result, we notice that current account ratio and capital account capital indicate an important influence on Tunisian foreign holdings, which is coherent with the increasing need of self-insurance. For further explanation, Tunisian reserves are quite sensible to current account vulnerability since the proxy used scales the openness of the economy and its exposition to external shocks (Dominguez and Frankel, 1993). This highly positive relationship affirms the assumption that foreign exchange reserves

accumulation is due to precautionary motive, as well as the limited access to international capital market. Moreover, this high coefficient suggests that an augmentation of this ratio by one unit, enhances the growth of foreign holdings by 23.2 units; therefore, precautionary need is ultimate in Tunisian case since reserves holdings are accumulated to face the current account vulnerability during the period of investigation.

The capital account vulnerability subscribe to the same assumption as current account vulnerability. This determinant exhibits the financial openness of the country and its exposure to the withdrawal of assets; hence its vulnerability to crisis. If capital account ratio increases by a unit, the level of reserves must grow by 19.5 units. This high impact is coherent with the increasing role of insurance need (Prabheesh, Malathy and Madhumati, 2007).

The exchange rate flexibility plays also a major role in defining the level of foreign exchange reserves. This significant negative relationship is explained by its crucial role in reducing the demand to foreign holdings. In fact, the central bank would decrease its stockpile of foreign exchange reserves if the exchange rate were flexible, and no longer pegged (Heller and Khan, 1978; Lizondo et al., 1989; Lane and Burke, 2001).In actual fact, since 2009, Tunisian balance deficit started to be worrying causing a pressure on foreign exchange reserves. Therefore, CBT has been engaged in multiple reforms[7] that started in 2012 in the aim of making the exchange rate more flexible, hence, mitigating the absorption of reserves in defending the domestic currency.

The interest rate differential is a negative significant influencer in the long run equilibrium, which is consistent with the theoretical framework. However, it has a higher impact compared to other determinants. In fact, Tunisia is very sensitive to European monetary policy; a large interest rate differential in favor of Tunisia, featured by the decrease of the interest rate differential, would launch capital inflows causing an increase of the level of foreign exchange reserves. Consequently, the domestic currency would appreciate because of the increasing demand of domestic currency. However, Baclet and Vidon (2008) outlined the risk of a sudden capital outflows that might cause a dangerous fluctuation for external balances. Fortunately, this threat is minimized thanks to restrictions on capital inflows and outflows. The latter have the advantage to lower the capital account vulnerability.

[7] The CBT reform is based on four axes, which are: i) exchange rate is determined according to interbank exchange rates, ii) setting up "Trade net" to ensure an immediate monitoring , iii) The intervention of CBT is based on its own initiative and according to interbank exchange rates, and iv) Market Makers role has been enhanced.

Based on the long run equilibrium, the detention of foreign exchange reserves reflects a self-insurance need, which subscribe to the category of precautionary motive. However, this co-integration relationship requires the definition of the correction mechanism of the short run disequilibrium, which is tested by the Vector Error Correction Model.

5-4- The Vector Error Correction Model

The existence of one or more co-integration relationship motivates us to utilize the VECM as an appropriate method of estimation. This method has the credit to capture the existence of a mechanism of adjustment and its speed.

Table III.6: The Vector Error Correction Model estimation

Error correction	ΔR_t	ΔTC_t	Δcap_t	$\Delta volt\_rate_t$	Δird_t
Adjustment	-0.035887**	-0.004480	0.039723*	-0.006976**	-3.41E-06
ΔR_{t-1}	-0.036736	-0.328585	-0.311659	-0.130455**	-0.000143
ΔTC_{t-1}	-0.075229	-0.717905**	0.318657	-0.163288**	-0.000121
Δcap_{t-1}	-0.023979	-0.052815	-0.206194	-0.094559**	-3.39E-05
$\Delta volt\_rate_{t-1}$	1.640515**	0.179996	-0.283558	0.447284**	0.000118
Δird_{t-1}	34.28285	-293.3943	116.0446	-1.743116	0.505840
C	-0.030640	-0.464796	0.564489	0.003514	-0.000253

Note: *the above table exhibits the VECM estimation results with *denotes 10% significance level, **denotes 5% significance level, and *** denotes 1% significance level.*

However, before adopting this model, testing its validity is crucial. As criteria of selection, residuals must be normally distributed with the absence of both serial correlation and heteroscedasticity.

Table III.7:Validity tests

Tests	t-Stat	Probability	Decision
LM test (Lags=12)	28.94759	0.2661	H_0 : No serial correlation at lag 12 *Accept H_0*
Jarque-Bera	184.0290	0.4440	H_0 : Residuals are multivariate normal *Accept H_0*
White's Chi-sq	175.8329	0.5738	H_0: Error is Homoscedastic *Accept H_0*

According to the table III.7, our model is proved to be valid and stable, and then it is able to capture the short run effects. In the light of this consideration, the speed of adjustment exhibited by the error correction term is significant at 5% level with a negative sign, which confirm the existence of correction mechanism. The celerity of adjustment as defined by VECM is-0.035887, thus, around three percent of the deviation from equilibrium is removed within each quarter. This speed is judged to be slow, which denotes that the return to equilibrium would be realized in slow pace and may take a long time. This low speed is explained by Clark (1970) as the urgent need to have a high level of foreign exchange reserves to reach equilibrium. Therefore, the guardianship authority is obliged to enhance the accumulation of foreign holdings in the aim of boosting the recovery of long-run equilibrium. In other terms, CBT ought to increase its level of reserves to face current account vulnerability, as well as capital account vulnerability. In the respect of the latter, it proved to have a short run effect at the level of 10% with a positive sign that indicates the urgent need to reduce capital account vulnerability in order to reach equilibrium, which is in line with previous researches.

Moreover, we notice that only the exchange rate flexibility turned out to have a recall force to reach long-run equilibrium at the level of 5%. Its negative sign indicates a need to increase exchange rate flexibility, so that CBT reach the long run equilibrium. The speed of adjustment mechanism estimated is -0.006976, which proposes that about 0.7% of deviation from the long-run equilibrium is eliminated each quarter. In fact, (Bahmani-Oskooee, 1988) highlighted the existence of a positive and significant relationship between exchange rate flexibility and the rapidity of adjustment. He explained this relationship by referring to the role played by exchange rate fluctuation to guard equilibrium of the balance of payment. In fact, countries are hesitant to use external adjustment when it is contradictory with the domestic stabilization. Therefore, it is common to utilize flexible exchange rates so that adjustment problems would be solved, as well as avoid pressure on the monetary authority to level up its reserves. The CBT has started a reform that aims to make the exchange rate more flexible since 2012, and get benefit of this positive relationship with the increasing adjustment celerity. Therefore, the exchange rate flexibility ought to be increased to accelerate the process of recovery.

To sum up, this section outlined the different influential factors that affect the level of Tunisian foreign exchange reserves by defining the long-run equilibrium. On one hand, the current account vulnerability, as well as the capital account vulnerability turned out to have a positive impact on the level of foreign exchange reserves, stressing on the need to raise the level of

reserves. On the other hand, the exchange rate flexibility and the interest rate differential have a negative impact, highlighting their impact on lower pressure on foreign holdings. These results propose that the accumulation of foreign exchange reserves in Tunisia seems to subscribe to the precautionary motive. However, the return to equilibrium is a concern to CBT, hence; we proved the existence of a recall force. The latter is considered slow, yet, it has highlighted the need to enhance the detention of foreign holdings. Surprisingly, only the exchange flexibility seemed to be determinant in the short run equation and has the impact to remove deviation from equilibrium. This conclusion is in good with Moody's opinion released 16 October 2018 that outlined that reserves drain is due mainly to defending domestic currency, before showing more flexibility that caused a decrease of the value of dinar by 19% against euro in one year.

Section 3: The currency composition demand function

Determining the different influencing factors on the level of Tunisian foreign exchange reserves is considered a first step to explore Tunisian reserves management. This scoop cannot be achieved without exploring the determinants of the currency composition of foreign holdings since it has the share of the lion. Therefore, we aim to determine the demand function of each currency by calling for different theoretical framework starting by the mean-variance theory passing by the transaction theory without neglecting the intervention approach.

1- Optimal composition of Foreign exchange reserves: Mean-variance method

In an attempt to understand the profile of CBT as an investor, and the relevance of the return and the risk in identifying the currency demand function, we referred to the mean variance theory. The main currencies examined are United States Dollar (USD), Euro (EUR), The Great Britain Pound (GBP), and the Japanese yen (JPY), for the period between 2000 and 2017. These currencies represent in average 97% of the currency reserves detained by the CBT during the same period.

1-1- Data and methodology

In this part, we seek to identify the optimal currency composition of the foreign exchange reserves by identifying the real return of each currency. The latter is justified by the need to estimate foreign holdings by their own purchasing power according to Levy and Sarnat (1975). He insisted that the optimal portfolio must take into consideration import patterns; hence, nominal returns will be deflated by the import price index.

Ex post real returns is calculated as:

Equation 4: Ex post real return

$$m_{it} = \frac{(1 + r_{it})(^{e_{it+1}}/_{e_{it}})}{(P_{t+1}/P_t)} - 1$$

Where:

- r_{it} is the monthly nominal returns of the portfolio denominated in currency i ; This portfolio take into consideration both liquidity and investment tranches with the recommendation to not exceed the duration of two years. Nominal return of each yield is acquired from Bloomberg.
- e_{it} is the exchange rate between a foreign currency and Tunisian dinar published by the CBT.
- P_t is the import price index published by the INS.

The estimation of the efficient frontier called for the objective function defined by the mean-variance theory, which is;

$$\text{Min } \sigma^2_{pf_t} = W_t' \Omega_t W_t$$

$$\text{Given} \quad \mu_{pf_t} = W_t' M_t \qquad W_t' c = 1 \qquad W_t' > O$$

Where; M_t is the vector of returns on different currencies, Ω_t is the variance-covariance matrix between different currency returns, c is a unit vector, and O is a vector of zero. However, the choice of the optimal portfolio requires the risk preference of CBT, which is highly confidential. In the light of this consideration, we referred to Sharpe (1964) and Lintner (1965) that aims to maximize the Sharpe ratio[8]. The use of latter requires the definition of the risk free asset, which is calculated as the weighted average of different treasury bills denominated in different currencies. Therefore, we will estimate the efficiency curve based on imports currency share weights as elaborated by (Ben-Bassat, 1980). In the respect of the latter, he defended this assumption by outlining the role of detaining the international reserves to cushion the vulnerability of the balance of payments flows; hence, the country ought to meet its imports

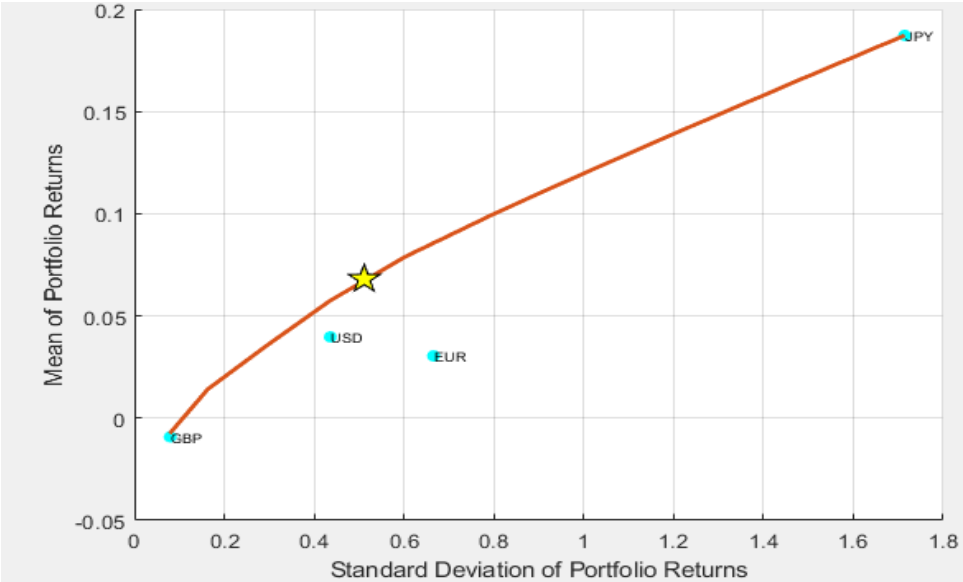
[8] The Sharpe ratio is the excess of return divided by the standard deviation of the portfolio. The optimal portfolio that maximize this ratio is the point of tangency between the line that rises from risk free asset, calculated as average of interest rates on treasury bills of three-month term of different currencies, and the efficient frontier.

using a variety of currencies. Due to this fact, the consumption currency have to play an important role in estimating the optimal portfolio.

1-2- Optimization findings

The efficiency curve presented in the following figure is dressing the relationship between the return of the currency portfolio and its standard deviation. As it is presented, the efficient frontier is concave since the mean of portfolio return increases in a diminishing rate when the risk, presented by the standard deviation, increases. This is consistent with the theoretical framework and the specificity of the central bank known for its highly risk aversion.

Figure III.3: The efficient frontier based on ex post returns (2000 to 2017)



The optimization process has given the optimal portfolio that will serve to compare it to the existing composition of foreign exchange reserves.

Table III.8:The comparison between the optimal currency composition and the existing composition

	Estimation in terms of imports currencies weights	The currency composition of FX reserves (2016)	The currency composition of FX reserves (2017)
USD	50.2%	38.1%	35,7%
EUR	24.7%	47.1%	51.5%
GBP	0%	11.3%	11.6%
JPY	25.1%	2.2%	0.3%

Interestingly, the results of optimization show a different allocation to those relative to the existing distribution of the last two years. The apportionment proposes the highest allocation in the USD at the level of 50.2%. The level of the Euro was around half the USD. Surprisingly, the share of JPY was almost at the same level as the EUR, whilst the GBP is absent in this allocation.

Table III.9:Returns and correlations 2000-2017 (Ex post-real return)

	Return (%)	**Standard deviation (%)**	**USD**	**EUR**	**GBP**	**JPY**
USD	3, 9746	43, 597	1	-0,036705892	0,064374969	0,312727998
EUR	3, 047	66, 557		1	0,005576476	0,010176487
GBP	-0, 9119	7, 977			1	0,01703576
JPY	18, 7213	171, 414				1

This allocation could be explained by the average rate of returns of each asset and its standard deviation. USD has a higher return than EUR and is less riskier, and the little correlation of both currencies is negative, whilst the USD correlation with GBP, on one hand, and JPY on the other hand, are positive. This clearly motivates the use of the couple EUR and USD in the reserves to decrease the total portfolio risk.

We notice, also, that although the GBP offers the lowest risk, a negative return and a positive low correlation with other currencies stand against it to be a strategic asset in the portfolio; hence, an investor would rationally neglect this currency.

Concerning JPY, the latter has the highest return, but the excess of volatility prevent it to be the dominant currency. However, although Japan has the lowest part in Tunisian import basket, JPY has got a considerable share in the optimized portfolio since it is considered as a safe haven currency that is expected to preserve or rise in value during periods of markets severe fluctuation. Therefore, this status, which is well founded thanks to the Japanese strong trade surplus, motivates the use of JPY in portfolio diversification.

Coming to the comparison of the estimated *ex post* optimal portfolio in terms of imports basket and the actual currency composition, the existing currency composition of foreign exchange reserves is completely different suggesting the EUR as the leading reserves currency and the

USD dollar as the second. The GBP, which is absent in the optimal estimated portfolio, present in the last years an important share beyond the 10%, whereas the JPY comes in the bottom with an average around 1.5%. These findings propose that the mean-variance theory is not good enough to explain the existing relative demand of the CBT of the main currencies. Therefore, we believe the being of other influential factors in determining the currency demand of the Central Bank of Tunisia. This striking result takes the credit of featuring the profile of the CBT as an investor. It stresses on the fact that reserves investment held by authorities is distinct from the investment strategy adopted by a normal investor. This process takes into consideration other determinant factors that are considered as priorities such external engagements.

2- The estimation of the currency demand functions relative to the Foreign Exchange reserves of the CBT.

The most striking result identified in the last part is the substantial difference between the optimized portfolio and the existing currency composition of foreign exchange reserves of the Central Bank of Tunisia. For this reason, the transaction theory, the ultimate contender of the mean-variance theory, appear to be the most plausible to explain the currency composition of foreign exchange reserves. However, it is more riveting to test the mean-variance theory officially, and in the same time with the transaction theory as well as the intervention approach. To do so, we will estimate a model that take into account both mean-variance approach, represented by the average rate real return and the risk associated to it, the transaction theory represented mainly by trade volume and external debt, the intervention approach by calling for the intervention level denominated in U.S. dollar and euro.

2-1- Data definition and sources

In this part of our research work, we will use annual data relative to the period between 2000 and to 2014. The variables subject to this empirical investigation are mainly:

- *Dependent variable*

The share of each reserves currency in percentage of foreign holdings: The main currencies that will be studied are mainly USD, EUR, GBP, and JPY. These dependent variables indicate the weight of each currency in foreign exchange reserves. This structure is published in annual report of CBT on annual basis.

Explanatory variables

The choice of independent variables took into consideration the previous results on the impact of different influencing factors on the level of foreign exchange reserves.

The annual rate of real return relative to each currency: is the average of monthly returns calculated in the previous part relative to portfolio optimization.

The currency risk: it is estimated as the annual standard deviation of real returns. It is calculated using monthly standard deviation of currencies return relative to previous part according to this formula: $\sigma = \sqrt{12} * monthly\ std.dev\ of\ real\ \ returns.$

The volume of trade denominated in each currency: The sum of imports and exports denominated in each currency in percentage of total trade volume. This proxy is calculated by referring to data available in the balance of payment that is published by the CBT.

Debt service payments denominated in each currency: it is the amount of money denominated in different currencies that CBT is engaged to pay every year. It might be the interest, or the principal of the concerned debt. This data is available in term of currency payment in the balance of payment.

The level of intervention conducted by the CBT: This variable is denominated only in USD and EUR since the great part of intervention is denominated in those two currencies. This data is highly confidential; consequently, they will not be subject of descriptive statistics

2-2- Data description

In this part, we will exhibit data description for different independent variables, except the intervention level since it is highly confidential. The descriptive statistics are presented in appendix III.1.

The real return of USD, GBP, and Japanese yen are normally distributed, contrary to the real return of euro that exhibits a positive high skewness with a leptokurtic form. The standard deviation of real returns of USD and GBP are lower than the one relative to Euro. Yet, the Japanese real return is quite important stressing on its volatility.

The standard deviations of real returns that represent the risk are characterized by highly skewed distribution with a tail extending out toward positive values, which is predicted since the

volatility cannot have a negative value. The shape of this distribution is leptokurtic since the Kurtosis relative to the four currencies is above the 3.

The volume of trade denominated in USD, EUR, and GBP are normally distributed with a low volatility. Yet the volume of trade denominated in yen is highly skewed extending out towards more positive values, with a leptokurtic form. This is due to the fact that the volume of trade denominated in Japanese currency is not stable over time.

Turning out to debt service payments, this variable showed a normal distribution highlighting the absence of aberrant values. The standard deviation is around 10% for debt service payments denominated in these currencies, except for GBP. It shows a volatility of 0.1% since its part in the apportionment of debt service payments is insignificant.

2-3- Multicollinearity tests

Preliminary verification of the absence of multicollinearity must be done. Therefore, we started by elaborating the correlation matrix that are exhibited in appendix III.2. All the regressors showed a correlation coefficient lower than $|0.8|$. Hence, the chosen explanatory variables are free from dual correlation.

However, this preliminary judgment must be confirmed by testing multicollinearity between different regressors using Variance Inflation Factors (VIF). Table III.10 summarizes the results of estimation. All the VIF coefficients are lower than 10, hence we accept the null hypothesis. All the regressors relative to each equation are free from multicollinearity.

Table III.10:Variance Inflation Factors test (VIF)

	USD	**EUR**	**GBP**	**JPY**
	VIF	VIF	VIF	VIF
Return	3.31	2.11	2.23	1.51
Risk	2.69	1.45	1.94	1.48
Trade	1.76	1.45	1.73	1.44
Debt service	1.69	1.21	1.47	1.38
Intervention level	1.50	1.15		

2-4- Empirical methodology

This part is the most instrumental, based on the previous empirical investigation; we aim to identify the determinants of the currency composition of foreign exchange reserves. The latter will serve to establish the currency demand function, hence, helping the CBT to quantify its exigency in main currencies.

In order to achieve this goal, we will estimate equations that trace the relationship between the shares of each currency with the relevant explanatory variables denominated in the same currency. The explanatory variables are chosen in the aim of capturing the relevance of the three approaches that are:

- The mean variance approach: This theory will be presented by both the return and the risk relative to the main currencies.
- The transaction approach: Transaction theory proxies will be mainly the level of trade denominated in each currency and the debt service payments.
- The intervention approach: The intervention level conducted by the CBT in the foreign exchange market

To exhibit the model more formally, we use the following equation

$$W_{it} = c_i + \beta_1 r_{it} + \beta_2 v_{it} + \beta_3 Trade_{it} + \beta_4 D_{it} + \beta_5 IL_{it} + \varepsilon_{it}$$

Where W_{it} is the share of each currency *i* in the total of Tunisian foreign exchange reserves

r_{it} the annual real return relative to each currency

v_{it} is the risk , exhibited by annual standard deviation, relative to currency *i*

$Trade_{it}$ is the share of trade denominated in currency *i* as a proportion of total trade volume

D_{it} is the share of each currency in the debt service payments

IL_{it} is the intervention level relative to each currency

ε_{it} is a stochastic disturbance term

However, these equations represent a problem of non-linearity since the dependent variable is bounded in the range zero to one, and in the same time not all the variables have the same constraints. In the light of these limitations, we will call for the approach used by Chinn and Frankel (2007)**.** The authors propose that the logistic specification proved its efficiency as being

the most successful functional form by assessing the number of coefficients statically significant. The following equation exhibit the model in its logistic transformation functional form.

$$Y_{it} = c_i + \beta_1 r_{it} + \beta_2 v_{it} + \beta_3 Trade_{it} + \beta_4 D_{it} + \beta_5 IL_{it} + \varepsilon_{it}$$

With $Y_{it} = Logit(W_{it}) = Log(\frac{W_{it}}{1-W_{it}})$

The method of estimation of the model is the Seemingly Unrelated Regressions (SUR). This method is presented by Arnold Zellner (1962) in order to estimate several regression equations. The main argument proposed is the existence of multiple relationships that are related by the fact that their disturbances are correlated. This assumption is in good with an equation relative to one currency since the function demand of one reserve currency is not entirely independent of other functions that represent other currencies. For further explanation, if a central bank chose to increase the share of one currency, the share of another currency would decrease consequently. In the light of its main contribution, Geweke (2003) has written "*The seemingly unrelated regressions (SUR) model developed in* Zellner (1962) *is perhaps the most widely used econometric model after linear regressions. The reason is that provides a simple and useful representation of systems of demand equations*".

In our investigation, there are numerous arguments that motivate us to use the SUR method, which are:

- Not all the explanatory variables have the same influential power on different currency shares. The being of each currency share is motivated by different explanatory variables with different level of effects.
- Gaining efficiency in estimation since we take into consideration information relative to each demand function.
- The ability to add and/or to assess restrictions on different parameters in different equations.

The estimation of function demand of each currency could be realized equation by equation by calling for the Ordinary Least Squares. This method is consistent, yet, it proved its inefficiency faced to a limited number of observations, or problems of autocorrelation or heteroskedasticity. The OLS does not incorporate this information in the estimation process contrary to the SUR method. Moreover, it neglects the information relative to the relationship between different

equations. However, we have to mention that the SUR is equivalent to OLS if the error terms relative to each equation are uncorrelated, and each equation contains the same regressors.

2-5- Empirical findings

In order to justify the use of the seemingly unrelated regression, we have to introduce the results relative to the OLS estimation. We have to outline that the currency demand function of each equation is estimated independently.

Appendix III.7 reports the results of estimated equations; it proves the efficiency of the ordinary least square regressions in estimating the currency demand function relative to the USD, EUR and GBP, yet, the currency demand function of the JPY showed a problem heteroskedasity at the level of 5%, as well as an issue of autocorrelation. Moreover, the equation relative to the Japanese yen is not globally significant. In the light of these consideration, we will refer to the Seemingly Unrelated Regression estimation in the aim of overcoming these issues, as well as to test the correlation between the different disturbances of each currency demand function.

The Seemingly Unrelated regression estimation

Table III.11:The Seemingly Unrelated Regression estimation

	Constant			The currency return			The currency volatility			Trade volume denominated in reserve currency			Debt service denominated in reserve currency			Intervention level in FX market		
	Value	Z	Prob	Value	Z	Prob	value	Z	Prob	Value	Z	Prob	value	z	Prob	value	z	Prob
USD	-3.175529	-7.48	0.000	0.716334	1.26	0.206	-0.05404	-0.98	0.325	4.50203	5.85	0.000	3.89188	6.58	0.000	0.413711	1.65	0.099
EUR	-4.201327	-7.43	0.000	0.019902	0.10	0.917	-0.07832	-3.65	0.000	5.81561	6.21	0.000	1.91721	6.54	0.000	0.569293	2.01	0.045
GBP	-2.906788	-8.01	0.000	9.409433	2.54	0.011	1.35622	1.19	0.235	-122.516	-2.54	0.111	38.5106	0.51	0.609			
YEN	-5.513145	-8.70	0.000	-0.46141	-0.98	0.329	0.13634	2.16	0.031	253.516	3.36	0.001	-10.1618	-3.39	0.001			

Table III.12:The explanatory power of each currency demand function

	Y_{USD}	Y_{EUR}	Y_{GBP}	Y_{JPY}
$\mathbf{R^2}$	0.7076	0.8143	0.4586	0.3107

The choice of adequate regression is an object of Breusch-Pagan test of independence, which hypotheses are:

H_0: There is no relationship between models'disturbances, hence OLS estimation is appropriate

H_1: There is a relationship between models'disturbances, hence SUR estimation is appropriate

To do this entails exhibiting the correlation matrix from the stochastic disturbances relative to the SUR estimation, this will allow us to determine the test statistic that follow Chi-square distribution χ^2.

Table III.13:Breusch-Pagan test of independence

χ^2 (6)	14.112	Probability	0.0284

According to this result, the null hypothesis can be rejected. Therefore, the currency demand functions are related by their disturbance term. In the light of these results, the currency demand functions system is:

Equation 3 : The currency demand functions relative to the main reserves currencies

$$\begin{cases} Y_{USDt} = -3.1755 + 4.5020.T_{USDt} + 3.8919.D_{USDt} + 0.0414.IL_{USDt} \\ Y_{EURt} = -4.2013 - 0.0783.v_{EURt} + 5.8156.T_{EURt} + 1.9172.D_{EURt} + 0.5693.IL_{EURt} \\ Y_{GBPt} = -2.906788 + 9.4094433.r_{GBPt} \\ Y_{JPYt} = -5.513145 + 0.1363481.v_{JPYt} + 253.5169.T_{JPYt} - 10.16185.D_{JPYt} \end{cases}$$

Where W_{it} the share of each currency in foreign exchange reserves is calculated as:

$W_{it} = \frac{e^{Y_{it}}}{(1+e^{Y_{it}})}$.

Results revealed that the estimated currency demand function of US dollar and Euro have the most important explanatory power, while those relative to the pound and the Japanese yen are relatively modest. Moreover, the constants of each function are all significant from zero at the level of 1%, and have different values, stressing on the specific currency impacts.

Shedding the light on the mean-variance approach, the real return of each currency has a positive impact as predicted, except the real return of Japanese yen. Yet, only the sterling pounds real return is significant at the level of 5%. This is due its positive high correlation with euro, and its feeble fluctuation compared to other currencies during the period of sample (Before Brexit), on one hand. On the other hand, the CBT raised the part of GBP in its investment tranche in the aim of getting the advantage of the best return rates served by the

sterling compared to other currencies. According to the annual report of CBT (2016), the GBP offered the highest performance thanks to its relatively high level of monetary and bond interest rates.

Surprisingly, the risk relative to each currency have different signs; while euro volatility, as well as U.S dollar volatility have a negative impact on the share of reserve currency as expected, the sterling pounds volatility and Japanese yen volatility have a positive effects. However, only the risk relative to euro and Japanese yen turned out to be significant at the level of 5%. This divergence is due to the specificity of the currency: In fact, the euro, known for its negative interest rate, pushed the CBT to opt for long maturities with higher yield in order to maintain a positive range, and ensure the standard of wealth preservation. Yet, the CBT has multiple engagements in different maturities. Seeking to reach an equilibrium between those different constraints, the guardianship authority has adopted, since 2014, a strategy that limited to the minimum the euro share in the working capital tranche, extended as possible the placements of liquidity tranche, and establish a Ladder[9] portfolio. The latter guarantees a low volatility, as well as hedging against interest rate risk, credit risk, and liquidity risk. In the light of these considerations, the great part of euro share is centered in low volatility assets. Concerning the Japanese yen, it is considered a safe haven currency, as mentioned previously. The rise of global risks during last decade enhanced the role of yen in the portfolio diversification since it preserves or increases in value in the period of turmoil. This positive relationship, which is specific to the Japanese currency, reinforces its share in foreign holdings to take advantage of its high volatility. Moreover, we have to mention that the CBT does not have strategic position in this currency since it has witnessed a period of depreciation during the period of sample. However, the risk turned out to have a significant impact because of unwilled position due to different issuance of Samurai according to the concerned department.

Turning now to the transaction approach, we notice that the trade volume has a positive significant influence on the currency composition of foreign exchange reserves at the level of 1%, except for trade volume denominated in GBP that has a negative effect, yet not significant. This finding is explained by the fact that rising trade flows denominated in a particular currency would probably cause an increase of the share of that reserve currency in the total of foreign holdings (Dooley, 1987**;** Dooley et al., 1989**;** and Soesmanto et al., 2015). To better draw this relationship, Tunisia's trade statistics show a great deficit that implies the incapacity of exports

[9] This strategy consists on purchasing distinct bonds with short staggered maturities instead of a one bond with a long maturity. Those bonds that come to maturity are being reinvested in the existing interest rate.

denominated in these currencies to cover the volume of imports denominated in the same currencies. Therefore, those currencies ought to be taken into consideration in the currency composition to finance the gap of imports denominated in those given currencies.

As far as the debt service payments structure is concerned, it is proved to have a significant impact on the share of Euro, U.S. dollar, and Japanese yen in the composition of foreign exchange reserves. Moreover, the debt services denominated in U.S. dollar, as well as those denominated in euro have a positive influence on the demand function of these two leading currencies as predicted (Heller and Knight, 1978 **;** Dooley et al., 1989**;** and Soesmanto et al., 2015). That is, if Tunisia is engaged to honor its liabilities in a certain currency, it will increase the share of that currency in its foreign holdings. In contrast, the debt service paid in Japanese yen proved to have an influencing negative effect on the Japanese yen share. In fact, around 16% of Tunisian debt is issued in samurai[10]; yet, the share of yen in foreign exchange reserves is far bellow this percentage. For further explanation, CBT bond issuance on international financial markets is trying to take the advantage from low interest rates and the liquidity of the market, which has been the case for Japanese financial place. Therefore, Tunisia has been engaged since 1994 in debts denominated in yen with long maturities (**Ministry of Finances**) that caused capital flows representing debt service payments during the period of sample. However, these huge capitals denominated in yen were a subject of swap lines in the aim of meeting external needs; in fact, a great part of Tunisian balance of payment expenditure is denominated in the euro and U.S. dollar at a rate of 90% in average. The latter is explaining the negative influence, and is stressing on the impact of the swap operations on the currency composition of foreign holdings. We have to highlight that swap lines are not included in the determination of foreign exchange reserves assets (IMF, 2001).

Regarding the accumulation of reserve currency for the purpose of intervention, it is proved that the intervention approach plays a significant role in influencing positively the share of euro and U.S. dollar at the level of 5% and 10% successively, as predicted. In fact, the exchange rate regime followed by the CBT until 2016 had subscribed into the soft pegs arrangements (IMF, 2016), in which authorities ought to allocate a part of reserves for intervention needs in the aim of guaranteeing the equilibrium of external accounts. The series relative to the level of intervention of the CBT taken into consideration in the regression stopped in 2014 because of the reform. The latter has sought to make the exchange rate more flexible gradually stop the

[10] Samurai are bonds denominated in yen, issued in Japanese market by a foreign institution, and given Japanese regulations.

drain of reserves. Therefore, the intervention of CBT since 2014 won't reflect only the need of defending the domestic currency, but it has gathered other goals relative to the management of foreign exchange reserves. For the period of our sample, the Central Bank of Tunisia had intervened in foreign exchange market to defend the domestic currency face to a basket of currencies denominated in great part in euro and U.S. dollar. According to the CBT (2013), the guardianship authority had intensified its intervention in foreign exchange market to mitigate the fluctuation of the exchange rate. For example, the volume of intervention held by CBT during 2013 had increased by 14.6% compared to 2012.

In spite of the reform engaged, since 2014, that intend to make the exchange rate more flexible, the CBT keeps the privilege of intervening in foreign exchange market. In fact, the intervention aim is no longer defending the domestic currency, but it has, also, taken into consideration the rebalancing of the currency composition of foreign exchange reserves compared to a target range. To better illustrate the latter, in the beginning of 2015, the currency composition of foreign exchange reserves showed a gap compared to the target range, in particular for the euro and U.S. dollar, as well as the collection of the product one billion dollar issuance had stressed the imbalances of the foreign exchange reserves structure. Hence, the intervention in dollar was among the solutions followed by authorities. In the light of these considerations, the intervention phenomenon has no longer limited to its traditional definition strongly coupled with the exchange rate regime. The CBT pointed out 9 market makers that guide the interbank exchange rate, which serves as a basis for its intervention. However, this intervention depends on the will of the guardianship authority and based on its tranching targets as drawn by the example. This investigation has benefited from the period in which the exchange regime was defined as soft pegs, yet, these results might change for other investigations that would take into consideration a sample starting from 2017,when Tunisia met the criteria of floating regime according to (IMF, 2017)**,** since it is proved that the scale of intervention held by authorities would be effected by the exchange rate regime. Being in a pegged exchange regime will be in need of a higher level of interventions in the foreign exchange market in a given currency compared to the floating arrangement. However, the latter does not deny the need of the authorities to hold foreign exchange reserves to provide liquidity in times of crisis (Dooley et al. (1989)**;** Eichengreen and Mathieson, 2000)

Overall, the currency demand functions prove that makes no sense to classify the currency composition of Tunisian foreign exchange reserves in one approach. Moreover, despite the fact that we have demonstrated the existence of a relationship between these different equations,

they showed different determinants. While U.S dollar function gives more prominence to transaction factors and intervention level, the sterling pounds equation place emphasis on mean-variance approach. The euro and the yen functions showed heterogeneous combinations of influencing factors since they called for different approaches. Even those two equations proposed the debt service payments and the currency real return volatility with contradictory effects.

2-6- Optimal currency composition according to the estimated demand functions

In this part, we will try to determine the adequate composition of foreign exchange reserves relative to 2015 and 2016 using the estimated demand function. The approximated shares will be compared to the existing composition published by the CBT in annual report. This step will allow us to verify the explanatory power of these demand functions, and their ability to predict the adequate shares of these main currencies. For needs of estimation, we will consider the average of intervention level rather than the existing values for considerations explained above.

Table III.14: A comparison between the estimated composition and the existing composition published in annual reports.

	Reserve currency	Observed composition	Estimated composition
2015	USD	37%	37.63%
	EUR	49.3%	53.51%
	GBP	10.9%	6.01%
	JPY	2.4%	9.61%
2016	USD	38.1%	36.81%
	EUR	47.1%	64.11%
	GBP	11.3%	3.97%
	JPY	2.2%	2.03%
2017	USD	35.7%	
	EUR	51.5%	
	GBP	11.6%	
	JPY	0.3%	

Building on table III.14, the existing share of US dollar reflects the transactional needs. Moreover, the demand function of USD proved its efficiency since, in 2016, we estimated a slight decrease in the share of the American currency, contrary to the observed value. Yet, 2017 existing share comes along this downtrend.

Concerning the euro, we estimate higher share compared to the existing one because of the depreciation of the domestic currency. The latter will cause an increase in costs of transactional needs such us imports and debts services, hence, we ought to increase euro share. In fact, we notice that the euro share subscribed to this trend in 2017.

Turning to the sterling pounds parts that exhibited higher level compared to the shares estimated by our demand function. To better understand this difference, the period that preceded Brexit had known a high positive correlation between the GBP and Euro; hence we notice that the difference in euro shares (4.21%) had been invested in GBP instead of Euro in 2015. Yet, the existing share of GBP of 2016 is higher than the one estimated. We believe that this difference is due to various reasons, which are; Firstly, GBP witnessed severe fallout after the announcement of the Brexit causing a dwindling of returns to negative values, and then the share of GBP ought to be decreased as estimated by the demand function. Secondly, our demand function focuses only on the return, and does not show other exceptional engagements of CBT.

Finally, the optimal share of JPY in 2015 was far higher than the existing share; this is due to the high volatility witnessed by the Japanese currency during that year, in which CBT did not engage since authorities do not speculate on short term fluctuations. However, the existing share and the estimated one were so close in 2016 confirming the efficiency of our demand function relative to this currency.

Conclusion

Our work has given an account of the foreign exchange reserves of Tunisia in which we have dealt with two crucial aspects; the level of foreign exchange reserves and its currency composition. It is found that the Tunisian's long run reserves demand is influenced by current account vulnerability, capital account vulnerability, exchange rate flexibility, as well as the interest rate differential indicating that the accumulation of reserves in Tunisia subscribe to self-insurance motive. Moreover, we have set up a vector of error correction model in the aim of measuring the short-run dynamics and the trend of each factor to reach the long run relationship. Only 3% of deviation is eliminated quarterly. This slow pace of adjustment suggests the being of an urgent need to boost the accumulation of reserves to reach the equilibrium. Moreover, the exchange rate flexibility turned out to have a positive effect in reaching the long run equilibrium, suggesting the obligation to increase the exchange rate flexibility to enhance the speed of adjustment, as well as lowering the pressure on the foreign exchange holdings.

Concerning the currency composition of Tunisian foreign exchange reserves, it is proved that restricting our focus on the mean-variance theory has given us a currency structure completely different from the existing composition. This result stresses on the fact that the profile of the central bank is very different from the normal investor, since it has other priorities than the return and the risk of a given reserve currency. This striking result pushed us to test this theory more formally in addition to the transaction approach and the intervention approach by using the Seemingly Unrelated Regression Estimation. The latter has the privilege of capturing the relationship between different currency demand functions, and correct the econometric issues that Ordinary Least Square cannot deal with as heteroscedasticity, autocorrelation, or limited number of observations. The empirical findings proved that each currency demand function is influenced by the specific currency effect. Furthermore, these currencies demand functions showed different determinants; while the US dollar demand function places emphasis on the transaction approach and intervention approach, the GBP demand function gives prominence on mean-variance approach. Yet, the euro demand function is influenced by the risk of the currency, the volume trade and debt service payments denominated in European currency, and the intervention level. Turning to the Japanese currency demand function that is defined by the risk of this currency, trade volume and debt service payments. The latter showed a different sign shedding the light on practices held by authorities to optimize the use of these holdings.

To sum up, determining the currency demand functions would help us to determine the adequate level of each reserve currency. Moreover, they helped us to outline the effect of reserves management strategies on the reserves currency composition. Indeed, we have proved that makes no sense to classify the reserves management of a country in one approach, central banks have an outstanding profile as an investor; they ought to make a severe equilibrium between the engagements of the country, the preservation of this public wealth, and the optimization of their use.

CONCLUSION

A strong belief gathers the unanimity of central banks around the world that an appropriate reserves management is playing a pivotal role in protecting the country, as well as keeping its economic balances. Tunisian foreign exchange reserves are not an exception; their dramatic decrease arouse many concerns in last years, questioning the ability of Tunisia to meet external engagements as mentioned in Moody's statement when reporting the degrading credit rating to B2 with negative perspective. It stated "*The key drivers for the downgrade are Moody's expectations that the further erosion in fiscal strengthen and foreign exchange reserve buffers will not reverse significantly in the next few years*." Regarding this insight, we believe that a better understanding of Tunisian foreign exchange reserves will shape a suitable management. Our current work subscribe to this conviction; hence, we investigated the most influential factors that affect the level of foreign exchange reserves, as well as elucidating the currency composition of foreign exchange reserves since it more crucial than defining the level (Beck and Weber, 2011). Therefore, we draw the landscape of the Tunisian foreign exchange reserves.

Our work has subscribed to this objective by seeking to give an account of two crucial aspects of the Tunisian foreign exchange reserves. Starting by the determinants of the level of foreign holdings: It is found that the long run reserves demand is influenced positively by current account vulnerability and capital account vulnerability. Both of them are scales of the openness of the economy and its exposition to external shocks (Dominguez and Frankel, 1993). This relationship implies the engagement of the CBT to increase the level of their foreign holdings for self-precautionary motives. The exchange rate flexibility turned out to have a negative impact while defining the demand of foreign exchange reserves since the central bank would decrease its stockpile of reserves devoted to intervention needs. In this concern, the CBT has engaged multiple reforms that aims to make the exchange rate more flexible and lower the pressure on reserves. Finally, the interest rate differential showed a negative influence with a higher impact compared to other determinants. Our result proved that Tunisia is very sensitive to the European monetary policy since a decrease in interest rate differential would launch capital inflows from the northern side of the Mediterranean toward Tunisia causing an increase in the level of reserves. Nonetheless, defining a long run relationship requires capturing the existence of a mechanism of adjustment. It is found that the return to equilibrium will be realized in slow pace and may take a long time. Therefore, the CBT ought to enhance the accumulation of foreign exchange reserves so that it would be able to face the current account

vulnerability and capital account vulnerability. Moreover, only the exchange rate flexibility proved to have a recall force to reach the long run equilibrium, yet, it is judged slow. To improve its celerity, it is highly recommended to increase the flexibility of the exchange rate (Bahmani-Oskooee, 1988); incidentally, the Central Bank of Tunisia subscribed to this assumption by setting up reforms that aim to make the exchange rate more flexible and get benefit from this relationship.

Meanwhile, this scoop cannot be achieved without scouting the determinants of the currency composition of foreign holdings since it has the share of the lion. This part of our empirical investigation took place in two steps: Firstly, we referred to the mean-variance approach to cast the light on the profile of the Central Bank as an investor. Surprisingly, the result of optimization showed a different allocation compared to the existing composition published by the CBT. This result would seem to suggest that the reserves investment held by authorities is distinct from the investment stratagem adopted by a normal investor. It lies stress on the existence of other determinant factors besides return and risk of each currency reserves, such external engagements. This preliminary observation paved the way to the estimation of the currency demand functions of the main reserves currencies by appealing transaction cost approach, and intervention approach, besides the mean-variance approach.

In the aftermath, our empirical investigation underlined the existence of a relationship between different main reserves currency demand functions, which justifies the use of the Seemingly Unrelated Regression Estimation. The latter is considered a strong point of our work. Furthermore, the results of estimations provided evidence on the being of the specific currency impacts. Moreover, the main reserves currencies demand functions showed different features; while the US dollar demand function gives prominence on the transaction cost approach and intervention approach, the GBP demand function lies stress on the mean variance approach. However, the euro demand function is influenced by the risk relative to the currency, the volume of trade, debt service payments denominated in European currency, and the intervention level. In addition, the Japanese yen demand function is explained by the risk of this currency, trade volume and debt service payments. The latter showed a different sign shedding the light on internal practices held by authorities to optimize the use of these holdings. We have to mention that the CBT positions in yen are unwilled because of the issuance of Samurai.

This study has an important managerial implication since it has provided the backbone to define the adequate currency composition without limiting the role of the CBT in one approach and

by casting the light on the relationship between main reserves currencies. Indeed, central banks have an outstanding profile as an investor; they ought to make severe equilibrium between the country's liabilities, wealth preservation, and the optimization of their use.

Despite the fact that our investigation could be a springboard to broaden knowledge on Tunisian foreign exchange reserves, we believe that our work has some limitations that could be subject for further researches. The most important limitation is the small sample size served to determine the demand function of the main reserves currencies, as well as they were not a subject of adjustment by the level of risk aversion of CBT. In addition, the elaborated model did not take into account exceptional engagements of the CBT in different reserves currencies. Another weak point needed to be considered is the range of financial instruments used by the CBT for hedging motives against adverse market movements. Finally, the model evinces an outstanding shortcoming since it has failed to look after the effect of the changing economic policies of the countries of the main reserves currencies toward the process of diversification adopted by the CBT.

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APPENDICES

APPENDICES

Appendix I: Empirical investigation on the determinants of the Tunisian foreign exchange reserves

Appendix I.1: Stationarity tests at the level

Null Hypothesis: R has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.699635	0.4246
Test critical values:	1% level	-3.584743	
	5% level	-2.928142	
	10% level	-2.602225	

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

Null Hypothesis: TC has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.809344	0.8061
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: CAP_SD has a unit root
Exogenous: None
Lag Length: 2 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.994854	0.2819
Test critical values:	1% level	-2.619851	
	5% level	-1.948686	
	10% level	-1.612036	

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

Null Hypothesis: VOLT_RATE2 has a unit root
Exogenous: Constant
Lag Length: 3 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-0.258214	0.9225
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: IRDI has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-1.615538	0.4663
Test critical values:	1% level	-3.588509	
	5% level	-2.929734	
	10% level	-2.603064	

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

Appendix I.2: Stationarity tests at first difference

Null Hypothesis: D(R) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.667889	0.0000
Test critical values:	1% level	-3.588509	
	5% level	-2.929734	
	10% level	-2.603064	

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

Null Hypothesis: D(TC) has a unit root
Exogenous: Constant
Lag Length: 4 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-5.476744	0.0000
Test critical values:	1% level	-3.605593	
	5% level	-2.936942	
	10% level	-2.606857	

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

Null Hypothesis: D(CAP_SD) has a unit root
Exogenous: Constant
Lag Length: 1 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-8.984867	0.0000
Test critical values:	1% level	-3.592462	
	5% level	-2.931404	
	10% level	-2.603944	

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

Null Hypothesis: D(VOLT_RATE2) has a unit root
Exogenous: Constant
Lag Length: 2 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.573199	0.0000
Test critical values:	1% level	-3.596616	
	5% level	-2.933158	
	10% level	-2.604867	

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

Null Hypothesis: D(IRDI) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-3.674447	0.0080
Test critical values:	1% level	-3.588509	
	5% level	-2.929734	
	10% level	-2.603064	

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

Appendix I.3: Selection of Lag

VAR Lag Order Selection Criteria
Endogenous variables: R TC CAP_SD VOLT_RATE2 IRD
Exogenous variables: C
Date: 10/08/18 Time: 11:26
Sample: 2005Q4 2017Q1
Included observations: 41

Lag	LogL	LR	FPE	AIC	SC	HQ
0	-290.9723	NA	1.281890	14.43767	14.64664	14.51377
1	-133.7633	268.4056	0.002049	7.988453	9.242286*	8.445030*
2	-104.5424	42.76220	0.001765	7.782558	10.08125	8.619616
3	-72.94397	38.53473*	0.001488*	7.460681	10.80424	8.678220
4	-45.34731	26.92357	0.001799	7.334015	11.72243	8.932034
5	-14.79535	22.35510	0.002518	7.063188*	12.49646	9.041688

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

Appendix I.4: Cointegration relationship

1 Cointegrating Equation(s): Log likelihood -156.1978

Normalized cointegrating coefficients (standard error in parentheses)

R	TC	CAP_SD	VOLT_RATE2	IRDI	C
1.000000	-23.64055	-19.99130	28.93647	2218.642	-2245.956
	(3.51398)	(2.79247)	(6.51757)	(510.056)	(501.964)

Adjustment coefficients (standard error in parentheses)

D(R)	-0.034967
	(0.00838)
D(TC)	-0.005323
	(0.01171)
D(CAP_SD)	0.040359
	(0.02624)
D(VOLT_RATE2)	-0.006766
	(0.00245)
D(IRDI)	-3.63E-06
	(1.2E-05)

Appendix I.5: Cointegration test

Null Hypothesis: EPS has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic - based on SIC, maxlag=4)

		t-Statistic	Prob.*
Augmented Dickey-Fuller test statistic		-7.401558	0.0000
Test critical values:	1% level	-3.584743	
	5% level	-2.928142	
	10% level	-2.602225	

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

Appendix I.6: Vector Error Correction Model

Vector Error Correction Estimates
Date: 10/17/18 Time: 15:59
Sample (adjusted): 2006Q2 2017Q1
Included observations: 44 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
R(-1)	1.000000
TC(-1)	-23.20108 (3.49154) [-6.64494]
CAP_SD(-1)	-19.50335 (2.77463) [-7.02917]
VOLT_RATE2(-1)	28.51766 (6.47595) [4.40363]
IRDI(-1)	2193.683 (506.798) [4.32851]
C	-2225.236

Error Correction:	D(R)	D(TC)	D(CAP_SD)	D(VOLT_RATE 2)	D(IRDI)
CointEq1	-0.035887 (0.00867) [-4.13873]	-0.004480 (0.01196) [-0.37455]	0.039723 (0.02714) [1.46360]	-0.006976 (0.00253) [-2.75221]	-3.41E-06 (1.2E-05) [-0.27376]
D(R(-1))	-0.036736 (0.18013) [-0.20394]	-0.328585 (0.24847) [-1.32245]	-0.311659 (0.56383) [-0.55275]	-0.130455 (0.05265) [-2.47760]	-0.000143 (0.00026) [-0.55298]
D(TC(-1))	-0.075229 (0.20067) [-0.37488]	-0.717905 (0.27680) [-2.59361]	0.318657 (0.62812) [0.50732]	-0.163288 (0.05866) [-2.78374]	-0.000121 (0.00029) [-0.42049]
D(CAP_SD(-1))	-0.023979 (0.12740) [-0.18823]	-0.052815 (0.17572) [-0.30056]	-0.206194 (0.39875) [-0.51709]	-0.094559 (0.03724) [-2.53931]	-3.39E-05 (0.00018) [-0.18537]
D(VOLT_RATE2(-1))	1.640515 (0.57533) [2.85145]	0.179996 (0.79357) [0.22682]	-0.283558 (1.80081) [-0.15746]	0.447284 (0.16817) [2.65972]	0.000118 (0.00083) [0.14227]
D(IRDI(-1))	34.28285 (97.8627) [0.35032]	-293.3943 (134.986) [-2.17352]	116.0446 (306.316) [0.37884]	-1.743116 (28.6056) [-0.06094]	0.505840 (0.14049) [3.60056]
C	-0.030640 (0.31556) [-0.09710]	-0.464796 (0.43526) [-1.06785]	0.564489 (0.98772) [0.57151]	0.003514 (0.09224) [0.03810]	-0.000253 (0.00045) [-0.55876]

R-squared	0.864883	0.448623	0.573808	0.233980	0.298835
Adj. R-squared	0.842972	0.359210	0.504695	0.109761	0.185132
Sum sq. resids	157.8207	300.2651	1546.211	13.48435	0.000325
S.E. equation	2.065291	2.848732	6.464479	0.603690	0.002965
F-statistic	39.47285	5.017445	8.302546	1.883606	2.628215
Log likelihood	-90.53324	-104.6838	-140.7395	-36.41478	197.4991
Akaike AIC	4.433329	5.076535	6.715432	1.973399	-8.659050
Schwarz SC	4.717177	5.360384	6.999280	2.257247	-8.375202
Mean dependent	0.065272	-0.276055	0.385657	0.031031	-0.000447
S.D. dependent	5.211864	3.558719	9.185385	0.639824	0.003284

Determinant resid covariance (dof adj.)	0.001896
Determinant resid covariance	0.000797
Log likelihood	-155.2140
Akaike information criterion	8.873362
Schwarz criterion	10.49535

Appendix I.7: VECM validity tests

VEC Residual Serial Correlation LM Tests
Null Hypothesis: no serial correlation at lag order h
Date: 10/17/18 Time: 11:27
Sample: 2005Q4 2017Q1
Included observations: 44

Lags	LM-Stat	Prob
1	30.89151	0.1926
2	42.71265	0.2050
3	23.80077	0.5309
4	25.28997	0.4462
5	20.47521	0.7215
6	15.40348	0.9314
7	23.03868	0.5753
8	18.17538	0.8349
9	30.39527	0.4054
10	26.53971	0.3793
11	22.34855	0.6155
12	28.94759	0.2661

Probs from chi-square with 25 df.

VEC Residual Heteroskedasticity Tests: No Cross Terms (only levels and squares)
Sample: 2005Q4 2017Q1
Included observations: 44

Joint test:

Chi-sq	df	Prob.
175.8329	180	0.5738

VEC Residual Normality Tests
Orthogonalization: Residual Covariance (Urzua)
H0: residuals are multivariate normal
Sample: 2005:4 2017:1
Included observations: 41

Component	Jarque-Bera	Df	Prob.
1	11.61596	2	0.0030
2	13.22918	2	0.0013
3	14.89635	2	0.0006
4	14.11625	2	0.0009
5	14.89756	2	0.0006
Joint	184.0290	182	0.4440

Appendix II: The optimal composition of foreign exchange reserves

Appendix II.1: Estimation approach of variables

- *US Generic Government (USGG) index*: It is considered as an underlying benchmark for bills, notes, and bonds issued by US Treasury. The different maturities are a one-month, three months, six months, one year, two years, three years, five years, seven years, and ten years yield.
- *GETB1 and GETB2 indices*: They are an underlying benchmark for bills, notes and bonds denominated in euro. The different maturities are one-month, three months, six months, one year, two years, three years, five years, seven years, and ten years yield.
- *GJTB index*: is government bond index denominated in Japanese yen. The different maturities are three months, six months, twelve months, two years, three years, five years, seven years, and ten years yield.
- *BP00 and GUKG indices*: are generic government bonds denominated in sterling pounds. BP00 belongs to short-term bonds as three months, six months, and twelve months, while GUKG exhibits returns relative to long-term maturities as two years, three years, five years, and ten years.

The nominal return relative to each maturity is calculated by referring to this equation:

$$r_{it} = \frac{Last\ price_{it} - Last\ price_{it-1}}{Last\ price_{it-1}}$$

These nominal returns will serve to determine nominal returns relative to liquidity portfolio as well as investment portfolio. The hypothesis taken into consideration in this part is all returns relative to each maturity are calculated as an equally weighted mean in each portfolio. However,

calculating the nominal return of the global portfolio relative to each currency is constrained by hypothesis offered by the concerned department, which is; *the global duration of the portfolio ought to be equal or lower than two years*. Hence, thanks to this preliminary work, we obtained nominal return relative of each currency that will serve to calculate the real return of each currency.

Appendix II.2: The determination of optimal composition using the maximization of Sharpe ratio

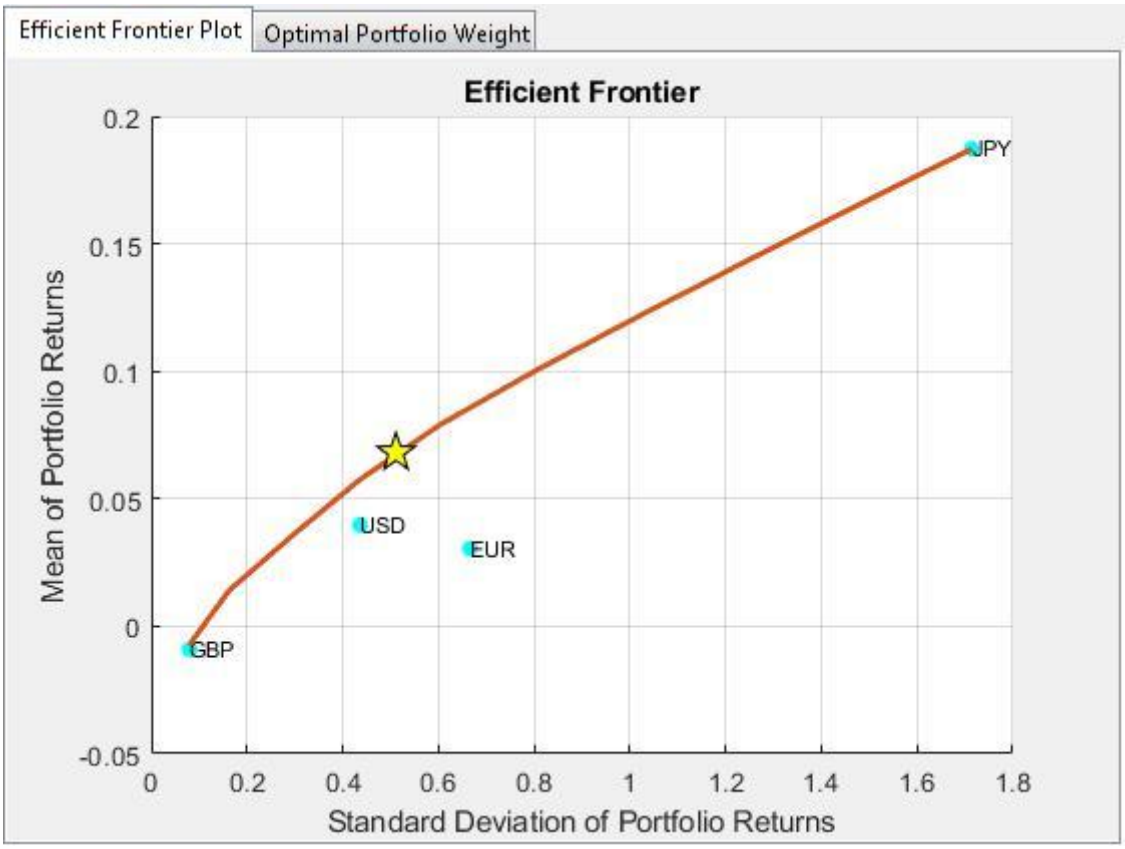
The determination of the Sharpe line ratio requires the definition of the level of the risk free asset. It is defined as the weighted average of interest rates on treasury bills of different currencies. In our case, we have chosen three-month interest rate relative to different currencies.

The computing of risk free asset return call for weights the average of import basket currencies, which are published in the statistical bulletin of the CBT. Therefore, the average of imports share weights of Tunisia by country by currency of payment is as follow:

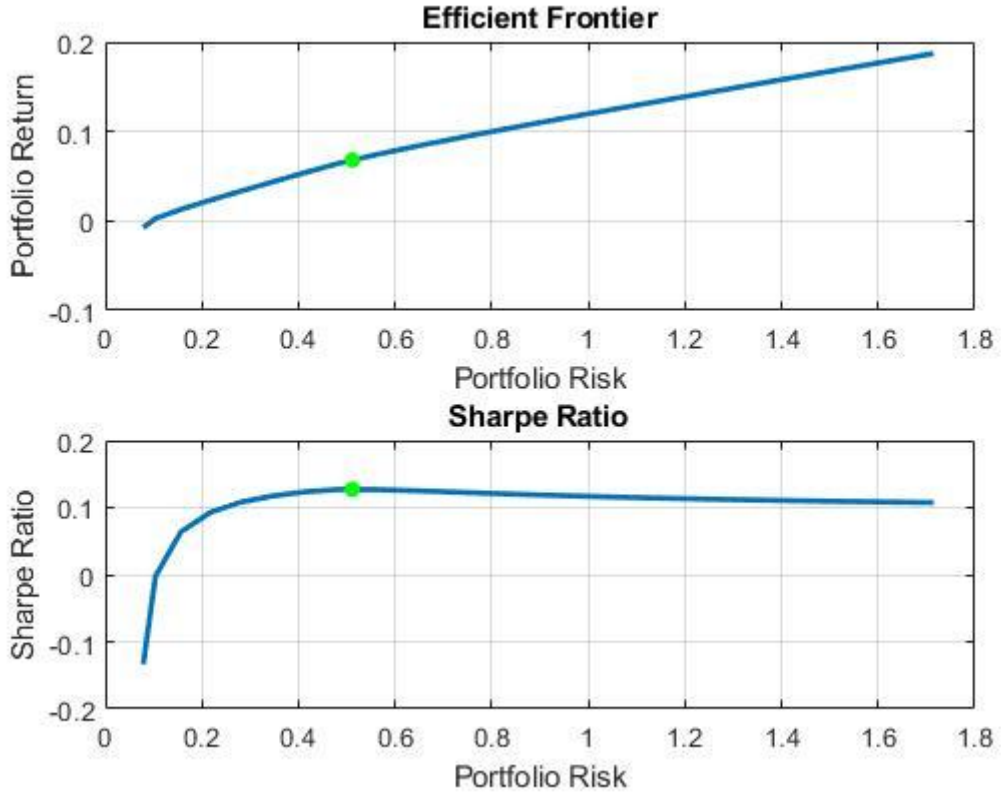
Table III.15:The Currency import basket

The currency of import payment	Weights
USD	48.2%
EUR	47.96%
GBP	0.42%
JPY	1.16%

Source: Statistical Bulletin of CBT



Source: Author construction with Matlab



Source: Author construction with Matlab

Appendix III: The currency demand function of reserve currency

Appendix III.1: Descriptive statistics for the estimation of main currencies

Table III.16:Descriptive statistics relative to U.S dollar

	Return USD	Risk USD	Trade USD	Debt service USD
Mean	0.035103	0.812716	0.416500	0.215400
Median	0.039757	0.419513	0.427000	0.201000
Maximum	0.204462	3.690588	0.515000	0.378000
Minimum	-0.119505	0.141436	0.333000	0.117000
Std.dev	0.088922	0.944980	0.055441	0.080760
Skewness	0.295221	2.119345	-0.007753	0.789525
Kurtosis	2.474347	6.887469	1.959217	2.517305
Jarque-Bera	0.390584	20.67432	0.677169	1.703997
Probability	0.822595	0.000032	0.712779	0.426562

Table III.17:Descriptive statistics relative to Euro

	Return EUR	Risk EUR	Trade EUR	Debt service EUR
Mean	0.029862	1.393439	0.527647	0.541118
Median	-0.000567	0.311824	0.522500	0.581000
Maximum	0.629408	6.232804	0.585000	0.644000
Minimum	-0.212936	0.108371	0.451500	0.291000
Std.dev	0.170981	1.942258	0.036835	0.111569
Skewness	2.559946	1.436663	-0.160996	-1.196832
Kurtosis	10.33947	3.711885	2.441691	3.078920
Jarque-Bera	56.72414	6.206972	0.294233	4.062900
Probability	0.000000	0.044892	0.863193	0.131145

Table III.18:Descriptive statistics relative to the pounds

	Return GBP	Risk GBP	Trade GBP	Debt service GBP
Mean	-0.009626	0.241010	0.004294	0.002436
Median	-0.006965	0.209843	0.003000	0.002000
Maximum	0.024865	0.670293	0.008500	0.006000
Minimum	-0.065065	0.120389	0.002500	0.000000
Std.dev	0.024020	0.135600	0.002194	0.001603
Skewness	-0.885366	1.999418	1.026724	0.532770
Kurtosis	3.285091	6.950105	2.545497	2.486785
Jarque-Bera	2.278545	22.37910	3.133114	0.990793
Probability	0.320052	0.000014	0.208763	0.609329

Table III.19:Descriptive statistics relative to Japanese Yen

	Return JPY	Risk JPY	Trade JPY	Debt service JPY
Mean	0.195371	3.586477	0.007294	0.147213
Median	0.028229	1.869430	0.006500	0.139000
Maximum	1.858732	17.56613	0.016500	0.337110
Minimum	-1.366516	0.112730	0.003500	0.063000
Std.dev	0.640123	4.707972	0.003057	0.084858
Skewness	0.411851	1.864228	1.642451	0.757886
Kurtosis	5.750056	5.708622	5.905468	2.477882
Jarque-Bera	5.837583	15.04359	13.62289	1.820540
Probability	0.053999	0.000541	0.001101	0.402415

Appendix III.2: Correlation matrixes

Table III.20:Correlation matrix of USD equation regressors

	Return USD	Risk USD	Trade USD	Debt service USD	Intervention level USD
Return USD	1.0000	0.7480	0.1136	-0.2902	0.2702
Risk USD	0.7480	1.0000	0.3604	-0.3077	0.4480
Trade USD	0.1136	0.3604	1.0000	-0.5138	0.1987
Debt service USD	-0.2902	-0.3077	-0.5138	1.0000	-0.4269
Intervention level USD	0.2702	0.4480	0.1987	-0.4269	1.0000

Table III.21:Correlation matrix of EUR equation regressors

	Return EUR	Risk EUR	Trade EUR	Debt service EUR	Intervention level EUR
Return EUR	1.0000	0.5289	-0.0027	0.0768	0.2799
Risk EUR	0.5289	1.0000	-0.2889	0.2909	0.5022
Trade EUR	-0.0027	-0.2889	1.0000	-0.2041	0.1746
Debt service EUR	0.0768	0.2909	-0.2041	1.0000	-0.0726
Intervention level EUR	0.2799	0.5022	-0.1746	-0.0726	1.0000

Table III.22:Correlation matrix of GBP equation regressors

	Return GBP	Risk GBP	Trade GBP	Debt service GBP
Return GBP	1.0000	-0.5439	0.0457	0.1448
Risk GBP	-0.5440	1.0000	-0.2361	0.5008
Trade GBP	0.0457	-0.2361	1.0000	0.6417
Debt service GBP	0.1449	-0.5008	0.6417	1.0000

Table III.23: Correlation matrix of JPY equation regressors

	Return JPY	Risk JPY	Trade JPY	Debt service JPY
Return JPY	1.0000	0.4965	-0.1655	0.1416
Risk JPY	0.4965	1.0000	-0.2356	0.0638
Trade JPY	-0.1655	-0.2356	1.000	0.5197
Debt service JPY	0.1416	-0.0638	0.5197	1.0000

Appendix III.3: OLS regression USD

```
. reg Yusd r_usd v_usd trade1 debtservice_usd Il_usd
```

Source	SS	df	MS	Number of obs	=	15
				F(5, 9)	=	4.79
Model	1.07154433	5	.214308867	Prob > F	=	0.0206
Residual	.402288574	9	.04469873	R-squared	=	0.7270
				Adj R-squared	=	0.5754
Total	1.47383291	14	.105273779	Root MSE	=	.21142

Yusd	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_usd	1.182504	1.042827	1.13	0.286	-1.176535	3.541543
v_usd	-.0611701	.108802	-0.56	0.588	-.3072973	.1849571
trade1	4.725696	1.325662	3.56	0.006	1.72684	7.724551
debtservice~d	4.209035	.9272018	4.54	0.001	2.111558	6.306511
Il_usd	.6095702	.5162367	1.18	0.268	-.5582384	1.777379
_cons	-3.436883	.7517591	-4.57	0.001	-5.13748	-1.736285

```
. ovtest

Ramsey RESET test using powers of the fitted values of Yusd
       Ho:  model has no omitted variables
                   F(3, 6) =      1.66
                  Prob > F =      0.2727

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of Yusd

         chi2(1)      =     1.08
         Prob > chi2  =   0.2988

. dwstat

Durbin-Watson d-statistic(  6,    15) =  2.095597
```

```
. vif
```

Variable	VIF	1/VIF
v_usd	3.31	0.302029
r_usd	2.69	0.371298
debtservic~d	1.76	0.569404
trade1	1.69	0.591069
Il_usd	1.50	0.664625
Mean VIF	2.19	

Skewness/Kurtosis tests for Normality

				joint	
Variable	Obs	Pr(Skewness)	Pr(Kurtosis)	adj chi2(2)	Prob>chi2
u_usd	15	0.2123	0.6802	1.97	0.3731

Appendix III.4: OLS regression EUR

```
. reg Yeuro r_eur v_eur trade2 debtservice_eur Il_eur
```

Source	SS	df	MS		
Model	1.07302865	5	.214605731	Number of obs	= 15
Residual	.240124449	9	.026680494	F(5, 9)	= 8.04
				Prob > F	= 0.0039
Total	1.3131531	14	.09379665	R-squared	= 0.8171
				Adj R-squared	= 0.7155
				Root MSE	= .16334

Yeuro	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_eur	.0710089	.2930142	0.24	0.814	-.5918353	.7338531
v_eur	-.0805073	.0321878	-2.50	0.034	-.1533213	-.0076934
trade2	5.667632	1.364997	4.15	0.002	2.579793	8.755471
debtservice~r	1.929648	.4136685	4.66	0.001	.993865	2.865431
Il_eur	.6703026	.4156219	1.61	0.141	-.2698994	1.610505
_cons	-4.174889	.820726	-5.09	0.001	-6.0315	-2.318278

```
. vif
```

Variable	VIF	1/VIF
v_eur	2.11	0.474235
Il_eur	1.45	0.691706
r_eur	1.45	0.691984
debtservic~r	1.21	0.829464
trade2	1.15	0.868568
Mean VIF	1.47	

```
. ovtest

Ramsey RESET test using powers of the fitted values of Yeuro
       Ho:  model has no omitted variables
                   F(3, 6) =      0.92
                  Prob > F =      0.4876

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of Yeuro

         chi2(1)      =     0.25
         Prob > chi2  =   0.6176


. dwstat

Durbin-Watson d-statistic(  6,    15) =  2.053182


. sktest u_eur

                    Skewness/Kurtosis tests for Normality
                                                              ------ joint ------
    Variable |        Obs  Pr(Skewness)  Pr(Kurtosis) adj chi2(2)    Prob>chi2
-------------+-------------------------------------------------------------------
       u_eur |         15     0.4440        0.4926        1.17         0.5567
```

Appendix III.5: OLS regression GBP

```
. reg Ygbp r_gbp v_gbp trade3 debtservice_gbp
```

Source	SS	df	MS	Number of obs	=	17
				F(4, 12)	=	3.97
Model	3.82693044	4	.956732611	Prob > F	=	0.0280
Residual	2.88917628	12	.24076469	R-squared	=	0.5698
				Adj R-squared	=	0.4264
Total	6.71610672	16	.41975667	Root MSE	=	.49068

Ygbp	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_gbp	8.072627	6.18254	1.31	0.216	-5.397971	21.54322
v_gbp	-2.229271	1.259966	-1.77	0.102	-4.974502	.5159598
trade3	-140.0364	73.50942	-1.91	0.081	-300.1996	20.12692
debtservice~p	-14.26679	114.1718	-0.12	0.903	-263.0257	234.4921
_cons	-1.917832	.4599353	-4.17	0.001	-2.919945	-.9157193

```
. dwstat

Durbin-Watson d-statistic(  5,    17) =   1.49302


. ovtest

Ramsey RESET test using powers of the fitted values of Ygbp
       Ho:  model has no omitted variables
                   F(3, 9) =      1.82
                 Prob > F =      0.2135

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of Ygbp

         chi2(1)      =     0.25
         Prob > chi2  =   0.6196


. sktest u_gb

                    Skewness/Kurtosis tests for Normality
                                                      ------ joint ------
    Variable |        Obs  Pr(Skewness)  Pr(Kurtosis) adj chi2(2)    Prob>chi2
-------------+-------------------------------------------------------------------
        u_gb |         17     0.5409        0.1191        3.24          0.1982
```

```
. vif
```

Variable	VIF	1/VIF
debtservic~p	2.23	0.449390
v_gbp	1.94	0.515505
trade3	1.73	0.578429
r_gbp	1.47	0.682317
Mean VIF	1.84	

Appendix III.6: OLS regression JPY

```
. reg Yjpy r_jpy v_jpy trade4 debtservice_jpy
```

Source	SS	df	MS	Number of obs	=	17
				F(4, 12)	=	2.01
Model	10.7000388	4	2.67500969	Prob > F	=	0.1565
Residual	15.9387685	12	1.32823071	R-squared	=	0.4017
				Adj R-squared	=	0.2022
Total	26.6388072	16	1.66492545	Root MSE	=	1.1525

Yjpy	Coef.	Std. Err.	t	P>|t|	[95% Conf.	Interval]
r_jpy	-.2251514	.5393869	-0.42	0.684	-1.400374	.9500716
v_jpy	.0749271	.0718355	1.04	0.317	-.081589	.2314432
trade4	173.2536	115.7402	1.50	0.160	-78.92267	425.4298
debtservice~y	-10.2861	4.137369	-2.49	0.029	-19.30065	-1.271547
_cons	-4.678481	.8512315	-5.50	0.000	-6.533156	-2.823807

```
. ovtest

Ramsey RESET test using powers of the fitted values of Yjpy
       Ho:  model has no omitted variables
                   F(3, 9) =      0.40
                 Prob > F =      0.7564

. hettest

Breusch-Pagan / Cook-Weisberg test for heteroskedasticity
         Ho: Constant variance
         Variables: fitted values of Yjpy

         chi2(1)      =     4.04
         Prob > chi2  =   0.0444

. dwstat

Durbin-Watson d-statistic(  5,    17) =   2.55561

.


. sktest u_jpy

                    Skewness/Kurtosis tests for Normality
                                                      ------ joint ------
    Variable |        Obs  Pr(Skewness)  Pr(Kurtosis) adj chi2(2)    Prob>chi2
-------------+-------------------------------------------------------------
       u_jpy |         17     0.6053        0.6395        0.51          0.7760
```

```
. vif
```

Variable	VIF	1/VIF
trade4	1.51	0.663099
debtservic~y	1.48	0.673465
r_jpy	1.44	0.696347
v_jpy	1.38	0.725784
Mean VIF	1.45	

Appendix III.7: Recap for OLS regressions

Table III.24: Ordinary Least Square Estimation

	Constant	β_1	β_2	β_3	β_4	β_5	R^2	F	DW	Tests	Ramsey test	Breusch Pagan test
USD	-3.436883	1.182504	-0.06117	4.725696	4.209035	0.6095702	0.7270		2.095597			
t-values	-4.57	1.13	-0.56	3.56	4.54	1.18		4.79		*Test*	1.66	1.08
Probability	0.001	0.286	0.588	0.006	0.001	0.268		(0.0206)		*probability*	(0.2727)	(0.2988)
EUR	-4.174889	-0.0805073	0.0710089	5.667632	1.929648	0.6703026	0.8171		2.053182			
t-values	-5.09	-2.50	0.24	4.15	4.66	1.61		8.04		*Test*	0.92	0.25
Probability	0.001	0.034	0.814	0.002	0.001	0.141		(0.0039)		*probability*	(0.4876)	(0.6176)
GBP	-1.917832	8.072627	-2.229271	-140.0364	-14.26679		0.5698		1.49302			
t-values	-4.17	1.31	-1.77	-1.91	-0.12			3.97		*Test*	1.82	0.25
Probability	0.001	0.216	0.102	0.081	0.903			(0.0280)		*probability*	(0.2135)	(0.6196)
JPY	-4.678481	-0.2251514	0.0749271	173.2536	-10.2861		0.4017		2.55561			
t-values	-5.50	-0.42	1.04	1.50	-2.49			2.01		*Test*	0.40	4.04
Probability	0.000	0.684	0.314	0.160	0.029			(0.1565)		*probability*	(0.7564)	(0.0444)

Appendix III.8: Seemingly Unrelated Regression estimation

Seemingly unrelated regression

Equation	Obs	Parms	RMSE	"R-sq"	chi2	P
Yusd	15	5	.1695133	0.7076	58.11	0.0000
Yeuro	15	5	.1275171	0.8143	84.26	0.0000
Ygbp	15	4	.3761653	0.4586	14.67	0.0054
Yjpy	15	4	1.062587	0.3107	26.16	0.0000

	Coef.	Std. Err.	z	P>|z|	[95% Conf.	Interval]
Yusd						
r_usd	.7163338	.5667256	1.26	0.206	-.394428	1.827096
v_usd	-.054045	.0549019	-0.98	0.325	-.1616508	.0535607
trade1	4.502036	.7695669	5.85	0.000	2.993712	6.010359
debtservice_usd	3.891884	.5911965	6.58	0.000	2.733161	5.050608
Il_usd	.4137111	.2505987	1.65	0.099	-.0774533	.9048755
_cons	-3.175529	.4243726	-7.48	0.000	-4.007284	-2.343774
Yeuro						
r_eur	.0199023	.1910614	0.10	0.917	-.3545711	.3943757
v_eur	-.0783189	.021456	-3.65	0.000	-.120372	-.0362658
trade2	5.815614	.9365673	6.21	0.000	3.979976	7.651252
debtservice_eur	1.917216	.2933377	6.54	0.000	1.342284	2.492147
Il_eur	.5692932	.2834549	2.01	0.045	.0137317	1.124855
_cons	-4.201327	.5653916	-7.43	0.000	-5.309475	-3.09318
Ygbp						
r_gbp	9.409433	3.709209	2.54	0.011	2.139516	16.67935
v_gbp	1.356223	1.14171	1.19	0.235	-.8814874	3.593934
trade3	-122.5163	48.25249	-2.54	0.111	-217.0894	-27.94315
debtservice_gbp	38.51064	75.37493	0.51	0.609	-109.2215	186.2428
_cons	-2.906788	.3629903	-8.01	0.000	-3.618236	-2.19534
Yjpy						
r_jpy	-.4614101	.4729369	-0.98	0.329	-1.388349	.4655292
v_jpy	.1363481	.0632634	2.16	0.031	.012354	.2603421
trade4	253.5169	75.3535	3.36	0.001	105.8268	401.2071
debtservice_jpy	-10.16185	3.000425	-3.39	0.001	-16.04258	-4.28113
_cons	-5.513145	.6335422	-8.70	0.000	-6.754865	-4.271425

Correlation matrix of residuals:

	Yusd	Yeuro	Ygbp	Yjpy
Yusd	1.0000			
Yeuro	-0.4469	1.0000		
Ygbp	-0.5041	0.0215	1.0000	
Yjpy	-0.3316	0.4355	-0.4322	1.0000

Breusch-Pagan test of independence: chi2(6) = 14.112, Pr = 0.0284

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