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Assessing the cost of international reserves in Tunisia

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Abstract

We endeavor to assess the cost of international reserves in Tunisia. They are of two types: the cost of holding reserves and the marginal cost of carrying reserves. The former is relevant when reserves are above optimal thus generating opportunity cost. The latter is relevant when reserves are sub-optimal and are measured by the cost of external debt. This is because debt is the driver of increasing reserves.

We found that reserves in Tunisia are suboptimal using the IMF ARA measure for optimal reserves. That means we will deal with the marginal cost of carrying reserves. We proxied it by the coupon rates on issue dates obtained from a rundown of prospectuses when Tunisia accessed the international market.

We ascertained the determinants of this cost. Essentially, we found that the cost is lower when reserves are accumulated, when a third-party guarantee is obtained, when sovereign rating is higher or when external debt is lower.

Key words: International reserves, cost of holding reserves, marginal cost of reserves, reserves accumulation, optimal reserves.

Acronyms

ADF	Augmented Dickey-Fuller
AIC	Akaike Information Criterion
ARA	Assessing Reserve Adequacy
BOP	Balance of Payments
CBT	Central Bank of Tunisia
CE	Cointegrating Equation
ECB	European Central Bank
EME	Emerging Market Economy
FX	Foreign Exchange
GDP	Gross Domestic Product
IMF	International Monetary Fund
IR	International Reserves
IRF	Impulse Response Function
KPSS	Kwiatkowski–Phillips–Schmidt–Shin
PP	Phillips Perron
RME	Reserve Management Entity
SC	Schwarz Criterion
SDR	Special Drawing Rights
SWIFT	Society for Worldwide Interbank Financial Telecommunication
US	United States
VAR	Vector Auto Regression
VECM	Vector Error Correction Model

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Main Introduction

In the aftermath of the Asian crisis in 1997, many economies have engaged in hoarding international reserves (IR) as a buffer against capital outflow (Levy-Yeyati E. a., 2020). Indeed, this trend has continued in the wake of the global financial crisis. (Assessing Reserve Adequacy-FURTHER, 2013). Throughout that period of financial disorder, several emerging and advanced economies used their IR to influence their exchange rates. That intervention helped in mitigating financial turmoil. Accumulating IR comes with many benefits for each economy. The most common is the mercantilist motive when the reserve management entity (RME) builds up reserves to keep the domestic currency undervalued to promote export growth. (Dooley, 2004), (Prasad, 2006), (Levy-Yeyati E. a., 2007), (Rodrik D. , 2008). The following motive is precautionary when reserves are accumulated as liquidity buffer against capital outflows and runs. (Jeanne O. a., 2006), (Aizenman J. a., Financial versus monetary mercantilism: long-run view of large international reserves hoarding, 2008), (Crispolti, 2011), (Levy-Yeyati E. a., 2020). Then there is the smoothing of the exchange rate to counter its cyclical fluctuation, (Papaioannou, 2006), (Cowan, 2006). This cyclical nature can be related to the mercantilist motive and so to prevent loss of competitiveness. Or, it can be related to the precautionary motive and so to avoid overvaluations that could cause exchange rate risk and volatility. (Levy-Yeyati E. a., 2020). Even central banks with a strong commitment to the floating regime did intervene in the foreign exchange market during the COVID-19 pandemic. (Lafarguette, 2021)

Despite the temptation of hoarding IR, they do come with costs. These costs take several forms such as the marginal cost of reserves, the cost of holding reserves, and the cost of intervention. The marginal cost of reserves refers to the cost by which reserves have increased. Or, in other words, the cost of purchasing them. (Levy Yeyati, 2005). (Levy-Yeyati E. a., 2020). This cost is measured typically by the sovereign risk spread plus the hard-currency interest rate term premium. The cost of holding reserves is also known as the opportunity cost. It is the foregone earnings on reserves had the reserves management entity used them to invest in projects with better yield such as infrastructure. (Rodrick, 2006). Nevertheless, this cost is only relevant if reserves are in excess. Then, there is the cost of intervention. It refers to the incurred cost if the reserve management entity decides to intervene on the domestic market to influence the

exchange rate whether through a sterilized intervention or unsterilized intervention. (Tosini, 1977), (Claro, 2013), (Levy-Yeyati E. a., 2020), (Adler, 2021) (Lafarguette, 2021)

We endeavor in this thesis to investigate the costs of reserves for the Tunisian economy. When it comes to the cost of reserves, the majority of papers focus on the cost of holding reserves. This is relevant in the case of Asian and oil-exporting economies which are prominent as export-driven economies. Henceforth, they have accumulated large stocks of reserves beyond the optimal level. Anyhow, this cannot befit the Tunisian economy. Its reserves are notorious for being sub-optimal.

In this regard, our focus is the marginal cost of reserves as we looked forward to ascertaining its determinants and to what extend a shock in one of its determinants could affect it. As we mentioned earlier, international reserves in Tunisia are notorious for being sub-optimal. Thus, the process of accumulating reserves is crucial for reaching the optimal level. Yet, this process is carried out mostly by debt (See Figure 6). Hence, we are motivated to study the determinants of this cost. So, we have followed the methodology of (Levy-Yeyati E. a., 2020), which is conducted on emerging economies with Tunisia included. We have also beard in mind the specificity of the Tunisian economy. In the aforementioned article, the cost of reserves is proxied by the sovereign risk spread plus the hard-currency interest rate term premium. Nevertheless, we adopted a different approach by taking the coupon rates on the issue dates as a proxy for cost. We found that the latter method produced better results than the former, hence the adoption.

To the best of our knowledge, we believe that our approach is considered a novelty that deals with the aforementioned aspects. Within this context and specificity of the Tunisian economy. We hereby undertake to answer the following questions:

- Does the Tunisian economy incur a cost of holding excess reserves?
- What determines the marginal cost of international reserves in the Tunisian economy?

To elucidate the first question, we need to confirm if reserves are sub-optimal as we claim. We assessed the optimal level using the benchmark formula developed by the International Monetary Fund (IMF). We found that reserves are not in excess. This means that the cost of holding reserves is not relevant.

As for the second question, which deals with the marginal cost of reserves, we started by exhibiting the most influential determinants from the literature. Then, we conducted the

necessary tests, first, on our data, second, on the relationship between the variables we proposed, and third, on the residuals after the estimation. We did find a stable long-term relationship between the variables even if in the short-term, it could deviate. The speed of adjustment seems to be not slow.

In the following, we distributed our work into three chapters. In chapter one, we provided an overview of international reserves. We have presented the overall trend observed worldwide of the IR. We also provided an overview of the reasons that motivate economies to hoard international reserves as we mentioned earlier. Furthermore, we aroused the IMF's guidelines on IR management that include a series of principles that a reserve management entity should follow for sound management.

In chapter two, we presented different methodologies to assess the optimal level of IR, and to assess their cost. The reserves adequacy level is determined using different approaches. There are simple methods that rely on macroeconomic ratios. There is the cost-benefit approach that relies on optimizations. And finally, the IMF Assessing Risk Aversion (ARA) index. Additionally, we have addressed the concept of the cost of reserves in further detail and how they are determined.

In chapter three, we carried with an empirical investigation to assess the cost of international reserve. First, we started with the cost of holding reserves. We settled that such a cost is not relevant to calculate. Second, we carried on an empirical investigation on what determines the marginal cost of reserves within the Tunisian economy. We estimated for two timeframes, from 2006 to 2019 and a sub-sample from 2011 to 2019. We concluded that the marginal cost of reserves depends on the availability of a third-party guarantee, reserves over the Gross Domestic Product (GDP), external debt, and sovereign rating. And to a lesser extent, international rate and sovereign risk.

Chapter I : An overview on international reserves

Introduction

International reserves are of the utmost importance throughout emerging economies and also advanced economies. Regardless of the nature of the economy, the accumulation of reserves serves to meet specific objectives. Among them is to finance the balance of payments needs and to fulfill external obligations. Or to prevent a financial crisis within their economies. These economies are prone to sharp swings in trade, exports, natural disasters, and capital-flow, (Dabla-Norris, 2011).

In this chapter, we endeavor to extend the motives for which economies hold IR. Most economies do so for precautionary measures (Jeanne O. a., 2006), (Jeanne O. a., 2008), (Aizenman J. a., Financial versus monetary mercantilism: long-run view of large international reserves hoarding, 2008), (Durdu, 2009), mercantilism motives to stimulate growth (Dooley, 2004), and managing exchange rate to smooth its volatility (Cowan, 2006).

We follow our overview by providing the guidelines as presented by the International Monetary Fund for sound management of IR within the RME. The principles are related to transparency and accountability, institutional framework, risk management framework, and efficient market role. We will similarly discuss the Tunisian case within this framework.

In the following, we will dissect the chapter into two sections. In section one, we will outline the definition of international reserves. Then, the motives that drive economies to hold them. In section two, we will present a set of guidelines for sound management of reserves in general and the Tunisian case in particular.

Section I.1: Definition and motives of international reserves

I.1.1: IMF's Definition of international reserves

According to the International Monetary Funds (IMF) (2001): International Reserves consist of official public sector foreign assets that are readily available to and controlled by the monetary authorities.

International reserves must fulfil two major criteria. First, they must be liquid and therefore easily marketable. So, they must be readily available and under the effective control of the

foreign reserve management entity. Second, these IR need to be held in a form of a convertible foreign currency.

Another definition of international reserves from the IMF Balance of Payments and International Investment Position Manual edition 6 (BPM6) which defines international reserves as:

"Those external assets that are readily available to and controlled by monetary authorities for meeting balance of payments financing needs, for intervention in exchange markets to affect the currency exchange rate, and for other related purposes (such as maintaining confidence in the currency and the economy, and serving as a basis for foreign borrowing)."

We extend this definition to include the various keywords:

Monetary authorities could be a central bank or certain operations attached to it but sometimes performed by other government institutions or commercial banks, such as government-owned commercial banks.

The concept of control conveys ownership of external claims by the monetary authorities. Only these claims are classified as reserve assets.

The resident entity can only accomplish these claims with nonresidents on the terms specified by the monetary authorities or only with their express approval. The RME has access on-demand to these claims on nonresidents to meet the balance of payments financing needs and other related purposes. There is a prior law or an otherwise legally binding contractual arrangement confirming this agency role of the resident entity that is actual and definite in the resident entity that is actual and definite in intent.

The availability depends on any set of conditions that affects the assets, including their liquidity or marketability. Owned assets that are immediately available and can be viewed as assets in the most unconditional form are Monetary gold, Special Drawing Rights (SDR), Reserve Position in the Fund.

Reserve assets must be readily available in the most unconditional form. A reserve asset is liquid in that the asset can be bought, sold, and liquidated for foreign currency (cash) with minimum transaction cost and time and without unduly affecting its value. The concept refers to both nonmarketable assets such as demand for deposits and marketable assets such as

securities. The ability to raise funds by using the asset as collateral does not suffice to make an asset a reserve asset. It should also be of high quality.

Reserve assets must be both denominated and settled in convertible foreign currencies. These can be those freely available to complete international transactions. And widely traded in the major exchange markets

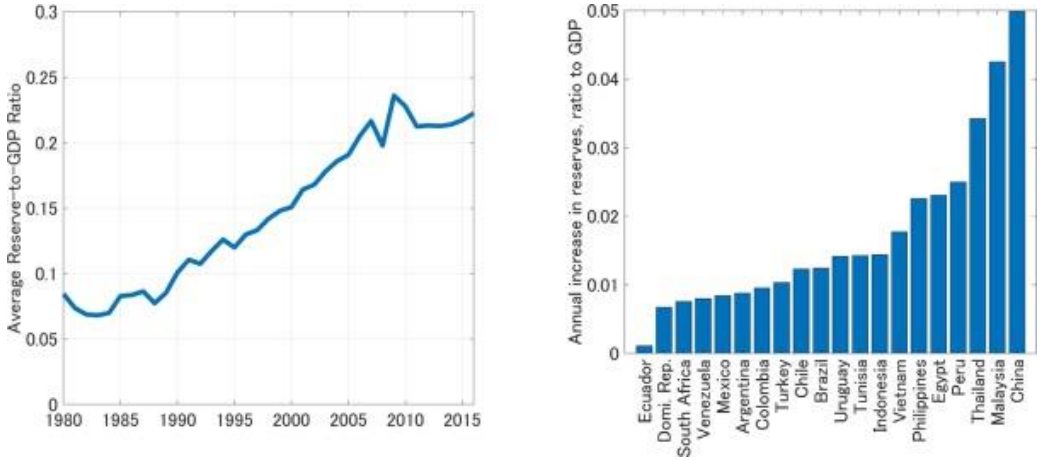
According to this definition, and similarly to the previous one, international reserves are reserves assets labeled in foreign currency and that they have to exist. Moreover, they must be ready for use and under the effective control of the reserve's management entity.

IR could take several forms according to IMF's BPM 6, such as Monetary gold, Special drawing rights, Reserve position in the IMF and Other forms of reserve assets (Currency and Deposits and Securities), Financial derivatives, and other claims.

I.1.2: The motives behind holding international reserves

International reserves have increased drastically since 1990. (Matsumoto, 2021), (Lafarguette, 2021). Most international reserve holders are emerging market economies (EMEs) and most importantly China. Oil exporting countries also have their fair share of reserves accumulation. This trend is illustrated in Figure 1.

Figure 1: Foreign Reserves accumulation from 1980-2015



Source: Hidehiko Matsumoto, Foreign reserve accumulation, foreign direct investment, and economic growth, Review of Economic Dynamics,2021.

The level of foreign reserves has reached, on average, almost 30% of GDP in 2018 from about 5% in 1990. (Arslan, 2019). Meanwhile, cross-country differences are noteworthy. Oil exporting countries remain were and are among the largest holder of international reserves to GDP even after the slowdown since 2010.

In this regard, central banks hold IR for multiple motives. The most important among them are: precautionary or self-insurance against crisis (Aizenman J. a., 2007), mercantilism motive to stimulate growth (Dooley, 2004), and intervention to manage exchange rate volatility. (Cowan, 2006).

I.1.2.1: Precautionary and self-insurance motive

In the precautionary motive, economies accumulate IR to smooth down the impact of a sudden capital outflow or inflow if the economy is prone to sudden stops (Jeanne O. a., 2006). This motive would protect the economy from the costly liquidation of long-term projects (Aizenman J. a., 2007).

In this regard, IR are accumulated on good days to be used on rainy days to smooth down potential turbulence within the currency market or the balance of payments. There is a consensus that this is especially the case for many emerging economies since these are faced with a high degree of capital mobility and an underdeveloped domestic financial system.

Many EMEs have experienced crises caused by sudden stops of capital flows that caused long-term damage to the financial system, (Arslan, 2019). Latin American Debt Crisis of the 1980s, Mexican peso crisis in 1995, Asian financial crisis in 1997, Russian ruble devaluation crisis in 1998, Turkey currency crisis in 1994 and 2001, Brazil samba effect crisis in 1999, and Argentina great depression in 2002 and 2018.

As a result of these consecutive crises, EMEs have become warier of these outcomes and thus engaged in a process of hoarding reserves as a precautionary motive given the lack of a satisfactory safety net. (Carstens, 2019). The amount of capital mobility did not stop increasing in the last decades which further exacerbated this motive for EMEs. As a consequence, EMEs accumulated so much that they went beyond the adequate level. This has proved its benefits during the global financial crisis. EMEs that accumulated more reveres have experienced fewer turbulences on their exchange rates. (Crispolti, 2011), (Arslan, 2019).

(Aizenman J. a., 2007), found that variables associated with trade openness and exposure to financial crises are both statistically and economically important in explaining the

accumulation of reserves. In contrast, variables associated with mercantilist concerns are statistically significant but economically insignificant in accounting for the patterns of hoarding reserves.

I.1.2.1: Mercantilist motive

In the mercantile view, reserve accumulation is a by-product of an export-growth strategy by keeping exchange rates undervalued to promote export growth and gain competitiveness. (Dooley, 2004), (Arslan, 2019). Besides, international reserves can serve as collateral for encouraging foreign direct investment (FDI).

Similarly, international reserve accumulation can occur as a result of a growth strategy that consolidates export promotion and credit subsidization. Also known as “financial mercantilism” (Aizenman J. a., 2008)

This motive is mostly observed throughout East Asian economies where their economies are export-oriented. These economies have programs to promote exports through preferential financing. These programs would effectively subsidize investment in targeted sectors (Aizenman J. a., 2008)

The promotion was achieved in several ways, whether by direct subsidies funded by state banks or by means of financial control where preferred sectors enjoyed preferential access to cheaper external debt or through “moral suasion” where private banks were urged to provide favorable financing.

(Aizenman J. a., 2008) provided heuristic arguments that explain reserves accumulation in east Asian economies. Japan and South Korea started the accumulation of reserves after they committed to a growth strategy driven by export promotion and credit subsidization. This phenomenon is called "financial mercantilism". (Aizenman J. a., 2007).

Not only emerging economies are involved with this motive, but several advanced economies are also involved like Denmark and Switzerland. (Arslan, 2019).

I.1.2.2: Managing exchange rate

In this view, the central bank accumulates reserves to use them as a tool to manage the exchange rate fluctuations so that volatility is curbed. In this regard, IR are purchased to encompass appreciation pressures of the domestic currency. On the flip side, they are sold to prevent a

rapid depreciation in the event of a sudden stop. (Kiguel, 2009). This form of intervention is also known as leaning-against the wind intervention.

In other words, leaning against the appreciation wind during the expansion of a cycle can be understood as a countercyclical reaction to procyclical capital flows and real exchange rate fluctuations. (Carstens, 2019).

This form of intervention is aimed to achieve sustainable foreign exchange rates even in economies with de-jure floating currency regimes, therefore confirming a de-facto managed nature of such regimes. (Papaioannou, 2006). The underlying explanation behind this is partly because expectations of further appreciation of the exchange rate generate short-term capital inflows, which in itself adds to the exchange rate pressure on the economy. Accordingly, central banks are induced to intervene to restraint an excessive exchange rate appreciation and/or to smooth down volatility. During the COVID-19 pandemic, central banks with a strong commitment to a floating regime did intervene in the FX market. (Lafarguette, 2021).

(Chamon, 2017) argue that in the case of economies with an underdeveloped financial system, a central bank intervention on exchange rate movements may be desirable.

In this retrospect, (Héricourt, 2015) show that firms export less when faced with greater exchange rate volatility. This phenomenon is magnified for those that are financially vulnerable.

(Devereux, 2004) shows that even if flexible exchange rates could serve as an effective shock absorber in response to shocks, then stable exchange rates may still be desirable due to the presence of nominal rigidities.

Although managing exchange rate volatility is widely praised. It is criticized for being destabilizing to the economy. (Chutasripanich, Foreign exchange intervention: strategies and effectiveness, 2015), argues that intervention does indeed lower volatility of exchange rate but also reduce the risk undertaken by speculators taking a position in the currency market. Therefore, speculation would increase in tandem with the intervention of the central bank. Therefore, the feedback loop is present and as a result, FX intervention is highly volatile.

Section I.2: The IMF's guidelines for the management of international reserves

I.2.1: Definition and importance of reserve management

The IMF defines reserves management as follows:

"Reserve management is a process that ensures that adequate official public sector foreign assets are readily available to and controlled by the authorities for meeting a defined range of objectives for a country or union."

In this context, a RME or central bank is usually responsible for the management of reserves and the risks that are associated with them.

Sound reserves management is very important because it can affect economies' resilience to shocks. This is seen through the interaction with financial where reserve managers have access to relevant information concerning markets developments and possible threats which come into assistance in keeping policymakers informed. If reserve management practices are weak, it will lead to reputation costs as it happened to some countries. This is because weak management hinders the ability of the authority to react efficiently to financial crises.

Hence, suitable portfolio management policies (regarding the currency composition, choice of investment instruments, and acceptable duration of the reserves portfolio), to the economy specificity, ensure that assets are safeguarded, readily available, and support market confidence.

Sound reserve management policies and practices can support, but not substitute for, sound macroeconomic management. Moreover, inappropriate economic policies (fiscal, monetary and exchange rate, and financial) can pose serious risks to the ability to manage reserves.

I.2.2: Purpose of the guidelines

The purpose of the guidelines is to assist governments and central banks to strengthen their policy framework with respect to IR management. It supports authorities to deliver suitable objectives and principles for reserve management. And to develop adequate foundations for good reserve management practices. Thus, it would be better off dealing with global or domestic financial crises.

The guidelines serve to spread sound practices while recognizing there is no unique set of reserve management practices. Or institutional arrangements that are best for all countries or situations. In this respect, they should be regarded as nonmandatory and should not be viewed as a set of binding principles.

In the context of this paper, these practices are reflected in guidelines that encompass:

- Clear objectives for the management of reserves;
- A framework of transparency that ensures accountability and clarity of reserve management activities and results;
- Sound institutional and governance structures;
- Prudent management of risks; and
- The conduct of reserve management operations in efficient and sound markets.

I.2.3: The objective of the guidelines

Reserve management should guarantee that sufficient foreign exchange reserves are readily available for meeting a defined range of objectives. This includes controlling liquidity, market, and credit risks in a judicious manner.

Reserve management activities are not only limited to managing international assets but also external liabilities. Reserve management follows strategies that should be consistent with the country's policy environment.

In the following, we will enumerate the principal recommended in this guideline.

I.2.3.1: Transparency and Accountability

Transparency and accountability refer to the clarity of roles, responsibilities, and objectives of financial the RME. They should be clearly defined and publicly disclosed. This goes beyond the RME and it should include its arrangement with the government and other agencies.

The definition of the RME with its counterparties should be apparent in its market operations. They should be carried out in an open process. So, publicly disclosed.

Reserves management entity should make certain information on official IR available to the public regularly and on pre-announced dates.

The reserves management entity should also be subject to an internal audit as an assurance of integrity. The financial statement regarding this entity should be disclosed.

I.2.3.2: Institutional Framework

The institutional framework refers to the legal and governance framework regarding the RME. The legal frameworks should be well defined with a clear establishment of responsibilities

As for internal governance, it should be backed by a legal framework. Therein, the separation of responsibilities should be ensured with clear allocations.

In order to carry sound management, the staff has to be well trained and follow sound business practices. they should also be subject to a code of conduct and managing conflict of interest. Besides, internal operations and their associated risks should be monitored. This ensures reliable information and reporting.

Finally, in the event of a system failure that could bring operations to halt, an emergency recovery procedure should be present.

I.2.3.3: Risk Management Framework

A risk management framework is a system that identifies and assesses risks related to reserve management. These risks should be handled with acceptable parameters and levels.

Regardless of whether reserves are managed internally or externally, the risk framework should uniformly apply to both of them.

Risk exposure should be monitored continuously so that it does not exceed the acceptable limit. These risks could result in potential losses that could be devastating. Thus, reserves managers should always be aware of this.

Stress tests should be conducted regularly to determine the potential shock of financial and economic variables.

I.2.4: Reserve management in the Tunisian context

The central bank of Tunisia (CBT) is the sole custodian for managing IR within the Tunisian economy. The CBT is regulated by a law that puts into words this particular assignment.

The management of IR is overseen by an investment policy for IR which is adopted by the CBT’s board of directors. That investment policy outlines the guidelines and principles of IR' investments including the range of eligible assets, risk policy, and eligible counterparties.

The investment policy for IR is then ratified through a number of notes and procedures within the competent department within the CBT which is the department of reserves management and markets.

The reserve's management of IR is carried out by a set of objectives organized by priority. The utmost priority is the preservation of reserves holdings. This conveys a prudent approach toward risk. Then, guaranteeing the external liquidity of the economy. The CBT needs to provide liquidity to meet the economy's external obligation. And finally, maximization of return on reserves. This objective is looked upon after the two aforementioned objectives are met.

I.2.4.1: Transparency and Accountability

The system structure within the department for reserves management and markets is organized in a way that separates front, middle, and back offices functions. At the front office level, transactions done are booked into the system. The middle office checks the conformity of deals with regard to risk limits. The Back office has the charge of checking the deal's accuracy and entries before the final validation of the transaction. Swifts and messages unit is independent of the Back office, offering thus an additional way to reduce settlement risks. The Back-office also copes with the follow-up of accounting records, and the reconciliation of all received reports from correspondents and custodians.

The CBT conducts an open market operation with local banks on regular basis. These operations follow a bid process.

The CBT is equipped with a system that provides a large range of activity, treasury, and statistical reports. These reports allow control of transactions processing, and follow-up of risk and return management tools such as limits, duration, and performance. Moreover, information relative to IR such as reserves' holding, the balance of payments accounts is disclosed to the public on regular basis.

The audit function is led by an internal entity. This entity undertakes periodical missions in order to assess reserves management operations processing, in accordance with objectives, principles, and operational procedures approved by the Governing Board of the Bank. No external auditing has till now been undertaken.

I.2.4.2: Institutional Framework

According to Tunisian law[1], and as mentioned previously the central bank of Tunisia is the sole custodian for managing IR.

The governance, management, and surveillance of the CBT are undertaken by the Governor, the Board of Directors, and a censor who is appointed by decree, respectively.

The governor is appointed by the president of the republic upon a proposal by the Head of Government. Then, the appointment is approved by an absolute majority of members of the Assembly of the Representatives of the People. He sets the bank's organization.[2]

Strategic decisions on overall objectives and principles of reserves management policy are set by the Governor on the proposal of the concerned departments (currency distribution, asset classes, limits, risk monitoring, etc.)

The operational framework of the policies adopted, and all decisions regarding investment strategy, currency exposure, credit risk, dealing counterparties, custodian arrangements, permissible instruments, etc., have to be approved by senior managers and by the Governor, on proposals of the concerned departments.

The head of the reserve management department ensures that all operational guidelines are followed, and senior management is kept informed of all deals done, daily. The portfolio position is communicated daily to senior management, and weekly to the Governor.

There is an explicit separation between the Front Office, Middle and Back office, and the entity responsible for swifts and messages. Pursuance of Treasury orders is immediately checked by the back office. Observance of limits (credit limits, permissible instruments, etc.) is checked through controls from the chief dealer, the back office, senior management, the banking relations department, and through frequent reporting to the Governing Board.

I.2.4.3: Risk Management Framework

Supervision of risks is conducted through a system of formal limits and several controls.

First, dealing is centralized in a single location: the dealing room. Dealing risks are minimized by a formal separation between the front office, middle and Back Office, and Swifts and messages unit. Formal deposit limits are set for each counterparty in terms of amounts and

[1] Law 2016-35 establishing the status of the Central Bank of Tunisia
[2] Tunisian Constitution of 2014, Article 78

maximum deposit periods. Settlement risk for bond operations is reduced through a systematic and immediate checking of counterparty's confirmations (security type, accrued interest, nominal and net amounts, value date), prompt processing, and settling through receive (or deliver) against payment settlement procedures.

Custodial risk is reduced by choosing good international clearing institutes (Federal Reserve Bank of New York, Euroclear, Clearstream, Bank of Tokyo Mitsubishi), and by undertaking a thorough custodian follow-up and systematic control of custodian statements.

Information technology risk is reduced by limiting access to data files and information systems, a daily backing up of data files, and similar precautions. Financial errors are minimized through prompt transaction processing and recording, Back Office control measures, as well as accounting checks on a daily basis.

Conclusion

In this chapter, we gave an overview of IR. We exhibited its trend worldwide. Reserves have risen significantly since the early nineties and especially in EMEs that underwent the greatest financial crises. These crises were a vital motive to start this trend of self-insurance by hoarding reserves. In addition, this trend is also seen in East-Asian economies as a by-product of their export promotion program or "financial mercantilism".

We also provided an overview of the motives that lead economies to hold IR. The first motive is the self-precautionary motive by which an economy protects itself against a crisis that could befall internationally or locally and that results in the capital outflow. This motive in particular is the most important motive across central banks. The second motive is mercantile, such is the case for east Asian economies and export-oriented economies in general. And the third motive is the exchange rate volatility, where IR are employed as a way to mitigate exchange rate volatility.

In order to carry out efficient management of IR and to better meet the aforementioned motives of the economy, the RME should follow a list of guidelines. These guidelines should enhance its governance and mitigate various risks such as counterparty risk, operational risks. In this regard, we aroused the IMF's guidelines on IR management. We enumerated a series of principles that a RME should follow. Then we focused on the case of reserve management in the Tunisian economy and how far it is compliant with the IMF's guidelines.

In the next chapter, we will provide a literature overview on the measure of the adequacy of IR. Knowing the adequate level is important to determine the cost. Henceforth, the next section of the next chapter will deal with the cost of the IR.

Chapter II : Reserves Adequacy and Costs

Introduction

In this chapter, we will further extend our understanding of the optimal level of IR and so on costs. The optimal level determines the right amount of IR that an economy should meet so that no financial crisis occur. That level also serves as a benchmark to recognize if reserves are in excess or sub-optimal.

The adequate level of reserves could be decided by different approaches. First, there are simple methods that rely on ratios such as the import ratio, reserves over short-term debt, and the reserves over broad money. Second, there are methods based on fundamentals. This is the cost-benefit approach first developed by (Heller, 1966). This approach is based on optimization. Then, there is the IMF measure, Assessing Reserve Adequacy. It is essentially an index calculated with macroeconomic variables.

Since the international trend is characterized by the accumulation of reserves beyond the optimal level. This process comes with a cost, the opportunity cost. This is the foregone earnings had these reserves been invested in projects with better yields. It could be proxied by the differences in interest rates between domestic and hard currency. Yet, this cost is no longer relevant if reserves are sub-optimal.

In that case, the marginal cost of reserves is more appropriate. It is the cost by which reserves are increased. If a given economy increases its reserves by debt, that cost is proxied by the interest rates on external debt. Which can be determined by the international rate plus the sovereign spread.

Another cost of reserves is linked to the cost of carrying that is the result of intervention mechanisms that carry on the influence of the exchange rate. These interventions can be sterilized (without changing the monetary base) or unsterilized (by changing the monetary base). This is what is known in the literature as “Leaning-against-the-wind”.

In this chapter, we will discuss in more depth the adequate level of reserves in the first section. In that section, we will discuss the rule-of-thumb methods i.e. the ratios and the cost-benefit approach. Then in section 2, we will further discuss the cost of reserves. First, the marginal cost of reserves, and second the cost induced by the leaning-against-the wind mechanism.

Section II.1: Reserves Adequacy

In a broad sense, the reserves management entity holds IR based on a cost-benefit approach. The early studies that looked into the adequate level of reserves with respect to the aforementioned approach are the works of (Heller, 1966) and (Olivera, 1969). They compared the role that IR play in buffering fluctuations in external transactions to the opportunity cost of holding these reserves. They deduced that optimal reserves level is determined by the balance of payments disequilibria, the propensity to import, and opportunity cost.

These studies were extended by the work of (Frenkel, 1981) as they introduced the inventory model within a continuous-time inventory control framework which they developed in 1980. According to them, the RME determines the optimal level by solving the minimization costs problem, the opportunity cost of holding reserves versus the cost of adjustment whenever the level of reserves reaches the lower bound. Higher levels of reserves mean a larger buffer against any change but higher forgone earnings.

In the following, we will provide the most widely used measures of IR. First, the rule-of-thumb measures, then the cost-benefit approach, and finally the IMF ARA index. All these methods have their pros and cons.

II.1.1: Rule of thumbs measure for reserves adequacy

II.1.1.1: Import ratio

This ratio represents the number of months of imports that an economy could sustain if all revenues (all capital inflows) come to a halt. As a rule of thumb, the conventional level for this ratio should be equal to three to four months of import. Nonetheless, this ratio is criticized by many for the lack of empirical basis for that level.

This ratio is more relevant for economies where shocks occur from the current account (IMF, 2011). And for the poorest economies where this assumption is plausible.

II.1.1.2: Reserves to short-term external debt

This ratio is obtained by dividing the IR by the short-term debt. This ratio, known as the Greenspan–Guidotti rule, reflects the ability of a given economy to service its existing short-term external debt (debt maturing within a year) if acute atrophy in external financing conditions occurs. The one-year cutoff is arbitrary and presumably inspired essentially by the definition of short-term debt.

As with the last ratio, the concept that an economy should survive for one year without external financing is not true to reality. A crisis can last much longer or shorter. Besides, if a crisis occurs, access to the international market does not stop altogether.

This measure was not a good predictor for crises. It was demonstrated by (IMF, 2011), that little association existed.

Typically, an economy is prudent if this ratio is at least equal to 1. (Rodrik D. a., 1999).

II.1.1.3: Reserves to broad money

This ratio is international reserves over broad money (M2 or M3). The optimal level is 20%. This metric is intended to capture the risk of capital flight. If capital outflow would occur, it will be accompanied by runs on deposits. Yet, this ratio shows little correlation to the crisis. (IMF, 2011).

Nevertheless, this metric could be interpreted as a potential need for bank support in times of crisis, provided that banks face large external exposures. If the exchange rate regime is pegged, the potential capital flight occurrence is more expected if this ratio is in the lower bounds.

II.1.2: Cost-benefit approach to optimal reserves

Cost-benefit approach models are an optimization problem typically between benefits of assumptions regarding holding reserves (such as lowering the probability of a crisis and smoothing consumption and costs) and the assumptions regarding cost (such as the opportunity cost).

In this regard, the optimal level in these models relies on numerous assumptions such as the size and probability of a sudden stop, potential loss in output and consumption, opportunity cost of holding reserves, and the degree of risk aversion.

The early studies that adopted this method are (Heller, 1966) and (Olivera, 1969). They compared the role that international reserves play in buffering fluctuations in external transactions to the opportunity cost of holding these reserves. They concluded that balance of payments disequilibria, the propensity to import, and opportunity cost are its main determinants.

(Ben-Bassat, Optimal international reserves and sovereign risk, 1992) developed a model to estimate the optimal reserve following this approach where a central bank minimizes its cost. The cost is composed of two components (the cost associated with reserve depletion or no

reserves, and the cost due to positive reserves). They argued that most developing economies hold high levels of IR to stay creditworthy. If international reserves turn to zero, this will incur costs coming from servicing external debt. Maintaining a high level of reserves would lower the probability of default.

Other models focused on this approach like (Caballero, 2004), focusing on the real cost of a sudden stop of capital flows. (Soto, 2004), assuming that reserves affect both the probability of a crisis and its cost. (Hviding, 2004), assuming that cost of international reserves decreases when reserves increase.

The most widely used model within the cost-benefit approach is the one developed by (Jeanne O. a., 2006). They determined the optimal level of reserves by balancing the economic cost defined by the opportunity cost. The economic cost is defined by the plausible loss in production and consumption given the probability of sudden stop and the size of the economy. The opportunity cost is defined by the foregone earnings on an alternative investment instead of holding reserves.

(Dabla-Norris, 2011) conducted a study based on this approach and find that optimal reserve holdings depend especially on country characteristics and policy fundamentals. In this regard, if the optimal level would be translated into months of import, it would be within the range of 1 to 12 months of imports. Where the optimal level is higher for fragile states and commodity export economies. Moreover, the optimal level is higher for economies with fixed exchange regimes and for those with a lower cost of reserves.

The shortcomings of this approach reside within the calibration of the model. The model is based on some assumptions when it comes to the probability of sudden stop and risk aversion. Hence, the result can output a wide range of estimated optimal reserves holdings. However, the model suggests that a range between 80 to 100 percent of short-term debt and a range of 75 to 150 percent of the current account deficit is the optimal range in the emerging economies

This approach although may be widely used in the literature, it has its shortcomings which are the calibration of the model and the estimation of certain probabilities such as the probability of an occurrence of crisis. Hence, in the next subsection, we will elaborate on another metric that is determined by the International Monetary Fund. This metric is Assessing reserve adequacy (ARA).

II.1.3: Assessing reserves Adequacy metric

As we mentioned in the previous subsection, one of the critics of a cost-benefit approach in determining the optimal level of international reserves resides within the calibration of the model. Assessing reserve adequacy metric does not deal with that. This measure is designed to combine simplicity and completeness.

The IMF proposed this metric for assessing adequate reserves in 2011, (IMF, 2011), then refined it in 2013, then in 2015. The introduction of this metric by the IMF was in response to the experience of previous balance of payments crises that occurred in some countries notably Brazil 1998 and Russia 2008. A key motivating factor for this index is the need for a metric encompassing a broad set of risks.

The index accounts for risks these economies face when holding international reserves. In addition, it is designed to be simple to use, complete and compatible with most economies. It comprises four components reflecting potential drains on the balance of payments which are:

- Income from exports which reflects the potential loss from a drop in the international market or terms of trade shock;
- Broad money to capture the capital fight by residents through the liquidation of their highly liquid domestic assets;
- Short-term debt to reflect debt rollover risks;
- Other liabilities to reflect other portfolio outflows. The relative risk weights for each component are based on the 10th percentile of observed outflows from EMEs during exchange market pressure episodes.

In this regard, the optimal reserves are in the range of 100-150 percent of the metric are considered broadly adequate for precautionary purposes. The selection of a range rather than a point estimate for the adequacy level reflects the intention to be cautious because of the uncertainty inherent in the estimation of various balance of payments risks.

The index is calculated with the following weight in mind depending on the exchange rate regime:

$$R^*_{fixed} = 30\%STD + 20\%OL + 10\%M2 + 10\%X$$

$$R^*_{floating} = 30\%STD + 15\%OL + 5\%M2 + 5\%X$$

Where R^*_{fixed} and $R^*_{floating}$ are the optimal reserves for an economy respectively for fixed regime and floating regime, STD denotes Short-Term Debt, OL denotes other liabilities, M2 denotes broad money, and X stands for exports. All these variables are represented in percentage.

In the next chapter, we will use the ARA measure to determine the optimal level of reserves in Tunisia. Determining the optimal level is important because we expect to calculate the social cost of reserves. In this regard, we will use this particular method since it fits the best Tunisian economy. Besides, it is a simple and complete method that the rule-of-thumb metrics. Above and beyond, adopting a cost-benefit approach conveys the development of an extensive methodology that is beyond the scope of this study.

Section II.2: Cost of Reserves

The accumulation of reserves that have been occurring during the last decades came with costs. The most cited cost in the literature is the cost of holding reserves. This is because many economies have engaged in a process of holding excess reserves and thus they incur large opportunity costs. Nevertheless, not all economies hold excess reserves. Some economies do not meet the optimal level. In this case, the cost of holding reserves is no longer significant since it only applies to excess reserves. Notwithstanding, the marginal cost of reserves comes into play. It is the cost by which reserves are increased. If reserves are increased by debt, then this cost is simply the interest on debt measured by the hard currency interest rate plus the sovereign spread.

In their working paper, (Levy-Yeyati E. a., 2020) argued that the correct way of computing the costs of international reserves depends crucially on the underlying motives.

In the case of self-insurance, the marginal cost of carrying reserves is proportional to the marginal cost debt that it implicitly funds (alternatively, that could be canceled with) reserves, net of the returns obtained on reserves which typically amounts to the sovereign spread over the risk-free rate plus the term premium if there is a duration mismatch between reserves and debt.

If the purchase of reserves is aimed at countering exchange rate variations, reserves are funded essentially by issuing local currency-denominated debt, which pays the local-to-foreign currency interest rate differential (a quasi-fiscal cost) and incurs valuation losses due to changes

in the nominal exchange rate (in other words, takes the other side of a “carry trade”). As they document empirically, the cost of reserves in these two cases differs substantially.

II.2.1: Marginal cost of reserves

When a central bank is concerned with self-insurance reserve accumulation policy, the purchase of the foreign currency is carried out by borrowing on the international market. The debt is issued by the economy whether through a firm, bank, or the treasury. Then, it comes in in form of capital inflows and ends up being purchased by the central bank. Then the proceeds are invested in the international market.

Holding international reserves comes with a cost. This cost is approximately equal to the spread between the cost of the borrowing and the yield that the central bank earns on its reserves if there are no maturity mismatches. Many authors across the literature used the U.S. Treasury securities as a proxy for the earned yield. (Landell-Mills, 1989), (Yeyati, 2008), (Jeanne O. a., 2011), (Levy-Yeyati E. a., 2020). And for the cost of borrowing, the private debt often takes place in the commercial bank sector where rates are often priced at the sovereign yield plus a spread.

The computation is more straightforward if the borrower is the central government since in this case the opportunity cost of reserves would be the yield differential between the country and the U.S., that is, the sovereign credit risk spread, for which the authors stated there is reliable high-frequency data.

In most emerging economies, they issue debt with a duration of 5 years to purchase 2-year duration US treasury bills. The cost of reserves would be the difference between the 5-year and the 2-year Treasury yields. In other words, the cost of reserves is measured by the sovereign risk spread plus the hard-currency interest rate term premium. This argument holds when the central bank is motivated by a self-insurance motive.

This cost could vary widely depending on the country’s perceived credit risk, the level of global risk aversion, and the slope of the risk-free yield curve.

Since the sovereign risk premium reflects the probability of default often linked to dollar liquidity shortages, an increase in liquid reserves, by reducing the probability of a liquidity crisis, reduces also the spread paid on the full stock of sovereign debt, adding to the marginal benefits of reserve accumulation. (Yeyati, 2008).

In their working paper, (Levy-Yeyati E. a., 2020) provided a simplified demonstration where reserves are only funded by new debts. The cost of reserves is expressed as follows.

$$L(R,D) = [\mathrm{r_f} + \rho(\mathrm{R},\mathrm{D})]\mathrm{D} - \mathrm{r_f} \times \mathrm{R}$$

Where $L(R,D)$ is the cost of reserves also called the fiscal cost of reserves, r_f is the hard currency cost, $\rho(R,D)$ is the sovereign risk premium, D are newly issued debt and R is the stock of reserves.

The marginal cost of reserves is obtained by applying the first derivative to the last equation by R. where $\frac{\partial D}{\partial R} = 1$

$$\frac{\partial L(R,D)}{\partial R} = [\rho_R(R,D) + \rho_D(R,D)]D + \rho(R,D) < \rho(R,D)$$

$$\Leftrightarrow \left[\rho_{\mathrm{R}}(\mathrm{R},\mathrm{D}) + \rho_{\mathrm{D}}(\mathrm{R},\mathrm{D})\right] < 0$$

This indicates that an increase in the reserve buffer more than compensates the negative impact of the corresponding increase in the stock of debt on the credit risk premium (that is, [ρR (R,D) + ρD(R,D)] < 0), then the marginal cost of reserves is less than the sovereign spread usually used as a proxy.

In the purpose to capture the cost of reserves following this approach, we will follow the methodology as presented by (Levy-Yeyati E. a., 2020) which they have augmented from the method of (Levy Yeyati, 2005).

The empirical model used to estimate the marginal cost of reserves is as follow:

$$log(spread)_{i,t} = Risk_{i,t} + CreditRating_{i,t} + IR_{i,t} + RR_{i,t} + SDR_{i,t} + PDR_{i,t} + \epsilon_{\mathrm{i,t}}$$

Where: Spread is the sovereign spread, Risk is Risk aversion, Credit rating is obtained from a rating agency and computed into an index ranging from 1 to 30. Where 1 is not rated and 30 is AAA rating, IR is the international rate or the US treasury notes 10 years maturity, RR is reserves ratio, SDR is sovereign debt ratio and PDR is the private debt ratio.

(Levy-Yeyati E. a., 2020) worked on a sample of 19 emerging economies including Tunisia. The author used panel data to estimate the marginal cost of reserves.

Since we aim to capture the marginal cost of reserves with this method. We will opt for a Vector Autoregressive Regression. Therefore, we need to ensure the stationarity of the data. Otherwise, we will use cointegration.

II.2.2: Leaning-against-the wind cost of reserves

Leaning against the wind or a managed floating is an intermediate exchange-rate regime between pegged and freely floating rates. Under the pegged regime, the RME has to intervene in the market to maintain the official exchange rates. Whereas in the free-floating, it has to restrain from intervening. In the managed floating, however, the RME sets a list of rules for intervention to influence the exchange rate to hover within a spectrum. The choice among them depends upon where along the continuum the floating-rate regime is to be located. (Tosini, 1977).

Leaning against wind intervention can be carried out by buying and selling international reserves against local currency or by buying and selling local currency. The former method is described as the unsterilized form of intervention because it influences the exchange rate to a target set by the central bank. The latter method is described as a sterilization intervention and does not affect inflation and is the method mostly used.

Sterilization intervention is when the central bank conducts a sale or purchase of international reserves against the local currency to influence the exchange rate but without influencing the monetary base.

According to a survey conducted by the Bank for International Settlements of central banks, the most common reason for intervention within central banks in the emerging economies is to limit exchange rate volatility and to smooth down the trend line of the exchange rate (Chutasripanich, 2015)). In this retrospect, this result is consistent with the results of a previous survey conducted by the BIS in 2005. Similarly, (Adler, 2021) find that half of the central banks intervene to smooth down exchange rate volatility.

When it comes to an appreciation of the local currency, the central bank concerned with LAW intervention will accumulate (buy) the foreign currency reserves against the local currency debts. This will increase its net foreign currency position. This behavior is the opposite of a carry trader (in this case scenario, the carry trader betting on further appreciation would short the foreign currency) and in the case of no transaction costs, the loss of central bank is the profit of a carry trader, as stated by (Levy-Yeyati E. a., 2020).

Foreign exchange intervention generates a change in the central bank balance sheet that is represented in the equation below:

$$\Delta NFA = \Delta MB - \Delta NDA$$

Where *NFA* denotes the central bank net foreign asset position; *MB* stands for base money; and *NDA* denotes net (interest-paying, normally short-term) domestic assets.

In this retrospect, the cost of intervention is defined as the cost of carry that results from the foreign exchange position regardless of the purpose whether it is smoothing exchange rate, reserves accumulation, Alder (2018).

The main concern about sterilized intervention has been the cost of carry, the local-foreign currency interest rate differential that the bank has to pay on its local currency-funded reserve position. In effect, this situation might lead central banks to deal with quasi-fiscal losses associated with steep interest rate differentials. These differentials may reflect either a decline international rate (for example, due to the spillovers of the U.S. expansionary monetary policy, as highlighted in the financial cycle literature), or a tightening of domestic monetary policy that triggers speculative capital inflows (which the exchange rate intervention tries to offset).

However, the conventional wisdom that associated intervention costs with interest rate differentials ignores another critical aspect of the process of hoarding reserves: the countercyclical nature of LAW intervention and the cyclical valuation effect that works in its favor. If intervention in the foreign exchange market delays appreciation, the central bank purchases reserves at a relatively low-price level, and when the exchange rate finally moves back towards its more depreciated equilibrium, it gives the bank a positive valuation gain. (Adler, 2021).

This process has overlooked implications. The cost of LAW reserve accumulation must be measured over the long term (to fully include the cycle). In floating exchange rates regimes, the intervention of central banks in the foreign exchange markets is believed to have at times positive and negative valuation effects. Nevertheless, LAW reserve accumulation would sustain important valuation losses if appreciation pressures are permanent. In that regard, intervention would be closer to the mercantilist motive. It endeavors at gaining price competitiveness by preserving an undervalued currency.

By contrast, if they are due to cyclical speculative inflows due to a differential monetary policy stance, or too short-lived terms of trade shocks, the reversion of the exchange rate to its earlier,

more depreciated level would eliminate much of the valuation losses, and may even be greater than the carry effect (i.e., a net profit scenario), since it benefits from the fact that the bank purchase reserves when they are cheap and sells them when they are expensive in term of the local currency.

II.2.3: The social cost of reserves

The social (opportunity) cost is defined as the foregone earnings if the economy as a whole would have gained had it invested in an alternative investment (such as public infrastructure or repays its debt) instead of holding the reserves. The most common proxy for this measure is the fiscal cost that is defined as the spread between the domestic interest rate of government bonds and the yield on reserves. (Hauner, 2005)

Nevertheless, some early studies assume that the social return on capital is determined through an assumption. (Hauner, 2005). It is assumed to be around 5%. Others, (Heller, 1966). (Frenkel, 1981), (Marion, 2002), and (Edison, 2003) assume that the social return on capital is equaled to some government bond yields.

Other authors assumed that the social cost of reserves altogether is solely determined from the foregone debt repayments. (Edwards, 1985), (Landell-Mills, 1989). (Bird, 2003).

In retrospect, (Ben-Bassat, 1992) argued that the true opportunity cost is difficult to estimate due to the lack of data on reserves composition and the real rate of return of capital which determines the proxy for the alternative investment. They developed a methodology to determine the real rate of return on capital. They proxied this rate by the ratio of profits to the gross capital stock of the business sector p. But, in periods of economic slowdown, this measure drops considerably and would no longer be a good proxy for the aforementioned alternative investment for holding reserves. Instead, the authors resorted to the yield of the public sector projects. In this case, the marginal rate of return on government projects is a better proxy. This rate was approximated by the criterion rate of return for approval of government infrastructure projects *pG*. Eventually, the rate pf return of an alternative investment is determined by the maximum between *p* and *pG*.

(Rodrick, 2006) argued that if an economy would abide by the Guidotti-Greenspan rules, (i.e. having an equal short-term debt to reserves), it will pay for every dollar of reserves, a cost that is equal to the spread between the private-sector cost of short-term borrowing abroad and the yield on liquid foreign asset.

By 2004, the social cost amounted to 0.70% of GDP (US$54 billion) in emerging economies and rose up to 1.21% in 2009 (US$190 billion). There was a slight dip in 2008, but even with the lowest spread of 3%, the social cost of excess foreign exchange reserve (adding extra cushion) is US$98 billion.

In this retrospect, the social cost should be measured on the excess of international reserves. This means that in order to calculate this cost. We need to determine the optimal level first and the cost will be measured with respect to the excess.

Conclusion

In this chapter, we provided an overview of the optimal level of international reserves and their costs within an economy.

The reserves adequacy could be determined through different approaches. There are simple methods that rely on certain ratios such as the import ratio, the reserves to short term ratio, and the reserves to broad money ratio. These methods have proved to be lacking in terms of empirical backing. This is why they are not used as a reliable method within the RME. Second, there are other methods that are based on the fundamentals. These are the cost-benefit approach first developed by (Heller, 1966) and (Frenkel, 1981). These methods are far better than the rule-of-thumb method since they rely upon macroeconomic fundamentals.

Additionally, we have discussed the cost of reserves and how they are determined. The cost of reserves can be determined through the marginal cost, which is the difference between what the economy pays on its external debts and what it earns on the reserves that it holds. We aim in our research to investigate this cost in the Tunisian context. We look to determine what makes up this cost. We base our model on the model provided by (Levy-Yeyati E. a., 2020) to point down the determinants of the marginal cost.

Alternately, we have discussed that the cost of reserves is linked to the cost of carry that is the result of intervention mechanisms that aims to influence the exchange rate. These interventions can be sterilized (without changing the monetary base) or unsterilized (by changing the monetary base). This is what is known in the literature as “Leaning-against-the-wind”.

In the next chapter, we will identify our model that will give an overview of the determinants of the cost of reserves. We will use time series to study the impact of each variable on the cost of reserves.

Chapter III : The cost of international reserves in Tunisia

Introduction

The RME in Tunisia is the Central Bank of Tunisia. It was founded as a national public entity and began operations on 3 November 1958. It is an independent legal entity with financial autonomy, pursuant to the New Organization Law 2016-35 published on April 25th, 2016. The CBT has maintained its status as an independent legal entity after the 14 January 2011.

The CBT is empowered to issue currency, to exercise control over the money supply and to control international reserves and international financial transactions. It is vested by the aforementioned law with the power to issue authorizations and set rules for Tunisian banks, and allowed to control and to sanction them.

The CBT is the sole banker to The Republic of Tunisia. It holds its current account balances and provides cash management services. In addition, it acts as its receiving bank and paying agent in relation to the issue, service and redemption of Treasury bills and other Government debt obligations. The central bank is entitled to borrow in foreign currency in the international financial markets for its own account and for the account of government of Tunisia.

In fact, since 1992, the Tunisian republic has accessed the international financial markets through a number of syndicated international bank loans through a variety of bond offerings and private placements denominated in Japanese Yen, U.S. Dollars and Euros which are signed and issued by the CBT. Then the proceeds from bond offerings are converted into Tunisian Dinars and made available to the government of Tunisia on the same terms and conditions as the original bonds. Borrowings by the CBT on its own behalf are not guaranteed by Republic of Tunisia and proceeds from these notes are made available to it.

In the following, any assessment on reserves will crucially depend on the average level of reserves with respect to the adequate level. As we discussed before, knowing this will determine if we should turn our focus on the cost of holding reserves or the marginal cost of reserves. Hence, we will posit a hypothesis in the first section on the state of reserves. We rejected that hypothesis. In the second section, we determined the factors influencing the marginal cost using time series.

Section III.1: The social cost of reserves in Tunisia

In this section, we will calculate the cost of holding reserves in Tunisia. It is the social cost that results from holding excess reserves. Before we can carry on with the calculation, we need first to determine the adequate level of reserves. So, we posit this hypothesis.

H_0: International Reserves in Tunisia are beyond the optimal level

If we prove that that hypothesis is true, we will calculate the cost based on the methods provided in the last chapter. But, if we reject that hypothesis, it means that IR are below the optimal level meaning there is no relevance to discuss the cost of holding reserves. Nevertheless, we will discuss the marginal cost of carrying reserves which is more relevant in that case.

The first step then is the measure the adequate level of reserves. As we have discussed in the earlier chapter, there are three main methods, the rule of thumb ratios, the cost-benefit approach and the ARA metric of the IMF. Our method of choice (ARA) is determined by elimination. We ruled out the use of the rule of thumb metrics since they provide little theoretical foundation behind them. We also ruled out the methods based on a cost-benefit approach since these methods are extensive work which goes beyond the scope of this thesis.

The ARA metric calculations are provided in Figure 1Figure 2. The highlighted area in yellow corresponds to the adequate range between 100% and 150% as mentioned by the IMF index in (IMF, 2011). As we can see, the level of reserves is mostly suboptimal in Tunisia for the last decade. The only instance where reserves were in excess is the period between 2006 and 2010. From 2011, this index has seen a gradual decline and stood at its lowest level in 2018.

Our hypothesis is therefore rejected. IR are not above the optimal level. The cost of holding reserves is not relevant (Rodrick, 2006). We focus our attention to the marginal cost of reserves in that case.

Figure 2: IMF's ARA index for the Tunisian economy

Source: Central bank study 2019

Section III.2: The marginal cost of reserves in Tunisia

In order to determine the details about the cost of reserves in Tunisia, we follow suit to the method developed by (Levy-Yeyati E. a., 2020) to determine what constitutes the marginal cost of reserves in an economy concerned with self-precautionary motive.

The model provided by the author is panel data that comprises 19 emerging economies with Tunisia included. Our aim is to determine the marginal cost of reserves for the Tunisian economy while keeping in mind its characteristics. In order to do so, we will utilize the time series Vector Error Correlation Model. This model will provide an overview of the long-run and short-run determinants of the marginal cost.

The empirical model as advanced by (Levy-Yeyati E. a., 2020) to estimate the marginal cost of reserves is as follow:

$$log(spread)_{i,t} = Risk_{i,t} + CreditRating_{i,t} + IR_{i,t} + RR_{i,t} + SDR_{i,t} + PDR_{i,t} + \epsilon_{i,t}$$

Where: Spread is the sovereign spread, Risk is Risk aversion, Credit rating is obtained from a rating agency and computed into an index ranging from 1 to 30. Where 1 is not rated and 30 is

AAA rating, IR is the international rate or the US treasury notes 10 years maturity, RR is reserves ratio, SDR is sovereign debt ratio and PDR is the private debt ratio.

In this retrospect, our model is as follows

$$cost_t = gar_t + log(Rating_t) + log(RR_t/GDP) + \log(pol_t) + log(debt_t) + \log(us10_t) + \log(sov_t) + c + \epsilon t$$

Where $cost_t$ is the marginal cost of reserves[3] that we have calculated from the bond issuance of the Tunisia on the international market, $Rating_t$ is an index[4] that we have compiled based on the Fitch Ratings rating for Tunisia. gar_t is a dummy variable the take the value of 1 if access to international market is guaranteed by a foreign government agency, 0 if it is not the case. RR_t/GDP is the reserves over GDP expressed in US dollars. pol_t is the political stability index for Tunisia provided by Worldwide Governance Indicator. $debt_t$ is the external debt for Tunisia expressed in US dollars. $us10_t$ is the interest rate for 10-years US treasury bill. The variable sov_t is the probability of default for the Tunisian economy. c is an intercept.

The difference between our model and the one provided by (Levy-Yeyati E. a., 2020) is the introduction of new variables that are specific to the Tunisian context. The majority of external debt comes from multilateral and bilateral agreements. As of 2019, it accounted for 63.1%. this means that politics has a significant influence on the cost of borrowing abroad. For this reason, we added both gar_t and pol_t. If the Tunisian government manages to secure a third-party guarantee, this should affect the marginal cost. Respectively, political stability should also come into play.

In the following, we will perform the unit root test to check for the stationarity of the variables. In case these variables are not stationary at level, we will perform the aforementioned test at first difference. If the variables do not exhibit unit root at the first difference, we will use cointegration tests to determine whether a long–term relation exists between the variables. This will output the Trace statistics and the Maximum Eigenvalue which will identify the

[3] This variable is further elaborated in the next page

[4] The index is a series of integers that go in tandem with the rating of Tunisia. It ranges from 1 to 7. Where 1 corresponds to the worst rating i.e. B- and 7 corresponds to the best rating i.e. BBB+.

cointegration model. Then, we determine the lag order of the VEC model. Then, we will determine the VECM output.

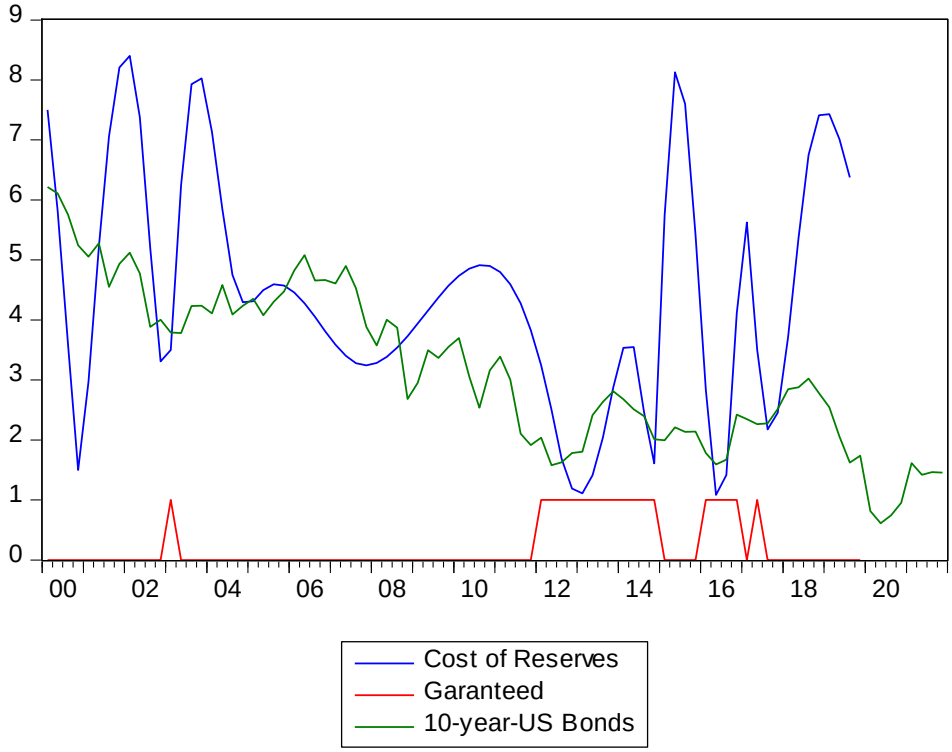
III.2.1: Data

Our dependent variable is the cost of reserves which is proxied by the external cost of borrowing. Our independent variables are dummy variables whether the loan is guaranteed, rating, reserves ratio, political stability, international rate proxied by US 10-year maturity, and sovereign risk.

The marginal cost of reserves is proxied by the interest rate by which the Tunisian economy borrows from the international market. We have used the coupon rates at the date of issuance as a proxy. The coupon rates range from 2000 to 2019 where the last issuance took place. We obtained the prospectuses regarding every international issuance. We checked if a third-party guarantee shows in every prospectus. Then we associated the coupon rate of each issuance to the corresponding year and in the corresponding quarter.

We have compiled this series by performing a rundown on Tunisian bond issuance that took place between 2000 until today. (See Appendix 2). Since access to the international market did not occur for some years, we had to interpolate the missing data with cubic-spline. Our frequency is quarterly and we obtained the data from the Central Bank of Tunisia, Ministry of Finances, Luxembourg Stock Exchange, and from Reuters.

Figure 3: Cost of Reserves *vs* 10y US T-bill *vs* Guarantees



As we can see from Figure 3, there seems to be a correlation between the 3 variables. It looks like the international goes in tandem with the cost of reserves. We can also notice that the instances where there is a guarantee affected negatively the cost of reserves. (See Table 1).

Table 1: Cost of reserves, 10y US T-bill and Guarantee correlation matrix

	Cost of Reserves	Guarantee	10-year US T-bill
Cost of Reserves	1	-0.582	0.310
Guarantee	-0.582	1	-0.532
10-year US T-bill	0.3107	-0.532	1

Guarantee is a dummy variable that takes the value of 1 if there is a third party that guarantees payment for creditors if the Tunisian government fails to repay. This variable is constructed by looking into the prospectuses on international bond issuance. The two guarantors are U.S. Agency for International Development (USAID) and Japan Insurance Brokers Association (JIBA).

Rating is an index constructed based on the Tunisian sovereign rating provided by Fitch Ratings. Tunisia was first rated in 1994. The index ranges from 1 to 7 where 1 is the worst rating which is B- and 7 is the best rating which is BBB+.

The Reserve ratio is the level of reserves over GDP.

Political stability is obtained from the Worldwide Governance indicator World Bank. Political Stability and Absence of Violence/Terrorism measures perceptions of the likelihood of political instability and/or politically motivated violence, including terrorism. The measure is constructed following several indicators including Orderly transfer of power, armed conflicts, violent demonstrations, social unrest, etc.

External debt is expressed in US dollars the sterilize the effect of the exchange rate. This data is available since 2006.

The international rate is proxied by the yield of US treasury bills of 10 years maturity. This variable is exogenous to the Tunisian economy characteristics and it rather describes a global factor.

The sovereign risk is proxied by the probability of default that is calculated by Fitch Ratings.

Our sample frequency is quarterly and the sample period extends from 2006 Q2 to 2019 Q4. We used cubic spline interpolation to change the frequency of some variables to quarterly. (See Appendix 1). The descriptive statistics are provided in Table 2.

Table 2: Descriptive Statistics[5]

	Cost of reserves	Guarantee	Rating	Reserves ratio	Political Stability[6]	External Debt	10y US treasury bills	Sovereign risk
Mean	3.798827	0.225000	5.386973	0.152357	-0.394578	2.64E+10	3.169053	3.355360
Median	3.510611	0.000000	6.000000	0.152436	-0.492889	2.53E+10	2.977167	3.156988
Maximum	7.375000	1.000000	7.000000	0.252473	0.320000	4.11E+10	6.215333	7.690176
Minimum	1.158942	0.000000	1.000000	0.069911	-1.140000	1.80E+10	0.612333	1.270428
Std. Dev.	1.817288	0.420217	1.800713	0.039832	0.505622	6.22E+09	1.334381	1.376896
Skewness	0.405021	1.317106	-0.618550	-0.109788	0.010485	0.632371	0.199388	0.864889
Kurtosis	1.834326	2.734767	1.905750	2.611694	1.296661	2.409735	2.139008	3.752190
Jarque-Bera	6.716541	23.36472	9.888271	0.621861	9.189039	4.951127	3.301213	12.89747
Probability	0.034795	0.000008	0.007125	0.732765	0.010107	0.084116	0.191934	0.001583
Sum	303.9062	18.00000	468.6667	11.42675	-29.98796	1.61E+12	278.8767	291.9163
Sum Sq. Dev.	260.9004	13.95000	278.8608	0.117405	19.17402	2.32E+21	154.9097	163.0425
Observations	80	80	87	75	76	61	88	87

[5] The variables Cost of reserves,10year US T-bill and sovereign risk are expressed in basis points divided by 100.
[6] This variable exhibits negatives values which will be problematic when it is logged. To solve this, we added all the values by 2 so that no value is negative or zero. Adding a constant should not distort the results since VECM deals with changes in values rather than values themselves.

Most of our variables do not follow normal distribution when we look at the Jarque-Bera Statistics. This however should not be an issue since VECM does not require normality of data for the estimation. In this regard, we will apply the log to most of the variables in the following. However, it is required that all variables are integrated of the same order.

III.2.2: Unit root test of the variables

The unit root test can be carried out with the Augmented Dickey-Fuller (ADF) test, Philips-Perron (PP) test, or Kwiatkowski–Phillips–Schmidt–Shin (KPSS) test. In this subsection, we will perform all the aforementioned tests and provide summary statics for each one of them. Our aim is the determine the order of integration for each variable.

The null hypothesis of the ADF test is:

H_0: The variable has a unit root.

If we fail to reject the null hypothesis, i.e. the t-statistic is greater than the critical value, then the variable does not have a unit root and is therefore stationary. This test is performed twofold. First, at the level. Second, it will be performed at the first difference.

We performed the Augmented Dickey-Fuller on the variables used in our model to test for stationarity. (See Table 3).

Table 3: Augmented Dickey-Fuller unit root Test summary[7]

	At level			At first difference			Order of integration
	t-statistic	Critical value[8]	p-value	t-statistic	Critical value	p-value	
Cost of reserves	0.575786	-1.945324	0.8385	-2.388107	-1.945389	0.0174	I(1)
Guarantee	-2.496801	-2.899115	0.1201	-12.93058	-2.899115	0.0001	I(1)
Rating	2.007909	-2.895512	0.9999	-6.314996	-2.895924	0.0000	I(1)
Reserves ratio	-2.263432	-2.874495	0.1849	-15.85787	-2.874556	0.0000	I(1)
Political Stability	-1.325539	-1.945596	0.1696	-2.166670	-1.945596	0.0301	I(1)
External debt	-3.180940	-3.486509	0.0981	-6.347549	-2.913549	0.0000	I(1)
10y US T-bill	-1.383374	-2.896346	0.5867	-7.181140	-2.896346	0.0000	I(1)
Sovereign risk	-0.985113	-1.944862	0.2883	-6.190799	-1.944862	0.0000	I(1)

[7] All variables are logged during the test except for Cost of reserves and Guarantee. We have followed the form in which the model is presented in the previous subsection.
[8] Critical value at 5% level.

At level, all the t-statistics are greater than the critical value at 5% level. This is interpreted as we cannot reject the null hypothesis implying the non-stationarity of the variables at the level. At the first difference, all the t-statistics are lower than the critical value of 5%. This means that we reject the null hypothesis at a 5% level implying that the variables are stationary at first difference. The outcome of the ADF test is all variables are integrated of the first order.

Table 4: Philips-Perron unit root test summary

	At level			At first difference			Order of integration
	Adj. t-statistic	Critical value	p-value	Adj. t-statistic	Critical value	p-value	
Cost of reserves	-1.989549	-3.467703	0.5978	-3.561438	-2.899115	0.0088	I(1)
Guarantee	-3.145164	-3.467703	0.1033	-12.94871	-2.899115	0.0001	I(1)
Rating	3.375048	-2.895512	0.9999	-3.769015	-2.895924	0.0046	I(1)
Reserves ratio	-2.755266	-2.898145	0.0694	-8.814727	-2.898623	0.0000	I(1)
Political Stability	-1.339049	-1.945199	0.1658	-2.695022	-1.945260	0.0076	I(1)
External debt	-3.056497	-3.486509	0.1262	-12.31833	-2.911730	0.0000	I(1)
10y US T-bill	-3.277880	-3.462912	0.0769	-6.233870	-1.944666	0.0000	I(1)
Sovereign risk	-2.514002	-2.895512	0.1157	-8.343845	-2.895924	0.0000	I(1)

The Table 4 shows a summary of Phillips-Perron unit root test. The null hypothesis for this test is similar to the ADF test:

H_0: The variable has a unit root.

If we fail to reject the null hypothesis, i.e. the adj.-statistic is greater than the critical value, then the variable does not have a unit root and is therefore stationary. This test is performed twice. First, at the level. Second, at first difference.

Similarly, to the ADF test, none of the variables is stationary at level. At first difference, all of the variables are stationary.

Both the tests ADF and PP came to the same results meaning that our data are integrated on first order. In the following, we will perform the cointegration test to check if a long-term relationship exists between the variables. Then, we can continue performing the VECM model.

III.2.3: VECM lag order determination

In order to determine the optimal lag selection for the VECM and cointegration test. There are several ways to get to it. One way is by estimating an unrestricted VAR model and determining

the lag length criteria. (Braun, 1993). Another way is by estimating using different lags with the longest possible lag first. Then, the lag is reduced each time. For each estimation, we chosen lag should correspond to the model with the lowest value of information criteria. Both methods should result be the same. The first one is simpler but does not offer the flexibility of choice contrary to the second method.

Our method of choice is a compromise between the lowest information criteria and a significant cointegrating equation. We chose 1 lag as an optimal lag. We came to this result starting with the model that corresponds to the highest number of lags. The maximum permissible lag is 2. So, the optimal lag should be whether 1 or 2. The information criteria (AIC and SC) for the model with 2 lags is lower implying a better fit. However, for this model, the cointegrating equation is not significant and therefore we cannot proceed. Notwithstanding, we opted for 1 lag. The resulting output although exhibiting a slightly higher AIC and SC criteria has a significant cointegrating equation.

In the next section, we will perform the Cointegrating tests to verify if a long-term relationship between the variables is established.

III.2.4: Cointegration test

In subsection III.2.2:, we performed the unit root test for the variables. We concluded that all variables are only stationary at first difference. This is a critical condition to carry on with the cointegration to establish a long-term relationship between the variables. This means that we adopt a long-term relationship between variables despite the fact that series are drifting in both ways, upward and downward.

A cointegration test could be performed with the Johansen test and Eigenvalue. This test can be seen as a multivariate generalization of the augmented Dickey-Fuller test. (Dwyer, 2015).

The Johansen tests are called the maximum eigenvalue test and the trace test.

The null hypothesis of this test is:

$$H_0: \textit{There is not cointegration equation.}$$

We used the lag order of 1 as we stated in the last subsection and the output of the Johansen cointegration test is exhibited in Table 6. The test can be carried out with 5 different variations. (no intercept or trend in the cointegrating equation (CE) or test VAR, intercept but no trend in CE and VAR, intercept but no trend in CE and test VAR, intercept and trend in CE with no

intercept in VAR, intercept and trend in CE with intercept in VAR). We performed all the sets of tests and for each instance, the output results in the existence of at least 2 cointegrating relations (See Table 5).

Table 5: Number of cointegrating relations by Model

Data Trend:	None	None	Linear	Linear	Quadratic
Test Type	No Intercept No Trend	Intercept No Trend	Intercept No Trend	Intercept Trend	Intercept Trend
Trace	3	3	3	3	3
Max-Eigenvalue	2	3	3	3	3

We carried on with the third variation of the model i.e. with intercept but no trend. The reasoning behind this is that the trend parameter is not significant thereafter but the intercept is significant. The output for this test is shown in Table 6 and Table 7.

Table 6: Johansen Cointegration test (Trace)

Hypothesized No of Cointegration equations	**Trace statistic**	**Critical Value of 5%**	**P-value**
None	304.2727	159.5297	0.0000
At most 1	180.9053	125.6154	0.0000
At most 2	104.6009	95.75366	0.0107
At most 3	60.05900	69.81889	0.2336
At most 4	31.25753	47.85613	0.6526
At most 5	16.02504	29.79707	0.7105
At most 6	4.170686	15.49471	0.8893
At most 7	0.082390	3.841466	0.7741
Trace test indicates 3 cointegrating equation at the 0.05 level			

From the output result the first hypothesis “None” in the second row of Table 6 implies the hypothesis that there is no existence of cointegration equation. The Trace statistic is greater than the critical value at the 5% level. That implies the rejection of this hypothesis. Hence, there is at least one cointegrating equation. Looking at the next hypothesized cointegration

equation in the next row (At most 1), the Trace statistic is still greater than the critical value meaning the rejection of this hypothesis and therefore there are at least 2 cointegrating equations. The same thing could be deducted for the next hypothesis (At most 2) and therefore there are at least 3 cointegrating equations. The next hypothesized cointegrating equation (At most 3) exhibits Trace statistics that are lower than the critical value. In this regard, we fail to reject this hypothesis and hence it can be deduced that there are 3 cointegrating equations.

Table 7: Johansen Cointegration Test (Maximum-Eigenvalue)

Hypothesized No of Cointegration equations	Max-Eigen statistic	Critical Value	P-value
None	123.3674	52.36261	0.0000
At most 1	76.30440	46.23142	0.0000
At most 2	44.54186	40.07757	0.0147
At most 3	28.80147	33.87687	0.1789
At most 4	15.23249	27.58434	0.7296
At most 5	11.85435	21.13162	0.5621
At most 6	4.088296	14.26460	0.8499
At most 7	0.082390	3.841466	0.7741
Max-eigenvalue test indicates 3 cointegrating eqn(s) at the 0.05 level			

The maximum-eigenvalue as shown in Table 7 indicates that there is a cointegrating equation. This result confirms the Trace test in Table 6. In this regard, the outcome of the Johansen Cointegration Test is there is a consensus between the two aforementioned tests. This means that we reject the null hypothesis H_0 of this test. Thus, there is a cointegrating equation. And we can carry on with the VECM estimations.

III.2.5: Cointegrating equation

As we mentioned in the previous section, the cointegration test proved the existence of 3 long-term relations between the variables. The relation that matters to us is expressed by Equation 1:

Equation 1: Cointegrating equation

$$\epsilon_t = cost_t + 0.988\ gar_t + 2.607\ log(Rating_t) + 3.085\ log(RR_t/GDP) - 0.706 \log(pol_t) - 2.106\ log(debt_t) - 0.903 \log(us10_t) - 0.416 \log(sov_t) + 35.063$$

This equation can be rearranged in the following format:

Equation 2: Long-term relations between the variables in full sample

$$cost_t = -0.988\ gar_t - 2.607\ log(Rating_t) - 3.085\ log(RR_t/GDP) + 0.706 \log(pol_t) + 2.106\ log(debt_t) + 0.903 \log(us10_t) + 0.416 \log(sov_t) - 35.063 + \epsilon_t$$

The results from Equation 2 confirm the existence of a long-term relationship between the variables. This means that despite all variables are not stationary at level, the result of a regression that would have been spurious with an OLS regression, is stationary. This can be interpreted as if variables can deviate in the short run, but they will revert to the long-term relationship.

Table 8: Cointegrating equation parameters

	cost (-1)	gar (-1)	Ln rating (-1)	Ln Res/GDP (-1)	Lnpol (-1)	Lnextdebt(-1)	Lnus10(-1)	Lnsov (-1)	c
Estimate	1	0.987763	2.607375	3.085	-0.705546	-2.10615	-0.903207	-0.41605	35.06315
Std. error	-	-0.21874	-0.8834	-0.41186	-0.68781	-1.18573	-0.37463	-0.14891	-
t-statistic	-	[4.51570]	[2.95153]	[7.49033]	[-1.02578]	[-1.77624]	[-2.41091]	[-2.79398]	-

The t-statistics are expressed between brackets for each of the variables in the model as shown in Table 8. The variable is significant at a 5% level if this statistic is higher in absolute value by 1.96 since the number of observations far exceeds 30. All the variables are significant except for *political stability* and *external debt*.

Equation 3: Long-term relation between variables without insignificant variables

$$cost_t = -0.536\ gar_t - 3.99\ log(Rating_t) - 2.907(RR_t/GDP) + 1.821\log(us10_t) + 0.695\log(sov_t) + 2.364 + \epsilon_t$$

Table 9: Cointegrating equation parameters (without insignificant variables)

	Cost (-1)	Gar (-1)	Lnrating (-1)	Lnresratio (-1)	Lnus10 (-1)	Lnsov (-1)	c
Estimate	1	0.535849	3.988962	2.907443	-1.820908	-0.695462	-2.364012
Std. error		-0.25315	-0.27033	-0.315	-0.36259	-0.22583	
T-statistic		[2.11671]	[14.7560]	[9.22993]	[-5.02194]	[-3.07957]	

Equation 3 represents the relation between the variables without accounting for the insignificant variables. These are *political stability* and *external debt*. The t-statistic between the brackets is all above the critical value of 1.96. That suggests that all the variables are statistically significant at a 5% level. (See Table 9).

We can see that by removing the insignificant parameters from the model, the remaining variables do not change their sign. And they stay significant. The link between each response variable and the predictor variable changes, however. In this regard, we will continue in the following by using the first relation presented in Equation 2.

III.2.6: Interpretation of results

The output of the estimation is presented in Table 10. We estimated for two time periods. From 2006 to 2019 and from 2011 to 2019[9]. The year 2011 has been a changing point for the Tunisian political scene ever since. We intend to capture that change by dividing the sample period into two sub-periods as mentioned in the table.

For each sub-period, we provided the estimates of the parameters, the standards error between parentheses, and the student statistics between brackets. We also appended information criteria in the bottom rows.

The sub-period between 2006 to 2011 does not show because of a low number of observations.

[9] We applied the Johansen cointegration tests as mentioned in the last subsection before going forward with the VECM estimations. The Trace statistics showed there are 4 cointegrating equations and the max-eigenvalue shows the existence of 3 cointegrating equations.

Table 10: Output estimation

Dependent variable is Cost of reserves		
Sample size	**Full sample**	**Post 2011**
Sample Period	2006Q2 - 2019Q4	2011Q1 – 2019Q4
Guarantee	-0.987763 *(-0.21874)* [4.51570]	-0.68938 *(-0.09018)* [7.64466]
Rating *(logged)*	-2.607375 *(-0.8834)* [2.95153]	-0.00841 *(-0.47553)* [0.01769]
Reserve Ratio *(logged)*	-3.085 *(-0.41186)* [7.49033]	-3.55761 *(-0.37281)* [9.54278]
Political Stability *(logged)*	0.705546 *(-0.68781)* [-1.02578]	-0.11019 *(0.29711)* [0.37086]
External Debt *(logged)*	2.10615 *(-1.18573)* [-1.77624]	8.279737 *(-1.13402)* [-7.30124]
10-year US T-bill *(logged)*	0.903207 *(-0.37463)* [-2.41091]	-0.2934 *(-0.17132)* [1.71254]
Sovereign Risk *(logged)*	0.416047 *(-0.14891)* [-2.79398]	1.372978 *(-0.13121)* [-10.4643]
Intercept	35.06315	145.5979
Cointegrating relation	-0.339512 *(0.02078)* [-16.3370]	-0.163878 *(0.06002)* [-2.73019]
Log likelihood	549.5868	418.7429
Akaike information criterion	-16.78497	-18.37461
Schwartz criterion	-13.57324	-14.50378
Number of coefficients	88	88

Based on the results of Table 10, we can understand at first glance that first, in both periods, long-term relation upholds since the error term of the cointegrating equation is negative and significant. Second, most of the parameters do not change their sign and remain significant between the two time periods. Some of the variables however are no longer significant in the sub-period of 2011 to 2019. Furthermore, the information criteria AIC and SC for the sub-sample of 2011-2019 are lower than the full sample suggesting a better fit. This can be the byproduct of two reasons. First, most of the dynamics within the variables happened after 2011 and remained more or less stable before. For example, almost no third-party guarantee has been secured before 2011 compared to post 2011. The same thing could be said to ratings that barely changed before 2011. Second, most of the interpolations of our data occurred during the period before 2011 and could therefore introduce a source of distortions. These so-called distortions are much less present in the second sub-sample and hence could explain the better fit.

The predictor dummy variable *guarantee* has a t-student of more than 22.4 and so is significant at a 1% level across both sub-periods. It has a negative sign meaning if a third-party guarantee is obtained by the Tunisian government from a third party, the cost of reserves is lower. This effect accounts[10] for 99 basis points across all the samples and 69 for post-2011. This means that the cost of reserves would be respectively lower by 99 and 69 basis points in 2006-2019 and 2011-2019 if a guarantee is secured compared to the scenario where no guarantee is secured. We believe the second sub-period is more accurate however since Tunisia has secured most of its guarantees from third-parties after 2011, more specifically during the period 2012 to 2014 and in 2016 by United States Agency for International Development (USAID) and during 2012 to 2014 by Japan Bank for International Cooperation (JBIC).

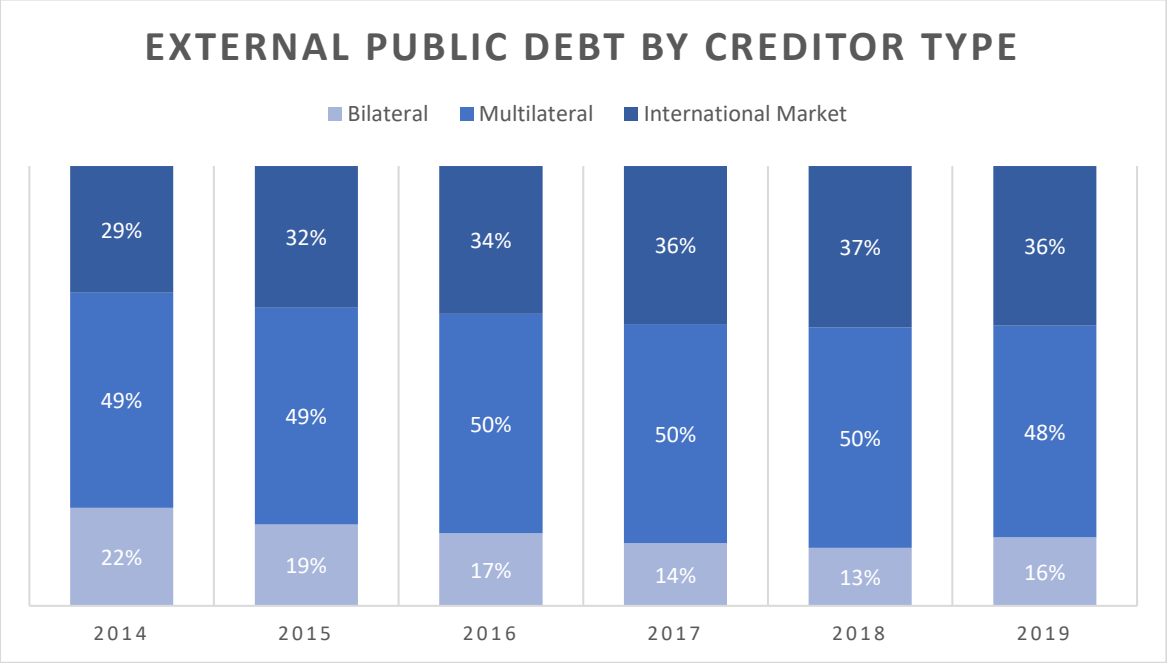
Rating is significant for the full sample and negative. That implies an increase in rating would lower the cost of reserves. That means if rating agencies increase the rating of Tunisia (e.g. from B- to B), the marginal cost decreases. This effect amounts to -2.61% for the full sample. In other words, it would lower the basis points of marginal cost by that percentage. However, in the second sub-sample 2011-2019, this variable is no longer significant in spite it retains its negative sign. The sovereign rating of Tunisia remained stable for most of the time and it started to witness a series of downgrades after 2011 due to increased political and social instability. We believe that in the full sample, this predictor variable did capture the period of a fairly stable economy and a period of a turbulent economy. Hence, it witnessed the differences

[10] The effects as shown in Table 10 are respectively -0.987763 and-0.68938 are rounded. Since the dependent variable is not logged and expressed in basis points over 100. The interpretation would be in basis points.

between both periods and thus this could explain why it is significant for the full sample. However, the second sub-sample only features a period of economic decline and thus our predictor variable *rating* is less capable of capturing the dynamics. Nevertheless, our result of the full sample is in line with the result found by (Yeyati, 2008), on the cost of reserves in EMEs, the effect of rating that was found amounted to -1.583%. In another study by (Levy-Yeyati E. a., 2020) for emerging economies. In their results, the effect of rating accounted respectively for -1.901% and -1.264% before and after the global financial crisis. We can deduct according to our estimations that Tunisia is more sensitive to the rating than the rest of the emerging economies.

The next variable *Reserve Ratio* is significant at 1% level (t-statistic is greater than 2.4) in both sub-samples. It is also negative suggesting an increase in reserves ratio by 1% should lower the basis points of cost of reserves by 3.1% in the full sample and by 3.5% for the second sub-sample. This result is coherent with the conclusion of (Hviding, 2004), as they find that holding high levels of international reserves comes with a benefit which is bringing down the cost of international reserves since this could improve its sovereign debt credit rating. This result is also similar to the findings provided by (Yeyati, 2008) and (Levy-Yeyati E. a., 2020), where reserves accumulation by emerging economies could lower the cost of reserves. In economies concerned with self-insurance motive, accumulating reserves would increase reserves' liquidity holding which will lower its risk among foreign investors and thus require lower spreads.

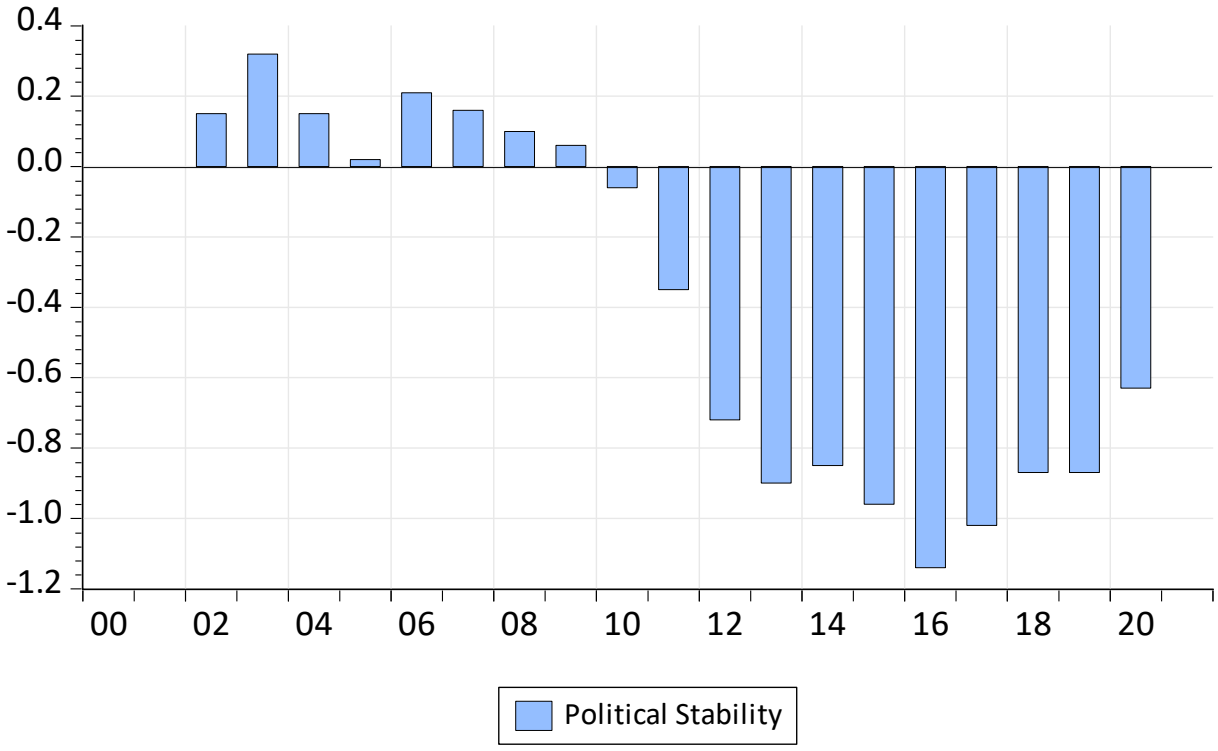
Figure 4: External public debt by creditor type



Source: Central bank of Tunisia,2019 balance of payments report

For the next variable, *political stability*, we intended to determine whether there is a relation between the *cost of reserves* and *political stability*. The reason being as we mentioned earlier is that politics come into play in external borrowing. Bilateral negotiations of financial and legal terms of the debt are conducted by the Ministry of Foreign Affairs. Loan agreements with multilateral partners are negotiated and signed by the Ministry of Development and Financial Cooperation, in each case in close coordination with other Government agencies, including the Central Bank of Tunisia and the Ministry of Finance. The political stability index is therefore not significant in both sample sizes. We believe this could be caused by small sample size or because this variable is interpolated. As a side note, the access to bilateral external debt has been decreasing over the years since 2011. (See Figure 4). This index is exhibited in Figure 5.

Figure 5: Political Stability from 2002-2020

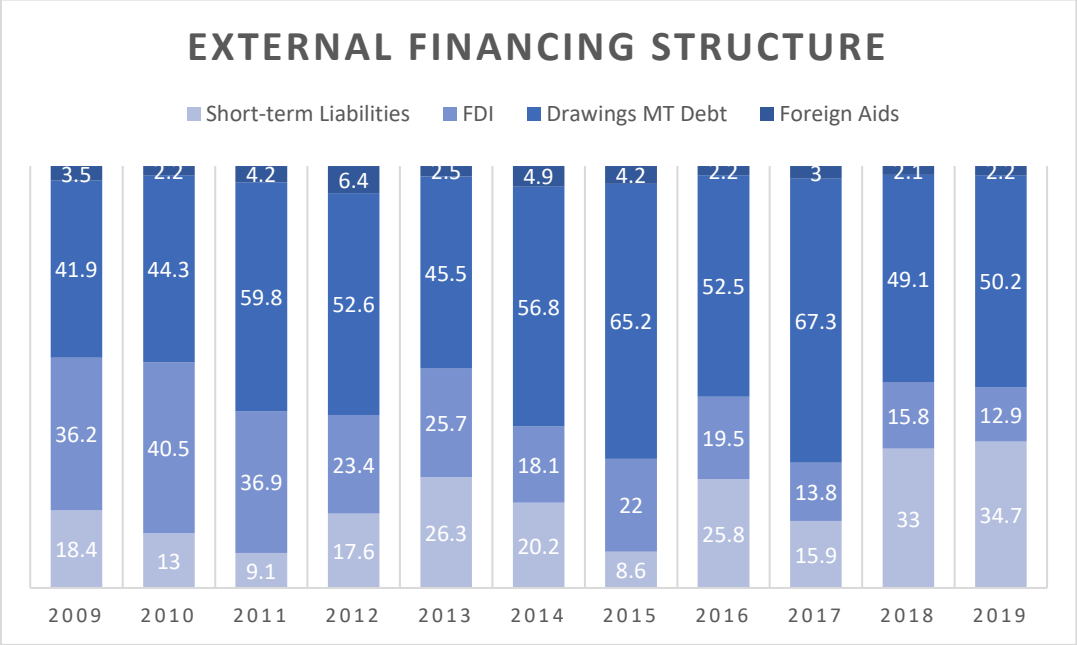


Source: Worldwide Governance indicator, World Bank

The next variable *external debt* is significant only in the sub-sample of 2011-2019 at a 1% level (t-student greater than 2.4). This variable, unlike the previous ones, has a positive effect on the cost of reserves. An increase in external debt by 1% is followed by an increase of basis points of cost of the reserve by 8.3%. This result is more or less in line with the result found by (Levy-Yeyati E. a., 2020) on emerging economies. It has been shown that on average, an increase by 1% in debt ratio, increases the cost of reserves by 0.7%. The similarities between our result and the one concerning emerging economies are both results affect the cost of reserves in the same general direction i.e. both increase cost of reserves. The differences reside in the unit of the account itself, as we have used the external debt in USD instead of the debt ratio. The reason being is the latter was not significant in our preliminary estimations. Although a direct comparison between our values and Yeyati's value cannot be performed. It is safe to say that the marginal cost of reserves is positively affected by external debt.

External debt is the major contributor to increasing reserves in Tunisia as can be seen in drawings of medium-term debt and short-term liabilities in Figure 6. We can also see that for the last 10 years; the Tunisian economy has become more and more reliant on these sources of financing since foreign direct investment has been thinning down.

Figure 6: External financing structure



Source: Central Bank of Tunisia 2019 Balance of Payments report

For the remaining variables, 10-*year US Treasury bill* and *sovereign risk*. They both are significant at 1% level and have a positive effect, ceteris paribus, on the cost of reserves by 0.9% and 0.42% respectively along with the entire sample size. The *10-year US treasury bill* is not significant for the sub-sample of 2011-2019 although *the sovereign risk* remains significant at a 1% level.

As we have stated earlier in Subsection III.2.1: the 10-year US T-bill yield is the proxy for the international rates in most studies (Landell-Mills, 1989), (Jeanne O. a., 2006), (Yeyati, 2008), (Jeanne O. a., 2011), (Levy-Yeyati E. a., 2020). This measure does not reflect any of the characteristics of the Tunisian economy. For this reason, it reflects the global economy. The borrowing by most countries is calculated based on the international rate plus the sovereign spread. An increase in this variable should also increase the cost of reserves. (Landell-Mills, 1989), showed that reserve holdings are sensitive to the rates at which emerging economies can borrow on international financial markets. (Yeyati, 2008), (Levy-Yeyati E. a., 2020).

Sovereign risk which measures the probability of default affects positively the cost of reserves. Part of this finding could be found in the variable, *reserves ratio*, as the sovereign risk in its calculation will depend on the reserve's ratios since an increase in the latter would make the economy more liquid and thus less risky to investors. This variable and rating translate nearly about the same thing. The risk of the economy. They explain the increase of risk but in opposite

directions. If the rating goes up, the sovereign risk goes down. Although it looks redundant to use two variables that explain the same thing, the predictor variable *sovereign risk* has proved to be significant in our estimation in the sub-sample. As we have explained earlier, ratings failed[11] to capture the dynamics post-2011. Yet, the sovereign risk did not fail in both sub-samples. We believe the reason for this is that rating is an index-based variable which in its nature omits some dynamics. Where a sovereign risk is a percentage number that captures more dynamic.

III.2.7: VECM result

Now that we know of the existence of a long-term relationship between the variables. We utilized the VEC model to understand the dynamic of short-term relationships for both samples' sizes (full sample and sub-sample 2011-2019). The outputs of the estimations are expressed in both Table 11 and Table 12.

The output as presented in Table 11 considers all the sample size suggests that the long-term relationship for cost of reserves is negative[12] and significant at 1% level, suggesting a correction mechanism. The speed of adjustment is -0.339512. This implies the long-term relationship would correct itself by 34% every quarter after a shock has been introduced to the equation. This speed is relatively not slow.

As of the subsample 2011-2019, the output is presented in Table 12. As we can observe, the estimates are following the estimates of the full sample. The long-term relationship for the cost of reserves remains negative and significant at the 1% level. The speed of adjustment for this model is 36% suggesting a reversion to equilibrium by that amount every quarter.

We can also see that two other variables exhibit long-term relations at a 1% level which are *guarantee* and *political stability* for the second sub-sample. Their speeds of adjustment are 16% and 0.6% respectively.

We have also run autocorrelations and normality tests for the residuals of the model to check for validity. Residual should be normally distributed and do not exhibit serial correlation. These tests are shown in Table 13. As we can see, the residuals of the full sample model are not normally distributed and exhibit autocorrelation. While in the sub-sample model, residuals are

[11] We stated that rating was not significant in the sub-sample that comes after 2011.
[12] And not less than -1. The parameter should be between -1 and 0 so the long term-relation reverts to equilibrium after the introduction of shock.

normally distributed and do not exhibit autocorrelations. This result could also be confirmed by the lower values of the information criteria of the second model suggesting a better fit.

Table 11: VECM output for the entire sample size 2006-2019

Error Correction:	D(Cost)	D(GAR)	D(LNRATING)	D(LNRESRATIO)	D(LNPOL)	D(LNEXTDEBT)	D(LNUS10)	D(LNSOV)
CointEq1	-0.339512***	-0.144367***	0.009802	0.001518	-0.002358	0.000229	0.012236	0.034765
D(Cost(-1))	0.997398***	-0.158777**	-0.024122**	0.004948	-0.004841	-0.013094	-0.000779	-0.006656
D(GAR(-1))	0.293014***	-0.469926***	0.010297	-0.03319	0.007055	-0.01052	-0.044051	0.000551
D(LNRATING(-1))	1.69153***	-0.695517	-0.010343	0.406776	-0.003029	-0.080717	0.407909	0.017314
D(LNRESRATIO(-1))	0.499235***	0.249698	-0.064365	-0.159521	0.005204	-0.019584	0.152828	-0.333574
D(LNPOL(-1))	3.473889***	-1.268438	0.117565	0.724361	1.038612***	0.340463	0.617065	0.788819
D(LNEXTDEBT(-1))	-0.818057	-0.390065	-0.11101	1.032409***	-0.035621	-0.098941	0.507325	-1.72932
D(LNUS10(-1))	-0.27141**	-0.342034	-0.194645***	-0.06098	-0.012868	-0.029625	0.198142	-0.176994
D(LNSOV(-1))	-0.064987	0.117197	0.000337	-0.038558	-0.001656	-0.005074	-0.000377	0.121547
C	0.06794***	-0.021608	-0.015006***	0.010181	0.00142	0.018194***	-0.008001	0.038697
R-squared	*0.961176*	*0.467268*	*0.380593*	*0.213034*	*0.902697*	*0.102697*	*0.154773*	*0.1204*
Adj. R-squared	*0.953411*	*0.360721*	*0.256712*	*0.055641*	*0.883237*	*-0.076763*	*-0.014273*	*-0.05552*
Sum sq. resids	*0.652798*	*3.196394*	*0.0703*	*0.402875*	*0.005603*	*0.063952*	*0.762535*	*2.979167*
S.E. equation	*0.120443*	*0.266516*	*0.039525*	*0.094619*	*0.011158*	*0.037698*	*0.130174*	*0.257301*
F-statistic	*123.7854*	*4.385577*	*3.072239*	*1.353516*	*46.386*	*0.572257*	*0.915568*	*0.684401*
Log likelihood	*43.88844*	*0.204403*	*105.1719*	*57.16107*	*174.7342*	*107.7748*	*39.61547*	*2.139842*
Akaike AIC	*-1.232307*	*0.356204*	*-3.460798*	*-1.714948*	*-5.990335*	*-3.555448*	*-1.076926*	*0.285824*
Schwarz SC	*-0.867337*	*0.721173*	*-3.095828*	*-1.349978*	*-5.625365*	*-3.190478*	*-0.711956*	*0.650794*
Mean dependent	*0.045075*	*0*	*-0.015405*	*0.008332*	*-0.009751*	*0.014498*	*-0.017293*	*0.012198*
S.D. dependent	*0.558009*	*0.333333*	*0.045845*	*0.097367*	*0.032654*	*0.03633*	*0.129255*	*0.250442*

Note: The significance levels are denoted in (**) and (***). Where (**) denotes 5% level and (***) denotes 1% level.

Table 12: VECM output for the sub-sample 2011-2019

Error Correction:	D(Cost)	D(GAR)	D(LNRATING)	D(LNRESRATIO)	D(LNPOL)	D(LNEXTDEBT)	D(LNUS10)	D(LNSOV)
CointEq1	-0.358154***	-0.163878***	0.011188	0.002202	-0.006472***	0.003715	-0.000192	0.039053
D(Cost(-1))	1.049262***	-0.137188	-0.024882	0.014748	-0.004095	-0.018933	-0.000958	-0.016308
D(GAR(-1))	0.182582***	-0.526935***	0.010758	-0.033754	0.004932	-0.00753	-0.036483	-0.012077
D(LNRATING(-1))	0.279205	-1.692365	-0.042868	0.332293	-0.009789	-0.079753	0.516953	0.233233
D(LNRESRATIO(-1))	-0.022395	-0.495094	-0.172813	-0.083193	0.00801	0.00443	0.36069	-0.712168
D(LNPOL(-1))	0.387283	-2.696953	0.279519	0.546748	1.017122***	0.404963**	0.646257	1.722711
D(LNEXTDEBT(-1))	-1.618195	-1.925046	-0.195665	1.263923**	-0.153839	-0.124222	0.063512	-0.97134
D(LNUS10(-1))	-0.166389	-0.391015	-0.270239***	-0.152511	-0.012019	-0.043156	0.29032	-0.412596
D(LNSOV(-1))	-0.162767	0.417383	0.011988	-0.076137	0.006717	0.010305	-0.007788	0.027472
C	0.023354	-0.030442	-0.019379*	-0.009121	0.005215**	0.022841***	0.009786	0.029276
R-squared	0.973766	0.519404	0.497349	0.311558	0.942625	0.22078	0.212098	0.184351
Adj. R-squared	0.964686	0.353044	0.323355	0.073252	0.922765	-0.04895	-0.060638	-0.097989
Sum sq. resids	0.421339	2.883574	0.053586	0.156746	0.00313	0.03093	0.530008	1.207183
S.E. equation	0.1273	0.333027	0.045398	0.077645	0.010973	0.034491	0.142776	0.215476
F-statistic	107.2329	3.122171	2.858422	1.307384	47.46225	0.818524	0.777667	0.652939
Log likelihood	28.97929	-5.640992	66.09791	46.77783	117.22	75.99028	24.84907	10.03234
Akaike AIC	-1.054405	0.868944	-3.116551	-2.043213	-5.956669	-3.666127	-0.824949	-0.001797
Schwarz SC	-0.614539	1.30881	-2.676684	-1.603347	-5.516803	-3.226261	-0.385082	0.43807
Mean dependent	0.127878	0	-0.023536	-0.001898	-0.008213	0.016645	-0.013307	-0.003046
S.D. dependent	0.677412	0.414039	0.05519	0.080655	0.039483	0.033676	0.138634	0.205637

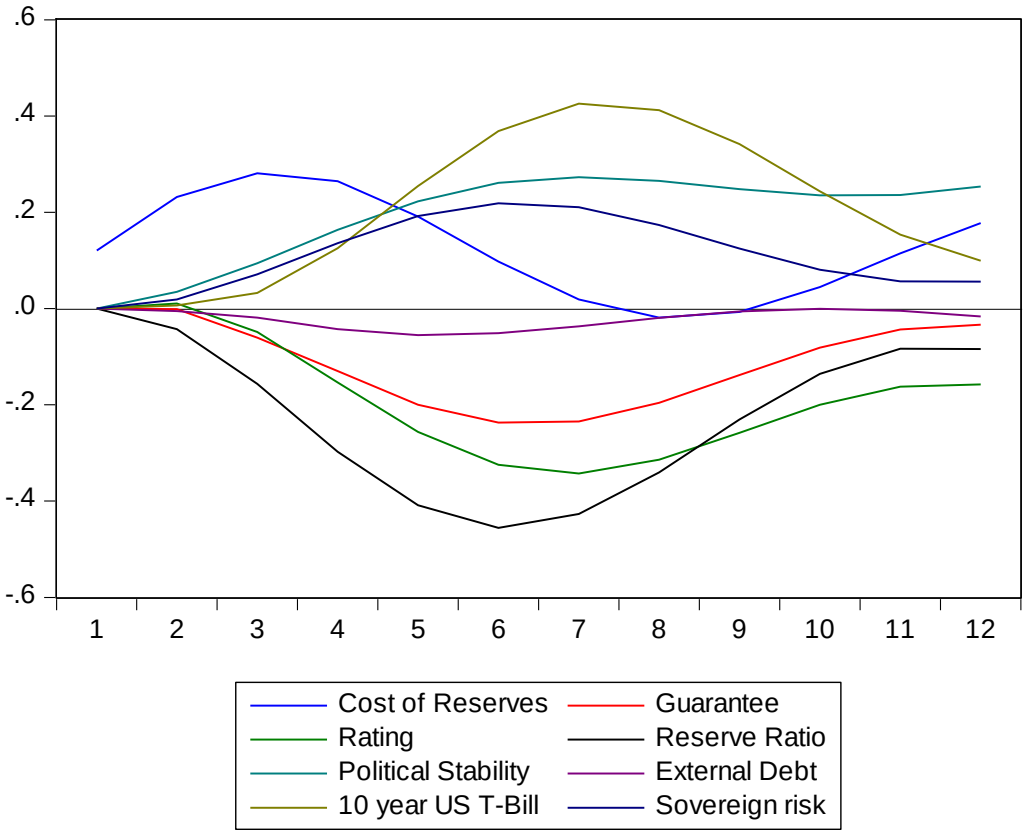
Note: The significance levels are denoted in (**) and (***). Where (**) denotes 5% level and (***) denotes 1% level.

Table 13: Residual tests

H0: No serial correlation at lag i					
Full sample			**Sub-sample**		
Lags	Statistics	Probability	Lags	Statistics	Probability
1	159.5726	0.0000	1	78.58297	0.1912
2	98.70439	0.0044	2	61.7692	0.6759
H0: Residuals are multivariate normal					
Jarques-Bera	399.2228	0.0000	Jarques-Bera	20.50406	0.1984

III.2.8: Impulse function

Figure 7: Impulse responses



Impulse Response Function (IRF) traces the effects of a shock to one variable onto the other variables. Figure 7 depicts a combined graph for the impulse responses of cost of reserves to innovations occurring from each of the variables[13] from the model for 12 quarters. The IRF shows that most shocks do not have an immediate effect on the first lag but this effect gradually

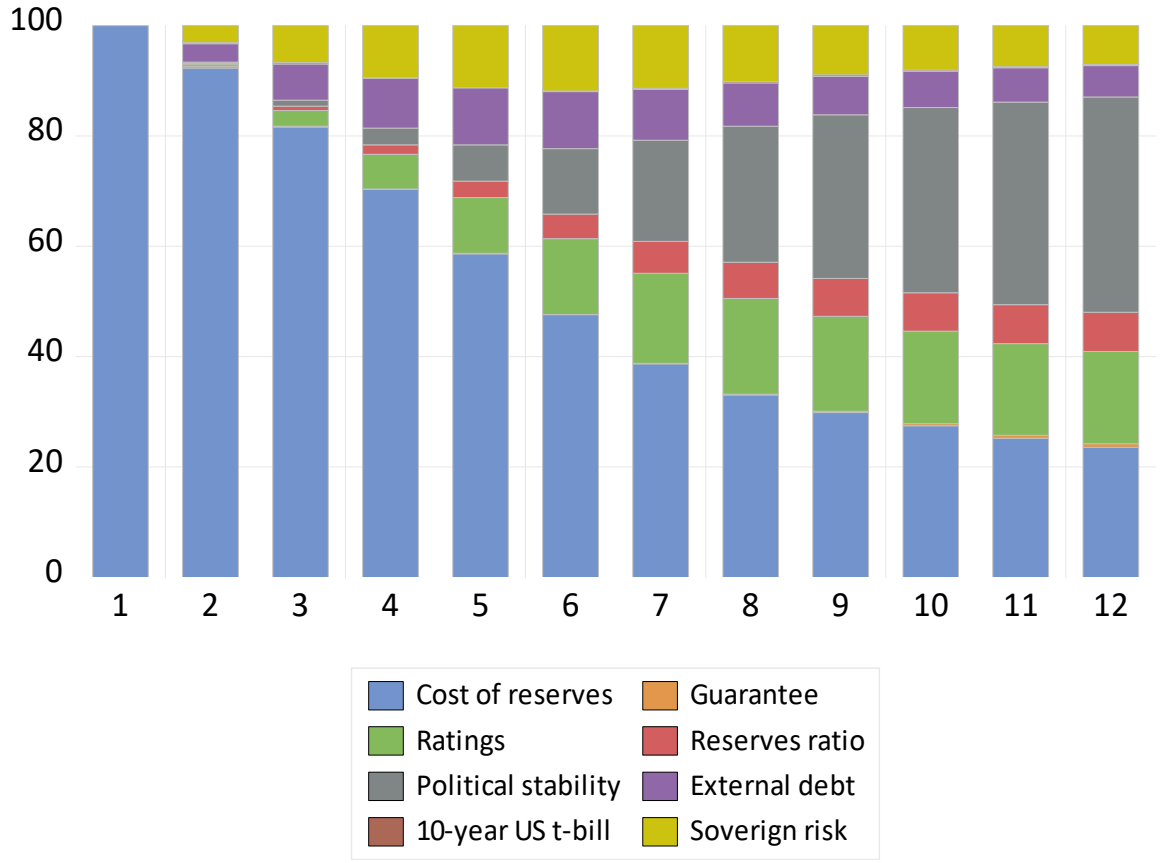
[13] We excluded the variables that are not statistically significant in the model in the sub-sample.

increases over the next few quarters (between 4 and 8 quarters) then they start to wither out. The marginal cost of the reserve, however, has an immediate shock on the first quarter by roughly 0.1 percent following a shock. This effect maxes up after four quarters to 0.47 percent and then starts to decrease significantly on the fifth quarter.

Table 14: Variance Decomposition

Period	S.E.	Cost of reserves	Guarantee	Rating	Reserve ratio	Political stability	External debt	10-year US bill	Sovereign risk
1	0.075	100.000	0.000	0.000	0.000	0.000	0.000	0.000	0.000
2	0.247	92.260	0.348	0.419	0.133	0.220	3.296	0.191	3.133
3	0.501	81.580	0.159	2.846	0.771	1.088	6.574	0.237	6.745
4	0.777	70.275	0.110	6.280	1.701	3.045	9.023	0.135	9.432
5	1.018	58.631	0.086	10.107	3.001	6.540	10.331	0.081	11.224
6	1.202	47.579	0.086	13.709	4.476	11.833	10.318	0.110	11.889
7	1.340	38.680	0.108	16.294	5.776	18.353	9.207	0.184	11.399
8	1.457	33.045	0.166	17.305	6.565	24.660	7.829	0.245	10.186
9	1.561	29.867	0.262	17.158	6.861	29.682	6.953	0.259	8.958
10	1.646	27.467	0.394	16.752	6.948	33.558	6.573	0.242	8.066
11	1.717	25.230	0.540	16.586	7.034	36.702	6.227	0.222	7.459
12	1.798	23.557	0.661	16.695	7.140	38.968	5.688	0.206	7.084

Figure 8: Variance decomposition (stacked view)



Variance decomposition shows how much of the variability in the dependent variable is explained by its shocks and the shocks from the other variables in the model. That variability is expressed in percentage. Both Table 14 and

Figure 8 illustrate the variance decomposition for our model. For the first period, all the shock is explained solely by the cost of reserves. This result is also seen in the IRF where none of the variables have an immediate effect on the first period. Then, this effect decreases over the next periods in absolute term and in relation to the other variables of the model.

In this section, we have developed a model that puts in relation the marginal cost of reserves to other macroeconomic data, we developed our model by following suit to the methodology deployed by (Levy-Yeyati E. a., 2020) on developing economies with Tunisia included. We also took into consideration the country specifics of the Tunisian economy by including two more variables *guarantee* and *political stability*. We estimated for two sample sizes and found out that *guarantee*, *rating* and *reserve ratio* affect negatively the response variable while *external debt*, *international rate* and *sovereign risk* affect it positively.

Conclusion

In this chapter, we assessed the cost of reserves in the Tunisia. We started by positing a hypothesis stating that IR are in excess. We rejected that hypothesis and therefore deducting that social cost of reserves are not relevant. We focused our attention to the marginal cost of reserves. Our intention is to determine its most influential factors.

We started with rundown on the variables to include. These variables are: third-party guarantee, rating, reserve ratio, political stability, external debt, 10-year US T-Bill rate and sovereign risk. We chose these variables based on the model of (Levy-Yeyati E. a., 2020). We also added two more variables, guarantee and political stability to better reflect the Tunisian context. The dependent variable was compiled from coupon rates obtained from prospectuses where Tunisian government borrowed on international market.

Then, we run the necessary tests on our variables and on the existence of the cointegrating relationship between our variables. Then we estimated using two sample sizes. A full-sample from 2006 to 2019 and a subsample from 2011 to 2019. For the most part, the interpretations did not change much. The sub-sample had a better fit because we believed it features less interpolation of data.

The result suggests that a third-party guarantee is the higher contributor to decreasing reserves. Reserves holding, rating also contribute negatively to this cost. On the opposite side, external debt, sovereign risk and international rate come into increasing the marginal cost. Not all variables remained significant in both sample sizes. this could be explained the change in the

economic dynamics before and after 2011. Or it could be explained by our data. Our results were similar to results found in the literature.

Main Conclusion

The cost of reserves has been attributed in most of the literature to the cost of holding reserves or the opportunity cost that the economy as a whole miss out, had it invested the excess reserves in an alternative investment with better yields instead of investing in bonds. This trend in the literature was the result of reserves accumulation trends that occurred worldwide since the late nineties and continued even after the global financial crisis. China and most Asian exporting economies are the largest holders of international reserves and to a lesser extend oil-exporting economies.

That statement is not relevant in the case of economies where international reserves holdings do not meet the optimal level. Depending on how the optimal level is defined, if there are no excess reserves, there is no opportunity cost. This is the case for the Tunisian economy. International reserves have always been suboptimal for the last decade. Nevertheless, much of the concerns center around how reserves should be increased to meet the adequate level. Needless to say, this process comes with a cost which is the marginal cost of reserves. Since we demonstrated that most external finances come from external debt, we intended to determine the factors that influenced this cost.

To prove that assumption stating that IR in Tunisia are sub-optimal, we calculated the optimal level of reserves using the IMF ARA index since it is a better measure than the rule-of-thumb measures, inclusive and simpler than adopting an optimization approach which is beyond the scope of this work. We found that international reserves holdings remained suboptimal for the last decade. This means that there is no reason to believe that the opportunity cost exists since there are no excess reserves.

Henceforth, we estimated the determinants of the marginal cost of reserves using time series and two sample sizes delimited by the events of 2011. We concluded that the existence of a third-party guarantee is one of the most contributing factors to lower these costs as well as rating and reserves ratio to a lesser extent. On the other hand, our response variable is positively affected by external debt, international rate, and sovereign risk. It is also noteworthy to say that not all variables remained significant in both sample sizes which is expected given that the Tunisian economic landscape has changed significantly since 2011. Nonetheless, the long-term relationship between our variables remained significant for both sample sizes.

Almost all of the results that we found are consistent with the results provided by the literature. Unlike our methodology, most of the articles in the literature focused on a panel of emerging economies and not on one particular economy. Although the determinants of reserves affect marginal cost in the same general direction as stated in the literature, the amplitude of this effect varies in our results because of the economy's specificity.

Although we managed to answer our research question, we believe that our work presented some shortcomings, the first of which is the reliance on cubic-spline interpolation to fill missing data in our sample. This interpolation could have caused distortions to our sample that could lower the accuracy of the results. We noticed that the second sub-sample of our data exhibited a better fit since it incorporates fewer missing data and thus fewer interpolations. Second, the method by which we compiled the marginal cost of reserves although it is the best proxy we found, can be improved. We used the coupon rates on issue dates every time the Tunisian government-issued bonds on international markets. This does not include bilateral and multilateral financing which constitute the majority of funding. And third, we did not account for the effect the COVID-19 pandemic had on the cost of reserves.

In this regard, we believe that our work could be further expanded in the future to incorporate the effect of the pandemic on the cost of reserves. Furthermore, since the start of the pandemic, the current account deficit of the balance of payment has been reduced. This led the international reserves to increase significantly even beyond the optimal level if we take the four-month-imports as a benchmark. If this trend continues in the future, we could extend this work to include the social cost of reserves.

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Appendices

Appendix 1:Variable frequencies and sources

Variables	Original Frequency	Modified Frequency	Range period	Source
Cost of reserves	undefined	Quarterly	2000Q1-2019Q4	Central bank of Tunisia, Ministry of Finance website, Luxembourg Stock Exchange, Reuters
Guarantee	undefined	Quarterly	2000Q1-2021Q2	2019 Central Bank prospectus, 2021 IMF article IV consultation
Rating	undefined	Quarterly	2000Q1-2021Q2	Fitch ratings
Reserves Ratio	Monthly	Quarterly	2000Q1-2021Q2	Reuters
Political stability	Annual	Quarterly	2002Q2-2020Q4	Worldwide Governance Indicators
External Debt	Quarterly	Quarterly	2006Q1-2021Q2	Central Bank of Tunisia
US Treasury bills	Monthly	Quarterly	2000Q1-2021Q2	Reuters
Sovereign risk	Monthly	Quarterly	2000Q1-2021Q2	Reuters

Appendix 2: Tunisian Access to international market rates since 2000

Issue Date	Rate	Currency
02/08/2000	3.3	JPY
02/08/2000	4.3	JPY
22/12/2000	1.5	JPY
15/03/2001	4.2	JPY
28/03/2001	2.27	JPY
25/04/2002	7.375	USD
03/02/2003	3.5	JPY
20/02/2003	6.25	EUR
07/04/2004	4.75	EUR
22/06/2005	4.5	EUR
09/08/2007	3.28	JPY
18/04/2012	2.5	USD
14/12/2012	1.19	JPY
07/08/2013	2.04	JPY
10/10/2014	1.61	JPY
30/01/2015	5.75	USD
17/02/2017	5.625	EUR
31/10/2018	6.75	EUR
15/07/2019	6.375	EUR

Appendix 3: Output estimation for the cointegrating equation the full sample

Vector Error Correction Estimates
Date: 11/19/21 Time: 14:21
Sample (adjusted): 2006Q2 2019Q4
Included observations: 55 after adjustments
Standard errors in ( ) & t-statistics in [ ]

Cointegrating Eq:	CointEq1
COUP(-1)	1.000000
GAR(-1)	0.987763 (0.21874) [4.51570]
LNRATING(-1)	2.607375 (0.88340) [2.95153]
LNRESRATIO(-1)	3.085000 (0.41186) [7.49033]
LNPOL(-1)	-0.705546 (0.68781) [-1.02578]
LNEXTDEBT(-1)	-2.106150 (1.18573) [-1.77624]
LNUS10(-1)	-0.903207 (0.37463) [-2.41091]
LNSOV(-1)	-0.416047 (0.14891) [-2.79398]
C	35.06315

Appendix 4: VECM output

Error Correction:	D(COUP)	D(GAR)	D(LNRATING)	D(LNRESRATIO)	D(LNPOL)	D(LNEXTDEBT)	D(LNUS10)	D(LNSOV)
CointEq1	-0.339512	-0.144367	0.009802	0.001518	-0.002358	0.000229	0.012236	0.034765
	(0.02078)	(0.04599)	(0.00682)	(0.01633)	(0.00193)	(0.00650)	(0.02246)	(0.04440)
	[-16.3370]	[-3.13938]	[1.43734]	[0.09297]	[-1.22464]	[0.03520]	[0.54475]	[0.78307]
D(COUP(-1))	0.997398	-0.158777	-0.024122	0.004948	-0.004841	-0.013094	-0.000779	-0.006656
	(0.03474)	(0.07687)	(0.01140)	(0.02729)	(0.00322)	(0.01087)	(0.03755)	(0.07422)
	[28.7097]	[-2.06541]	[-2.11588]	[0.18130]	[-1.50416]	[-1.20421]	[-0.02075]	[-0.08968]
D(GAR(-1))	0.293014	-0.469926	0.010297	-0.033190	0.007055	-0.010520	-0.044051	0.000551
	(0.05163)	(0.11425)	(0.01694)	(0.04056)	(0.00478)	(0.01616)	(0.05580)	(0.11030)
	[5.67518]	[-4.11320]	[0.60772]	[-0.81829]	[1.47499]	[-0.65096]	[-0.78942]	[0.00499]
D(LNRATING(-1))	1.691530	-0.695517	-0.010343	0.406776	-0.003029	-0.080717	0.407909	0.017314
	(0.39239)	(0.86828)	(0.12877)	(0.30826)	(0.03635)	(0.12282)	(0.42409)	(0.83826)
	[4.31081]	[-0.80102]	[-0.08032]	[1.31959]	[-0.08331]	[-0.65722]	[0.96184]	[0.02065]
D(LNRESRATIO(-1))	0.499235	0.249698	-0.064365	-0.159521	0.005204	-0.019584	0.152828	-0.333574
	(0.18438)	(0.40799)	(0.06051)	(0.14484)	(0.01708)	(0.05771)	(0.19927)	(0.39388)
	[2.70770]	[0.61202]	[-1.06379]	[-1.10133]	[0.30469]	[-0.33935]	[0.76693]	[-0.84689]
D(LNPOL(-1))	3.473889	-1.268438	0.117565	0.724361	1.038612	0.340463	0.617065	0.788819
	(0.59658)	(1.32012)	(0.19578)	(0.46867)	(0.05527)	(0.18673)	(0.64478)	(1.27447)
	[5.82296]	[-0.96085]	[0.60050]	[1.54556]	[18.7920]	[1.82331]	[0.95701]	[0.61894]
D(LNEXTDEBT(-1))	-0.818057	-0.390065	-0.111010	1.032409	-0.035621	-0.098941	0.507325	-1.729320
	(0.51876)	(1.14792)	(0.17024)	(0.40754)	(0.04806)	(0.16237)	(0.56067)	(1.10822)
	[-1.57694]	[-0.33980]	[-0.65208]	[2.53330]	[-0.74118]	[-0.60935]	[0.90485]	[-1.56044]
D(LNUS10(-1))	-0.271410	-0.342034	-0.194645	-0.060980	-0.012868	-0.029625	0.198142	-0.176994
	(0.13344)	(0.29529)	(0.04379)	(0.10483)	(0.01236)	(0.04177)	(0.14423)	(0.28507)
	[-2.03388]	[-1.15832]	[-4.44480]	[-0.58168]	[-1.04090]	[-0.70927]	[1.37384]	[-0.62087]
D(LNSOV(-1))	-0.064987	0.117197	0.000337	-0.038558	-0.001656	-0.005074	-0.000377	0.121547
	(0.06709)	(0.14847)	(0.02202)	(0.05271)	(0.00622)	(0.02100)	(0.07251)	(0.14333)

	[-0.96860]	[0.78939]	[0.01529]	[-0.73154]	[-0.26634]	[-0.24162]	[-0.00519]	[0.84801]
C	0.067940	-0.021608	-0.015006	0.010181	0.001420	0.018194	-0.008001	0.038697
	(0.02003)	(0.04433)	(0.00657)	(0.01574)	(0.00186)	(0.00627)	(0.02165)	(0.04280)
	[3.39109]	[-0.48741]	[-2.28232]	[0.64687]	[0.76523]	[2.90137]	[-0.36951]	[0.90413]
R-squared	0.961176	0.467268	0.380593	0.213034	0.902697	0.102697	0.154773	0.120400
Adj. R-squared	0.953411	0.360721	0.256712	0.055641	0.883237	-0.076763	-0.014273	-0.055520
Sum sq. resids	0.652798	3.196394	0.070300	0.402875	0.005603	0.063952	0.762535	2.979167
S.E. equation	0.120443	0.266516	0.039525	0.094619	0.011158	0.037698	0.130174	0.257301
F-statistic	123.7854	4.385577	3.072239	1.353516	46.38600	0.572257	0.915568	0.684401
Log likelihood	43.88844	0.204403	105.1719	57.16107	174.7342	107.7748	39.61547	2.139842
Akaike AIC	-1.232307	0.356204	-3.460798	-1.714948	-5.990335	-3.555448	-1.076926	0.285824
Schwarz SC	-0.867337	0.721173	-3.095828	-1.349978	-5.625365	-3.190478	-0.711956	0.650794
Mean dependent	0.045075	0.000000	-0.015405	0.008332	-0.009751	0.014498	-0.017293	0.012198
S.D. dependent	0.558009	0.333333	0.045845	0.097367	0.032654	0.036330	0.129255	0.250442

Determinant resid covariance (dof adj.)	1.44E-18
Determinant resid covariance	2.89E-19
Log likelihood	549.5868
Akaike information criterion	-16.78497
Schwarz criterion	-13.57324
Number of coefficients	88

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