ESSAYS ON CREDIT AND RESERVES

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ABSTRACT

ESSAYS ON CREDIT AND RESERVES

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This thesis consists of three separate essays that concern some challenges in the monetary sphere of developing countries. The theme of the first essay is the low level of credit creation capacity in developing countries. It focuses on a particular impediment on the credit creation capacity, which is the hierarchical nature of monetary (financial) instruments. The concept of the hierarchy of money is put to use in order to discuss the structural forces that constrain domestic currency denominated credit creation and lead to massive foreign exchange reserves accumulation. The theme of the second essay is the identification of credit booms, which are arguably the most prominent cause of severe financial distress episodes and crises. This essay particularly concentrates on the time-specific aspects of credit booms and develops a modified method for credit boom identification with that purpose. Then, this novel method is applied for a large data set with the purposes of documenting the time-specific and country-group characteristics of credit booms and their relationships with banking crises. The third essay is related to the reserve management and

strategic asset allocation for central banks in developing countries. This essay focuses on developing an alternative framework for strategic asset allocation among multiple currencies by using common portfolio optimization methods. It suggests using a basket-currency (consisting of major currencies) as a numeraire by providing a formulation for constructing a basket with desired properties, and then presents the performance of optimization results in comparison to general practices.

Keywords: Credit Creation Capacity, Hierarchy of Money, Credit Booms, Strategic Asset Allocation, Mean Variance Optimization

ÖZ

KREDİ VE REZERVLER ÜZERİNE MAKALELER

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Bu tez gelişmekte olan ülkelerin (GOÜ) parasal alanda karşılaştıkları zorluklarla ilgilenen üç ayrı makaleden oluşmaktadır. İlk makalenin teması GOÜ'lerin düşük seviyede kredi yaratma kapasitesidir. Bu makale, özel olarak, kredi yaratma kapasitesi önündeki engellerden biri olan parasal (finansal) enstrümanların hiyerarşik doğasına odaklanmakta ve bu kavram etrafında GOÜ'lerde yerel para birimi cinsinden kredi yaratmanın önündeki yapısal güçleri ve GOÜ'lerin devasa rezerv biriktirmelerine yol açan yapısal güçleri tartışmaktadır. İkinci makalenin teması, ağır finansal stres ve kriz dönemlerinin, tartışmalı olarak, en önde gelen nedeni olan kredi patlamalarının tespitidir. Bu makale kredi patlamalarının zamana özgü taraflarını ön plana çıkarmakta ve bu amaçla kredi patlamalarını tespit etmeye yönelik yeni bir yöntem geliştirmektedir. Sonrasında, bu yeni yöntemi geniş kapsamlı bir veri setine uygulayarak, kredi patlamalarının zamana özgü ve ülke grupları özelindeki karakteristik özelliklerini ve bankacılık krizleriyle ilişkisini belgelemektedir. Üçüncü makale ise GOÜ merkez bankalarında rezerv yönetimi ve stratejik varlık

tahsisi problemiyle ilgilenmektedir. Bu makale, özel olarak, yaygın portföy optimizasyonu yöntemleriyle birden fazla para birimine dayalı finansal varlıklar arasında stratejik varlık tahsisi probleminin çözümü için alternatif bir çerçeve geliştirmektedir. Bu minvalde, majör para birimlerinden oluşan bir sepet kurun hesap birimi olarak kullanılması önerilmekte ve istenen özelliklere sahip bir sepet kurun oluşturulması için genel bir formül sağlanmaktadır. Sonrasında, önerilen çerçevenin performansı genel pratiklerle karşılaştırılmaktadır.

Anahtar Kelimeler: Kredi Yaratma Kapasitesi, Para Hiyerarşisi, Kredi Patlamaları, Stratejik Varlık Tahsisi, Ortalama Varyans Optimizasyonu

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CHAPTER 1

INTRODUCTION

This thesis consists of three separate essays that concern some challenges in the monetary sphere of developing countries. The theme of the first essay is the low level of credit creation capacity in developing countries. It focuses on a particular impediment on the credit creation capacity, which is the hierarchical nature of monetary (financial) instruments. The concept of the hierarchy of money is put to use in order to discuss the structural forces that constrain domestic currency denominated credit creation and lead to massive foreign exchange reserves accumulation. The theme of the second essay is the identification of credit booms, which are arguably the most prominent cause of severe financial distress episodes and crises. This essay particularly concentrates on the time-specific aspects of credit booms and develops a modified method for credit boom identification with that purpose. Then, this novel method is applied for a large data set with the purposes of documenting the time-specific and country-group characteristics of credit booms and their relationships with banking crises. Finally, the third essay is related to the reserve management and strategic asset allocation for central banks in developing countries. This essay focuses on developing an alternative framework for strategic asset allocation among multiple currencies by using common portfolio optimization methods. It suggests using a basket-currency (consisting of major currencies) as a numeraire by providing a formulation for constructing a basket with desired properties, and then presents the performance of the proposed method compared to the US dollar-based general optimization practices.

These three essays can broadly be put under the field of monetary and financial economics. They are mostly related with the problems of developing countries, although all of the topics (credit creation capacity, credit booms and reserve management) are, to some extent, relevant for advanced economies as well. These are the common aspects in these separate essays and we expect all three essays to make positive contributions to the policymaking processes in financial development, in the management of credit cycles and in reserve management.

We start with a foundational study in the field of monetary economics, in which we discuss the fundamental issues related to credit creation and try to put the lack of credit creation capacity of developing countries within the broader context of hierarchy of money. The starting point of this study is the fact that developing countries have lower credit creation capacity than their advanced counterparts. The vast majority of economic theories on monetary issues related to credit creation are based on a perspective nourished by the historical and current experience of advanced countries and they often suffer from a disconnection from real-world practices (see e.g. Bindseil, 2004; Lavoie, 2014). In this chapter, we recognize the fact that developing countries face far more peculiar and different constraints, in a different historical context, in credit creation than that is encountered by advanced ones and we benefit from the ideas/concepts that are obsessed with the real-world mechanics of monetary sphere.

Post-Keynesian literature presents a good starting point for its steadfast emphasis on the real-world mechanics of credit creation. However, it is argued in this article that this literature does not provide a comprehensive explanation for low credit creation capacity in developing countries. The post-Keynesian literature puts forward the theory of endogenous money and fundamentally claims that credit creation is demand-determined and that the demand for bank loans is dependent on the “state of trade”, mainly on the income-generating production process. This argument, which links the amount of credit in the system to the demand level in the real economy, implies that credit-to-GDP levels should be similar for all countries. However, this is contrary to the facts. Although the post-Keynesian literature has an emphasis on

credit rationing and institutional factors that can partly explain cross-country differences, the structural impediments resulting from the international monetary architecture are barely taken into consideration in this literature. If there are such impediments, then the post-Keynesian claim that credit creation is demand-determined is only a part of the story for developing countries.

This chapter, first of all, emphasizes on recognizing the credit nature of modern money. Relying on a vast literature, extending from Schumpeter to post-Keynesians, from modern central bankers to economic historians, we discuss what is credit (and money), how it is created out of thin air in the modern world and why there is no technical boundary on "limitless" credit creation. Then, we emphasize on the constraints that sets a loose boundary upon credit creation, and group those constraints as risk considerations, legal – regulatory environment, macroeconomic conditions and structural forces. We define the concept of "credit creation capacity" with reference to those constraints. Finally, we highlight one of those constraints, which is the hierarchical nature of monetary instruments and the low level of developing country financial instruments within the international hierarchy of money. This constraint, then, is explained as a reason of low credit creation capacity in developing countries.

The basic tool of this study, the hierarchy of money, has been mentioned by some post-Keynesians (e.g. Bell, 2001; Minsky, 1986; Wray, 1998; 2015), and Marxists (Foley, 1989). Nonetheless, the international dimension of the monetary hierarchy, which is the basis of this study, has received little attention in those studies. In particular, Bell (2001) and Wray (1998) used this concept by embedding it into the Modern Monetary Theory (MMT) -a modern version of the state theory of money-, which is, we argue, not a good starting point when discussing modern monetary issues in developing countries, since the national currency of a developing country cannot be considered at the top of the hierarchy of money, thereby cannot be considered as costless, fiat money, given that country is open to international financial markets.

On the other hand, Perry G. Mehrling (2000, 2012a, 2012b and 2013) elaborated the concept of the hierarchy of money, emphasizing the credit character of all national currencies and bank money, the inherency of the hierarchy of money in an exchange-based economy, and the necessary conditions for the operation of all different kinds of credit instruments together. Making a critical appraisal of these studies, this chapter use Mehrling's (and later Zoltan Pozsar's) conceptualization of the hierarchy and enriches it by laying out the historical evolution of the hierarchy of money, its connection with "the hierarchy of traders" (Braudel, 1983) and focusing on how new layers are created in the pyramid of money.

In sum, alongside its minor contributions and secondary discussions, this chapter has four main arguments. Firstly, recognizing the credit nature of modern money and conceptualizing international monetary structure in a hierarchical manner is essential and these may help capture the differences in credit creation capacity of developing and advanced countries. The evolution of the international monetary hierarchy since the beginning of capitalism has always reflected the evolution of the hierarchy of trading centers, economic powers and nation-states. Therefore, there is a close connection between the hierarchy among traders (as well as trading centers and nation-states) and the hierarchy of liabilities issued by different-layer traders. Thus, the hierarchy of money reflects the fact that the demand for the liabilities issued by developing country financial institutions will be less than those issued by their advanced counterparts. This, ultimately, constrains the credit creation in developing countries in various ways and makes domestic credit conditions dependent on developments in advanced country financial markets.

"Original sin" (Eichengreen et al., 2003a; 2003b; 2007), which is the inability of the developing countries to borrow in their own currency, is one of the signs of the monetary hierarchy, and the negative effects it has on output instability, capital flow volatility, credit ratings, etc. are deliberated in the related literature. All these factors have limiting effects on credit creation capacity. Another sign of the monetary hierarchy is dollarization, which is an unending problem for developing countries. In the related literature, it is emphasized that dollarization leads to unstable money

demand, failure of transmission mechanisms, increased probability of banking crisis and output growth volatility (Levy-Yeyati, 2006). It is clear that all these factors will also have negative effects on the credit creation capacity in developing countries. Finally, the macro-finance literature has recently emphasized that financial cycles have been globalized and advanced country financial cycles are effective upon the financial and economic cycles of developing countries (Rey, 2013; Bruno and Shin, 2014). Such findings also support the claim of this article regarding the international monetary hierarchy, that is, hierarchy will be more effective under financial integration conditions and monetary conditions of the upper level will determine monetary conditions in the lower levels of the hierarchy.

Secondly, this essay shows that under financial openness, the hierarchy of money generates binding constraints on developing country banking sector balance sheets, such as funding and exchange rate risks that need to be managed, simply through the validation of payment commitments to the rest of the world. When economic agents in developing countries enter into payment relations with foreign economic agents for any reason, developing country banking sector has to expand its balance sheet (accompanied by creating a foreign exchange short position), in general. As a result of such transactions, developing country banking sector faces with an exchange rate risk and foreign currency funding risk that needs to be managed carefully. This is a natural consequence of the hierarchy between developing country currencies, which are at the lower levels of the monetary hierarchy and are not generally demanded as a payment instrument by other countries' economic agents, and developed country currencies, which are at the upper levels of the monetary hierarchy and have higher validity in international payments.

Thirdly, given that a country is open to international financial markets, having/issuing a national currency lower in the hierarchy requires the issuer of that currency either to hold international reserves or to ensure a credible access to such reserves. This is a way to increase the credibility, liquidity and safety of the liabilities supplied by developing country financial institutions. For example, in order to make their payments and settle their debts to the financial sector, households

and firms in a country cannot use any instrument of their own issuance, but they have to use debt instruments issued by the financial sector itself, which is above themselves in the hierarchy, and must somehow guarantee their access to these resources at all times. Similarly, the banking sector needs reserve money issued by the central bank in order to make payments to each other and settle their debts against each other. In a similar fashion, if a central bank and the related banking system are at a lower level in the international hierarchy, they cannot make payments or settle debts with local currency in the international arena, thereby they need international reserves. As a natural result of globalization and financial integration, there has been a frantic reserve accumulation activity in the developing countries in the last quarter century. Although it cannot be claimed that international reserves have a direct push or pull effect on the credit creation capacity; it can be said that international reserves increase the resilience of the developing country financial systems and allow flexibility for their credit creation capacity. On the other hand, when the boundaries of credit creation capacity are challenged or breached in developing countries, which will naturally induce overheating, inflation and/or dollarization pressures, international reserves will be threatened. Therefore, we can say that international reserves (or access to them) will determine/limit the reach of excesses in credit creation.

Finally, the evolution of the international and national hierarchy of money implies that creating new layers in the hierarchy and maintaining a desirable position requires power struggles with existing forces and accumulating/holding of money reserves issued by upper level agents. This implies that for a developing country to reduce its dependency on the international credit system and to economize on keeping its financial system intact, it must increase its economic and political power in the international arena, which is easier said than done. The only other alternative for a developing country is to keep going on accumulating reserve assets that will make its liabilities much more solid and desirable. This obviously does not result in a better position in the hierarchy, but it helps maintaining the existing position and also explains why developing countries needed and depended on so much reserve

accumulation over the past three decades as their economies have become increasingly integrated into the global commerce and finance.

The second essay detours from foundational discussions about credit creation and concerns over credit booms, which have been a headache especially for developing countries that seek to achieve ambitious growth targets by increasing their credit creation capacity. Understanding credit booms has a critical importance for policymakers due to well-documented link between credit booms and financial crises. After the global financial crisis, there was a growing interest in the early identification of booms. In 2010, the Basel Committee recommended the use of private sector “credit-to-GDP gap”, a measure of credit booms, as a guide for determining the amount of counter-cyclical capital buffers (BCBS, 2010). Recently, the Bank for International Settlements (BIS) has started to publish and update a database that exhibits the quarterly series of credit-to-GDP gaps. A series of studies conducted by BIS researchers in recent years find and emphasize that credit booms are the most successful indicator in predicting banking crises.

In general, there are two main approaches, and various methods, to identify credit booms. These two approaches can be labeled as (i) “fundamentals approach”, and (ii) “statistical approach” (or “threshold approach”). The first approach focuses on the difference between the credit level implied by the indicators that represent the economic fundamentals and the actual credit level. The second approach, which forms the basis of this study, generally focuses on the extent to which the credit variable deviates from its trend obtained through univariate statistical analysis or time series analysis. In this approach, a credit boom is defined as an excessive deviation of the cyclical component of a credit variable from its "normal" level relative to a predetermined threshold.

Credit boom identification by detrending the credit series via HP-filter and setting a threshold strategy over the cyclical component of credit series has become a common practice recently, since this framework offers an easy and replicable application for credit boom identification and provides good signaling performance

for banking crises (Drehmann et al., 2011). However, there is no single way to use this approach. Although, considering practicality and performance, one-sided HP filters may seem preferable to full sample HP filter in credit boom identification, it is not appropriate to analyze the characteristics of credit booms using one-sided filter. One-sided HP filters distort the characterization of the trend component, may not determine the date of credit booms accurately and produce inconsistent results when different credit variables are used. In this regard, the full-sample HP filter seems preferable when analyzing the characteristics of credit booms (Mendoza and Terrones, 2008; Edge and Miesenzahl, 2011). While most of the literature on the identification of credit booms focus on early warning indicators, this study mainly aims to provide a more comprehensive analysis of the historical and country group dynamics of credit booms. It is believed that such an analysis will complement and form a basis for the studies that mainly focus on forecast performance. The aim of this chapter is to identify the characteristics of credit booms, with a particular focus on the historical and country-group dimensions and so, the study is based on full-sample HP filters.

Thanks to Montiel (2000) and Mendoza and Terrones (2004), the literature paid a greater attention to country-specific dynamics of credit cycles, and thus, it is almost a common practice to use country-specific thresholds in credit boom identification. In a credit expansion process, the deviation of credit from the trend value above a certain threshold is the key element that defines the credit boom. Then, the primary concern of such methods is the determination of this threshold. Instead of randomly determining thresholds applied for all countries as it was the case in the early literature, a threshold approach based on the variance of each country's own credit cycle is an important improvement.

However, the time-specific dynamics of credit cycles have received almost no attention so far. Indeed, the cyclical component of a credit variable does not need to exhibit fluctuations of the same size over time. If the variance of the cyclical component changes significantly over time, then we need to adjust the threshold accordingly for any country over time, just as we adjust the threshold for different

countries. Indeed, by replicating Mendoza and Terrones' (2008, 2012) method, we show that the variance of the cyclical component of credit variables increases over time. This pattern holds for each income group of countries as well, except for low-income countries. The standard deviation of the cyclical component of real credit per capita grows by 2-3 percentage points for the median country between 1980 and the 2000s, which implies larger deviations of the actual credit series from their trend components for the most recent periods. Relying on these findings, we offer a new method and new definition of credit boom based mainly on a recursive application of Mendoza and Terrones' method. In this study, this new credit boom detection method is explained in detail and a new credit boom definition is presented.

Alongside its methodological contribution, the second essay employs this novel method for a large sample of advanced and developing countries in order to analyze the characteristics of credit booms in the historical and country-group dimensions. The compiled data set covers the period between 1950 and 2016 and includes a total of 148 developed and developing countries. In order to calibrate parameters for threshold coefficient and smoothing parameter of Hodrick-Prescott (HP) filter, we use a signal extraction analysis, following Kaminsky and Reinhart (1999) and Drehmann et al. (2010), for credit booms and banking crises. The banking crisis data used in this study are based on Laeven and Valencia (2012) and Drehmann et al. (2011). This preliminary analysis reveals that low and lower-middle income countries have higher missed-crisis and noise-to-signal ratios, which implies that credit booms and banking crises are not synchronized and are possibly driven by different factors for those developing countries. This view is also supported by our finding that for the low income and lower-middle income countries, there are very few cases of credit booms that are followed by banking crises in our baseline analysis. All in all, credit booms followed by banking crises appear to be an above-average developing country and advanced country phenomenon. Signal extraction analysis of high and upper-middle income countries produces results that support this view. Almost all crisis periods in our banking crisis data sets, where credit deviated positively from its pre-crisis trend, were associated with some of the credit booms we detected.

As a result of the analysis we conducted by targeting low missed-crisis ratio and low noise-to-signal ratio, we set the HP filter smoothing coefficient as 100 and the threshold coefficient as 1 (i.e., we set credit boom threshold to 1 standard deviation above trend). After detecting credit booms by using these values, we apply for event window analysis. We find that although the credit booms, as we have defined, do not increase in number over time, the ratio of detected credit booms to the number of observations of the period in which they were obtained do not appear to change over time. On the other hand, the magnitude of the deviations of real credit per capita from trend values around credit boom peaks are found to be increasing over time. This implies that the effects of a credit boom on an economy, especially in the recent past, might have been getting stronger. The duration of credit booms has also extended from 3-5 years (pre-1970) to 5-7 years (post-1970) over the course of the history. Moreover, credit booms of different countries have become more clustered for smaller time periods over time, suggesting that the global determinants of credit booms might have outweighed local ones as financial integration has prevailed. Combined with the findings and implications of the first essay, this implies that developing countries have to monitor the global financial cycles and/or reconsider the structure of financial integration with the rest of the world in order to manage their own financial cycles.

Country-group comparisons show that the evolution of credit booms around credit boom peaks is significantly different for different country groups. High credit-to-GDP ratio countries experience smoother cyclical fluctuations of credit. Therefore, the higher the credit-to-GDP ratios, the more likely the credit booms to emerge out even for smaller deviations. In addition, cyclical behavior of credit is more pronounced in more developed (both in financial and economic terms) countries. On the other hand, countries with lower credit-to-GDP ratios today experienced much higher deviations of credit at credit boom peaks. As the credit-to-GDP ratio falls, the cyclical behavior of credit becomes uncertain, making the countries' experience much more diverse. This is also true for the relation between income groups and credit booms.

We reconfirm the common finding that most banking crises (60 percent in our baseline experiment) have been preceded by credit booms, although only a small fraction of credit booms (only one fifth) has been followed by a banking crisis. These results can vary considerably according to the selected parameters and country groups. As mentioned before, low- and low-middle income countries weaken our results, whereas the relationship between credit booms and banking crisis is much more evident in upper-middle income and high income countries. Also, comparing the characteristics of credit booms followed by banking crises with those not followed by any crisis; we show that the former had much higher deviation levels (ranging from 1.5 to 2 times the deviations in non-crisis credit booms) at boom peaks. When the credit boom peak ends with a crisis, a rapid reversal below the trend is observed. These suggests that middle-income developing countries need to carefully monitor the dynamics of credit expansion periods in order to avoid from costly financial crises that would possibly follow up credit boom episodes.

To sum up, the literature mostly relies on the threshold approach when identifying credit booms, which are defined and measured as the excessive deviation of the cyclical component of credit variables from the “normal” levels. Although country-specific thresholds have been widely used in order to account for country-specific dynamics of credit cycles, time-specific dynamics, and thus, long-run changes in the financial markets are often overlooked. This study finds that using time-specific threshold values for the detection of credit boom periods is necessary and argues that this method will give more reliable results. This study offers a novel method that captures time-specific dynamics and shows that the variance of the cyclical component of credit variables increases over time. With this method, and by using a large data set, the links between credit boom periods and banking crises have been successfully determined and it has been seen that the presented method is quite successful especially for upper-middle income group and high income group countries.

Finally, the third essay dives into the realm of finance and focuses on some of the challenges in the international reserve management for developing countries. On the

macroeconomics side, growing amounts of international reserves held by developing economies and the benefits and costs of holding large amount international reserves has long been discussed (e.g. Rodrik, 2006; Levy-Yeyati and Gomez, 2019). The main cost of holding reserves comes from the difference between low-yields to reserve assets held by central banks (CBs) and typically higher cost of external borrowing for a developing country. The expected benefits of holding international reserves, on the other hand, are reducing the potential costs of global financial shocks and/or capital flow sudden stops/reversals, lowering the borrowing costs for government and all residents in general by increasing credibility, and smoothing out exchange rate variations when reserves are used countercyclically.

On the financial side, the large amount of international reserves held by CBs necessarily force them to taking into account the risk-return characteristics as well. The order of priorities for central bank reserve management practices, in general, are (i) holding adequate liquid investment to meet defined objectives, (ii) preservation of capital by managing various risks and (iii) obtaining reasonable risk-adjusted return after other conditions are met (IMF, 2014). Thus, liquidity and risk considerations necessarily narrow the investment universe for central bank strategic asset allocation process. Since central banks are conservative investors, the typical asset management framework involves setting a quite narrow investment universe with pre-determined liquidity, currency and/or country allocations. In such a setup, the reserve management activity is typically reduced to managing the market risk (duration) of a sub-portfolio of high-grade reserve-currency government bonds.

Since the global financial crisis, low-yield and even negative yield environment in high-grade government bond market and large reserve amounts seem to accelerate the evolution of central bank reserve management practices and many central banks embraced a much more return (or cost reduction) oriented perspective. Many emerging market CBs employed optimization based strategic asset allocation process to their entire reserve portfolio or to investment sub-portfolios (see Table A.2).

Markowitz mean-variance portfolio optimization is the natural starting point for a portfolio manager who wants to rely upon a quantitative tool during the strategic asset allocation process (Koivu et al., 2009). However, Markowitz mean-variance portfolio optimization framework has been seen as a problematic model in practice and has been criticized by many, mainly on the following grounds: (i) it represents the utility and/or targets of the portfolio manager in terms of mean return and standard deviation, which may not be the most appropriate and reliable indicators, (ii) the return distributions of the constructed input assets or portfolios are assumed to be normal, which is certainly not true for many asset classes, (iii) it is a static modelling for investment and does not allow for adjustments and rebalancing in the portfolio, (iv) it produces unintuitive portfolio allocations and significantly unstable weights for minor changes in input variables (Michaud and Michaud, 2008, Koivu et al., 2009).

Modern enhancements to the mean-variance (MV) portfolio optimization aim to reduce these inherent problems. Several dimensions of improvements are related to input estimation enhancements, robust optimization methods, addition of analyst's views, alternative risk-return measures, and dynamic multi-period optimization procedures (see e.g. Kolm et al, 2014 for a recent literature review). In the context of strategic asset allocation for central banks, Fernandes et al. (2011) compare the results from better input estimation (via Black-Littermann model), resampled optimization and analyst view inclusion with the original MV optimization. They find evidence that all these enhancements improve upon the original MV optimization. Zhang et al (2013) develop a strategic asset allocation process by combining return forecasts from Black-Littermann with behavioral portfolio theory approach that segregate the entire portfolio into sub-portfolios with different goals and risk preferences. Koivu et al. (2009) develops a dynamic optimization framework that uses inputs derived from term-structure forecasting. Romanyuk (2012) aims to develop an objective function in a stochastic modelling framework, with a particular focus on the trade-offs between net returns and liquidation costs when the central bank reserves are required for intervention purposes.

In this study, the original MV optimization (with budget and no-short constraints) is mainly used and it is shown that even with the original MV optimization, it is possible to obtain results that are diversified, stable and plausible. Among the improvements in the literature, it was considered reasonable to use the procedure based on resampling, and this improvement was utilized. Resampled efficiency idea rests on the fact that the inputs that will be used in the optimization procedure are statistical estimates that have variability and carry estimation error; thereby, the outputs, efficient portfolios, should have a statistical character, or there should be "statistically equivalent" efficient portfolios that cannot be differentiated from the original efficient portfolios (Michaud and Michaud, 2008). The benefits of resampled optimizations are counted as less extreme outcomes in terms of weight distributions in the optimal portfolios, better out-of-sample performance and lowered rebalancing/readjusting costs (Michaud and Michaud, 2008; Markowitz and Usmen, 2003).

Central bank strategic asset allocation process involves determining the investment universe, general guidelines and delegation on reserve management activities and a model portfolio that includes targets and deviation limits. While determining a model portfolio, central banks that aims to achieve reasonable returns (or to reduce the cost of holding reserves) wants to take advantage of diversification in various currencies and various asset classes. However, this brings with it the immediate problem of numeraire (unit of account) selection, which leads to different optimal allocations corresponding to different choices of numeraire. The returns of instruments issued in different currencies vary depending on the numeraire selection. Hence, different numeraire selection results in different optimal allocations. Borio et al. (2008a; 2008b) suggest that the choice of numeraire should be in line with the main purpose(s) of holding reserves and the fundamental uses of them. Although this approach, i.e. linking the choice of numeraire to the purpose of holding and using reserves, is reasonable from a "liquidity" perspective, it is not necessarily the best or the optimal suggestion from an "investment" perspective. When there are "more than adequate" foreign reserves, or net foreign exchange reserves that is held against domestic currency, then how that portion of reserves should be managed and what is

the best choice of numeraire are open questions. In this essay, leaving aside the "liquidity" perspective and focusing on the "investment" perspective, we assume that the central bank wants to maximize risk adjusted returns over a set of high quality major-currency assets. This requires a multi-currency optimization setup and a specific choice of numeraire that is not biased for/against any major currency.

Multi-currency optimization is generally avoided by practitioners, since typical selections of numeraire as the USD or EUR make returns to assets denominated in other currencies much more volatile due to high volatility of exchange rates compared to interest rates (see e.g. Koivu et al, 2009). This, in turn, penalizes assets denominated in other currencies in terms of their risk-return characteristics in USD-based optimization exercises. Moreover, most of the literature does not pay attention to the numeraire question and ignores how much of their results are distorted by the selection of numeraire as USD (see e.g. Fisher and Lee, 2004; Fernandes et al., 2011). As will be seen in the empirical sections of this essay, the numeraire choice is not negligible, harmless and typical selections (such as the USD) leads to unintuitive, highly concentrated portfolios.

Since choosing a major currency as the numeraire in the allocation problem for assets based on major currencies has negative consequences, two alternatives remain. The first one is to choose a currency other than these major currencies as the numeraire. As suggested by Borio et al. (2008a; 2008b) local currency as a numeraire is a reasonable alternative, but DC currencies are highly volatile against the major currencies. This will make the returns of foreign assets calculated in local currency highly volatile due to the exchange rate effect, which will lead to new problems. The second alternative is to create a basket of major currencies. In this case, the first thing that comes to mind is the use of SDR (IMF special drawing right) basket as numeraire. Hoguet and Tadesse (2011) discuss the possible benefits of using SDR as a unit of account for large institutional investors and show that the SDR-based investment process reduces portfolio volatility. However, we do not prefer SDR (weights) since it may not be the optimal weighting scheme for all developing countries. Instead, we argue that if the exchange rate volatility in the

local currency returns is adjusted, the currency basket derived from it will be much more appropriate. In fact, we propose tailor-made construction of baskets like SDRs and our method can be considered as a generalized version for SDR.

In this article, Turkish lira (TRY) returns on reserve assets issued in major currencies are taken, and the effect of TRY volatility are cleaned from these returns by means of Principal Component Analysis. This way, a synthetic currency basket consisting of major currencies is obtained. Several other developing country currencies are also analyzed for controlling the stability of optimal portfolios across different sets of basket currencies. Our approach yields a synthetic numeraire with the following features: (i) it does not favor any currency in the multi-currency optimization framework; (ii) it relies on a reasonable and logical procedure that yields transformed return series with features close to original own-currency returns; (iii) the outputs are compatible with different kind of unit of account selections practiced by central banks, i.e. the optimal allocations cannot specifically be penalized in any of the common numeraire selection of central banks (domestic currency, a basket of selected currencies, the USD and so on); (iv) it is useful in generating diversified portfolios via optimization procedures across major currencies and it is beneficial for reducing the exchange rate volatility of the portfolio.

MV optimization based on a basket currency leads to several interesting results. Firstly, we show that there are significant gains from diversification with the addition of alternative instruments (such as gold, CNY bonds or stocks) to a typical investment universe of only major bonds. Asset classes, such as gold and Chinese government bonds, are (or will be) widely preferred by central banks in practice, but have generally not been included in previous studies of optimal strategic asset allocation. In this study, it has been shown that it would be beneficial to expand the investment universe that central banks can use with gold and Chinese treasury bonds.

Secondly, we show that the resulting portfolio weights from a MV optimization based on return inputs in terms of a basket currency are highly diversified and quite stable across several dimensions. On the other hand, optimal portfolio weights

obtained from a USD based MV optimization yields highly concentrated portfolios and show instability in different analyses. Moreover, weight attributions from basket currency-based optimization to each asset class are reasonable considering the main features of the last two decades (the period of interest), but it would be impossible to draw such a conclusion from USD based optimizations.

Thirdly, we show that the resampled optimization based on a basket currency increases diversification ratios further and the stability of weights is also slightly increased. USD-based resampled optimization, on the other hand, does not improve on the diversification side and on the stability side across different sets of investment universes (except for the low risk averse options of optimal portfolios). Fourthly, carrying out an out-of-sample performance analysis, we show that the basket currency-based optimization procedure that we developed performs quite well in different scenarios. Finally, by constructing a constrained optimization framework, we show that typical predetermined liquidity, currency and duration constraints confine optimal allocations to the less risky side of the unconstrained frontier. These constrained frontiers are actually very close to our unconstrained resampled frontier, which implies that typical constraints of a central bank actually do the same job with the resampling process and they confine optimal allocations into the conservative side of optimal portfolio search.

This essay contributes to the literature by developing a fundamental, flexible and practitioner-friendly optimization framework for the strategic asset allocation process of a developing country central bank, with a particular focus on the optimal currency allocation of an investment portfolio. The framework is open to further improvements by using state-of-the-art extensions to the Markowitz portfolio optimization framework by combining forward-looking inputs via yield curve forecasting, adding analyst views and constructing tailor-cut objective functions.

The structure of this thesis is as follows. The second chapter is devoted to the essay on the credit creation capacity of developing countries through the lens of international hierarchy of money. The third chapter offers a novel method for credit

boom identification and employs this method for a large data set by focusing on the time-specific and country-group characteristics of credit booms. Finally, the fourth chapter provides a framework for strategic asset allocation optimization in a multi-currency setup for a developing country central bank.

CHAPTER 2

CREDIT CREATION CAPACITY OF DEVELOPING COUNTRIES FROM THE LENS OF INTERNATIONAL HIERARCHY OF MONEY

Credit and money creation is necessary and essential to the functioning and growth of a capitalist economy[1]. In theory, in a capitalist economy, there are no hard, technical limits on credit creation for any agent, in particular for banking institutions[2]. However, in practice, credit creation is constrained by many factors, which can be classified as subjective economic constraints -such as concerns with respect to profitability, liquidity and various risks-, legal and regulatory constraints, macroeconomic conditions, and finally, structural economic factors, such as

[1] According to Schumpeter (1974: 107), "[c]redit is essentially the creation of purchasing power for the purpose of transferring it to the entrepreneur, but not simply the transfer of existing purchasing power. The creation of purchasing power characterises, in principle, the method by which development is carried out in a system with private property and division of labor. By credit, entrepreneurs are given access to the social stream of goods before they have acquired the normal claim to it … It is only thus that economic development could arise from the mere circular flow in perfect equilibrium. And this function constitutes the keystone of the modern credit structure."

[2] As McLeay et al. (2014a:4) envisages it, "[e]veryone in the economy could … create their own financial assets and liabilities by giving out IOUs every time they wanted to purchase something, and then mark down in a ledger whether they were in debt or credit in IOUs overall." However, the first problem with this is to make those IOUs acceptable. As Minsky (1986: 255) succinctly puts it, although "… everyone can create money; the problem is to get it accepted". Banking institutions are special in that sense. As Ryan-Collins et al. (2011) nicely summarizes, "[n]ew money is principally created by commercial banks when they extend or create credit, either through making loans, including overdrafts, or buying existing assets. In creating credit, banks simultaneously create brand new deposits in our bank accounts, which, to all intents and purposes, is money. This basic analysis is neither radical nor new. In fact, central banks around the world support the same description of where new money comes from – albeit usually in their less prominent publications."

prevailing international monetary arrangements and conventions[3]. Thus, credit creation capacity (CCC) can be defined as the limit, in practice, to the amount of credit extendable by the agents in a capitalist economy; given that those four types of constraints are binding[4] .

Mechanics, determinants and effects of credit creation, constraints on it and various theories with regard to monetary issues related with credit creation have mostly based on a perspective nourished by the historical and current experiences of advanced countries (AC). Some of those theories are able to shed light on understanding credit creation in developing countries (DC) as well. However, DC may face with much more peculiar and different constraints in credit creation than that is encountered by AC, especially when one considers the structural ones. Indeed, a simple glance at the patterns of outstanding credit to non-financial private sector provided by domestic financial sector for different income groups of countries vindicates that DC have lower CCC depending on their level of capitalist development[5].

This study argues that recognizing the credit nature of modern money and conceptualizing international monetary structure in a hierarchical manner may help capture the differences in the CCC of AC and DC. The obvious demonstration of the hierarchical international monetary structure is the hierarchy of currencies, which is visible in the existence of regional reserve currencies (USD, JPY and EUR) and "the" reserve currency (USD). In that layered structure, DC currencies are at the bottom. The evolution of the international monetary hierarchy since the beginning of capitalism has always reflected the evolution of the hierarchy of trading centers,

[3] Here, structural factors refer to those forces that cannot be altered easily by only one country. Nonetheless, structural factors are not considered as permanent and invariable.

[4] In other words, as Schumpeter (1974: 113-14) aptly puts it, "even if we cannot, in the nature of things, state the limit to the creation of purchasing power under the assumptions made as accurately as, say, the limit to the production of a commodity, and even if the limit must vary according to the mentality of the people, legislation, and so on, yet we can state that there is such a limit at any time and what circumstances normally guarantee its maintenance… [, which] makes its volume at any time an elastic, though nevertheless a definite, magnitude."

[5] See Figure 1 in the next section.

economic powers and nation-states. There is a close connection between the hierarchy among traders (also, trading centers and nation-states) and the hierarchy of liabilities issued by different-layer traders. Thus, the hierarchy of money reflects the fact the demand for the liabilities of DC financial institutions will be less compared to the liabilities of AC financial institutions, which, in the end, constrain the credit creation in DC in various ways and make domestic credit conditions dependent upon the developments in AC financial markets[6].

This study shows that under financial openness, the hierarchy of money generates binding constraints on the DC banking sector balance sheets, such as funding and exchange rate risks that need to be managed, simply through the validation of payment commitments to the rest of the world. Furthermore, given that a country is open to international financial markets, having a lower layer national currency in the hierarchy requires the issuer of that currency either to hold international reserves or to ensure a credible access to such reserves, which explains why DC needed and depended on so much reserve accumulation for the last three decades. It will be shown that there is a close association of the expansion of CCC in many DC with reserve accumulation.

This study relies on a heterodox conceptual framework. The basic tool of this study, the hierarchy of money, has been utilized by some Post-Keynesians (e.g. Bell, 2001; Minsky, 1986; Wray, 1998; 2015), and Marxists (Foley, 1989) as well. Nonetheless, the international dimension of the monetary hierarchy, which is the basis of this study, has taken little attention in those studies. In particular, Bell (2001) and Wray (1998) made use of this concept by embedding it into the Modern Monetary Theory (MMT) -a modern version of the state theory of money-, which is, arguably, not a good starting point while discussing modern monetary issues in DC, since the national currency of a DC cannot be considered as a costless, fiat money given that

[6] The recent literature on "original sin" (Eichengreen et al, 2003a, 2003b, 2007), on "financial dollarization" (Levy-Yeyati, 2006), and on the transmission of global financial conditions from financial centers toward other countries (Rey, 2013; Bruno and Shin, 2014) can be interpreted as different examples of interactions between a structural international constraint (international hierarchy of money) and macroeconomic conditions that lead to constrain credit creation in DC.

country is open to international financial markets[7] . On the other hand, Perry G. Mehrling (2000, 2012a, 2012b and 2013) elaborated on the concept of the hierarchy of money, emphasizing on the credit character of all national currencies and bank money, on the inherency of the hierarchy of money in an exchange-based economy, and on the necessary conditions for the operation of all different kinds of credit instruments together. Making a critical appraisal of these studies, this study make use of Mehrling's conceptualization of the hierarchy and enriches it by laying out the historical evolution of the hierarchy of money and focusing on how new layers are created in the pyramid of money.

This study focuses on the interplays between the CCC and the current international monetary structure. Some of the arguments has affinity with the arguments proposed in the international macro-finance literature on the "original sin" (Eichengreen et al., 2003a; 2003b; 2007). Also, the main concern of this study, the CCC of DC, has been analyzed in the context of the determinants of financial development (see e.g, Beck and Levine, 2005, Djankov et al., 2007). Admittedly, the legal, institutional, geographical, cultural, political constraints and the constraints arising from the policy choices may play a role in determining the CCC. Nevertheless, we focus on the international structural constraints on the CCC of DC. Moreover, this essay differentiates itself from the mainstream literature by taking a non-orthodox position in monetary economics. Therefore, it would be better to concentrate on the non-orthodox literature. In this regard, this study addresses some important weaknesses in Post-Keynesian literature, which fundamentally claims that credit creation is demand-determined and the demand for bank loans is dependent upon "the state of trade", mainly on the income-generating production process[8]. This argument implies

[7] L. Randall Wray argues that "MMT principles apply to all sovereign countries" (Wray, 2015: 289), which include all DC that issue their own currency, even if that currency is convertible. This follows that DC governments can achieve full employment by taking necessary measures funded by national currency issuance. Wray (2015) is aware of the fact that this could lead to currency depreciation and inflation in DC, but he emphasizes on the policy options available to the governments that issue its own national currency, such as import and capital controls. However, such measures are exactly the constraints on the practical convertibility of a national "convertible" currency.

[8] Howells (2001: 134) states that one of the core propositions of the Post-Keynesians is that "the demand for bank lending ... is driven by the 'state of trade', essentially the level of nominal output. Since this is normally rising, as the result of some combination of price and volume changes, the

that credit-to-GDP levels should be same for all countries. However, this is contrary to the facts. Although Post-Keynesian literature has an emphasis on credit rationing and institutional factors, which may partly explain cross-country differences in the CCC, structural impediments resulting from the international monetary architecture are barely taken into consideration in this literature[9]. If there are such impediments, then, the Post-Keynesian claim that credit creation is demand-determined is only a part of the story for DC.

The organization of the article is as follows. The next section emphasizes on recognizing the credit nature of modern money and the importance of conceptualizing the international monetary system in a hierarchical manner. Section two deals with the evolution of the hierarchy of money, how new layers are created and how the hierarchy becomes a structural constraint for DC. Section three discusses the implications of that conceptualization for the CCC of different country groups and exemplifies the mechanisms of interactions between the hierarchy of money and the credit creation capacity of DC. Section four addresses the weaknesses in Post-Keynesian monetary theory in the context of DC. The final section provides concluding remarks.

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normal case is for the stock of bank loans to expand." In general, the demand for bank credit is mainly seen as a function of the working capital needs of the firms, though there seems also a consensus on the effect of additional forces, such as speculative activities. Niggle (1991:142), for instance, states, on the consensus of Post-Keynesians, that "[t]he demand for credit is a function of the level of economic activity, exogenous changes in the average wage rate and the price level, expectations regarding all of these, and the level of speculative financial transactions."

[9] Wray (1990), to the best of our knowledge, was the only one that touched upon the impediments on the CCC of DC posed by the international hierarchy of currencies, referring to the acceptability of state debts in the international financial markets, but he did not provide any explanation on how these two are linked. On the other hand, some Post-Keynesians have emphasized on institutional characteristics that determine the stages of banking development in the UK and the US, arguing the universality of these characteristics (Chick, 1992, 1993; Chick and Dow, 1988; Niggle, 1990, 1991). By making a critical appraisal of the studies, we argue that adapting the staging-approach to DC is nearly impossible because of highly interactive development process of the banking systems in DC in the 20th and 21st century, which has been influenced by the financial developments and innovations in the AC and also by the changes in the international monetary system.

2.1. Credit creation and the hierarchy of money

"Credit" denotes every kind of allowance of taking money or goods or of using services by one party to another, without requiring any immediate compensation or payment, by trusting in the ability of the counterparty's future payment[10]. By this definition, a typical contract between an employee and an employer can be regarded as a simple credit creating arrangement, by which the employee agrees to work for every day without being paid until the pre-arranged payday, the day at which the credit that had been given in the form of labor force is settled with the delivery of money, typically an accepted form of medium of exchange by the society[11]. Similarly, a farmer may contract with a food processing company or a trader to sell its harvest on a seasonal basis but the payment is typically done at future settlement day. Such delayed-payment arrangements are common in both retail and wholesale trade, which may generate promissory notes, negotiable and circulating bills. The common feature in these examples is the creation of a temporary purchasing power by the lender in exchange for the promise of future payment in terms of money from the borrower. These types of credit arrangements have contributed to development of markets and also capitalist production by facilitating exchange and production and by allowing for the efficient use of scarce money as a settlement device[12]. In these examples, money is only required to be delivered at the settlement day, i.e. it is required as a means of payment, which defines what is meant by money in this study.

[10] This is one of the lexical meanings of the word. The origins of the term in English dates back to the age of classical Latin. It had also similar meaning in French and in Italian languages during the late Middle Ages (see Oxford English Dictionary).

[11] This example rests on Marx (1867), who sees the workers as the creditors of the capitalists.

[12] For example, while describing the development of trade and capitalism in the early capitalist societies, Braudel (1983: 73) states that "the principal reason for the development of shops was credit. One step up from the shops, the wholesaler granted credit; the retailer had to pay what we would today call instalments… the shopkeeper himself granted credit to his customers and to the rich more readily than to the poor."

Modern capitalist societies have mainly depended upon financial institutions, particularly commercial banks, as the main suppliers of credit[13]. What is the difference between the credit supplied by financial institutions and the credit created by other agents? The first difference is about the quality of the thing supplied by the creditor. In private credit contracts, the creditor just delivers what is specifically demanded by the borrower at the moment of any arrangement. In other words, these are tailor-made credit, which leads to a specific type of purchasing power in each case and allows only for purchasing of what is supplied by the creditor. The main difference of the credit provided by financial institutions is that they create not only purchasing power for the borrower, but also, they create money, from the perspective of all private agents in the economy[14]. Money, on the other hand, as an acceptable means of payment, appears only at the settlement day in private credit contracts. Although some mercantile paper may circulate as executing some particular functions of money, they are destroyed at the settlement day requiring the necessary means of payment, i.e. money. As MacLeod (1896: 337) aptly puts it, mercantile credit may facilitate the commerce since it "effects exchanges exactly like money until they are paid off and extinguished", but they "are always extinguished when they become due"; on the other hand, bankers "turn mercantile debts into ready money" by "creating and issuing credits, or debts, of their own payable on demand… with the hope and expectation that they will not be demanded and extinguished."[15]

The second fundamental difference between the private credit contracts and the bank credit is about technical limits on credit creation. In private credit contracts, the

[13] See Figure 1. The bulk of the credit is supplied by commercial banks in almost all countries. There are exceptions to the rule among both developed (the US, Japan since the mid-1990s) and developing countries (South Africa, Venezuela and Chile), in which non-bank financial institutions have reached a considerable volume in providing credit to private sector.

[14] See McLeay (2014a, 2014b) for a simple exposition of money creation by such institutions in the modern world.

[15] MacLeod (1896: 337) asserts that "[t]here is no necessity that banking credits should ever be extinguished; in fact, if banking credits were extinguished as soon as they are created, the business of banking could not exist… Money is a very expensive machine to purchase and keep up; but banking credit cost nothing to create, and they may endure forever." (Note that "money", here, refers to commodity.)

creditors are always limited by what they are able to supply, such as the labor force one can supply in a month or a week, the production capacity of a firm, or the inventory capacity of a merchandiser or shopkeeper. On the other hand, the banking system has no such hard limits in credit creation, since what it supplies is created out of nothing, at the stroke of a pen, in Tobin's (1963) words. What is supplied by the banking system as granting credit is just the debt of a bank (or rather the debt of the banking system, when there is a system), which may take the form of a note or an account-money. As Schumpeter (1934 [1974]: 112) succinctly puts it, what is supplied by the banking system is constrained neither "by the quantity of liquid resources existing independently of creation for the very purpose of granting credit, nor by the existing – idle or total – quantity of goods". As many Post-Keynesians emphasize, bank money is created ex nihilo, requiring only a simple decision by a lending institution and a willing agent to borrow. In particular, the horizontalist Post-Keynesians asserts that the existing amount of savings in the economy and the volume of central bank reserves are not binding constraints on bank lending (Lavoie, 1984, 1985, 2006a, 2006b, 2014; Kaldor, 1970; Le Bourva, 1992 [1958]). The latter part is also well-known to the prominent central bankers. For example, Borio and Disyatat (2009: 19) states that "the level of reserves hardly figures in banks' lending decisions. The amount of credit outstanding is determined by banks' willingness to supply loans, based on perceived risk-return trade-offs, and by the demand for those loans. The aggregate availability of bank reserves does not constrain the expansion directly". As Goodhart (2001: 15) succinctly puts it, "the level of H [high-powered money], and M [money stock], is an endogenous variable, determined at the end of a complex process, mostly driven by up-front concern with, and reactions to, the 'appropriate' level of short-term interest rates. This has been so, almost without exception, in all countries managing their own monetary policy for almost the whole of the last century, in the UK for even longer."[16]

[16] In a different context, Goodhart (1989: 293) states that: "Central Bank practitioners, almost always, view themselves as unable to deny the banks the reserve base that the banking system requires, and see themselves as setting the level of interest rates, at which such reserve requirements are met, with the quantity of money then simultaneously determined by the portfolio preferences of private sector banks and non-banks." See also Bindseil (2004a, 2004b) for a perfect layout of the modern structure

Having no technical limits on what they create or supply, the banking sector is still constrained in credit creation. As Schumpeter (1974:113) puts it, although there is no natural, technical limit on the credit creation of banks, "we can state that there is such a limit at any time and what circumstances normally guarantee its maintenance". This is the basis for defining credit creation capacity (CCC) of a country, which is the amount of credit extendable by the agents in a capitalist economy, under the strains of maintaining a profitable and sound business, legal and regulatory environment, macroeconomic conditions and structural factors. The proper measurement of CCC of a country is technically impossible. First, the actual levels of credit may not be in line with the "capacity" since credit follows a cyclical behavior and cycles may end up with extreme outcomes on both side. Second, it is constrained by data availability. It is simply impossible to collect data over all the private credit contracts in place. Nonetheless, since the bank credit provides the means for the expansion of such contracts in modern capitalist societies, it can be considered as a rough measure of CCC. Therefore, we focus on credit created by domestic financial institutions, particularly by commercial banks, while measuring CCC. The best measure of the CCC is, arguably, the outstanding credit stock to the private sector provided by all domestic financial institutions[17]; and, as Figure 1 shows, the CCC of different income groups of countries have been ordered according to their per capita income levels.

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of monetary policy implementation in the key ACs and for a nice discussion of how the wrong doctrine of quantity-oriented monetary policy implementation and the associated money multiplier story has risen and has been doomed to fail. Disyatat (2008) also focuses on the universal characteristics of monetary policy implementation and the popular misconceptions about the operations of central banks. Finally, McLeay et al. (2014a, 2014b) provides a good introductory statement on the mechanics of money creation, touching on the main functions of central bank reserves and how central bank operations are supposed to influence upon the financial and non-financial private sectors.

[17] Total credit provided by domestic financial institutions is not a good measure since it includes credit granted to the government, which may involve the effects of non-market forces. However, one should note that credit provided to private sector may sometimes involve credit provided to state-owned enterprises, which can be regarded as a noise in the available data.

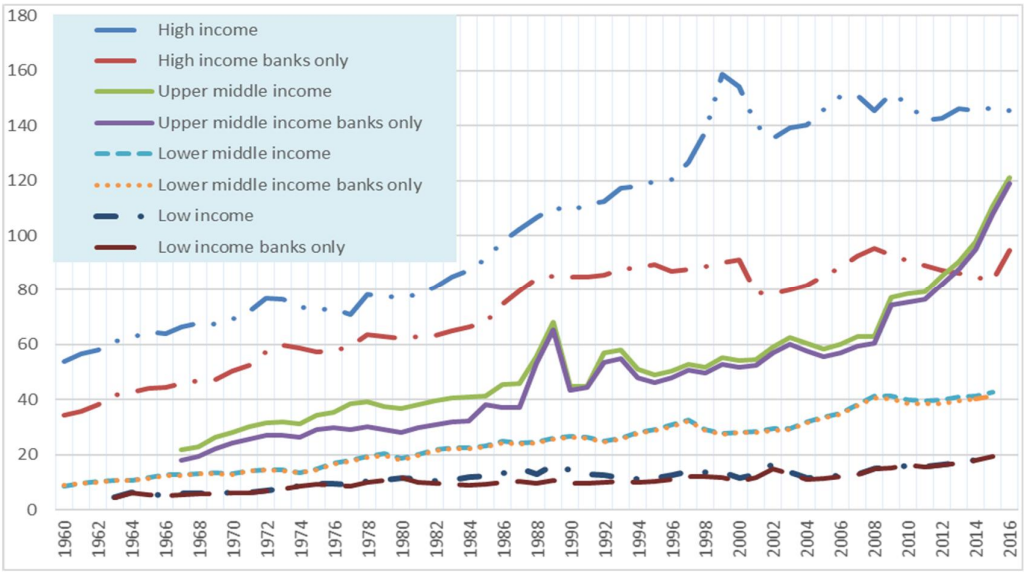

Figure 2.1 Credit-to-GDP Ratios of Country Groups (1960-2016)

Source: World Development Indicators

Note: "Credit" refers to the outstanding credit stock provided by all domestic financial institutions to the private sector, whereas "Banks only" refers only to a subcomponent of the total credit stock provided by the depository institutions.

There are many explanatory factors for the cross-country and historical differences in the CCC. Legal, institutional and regulatory environment is an important constraint on the credit creation by banks. Djankov et al. (2007), for instance, shows that legal environment that support creditor rights and the existence of information-sharing institutions help explain the cross-country differences for a large set of countries. Macroeconomic conditions and policy choices also influence upon both demand and supply sides of credit growth. A large literature has shown the association between credit growth, macroeconomic fluctuations and policy choices (see e.g. Mendoza and Terrones, 2012; Elekdag and Wu, 2011). Despite all, this study does not focus on cross-country and historical determinants of CCC differences. Instead, we focus on the general sticky pattern of the association of low CCC with less development, as exhibited in Figure 1. In this regard, we single out the role of a structural factor, the existing international monetary architecture, to explain the low level of CCC in DC.

In this vein, in order to capture the basic features of the existing international monetary structure, we utilize the concept of the hierarchy of money.

Modern economics is actually quite close to view domestic credit instruments in a hierarchical scheme, which can be followed in the separation of different financial instruments in different categories of money, such as M0, M1, and M2, and so on. Yet, modern economics also typically assumes that foreign currency and foreign financial instruments are symmetric alternatives to domestic currency and domestic financial instruments. Furthermore, modern economics is quite distant from recognizing the credit nature of modern money and viewing it as, first and foremost, a means of settlement. Textbook conceptualization of money commonly refers to, first and foremost, its "medium of exchange" function and its usefulness in getting rid of the impracticalities of a barter economy[18]. On the other hand, as many heterodox monetary economists argued, it would be much more useful to conceptualize money as a medium of payment, "a vehicle to settle debts", first and foremost (Lavoie, 2014:188). In this conceptualization, there is a hierarchical distinction between the debt/credit contract and the vehicle to settle that debt. This is the basis of the concept of "hierarchy of money". It can be applied to categorize all financial instruments and the concept of "money" can be used to describe all financial instruments that are used as a means of payment, to make final settlements; whereas the concept of "credit" can be used to describe the instruments that are used as promise to make payments in the future, i.e. promise to pay "money". Almost all financial instruments can be considered both as money and as credit, depending on the context. For example, a national currency, the ultimate medium of exchange in a

[18] Allyn Abbott Young (2002 [1924]: 265) has discredit this idea long ago: "For a long time, it was the habit of writers on the subject of money to picture an imaginary stage of barter which continued for a long period before it became possible to agree to use one particular commodity as the medium of exchange or measure of value, and thus to adopt money. This view of things, that men invented money in order to rid themselves of the difficulties and inconveniences of barter, belongs, along with much other conjectural history, on the scrap-heap of discredited ideas. Men did not invent money by reasoning about the inconveniences of barter any more than they invented government by reasoning about the inconveniences of some mythical primitive state of anarchy. The use of money, like other human institutions, grew or evolved. Its origins are obscure. It is, nevertheless, fairly certain that at no period in his history has man ever conducted any considerable volume of trade by means of barter. There was a very small gap, perhaps no gap at all, between the beginnings of trade and the origin of money."

jurisdiction, is money as long as everyone pays its daily purchases of goods and services, settles all kinds of debts and pays its taxes to the government by using it. However, on the other hand, it is also a credit instrument issued by the government, which promises to pay various things on demand, depending on the foreign exchange regime adopted and also depending on the political power of the government. Even if the state does not promise to pay its liabilities by any means other than its own liabilities, it is still a credit instrument, functioning as money as long as the society accepts the "credit" in it as a settlement device[19].

The key to understanding the hierarchy of money is to observe how it operates in the modern world[20]. The obvious starting point is different qualitative characteristics of different financial instruments, which reflect itself into quantitative differences (premiums) in tranquil times. This is even true for money-like claims and as Pozsar (2014) puts it: "not all money claims are equally strong in their par on demand promise in all states of the world". The qualitative differences are severely asserted during the periods of financial stress, reflecting itself into the drying up of liquidity in markets for some financial instruments. Secondly, the quality of financial instruments reflect the qualitative character of their issuers and the institutional setup that back those instruments. Thirdly, at each level of the hierarchy of money, there

[19] Adapting the Kaldor's (1970:6-7) words, spelled in a different context, if the government issues non-convertible currency that is not so much acceptable by the society for a reason, "all kinds of money substitutes would spring up: credit cards, promissory notes, etc., issued by firms or financial institutions which would circulate in the same way as" national currency. "Any business with a high reputation- a well-known firm which is universally trusted- could issue such paper, and anyone who could individually be "trusted" would get things on "credit"." It should be added that such a business should have widespread payment relations in the community. "The trust-worthy or credit-worthy part of the population- the people who can be trusted not to spend in excess of what they can afford to spend- would thus live on credit cards. The rest of the population- the mass of weekly wage-earners, for example, who have no "credit", not being men of substance- would get paid in chits which would be issued in lieu of cash by, say, the top five hundred businesses in the country (who would also, for a consideration, provide such chits to other employers). And these five hundred firms would soon find it convenient to set up a clearing system of their own, by investing in some giant computer which would at regular intervals net out all mutual claims and liabilities. It would also be necessary for the member firms of this clearing system to accord mutual "swops" or credit facilities to each other, to take care of net credit or debit balances after each clearing. When this is also agreed on, a complete surrogate money-system and payments-system would be established, which would exist side by side with "official money"." Without bearing on so much trouble, simply, the society may choose to use another currency in their transactions and settlements as much as possible.

[20] This paragraph rests heavily on Mehrling (2000, 2012a, 2012b, 2013) and Pozsar (2014).

are institutions (dealers, suppliers) acting as market-makers by exchanging different level financial instruments; i.e. credit for money and money for credit. Banking sector is the most visible one, which stands ready to buy the debt of its customers by selling its own debt instruments (deposits), which is accepted as money by the society[21]. Banks can also be considered as a special market-maker, a dealer, which stands ready to buy and sell deposits (credit) in exchange for currency (money) at par, with the help of central banks. Many central banks (with the help of commercial banks) can also be considered as (the last) foreign currency dealers, as long as they have "enough" international reserves, which stand ready to buy and sell foreign currency (money) in exchange for domestic currency (credit). Thus, there is also a simple hierarchy of market-makers to go along with the hierarchy of instruments. Furthermore, there is an associated price of credit in terms of money for each market-maker; and thus, there is a hierarchy of prices, too. In its simplest form, exchange rate (the link between international reserve money and the national currency) is at the top of this hierarchy. Then, the central bank interest rate that links central bank money with bank money comes next. Finally, interest rates that link currency/deposits to various private sector debt instruments are at the bottom of the price hierarchy. At each level of the hierarchy, a dealer, which overtakes market-making activity, quotes the prices and links the layers of the hierarchy by using its own balance-sheet to take positions on both sides. The balance-sheet of a dealer is where the various kinds of risks are carried over, and so, these risks are priced, which is visible in the price of credit in terms of money. Prices of different financial instruments, i.e. prices of credit in terms of money, are just quantitative links between qualitatively different instruments, which can be continuously adjusted by dealers during tranquil periods in order to keep the convertibility or tradability of various kinds of credit instruments. Financial stress episodes may lead up to unbearable balance-sheet positions for a dealer, which will reflect itself into

[21] As Minsky (1986: 256) aptly puts it, "[b]anking is not money lending … The fundamental banking activity is accepting, that is, guaranteeing that some party is creditworthy. A bank, by accepting a debt instrument, agrees to make specified payments if the debtor will not or cannot. Such an accepted or endorsed note can then be sold in the open market. A bank loan is equivalent to a bank's buying a note that it has accepted."

increased premiums by such a dealer. Financial stress and associated price adjustments may sometimes be self-equilibrating, but they may also become self-feeding and lead to solvency or liquidity challenges, which may even terminate market-making activity by such a dealer. This is where the hierarchy among different financial instruments is most visible.

The traces of the hierarchy of money as a concept can be found in Post-Keynesian or Marxist literature, with the emphasis on different degrees of social acceptability of different financial instruments as the separator of different layers in the hierarchy (Foley, 1989; Minsky, 1986). Despite the recognition of the hierarchy, the conceptualization and its implications are not well-developed by those early scholars. Some Post-Keynesians, such as Bell (2001) and Wray (1998), considered the hierarchy in a different context while building up the modern version of the state theory of money. From this perspective, the fundamental emphasis is on the money issued by the government. Since it is generally at the top of the hierarchy within national borders, it is seen as a "fiat money". Furthermore, Wray (2015) argues that this applies for all sovereign governments, including DC governments. Although it is recognized that convertibility of DC national currencies distorts the "fiat money" character, Wray (2015) states that DC governments are still able to make their liabilities act like a fiat money by applying for the available policy options, such as import and capital controls. Contrary to these arguments, we argue that it is not a good starting point to consider DC currencies as "fiat money" while discussing the credit creation in DC. Import and capital controls, leaving aside their desirability and practicality, are exactly the constraints on the practical convertibility of a national currency. Thus, one can say, Wray's claims can be seen as applicable only to the country that issues international reserve money in the best case. Moreover, the critical point about the modern money is its credit nature, and as Mehrling (2000: 401) puts it, "the fact that state money is not a fiat outside money … but, rather, an inside credit money because it is the liability of the central bank." Recognizing this fact implies that convertibility/inconvertibility has a secondary importance since, even if the national currency is deemed inconvertible, it is still a credit, functioning as money, as long as the society accepts the "credit" in it. Recognizing that even the

international reserve money today is a liability of a central bank is the critical element in an earthly theory of money.

Alongside the failure to recognize the credit character of all national currencies, MMT fails to recognize the inherent nature of the hierarchy of all financial instruments in an exchange-based economy. The position of the state's liabilities at the top of the hierarchy, from a closed economy perspective, is attributed to the taxing and law enforcement power of the state (Bell, 2001). However, as Mehrling (2000:403) succinctly puts it, "[m]onetary systems are always hierarchical, with the best quality debts circulating as money to clear lesser-quality debts." The higher rank of the state liabilities cannot be taken as granted and it requires to be sustained by the social harmony and institutional arrangements[22]. The next section stresses on the spontaneity of the hierarchy of money in a capitalist society. It particularly aims at describing the hierarchy of money in its evolution and making inferences about how the new layers are created, which will be important to understand the current configuration of the international monetary hierarchy and the structural nature of it for DCs.

2.2. The evolving structure of the hierarchy of money from international perspective

The evolution of the hierarchy of money since the beginning of capitalism can be described, in a highly stylized fashion, in three stages. For modelling purposes, Figure 2, 3 and 4 below describe the evolution of the hierarchy of money from the first phases of capitalism (before 19th century), to the development of full-fledged banking system in the more advanced capitalist countries (from 19th century to the end of Bretton Woods era), and finally to the latest globalization era (post-Bretton Woods period), respectively. For all the figures below, the left plots are devoted to

[22] See Pozsar (2014) for an exposition of the institutional arrangements that support the "quintessential attribute of money", that is "money always trade at par on demand". Recently, Borio (2018) also emphasizes on "the importance of trust and of the institutions needed to secure it" for a functioning monetary system and the critical role of ensuring price and financial stability in building up and maintaining that trust.

describe the international monetary hierarchy or the monetary system of a financial center of the world, while the right plots are devoted to describe the hierarchy from the perspective of a developing nation[23]. This sketch of the history wishes to describe the evolution of the hierarchy and to underline the critical difference in the evolution of the banking systems of contemporary advanced and developing countries.

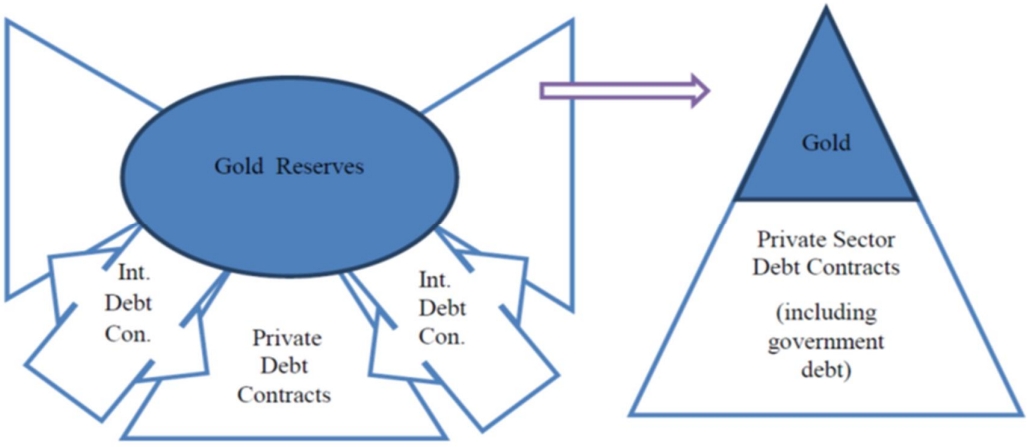

Figure 2.2 The hierarchy of money in the early phases of capitalism (before 19th century)

Note: The left plot describes the international monetary hierarchy, while the right plot describes the hierarchy from the perspective of any nation.

At the earlier phases of banking development and before the emergence of central banking practices in the 19th century, international monetary system can be described in a much more egalitarian manner (Figure 2 – left plot). It is egalitarian since the ultimate money in the international system is a commodity- not a debt instrument issued by any government. Precious metals like gold and silver were at the top of the hierarchy of money for each country (Figure 2 – right plot) as the primary settlement device of private debt contracts and also government debt contracts. International trade and debt linkages among different countries were also

[23] For the figures below, except for the first one, we will not show international debt contracts separately in order to ease exposition, but the reader should be noticed that they are always there. Also, the validity of these pictures in details and for long periods of times are not of a primary concern here. The important point is to depict the basic elements in their evolution and it is not attempted to give a complete account of the evolution of the international monetary system.

required to be settled with commodity money in the end, though there existed long-lasting clearance mechanisms through book transfers, loans and bills of exchange[24].

Figure 3 describes how monetary system looked like after the development of commercial banks in the advanced capitalist societies[25]. The left plot shows that commercial banks have accomplished to put their liabilities permanently into the middle of the hierarchy. Those banks monetized private and public sector debts and provided settlement devices (banknotes and deposits) for private debt contracts, but they still had to hold gold reserves (or claims on government banks/central banks that held the gold reserves) which has been the ultimate internationally acceptable money in the system until the beginning of the 1930s (in practice) or until the end of the 1960s (in theory). In many AC, some banks evolved into (or were established as) central banks in the 19th and early 20th century. Their liabilities could have been described in the same picture by just adding another layer in between gold reserves and bank liabilities. The right plot of Figure 3, on the other hand, depicts the basic hierarchy in the monetary systems of independent underdeveloped countries for the 19th century and for the most of the 20th century. Banking development and commercial development are at their elementary stages so that there is no well-established position for domestic bank liabilities (other than central bank liabilities). Nonetheless, alongside the gold reserves, bank liabilities of the financial centers also increase the elasticity of payment devices for such countries. Typically, a state bank or a central bank takes the lead in order to contribute both to the development of private markets and to the government finance, so that it naturally position its liabilities above the private debt contracts.

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[24] Usher (1934: 407) states that "[d]escriptions of the fairs in the early thirteenth century show that many of the transactions were cleared by book transfers… Loans repayable at the next fair appear in the records at the Champagne fairs as early as 1218, though the practice was not definitely established until the close of the century… In the fifteenth and sixteenth centuries such loans were made on bills of exchange, drawn in favour of the lender." Note that the use of a clearance system through book transfers, loans, bill of exchanges in Medieval fairs as early as 12th century does not change the fact the ultimate means of payment was a commodity money.

[25] Grossman (2010:28-9) states that "the modern commercial bank dates from the late eighteenth and early nineteenth centuries", which are separated from the earlier examples of banking businesses as being "wholly private institutions" and having "a corporate form organization."

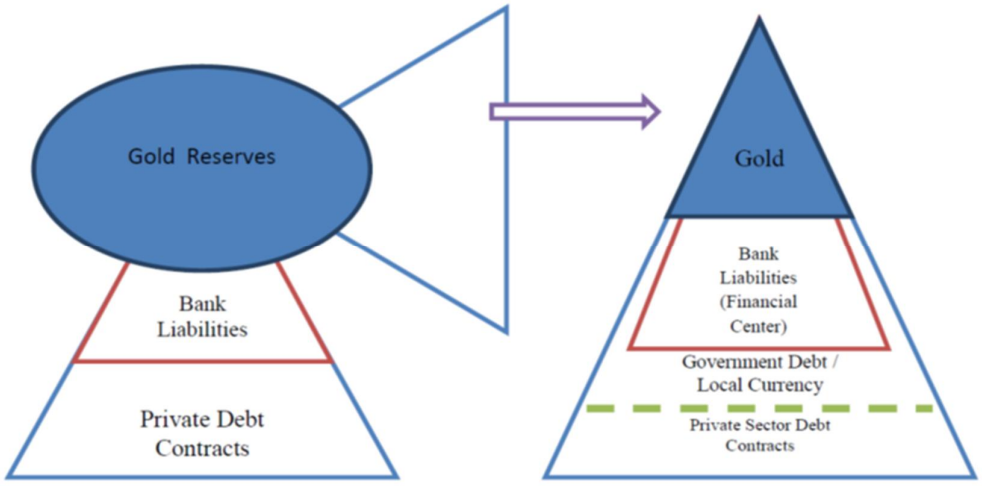

Figure 2.3 The hierarchy of money after the development of banking in today's advanced countries (19th century – the end of Bretton Woods)

Notes: The left plot describes the monetary hierarchy in advanced economies, while the right plot describes the hierarchy from the perspective of independent underdeveloped nations.

Finally, Figure 4 captures the basic features of the hierarchy in monetary systems of the modern globalization era. At this stage, precious metals serve no longer as settlement devices. Note that at the end of WWII, the bulk of the gold reserves of the planet was accumulated in the hands of the United States (US) government and the US dollar (USD), convertible to gold at a fixed price, assumed the role of main international settlement device[26]. The next quarter of a century, in effect, rendered the currency issued by the US into the world reserve currency. The globalization era after the collapse of the Bretton Woods Agreement has clinched that short-term liabilities issued by the US government can be regarded as the ultimate international reserve. The left plot of Figure 4 depicts the pyramid of the USD-based monetary system which ends up with the private debt contracts in the US and Eurodollars[27] at the bottom. On the other hand, as the right plot of Figure 4 shows, Eurodollar market, international lending provided by the US banks and the credit supplied by

[26] See Eichengreen (2011).

[27] Eurodollars refer to the USD denominated deposits held outside the US. Here, we use the term to cover all private debt contracts denominated in USD outside the US.

the US government and the Fed has ultimately sits atop of the hierarchy of money from the perspective of a developing nation. Although DC have developed their own banking systems, thanks to technological, commercial, institutional and financial developments/innovations, the modern financial globalization era has made them increasingly dependent upon the international financial markets and the hegemony of the USD-based international monetary system.

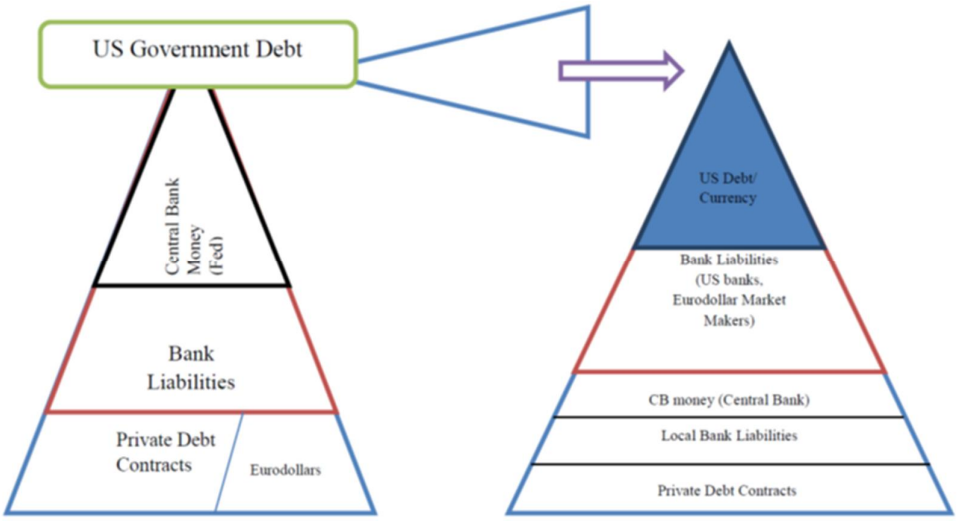

Figure 2.4 The hierarchy of money in the latest globalization era (after the end of Bretton Woods)

Notes: The left plot describes the monetary hierarchy in the US (as a representative of a financial center), while the right plot describes the hierarchy from the perspective of emerging/developing market economies.

The relevant question here is what makes the current hierarchical configuration a structural constraint for DC. The answer is related to long-term dynamics of the hierarchy, how the new layers are created and how the transformation of the hierarchy occurs. We argue that, first, the hierarchy in the monetary systems follows the hierarchy in trade, in particular, the hierarchy among traders and trading centers, and also the hierarchy among the nation states in the modern capitalism. The hierarchical positions of the liabilities are determined by the patterns and abundance of payment commitments of their issuers, thereby the amount of flow of funds into

the hands of their issuers[28]. Second, when there is a change in the configuration of the hierarchy and/or when new layers are created in the hierarchy, there should always be clash of interests between the potential winners and losers. The power struggle (political, economic and/or military forces involved) resolves the clash and the new hierarchical structure settles down in the end.

First of all, in historical context, products of the first bankers should have been useful and convenient for the private sector and/or for the government in their daily economic activity. This is a necessary condition for bank liabilities to obtain a central stage in the hierarchy[29]. Alongside the necessary property of usefulness, the liabilities issued by the first bankers should have been credible and liquid enough to obtain a higher position among other private debt contracts. The credibility and liquidity of a liability depends always on the credibility of its issuer and the abundance of economic relations and payment commitments engaged in by its issuer. Thus, the hierarchy of the liabilities should have followed from the "hierarchy in trade", a concept borrowed from Braudel (1983:376)[30] , who states that "there has

[28] The idea is close to the view of Mehrling (2000:403), who claims that the hierarchy of debt instruments reflects the pattern of payments. Mehrling (2013) argues that the hierarchy in the current international monetary system follows both the political hierarchy of states (so the state interests) and the hierarchy in the national economic development (so the private interests).

[29] Kindleberger (1984: 17) emphasizes on these advantages as a determinant for the rise of credit instruments: "The inefficiency associated with payments in specie, especially payments at a distance, led to the substitution for it of bills of exchange that could be cleared in various directions and of bank money."

[30] Braudel (1983: 376-7) exemplifies that "[i]n Europe, such inequalities became increasingly apparent after the economic revival of the eleventh century. As the Italian cities began to take part once more in the Levant trade, they witnessed the rise of a class of wealthy merchants, who quickly secured the leadership of the urban patriciates. And this tendency towards hierarchy became more pronounced during the prosperity of the following centuries. High finance could probably be described as the ultimate development in this direction. And already, by the time of the Champagne fairs, the Buonsignori of Siena were running the *Magna Tavola*, a large firm exclusively devoted to banking: they were, as Mario Chiaudano called his book about them, *the Rothschild del Duecento*, the Rothschilds of the thirteenth century…In Germany, Friedrich Lütge tells us, the distinction between wholesalers and retailers was already appearing by the fourteenth century, because of the geographical expansion of trade, the need to handle different currencies, the new division of labour (agents, factors, warehousekeepers) , and the new book-keeping made necessary by the everyday use of credit… All trading communities sooner or later produced such hierarchies, identifiable in everyday vocabulary… The difference was not simply a matter of words: there were manifest social distinctions from which men either suffered or drew comfort. At the top of the pyramid were the proud ranks of those who 'understood finance'."

probably never been a country, in any period of history, where the merchants were all on the same footing, equal to each other and interchangeable so to speak". As broadly observed by Braudel (1983: 378), at each level of the hierarchy among traders "there was always to be seen that detested but indispensable fellow-traveller, the usurer, from the great financier who lent money to the crowned heads of Europe, to the humble pawnbroker." When the origins of the private bankers are considered, there is also a close connection with trade and the hierarchy in trade (Kindleberger, 1984; Braudel, 1983)[31]. As this was true for the great centers of trade, finance and economic development, it was also the case in a smaller scale. For example, while London was improving its trading and financial activities in the 18th century to become a world leader soon, banking activities in its periphery were carried out by emerging local merchants (Grossman, 2010)[32].

As long as only lending out of the existing money stock is considered, the dominance of the wealthiest of any society in lending activities may seem obvious to anyone. The important point we emphasize about the merchant connection of banking is,

[31] Kindleberger (1984: 35), for example, states that "[t]he usual textbook view is that banking developed from goldsmiths... The story is well told, but inaccurate. Goldsmiths evolved into bankers only in the middle of the seventeenth century in England. Banking developed much earlier and was connected especially with foreign trade. Even in the eighteenth century more banks in England developed from merchants than from goldsmiths. At that stage, moreover, many other paths led to banking- industry issuing tokens to pay wages, tax farmers handling public funds, notaries (scriveners) recommending investments and then making them for others, and so on. But the merchant connection remained paramount… By 'merchant' in this connection we mean 'great merchant,' and by 'great merchant' one who deals in international trade, not a domestic wholesaler or jobber, and assuredly not a retailer." Although it is not clear whether the issue is money-lending or credit creation, Braudel (1983: 388) states that "[t]he really big lenders, those who counted, were usually men of substance, known by the end of the seventeenth century by the specific title 'capitalists'... In Genoa, the entire upper class of businessmen … was composed of financiers... Even in Amsterdam, where a lending-bank, supported by the Bank of Amsterdam, had existed since 1614, this only advanced loans for trade for a limited period. In about 1640, it became a sort of safedeposit institution, and left trade to private capital."

[32] Grossman (2010: 174) describes the development of banking in the periphery of London in following way: "[i]n the provinces, banking functions were undertaken by merchants who extended credit and bought and sold local bills of exchange… Unlike their London counterparts, provincial bankers did not face competition from the Bank of England, which had not established branches in the provinces. Although precise data are not available, it is clear that private banking expanded rapidly during the second half of the eighteenth century… The spread of country banking reflected increased demand coming from the rapid growth in commerce and industry in the industrializing North and Midlands. Growth in private banking was also encouraged by the relatively loose restrictions placed on them."

however, not about money-lending only, but about the creation of money by lending. If we define and identify banking with credit creation through expanding its balance-sheet, as Usher (1934) did, then the rise of banking activities, i.e. the creation of substitutes for commodity-money by issuing liabilities, requires, logically, the abundance of payment commitments in and out to the one that will turn out to be a banker. In Usher (1934: 399-400)'s words, "[b]anking begins only when loans are made in bank credit. This is possible only when deposits nominally payable in specie on demand can be used effectively by a system of book transfer and clearance… The deposits become a means of payment that is independent of specie to the extent that the transactions involved can be offset by book clearance without using specie… The lending of credit becomes an assured possibility as soon as a considerable number of current deposit accounts can be drawn together in one enterprise. We may therefore presume that banking begins when we are able to find separate accounting units-handling some appreciable number of current accounts." Therefore, it is not hard to predict that the most possible candidates for carrying out the banking business all over the world are great merchants, having considerable number of ties with other great merchants and with the local, small-scale trading community. The state or municipality, having engaged with various payment commitments with its citizens, are also good candidates to create their own banking facilities. At a lower-scale, local merchants, having considerable number of ties with great merchants and also with the local community are the best candidates of small-scale bankers. Yet, as Braudel (1983) clearly differentiates it, the advantageous position was belong to the great merchants, since they had also an access to the large-scale money-lending facilities of the international trade and financial centers, i.e. an access to international reserves[33].

[33] Braduel (1983: 385) states "[o]n every merchant's books, alongside the stock of goods, there regularly figured his assets (credit) and liabilities (debts). The wise trader sought to maintain a balance, but never abandoned these forms of credit which in the end amounted to a huge mass, multiplying the volume of trade by four or five. The entire commercial system depended on it. If credit arrangements broke down, the economy would grind to a halt. The important point is that this was a kind of credit inherent in the commercial system, generated by it – an internal form of credit which was interest-free… The wealthy merchant could also take advantage, and enable his clients to take advantage of this internal facility. But he had recourse fairly regularly to another form of credit, calling on the money of financiers and moneylenders outside the system. These were cash loans which

Large-scale commercial banks started to dominate the scene by replacing private bankers, and bank liabilities are established as a common means of payment in the 19th century. This development has put bank liabilities into the center of hierarchy of money in the AC. Two factors, among others, stand out as the main reasons of this development: growing scale of commercial banks and the rise of central banking. Firstly, growing scale of commercial banks have arisen from the rise of demand factors, from new regulations that allowed for the incorporation in the banking sector and operating of it with limited liability, from the existence of role-model government banks, and from the wave of mergers and acquisitions (Grossman, 2010). The establishment of bank liabilities at a central stage in the hierarchy of money is closely connected with our emphasis on the link between the hierarchy in trade (now, it is seen as a hierarchy among bankers) and the hierarchy of money. Secondly, the rise of central banking, firstly and not surprisingly in the financial center of the time, on the other hand, is characterized by the assumption of the role of the lender of last resort to the banking sector, the monopolization of note issuance and the accumulation of commodity-money reserves in the hands of these banks, and finally, the transformation of those institutions into non-profit-driven government banks (Capie et al., 1994)[34]. All these functions assumed by central banks serve to the protection of the value of the national currency and the value of banking sector liabilities, which exchange on par with the currency almost all the time, so that

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regularly carried interest – a crucial difference since a trading operation mounted on this basis had at the end of the day to show a rate of profit well above interest rates … [I]f the great merchant could regularly borrow money 'from other men's purses', calling on external credit, it must mean that his normal profit margins were very much greater than those of the ordinary run of merchants. This takes us to the crucial dividing line separating off a particular and privileged sector of the world of trade."

[34] As being a large-scale incorporated half-government half-commercial bank in its establishment and being the first bank assumed the identifiable functions of central banks, the Bank of England used its scale advantages right from its beginning and began naturally as the terminal of money reserves. Grossman (2010: 173-4) states that "[f]rom 1694 until the early nineteenth century the Bank of England was the only bank in England, note-issuing or not, with more than six partners… Although Bank of England notes were not made legal tender until 1833, due to its superior resources its notes nonetheless drove the preexisting note issues of London private bankers out of circulation soon after its establishment… [T]he private bankers accommodated themselves to the bank, as the growing use of deposits against which written orders of payment could be made gave private banks an important alternative source of funds. By the 1770s, the London private banks had established a clearinghouse to more easily clear checks. They also began to deposit spare balances with the Bank of England, viewing them as reserves, and applying to the bank for loans when they needed funds."

banking sector liabilities and the central bank liabilities have gained permanently the position they had in the hierarchy of money.

Before the rise of commercial banking and central banking in the 19th century, the earlier phases of capitalist development in Western Europe had continuously witnessed the rise and fall of great merchants/bankers and great trading centers (city-states and states) alongside with the rise and fall of wide-range use of credit as a substitute for gold[35]. This pattern has continued in the 19th and 20th centuries but with a quite visible difference. When banking development in the AC has reached to its maturity stage in the last two centuries, first, the UK, and then the US, took the lead in international finance, but now providing international credit denominated in their national currencies instead of a commodity-money. Like the connection of trade hierarchy with the hierarchy of money, the hierarchy among the nation-states, according to their economic, financial, political and military power was also followed by the acceptability of and the demand for the liabilities of those states, i.e. the hierarchy among currencies. In the context of the rise of the US dollar to the top of the hierarchy of money, Eichengreen (2011), for example, emphasizes on "the growing importance of the United States in international transactions generally" (2011:30), alongside the destruction of its rivals due to World Wars, the flow of the world reserves of gold into the US, and financial stability (compared to its rivals) that preserves the value of the currency against gold and also against the goods and services.

[35] Braudel (1983: 392) states that "[b]roadly speaking, there were three occasions in the West when there was an expansion of banking and credit so abnormal as to be visible to the naked eye: in Florence before and after 1300; in Genoa in the latter part of the sixteenth century and the first two decades of the seventeenth; and in Amsterdam in the eighteenth century. Can any conclusions be drawn from the fact that three times a well-advanced development, which appeared to be leading in the medium or the long term towards the triumph of some form of financial capitalism, was blocked in mid-career? Not until the nineteenth century would this development be completed." In the following pages, Fernand Braudel shortly describes the rise and fall of those three cities as financial centers, emphasizing on the common elements: the wide range of international trade linkages they had, and the abundance of commodity money flowed in and out the cities, and the government and war finance activities through money-lending they were involved in, which partly was responsible for the decline of those cities as leading financial centers.

When there is a change in the prevailing configuration of the hierarchy of money and/or during the process that new layers are created in the hierarchy of money, there has always been a clash of interests between the potential winners and losers. All in all, as one's liability get a higher position in the hierarchy, the issuer of those liabilities obtains a privileged position in terms of borrowing conditions. As Foley (1989:250) observes: "the issuers of liabilities of high acceptability find that agents are willing to hold them even when they pay a lower rate of return than other assets" and even "the most socially accepted liabilities pay a zero interest rate. Agents continue to hold these liabilities as their assets because of their wide acceptability as payment, and because they serve very well as a reserve against the contingency that the agent will not be able to borrow." Yet, it is not always easy to come to a stage of resolution or settlement. The clash of interests requires power struggle (political, economic and/or military) to resolve issues. Therefore, the newborn hierarchical configuration is always a reflector of that struggle. For example, in the context of the rise of commercial banking in the 19th century, Grossman (2010: 49) states that "[a]lthough strong demand was necessary for the emergence of incorporated commercial banking, purely economic factors alone were not sufficient. The timing of the process was crucially affected by political-economic factors, such as interest group pressure, ideology, and legal evolution". For the UK case, "the Bank of England used its leverage as the government's creditor to pressure it into maintaining the Bank of England's position as England's only incorporated commercial bank for more than 125 years" (Grossman, 2010: 50)[36]. The Federal Reserve's liabilities and the US Treasury bills did not also reach smoothly to the top of the current hierarchy. The position of the USD at the top of the hierarchy has always been a discomfort for the other advanced countries and its privileged position since the end of Bretton Woods Agreement has been challenged by the others from time to time (Eichengreen, 2011).

[36] The details of the power struggle are interesting as well. Grossman (2010:171-2) says that for the Bank of England, "[s]tatistical analysis of the timing of charter renewals suggests that the government offered the bank a charter renewal under two sets of circumstances: (1) when the government was fiscally strapped, it offered to extend the bank's charter in return for an additional loan; and (2) when the bank appeared to be too profitable, the government attempted to renegotiate the contract on more favorable terms."

When a new hierarchical configuration of money settled down, it became a structural constraint from the perspective of lower lever agents in trade hierarchy and in the hierarchy of nation-states so that it seems almost invariable and impossible to change. From the perspective of a household and a small- or medium-scale firm, issuing a liability that has a near-zero cost is inconceivable as long as their wealth and economic activity has remained stable. In the best case scenario, the wealthier households and large-scale firms, corporations or conglomerates may achieve to borrow with a near-zero cost, depending on the macroeconomic conjunctures, yet, each one of these agents would still see the banking liabilities as more like money than their own liabilities. Similarly, for a DC government, being a sovereign, having a national currency does not mean that it has the power to transform all their liabilities into costless papers. The hierarchical constraint for DC seems inevitable and inescapable as long as national economic development and international political position of the country lag behind the current leaders.

So far, this study laid the foundations for recognizing the credit nature of modern money and conceptualizing international monetary structure in a hierarchical manner. The next section will discuss how this may help capture the differences in the CCC of AC and DC, emphasizing on being at a lower layer in the hierarchy of national currencies requires the issuer of that currency either to hold international reserves from a higher level or to ensure a credible access to such reserves.

2.3. The implications of the hierarchy of money for credit creation in developing countries

Economic agents can be considered as a part of hierarchy, in which their ranks are depended upon their wealth and trading activity, particularly, the amount of regular payment commitments they are engaged in. Then, the hierarchy of money can be thought as a notion that abstracts the relations between liabilities of different layer economic agents. For an agent, settlement of a debt contract with an upper-level agent requires obtaining “money” from the perspective of that upper-level agent. To do this, it needs either previously accumulated reserves of that money or borrowing

from the other upper-level agents. The latter one, borrowing from an upper-level agent requires, first, providing eligible collateral, the standards of which are generally set by lenders. In any kind of promise to pay, which can be issued by a firm or a household, or a financial institution, or a central bank, the credibility of the issuer of the debt instrument always comes to the table, which is compensated by providing eligible collateral and associated haircuts and/or a premium to cover credit risk. Besides that, borrowing from an upper-level agent requires paying liquidity premium to acquire that money in order to compensate the liquidity (funding) risk taken by the creditor. Thus, if an agent engages in payment commitments with and requiring settlement devices of higher order in the hierarchy, it has to make a choice between holding reserves of that device and borrowing it.

From cost-benefit perspective, it seems that those two options, holding reserves and borrowing reserves, should have equal costs assuming that they are perfect substitutes in a "perfect" world. However, as stated earlier, the qualitative nature of the hierarchy asserts itself during the periods of financial stress and it is clear that holding up reserves compared to the option of borrowing is the safer alternative in such cases. Overall, considering any kind of borrowing entity, from the perspective of the borrower, the reserves are money instruments. Holding of such balances or guaranteeing the future flows of such balances simply enhances the credibility of the borrower, reduces the implicit costs associated with borrowing such balances and provides a safety net against deadly illiquidity problems.

Similar to economic agents, the liabilities of nation-states follow the international hierarchy among nation-states. For a DC government, bank or firm, settlement of a debt contract with another economic agent at the upper-level (and at the same level), requires obtaining reserve currencies since the bulk of cross-country transactions is denominated in those currencies, reflecting the hierarchy. For a DC agent to make a transaction with, denominated in its own national currency, there is a need for a foreign agent, willing and able to transform its own more liquid, internationally acceptable and demandable currency, which is, in effect, an international money, with a less liquid, only nationally acceptable and demandable currency. Thus, in

effect, there is a need for a foreign agent to take the exchange rate and liquidity risks associated with having a DC currency. The original sin parable vindicates that such a foreign agent does not show up in general (Eichengreen et al., 2003a; 2003b; 2007). The hierarchy of money parable, on the other hand, asserts that a national currency is the liability of a central bank and its acceptability and liquidity depends on the degree of universality of direct and indirect payment relations with that central bank. Thus, from the international market perspective, a debt instrument denominated in a DC currency is not seen, in general, as a symmetric alternative to a debt denominated in any one of reserve currencies. The asymmetry among these debt instruments is reflected in the country risk premiums, which are priced by markets at any second. Similarly, from the international market perspective, a DC currency, and DC banking sector liabilities denominated in and exchanged at par to that currency is not and cannot be a symmetric alternative to reserve currencies, i.e. to the set of international monies. In other words, a DC currency and DC banking sector liabilities are not and cannot be seen as money from the international market perspective.

The original sin literature has shown that the original sin is "a key determinant of the stability of output, the volatility of capital flows, the management of exchange rates, and the level of country credit ratings" (Eichengreen et al., 2003a:3). Since all these are among the macroeconomic factors that have impacts upon the CCC of a country and since original sin is a natural consequence of being at a lower level in the hierarchy, then, it can be concluded that the hierarchy of currencies, leading to a problem dubbed as original sin, which determines key macroeconomic variables of DC, is one of the key determinants of the CCC of DCs.

The international market perspective is not exclusively belonging to those engage in international trade and finance. Any DC citizen and firm, which would have options to choose among alternative currencies to denominate its assets and liabilities, sooner or later, will recognize the hierarchy, which is followed by loan and deposit dollarization. As for the original sin, the hierarchy of money is the underlying structural force that paves the way for financial dollarization, which is a prevalent phenomenon among developing countries and which leads to "a more unstable

demand for money, a greater propensity to suffer banking crises after a depreciation of the local currency, and slower and more volatile output growth, without significant gains in terms of domestic financial depth" (Levy-Yeyati, 2006). Again, all these are among the macro factors that have impacts upon the CCC of a country.

The existence of the hierarchy of money implies not only lesser liquidity and demand for the DC debt instruments in the international financial markets, but also the option of conversion of DC banking sector assets and liabilities into reserve currency denominated assets and liabilities. These imply that the expansion of DC banking sector balance sheets and the CCC of DC banking sector should have tightly connected with the conditions in the international and national financial markets for reserve currencies. If the international reserve currencies are relatively cheaper and ample, and/or if the risk appetite of international lenders and investors is high with respect to DC assets, then the CCC of DC banking sector would be highly likely to increase. As Rey (2013) shows, under financial openness, monetary conditions and the risk appetite in the financial centers determine the fluctuations in capital flows into the rest of the world so that there is a global financial cycle in credit growth and asset prices. In other words, the elasticity or stringency in the upper levels of the hierarchy infiltrates into the lower levels[37].

Just as banking credit availability would relax the private credit conditions and the commercial activity, increasing risk appetite and easy monetary conditions in the financial centers that provide reserve currencies would relax the constraints on the lower-level financial instruments created by commercial banks of DC and also private credit contracts. The mechanism of transmission may evolve over time, depending on the institutional structures, but the global and local banks are likely to be at the central stage at all times. Recently, Bruno and Shin (2014) modelled and

[37] From a similar perspective, De Conti et al. (2013) suggests a mechanism for the permeation of credit conditions from the upper-level: "The International Monetary System is hierarchical and the international liquidity of the peripheral currencies depends not so much on the domestic fundamentals but instead depend primarily on the expectations of international agents. Hence, the alternation of moments of higher and lower liquidity preference sets the liquidity cycles and moreover determines moments of "search for yield", with strong demand for assets in peripheral currencies, and moments of "flight to quality ", with a return to the central currencies."

provided evidence on the transmission mechanism of financial conditions in the financial centers toward other countries through leverage cycles and lending linkages between global banks (which links USD money markets to regional banks) and regional banks (which links global banks to local borrowers)[38]. Moreover, on the downside of a cycle, when tight conditions prevail in the reserve currencies, this would reflect itself in the DC money and capital markets. The whole story can be thought as an interaction of a structural constraint, the international hierarchy of money, with a macroeconomic constraint, the monetary conditions and the risk appetite in the financial centers, on the CCC of DC.

As stated before, for an agent, settlement of a debt contract with another agent at the upper-level requires obtaining "money" from the perspective of the upper-level agent. From an international economics perspective, this means that when DC agents engage in payment commitments to the rest of the world, they must have an access to reserve currencies. As being market makers between foreign currencies and the national currency, DC banks and central banks, then, have to provide uninterrupted, stabile means of access to such reserve currencies, which implies that these institutions should have stabile means of access to international reserve currencies. As stated before, the qualitative nature of the hierarchy asserts itself during the periods of financial stress and it is clear that holding up money reserves compared to the option of borrowing is the safer alternative in that case. Thus, given the hierarchy of money, financial openness naturally induces DC banking system to accumulate

[38] On the modelling side, "the leverage cycle" of the DC banking system rests on the appreciation of domestic currency and the associated improvement in net worth of DC residents. Bruno and Shin (2014:3) states that "A distinctive feature of our model is the link between local currency appreciation and loosening of financial conditions through the build-up of leverage in the banking sector. The channel is through shifts in the effective credit risk faced by banks who lend to local borrowers that may have a currency mismatch. When the local currency appreciates, local borrowers' balance sheets become stronger, resulting in lower credit risk and hence expanded bank lending capacity. In this way, currency appreciation leads to greater risk-taking by banks… In addition, given the pre-eminent role of the US dollar as the currency used to denominate debt contracts, our results shed light on why dollar appreciation constitutes a tightening of global financial conditions, and why financial crises are associated with dollar shortages." On the empirical side, Bruno and Shin (2014: 5) shows that "an appreciation of the local currency vis-à-vis the US dollar is associated with an acceleration of bank capital flows in the subsequent quarter" and both the level and change in the leverage of global banks, associated with the risk appetite in financial centers, are among the determinants of cross-border banking flows.

foreign exchange reserves. Whatever the explicit justification for accumulation of reserves and whichever incident triggered it, it has to be, because it is the only reasonable behavior given that financial openness of a DC leads to payment commitments denominated in reserve currencies.

Reserve accumulation provides various shields against the vagaries of international financial markets. It allows central banks for controlling their monetary jurisdiction and credit conditions, as much as possible, and for providing stability in the exchange rates. All these are necessary conditions for the working of domestic credit system and improving the CCC in DC. Eichengreen et al. (2003a) also refer to the accumulation of foreign exchange reserves by the central banks as an alternative to financial autarchy in order to reduce the possible negative effects of original sin, such as currency mismatch, on the aggregate balance sheet of DC. In an interesting contribution to the trilemma debate, Aizenman (2011) and Aizenman et al. (2012) claim that there might have been a changing configuration of the trilemma for DC with increasing reserve accumulation, which leads an economy to achieve a middle ground position in the trilemma, i.e. achieving financial openness, monetary autonomy and exchange rate stability at the same time.

Although there were episodes of global expansion of the CCC, arising from the easy monetary conditions in the financial centers, and although the expansion and contraction in all levels of the hierarchy of money seems synchronized many times, the hierarchy of money perspective does not imply that the expansion of credit in DC requires accommodative conditions in the financial centers. Since there are no technical limits on credit creation, the expansion of credit created by the banking sector of DC does not require any accommodative condition in the financial centers. Also, easy monetary conditions in the financial centers does not necessarily lead to improvement in CCC of DC, which depends on, among other things, domestic economic conditions. Needless to say, the amount of international reserves does not have a direct influence upon the CCC of DCs. On the other hand, the hierarchy of money perspective implies that having payment commitments in terms of reserve currencies, tight monetary conditions in the financial centers or tight conditions for

the reserve currencies in the national financial markets are a binding constraint for the CCC in DC (not binding on the actual credit, but for the credit creation capacity). For similar reasons, the amount international reserves held by the DC banking sector determines the reach of the CCC in DC (again, not of the actual levels, but of the capacity).

Figure 5 confirms that international reserves and the CCC have a strong connection in time-series dynamics for a selected set of DC. Both reserves and the local credit stock is denominated in USD terms. In order to ease the comparison, international reserves are re-scaled in these plots by the multiplication of the historical country mean of credit divided by the historical country mean of reserves, so that the fluctuations of international reserves are more pronounced. Particularly striking in these plots is the existence of a kind of correction in the CCC of some DC to remain close or below to re-scaled international reserve series. Figure 6, on the other hand, shows the convergence of credit-to-reserves ratio among the same set of DC toward constant levels after the mid-1990s, which predates the second attempt and, arguably, successful period of take-off of the CCC in the middle-income DCs in the 2000s (see Figure 1)[39].

[39] It is successful in the sense that the CCC of DC have considerably increased both with respect to GDP (Figure 1) and in terms of USD (Figure 5) without any significantly visible pattern of correction or reversal for the whole set of DC, though there is a tendency to stabilization for some of the DC during the 2010s (Figure 5). The increase in the CCC and the corresponding increase in international reserves of DC in the 2000s might have been facilitated and fed by the easy monetary conditions in the financial centers.

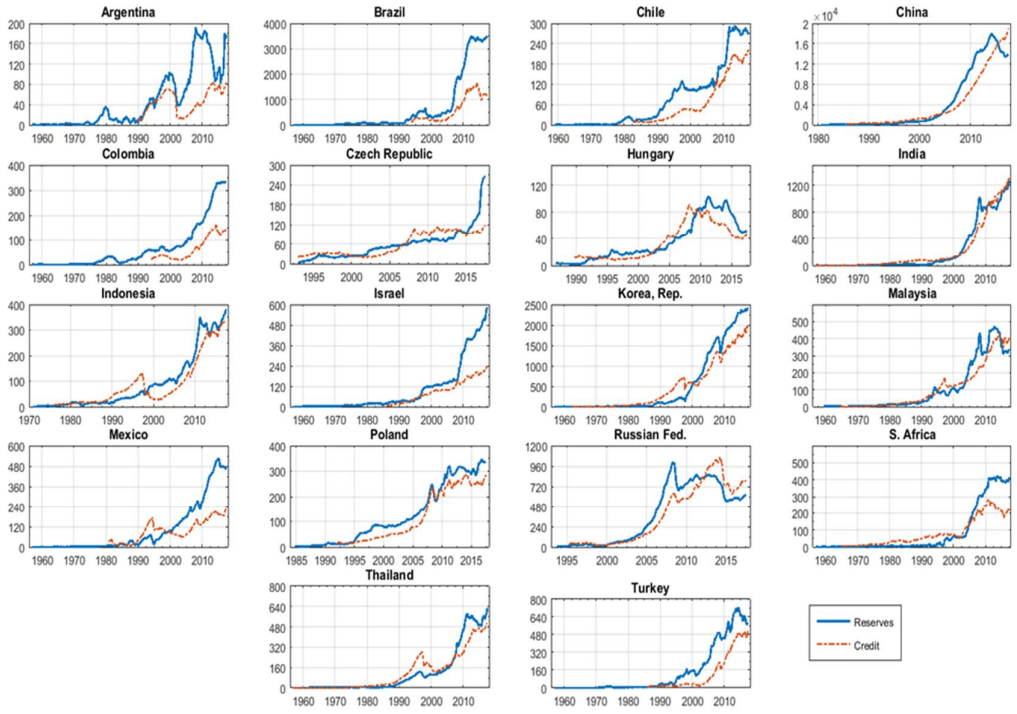

Figure 2.5 International Reserves (re-scaled) and Total Domestic Credit to Private Sector, (Billions, USD, quarterly series)

Source: International reserves: Total reserves, excluding gold, USD (IFS); Credit: Total Domestic Credit to Private Sector, USD (BIS).

Notes: International reserves are re-scaled by the multiplication of the historical mean of credit divided by the historical mean of reserves.

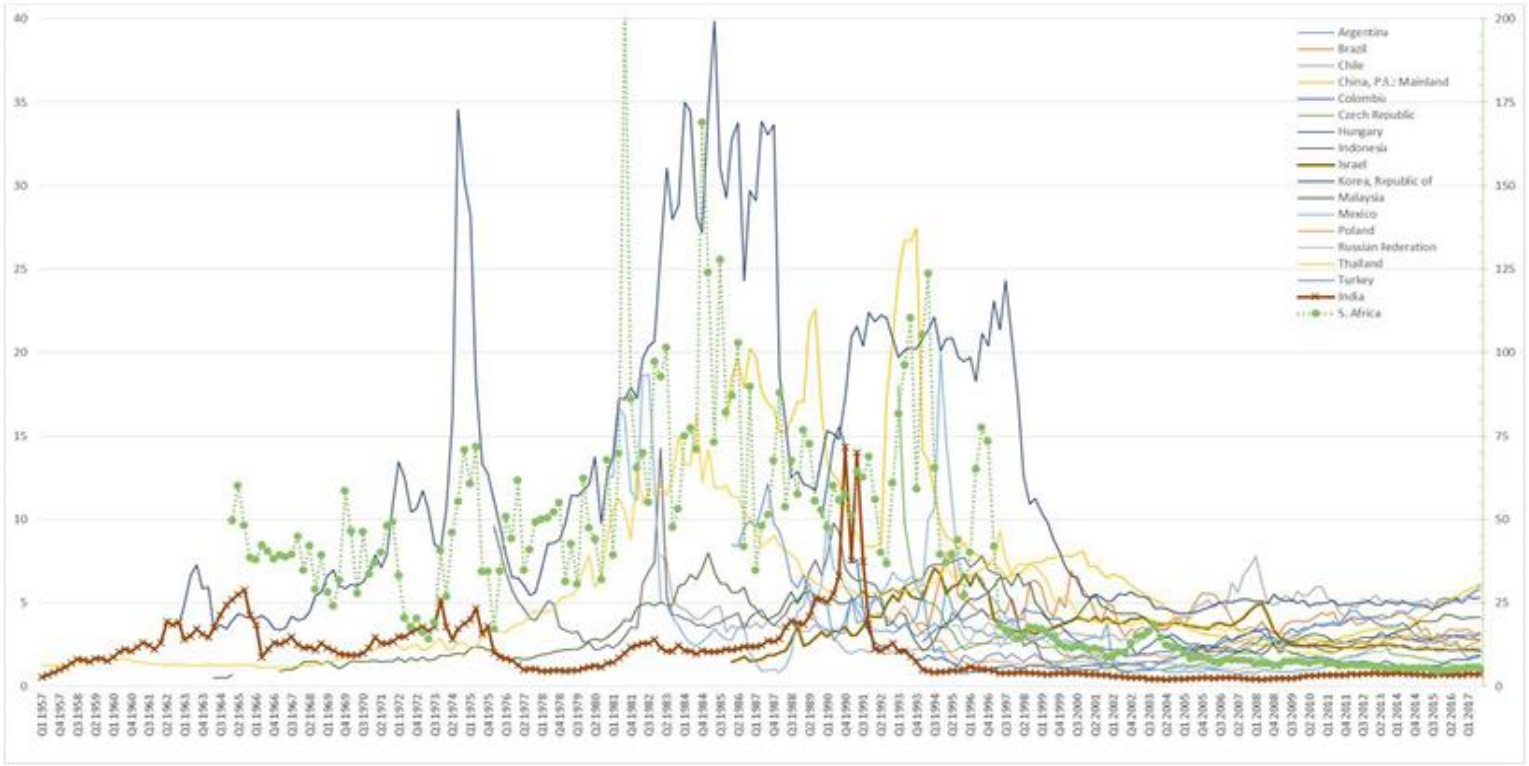

Figure 2.6 Credit to reserve ratio for a selected set of developing countries

Source: International reserves: Total reserves, excluding gold, USD (IFS); Credit: Total Domestic Credit to Private Sector, USD (BIS).

Note: South Africa and India (right axis); the rest of the countries (left axis).

Although there is a clear convergence of the credit-to-reserves ratios toward some constants in each country, as Figure 6 shows, there is no such thing as a mechanical reserve multiplier from the hierarchy of money perspective. In the extreme case, when tight financing conditions in reserve currencies prevail, the banking system in a DC may choose to hold no international reserve at all. There would still be credit creation denominated in domestic currency by commercial banks and the central bank. Suppose that the amount of outstanding credit to private sector and the corresponding domestic money and money-like instruments are in line with potential domestic economic activity. Then, any additional credit creation in domestic currency, which would supposedly disrupt the balance between monetary and real assets, is a depreciating force for domestic currency against goods and services and/or against other national currencies, since the creation of additional purchasing power leads to additional demand for goods and services and/or for foreign currencies. In a Schumpeterian sense, the additional credit may turn itself into an increase in productive capabilities, which may reduce production costs and turn out to be a profitable production process. In that case, there is a possibility that the additional credit created by banks could safely be repaid/renewed that would enhance the risk appetite of bankers to create additional credits. Moreover, this case may result in an appreciating force for domestic currency against the value of goods and services, and other currencies. Thus, the additional credit may enhance domestic economic activity so that there may arise a renewed balance between domestic monetary and real assets at a higher level. However, the additional creation of credit may turn itself into the full assault of inflationary and depreciating forces at the same time, if the additional creation of credit does not turn out to be productive, profitable, and redeemable/renewable. In this case, there is no chance for a central bank and domestic banking system to hold against the pressure of inflation and/or dollarization, other than increasing interest rates and/or providing secure access to foreign exchange. In this latter case, the CCC of the banking sector is constrained by the tight monetary conditions in reserve currencies and/or the existence of foreign exchange reserves.

The main assumption that makes the international hierarchy of money a binding constraint is the existence of open financial markets in DC. Under this assumption, the problem of DC does simply arise from the existence of payment commitments to the rest of the world, without relying on any additional assumption about portfolio and/or debt denomination preferences of domestic non-financial sector (i.e. deposit or liability dollarization). Moreover, when the payment commitments in and out to the country are netted out, a DC may be in a net creditor position against the rest of the world, however, it would still face up with the constraints imposed by the hierarchy of currencies while settling a payment commitment to the rest of the world. This implies that the hierarchy of money is a binding constraint regardless of the current account balances of DC. Also, the constraints arising from the hierarchy of money does not depend on the exchange rate regime. Although the examples below suppose a flexible exchange rate regime, this does not essentially change any significant conclusion. Finally, one should note that current account balance or exchange rate regime of the country has no relevancy for the implementation of international reserve accumulation by DC central banks and/or commercial banks under financial openness[40].

Now, let us exemplify how payment commitments of a DC makes the constraints of the hierarchy of money binding on the DC banking system. Consider that a DC resident wants to purchase goods or services from abroad, or an asset denominated in the reserve currency, USD, from a foreign agent; or wants to service a payment on its existing debt to a foreign agent. Suppose that DC resident holds DC currency (DCC) in cash, a DC Bank facilitates the settlement with the help of its correspondent foreign bank, and the foreign agent wants to be paid in USD. Figure 7 follows the balance sheets of these three agents for the following transactions among them in each step[41]. The first line shows the initial balance sheets of three agents, at which

[40] As Borio and Disyatat (2011: 11-12) aptly puts it, "the accumulation of foreign exchange reserves is generally a purely financial transaction… the oft-heard view that current account surpluses are necessary to accumulate reserves is highly misleading. It harks back to a world of tight currency controls, in which official authorities would require economic agents to surrender scarce foreign exchange to meet import demands."

[41] This example is inspired by and follows Mehrling (2013).

DC Resident owns cash in DCC –a claim against the DC central bank (CB), and the Foreigner owns goods or services or assets denominated in USD[42]. In the second line, DC resident sells DCC cash into a DC bank in exchange for a current account deposit in USD ($ depo). In the third step, transaction between the DC Resident and the Foreigner is completed so that the DC Resident obtains goods or services or assets denominated in USD, the Foreigner obtains current account deposit in USD at a Foreign Bank (FB). Since we have started with a net zero position in USD for the DC bank, it has to make its USD payment to its correspondent FB via, say, overnight borrowing. Note that the DC Bank and the Foreign Bank, in effect, create credit in the second and third steps by extending their balance sheets. The DC Bank, in effect, issues a liability in USD against the Foreign Bank in exchange for a DCC claim held against the DC central bank. The Foreign Bank, in effect, issues a USD denominated liability against the Foreigner as holding a USD claim against the DC Bank. In the final step, excess DCC reserves/cash on the asset side of the DC bank is absorbed by the DC central bank, which is assumed to sterilize any excess or deficit of DCC reserves in order to keep interbank rates stable. The first appearance of the hierarchical constraint on the DC bank reveals itself on the liability side of its balance sheet in the form of a requirement to roll over its USD liability issued against its foreign counterparty. When the Foreign Bank extends its balance sheet, it creates credit for the DC Bank, which requires a premium to be paid by the DC Bank. Say that, the claim of the Foreign Bank on the DC Bank turns itself into repeated overnight (O/N) lending to the DC bank. The final position of the DC bank shows the second constraint imposed by the hierarchy of money, which is the exchange rate risk the DC bank has to deal with. To avoid the exchange rate risk, the DC bank has to engage in a forward contract (or its equivalents via spot and swap transactions), which can be visualized as an on-balance-sheet item in the following way: the DC bank obtains a USD term deposit as an asset by issuing DCC term deposit (Mehrling, 2013). Then, the DC Bank would be able to avoid the exchange

[42] Note that DC resident does not have to have DCC Cash in its hand, it may borrow from the DC bank. This might be more realistic case, but it does not change anything significant in the story.

rate risk. However, the counterparty position to such a contract, now, takes over the exchange rate risk associated with the depreciation of DCC vis-à-vis USD.

DC Resident		**DC Bank**		**Foreigner**	
DCC Cash (CB)				Goods/ Services/ $ Assets	
$ Depo (B)		DCC Reserve/Cash (CB)	$ Depo (DC Resident)	Same as above	
Goods/ Services/ $Assets		DCC Reserve/Cash (CB)	$ O/N borrowing (FB)	$ Depo (FB)	
Same as above		DCC Domestic Assets (due to Monetary Policy)	$ O/N borrowing (FB)	Same as above	
		DCC Domestic Assets	$ O/N borrowing		
		$ Term Depo	DCC Term Depo		
		Counterparty position below			
		DCC Term Depo	$ Term Depo		
		Forward Contract			

Figure 2.7 DC citizen has payment commitment to the rest of the world

Notes: "Depo" denotes deposits. For each asset/liability, its denomination is specified as either $ or DCC, referring to a reserve currency and a developing country currency, respectively. The correspondent agents against each claim is denoted by abbreviations within the parenthesis. In this respect, CB stands for central bank; B stands for a developing country bank; FB stands for a foreign bank.

If there is no private agent to take over the exchange rate risk in the balance sheet of the DC bank, then the DC Bank would bear the burden as long as its capacity to take such risks allows for. When the realization of such payment commitments increase, however, the net short position of the DC bank in USD deteriorates, which will force the premium it pays to the Foreign Bank to increase and/or the DCC may depreciate against the USD, ceteris paribus, since the DC Bank and other market-makers in foreign exchange would not want to take so much long position in DCC against USD. In other words, search for yield via taking long position in DCC will become much riskier so that it will require higher compensation. Note that any fall in the price of domestic currency and domestic assets are not in the best interest for the DC central bank, which has a target short-term interest rate that would supposedly

influence upon the long-term rates. When things become unbearable, the DC central bank should intervene into the market to take over the exchange rate and liquidity risks.

Figure 8 shows how the DC central bank intervention affect relevant balance sheets. In the first case, the central bank may borrow from a foreign agent, which may be a foreign bank or the Federal Reserve[43]. The first line shows the credit creation in USD by the foreign bank, which lends out its own liabilities to the DC central bank. In the second step, the central bank transfers its USD deposits to the DC bank in exchange for DCC reserves, and then clear up the deficit of DCC reserves in the interbank market by purchasing domestic assets from the DC bank. The position of the DC bank now is exactly balanced with the position at the end of Figure 7, so that the DC Bank does not require USD funding anymore and carries no exchange rate risk. USD funding requirement and the exchange rate risk is transferred onto the balance sheet of the DC central bank. In the second scenario, assuming that the DC central bank had already accumulated USD reserves (shown up in the first line), it can take the same actions by reducing the holding of international reserves. Notice that, holding an adequate amount of international reserves makes the banking system of DC much more flexible and much more solid against the feedback loops. However, in effect, the DC central bank is a moneylender of the last resort in such operations, not the lender of the last resort in the reserve currency, because he does not create money but just lends out the money it holds. Also, that is why, in the international financial context, the DC central bank is below the private financial sector of ACs in the hierarchy.

[43] In practice, it is more likely that the DC government will issue Eurobonds and/or the DC central bank may engage in a swap line with the Federal Reserve, if possible.

DC Central Bank		DC Bank		Foreign Bank	
Scenario 1: Borrowing in Reserve Currency					
$ Depo (FB)	$ Term Depo (FB)			$ Term Depo (CB)	$ Depo (CB)
DCC Domestic Assets	$ Term Depo (FB)	- DCC Domestic Assets		$ Term Depo (CB)	$ Depo (B)
		$ Depo (FB)			
Scenario 2: Reducing Reserve Currency Assets					
$ Reserves [$ Depo (FB)]	DCC Reserves (B)				[$ Depo (CB)]
DCC Domestic Assets	DCC Reserves (B)	- DCC Domestic Assets			[$ Depo (B)]
		$ Reserves [$ Depo (FB)]			

Figure 2.8 Central Bank foreign exchange operations in DC

In order to see the asymmetry between making a payment to and taking a payment from the rest of the world for a DC, consider the reverse scenario, as it is described in Figure 9. Now, the foreign agent is replaced by the foreign bank, acting as an intermediary for the foreign agent. The first line shows the initial positions and the rest of the lines evaluate different scenarios after the transaction takes place. In the first case, the DC Resident (DR) may have a deposit account in the Foreign Bank (FB) and may want to hold its proceedings in that account. In the second case, the DC resident may have a deposit account only in a DC bank and may still want to hold its proceedings in USD. In this case, the DC bank expands its balance-sheet by creating a USD liability against DC resident and holding USD claim against the Foreign Bank, without having to bear any risk at all, and possibly making a profit out of this position due to interest rate differentials. In the third case, the DC resident may want to hold its proceedings in terms of its own currency, which is a common assumption in modern macroeconomics. In that case again, the DC bank expands its balance sheet, but, now, it has to take exchange rate risk associated with the appreciation of the domestic currency. In the fourth case, given the scenario 3 is realized, the DC bank may want to avoid exchange rate risk by obtaining a forward exchange contract, or its equivalent, by lending in DCC and borrowing in USD. Notice that the DC bank may want to hold international reserves by assuming the exchange rate risk, but a growing net long position in USD vis-à-vis DCC requires

the DC Bank, alongside other market-makers, to increase the price of DCC and DCC denominated assets, which may further deteriorate the position of the bank. The DC central bank is a natural candidate to take long position in USD against DCC, as the last market-maker in foreign exchange. As long as it recognizes the significance of international reserve accumulation, the DC central bank generally involves in taking up the "excess" in the market for reserve currency in such cases.

Domestic Resident		**DC Bank**		**Foreign Bank**	
Goods/ Services/ DCC Assets					$ Depo (Foreigner)
Scenario 1					
$ Depo (FB)					$ Depo (DR)
Scenario 2					
$ Depo (B)		$ Depo (FB)	$ Depo (DR)		$ Depo (B)
Scenario 3					
DCC Depo (B)		$ Depo (FB)	DCC Depo (DR)		$ Depo (B)
Scenario 4					
DCC Depo (B)		$ Depo (FB)	DCC Depo (DR)		$ Depo (B)
		DCC Term Depo	$ Term Depo		
		Corresponding Position			
		$ Term Depo	DCC Term Depo		
		Forward Contract			

Figure 2.9 DC citizen gets a payment from the rest of the world

Notes: See notes of the previous figures. Additionally, B stands for a developing country bank; DR stands for domestic resident of a DC.

The previous figures can also be interpreted from the balance of payments or financial dollarization frameworks as well. Figure 7, then, can be seen as an example of import of goods/services or gross financial outflow or a reversal in gross inflows; and Figure 9 can be seen as an example of export of goods/services or gross inflow or a reversal in gross outflows. Every DC that opens up its borders to international trade and finance, then, involves in such operations regardless of its current account balance. Also, Figure 7 (line 3-4) can be read as examples of deposit dollarization; and, Figure 9 can be read in the context of loan dollarization. As Figure 7 shows, DC faces up with the harsh constraints imposed by the hierarchy of money while validating its payment commitment to the rest of the world. From a DC perspective, as Figure 9 shows, getting a payment from the rest of world is obviously much more relaxing as long as the line of events reaches to 4th scenario in Figure 9, which is not

guaranteed in any sense. Even in the case of net exporting DC, under financial openness, there is no guarantee that the central bank and the banks of DC would not face up with a short squeeze in foreign exchange, since the hierarchy of money asserts itself as a higher demand for the upper-level financial assets.

In sum, international hierarchy of money creates binding constraints for the balance sheet expansion of the DC banking sector in the case of open financial markets. As we have shown, under financial openness, DC banking sector faces several risks to be managed due to the existence of payment commitments to the rest of the world. Given that, credit conditions in the DC are tightly connected to how these risks are managed in both good and bad times.

2.4. The implications of the international hierarchy of money for Post-Keynesian Theory in the context of credit creation capacity of developing countries

Post-Keynesian theory, compared to mainstream monetary economics, provides a much more solid and realistic foundation to discuss monetary matters. It has always urged upon "the endogeneity of money"; i.e. the creation of money is causally dependent upon the needs and demand of the economy and both commercial banks and central banks accommodate the needs of the system by granting credit. This implies that the stock of credit created by financial institutions of any country should be in line with the economic activity there, which can be measured roughly by the nominal GDP level of a country. However, this is not the case, as can be seen from Figure 1.

From the horizontalist Post-Keynesian perspective, both high-powered money and credit-money are perfectly endogenous. The short-run interest rate is exogenously set by the central bank (CB) rather than market-determined and the amount of high-powered money is totally demand-determined (Lavoie, 2014)[44] [45]. Similarly, after

[44] The clearest presentation of the Post-Keynesian monetary theory from a horizontalist perspective can be found in Lavoie (2014). Thus, I mostly rely on this work to summarize horizontalist approach.

banks set up the interest rates and the contractual terms, the amount of bank credit extended is totally demand-determined. Thus, central banks can neither directly control money supply (currency plus demand deposits) nor exert quantity constraints on the reserves of banks[46]. Also, commercial banks do only set the price and terms of borrowing, then they provide any amount of loan as long as they find a creditworthy borrower that shows up eligible collateral. These imply that neither central banks nor commercial banks do not have a direct control over the credit volume and the CCC of a country; and, there are three determinants of the credit volume in a country from the horizontalist perspective: (i) the willingness of borrowers to borrow; (ii) the amount of eligible collateral that the ultimate borrowers could show up; (iii) the willingness of the banks to assign creditworthy status; i.e. the liquidity preference of banks (Lavoie, 2014: 193). Thus, from the horizontalist perspective, "credit rationing" and "liquidity preference of banks" can be seen as the main concepts to explain the constraints on credit creation in DC. Both of these concepts refer to the level of mutual confidence among lenders and borrowers, the availability of eligible collateral, expectations with regard to economy, confidence level on those expectations and uncertainty. Arguably, these factors may explain cross-country and historical differences in the CCC of DCs, but they are not enough to account for the general low levels of CCC in DC in comparison to AC.

The international dimension of monetary issues and structural constraints arising from the international monetary architecture are barely taken into consideration in the Post-Keynesian literature. Wray (1990), to the best of our knowledge, was the first one that touched upon the impediments on the CCC of DC imposed by the

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The interested reader may also see Lavoie (1984, 1985, 2006a; 2006b), Kaldor (1970), Le Bourva (1992 [1958]), Moore (1988).

[45] Goodhart (2001) suggests differentiating "exogenous variable" and "policy-determined variable", among which the latter is much more close to what horizontalists perceive.

[46] Here, the analysis is abstracted from the direct policy tools of central banks such as setting caps on credit volume and interest rates. However, one should never forget that this is not a realistic assumption in any sense. Those direct tools of monetary policy have always been in the arsenal of central bankers, especially for the developing countries. See Buzeneca and Maino (2007) for a survey on the monetary policy implementation practices.

international hierarchy of currencies, referring to the acceptability of state debts in the international financial markets. However, he did not provide any explanation on how these two are linked. According to him, financial development that would support capital accumulation in DC requires either the development of fiat money, or trade surplus or foreign loans[47]; the last two of which provide commodity money and/or direct finance in the DC, but the last one is unsustainable. If the country wants to generate domestically generated growth depending on its own financial system, the ultimate aim should be the development of fiat money and a working credit system from this perspective. The main impediments, according to Wray, on the development of those two in DC can be summarized in two main points: (i) The presence of a highly developed financial system in the advanced countries; (ii) Banking development does not follow the same paths followed in AC[48]. The first problem, i.e. the presence of a highly developed financial system in the AC, has some critical implications, for Wray (1990). First, some AC are financial centers of the world economy, so that their own currency has a dominant role in financial relations all over the world. For DC, this implies that there exists a much more preferable currency alternative to domestic currency. Second, the very same fact implies that there exist preferable debts issued by the economic agents in AC that would be held by the agents in DC. These two obstacles are exactly the reflections of the hierarchy of money, but Wray (1990) misses the chance to elaborate on the interactions of these obstacles with the CCC of DC.

Structuralist Post-Keynesians, on the other hand, emphasize on the particular structural and institutional arrangements and their evolving nature while constructing a theory. Accordingly, monetary and macroeconomic explanations are always contingent upon the particular structure or phases of the economy (Dow, 2006; Howells, 2001; Niggle, 1991)[49]. Some structuralist Post-Keynesians have identified

[47] The same argument survives in Wray (2015).

[48] This claim is quite akin to the views expressed in the second section.

[49] Howells (2001: 140) states that the theme, "that 'good' monetary theory needs to be historically and institutionally specific, is widely held amongst post-Keynesian economists".

particular institutional characteristics that determine the stages of banking development in the UK and the US, arguing for the universality of these characteristics (Chick, 1992, 1993; Chick and Dow, 1988; Niggle, 1990, 1991). The critical and common elements in all these accounts can be summarized under four headings according to some characteristic developments in the evolution of banking, which can be considered as changing the degree of endogeneity of money in different stages so that they would have critical effects on the credit creation capacity. The first one is the acceptability of bank liabilities as a means of payment. The second one is the absence or the obsolescence of reserve requirements as a monetary control tool. The third element is the explicit or implicit commitments of central banks in stabilizing interest rates, and in general, maintaining financial stability. The fourth one is the rise of some of critical financial innovations, such as interbank market or liability management techniques/instruments as a response to constraints posed by reserve requirements and other regulations on the banking system.

Although some of these elements can be considered as universal characteristics that improves the CCC, adapting those stages to DC is nearly impossible because of highly complicated development process of the banking systems in DC in the 20th and 21st century, which has been influenced by the financial developments and innovations in the advanced countries and also by the changes in the international monetary system. Nonetheless, the four characteristics, which has been thought as separating the stages of banking development and significantly changing the endogeneity of money, thereby the CCC, needs to be re-assessed within our framework. First, already mentioned, the acceptability of bank liabilities as money in the early stages of capitalist development in AC is a key to understand the current international monetary structure. Some of those surviving early banks have either become international bankers or turned into a central bank, whereas the banks established in DC have been more likely to serve as the credit supplier of a group of

privileged firms or of the government for a long period of time[50]. Thus, being the bankers of a late capitalist society, the DC banking system has doomed to get a lower position in the international hierarchy and to endure the costs associated with that position. This means that the acceptability of bank liabilities as money in DC occurred in a different context, in which AC banks dominated international finance and payment arrangements, and the AC banking system liabilities were solid alternatives to store wealth.

Second, the reserve requirements and the associated money multiplier story have never been valid for any country and any time, since the banking business has always been all about credit creation, not about the transference or lending out of reserve money[51]. Therefore, reserve requirements as a monetary control tool are a kind of oxymoron, though it may help monetary policy implementation and the central banks to achieve their target rates (implicit or explicit) of interest[52]. In that sense, there is no place for reserve requirements (the existence or absence) to explain the CCC of both AC and DC. Similarly, the third element, pointed out by structuralist Post-Keynesians, in the banking development has also problems from our perspective. It is true that when central banks assume the role of the lender of the last resort, it would help stabilizing money markets and the payment system. This is considered as a key for the endogeneity of money, which is a fundamental argument for the Post-Keynesian theory[53]. In general, modern central banks in DC have explicitly assumed that role, yet, this does not mean that they are capable of doing this, since domestic money markets and payment system do not only consists of the local-currency

[50] For example, in Turkish case, see Altunbas et al. (2009) for the ownership structure and development of Turkish banking; and see Ozturk (2008) for the close connections of large privately-owned commercial banks with the first domestic conglomerates/holdings of Turkey.

[51] Usher (1934) delves into the late Mediaeval Age and searches for exactly such kind of institutions in order to detect the origins of banking. As Minsky (1986: 256) puts it "[b]anking is not money lending … The fundamental banking activity is accepting, that is, guaranteeing that some party is creditworthy."

[52] See Bindseil (2004a, 2004b).

[53] This is so not only for structuralist Post-Keynesians, but also for all Post-Keynesians. See Lavoie (2014).

denominated debts and settlement instruments, but also foreign-currency denominated ones. As already explained above, this is where the position in the international hierarchy matters. The advanced country central banks are less prone to deal with foreign exchange since the private dealers in foreign exchange markets have the capability of doing so by having large balance-sheets, by having large US counterparties or branches and by issuing more acceptable liabilities compared to the ones existed in the DC. On the other hand, DC central banks often has to undertake the role of market-making in foreign exchange markets, which necessarily requires holding a huge amount of foreign exchange reserves or a sound mechanisms of access to borrow those reserves. In a nutshell, assuming the lender of the last resort in a DC may certainly improve the CCC, as Post-Keynesians argue, but it requires building up or access to international reserves for a DC.

As to the fourth element in the banking development story, no one can deny that financial innovations, the establishment of clearing arrangements among banks, liability and asset management techniques improve the CCC by economizing on cost items. The important question here: which innovations are critical for the development of CCC in DC? Though a deeper investigation is required to answer for such a question, we expect that those innovations that improve the availability and accessibility of international reserves should have played a key role in upgrading the CCC, as it is shown in the previous section.

In sum, most of the Post-Keynesians assume that apart from some cyclical impediments and/or institutional underdevelopment, there is no reason to be any difference of CCC between AC and DC. Moreover, the Post-Keynesian theory implies that any country with a sound financial system should be able to finance its growth and development process without bearing the burden of external debt and being dependent upon the flows of foreign finance. Both of these ideas do not seem realistic in the modern world of finance. Some of DC have already overcome main institutional problems, but they have not accomplished to reach the levels of CCC of AC and to save themselves from being dependent on USD dominance. The obvious demonstration of such a dependence is the accumulation of foreign currency reserves

by the central banks of DC with the purpose of shielding the country against extravagancies of international financial markets and stabilizing the exchange rates and money markets. In that sense, Post-Keynesian theory of endogenous money needs to be re-assessed by taking into account the international monetary hierarchy and its effects on credit creation.

2.5. Concluding remarks

Overall, we argue that conceptualizing national monetary systems and their interactions within a hierarchy provides a good starting point to capture the main differences in the credit creation capacity of developing countries and advanced countries. Post-Keynesian theory of money may well work on after embracing that conceptualization and its implications. Although domestic currency is at the top of the hierarchy of money from a closed economy perspective, this does not have to be so from an international viewpoint. Developing country currencies are at the bottom of the international hierarchy of currencies, so that developing country governments and/or central banks have to confront with the associated challenges forced by issuing a liability at such a position. We argue that demand for the liabilities of such institutions will always be less compared to the liabilities of higher-level institutions in the hierarchy since the credibility, liquidity and safety of those higher level liabilities are higher. Also, being in such a position requires either holding money reserves from a higher level or having a credible access to such reserves. This will increase the credibility, liquidity and safety of the liabilities supplied by developing country financial institutions, which necessarily improves the credit creation capacity of them.

As discussed, the evolution of the international and national hierarchy of money shows that creating new layers in the hierarchy and keeping a position in there requires a power struggle with the existing forces that keep up a position in the hierarchy and accumulating/holding of money reserves issued by an upper level agent. This, first, implies that for a developing country to reduce its dependency on the international credit system and to economize on keeping its financial system

intact, it requires increasing the economic and political power in the international arena, which is easier said than done. The other implication for a developing country is a double-edged knife, which is: keep going on accumulating USD reserve assets which will make your own liabilities and the liabilities that you are backing-up much more solid and desirable. This obviously does not end up with a better position in the hierarchy, but help protecting the position in the hierarchy, since the object of accumulation, reserve assets, is a liability of some another country. That is why we described the international hierarchy of money as structural force acting upon the credit creation capacity of developing countries, which cannot be altered by a single developing country easily.

CHAPTER 3

TIME-SPECIFIC AND COUNTRY-GROUP CHARACTERISTICS OF CREDIT BOOMS: WITH A NOVEL METHOD FOR CREDIT BOOM IDENTIFICATION

Understanding credit booms has a critical importance for policymakers, given that there is a connection between credit booms and financial crises followed by debt overhang. Various methods have been offered in order to identify credit booms and their origins date back to the late 1990s, shortly after a catastrophic episode of financial crises in the emerging market economies (EMEs) (see e.g. Gourinchas et al., 2001). After the global financial crisis, the practical purpose of ex ante or contemporaneous identification of booms has seemingly attracted a new wave of researchers into the area. In 2010, the Basel Committee suggested the use of private sector "credit-to-GDP gap", a measure of credit booms, as a guide for determining the amount of counter-cyclical capital buffers (BCBS, 2010). Recently, the Bank for International Settlements (BIS) has started to publish and update a database that exhibits the quarterly series of credit-to-GDP gaps for 43 countries, which is supposed to provide an early warning signal for excessive credit growth episodes.

The majority of the literature on credit boom identification is related to the early warning indicators. Given that, the appropriate strategy is to develop a method that uses only up-to-date information available to a researcher in order to improve forecasting performance for possible financial stress episodes. On the other hand, this paper mainly concerns with a more comprehensive analysis of historical and country-group dynamics of credit booms. Such analysis, arguably, complements and

forms a basis for those studies that focus primarily on predictive performance. In this respect, the appropriate strategy for our purpose is to develop a method that uses all historical information available.

In general, there are two main approaches, and various methods, to identify credit booms. These two approaches can be labeled as (i) “fundamentals approach”, and (ii) “statistical approach” (or “threshold approach”). The latter one will be the basis of this study. The general idea behind it is simple: detrend the time series of a credit variable and define credit boom as an excessive deviation of the remaining cyclical component from its “normal” levels according to a predetermined level of threshold. Thanks to Montiel (2000) and Mendoza and Terrones (2004), the literature paid a greater attention to country-specific dynamics of credit cycles, and thus, it is almost a common practice to use country-specific thresholds in credit boom identification. However, time-specific dynamics of credit cycles have got almost no attention so far. Indeed, the cyclical component of a credit variable does not need to exhibit fluctuations of the same size over time. If the variance of the cyclical component changes significantly over time, then we need to adjust the threshold choice for any country over time, just as we adjust the threshold for different countries. To solve this problem, this study offers a recursive application of Mendoza and Terrones’ method and it, indeed, shows that the variance of the cyclical component of credit variables increases over time (see Figure 6). The standard deviation of the cyclical component of real credit per capita grows by 2-3 percentage points for the median country between 1980 and the 2000s, which implies larger deviations of the actual credit series from their trend components for the most recent periods.

Alongside its methodological contribution, this paper employs this novel method for a large sample of advanced and developing countries (148 countries, 1950-2016) in order to analyze the characteristics of credit booms in the historical and country-group dimensions. In order to calibrate parameters for threshold coefficient and smoothing parameter of Hodrick-Prescott (HP) filter, we use a signal extraction analysis, following Kaminsky and Reinhart (1999) and Drehmann et al. (2010), for credit booms and banking crises. This preliminary analysis reveals that low and

lower-middle income countries have higher missed-crisis and noise-to-signal ratios, which implies that credit booms and banking crises were not synchronized and possibly driven by different factors for low income developing countries.

After the calibration of parameters, our analysis shows that, contrary to expectations, the frequency of credit booms per observation does not seem to increase over time since the 1950s[54]. Even if credit booms did not increase in number, their impact on the economy might have been higher in the most recent periods, since there is an increasing trend in the deviations of credit from its trend at around credit boom peaks. In addition, we show that since the 1970s, there exist more recognizable centers for the international clusters of credit booms, reflecting financial integration and globalization trends and implying that global factors that drive credit booms might have far overweighed local drivers of credit booms as financial integration has prevailed. Secondly, we find that there are differences among country groups in terms of the evolution of credit booms around credit boom peaks. The higher the credit-to-GDP ratios, the more likely the credit booms to emerge out even for smaller deviations of actual credit from the trend, since high credit-to-GDP ratio countries experience smoother cyclical fluctuations of credit and, thereby, they have lower levels of thresholds for a credit boom to emerge out. In addition, for the high income and high credit-to-GDP groups, there is more similarity among credit booms experienced by different countries, which implies that the cyclical behavior of credit is more pronounced in advanced countries. Finally, our analysis confirms a common finding that most of the banking crises (60 percent, in our baseline experiment) have been preceded by credit booms. However, our baseline analysis shows that only one-fifth of credit booms has been followed by a banking crisis[55]. We compare the characteristics of credit booms followed by banking crises with those that are not followed by any crisis. This yields that credit booms followed by a banking crisis reach to much higher deviation levels (ranging from 1.5 to 2 times of the deviations

[54] This result is basically driven by our methodological choice that favors the identification of credit booms within the standards of their time.

[55] Note that the exact figures highly depend on the selection of threshold coefficients. See below.

in credit booms that do not end up with any crisis) at around boom peaks and they are more likely to end up with significant negative deviations from the trend in many cases.

The structure of this essay is as follows. A detailed review of the methods used to identify credit booms is provided in the next section. Second section introduces the methodological innovation of this article, which is the use of a recursive version of full-sample Hodrick-Prescott (HP) filter in order to obtain credit booms by taking into account time-specific aspects of credit cycles. We show the advantages of our method and show that the variance of the cyclical component of credit aggregates have been increased over time for a large set of countries. Third section introduces the data set used. The fourth section starts with the implementation of a signal extraction analysis for credit booms and banking crises in order to select appropriate parameters and, then, presents our findings about country-group and time-specific characteristics of credit booms, as well as the relationship between credit booms and banking crises. Final section concludes.

3.1. A review of the methods for the identification of credit booms

Different methods to identify credit booms can be grouped under two approaches, which will be called as "fundamentals approach" and "statistical approach" in this study. In general, whereas the "fundamentals approach" rely on a multivariate equilibrium analysis, the "statistical approach" relies on a univariate statistical analysis. The former rests on the idea that a healthy period of credit growth should be in line with the "fundamentals" of the economy, represented by a number of macroeconomic and institutional variables. Any significant positive discrepancy of the credit variable from the levels that these fundamentals of the economy imply can be labeled as a credit boom (e.g., Cottarelli et al., 2005; Kiss et al., 2006). Accordingly, this method requires the estimation of parameters that link the fundamentals to a credit variable. The estimated parameters are then used to determine the "equilibrium" level of credit for a country (or a set of countries) in

order to determine whether the actual level of the credit variable is in line with the model-implied "equilibrium", or not.

The statistical approach, on the other hand, uses mainly univariate statistical properties of a credit variable in order to identify credit booms. The basic statistical method to identify credit booms was to set arbitrary (or performance-based) threshold levels for the growth rate of credit. For example, Hernandez and Landerretche (2002) define the year *t* as a lending boom period if the growth rate of bank credit is at least *x* times the growth rate of GDP at time t and $t + 1$, where $x > 1$. As employing this criterion, different levels of lending booms are considered by choosing different values of *x*, such as 1.2, 1.4, … 2. Tornell and Westermann (2002) use another strategy and define lending boom as a period that starts at time t if the real credit stock (bank credit to private sector) grows by more than 10 percent or more during the time t and $t + 1$. The threshold growth rate is varied to 20 or 30 percent for the sake of robust analysis. This method is used in identifying capital flow bonanzas as well (see e.g Reinhart and Reinhart (2008) for a highly cited example). Although no one argues that utilizing credit growth rates as thresholds is the best way for identifying credit booms, this method can provide a benchmark for other methods. Moreover, some studies use credit growth rates or credit-to-GDP levels as an additional criterion among the set of others that constitute thresholds (e.g. Barajas et al, 2007; Cardarelli et al., 2010).

The employment of more complicated methods starts with Gourinchas, Valdes and Landerretche [GVL] (2001), who detrended the credit series using rolling, backward-looking HP filter and applied a universal threshold level for the remaining cyclical component to identify credit booms. A similar approach had already been employed by Montiel (1998, 2000) in the context of identifying consumption booms. In those studies, the author employed a time-series regression for each country in order to disaggregate the cyclical component from a deterministic trend (determined mainly by the time trend, structural shifts and breaks). When the cyclical component was obtained, a threshold level, which is dependent on the standard deviation of the cyclical component was set to identify booms. Later on, the method of Montiel

(2000) was adapted by Mendoza and Terrones [MT] (2004) to identify credit booms, who employ full-sample HP filter to disaggregate the trend of the credit variable and favor the use of country-specific thresholds as in Montiel (2000).

In sum, this part of the statistical approach to identify credit booms can be explained in two steps: (i) detrending and (ii) setting a threshold to cyclical component. This approach was extensively used with minor changes and it basically relies on the idea that due to gradual or rapid financial deepening, the credit series have a tendency to follow an upward-sloping trend. The remaining cyclical component, on the other hand, represents the cyclical movements of the credit series, in which the extreme positive deviations from the trend that exceed a threshold are identified as credit boom episodes.

Typical detrending strategy of this literature is to apply HP filter to credit series. HP filter solves the following minimization problem in order to extract the trend component:

$$\min_{\{\tau_t\}_{t=-1}^{T}} \left\{ \sum_{t=1}^{T} (y_t - \tau_t)^2 \; + \; \lambda \sum_{t=1}^{T} (\tau_t - 2\tau_{t-1} + \tau_{t-2})^2 \right\}$$

where $\{y_t\}_{t=1}^{T}$ is the observed time series, $\{\tau_t\}_{t=-1}^{T}$ represents the trend component that will be estimated and λ is the smoothing parameter that penalizes variations in the estimated trend component. Typically, the smoothing parameter is chosen as 1600 for a quarterly series, "based on the prior belief that a large change in the cyclical component within a quarter would be around 5%, whereas a large change in the trend component would be around (1/8)%, suggesting a choice of $\lambda = {\sigma_c^2}/{\sigma_v^2} = (\frac{5}{1/8})^2 = 1600$" (Hamilton, 2017), following Hodrick and Prescott (1997) in the empirical macroeconomic research[56].

[56] Ravn and Uhlig (2002) provides rules of thumb for correcting the choice of λ at other frequencies. Drehmann et al. (2010) show how the smoothing parameter should be adjusted according to the duration of credit cycles.

GVL (2001) and many followers favored the use of backward-looking HP filter as a detrending strategy since it uses only the latest available information when disaggregating the trend component. This choice concerns more about policymaking processes than historical or theoretical analysis of credit booms. After identifying credit booms, GVL (2001) analyzed the associations of credit booms with macroeconomic variables and financial instability episodes. Borio and Lowe (2002), Hilbers et al. (2005) and Ottens et al. (2005) adopted GVL method to make similar analyses in different contexts.

The use of universal thresholds, on the other hand, by GVL method has been criticized by many researchers, since it does not take into account country-specific dynamics of credit cycles. As noticed by Hilbers et al. (2005), for example, due to this threshold strategy, the identification of credit booms depends on the entire data set at hand and tends to crowd out some of the well-known credit boom episodes. To overcome these issues, the followers of GVL detrending strategy preferred to use country-specific thresholds as in Montiel (2000) and MT (2004). For example, Barajas, et al. (2007) employed GVL method by defining credit booms according to the following two conditions: (i) The deviation of credit-to-GDP from the trend is greater than 1.5 times its historical country-specific standard deviation and the annual growth rate of the BCPS ratio exceeds 10 percent; and (ii) the annual growth rate of the BCPS ratio exceeds 20 percent.

The BIS has also used one-sided HP filter and started publishing credit-to-GDP gap series since September 2016. Since the database aims at providing information for policymaking purposes, it uses backward-looking HP filter by eliminating the first ten years of observations in order to construct the trend, justified by eliminating the "start-point problem" in detrending (Drehmann et al., 2016). GVL method has particularly been improved by the BIS researchers in order to foresee the build-up of financial distress and to offer universal rules for employing countercyclical capital buffers in the banking sector (BCBS, 2010). Relying on extensive research, the BIS researchers find that credit booms, identified by credit-to-GDP gaps, "are probably the best single-variable leading indicator of banking distress" (Drehmann et al.,

2010:9; see also, Drehmann et al., 2011; Drehmann and Tsatsaronis, 2014)[57]. Concerning the criticism that credit-to-GDP gaps are not based on macroeconomic models, Drehmann et al. (2010) shows that, for the US, credit-to-GDP gaps have a better performance compared to a model-based measure of credit booms, identified as deviations from long-run equilibrium value of credit-to-GDP (derived from a Vector Error Correction Model). In addition, detrending via HP filter provides a simple and transparent way of measuring credit booms compared to highly complicated, black-box model-based measures. Instead of moving-average or deterministic time trends, HP-filter is preferred because of its superiority in handling with structural breaks (BCBS, 2010:13). The preference toward one-sided filter is relied on concerns about proactive management of credit booms. Despite the criticism that with the unfolding of history, the estimated trend by one-sided HP-filter would require substantial changes as it is compared to two-sided (full-sample) HP-filter (Edge and Meisenzahl, 2011), the BIS researchers emphasize on the importance of real-time information for policymakers and also on the importance of well-documented leading indicator performance of credit-to-GDP gaps derived from one-sided HP-filter (Drehmann et al., 2011; Drehmann and Tsatsaronis, 2014)[58]. Additionally, instead of using a standard lambda (HP smoothing parameter), set at 1600 for quarterly data, the BIS researchers set the lambda at a very high level, 400.000, relying on the idea that the smoothing parameter should reflect the duration

[57] The BIS research shows that the variables that combines the information from credit booms and asset prices are better as a leading indicator of financial stress, but the data availability for asset prices is considered as a major constraint for a universal analysis (Borio and Lowe, 2002; Drehmann et al. 2010). Moreover, Drehmann (2013) shows that total credit provided to private non-financial sector, which includes international lending alongside the usual measure of bank credit, i.e. credit provided to the non-financial private sector by domestic depositary institutions, is much more informative than bank credit alone about the build-up of credit booms and upcoming financial distress. The database for credit-to-GDP gaps updated by the BIS provides information on both total and bank credit. In a detailed analysis, Drehmann and Tsatsaronis (2014:61) shows that "among those considered, the credit-to-GDP gap is statistically the best single EWI [early warning indicator] for forecast horizons between five and two years. At shorter horizons, the best single indicator is the DSR [debt-to-service ratio]. The other indicators have an inferior performance to these two and often fail to satisfy the stability property."

[58] Note that Drehmann et al. (2011) and Drehmann and Tsatsaronis (2014) compare the performance of one-sided and two-sided HP-filters. In fact, their results give mixed signals depending on the data set chosen. The important point to emphasize for our purpose is that although one-sided filter is the reasonable option for policymakers and it may have quite sufficient performance as an early warning indicator, two-sided HP-filter is the correct choice for theoretical purposes, as discussed below.

of cycle, relying on the observation that credit cycles should have been 3-4 times longer than business cycles[59] and finding that the lambda set at 400.000 for credit-to-GDP performs better in signal extraction analysis among other alternatives (Drehmann et al., 2010).

Recently, Hamilton (2017) criticized the widespread use of HP filter in detrending macroeconomic variables by demonstrating that HP filter yields spurious dynamics that are not resulting from the underlying data generating process. Instead, he suggests the use of linear regressions (projections) as detrending method by regressing the value of the variable at $t + h$ on its four values at $[t - 3, t]$ and taking out the residual as the cyclical component. On the other hand, Drehmann and Yetman (2018) argue that since there is no clear theoretical base to identify credit booms, all that matters is the empirical success of any suggested method for credit boom identification. Comparing the various alternatives, they show that all those alternative proposed credit gap measures are not able to outperform the baseline measure derived from one-sided HP filter.

Mendoza and Terrones (2004; 2008; 2012) employ two-sided HP filter and strictly opt for the use of country-specific thresholds instead of universal thresholds and present the latter as a key feature of their method (MT, 2008). The case for country-specific threshold rests on the idea that financial development is a country- and a path-dependent process, and each country's cyclical variability of credit may differ from each other. According to the MT method, for a period to be defined as a credit boom, the deviation of the actual value of the credit variable from its HP-filtered trend is greater than 1.75 or 1.65 standard deviation of the cyclical component for at least 1 year. Assuming that the cyclical component of the credit variable follows a normal distribution, the choice of threshold coefficient as 1.75 or 1.65 implies that a credit boom is specified as belonging to the upper 4 percent or upper 5 percent tail of the distribution of the cyclical component. MT method is applied for the analysis of the association of credit booms with macroeconomic variables, the determinants of

[59] See Borio (2012) and Drehmann et al. (2012) on financial cycles.

credit booms and the consequences of credit booms by many, such as Sa (2006), Elekdag and Wu (2011) and Calderon and Kubota (2012).

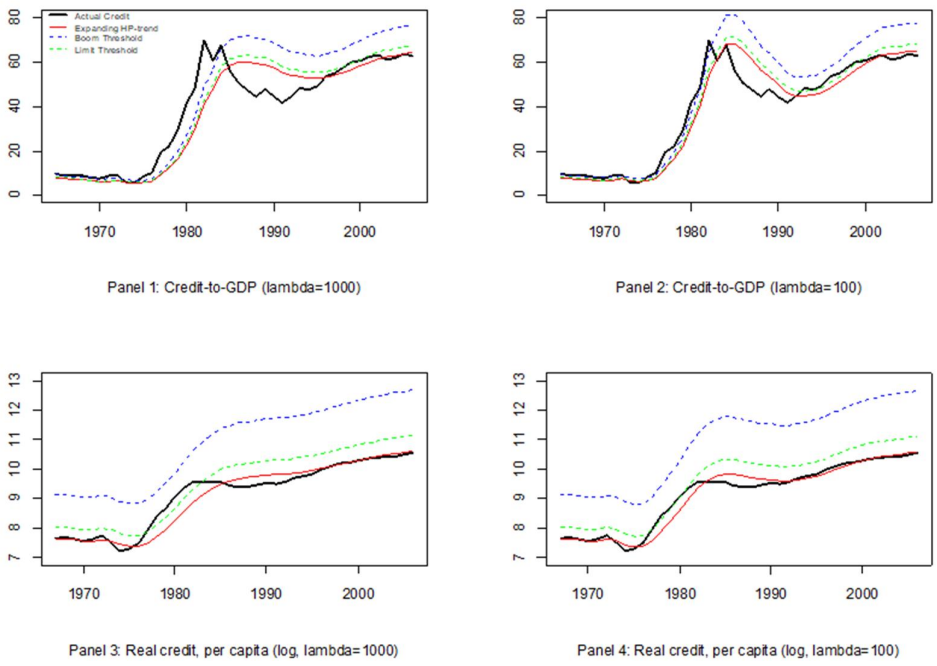


Figure 3.1 Credit booms in Chile identified by GVL method

Source: Source: IFS, WDI; UN; Author's calculations; MT (2008) and GVL (2001).

Notes: Real credit is defined as in MT (2008). Credit-to-GDP is defined as the simple ratio of credit aggregate and GDP at time t. As in GVL (2001), for the boom threshold, 19.5 percent relative deviation criterion is used and for the limit threshold, 5 percent relative deviation criterion is used.

How does the choice of detrending and threshold strategy affect the results? Figure 1 and Figure 2 replicate the comparisons of MT (2008), which applies both GVL and MT methods for the Chilean data. Figure 1 documents the results for GVL method, while Figure 2 does the same for MT method. The first panels of both figures exhibit the results of baseline detrending and threshold strategies of GVL and MT methods, while the others exhibit how baseline results change when smoothing parameter of HP filter is changed (Panel 2), when the main variable is changed (Panel 3) and when both smoothing parameter and the main variable are changed (panel 4). The

striking result of this exercise is the higher sensitivity of GVL method to the smoothing parameter and variable choices in detecting credit booms and their durations.

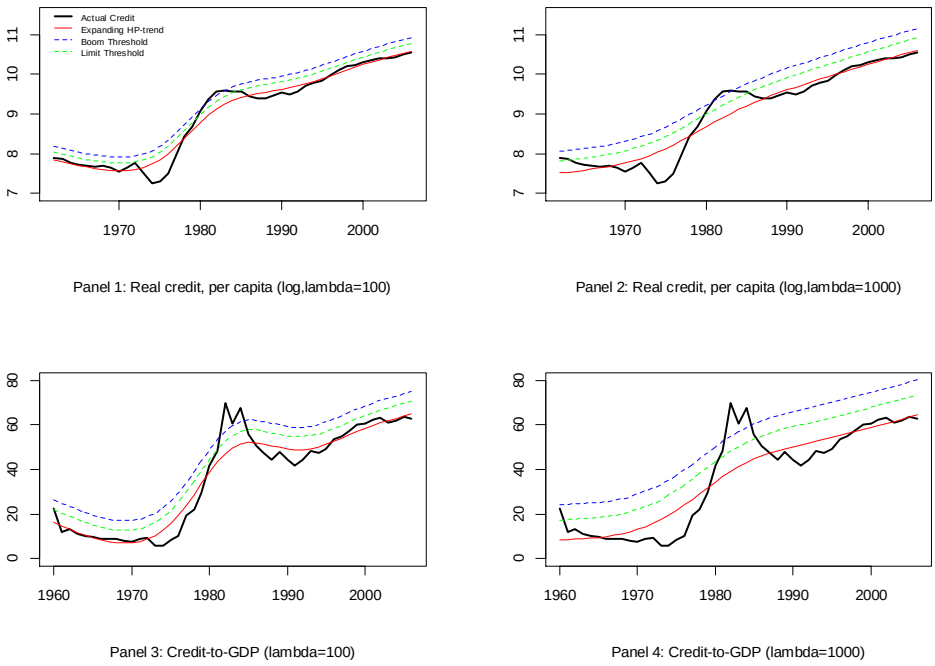


Figure 3.2 Credit booms in Chile identified by MT method

Source: Source: IFS, WDI; UN; Author's calculations; MT (2008) and GVL (2001).

Notes: Real credit is defined as in MT (2008). Credit-to-GDP is defined as the simple ratio of credit aggregate and GDP at time t. As in MT (2008), the boom threshold is set at 1.75 standard deviation of the cyclical component of the credit variables and the limit threshold is set at 1 standard deviation.

As Mendoza and Terrones (2008) aptly put it, the main problem with one-sided HP filter is that it generates a trend component that resembles to a smoothed, lagged transformation of the original series. One may observe that the trend estimated by GVL method has a persistence at turning points, but it accommodates very early and rapidly to actual credit-to-GDP values while they are drifting upward or downward rapidly, following the lead of actual values. This implies that, with GVL method,

credit observations for the recent past will be added to the trend component although they might be due to excessive fluctuations. In addition, long-term secular rise of credit-to-GDP, which may rely on a sound institutional development in a country, may show up as a credit boom due to the follower property of the trend estimated by GVL method[60]. These features make GVL detrending strategy very ineffective in historical or theoretical analysis.

Figure 3 shows intuitively how using one-sided HP-filter will not be a good representation of the trend of a credit series. The thin black line in the figure is the actual credit-to-GDP series of Thailand from 1960 to 2015, while the thick gray line is the full-sample HP-filtered trend, as in MT method. Those dashed/dotted fringes in the figure, on the other hand, are HP-filtered trends for all different periods: 1960-1975, 1960-1976, … and 1960-2014, as in MT method. GVL method uses only the last point from those dashed/dotted trends calculated for each year and, indeed, an imaginary one-sided HP-filter can be visualized by linking the end-points of dashed/dotted lines. As can be seen from the figure, the last five or six years of trends constructed for a part of the sample tend to follow closely the actual series. This is particularly striking for the trend series ending around 2000, in which 1997 is identified as a credit boom year in many studies. Though GVL method may also identify the credit boom at around 1997, it clearly exhibits much less deviation from the "optimal"[61] full-sample trend. All in all, one-sided HP-filter may significantly distort the characterization of the credit boom episodes and will not be helpful in an historical analysis of credit booms (MT, 2008).

[60] An example of this might be Turkish case in the 2000s. Turkey experienced a severe banking crisis in 2001. After a restructuring in the banking sector, a long-term secular rise of credit-to-GDP has been observed. When GVL method is used, depending on the threshold set, Turkey seems to experience a credit boom in 2000s, which is quite a controversial argument (see Figure 4 below).

[61] Mise et al. (2005) argues that HP-filter is an optimal component estimator for the mid-sample, but it is suboptimal at end-points of the sample.

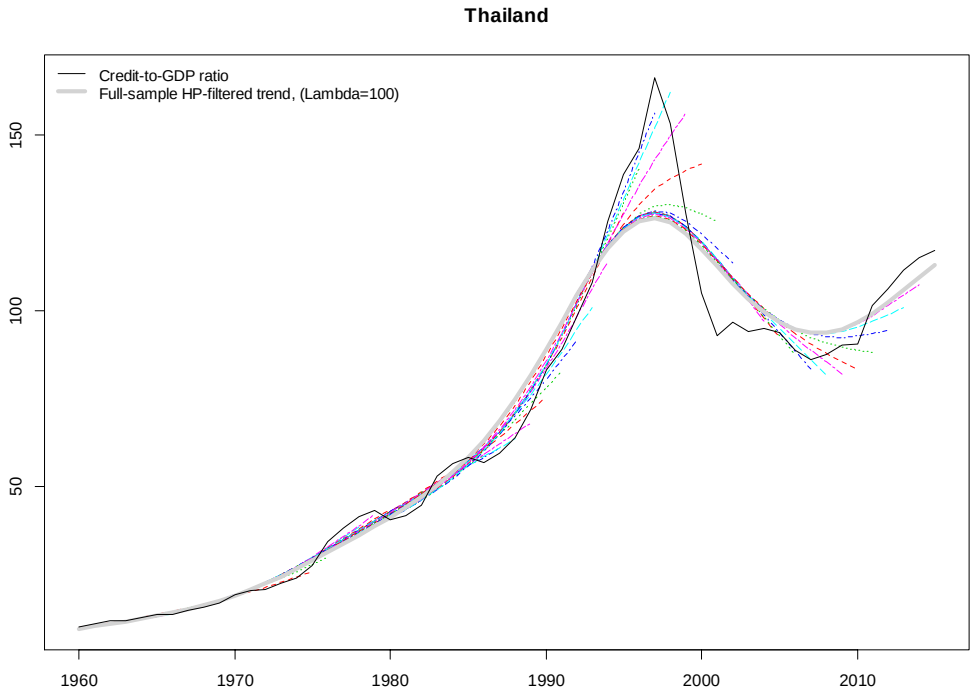


Figure 3.3 Various HP-filtered trends of credit-to-GDP ratio for Thailand
Source: IFS, WDI; Author's calculations; MT (2008).
Notes: The thin black line is the actual credit-to-GDP series of Thailand from 1960 to 2015, while the thick gray line is the full-sample HP-filtered trend. Dashed/dotted fringes are HP-filtered trends for all different time periods: 1960-1975, 1960-1976, … and 1960-2014.

Although the literature is dominated by the use of both GVL and MT detrending strategies and by the use of country-specific thresholds, there are also other researchers who employed different detrending strategies. For example, both Binici and Köksal (2012) and Orhangazi (2014) have estimated the trend component of a shorter-term (approximately ten years) monthly credit series using 12-month moving-average. Dell'Ariccia et al. (2012), on the other hand, uses a country-specific, backward-looking, rolling cubic trend for the period t estimated by using the window, $t - 10$ and t. The cubic trend is considered to be allowing for the elimination of the episodes where financial deepening and a reversal of deepening

occurred. Jorda et al. (2011) use 20-quarter changes in order to separate the credit gaps.

Finally, one should note that the choice with regard to the transformation of credit aggregates may influence upon the characterization of credit booms. Instead of credit-to-GDP ratio, MT uses the real credit stock (see MT, 2004) or the log of real credit per capita (see MT, 2008; 2012). The reasons for disregarding the credit-to-GDP ratio are threefold according to the users of this method: (i) credit-to-GDP ratio does not allow for real credit and real GDP to follow different trends, which may significantly differ from each other due to financial deepening or other reasons from time to time; (ii) during the periods when both nominal GDP and nominal credit stock falls, the credit-to-GDP ratio can increase if the fall in GDP is more rapid than the fall in credit stock; (iii) during the periods of high inflation, the fluctuations in credit-to-GDP ratio could be very misleading due to improper price adjustments on both series (see e.g. MT, 2008; Elekdag and Wu, 2011).

3.2. A new method to identify credit booms

The idea behind the construction of our method and the reason for the choice of the main variable can be summarized in the following way. We start by the question of what constitutes a credit boom. Following and enlarging the framework defined by Mendoza and Terrones (2008), we assume that the value of outstanding stock of bank credit to private sector is basically driven by five factors. First of all, the size of the economy and the number of economic agents usually grows, which requires the adjustment of credit volume to such developments. We consider that this can be seen as a “normal” financial development process, which complies with the trend of economic and demographic developments. Secondly, the general level of prices tends to grow so that the nominal value of the credit stock grows. Considering these two effects, the nominal stock of bank credit to private sector requires an adjustment by the population and/or the size of the economy and/or a price index. In general, two types of adjustment of the nominal credit stock is used in the literature: credit-to-GDP ratio and real credit per capita. After constructing our data set for 148

countries[62], we checked correlation coefficients between various representative variables of credit. Table 1 documents the summary statistics for those correlations. This table gives the impression that either way of adjustments can be used, since there is very high correlation among these variables for most of the countries. Since our method for the identification of credit booms follows Mendoza and Terrones (2008), we prefer real credit per capita to credit-to-GDP in the following analysis.

	Adjusted level variables	Median	Average	St. Dev.	Min	Max	Q1	Q3
1	Real BCPS pc vs. Credit to GDP	0,93	0,84	0,24	-0,62	1,00	0,81	0,98
2	log Real BCPS pc vs. Credit to GDP	0,92	0,83	0,24	-0,61	1,00	0,81	0,95
3	Real BCPS pc vs. Log Real BCPS pc	0,95	0,94	0,04	0,74	1,00	0,92	0,98
4	Real BCPS pc vs. Real BCPS pc back	1,00	0,99	0,01	0,92	1,00	0,99	1,00
5	Credit to GDP vs. Real BCPS pc back	0,93	0,84	0,24	-0,55	1,00	0,84	0,97
6	Log Real BCPS pc vs. Real BCPS pc back	0,94	0,93	0,04	0,78	0,99	0,92	0,96
7	Real BCPS pc vs. Log Real BCPS pc back	0,95	0,94	0,04	0,74	0,99	0,92	0,97
8	Credit to GDP vs. Log Real BCPS pc back	0,93	0,84	0,23	-0,55	1,00	0,82	0,95
9	Log Real BCPS pc vs. Log Real BCPS pc back	1,00	0,99	0,02	0,85	1,00	0,99	1,00
10	Real BCPS pc back vs. Log Real BCPS pc back	0,95	0,95	0,04	0,78	1,00	0,92	0,98
	Growth rate variables							
11	Growth rate of Credit to GDP vs. LogDifference Real BCPS pc	0,89	0,80	0,22	-0,27	1,00	0,74	0,94
12	Growth rate of Credit to GDP vs. LogDifference Real BCPS pc back	0,68	0,64	0,17	-0,01	0,94	0,56	0,75
13	LogDifference Real BCPS pc vs. LogDifference Real BCPS pc back	0,80	0,79	0,09	0,38	0,95	0,74	0,86

Table 3.1. Summary statistics for the correlation coefficients of various variables for 148 countries

Sources: IFS, WDI, UN; BIS; Author's calculations

Notes for the abbreviations: BCPS- bank credit to private sector; log-natural logarithm; pc-per capita; back-the backward average of the real BCPS per capita series for two contiguous years (i.e., the observation of a "… back" series at time t represents the average of the observations of the original series at times $t-1$ and t).

The third factor that drives the stock of bank credit to private sector can be defined as "rapid financial deepening" process which may occur due to structural, institutional and/or regulatory changes, so that for a given size of the economy, for a

[62] See the next section and Appendix A.

given number of agents in the economy and for a given level of prices, the value of outstanding credit grows rapidly, without requiring any abrupt reversal. Such episodes are considered as different both from "normal" financial development that follows economic and demographic developments; and from "credit booms" that would require reversals. These can be labeled as "good credit booms", as in Barajas et al. (2007), yet we opt for "rapid financial deepening" to describe such episodes and they should be captured by trend breaks (level and/or slope) in credit-to-GDP or real credit per capita series. The examples of such episodes can be seen in Figure 3 for Thailand, starting in the mid-1980s (overlapped with a "bad credit boom" in the mid-1990s), and in Figure 4 below for Turkey, starting in the 2000s.

Fourthly, due to the business cycle dynamics, the outstanding credit volume may fluctuate with the working capital and investment needs of the firms (Mendoza and Terrones, 2004). This dynamic is captured by the fluctuations of actual credit series around the hypothetical trend series (see e.g. Figure 3-4). Finally, the credit stock may explosively and unusually grow without being related with any of the previous reasons. Such episodes may arise from euphoric expectations, may be in line with asset price bubbles and excessive capital flow bonanzas, and they also may arise from the mismanagement of financial liberalization episodes. We expect that such episodes should be unsustainable and out of the line with "economic fundamentals". Therefore, they require severe (and mostly abrupt) adjustments. Such periods are defined as "credit booms" (which are called as "bad credit booms" by Barajas et al. (2007)). Note that we do not argue that credit booms should necessarily end up with financial collapse or banking crises, but we expect that there should be rapid adjustment process of credit volume after a credit boom peak. In technical terms, credit booms are considered as a part of cyclical fluctuations. Yet, this part of fluctuations is considered as excessive compared to the standard levels of volatility and expected to lead to rapid reversal of credit stock to its trend levels, sometimes accompanied by a destructive financial crisis.

MT method is justified by relying on a similar framework described above. Although we consider that it provides more appropriate detrending and threshold strategies

than GVL method in detecting credit booms, it also suffers from technical difficulties that reflect themselves in differing results. First of all, the end-point problem of the HP-filter applies for the MT method as well. For example, Mendoza and Terrones (2008) detected an ongoing credit boom for Turkey in 2006, using the 1960-2006 periods and setting the baseline threshold at 1.75 standard deviation above the full-sample HP trend. Mendoza and Terrones (2012) repeated the same exercise using the 1960-2010 periods and setting the baseline threshold level at even lower value of 1.65, but they did not find any credit boom for Turkey within the 2000s.

We replicated the application of MT method for Turkey starting with 1960-1975 sample and moving the end-year one by one up until 2016, setting the threshold level at 1.75 standard deviation as in MT (2008). In this way, we actually have a chance to see what the results would be if we used the MT method for each year since 1975. Table 2 displays the results of this experiment. Had Mendoza and Terrones used the 1960-2005 sample, they would have discovered an ongoing credit boom in 2005, as it was the case for the ongoing boom they have detected in 2006 by using the 1960-2006 sample. However, they could not have detected any boom within the 2000s, if they had used another sample other than those two.

Credit Boom Peak for Turkey	The end-years of samples, in which the credit boom is detected
1960	1975, … , 2000 (except 1983)
1976	1980, … , 2004
1997	1999, … , 2016
2005	2005
2006	2006

Table 3.2. Credit Booms in Turkey by the application of MT method for different time horizons

Source: IFS, WDI; UN; Author's calculations; MT (2008).

Notes: MT method is applied here for Turkey, setting the threshold level at 1.75 standard deviation as in MT (2008), for different time horizons, starting with 1960-1975 sample and moving the end-year one by one up to 2016. The first column shows the peak year of a credit boom when MT method is applied for a time horizon starting with 1960 and ending with the years given in the second column.

Figure 4 shows how detrending with HP-filter fails at the end of samples. The thin black line in the figure is the actual real credit per capita series of Turkey, transformed as in Mendoza and Terrones (2008) by taking the natural logarithm and two-year backward-looking moving average, from 1960 to 2016. Thick gray line is the full-sample HP-filtered trend. The dashed/dotted fringes in the figure, on the other hand, are HP-filtered trends for all different periods: 1961-1976, 1961-1977, … and 1961-2015. It can be observed that bank credit in Turkey started to grow rapidly in the mid-2000s, but as can be seen from the full-sample HP-filtered trend, there is a trend break for the credit series at around 2002 or 2003. However, such a trend break could not be captured by HP-filter when the end-year is 2005 or 2006.

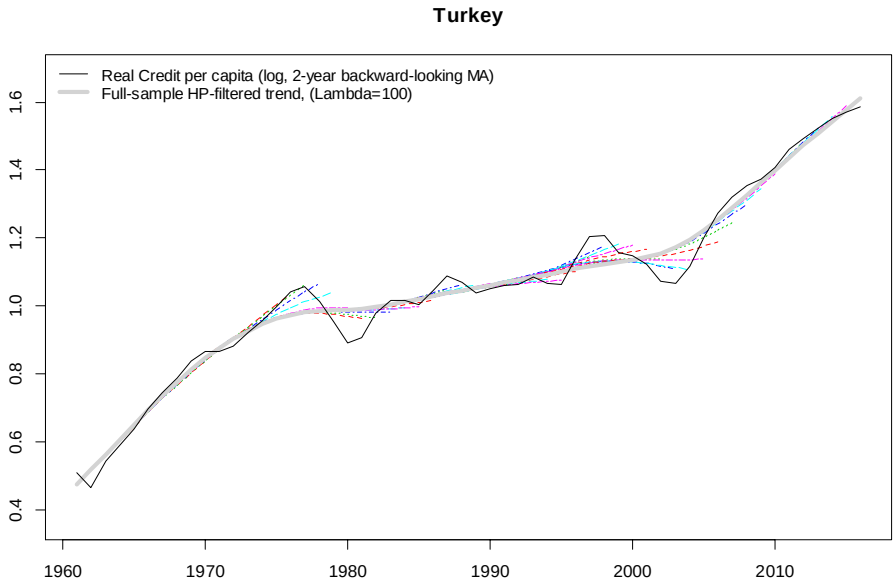


Figure 3.4 Various HP-filtered trends of real bank credit to private sector for Turkey

Source: IFS, WDI; UN; Author's calculations; MT (2008).

Notes: The thin black line is the actual real credit per capita series of Turkey from 1960 to 2015, calculated as in MT (2008), while the thick gray line is the full-sample HP-filtered trend. Dashed/dotted fringes are HP-filtered trends for all different time periods: 1960-1975, 1960-1976, … and 1960-2016, as in MT method.

Second problem with the MT method is that it ignores time-specific aspects of the cyclical component. Since the 1970s, there has been a trend of financial liberalization and deregulation all over the world. This was accompanied by growing financial integration among different countries. Many countries have experienced financial boom-bust cycles, which sometimes ended up with severe financial crises and recessions. On the other hand, the high tide of the wave of financial liberalization and integration have been settled down by the global financial crisis since 2008. Many countries have turned their attention to restrain the excesses in the financial markets by utilizing different sets of macro-prudential measures. Some of these measures have put effective limits on the fluctuations of credit, such as direct caps on credit growth rates, limits on loan-to-value ratios and constraints on financial

flows, which is a funding source for domestic credit provided by banks. These developments might have significantly changed the dynamics of the cyclical component of credit series for each country[63].

Indeed, Figure 5 shows that the cyclical component derived from HP filter for Turkey has different characteristics over time. Figure 5 shows the standard deviations of the cyclical components derived from HP-filter for each end-point from 1968 to 2016 (the starting point is always at 1953). Since the threshold level is a linear function of the standard deviation, this figure also hints at how the threshold levels would have changed if we used different end-points for the sample.

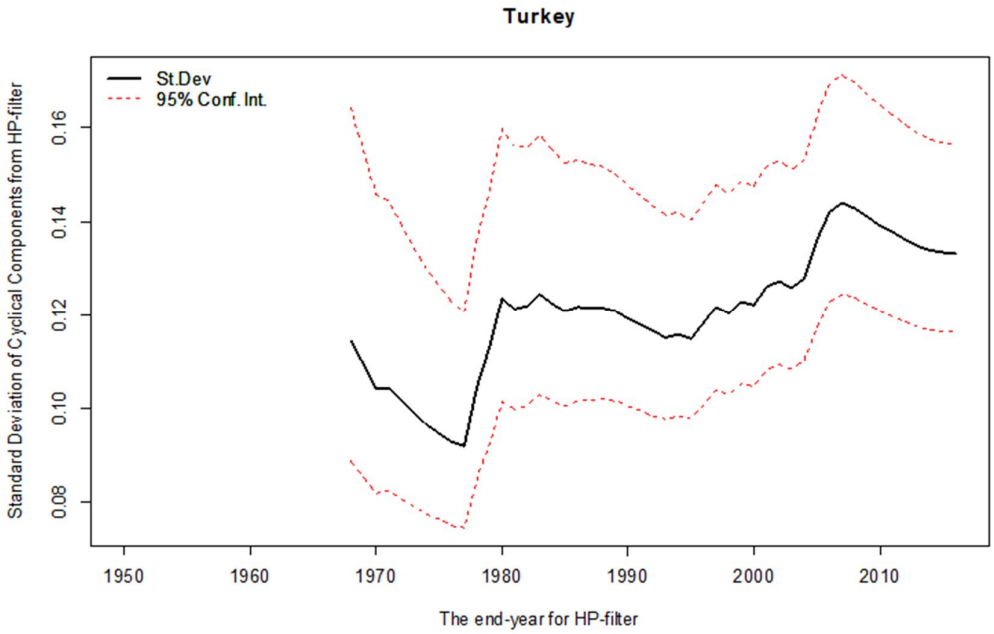


Figure 3.5 Standard deviations of the cyclical components derived from HP-filter for different end-points (from 1968 to 2016)

Source: IFS, WDI, UN; Author's calculations.

Notes: HP-filter smoothing parameter is set at 100.

[63] This narrative is in line with the timing and characterization of global financial cycles by Borio (2012) and Drehmann et al. (2012).

Figure 6 documents the evolution of the standard deviation of the cyclical components for the median and mean of standard deviations of the cyclical components for 148 countries in the upper panel and for country income groups in the lower panels (according to WDI). Although the data suffers from outliers and missing observations for the beginning- and end-periods for Figure 6, the graph suggests that there is a clear upward trend for the variance of cyclical fluctuations of real credit series over time. This pattern is valid for different country groups, except for the low income countries[64]. Moreover, 2 to 3 percentage point difference of the median standard deviation for all countries between 1980 and the 2000s has a practical significance. It implies that a typical credit cycle (say, with an amplitude of one standard deviation) for a typical country (say, the median country) would have an amplitude of 10 percent deviation from the trend value of the real credit per capita in the 1980s, whereas it would have 12-13 percent deviation from the trend value of the real credit per capita during the 2000s. This would also affect the identification of a credit boom. Since MT method sets a threshold at 1.75 or 1.65 standard deviation from the trend, there would be a difference of 3-5 percentage points among the thresholds set for the samples ending in the 1980s and ending in the 2000s. Figure 5 and 6 are also in line with the story told above, which roughly describes the evolution of financial markets since the 1970s. For example, standard deviation of the cyclical components for Turkey increased significantly at the end of the 1970s, remaining roughly stable until 2000, and it started to increase again during the 2000s and eventually falling after 2007. The effects of these changes can be seen both in Table 2 and Figure 6. Two credit booms that are detected for 1960 and in 1976 have lower end-point values and they are vanished when the samples that has end-points in the 2000s, since the standard deviation has increased in the latter cases.

All in all, these graphs show an important dynamic clearly, which is ignored by credit boom literature. These graphs imply that using time-specific threshold values for the detection of credit boom periods is necessary and ignoring that will distort any credit boom identification procedure.

[64] This is line with the upcoming findings in next sections.

Figure 3.6 Standard deviations of the cyclical components derived from HP-filter for different end-points for all countries and for country groups (from 1965 to 2016)

Source: IFS, WDI, BIS, UN; Author's calculations.

Notes: HP-filter smoothing parameter is set at 100. Income groups are defined by WDI, as of March 2017.

Taking those observations into account, we offer a new method that aim at accounting for both country-specific and time-specific dynamics of credit cycles. In this method, we also pay greater attention to the end-point problem of HP-filter. In order to get rid of the end-point problem of HP-filter, we will not count those episodes detected at the last 5 years of observations of the sample as a credit boom in our application. The 5-year horizon is chosen arbitrarily since we do not have any prior knowledge about how many years are required to escape from the end-point problem. However, as far as those figures above are taken into account, 5-year horizon seems enough. In addition, in order to improve threshold strategy, we will use the following **operational definition of credit boom**:

> the year t is defined as a ***credit boom*** for country i, if for any of the following samples $j = [t_0, (t_0 + 15)], [t_0, (t_0 + 16)], \dots [t_0, t_{final}]$, the deviation of the actual credit series from the trend component derived from two-sided HP filter for the sample j exceeds $\alpha \times \sigma_j$ (i.e., α, threshold coefficient, times standard deviation of the cyclical component from HP filter for the sample j) and if t is not an element of the last 5-years in the sample j.

The threshold coefficient, α, and the frequency parameter, λ, for HP filter will be chosen by using a signal extraction method, following Kaminsky and Reinhart (1999) and Drehmann et al. (2010)[65]. This means that the year t is defined as a credit boom episode if the actual credit stock exceeds the threshold level of positive deviation from the HP trend (as in MT method), but the threshold level is set differently for each country considering the time-specific cyclical characteristics of the period covered in the sample for that country.

[65] See following sections.

3.3. Data

Domestic banking sector (deposit banks) claims on non-financial private sector for all countries, denominated in national currencies, are obtained from IMF-IFS database (see Appendix A). This unbalanced data set covers the period 1950-2016 and it is considered as the baseline nominal bank credit to private sector (BCPS) data set. Then, in order to eliminate countries that have had a very low credit creation capacity so that time series dynamics of credit creation would be disturbed easily by minor local events, an arbitrary threshold level for credit-to-GDP ratios, obtained from WB-WDI database, are used. By calculating the maximum value of credit-to-GDP ratio for all countries, we eliminated the countries with maximum credit-to-GDP ratio below 20 percent from our baseline nominal BCPS data set. Finally, using the CPI index (or WPI when necessary), we constructed a "real BCPS" data set for the remaining countries.

After a detailed examination, the real BCPS data set is further modified in order to resolve detected problems (see Appendix A for explanations). Then, the data set is adjusted by the population series, obtained from WDI and UN databases, and we were left with 148 countries and 6600 observations in total. This implies that there are 45 observations for each country, on average, with a minimum of 16 observations. Finally, in order to apply HP filter, the real BCPS per capita series of some countries that contain missing observations are linearly interpolated.

3.4. Credit booms and their characteristics

In order to determine the "optimal" levels for the threshold coefficient, α, and the frequency parameter, λ, for HP filter, we apply for a simple signal extraction strategy, following Kaminsky and Reinhart (1999) and Drehmann et al. (2010). Our strategy implies that the optimal levels of threshold coefficient and smoothing parameter are the ones that yield the lowest noise-to-signal ratio for credit booms as signals of banking crises, given that the ratio of missed banking crises (i.e., the crises

that could not be signaled by any credit booms) to all banking crises does not exceed 40 percent[66].

Noise-to-signal ratio is calculated as in Kaminsky and Reinhart (1999). Given that we identify a signal of credit boom at time t, if there is a banking crisis at the interval $[t, t + 3]$, it is called as a true signal (A), otherwise as a noisy signal (B). On the other hand, if we did not identify any signal of credit boom at time t, but if there is a banking crisis at the interval $[t, t + 3]$, we call it as a false signal (C), otherwise it will be called as a true no-crisis signal (D). Then, noise-to-signal ratio is defined and calculated as the ratio of type II errors $\left(\frac{B}{B+D}\right)$ to one minus type I errors $\left(\frac{A}{A+C}\right)$. Missed crises ratio is defined as the ratio of banking crises that could not be signaled by any credit boom to all banking crises. For a crisis to be defined as missed, it should not be identified by any credit boom signal within the interval of previous three-years and the same year (i.e., for a banking crises at time t, we search for a credit boom signal in the interval $[t - 3, t]$).

Credit booms are identified for different values of threshold coefficients and smoothing parameters using the operational definition of a credit boom, with an additional criterion that the deviation of the actual credit series from its full-sample trend at time t should be positive[67].

The set of possible threshold coefficients consists of ten elements: {0.25, 0.5, 0.75, 1, 1.25, 1.5, 1.65, 1.75, 1.9, 2} which covers the entire positive side of the distribution of the cyclical component values. In the literature, threshold coefficients are usually chosen within the interval of 1.5 and 2, so much more concentration is given to this

[66] Drehmann et al. (2010; 2011) choses a more conservative missed crises ratio of 33 percent, but the data set they worked on is much more refined in the sense that it consists of advanced, industrialized high- and upper-middle income countries. As our results below show that for the groups of high income and upper-middle income countries, it is possible to choose a more conservative missed crisis ratio. Indeed, in our optimal choice of parameters, we achieve to obtain a missed crisis ratio of 27 percent for both of those income groups, though it increases to 35 percent when the entire data set is considered (see Table 3 and Table 4).

[67] In our preliminary analyses, we encountered with the cases of booms with negative deviations from their full sample trends, particularly for the cases of low threshold coefficient and wild history of credit cycles, so we want to avoid from such examples in our credit booms set.

specific interval. The set of possible smoothing parameters consists of four elements: {6.25, 100, 500, 1600}. This set is constructed by following the rules of Drehmann et al. (2010) and Ravn and Uhlig (2002). Accordingly, given that the value of 1600 is optimal as a smoothing parameter in identifying business cycles from quarterly data, the optimal choice for the lambda for other cycles (such as, credit cycles in our case) and for other data frequencies is 1600 times the fourth power of the multiplication of the frequency change of data (e.g., ¼ is used for the change from quarterly data to annual data) with the frequency change of the cycle with respect to business cycle (e.g., 3 is used for a cycle that is three times longer than the business cycle). Since the frequency of our data set is annual, ¼ is the coefficient of adjustment in this study. Then, following Drehmann et al. (2010), we choose four different values for the smoothing parameters depending on the four different assumptions that credit cycles are 1, 2, 3 or 4 time(s) longer than business cycles. Below, we show how the set of possible smoothing parameters are found:

$$\lambda_1 = 1600 \times \left(\frac{1}{4} \times 1\right)^4 = 6.25 \;\; ; \;\; \lambda_2 = 1600 \times \left(\frac{1}{4} \times 2\right)^4 = 100 \;\; ;$$

$$\lambda_3 = 1600 \times \left(\frac{1}{4} \times 3\right)^4 \approx 500 \;\; ; \;\; \lambda_4 = 1600 \times \left(\frac{1}{4} \times 4\right)^4 = 1600$$

Figure 7 shows how the choice of smoothing parameter for HP filter influences the cyclical components derived from HP filter for advanced and emerging market economies by taking one country from each group as an example. For all different values of smoothing parameter, the left plot shows the cyclical components of real credit per capita (in log terms) for the US and the right plot shows the same for Turkey. In general, for the lower levels of smoothing parameters, we observe more credit cycles with smaller wavelength and smaller amplitude, whereas, for the higher choices of smoothing parameters, we observe smaller number of credit cycles with larger wavelength and larger amplitude. For example, compare the effects of the 2001 crisis of the US on the cyclical components when the smoothing parameter is 6.25 and 1600. For the lower smoothing parameter, we observe that the beginning of the 2000s can be dubbed as a start of new credit cycle, whereas for the higher smoothing parameters, it can be dubbed as a small disruption in the credit cycle

starting at the beginning of the 1990s. A comparison of the US and Turkish cases, on the other hand, implies that the choice of smoothing parameter may have a larger impact on the identification of cyclical components in non-advanced countries (such as Turkey), since we observe that the credit cycles of non-advanced countries are generally prone to be disrupted by random shocks so that the cycles have more ups and downs. Indeed, this can be seen by counting the cycles in Turkey during the 2000s and also around the 1960s obtained by using different smoothing parameters (Figure 7).

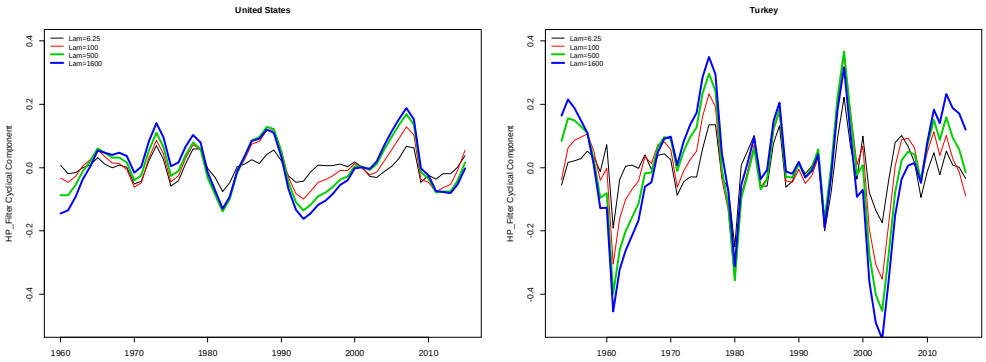


Figure 3.7 Cyclical components from HP filter for different smoothing parameters: Turkey and United States

Source: IFS, WDI, UN; Author's calculations.

Notwithstanding the hardships in obtaining credit cycles and credit booms, for different choices of threshold coefficients and smoothing parameters, we identified credit booms and calculated the noise-to-signal ratio and the missed crisis ratio. Table 3 and Table 4 document the results for four different sets of countries: all countries (Table 3 – left block), BIS countries (Table 3 – right block), high-income countries (Table 4 – left block) and upper-middle income countries (Table 4 – right block). These tables also document the ratio of type II errors, the number of credit booms identified for different levels of parameters, the number of crises in the matched-up data sets and the components of noise-to-signal ratio (true signals [A], noisy signals [B], false signals [C] and true no-crisis signals [D]).

Growth Rate Threshold = 0; ALL Countries; Missed Crises Cutoff= 0.4

130 Countries (of 148 Originally Selected Countries); (1970-2016); Real Credit per capita (log); Crisis dataset: Laeven and Valencia (2012), originally 147 banking crises identified for 162 countries, over the period 1970-2011.

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 6.25	Thr=0.25	0,69	0,12	0,35	1720	121	211	1509	209	2814
	Thr=0.5	0,61	0,17	0,26	1309	121	180	1129	240	3194
	Thr=0.75	0,58	0,26	0,19	971	121	140	831	280	3492
	Thr=1	0,53	0,35	0,14	707	121	110	597	310	3726
	Thr=1.25	0,56	0,48	0,10	502	121	74	428	346	3895
	Thr=1.5	0,49	0,55	0,07	347	121	57	290	363	4033
	Thr=1.65	0,47	0,60	0,05	278	121	48	230	372	4093
	Thr=1.75	0,44	0,63	0,04	227	121	41	186	379	4137
	Thr=1.9	0,44	0,69	0,03	177	121	32	145	388	4178
	Thr=2	0,42	0,72	0,03	144	121	27	117	393	4206

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 100	Thr=0.25	0,58	0,16	0,37	1890	121	270	1620	150	2703
	Thr=0.5	0,52	0,21	0,29	1463	121	230	1233	190	3090
	Thr=0.75	0,50	0,26	0,22	1125	121	182	943	238	3380
	Thr=1	0,45	0,35	0,16	836	121	148	688	272	3635
	Thr=1.25	0,42	0,48	0,11	588	121	110	478	310	3845
	Thr=1.5	0,38	0,57	0,07	401	121	81	320	339	4003
	Thr=1.65	0,35	0,60	0,06	321	121	70	251	350	4072
	Thr=1.75	0,33	0,64	0,05	262	121	60	202	360	4121
	Thr=1.9	0,29	0,65	0,03	202	121	51	151	369	4172
	Thr=2	0,30	0,70	0,03	155	121	38	117	382	4206

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 500	Thr=0.25	0,60	0,20	0,38	1923	121	268	1655	152	2668
	Thr=0.5	0,54	0,23	0,31	1584	121	241	1343	179	2980
	Thr=0.75	0,49	0,30	0,24	1217	121	200	1017	220	3306
	Thr=1	0,45	0,37	0,17	879	121	155	724	265	3599
	Thr=1.25	0,41	0,45	0,12	631	121	120	511	300	3812
	Thr=1.5	0,38	0,58	0,08	419	121	85	334	335	3989
	Thr=1.65	0,35	0,64	0,06	315	121	68	247	352	4076
	Thr=1.75	0,33	0,68	0,05	256	121	58	198	362	4125
	Thr=1.9	0,28	0,70	0,03	187	121	48	139	372	4184
	Thr=2	0,29	0,72	0,03	151	121	38	113	382	4210

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 1600	Thr=0.25	0,60	0,19	0,39	1959	121	274	1685	146	2638
	Thr=0.5	0,56	0,24	0,32	1634	121	243	1391	177	2932
	Thr=0.75	0,51	0,33	0,25	1280	121	204	1076	216	3247
	Thr=1	0,47	0,38	0,17	904	121	154	750	266	3573
	Thr=1.25	0,43	0,47	0,12	633	121	116	517	304	3806
	Thr=1.5	0,42	0,62	0,08	406	121	77	329	343	3994
	Thr=1.65	0,38	0,69	0,06	304	121	62	242	358	4081
	Thr=1.75	0,35	0,70	0,05	249	121	54	195	366	4128
	Thr=1.9	0,31	0,74	0,03	169	121	40	129	380	4194
	Thr=2	0,30	0,77	0,02	140	121	34	106	386	4217

Growth Rate Threshold = 0; BIS Countries; Missed Crises Cutoff= 0.4

33 Countries (of 43 BIS countries); (1970-2016); Real Credit per capita (log); Crisis dataset: Drehmann et al. (2011), originally 36 countries

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 6.25	Thr=0.25	0,59	0,09	0,33	510	47	106	404	82	809
	Thr=0.5	0,51	0,15	0,24	387	47	90	297	98	916
	Thr=0.75	0,54	0,26	0,18	281	47	63	218	125	995
	Thr=1	0,49	0,40	0,13	205	47	49	156	139	1057
	Thr=1.25	0,53	0,47	0,10	154	47	35	119	153	1094
	Thr=1.5	0,49	0,57	0,07	113	47	27	86	161	1127
	Thr=1.65	0,47	0,57	0,06	97	47	24	73	164	1140
	Thr=1.75	0,46	0,62	0,05	79	47	20	59	168	1154
	Thr=1.9	0,41	0,70	0,03	58	47	16	42	172	1171
	Thr=2	0,39	0,72	0,03	53	47	15	38	173	1175

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 100	Thr=0.25	0,53	0,13	0,36	560	47	126	434	62	779
	Thr=0.5	0,47	0,15	0,27	438	47	108	330	80	883
	Thr=0.75	0,40	0,17	0,21	347	47	97	250	91	963
	Thr=1	0,36	0,26	0,16	275	47	82	193	106	1020
	Thr=1.25	0,33	0,38	0,11	201	47	64	137	124	1076
	Thr=1.5	0,31	0,47	0,08	144	47	48	96	140	1117
	Thr=1.65	0,28	0,49	0,06	121	47	43	78	145	1135
	Thr=1.75	0,23	0,51	0,05	103	47	41	62	147	1151
	Thr=1.9	0,21	0,53	0,04	83	47	35	48	153	1165
	Thr=2	0,24	0,60	0,03	67	47	26	41	162	1172

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 500	Thr=0.25	0,55	0,13	0,37	580	47	127	453	61	760
	Thr=0.5	0,50	0,15	0,31	486	47	115	371	73	842
	Thr=0.75	0,44	0,15	0,24	393	47	103	290	85	923
	Thr=1	0,37	0,26	0,17	296	47	87	209	101	1004
	Thr=1.25	0,34	0,36	0,13	221	47	69	152	119	1061
	Thr=1.5	0,30	0,45	0,09	160	47	55	105	133	1108
	Thr=1.65	0,29	0,53	0,07	126	47	44	82	144	1131
	Thr=1.75	0,27	0,57	0,06	110	47	40	70	148	1143
	Thr=1.9	0,22	0,60	0,04	84	47	35	49	153	1164
	Thr=2	0,24	0,60	0,03	68	47	27	41	161	1172

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 1600	Thr=0.25	0,56	0,11	0,38	594	47	128	466	60	747
	Thr=0.5	0,52	0,15	0,32	509	47	117	392	71	821
	Thr=0.75	0,47	0,19	0,26	414	47	103	311	85	902
	Thr=1	0,42	0,28	0,18	302	47	82	220	106	993
	Thr=1.25	0,38	0,38	0,13	230	47	67	163	121	1050
	Thr=1.5	0,33	0,53	0,09	155	47	50	105	138	1108
	Thr=1.65	0,30	0,62	0,07	121	47	41	80	147	1133
	Thr=1.75	0,30	0,62	0,06	105	47	36	69	152	1144
	Thr=1.9	0,25	0,66	0,04	78	47	30	48	158	1165
	Thr=2	0,26	0,70	0,03	67	47	25	42	163	1171

Table 3.3. Noise-to-Signal and Missed Crisis ratios for different threshold coefficients and smoothing parameters; All countries and BIS countries

Source: IFS, WDI, BIS.

Notes: Credit booms are identified with an additional criterion that imposes that the deviation of the actual credit series from its full-sample trend at time t should be positive. Banking crises are obtained from Laeven and Valencia [LV] (2012) for the left block. After matching-up credit boom and banking crisis data sets, we are left with 130 countries. Banking crises are obtained from Drehmann et al. (2011) for the right block. The subset of countries in the right block consists only of 43 countries that are included in the BIS database of credit-to-GDP gap. After matching-up credit boom and banking crisis data sets, we are left with 33 countries.

The left block of Table 3 documents the results of this experiment for the whole data set. Banking crises are obtained from Laeven and Valencia [LV] (2012), who cover the 1970-2011 periods and identify 147 banking crises for 162 countries. After matching-up time horizon of credit booms and banking crisis data sets and taking the intersection of countries that are exist in both data sets, we are left with 130 countries and 121 banking crises for the 1970-2011 periods. According to our criterion that the optimal levels of threshold coefficient and smoothing parameter are the ones that yield the lowest noise-to-signal ratio given that missed-crisis ratio does not exceed 40 percent, the optimal threshold coefficient should be equal to 1, independent of the choice of smoothing parameter (Table 3, left block). On the other hand, our method suggests that the smoothing parameter for HP filter may be chosen as either 100 or 500 (and even 1600). Although noise-to-signal ratios are very close to each other for these smoothing parameters, when lambda is chosen as 100, we obtain a slightly lower missed crisis ratio, therefore, it will be the baseline choice.

The right block of Table 3 documents the results of a similar experiment for a subset of our data set. The subset consists of 43 countries that are included in the BIS database of credit-to-GDP gap. The banking crisis database is taken from Drehmann et al. (2011), who combines the earlier works of Laeven and Valencia on banking crises with the works of Reinhart and Rogoff (2008). This set consists originally of 36 countries, but after matching-up the two data sets, we are left with 33 countries, having experienced 47 banking crises within the 1970-2011 periods. The results of signal extraction analysis for this subset suggests that the threshold coefficient of 1.25 combined with the smoothing parameter of 100 or 500 may be considered as appropriate choices.

Finally, Table 4 documents the results of signal extraction analysis for high-income and upper-middle income countries, as classified by the World Bank - WDI. Banking crises are obtained from LV (2012) and after matching-up data sets, we are left with 43 high income and 41 upper-middle income countries, which experienced 42 and 37 banking crises, respectively. Overall, these two experiments suggest that the choice of 1 as a threshold coefficient and the choice of 100 and 500 for the smoothing

parameter would be the most appropriate options. Moreover, when we compare Table 4 with Table 3, at the optimal choice of parameters at $(\alpha, \lambda) = (1,100)$, we achieve to obtain a missed crisis ratio of 26-27 percent for high income and upper-middle income groups, though it increases to 35 percent when the entire data set is considered. This implies that lower-middle and low income countries have higher missed-crisis and noise-to-signal ratios. Thus, the interactions of credit booms and banking crises are much weaker in lower income groups of countries.

43 High Income (WDI) Countries (of 148 Originally Selected Countries); (1970-2016); Real Credit per capita (log); Crisis dataset: Laeven and Valencia (2012), originally 147 banking crises identified for 162 countries, over the period 1970-2011.

Growth Rate Threshold = 0; High Income (WDI) Countries; Missed Crises Cutoff= 0.4

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 6.25	Thr=0.25	0,61	0,07	0,33	582	42	85	497	69	988
	Thr=0.5	0,55	0,19	0,25	439	42	70	369	84	1116
	Thr=0.75	0,55	0,33	0,18	315	42	50	265	104	1220
	Thr=1	0,48	0,40	0,13	231	42	41	190	113	1295
	Thr=1.25	0,50	0,50	0,10	174	42	30	144	124	1341
	Thr=1.5	0,45	0,57	0,07	128	42	24	104	130	1381
	Thr=1.65	0,48	0,62	0,06	107	42	19	88	135	1397
	Thr=1.75	0,47	0,62	0,05	88	42	16	72	138	1413
	Thr=1.9	0,62	0,76	0,04	63	42	9	54	145	1431
	Thr=2	0,68	0,81	0,03	53	42	7	46	147	1439

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 100	Thr=0.25	0,51	0,12	0,37	654	42	111	543	43	942
	Thr=0.5	0,44	0,14	0,28	507	42	97	410	57	1075
	Thr=0.75	0,40	0,19	0,21	394	42	81	313	73	1172
	Thr=1	0,38	0,26	0,16	305	42	66	239	88	1246
	Thr=1.25	0,35	0,40	0,12	228	42	52	176	102	1309
	Thr=1.5	0,30	0,48	0,08	159	42	41	118	113	1367
	Thr=1.65	0,28	0,52	0,07	133	42	36	97	118	1388
	Thr=1.75	0,25	0,57	0,05	113	42	33	80	121	1405
	Thr=1.9	0,25	0,60	0,04	91	42	27	64	127	1421
	Thr=2	0,31	0,67	0,04	71	42	18	53	136	1432

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 500	Thr=0.25	0,52	0,12	0,38	669	42	112	557	42	928
	Thr=0.5	0,44	0,14	0,30	557	42	106	451	48	1034
	Thr=0.75	0,41	0,17	0,24	446	42	90	356	64	1129
	Thr=1	0,37	0,29	0,17	331	42	72	259	82	1226
	Thr=1.25	0,34	0,38	0,13	248	42	58	190	96	1295
	Thr=1.5	0,32	0,52	0,09	178	42	44	134	110	1351
	Thr=1.65	0,29	0,55	0,07	142	42	37	105	117	1380
	Thr=1.75	0,27	0,60	0,06	119	42	33	86	121	1399
	Thr=1.9	0,23	0,64	0,04	88	42	27	61	127	1424
	Thr=2	0,28	0,67	0,03	70	42	19	51	135	1434

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 1600	Thr=0.25	0,52	0,12	0,39	695	42	115	580	39	905
	Thr=0.5	0,44	0,12	0,31	576	42	109	467	45	1018
	Thr=0.75	0,41	0,24	0,25	463	42	93	370	61	1115
	Thr=1	0,39	0,29	0,18	335	42	71	264	83	1221
	Thr=1.25	0,37	0,40	0,14	257	42	56	201	98	1284
	Thr=1.5	0,34	0,55	0,09	172	42	40	132	114	1353
	Thr=1.65	0,30	0,62	0,07	135	42	35	100	119	1385
	Thr=1.75	0,30	0,64	0,06	117	42	30	87	124	1398
	Thr=1.9	0,28	0,69	0,04	85	42	23	62	131	1423
	Thr=2	0,28	0,74	0,03	70	42	19	51	135	1434

41 Upper-Middle Income (WDI) Countries (of 148 Originally Selected Countries); (1970-2016); Real Credit per capita (log); Crisis dataset: Laeven and Valencia (2012), originally 147 banking crises identified for 162 countries, over the period 1970-2011.

Growth Rate Threshold = 0; Upper-Middle Income (WDI) Countries; Missed Crises Cutoff= 0.4

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 6.25	Thr=0.25	0,63	0,05	0,35	537	37	68	469	54	873
	Thr=0.5	0,55	0,08	0,27	419	37	59	360	63	982
	Thr=0.75	0,50	0,08	0,20	325	37	50	275	72	1067
	Thr=1	0,48	0,19	0,15	245	37	39	206	83	1136
	Thr=1.25	0,51	0,32	0,11	172	37	26	146	96	1196
	Thr=1.5	0,42	0,41	0,07	113	37	20	93	102	1249
	Thr=1.65	0,34	0,43	0,05	86	37	18	68	104	1274
	Thr=1.75	0,35	0,51	0,04	72	37	15	57	107	1285
	Thr=1.9	0,30	0,54	0,03	56	37	13	43	109	1299
	Thr=2	0,26	0,59	0,02	43	37	11	32	111	1310

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 100	Thr=0.25	0,59	0,11	0,38	592	37	79	513	43	829
	Thr=0.5	0,54	0,19	0,29	462	37	67	395	55	947
	Thr=0.75	0,56	0,24	0,23	356	37	50	306	72	1036
	Thr=1	0,45	0,27	0,16	260	37	44	216	78	1126
	Thr=1.25	0,35	0,43	0,10	170	37	35	135	87	1207
	Thr=1.5	0,34	0,51	0,07	115	37	24	91	98	1251
	Thr=1.65	0,28	0,51	0,05	93	37	23	70	99	1272
	Thr=1.75	0,30	0,57	0,04	74	37	17	57	105	1285
	Thr=1.9	0,24	0,57	0,03	58	37	16	42	106	1300
	Thr=2	0,19	0,59	0,02	44	37	14	30	108	1312

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 500	Thr=0.25	0,64	0,22	0,39	603	37	75	528	47	814
	Thr=0.5	0,60	0,24	0,32	501	37	66	435	56	907
	Thr=0.75	0,52	0,27	0,23	369	37	55	314	67	1028
	Thr=1	0,45	0,30	0,16	261	37	44	217	78	1125
	Thr=1.25	0,39	0,43	0,11	175	37	33	142	89	1200
	Thr=1.5	0,32	0,51	0,07	113	37	25	88	97	1254
	Thr=1.65	0,28	0,57	0,05	85	37	21	64	101	1278
	Thr=1.75	0,29	0,59	0,04	71	37	17	54	105	1288
	Thr=1.9	0,25	0,62	0,03	52	37	14	38	108	1304
	Thr=2	0,24	0,65	0,03	47	37	13	34	109	1308

Lambda	Thresholds	Noise-to-Signal	Missed Crisis Ratio	Typer II Error	No. of Boom Signals	No. of Crises	A	B	C	D
Lambda = 1600	Thr=0.25	0,65	0,22	0,39	603	37	74	529	48	813
	Thr=0.5	0,62	0,24	0,33	509	37	65	444	57	898
	Thr=0.75	0,53	0,30	0,25	393	37	58	335	64	1007
	Thr=1	0,46	0,32	0,17	271	37	45	226	77	1116
	Thr=1.25	0,42	0,41	0,11	175	37	31	144	91	1198
	Thr=1.5	0,38	0,54	0,07	113	37	22	91	100	1251
	Thr=1.65	0,33	0,62	0,05	79	37	17	62	105	1280
	Thr=1.75	0,30	0,62	0,04	64	37	15	49	107	1293
	Thr=1.9	0,26	0,70	0,02	43	37	11	32	111	1310
	Thr=2	0,24	0,70	0,02	40	37	11	29	111	1313

Table 3.4. Noise-to-Signal and Missed Crisis ratios for different threshold coefficients and smoothing parameters; High-Income and Upper-Middle Income Countries

Source: IFS, WDI, BIS.

Notes: See Table 3 Notes for the general instructions. Banking crises are obtained from Laeven and Valencia [LV] (2012). After matching-up credit boom and banking crisis data sets, we are left with 43 high income and 41 upper-middle income countries.

All in all, our signal extraction analysis yields that the combination of threshold coefficient of 1 and the smoothing parameter of 100 would be a good starting point to analyze the characteristics of credit booms[68]. Given these parameters, we applied our method and operational definition of credit boom for 148 countries having varying time-spans. The largest time-span for a country consists of 67 observations (1950-2016) and the smallest one consists of 16 observations, due to the construction procedure of our data set (see Appendix A).

Although we need all the credit boom signals in order to carry out a signal extraction analysis, it is much more convenient to focus on credit boom peaks in order to analyze the characteristics of credit booms, because a sequence of credit boom signals can be represented by a single peak year. In order to pick out the credit boom peaks, we impose additional criteria on the identification of credit booms: for any of the following samples $j = [t_0 , (t_0 + 15)]$, $[t_0, (t_0+16)]$, … $[t_0, t_{final}]$, a credit boom identified at t should yield the highest deviation from HP trend calculated for the sample j within the window $[t-2, t+2]$ and also the deviation of the actual series at time t from its trend value derived from full-sample HP filter, $[t_0 , t_{final}]$, should be the highest deviation within the window $[t-1, t+1]$. These criteria ensure that any two credit booms can only have a 3-years difference and any credit boom peak can be represented by a single year.

Using these additional criteria, we obtained 493 credit boom peaks for 148 countries[69]. The distribution of these credit booms over time is depicted in Figure 8. Note that the weight of observations in the data set is biased towards the end of the 1950-2016 periods. For many countries, there is no available data for earlier periods and so the number of credit booms identified for them are lower than the number for the most recent periods. The bottom panel of Figure 8 shows the frequency of credit

[68] The other alternatives from the set $\{(1,500),(1.25,100),(1.25,500)\}$ can be considered for robustness checks for the upcoming results.

[69] Note that without the additional criteria for the identification of boom peaks, we had 836 credit boom signals for 130 countries (out of 148 countries), given that the parameters are set as (α, λ) = (1, 100) (see Table 3).

booms identified for each year as adjusted by the number of available observations at that year. Though the frequency of credit booms increases over time, there is no clear tendency to increase or decrease for the number of credit booms when the frequency is adjusted by the number of available observations. This result may seem surprising (and even conflicting) at first sight due to the common perception that the number of credit booms have been increasing with the new wave of financial liberalization. However, our methodological choice allows us to identify credit booms by considering the standards of the time they were observed. Credit booms that we identified for the pre-liberalization era will differ in characteristics than the ones identified for liberalization era, since we used a lower threshold level derived from a less volatile cyclical component of real credit to identify them (see also Figure 12). Another important point implied by this figure is the clustering of credit booms in a much shorter time horizon over time. While there is no recognizable center of the cluster of credit booms in the 1960s, there exists recognizable centers of the clusters from the 1970s onward (such as 1973, 1978, 1989, 1997, 2007-8). This pattern gets even more obvious for the recent periods, which implies that global factors that drive credit booms have far overweighed local drivers of credit booms.

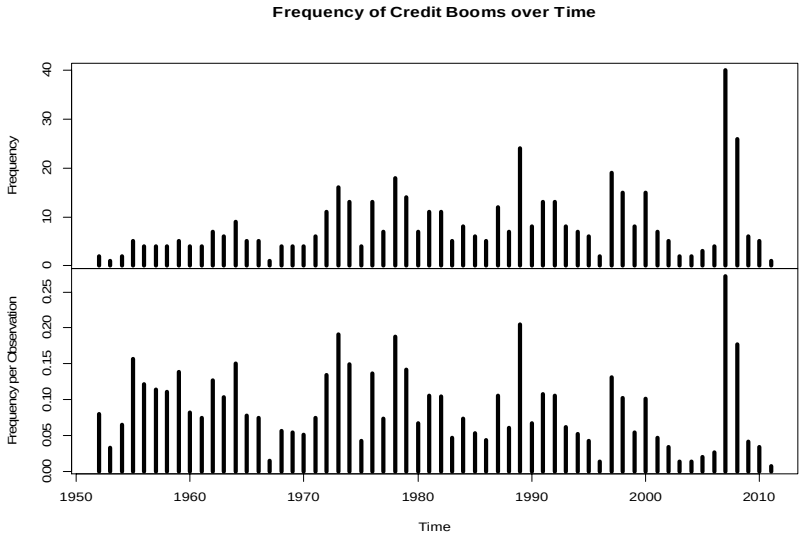
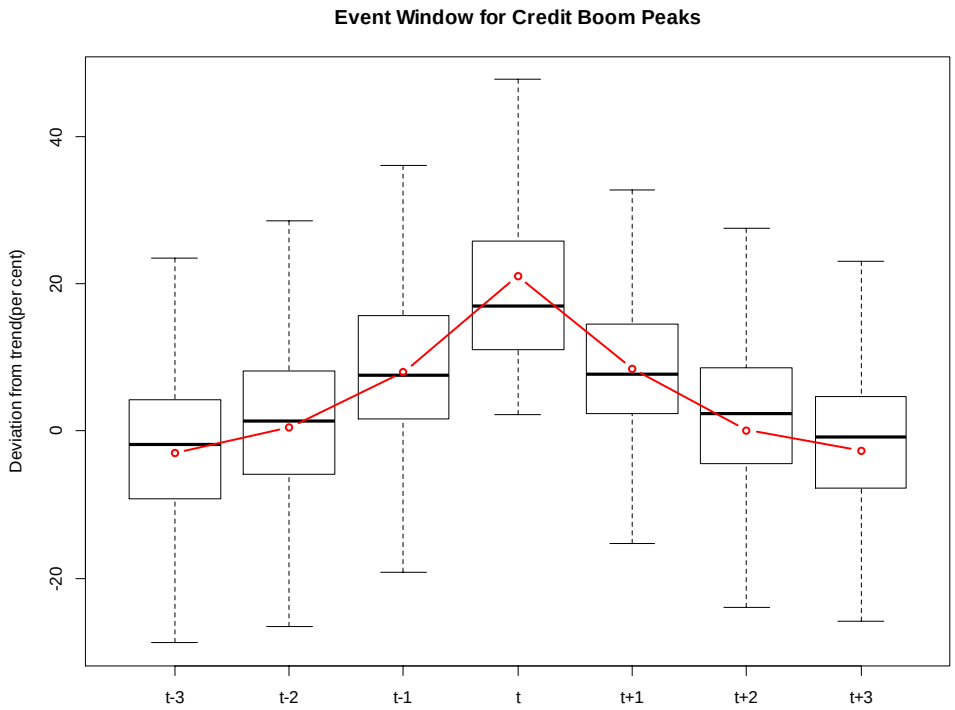


Figure 3.8 Frequency and Frequency per observation of Credit Booms over Time
Source: IFS, WDI, UN; Author's calculations

To see the basic characteristics of these booms, we draw a seven-year event window for the median and mean deviations of the actual real bank credit to private sector (BCPS) per capita (in log terms) from its trend component derived from full-sample HP filter. A seven-year window is preferred, since the identified credit boom peaks start departing from the trend value 2-3 years before the peak year and returns back to the trend value 2-3 years after the peak. Figure 9 depicts the event window for 493 credit boom peaks of 148 countries. The box plots for each year within a seven-year event-window show the distribution of the deviations (in percentage terms) of the actual credit series from their trend component around the identified credit boom peaks. The table below the figure gives the exact numbers for important quantiles. Accordingly, the median deviation of the actual credit series from its full-sample trend is 17 percent and the mean deviation is 21.1 percent at a credit boom peak. There is also a clear picture of boom-bust cycles for the credit boom events we identified, where the actual credit deviates from its trend with an accelerated pace at around two years before the credit boom peaks and it returns to the trend level with a decelerated pace within two to three years after the peak. This implies that a credit boom has typically 5 to 7 years of duration.



	t-3	t-2	t-1	t	t+1	t+2	t+3
min_IQR	-28.8%	-26.6%	-19.2%	2.3%	-15.2%	-23.9%	-25.8%
1st quartile	-9.2%	-5.8%	1.7%	11.0%	2.4%	-4.4%	-7.7%
Median	-1.8%	1.3%	7.5%	17.0%	7.8%	2.4%	-0.8%
3rd quartile	4.3%	8.2%	15.7%	25.9%	14.5%	8.6%	4.7%
max_IQR	23.6%	28.6%	36.1%	47.8%	32.7%	27.6%	23.1%

Figure 3.9 Event Window (7 years) for Credit Boom Peaks

Source: IFS, WDI, BIS, UN; Author's calculations

Notes: Smoothing parameter for HP filter is set to 100; the threshold coefficient is set to 1.

Figure 10 and Figure 11 depict the results of a similar analysis for different country groups. Figure 10 groups 148 countries into 4 categories according to their average credit-to-GDP ratios after 2000. The low credit-to-GDP ratio group (52 countries) has an average below 30 percent, whereas the lower-middle group (50 countries) has an average between 30 and 60 percent, the upper-middle (21 countries) group has an average between 60 and 90 percent, and finally the high credit-to-GDP group (25

countries) has an average of more than 90 percent. Figure 11 groups 148 countries into 4 categories according to their income groups defined by WDI, as of March 2017. The four panels of two graphs have the same scale so that deviations for each country group are visually comparable. It is clear from both pictures that for the low income and low credit-to-GDP groups, the deviations around boom years have significant dispersion, whereas among the high income and high credit-to-GDP countries, there is more similarity among the credit booms. The dispersion of the middle groups, on the other hand, falls somewhere in between these two extreme cases. These graphs imply that one should be careful about specifying any "general characteristics" of credit booms for all countries. Low credit-to-GDP countries experienced 23 percent median deviation (26 percent, on average) at credit boom peaks, whereas lower-middle group experienced 17 (on average, 23) percent; upper-middle group experienced only 13 (on average, 16) percent and high credit-to-GDP group experienced 10 (on average, 13) percent deviations at peaks. Thus, there is a clear pattern that for higher credit-to-GDP ratios, credit booms are more likely to emerge out even for smaller deviations of actual credit from the trend. This reflects the fact that high credit-to-GDP ratio countries experience smoother cyclical fluctuations of credit and, thereby, they have lower levels of thresholds for a credit boom to emerge out. On the other hand, there is no such visible pattern between income groups of countries and the behavior of credit around credit boom peaks. The upper-middle income group experienced 20 (on average, 24) percent median deviation at credit boom peaks, which is close to the experiences of low income and lower-middle income countries that had median deviations of 21 percent (26 percent, on average) and 18 percent (on average, 22), respectively. Nonetheless, high income group differentiates itself from the others, having 13 percent median deviation (on average, 17). Moreover, the general results about the deviations of real credit from its trend around credit boom peaks are mostly driven by the patterns observed in high and upper-middle income (or credit-to-GDP) groups. Although low and lower-middle income (or credit-to-GDP) groups have exhibited similar patterns of deviations on average and on median, there are significant number of cases where booms exhibit extraordinary patterns.

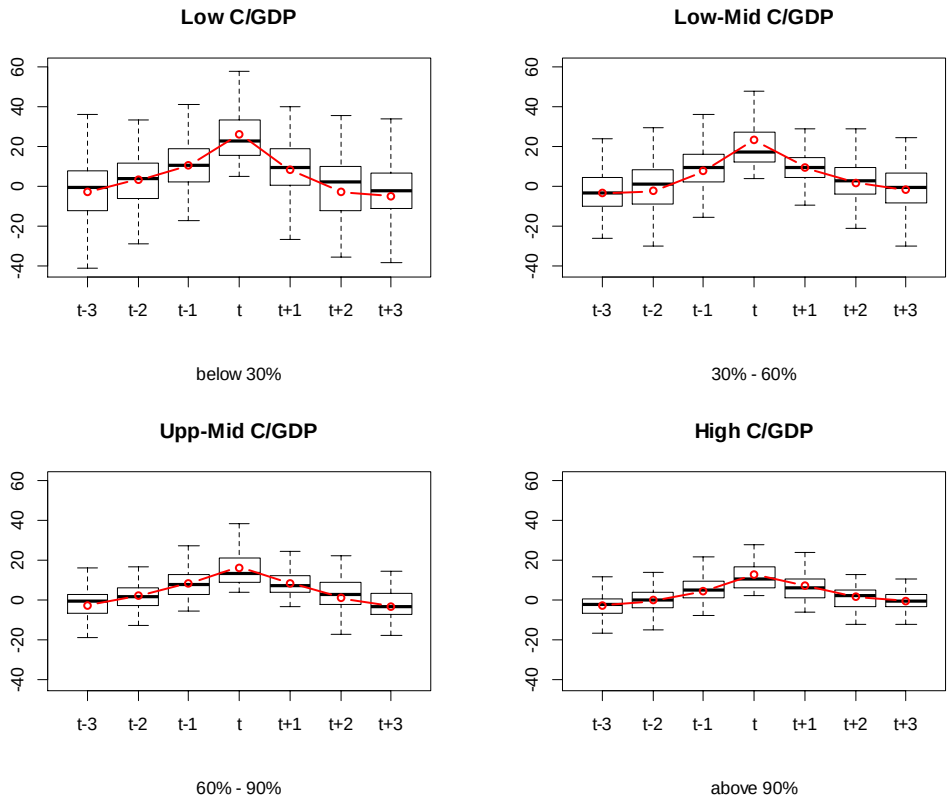


Figure 3.10 Event Window (7 years) for Credit Boom Peaks according to Credit-to-GDP levels

Source: IFS, WDI, BIS, UN; Author's calculations

Notes: Smoothing parameter for HP filter is set to 100; the threshold coefficient is set to 1. Credit-to-GDP ratios are taken from WDI and calculated as the average of post-2001 period and then divided into four groups.

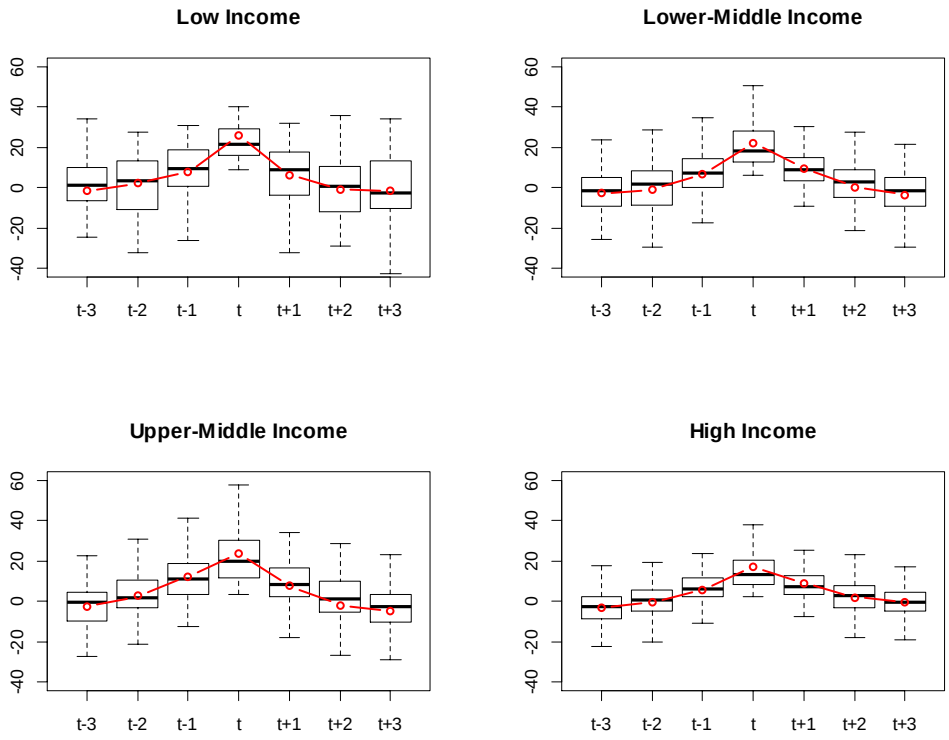


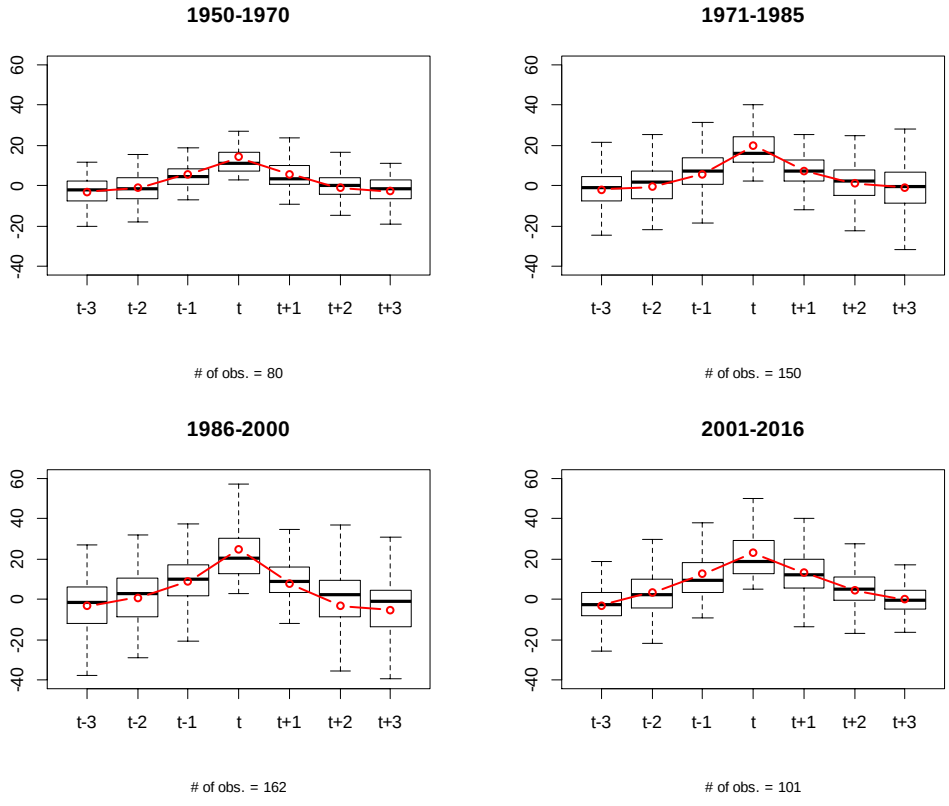
Figure 3.11 Event Window (7 years) for Credit Boom Peaks according to income levels

Source: IFS, WDI, BIS, UN; Author's calculations

Notes: Smoothing parameter for HP filter is set to 100; the threshold coefficient is set to 1. Credit-to-GDP ratios are taken from WDI and calculated as the average of post-2001 period and then divided into four groups. Income groups are defined by WDI, as of March 2017.

Figure 12, on the other hand, groups credit boom peaks into 4 periods by their peak years. This figure also has the same scale with Figure 10-12 and it allows for a visual comparison of the behavior of credit booms in four different periods: 1950-1970, 1971-1985, 1986-2000 and 2000-2016. The table included in Figure 12 presents the median of deviations of actual credit from trend values at the related years. The figure shows that there has been an increasing trend of deviations of real credit per capita from HP-filtered trend values around credit boom peaks. For the period

between 1950 and 1970, an 11 percent deviation of actual credit series from its trend credit is seen as excessive, whereas for the last 30 years (or more), a 19-20 percent deviation is barely identified as a credit boom peak. Moreover, for the 1986-2016 periods, a 10 percent deviation (almost equal to the deviation at a credit boom peak in 1950-70s) has been a common figure for the year before the credit boom peaks and 9-12 percent deviations have become a "norm" for the year after the peaks. The duration of credit booms has also extended from 3-5 years to 5-7 years over the course of the history. Whereas the deviations from the trend are still negative two years before the credit boom peak and the actual credit returns to its trend level two years after the peak in the 1950-70s, the take-off of a credit boom starts three years before the peak and it takes three years before it lands on the ground since the 1970s. As a result, these findings are also in line with our emphasis on the importance of time-specific aspects of credit expansions and with our finding that the volatility of credit cycles has been increasing over time, expanding the duration of credit booms and increasing the excesses around credit boom peaks.



	t-3	t-2	t-1	t	t+1	t+2	t+3
1950-1970	-0.02	-0.01	0.05	0.11	0.03	0.00	-0.02
1971-1985	-0.01	0.02	0.07	0.16	0.07	0.02	-0.01
1986-2000	-0.01	0.03	0.10	0.20	0.09	0.02	-0.01
2001-2016	-0.03	0.02	0.10	0.19	0.12	0.05	-0.01

Figure 3.12 Event Window (7 years) for Credit Boom Peaks according to their years
Source: IFS, WDI, BIS, UN; Author's calculations
Notes: Smoothing parameter for HP filter is set to 100; the threshold coefficient is set to 1.

To analyze how credit booms that are followed by a banking crisis differ from the ones that are not followed, we go back to the banking crises data set constructed by Laeven and Valencia (2012). After matching-up the real credit and banking crises data sets, we are left with 130 countries and 121 banking crises for the 1970-2011 periods. For this subset, we identify 366 credit boom peaks (of the originally identified 493 boom peaks) and 72 of these booms are followed by a banking crisis, while 294 of them are not. This implies that only one-fifth of credit booms that we

identified has been followed by a banking crisis. On the other hand, almost 60 percent of banking crises are preceded by a credit boom peak in our data sets. Figure 13 shows how event windows around credit boom peaks look like for the cases of boom peaks with and without banking crises. There is an obvious difference between these two groups of credit booms. Credit booms that are followed by a banking crisis reach to much higher deviation levels (appr., 25-30 percent) around boom peaks on average and on median and they are more likely to end up with significant negative deviations from the trend in many cases. Moreover, the general results about the credit booms depicted in Figure 9 seems to be driven by the cases of credit booms that are not followed by banking crises. The convex arms of the average deviations before and after the credit boom peaks depicted in Figure 9 are repeated in the right plot of Figure 13. However, credit booms with banking crises do not exhibit any pattern of accelerating pace of deviation before the boom peaks. Instead, the actual real credit deviates from the trend at a steady but higher pace (compared to the credit booms without banking crises) starting at 2-3 years before the boom peak. This leads to the return of the actual credit to its trend very rapidly in the case of credit booms with banking crises.

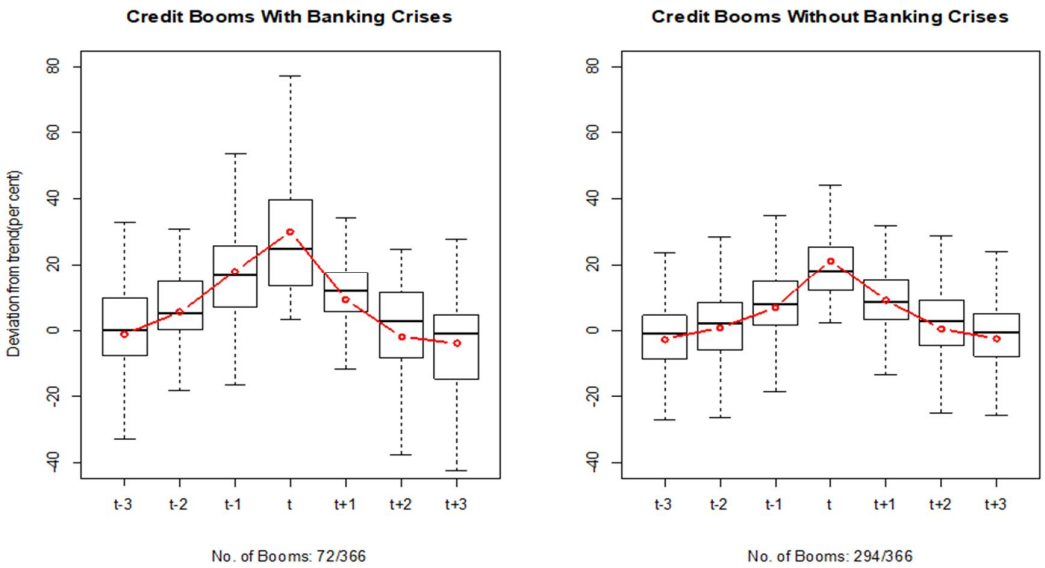


Figure 3.13 Event Window (7 years) for Credit Boom Peaks with and without Banking Crises

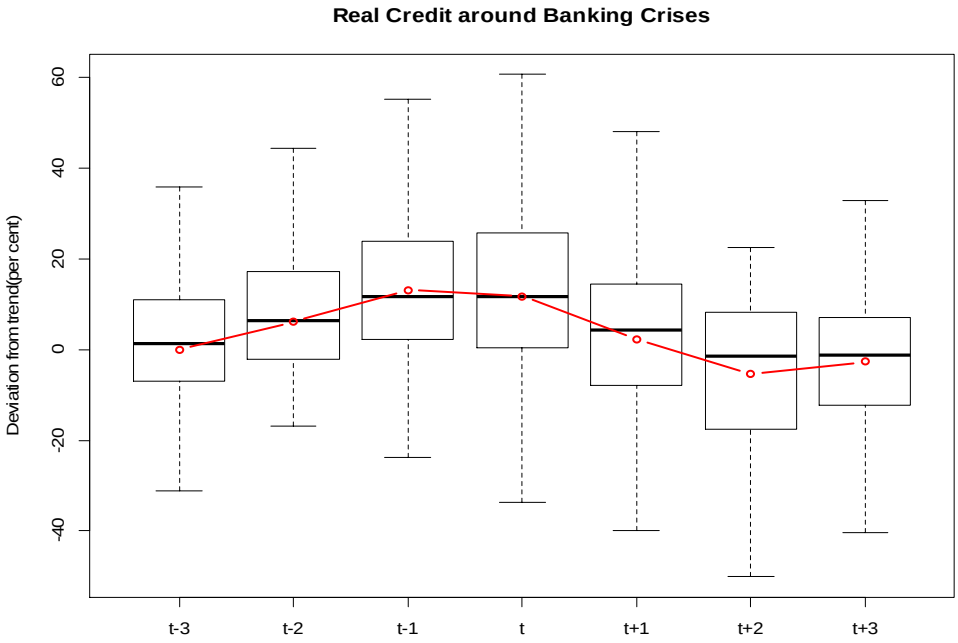
Source: IFS, WDI, BIS, UN; Laeven and Valencia (2012). Author's calculations

Notes: Smoothing parameter for HP filter is set to 100; the threshold coefficient is set to 1. Real credit and the banking crises data sets have 130 countries in common for the 1970-2011 periods. For this subset, there are 121 banking crises and 366 boom peaks. 72 of credit boom peaks are followed by a banking crises.

When we look at the behavior of real credit per capita around banking crises, there is no clear Inverse-V shape and the median deviation of real credit from its trend component at the year of a banking crisis is equal to the median deviation at one-year before the crisis (Figure 14). Also, it is interesting to note that two years after banking crises, there are signs of recovery in the real credit. As Figure 14 shows, the median deviation of actual credit from its trend is 12 percent at a crisis year, but there is a very large range for deviations, from –34 to +61 percent, of real credit at banking crisis years[70]. Notice that the first quartile of deviations of real credit at banking crises is 0.5 percent; it is 2.3 percent for the year before the banking crisis and negative for 2-3 years before the crises. This means there is almost no deviation

[70] These figures might have been influenced by the exact timing of banking crises, depending on whether they occurred at the beginning or at the end of the year.

of actual credit from its trend component for nearly 25 percent of banking crises, which implies that we had no chance to find any credit boom that would be associated with nearly 25 percent of crises in our data set since we ruled out deviations below zero in our credit boom defining criterion. Considering that, the performance of our method in finding the associations of credit booms and banking crises are quite satisfactory.



	t-3	t-2	t-1	t	t+1	t+2	t+3
min_IQR	-31.2%	-16.8%	-23.8%	-33.6%	-40.0%	-50.1%	-40.5%
1st quartile	-6.9%	-2.0%	2.3%	0.5%	-7.9%	-17.5%	-12.3%
Median	1.4%	6.4%	11.7%	11.8%	4.4%	-1.4%	-1.2%
3rd quartile	10.9%	17.3%	24.0%	25.8%	14.5%	8.3%	7.2%
max_IQR	35.9%	44.5%	55.3%	60.7%	48.2%	22.6%	33.0%

Figure 3.14 Event Window (7 years) for Real Credit per capita around Banking Crises

Source: IFS, WDI, BIS, UN; Laeven and Valencia (2012). Author's calculations

Notes: Smoothing parameter for HP filter is set to 100; the threshold coefficient is set to 1. Real credit and the banking crises data sets have 130 countries in common for the 1970-2011 periods. For this subset, there are 121 banking crises and 366 boom peaks. 72 of credit boom peaks are followed by a banking crises.

Finally, Figure 15 documents the distribution of credit booms that are followed by banking crises within a 3-year horizon with respect to the income groups of countries. First of all, there are very few observations for the low and lower-middle income countries, which suggests that credit boom followed by banking crises is an above-average developing country and advanced country phenomenon[71]. Secondly, except for the low income countries, which have only 5 observations of credit boom followed by a banking crisis, Inverse-V shape of credit booms is highly visible for all country groups. However, there are significant differences between middle income and high income groups. The median and mean deviation of real credit above its trend reach 40-45 percent at credit boom peaks for the middle income countries, whereas they reach only 20-25 percent for high income countries. Notice that these figures are nearly twice the amount of deviations for all credit booms in Figure 11, which implies that credit booms that reach to nearly two standard deviations above the trend are more likely to be associated with a banking crisis. The reversal of real credit to the trend level after a credit boom peak associated with a banking crisis is also much faster in lower-middle and upper middle income countries (1-2 years compared to 3 years in high-income countries). Moreover, for the median and mean cases and for the bulk of middle income countries, the real credit significantly deviates towards the downside of trend 2-3 years after the credit boom peak, whereas the real credit in high income countries returns to the trend level after a credit boom (associated with a crisis) for the average and median cases.

[71] The ratios of the number of credit booms followed by banking crises to the number of countries in each income group are 0.36, 0.35, 0.58 and 0.54, from low to high income group, respectively.

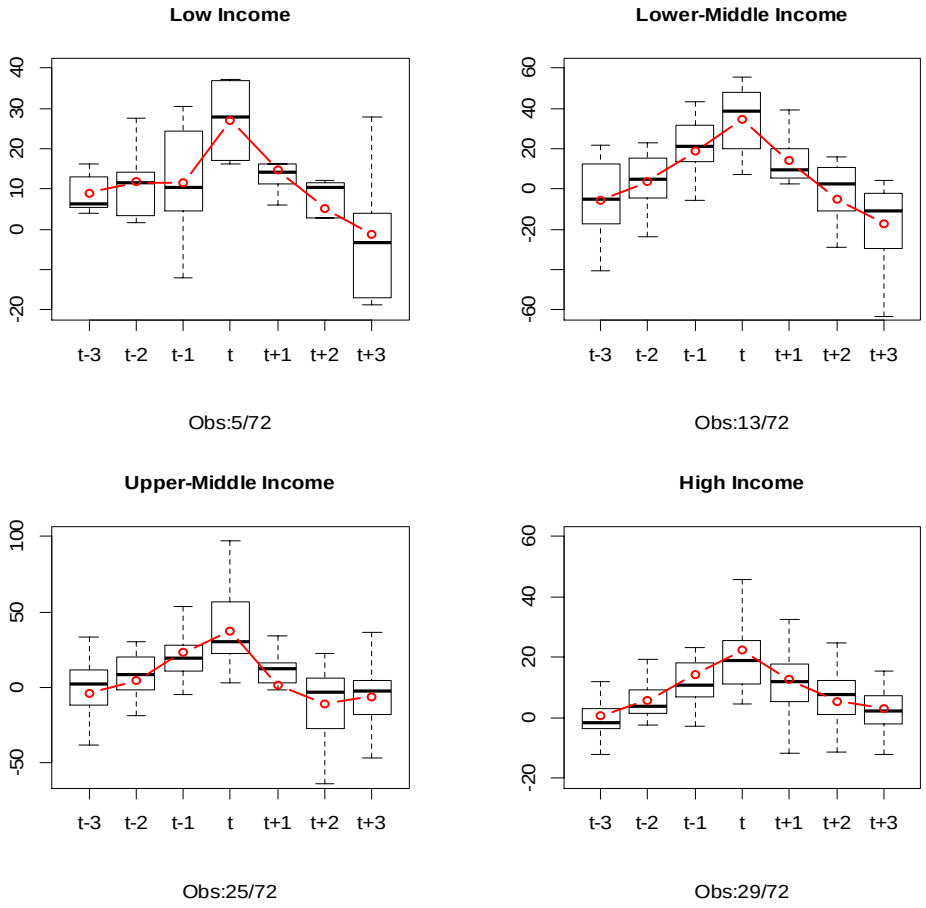


Figure 3.15 Event Window (7 years) for Credit Boom Peaks followed by Banking Crises according to Income Groups of Countries

Source: IFS, WDI, BIS, UN; Laeven and Valencia (2012). Author's calculations

Notes: Smoothing parameter for HP filter is set to 100; the threshold coefficient is set to 1. Real credit and the banking crises data sets have 130 countries in common for the 1970-2011 periods. For this subset, there are 121 banking crises and 366 boom peaks. 72 of credit boom peaks are followed by a banking crises.

Figure 16 repeats the same exercise for the credit-to-GDP groups of countries and documents the distribution of credit booms followed by banking crises with respect to the credit-to-GDP groups of countries (see Appendix, Table A.1). Firstly, although there are fewer observations of credit booms followed by banking crises for the higher level (60+ percent) credit-to-GDP groups, there is, in fact, a steady rise of

such observations in proportion to the number of countries in each group[72]. This suggests that credit booms followed by banking crises are more likely to occur as credit-to-GDP ratio increases. Secondly, the Inverse-V shape of credit booms for the 7-year event windows is highly visible for all country groups, in particular for the higher level (60+ percent) credit-to-GDP groups. On the other hand, the duration of credit booms followed by banking crises seem much shorter for the lower level (60– percent) credit-to-GDP groups, for which the positive deviation of real credit per capita from its trend starts 2 years before the peak and the credit cycle ends 2 years after the peak. Also, the median and mean deviation of real credit above the trend reach much higher levels at credit boom peaks for the lower level credit-to-GDP groups (about 30-36 percent compared to 13-18 percent of high credit-to-GDP group). The deviations of real credit per capita at credit boom peaks associated with banking crises are roughly 1.5 times the amount of deviations for all credit booms in Figure 10, which implies that credit booms that reach to nearly 1.5 standard deviation above the trend are more likely to be associated with a banking crisis.

[72] The ratios of the number of credit booms followed by banking crises to the number of countries in each credit-to-GDP group are 0.42, 0.48, 0.52 and 0.6, from low to high credit-to-GDP group, respectively.

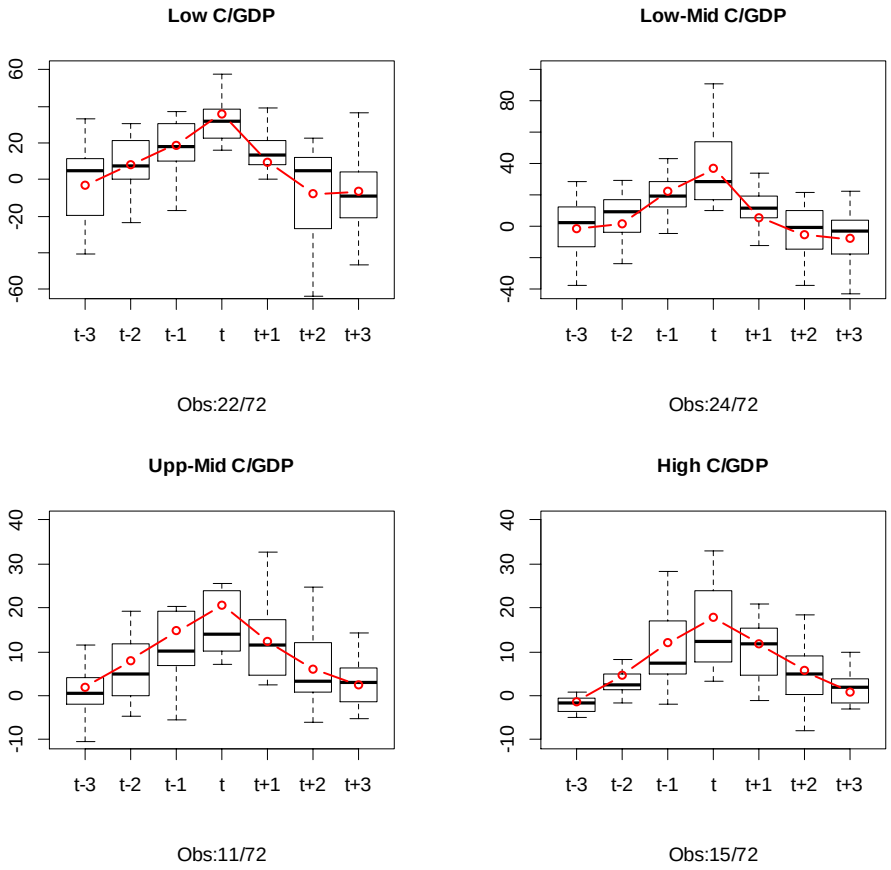


Figure 3.16 Event Window (7 years) for Credit Boom Peaks followed by Banking Crises according to Credit-to-GDP Groups of Countries

Source: IFS, WDI, BIS, UN; Laeven and Valencia (2012). Author's calculations

Notes: Smoothing parameter for HP filter is set to 100; the threshold coefficient is set to 1. Real credit and the banking crises data sets have 130 countries in common for the 1970-2011 periods. For this subset, there are 121 banking crises and 366 boom peaks. 72 of credit boom peaks are followed by a banking crises.

3.5. Concluding remarks

Credit boom identification by detrending the credit series via HP-filter and setting a threshold strategy over the cyclical component of credit series has become a common practice recently, since this framework offers easy and replicable application for credit boom identification and provides good signaling performance

for banking crises (Drehmann et al., 2011). However, there is no single way to use this framework. Although, considering practicality and performance, one-sided HP filter seems preferable to two-sided, full sample HP filter in credit boom identification, it is not appropriate to analyze the characteristics of credit booms using one-sided filter, since it distorts the characterization of the trend component (Mendoza and Terrones, 2008; Edge and Miesenzahl, 2011). Also, which type of transformation is required for the original nominal credit stock and whether universal or country-specific thresholds should be used are still controversial issues. Notwithstanding the controversies in credit boom identification literature, time-specific dynamics of credit expansions have received almost no attention so far and the literature ignores the fact the cyclical component of the time series of a credit variable does not need to exhibit fluctuations of the same size over time. This paper shows that, in fact, the variance of the cyclical component of real credit per capita has significantly increased since the 1980s. This requires that we need to adjust the threshold levels for the identification of credit booms over time, just as we adjust the threshold levels for different countries. In order to solve this problem, we used a recursive application of Mendoza and Terrones' (2008) method and applied it for a large sample of advanced and developing countries (148 countries, 1950-2016) to analyze the characteristics of credit booms at different times and for different country groups.

The signal extraction analysis for credit booms and banking crises reveals that low and lower-middle income countries have higher missed-crisis and noise-to-signal ratios. Credit booms and banking crises might have been driven by different factors for lower income developing countries, and as a result, there might have been a weak association between credit booms and banking crises. This view is also supported by our finding that for the low income and lower-middle income countries, there are very few cases of credit booms that are followed by banking crises in our baseline analysis. All in all, credit booms followed by banking crises seem as an above-average developing country and advanced country phenomenon.

In the event window analyses, we find that although credit booms, as we defined them, did not increase in number over time, their influence on the economy might have been higher in the most recent periods, since there has been an increasing trend of deviations of real credit per capita from trend values around credit boom peaks. The duration of credit booms has also extended from 3-5 years (pre-1970) to 5-7 years (post-1970) over the course of the history. Moreover, credit booms of different countries have become more clustered over time for smaller time periods, which suggests that global determinants of credit booms might have overweighed local ones as financial integration has prevailed. Besides, there are significant differences among country groups in terms of the evolution of credit booms around credit boom peaks. Countries that have lower credit-to-GDP today have experienced much higher deviations of credit at credit boom peaks, whereas the others have experienced much lower deviations. This is also true for the relation between income groups and credit booms; except for the upper middle income group, which has experienced credit booms with deviations of real credit at credit boom peaks close to that of the low income group. Since high credit-to-GDP and high income countries experience smoother cyclical fluctuations of credit, they have lower levels of thresholds for a credit boom to emerge out. Moreover, whereas low income and low credit-to-GDP groups exhibit significant diversity in their experiences of credit booms, there is more similarity in the high income and high credit-to-GDP groups, which implies that the cyclical behavior of credit is more pronounced in more developed countries.

Our analysis also confirms the common finding that most of the banking crises (60 percent in our baseline experiment) have been preceded by credit booms. However, our baseline analysis shows that only one-fifth of credit booms has been followed by a banking crisis. Credit booms followed by a banking crisis have higher deviation levels around boom peaks and they are more likely to end up with significant negative deviations from the trend in many cases. These findings are more pronounced in the middle income countries, particularly in upper-middle income countries.

We developed our method of credit boom identification mainly for the purpose of analyzing the historical and country-group properties of credit booms. Our signal extraction analysis shows that credit booms we identified have satisfying performance in predicting upcoming banking crises for a very large set of countries, in particular, for the high and upper middle income (and credit-to-GDP ratio) groups of countries. This suggests that the method can be adapted to the purpose of forecasting possible financial distress episodes for such countries. Since we do not use the last five years of observations of real credit in order to save ourselves from "end-point problem" of HP filter, the adaptation of our method requires either accepting the end-point problem or forecasting the next five years of real credit per capita in order to decide whether today's observation can be deemed as a credit boom or not. Although forecasting of real credit per capita has its own hardships, it may yield superior performance compared to one-sided HP filter, which suffers from "sub-optimal" estimation of the trend component at the end of the samples.

CHAPTER 4

A FRAMEWORK FOR STRATEGIC ASSET ALLOCATION OPTIMIZATION IN A MULTI-CURRENCY SETUP FOR A DEVELOPING COUNTRY CENTRAL BANK

Developing country central banks accumulate and manage international reserves with the purpose of keeping/developing the ties of national economy with international markets. In practice, this means that central banks have to choose an exchange rate (ER) regime that is best suitable for the macroeconomic conditions and strategic priorities of the country and sustain that regime by providing/assuring required liquidity and lower price volatility in foreign exchange markets. As the government's treasurer, central banks are also assigned by the role of international debt service payments for the governments. In addition, central bank reserves can potentially be used as a source for purchasing foreign goods/services, supporting national programs under emergency conditions and/or supporting domestic monetary policy operations (Nugee, 2001; IMF, 2014, Borio et al., 2008a).

On the macroeconomics side, growing amounts of international reserves held by developing economies and the benefits and costs of holding large amount international reserves has long been discussed (e.g. Rodrik, 2006; Levy-Yeyati and Gomez, 2019). The main cost of holding reserves results from the difference between low-yields to reserve assets held by central banks (CBs) and typically higher cost of external borrowing for a developing country. The expected benefits from holding international reserves, on the other hand, are reducing the potential costs of global financial shocks and/or capital flow sudden stops/reversals, reducing

the borrowing costs for government and smoothening exchange rate variations when reserves are used countercyclically.

On the financial side, the large amount of international reserves held by CBs force them necessarily into taking into account the risk-return characteristics as well. Given the conditions and reasons for holding reserves, the order of priorities for CBs in reserve management are, respectively, liquidity, capital preservation and return, i.e. holding adequate liquid investment to satisfy defined objectives when necessary, preservation of capital by managing various risks and obtaining reasonable risk-adjusted return (IMF, 2014).

Liquidity and risk considerations necessarily narrow the investment universe for CB strategic asset allocation process. Nonetheless, CBs has taken the conservative asset management one step further and typical asset management framework has been setting a quite narrow investment universe with pre-determined liquidity, currency and/or country allocations. In such a setup, the reserve management activity is typically reduced to the management of market risk (duration) of a sub-portfolio of high-grade reserve-currency government bonds[73]. This type of conservatism has been criticized. Fisher and Lie (2004) shows that relaxing the pre-determined constraints on liquidity, currency, credit and duration risks and allowing for a simple mean-variance optimization significantly increases the expected return levels for the same levels of portfolio risk.

Since the global financial crisis, low-yield and even negative yield environment in high-grade government bond market seem to accelerate the evolution of central bank reserve management practices and many central banks embraced a much more return (or cost reduction) oriented perspective. Many emerging market CBs employed

[73] Fisher and Lie (2004) summarizes typical central bank asset allocation process: preserving capital and liquidity are the main investment objectives, which leads to restricting investment universe into high-grade fixed-income securities and establishing a separate liquidity tranche that allows quick and low-cost foreign exchange intervention. Currency allocation is typically followed benchmarks such as weights of global bond indices, international payment patterns, the government's foreign debt service composition or the practices of other peer-group central banks; country weights in asset allocation is typically set equal to the currency weights, so that each sub-portfolio denominated in one currency is managed separately with the aim of achieving optimal duration for a given level of risk appetite.

optimization based strategic asset allocation process to their entire reserve portfolio or to investment sub-portfolios (see Appendix Table A.2)[74]. To name a few, Bank of Israel reformed its strategic asset allocation framework towards an optimization process based on government bonds, equities and corporate bonds, on the ground of abundant FX reserves and falling yields on traditional assets (Benita et al., 2019); Bank of Chile constructed a diversification portfolio based on treasury bonds from various countries, emphasizing on the objective of "reducing the costs of holding reserves" (Bank of Chile, 2018); and the Bank of Korea has started to increase the share of equities since 2007 in order to increase returns while diversifying away from the risks related with bonds market (Bank of Korea, 2019).

Markowitz mean-variance portfolio optimization is the natural starting point for a portfolio manager involved in the strategic asset allocation process and requiring for a technical decision support framework (Koivu et al., 2009). The basic mean-variance process or its enhanced versions are adopted by many central banks. However, Markowitz mean-variance portfolio optimization framework has been criticized on the following grounds: (i) it represents the utility and/or targets of the portfolio manager in terms of mean return and standard deviation, which may not be the most appropriate and reliable indicators, (ii) the return distributions of input assets or portfolios constructed are assumed to be normal, which is certainly not true for many asset classes, (iii) it is a static modelling for investment and does not allow for adjustments and rebalancing in the portfolio, (iv) it produces unintuitive portfolio allocations and significantly unstable weights for minor changes in the input variables (Michaud and Michaud, 2008, Koivu et al., 2009).

Modern enhancements to the mean-variance (MV) portfolio optimization aim to reduce those problems. Several dimensions of improvements are related to input estimation enhancements, robust optimization, addition of analyst's views, alternative risk-return measures, and dynamic multi-period optimization procedures (see e.g. Kolm et al, 2014 for a recent literature review). In the context of strategic

[74] Appendix Table A.2 summarizes the methods for currency allocation in the strategic asset allocation process used by a selected set of advanced and developing country central banks.

asset allocation for CBs, Fernandes et al. (2011) compare the results from better input estimation (via Black-Littermann model), resampled optimization and analyst view inclusion with the original MV optimization. They find evidence that all these enhancements improve upon the original MV optimization. Zhang et al (2013) develop a strategic asset allocation process by combining return forecasts from Black-Littermann with behavioral portfolio theory approach that segregate the entire portfolio into sub-portfolios having different goals and risk preferences. Koivu et al. (2009) develops a dynamic optimization framework that uses inputs derived from term-structure forecasting. Romanyuk (2012) aims to develop an objective function in a stochastic modelling framework, with a particular focus on the trade-offs between net returns and liquidation costs when the CB reserves are required for intervention purposes.

This paper will benefit from the use of one of those improvements, resampled optimization. Resampling idea rests on the fact that the inputs that will be used in the optimization procedure are statistical estimates which have variability and carry estimation/measurement error; thereby, the outputs, i.e. efficient portfolios, should have a statistical character as well, or there should be "statistically equivalent" efficient portfolios that cannot be differentiated from the original efficient portfolios (Michaud and Michaud, 2008). The benefits of resampled optimizations are counted as less extreme outcomes with respect to weight distributions in the optimal portfolios, better out-of-sample performance and lowered rebalancing/readjusting costs (Michaud and Michaud, 2008; Markowitz and Usmen, 2003). In the strategic asset allocation context, Bank of Israel finds and analyze "near-efficient" portfolios in order to achieve high degree of robustness to various risks under different scenarios (Benita et al., 2019).

Strategic allocation of official reserves requires for a decision support framework that allow for taking advantage of diversification into the assets denominated in various major currencies[75]. However, this brings about the immediate problem of

[75] Brennan et al. (2011) show that even in the background of increasing integration and increasing role for the global determinants in explaining high-grade government bond market returns, local

numeraire (unit of account) selection, which leads to different optimal allocations corresponding to different choices of numeraire. The returns of instruments issued in different currencies vary depending on the numeraire selection. Hence, different numeraire selection results in different optimal allocations. Borio et al. (2008a; 2008b) suggest that the choice of numeraire should be in line with the main purpose(s) for holding reserves and the fundamental uses of them[76]. Although this approach is reasonable from a "liquidity" portfolio perspective, it is not necessarily the best or the optimal suggestion from an "investment" portfolio perspective. When there are "more than adequate" foreign reserves, or net foreign exchange reserves that is held against domestic currency, then how that portion of reserves should be managed and what is the best choice of numeraire are open questions. In this paper, leaving aside the "liquidity" perspective, we assume that the CB wants to maximize risk adjusted returns over a set of high quality major-currency assets. This requires a multi-currency optimization setup and a specific choice of numeraire that is not biased for/against any major currency.

Multi-currency optimization is generally avoided by practitioners, since the typical selection of base currency (numeraire) as USD makes the returns to assets denominated in other currencies much more volatile due to exchange rate volatility (see e.g. Koivu et al, 2009). This, in turn, penalizes those assets denominated in other currencies in terms of their risk-return characteristics. Moreover, much of the literature (see e.g. Fisher and Lee, 2004; Fernandes et al., 2011) does not pay attention to the numeraire question and ignores how much of their results are distorted by the selection of numeraire as USD. As it will be seen in the empirical part of this study, the numeraire choice is not harmless and typically leads to non-intuitive, highly concentrated portfolios.

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determinants still explain about 25 per cent of risk premia, which leads to significant gains from volatility reduction in a high-grade government portfolio.

[76] "Different choices of numeraire imply different definitions of returns and risk and hence, in general, different optimal allocations. The choice of numeraire should ultimately derive from an evaluation of the economic function (use) performed by the FX reserves" (Borio et al., 2008a:6).

In this essay, we offer a multi-currency portfolio optimization framework for developing country CBs, by which currency allocation of official reserves is optimally selected within the optimization framework. To this end, the numeraire is constructed as a basket of currencies selected from the investment universe. The weights are derived from the principal component analysis of the exchange rates of those currencies with respect to the own currency of a developing country. In this essay, Turkish Lira (TRY) is used as the baseline case in order to derive weights of the major reserve currencies in the basket mentioned above[77]. This approach yields a synthetic numeraire with the following features: (i) it does not favor any currency in the multi-currency optimization framework; (ii) it relies on a reasonable and logical procedure that yields transformed return series with close features to the original own-currency returns; (iii) the output of our study is compatible with different kind of unit of account selections practiced by CBs, i.e. the optimal allocations cannot specifically be punished in any of the common numeraire selection of CBs (domestic currency, a basket of selected currencies, the USD and so on); (iv) it is useful in generating diversified portfolios via optimization procedures across major currencies and it is beneficial to reduce exchange rate volatility of the portfolio.

This paper contributes to the literature by developing a basic, flexible and practitioner-friendly optimization framework for the strategic asset allocation process of a developing country CB with a specific focus on the optimal currency allocation of an investment portfolio. The framework is open to further improvements by using the state-of-the-art extensions to the Markowitz portfolio optimization framework by combining forward-looking inputs via yield curve forecasting, adding analyst views and constructing tailor-cut objective functions. Moreover, this study enhances the investment universe of a CB that will be used for optimization by adding some asset classes, such as gold and China government bonds. Although these asset classes are (or will be) widely preferred ones by the CBs

[77] Several other developing country currencies are also analyzed for controlling the stability of optimal portfolios across different sets of basket currencies.

in practice, they are generally not included in previous studies related with optimal strategic asset allocation.

Our optimization results suggest that there are significant gains from diversification with the addition of alternative instruments (such as gold, CNY bonds or stocks) to a typical investment universe that consists of only major bonds. Secondly, we show that the resulting portfolio weights from a MV optimization based on return inputs in terms of a basket currency are highly diversified and quite stable across several dimensions, whereas USD based MV optimization yields too much concentrated portfolios with unstable weights. Moreover, the weight attributions from basket currency based optimization to each asset class is reasonable considering the main features of the recent two decades (the period of interest), but it would be impossible to reach such a conclusion from USD based optimization. Thirdly, we show that the resampled optimization based on a basket currency increases diversification ratios further and the stability of weights also slightly increases. USD based resampled optimization, on the other hand, does not improve on the diversification side and on the stability side across different sets of investment universes (except for the low risk averse options of optimal portfolios). Fourthly, by the out-of-sample performance analysis, we can say that basket currency based optimization procedure that we developed performs quite well in different scenarios, by yielding comparable returns to equal-weight portfolio and the global minimum variance portfolio in terms of USD. Finally, constructing a constrained optimization framework, we show that predetermined liquidity, currency and duration constraints confine optimal allocations to the less riskier side of the unconstrained frontier and those constrained frontiers are actually very close to our unconstrained resampled frontier, which implies that typical constraints of a CB actually do the same job with the resampling and confine itself into the conservative side of optimal portfolio search.

The structure of the article is as follows. First, we explain how we construct the numeraire that will be used throughout the study and we show how our transformation of returns change the risk-return characteristics of different asset classes. In the following section, we start with carrying out an unconstrained MV

optimization process as a benchmark by using basket currency based returns and USD returns. Then, we employ resampled optimization process and control whether the resampling leads to any improvement upon previous results. Furthermore, we carry out an in-sample and extensive out-of-sample performance analysis for the previous results. Finally, we construct a constrained optimization framework for a typical CB in order to understand how basket currency based optimization can be generalized for the management of the entire reserve portfolio. The last section concludes and discuss about the further avenues to enrich our framework.

4.1. Numeraire selection

4.1.1. Numeraire construction

To carry out a multi-currency portfolio optimization, a numeraire other than the currencies involved in the investment universe is required in order to avoid the bias for the risk-return characteristics of the numeraire-denominated assets. The first alternative is to use domestic currency, which is suggested as a good choice when the CB has a "national wealth" focus in its reserve management (Borio et al., 2008a; 2008b). Unfortunately, for many developing countries, exchange rate volatility is very high against the majors so that it makes hard to use domestic currency based returns in an optimization framework. Alternatively, one can try to take out the effect of domestic currency volatility against the majors in the domestic currency based returns, which is the starting point of this study. One could easily realize that this approach is, in fact, equivalent to construct a basket of currencies within the investment universe and calculate the returns in terms of that basket[78].

[78] Another obvious alternative is to use SDR as a unit of account. Hoguet and Tadesse (2011) explore the benefits of SDR as a unit of account for reducing exchange rate risk of the portfolio and for increasing diversification, and the possible benefits of developing a market of SDR-based instruments. We reach similar conclusions about risk reduction and diversification benefits from a basket of major currencies (with nearly equal weights) used as a numeraire, although we do not prefer SDR since it may not propose the optimal weighting scheme. In fact, we propose tailor-made construction of baskets like SDRs may be much more suitable.

In this study, we take out the effect of domestic currency volatility from domestic currency returns by using principal component analysis. This is equivalent to say that the weights of currencies in the basket currency equivalent that we use as a numeraire are selected by using principal component analysis of the exchange rates of those currencies with respect to domestic currency. Let us use Turkish Lira (TRY) as domestic currency to show how our numeraire is constructed. Our investment universe consists of six major currencies: USD, EUR, JPY, AUD, CAD, and GBP.

Defining our basket-currency, B, such that $B^{TRY} = \sum_{i=1}^{6} w_i E^i$, where B^{TRY} is the basket-currency in terms of TRY, E^i is the exchange rate of major currencies with respect to TRY and w_i represents the weight of the currency i. Let the vector of weights, w, be calculated as, $w = PC1$, where $PC1$ is the normalized first principal component[79] of the depreciation rate of TRY, $d_t^i = \frac{E_t^i}{E_{t-1}^i} - 1$ for each time t, so that $\sum w_i = 1$, for $i = 1, \dots 6$. Then, for any asset within the investment universe, the gross return to that asset in terms of the basket-currency can be formulated as $\frac{1+r_t^{TRY}}{1+d_t^B}$, where r_t^{TRY} is the TRY return to the asset and d_t^B is the percentage change of the basket-currency in terms of TRY at time t. Simple algebra yields that:

$$\frac{1+r_t^{TRY}}{1+d_t^B} = (1 + r_t^*) \times (1 + x_t^*) \qquad (1)$$

where r_t^* is the own-currency return to an asset and x_t^* is the appreciation rate of the currency of that asset against the basket of majors.

The left-hand side of the equation is actually taking domestic currency returns and then taking out the effect of domestic currency volatility, calculated against a basket of major currencies. The equality shows that this is equal to taking own-currency return of an asset multiplied by that currency's appreciation against its peers. This equation shows that our transformation of asset returns yields comparable and unbiased asset returns in terms of their risk-return characteristics, since the return to

[79] See the next subsection for the explanation of why the first principal component is taken only.

an each asset is represented by its own-currency return weighted by that currency's appreciation against its peers. In order to see how this transformation affects the time series of returns, Figure 1 compares the returns to four selected asset classes (US Treasury Bonds Index 1-10 years maturity, AAA-AA rated Eurozone government bonds 1-10 years maturity, gold and S&P 500 Total return index) after transformation against their USD returns. This shows that (i) the volatility of the US Treasury Bonds increases with the exchange rate effect so that the bias in favor of the US Treasury Bonds disappeared after transformation, (ii) the volatility of non-USD bonds are reduced since the basket includes the own currencies of non-USD assets with some weight, (iii) for real strategic assets, such as gold, there is a little change in terms of risk-return characteristics after transformation, (iv) for high risk asset classes (such as gold and S&P 500), the exchange rate effect compared to price effect are much less pronounced so that the effect of transformation is limited and the transformed monthly returns are close to own-currency returns.

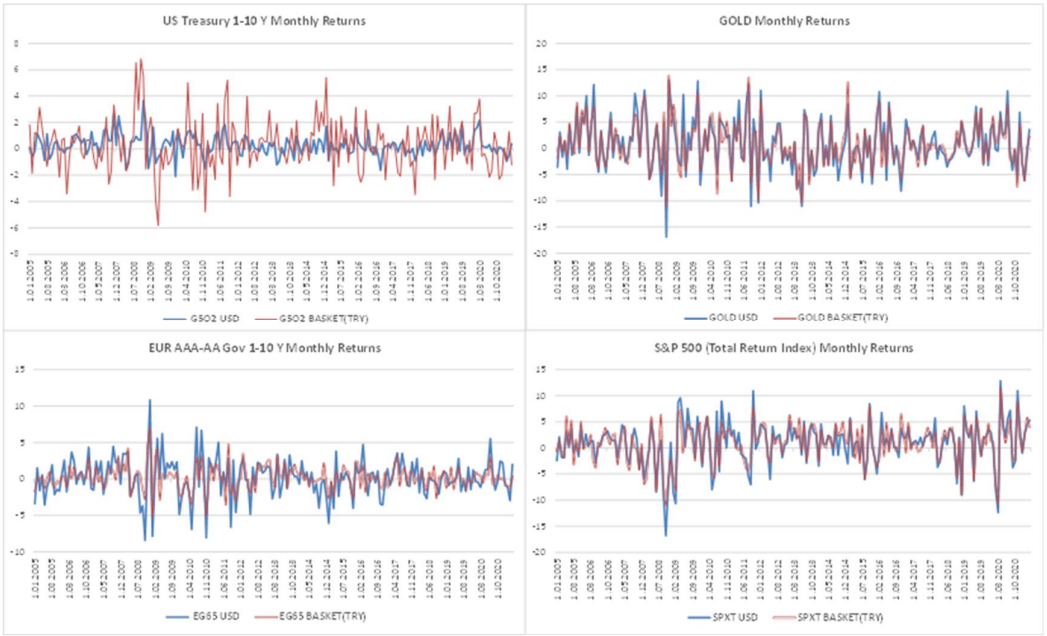

Figure 4.1 Monthly Returns of Selected Asset Classes in Terms of USD vs in Terms of Basket Currency

Sources: ICE indices, Bloomberg. Author's calculations.

4.1.2. Results of principal component analysis

We use six exchange rate series (USDTRY, EURTRY, JPYTRY, GBPTRY, AUDTRY and CADTRY), covering the period from January 1999 to April 2021, in order to construct the basket currency. In order to avoid any possible bias resulting from the use of TRY in the construction of the numeraire and in the upcoming mean-variance optimization process, we also analyze the data for six other emerging market countries (Brazil, India, South Korea, Mexico, Russia, and South Africa)[80].

Principal components are calculated using the monthly returns to the exchange rates of domestic currencies against the majors. Table 1 shows a summary of the principal component analyses of exchange rates, which includes the first two of six sample eigenvectors with corresponding sample standard deviations and explained cumulative proportions of variations (with scree plots). The first part of the table shows the results for TRY, a representative example for other emerging market currencies in our data set, except for INR; and the second part of the table shows the results for INR, which shows some exceptional patterns. Firstly, the first components are roughly equally weighted linear combinations of exchange rates. Moreover, the first principal component explains 86.15 per cent of the total variation for the case of TRY and, in general, more than 70 per cent of total variation for the other cases, except for India, for which the proportion of variance explained is 49.8 per cent. For the exceptional INR case, the lesser weight attributed to USD is related with the lower volatility of USDINR compared to other major-INR pairs[81]. Thus, the first components can be interpreted as the representative of domestic currency volatility against majors, i.e. *domestic component*[82]. The eigenvectors of the second

[80] The country selection is mainly restricted by the main data source for bond returns and the selected ones are subjectively considered as the most eligible group of countries for a peer group analyses. See Appendix A for data descriptions.

[81] We made additional analyses for INR and for other currencies. If we have worked with the data belong to 2010s only, the explanatory power of the first principal component increases toward 60 per cent for INR case. The principal component analysis of CHF against majors, for example, displays a similar pattern with INR in terms of cumulative proportions and in terms of the skewed structure of the first eigenvector. In CHF case, the lesser weight is attributed to EUR in the first component.

[82] Such interpretations for the meaning of principal components can be found in the literature of yield curve forecasting (e.g. Duffee, 2012) or in the context of stock market returns (Tsay, 2010).

components, on the other hand, have quite similar structure for all cases, in which USD and JPY (safe-haven currencies of the last two decades) take positive weights and the other majors take negative weights. Moreover, the magnitudes also hint at the safe haven effect (AUD has the most negative weight and JPY has the most positive one). Thus, this component might represent the global risk aversion patterns, hence can be interpreted as *global component*.

	USDTRY	EURTRY	JPYTRY	GBPTRY	CADTRY	AUDTRY		St.Dev	Cum.Proportion	Scree Plot
Comp.1	0.41	0.41	0.48	0.42	0.38	0.35	Comp.1	12.34	86.2%	
Comp.2	0.17	-0.17	0.77	-0.23	-0.28	-0.48	Comp.2	3.27	92.2%	
	USDINR	EURINR	JPYINR	GBPINR	CADINR	AUDINR				
Comp.1	0.24	0.46	0.45	0.42	0.39	0.44	Comp.1	4.72	49.8%	
Comp.2	0.25	-0.11	0.77		-0.24	-0.52	Comp.2	3.14	71.9%	

Table 4.1. Summary of the Principal Component Analyses of Exchange Rates
Source: Bloomberg; Author's calculations.

By the construction of our analysis, we move on with eliminating the first principal components only from domestic currency based returns. Note that this is not the only option. Eliminating the effects of other components from domestic currency based returns offers interesting avenues for further research. For example, when we eliminate the effects of the first two components (domestic and global components), we obtain a different basket currency, in which USD and JPY have much higher weights. For this basket currency, descriptive analysis of risk-returns favors USD and JPY assets. Thus, optimizations based on such a basket currency overweight USD and JPY asset classes, as expected, particularly for the middle and higher risk aversion cases.

Table 2 shows the results for the basket currency weights in terms of percentage points in excess of equal weights (16.6%) attributed to each major currency when we take out the effect of the first principal component (i.e. domestic currency volatility component). These weights (added to equal weight) will be used for the construction of the basket currency for each case.

Excess Weights Attributed to Major Currencies
(percentage points in excess of equal weights; derived from normalized 1st principal component)

	USD	EUR	JPY	GBP	CAD	AUD
TRY	0.1	0.0	2.9	0.4	-1.0	-2.3
BRL	1.1	0.0	2.7	1.0	-1.8	-3.1
INR	-6.8	2.5	2.1	0.9	-0.4	1.5
KRW	0.6	0.4	0.6	0.7	-0.4	-2.0
MXN	-0.4	1.0	5.0	-0.5	-2.4	-2.7
RUB	1.3	0.1	3.6	-0.2	-2.1	-2.7
ZAR	1.7	0.3	2.2	0.8	-1.4	-3.7

Table 4.2. Excess Weights Associated with the Major Currencies in the Construction of the Basket

Source: Bloomberg; Author's calculations.

The normalized weights derived from the first principal components are close to equal weights, in general. We should note that these weights do not tell too much about the patterns of foreign exchange market in a country. For example, foreign exchange market in Turkey is dominated by USD and EUR[83]. However, since the principal component analysis aims to find the portfolio that explains the maximum total variation of TRY against all six major currencies, it is reasonable to expect that the weights of that portfolio should be close to equal weights. Another note should be the general tendency of our analysis to attribute significantly less weight to a major currency if the country in case pegs domestic currency to that major for a period. This can be seen for the weight attributed to USD from the principal component analysis of the INR (Indian rupee). One should expect that this will increase the volatility input of USD denominated assets compared to others in the mean-variance optimization process based on the basket currency, thereby, any USD denominated assets will have lesser weight in the optimal portfolios[84]. This implies

[83] According to BIS (2019) Triennial Survey results, 92 per cent of foreign exchange transactions against local currency were denominated in USD and 7 per cent of them were denominated in EUR. Furthermore, USD appeared in one leg of the 89 per cent of all foreign exchange transactions in Turkey in 2019, whereas TRY appeared in one leg of the 64 per cent of all foreign exchange transactions, which is followed by the 33 per cent share of EUR, 5 per cent share of GBP and 3 per cent share of JPY.

[84] Our results confirm that expectation. USD has the smallest weight in currency allocation for the optimization analysis based on INR.

that our framework is inclined to attribute less weights to the assets denominated in a "pegged" currency. Although this seems contradictory from liquidity perspective, it is perfectly reasonable from investment perspective, since the depreciation of the pegged currency against other majors means that the value of other majors in terms of the pegged currency or in terms of domestic currency -typical choices of numeraire for a country which pegs its domestic currency to a major, will increase so that the value of international reserves will be inclined to be preserved by the weight of other majors.

4.2. Portfolio optimization based on currency baskets

4.2.1. Data and descriptive statistics

In order to carry out mean-variance (MV) optimization analysis, we use a set of government bond indices, obtained from the ICE Indices. For the six major currencies, we choose the group of indices for 1 to 10 year maturities. For EUR denominated government bonds, we use the index restricted for the countries that have credit ratings above AA in order to work with a comparable index. The group of six Treasury bond indices will be the fundamental block of our analysis and is defined as "Major Bonds". Secondly, we add gold prices to this group and we define the second group as "+Gold". Thirdly, benefiting from the same data source, we add three more bond indices, which include China Government Bond Index (1-10 years maturity), USD denominated Foreign Government and Supra-Nationals Index (1-5 years maturity) and the US Corporate AAA Index (1-10 years maturity). We define this group that consists of nine bond indices and gold prices as "Bonds Expanded". Finally, we add total return indices for the main stock market indices of six major currencies and we call this final group that consists of 16 asset classes as "+Stocks".

All indices are obtained in terms of TRY, then monthly return series are transformed by using the left-hand side of equation (1) and they become monthly returns in terms of the basket currency. Table 3 shows the summary statistics for the monthly returns of 16 asset classes in terms of the basket-currency derived from the principal

component weights associated with TRY[85]. Since TRY-based bond indices start at December 2004, the monthly return series cover the period between January 2005 and April 2021, consisting of 196 observations[86].

Name	Code	Currency	Mean*	Trimmed Mean (10%)*	Standard Deviation*	Skewness	Kurtosis
US 1-10Y	G5O2	USD	3.9	3.5	6.8	0.3	4.0
Canada 1-10Y	G5C0	CAD	3.4	3.6	5.4	-0.3	4.6
Euro AAA-AA 1-10Y	EG65	EUR	2.6	2.4	5.8	0.2	4.7
UK 1-10Y	G5L0	GBP	2.3	3.0	5.8	-0.8	5.7
Australia 1-10Y	G5T0	AUD	5.5	6.1	7.3	-0.5	5.6
Japan 1-10Y	G5Y0	JPY	1.5	0.3	9.5	1.1	7.1
Gold	GOLD	(USD)**	10.2	9.8	15.2	0.2	3.3
China 1-10Y	G5CN	CNY	6.2	5.4	7.0	0.7	5.7
Foreign Gov.&Supra-Nat 1-5Y	DS2V	(USD)**	3.7	3.5	6.2	0.3	3.8
US Corporate AAA 1-10Y	GLC1	USD	4.4	4.2	5.4	0.3	4.5
SPX Total Return (TR)	SPXT	USD	11.1	12.7	12.9	-0.6	3.6
DAX 30	DAX	EUR	9.5	12.1	19.2	-0.6	4.0
NIKKEI	NIKKEI	JPY	6.8	7.8	14.1	-0.3	3.6
FTSE100	FTSE100	GBP	5.6	7.4	14.1	-0.7	4.7
ASX	ASX	AUD	10.0	12.7	18.9	-0.9	5.9
TSX	TSX	CAD	9.2	11.0	16.7	-0.9	6.3

*Annualized mean is twelve times the monthly returns; and annualized standard deviation is the square root of 12 times the monthly standard deviations.
**Gold prices and DS2V index constituents do not directly reflect an exposure to the US country risk, although these assets are priced and/or denominated in USD.

Table 4.3. Descriptive Statistics (in terms of the Basket Currency derived from TRY Principal Component)
Source: ICE indices, Bloomberg; Author's calculations.

4.2.2. Mean-Variance unconstrained optimization

As a base case, we apply unconstrained MV optimization process for the monthly returns in terms of the basket currency. Although we use the term "unconstrained", we always put budget constraint (i.e. portfolio weights are equal to 1) and no-short constraints for individual asset classes (i.e. any asset class should take a weight from the [0,1] interval) throughout the study. "Constrained" cases will include natural constraints related to CB strategic asset allocation process (i.e. constraints on liquidity, credit, currency risks and duration). We follow Nyholm (2008) to build up optimization process in MATLAB: (i) we calculate the maximum return and the

[85] See Appendix Figure A.1 for boxplots.

[86] See Appendix Table A.3 for the periods covered in other country cases.

minimum variance portfolio weights analytically, and then, (ii) we calculate 50 efficient portfolios between the minimum risk (minimum return) and maximum return portfolios by solving the following optimization problem for 50 equally spaced portfolio return, r_p, between the maximum and minimum returns:

$$\min \sigma_p^2 = \frac{1}{2} w_p' \times C \times w_p \qquad (2)$$

$$subject\ to\ w_p' \times r = r_p$$

$$w_p' \times \mathbf{1} = 1\ and\ 0 \leq w_i \leq 1,\ for\ each\ i\ (asset\ class)$$

where σ_p^2 is the portfolio variance, w_p is the vector of portfolio weights, C is the covariance matrix for asset classes, r is the vector of mean returns for asset classes, r_p is the portfolio return, $\mathbf{1}$ is the vector of ones with appropriate length and w_i is the weight of any asset class i.

Figure 2 shows the risk return characteristics of 16 asset classes in the standard deviation – expected return space and the associated efficient frontiers from unconstrained MV optimization calculated for four sets of asset classes (i.e., (i) six major-currency government bonds, (ii) gold added to that bonds, (iii) three other bond indices added to the previous one, (iv) stock market indices added to the previous one). Figure 2 shows that there are significant gains from diversification with the addition of alternative instruments to a typical investment universe that consists of only major bonds. The addition of gold to major government bonds shifts expected returns up for a given risk level for the intermediate-risk optimal portfolio selections. For the lower-risk portfolio selections, however, it is typically not involved in the optimal portfolios. The addition of China government bonds (with a little contribution by the addition of supranational bonds) significantly bends up the frontier, which implies significant gains from diversification especially for the lower and intermediate risk selections. The inclusion of stock market indices lead to further improvements for entire optimal frontier selections. Notice that even the minimum

variance portfolio improves with the addition of stock markets, although the gains are quite small on that lower-risk portions of optimal frontiers.

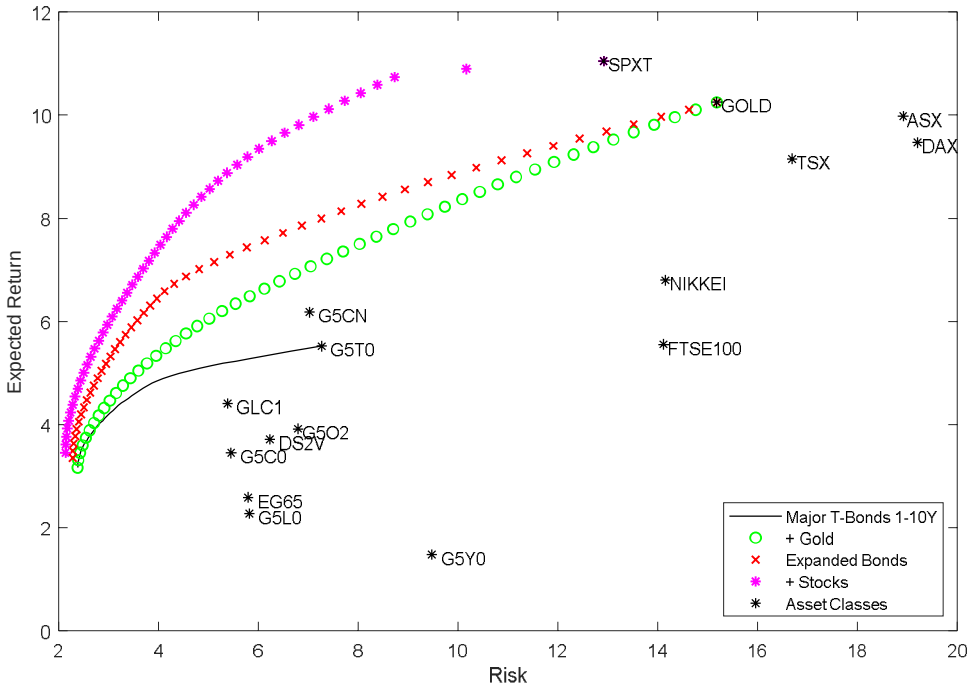

Figure 4.2 Asset Classes and Efficient Frontiers from Unconstrained Optimization
Sources: ICE indices, Bloomberg. Author's calculations.

Although any portfolio on the efficient frontier is optimal, which one or which set of portfolios will be considered as a benchmark for the investment process depends on the risk-return preferences of the decision-maker. In order to ease presentation of the following results, we focus only on the optimal portfolio that has the maximum Sharpe ratio. Figure 3 shows the Sharpe ratios (assuming that risk-free return is zero) calculated for the optimal portfolios on each efficient frontier. As the figure shows, the highest Sharpe ratios are achieved at the lower ranks of optimal portfolios in each set of asset classes (the ranks differs from 7 to 14 for TRY based basket currency, and in general, differ from 5 to 19 for other cases of emerging market domestic currencies). With this selection, we actually focus on the lower-risk and intermediate-risk portions of the optimal frontiers throughout the study, which is, we

think, a harmless assumption in the context of CB strategic asset allocation. Note that with the addition of high-risk assets to the investment sets, the Sharpe ratios for optimal portfolios shift upward especially for the lower rank (lower risk) optimal portfolios. Since the CBs are expected to be risk-averse investors, our focus on the optimal portfolio with maximum Sharpe ratio seems quite reasonable.

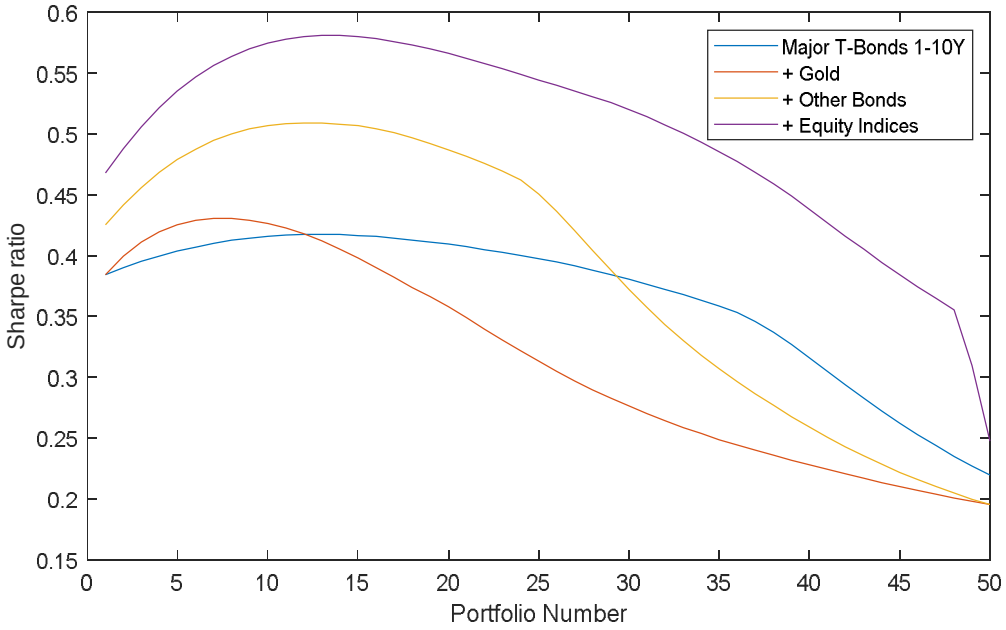

Figure 4.3 Sharpe Ratios for Efficient Frontiers

Sources: ICE indices, Bloomberg. Author's calculations.

Table 4 summarizes the results related to optimal portfolio weights. The first 4 columns show the average optimal portfolio weights (of maximum-Sharpe-ratio-portfolio (hereafter, MS portfolio) attributed to each asset class when we apply MV optimization procedure for the monthly returns in terms of 7 different basket currencies derived from the principal component analysis of BRL, INR, KRW, MXN, RUB, TRY and ZAR. The second 4 columns show the difference between the weights from TRY based analysis and the average weights presented in the first 4 columns. To put things into perspective, the last four columns show the optimal portfolio weights for the MS portfolios derived from an analysis based on USD denominated returns, which is the typical choice of numeraire for the bulk of

research in this area. Finally, we calculate a diversification measure based on Herfindahl-Hirschman. We adjust the Herfindahl-Hirschman index by the count of asset classes in a given set so that it gives comparable results for each investment universe. Also, we adjust the measure to yield 100% for equal-weight portfolio and 0% for a single-asset dominant portfolio. This comparison shows that the resulting portfolio weights from a MV optimization based on return inputs in terms of a basket currency are highly diversified and quite stable near the equally- weighted basket of major currencies. Moreover, when new asset classes added to the investment universe, starting with the set of major bonds only, the resulting re-distribution of weights seems reasonable enough considering the descriptive features of data, whereas USD based MV optimization yields too much concentrated portfolios with abrupt changes of weights when new asset classes added. Note that MS portfolios from the USD based optimization are very close to minimum variance portfolio so that one might think the concentration is resulting from the MS, however the diversification is too low at all risk-levels for the USD based optimization (see Appendix Figure A.2; the upper plot shows weight distribution for USD based optimization for the universe of "+Stocks" as an example).

	AVERAGE (7 Countries)				TRY-AVERAGE OF ALL				USD			
	Major Bonds	(+) Gold	(+) Other Bonds	(+) Equity	Major Bonds	(+) Gold	(+) Other Bonds	(+) Equity	Major Bonds	(+) Gold	(+) Other Bonds	(+) Equity
Rank of MS	10.9	7.6	13.4	13.1	2.1	-0.6	-1.4	0.9	2.0	1.0	3.0	3.0
US 1-10Y	22.0	23.0	0.0	0.0	1.5	1.1	0.0	0.0	88.5	90.1	0.0	0.0
Canada 1-10Y	18.2	16.5	11.6	3.2	0.1	0.6	0.3	-3.2	10.0	7.6	0.4	0.0
Euro 1-10Y	8.6	8.6	9.4	12.4	-1.5	-1.1	-0.7	-2.8	0.0	0.0	0.0	0.0
UK 1-10Y	16.7	16.4	12.7	12.1	-0.1	0.3	0.9	-0.1	0.4	2.4	0.0	0.0
Australia 1-10Y	26.4	24.5	23.5	11.8	1.3	0.9	1.5	5.3	1.1	0.0	0.0	0.0
Japan 1-10Y	8.1	5.2	1.8	7.7	-1.3	-0.4	0.8	1.4	0.0	0.0	0.0	0.0
Gold		5.8	7.3	7.7		-1.4	-1.2	-0.8		0.0	0.0	0.0
China 1-10Y			33.0	29.7			-3.8	-3.8			24.0	18.0
Supra 1-5Y			0.4	2.2			2.6	3.1			75.5	77.2
Corporate			0.3	0.0			-0.3	0.0			0.0	0.0
SPX				5.7				0.5				4.8
DAX				0.5				1.0				0.0
NIKKEI				0.3				1.7				0.0
FTSE100				0.0				0.0				0.0
ASX				2.9				-2.9				0.0
TSX				3.7				0.6				0.0
Diversification	84%	76%	42%	38%					5%	4%	7%	4%

Table 4.4. Average Optimal Portfolio Weights from Basket Currency Based Optimization

Source: ICE indices, Bloomberg; Author's calculations.

One of the main motivating factors for this study is to construct a reasonable, easy-to-follow optimal benchmark for the currency allocation process within the strategic asset allocation process of a developing country CB. When we rearrange the results for optimal weights above considering the currency allocation of optimal portfolios, we obtain the following results that are presented in Table 5. Accordingly, for a narrow investment universe that consists only major bonds, we obtain a well-diversified portfolio, with weights in excess of equal-weights are diverted to AUD and USD and they are taken from low-return EUR and JPY assets. Gold is getting a stable share of 5-10 per cent for all the investment sets. CNY is obtaining the lion's share when it is included, reflecting the fact that it is allowed to appreciate against USD in a controlled manner since 2008. Note that, all these weight distributions are reflecting the data set we study on, which covers 2000s and 2010s so that the results naturally reflect the exchange rate and interest rate developments of this specific era.

Nonetheless, the portfolio weights are again quite stable for TRY based analysis, when it is compared with the average results[87] and the weight attributions to each asset class is reasonable considering the main features of the recent two decades. It would be impossible to reach that conclusions from USD based optimization, however.

	AVERAGE (7 Countries)				TRY-AVERAGE OF ALL			
	Major Bonds	(+) Gold	(+) Other Bonds	(+) Equity	Major Bonds	(+) Gold	(+) Other Bonds	(+) Equity
Rank of MS	10.9	7.6	13.4	13.1	2.1	-0.6	-1.4	0.9
USD	22.0	23.0	0.7	7.9	1.5	1.1	2.3	3.6
CAD	18.2	16.5	11.6	7.0	0.1	0.6	0.3	-2.7
EUR	8.6	8.6	9.4	12.9	-1.5	-1.1	-0.7	-1.8
GBP	16.7	16.4	12.7	12.1	-0.1	0.3	0.9	-0.1
AUD	26.4	24.5	23.5	14.7	1.3	0.9	1.5	2.4
JPY	8.1	5.2	1.8	8.0	-1.3	-0.4	0.8	3.1
GOLD		5.8	7.3	7.7		-1.4	-1.2	-0.8
CNY			33.0	29.7			-3.8	-3.8
Diversification	84%	76%	54%	73%				

Table 4.5. Average Currency Allocation from Basket Currency Based Optimization
Source: ICE indices, Bloomberg; Author's calculations.

4.2.3. Resampled Mean-Variance optimization

One of the main problems with original MV optimization procedure is its high sensitivity to the inputs (mean return and variance) and the resulting instability in optimal portfolio weights (Kolm et al. 2014, Michaud and Michaud, 2008). Since inputs are statistical estimates of true parameters, and those parameters are unknown, they are subject to estimation error. Michaud and Michaud (2008) emphasize on the statistical nature of inputs used in the optimization procedure and argues that the resulting efficient frontiers should also have a statistical character. In other words,

[87] The stability of our results improves further, when the analyses based on INR is excluded. We calculated the differences of minimum and maximum weights and the range for the average weights is close to 10 percentage points, on average. The most stable results are belong to the investment universe of "Expanded Bonds", for which the range is close to 8 percentage points, on average.

since there is a confidence interval for the input estimates, then there should be "statistically equivalent" efficient portfolios that cannot be differentiated from the original efficient frontiers.

In this study, we benefit from the concept of "resampled efficiency" (RE), developed by Michaud and Michaud (2008), in order to see whether there is further gains in terms of stability of the results. We produce resampled optimal portfolios with the following procedure: (i) using bootstrap method, samples for each asset class are constructed separately, (ii) sample returns and covariance matrix are generated then using the Choleski decomposition of the original covariance matrix, (iii) unconstrained MV optimization procedure, as defined in the previous part, is applied for 1000 simulated data sets[88]. After the simulation process, we obtain 50 optimal portfolios for each simulated data and rank them according to their portfolio returns in order to compare them with the original MV efficient frontier. For each simulated optimal portfolio with the rank k, we compare its portfolio return and standard deviation with those obtained from the original optimal portfolios with the rank belong to [k-7, k+7] interval, and it stays for the construction of resampled frontier only if its return is smaller than that one of the original ones and its standard deviation is higher than that one of the original optimal portfolios. Finally, for each rank k, we take simple arithmetic averages for the remaining simulated portfolios to construct the resampled frontier[89].

Figure 4 summarizes the process of constructing resampled frontier for the example of "Expanded Bonds" (i.e., 9 Bond Indices plus gold). Original MV efficient frontier, drawn as a black line, constitutes the main reference for constructing resampled

[88] This number of simulation is used only for TRY based analysis and the number of simulation is reduced to 500 for other cases due to computational burden.

[89] We also carried out robustness analyses by using Monte Carlo simulation based on the Kernel distribution. We started with the normal distribution, as is usual, but we tried to get "unusual" z-scores from the Kernel distribution, as it exists in original data set. Detailed analysis shows that the covariance matrices derived from the Kernel distribution replicate the properties of the original one better than the normal distribution. Notwithstanding, the optimal portfolios obtained from both distributions are close to each other. The results from those Monte Carlo experiments (especially with the Kernel distribution) do not change any of the conclusions of this study. Those unpublished results are available upon request.

frontier. Simulated optimal portfolios that are below the original MV frontier seem as a cloud of black dots. These group of optimal portfolios are selected because they are statistically equivalent to their corresponding (rank-related) original MV optimal portfolios but they are "sub-optimal" from the perspective of MV efficiency. Taking the rank-based averages of these portfolios, we obtain the resampled frontier, drawn as a red line. The green diamond on the original MV frontier represents the position of maximum-Sharpe portfolio; the blue dots are its statistical equivalents from the simulation process and the yellow diamond on the resampled frontier is the maximum-Sharpe portfolio for the resampled frontier[90].

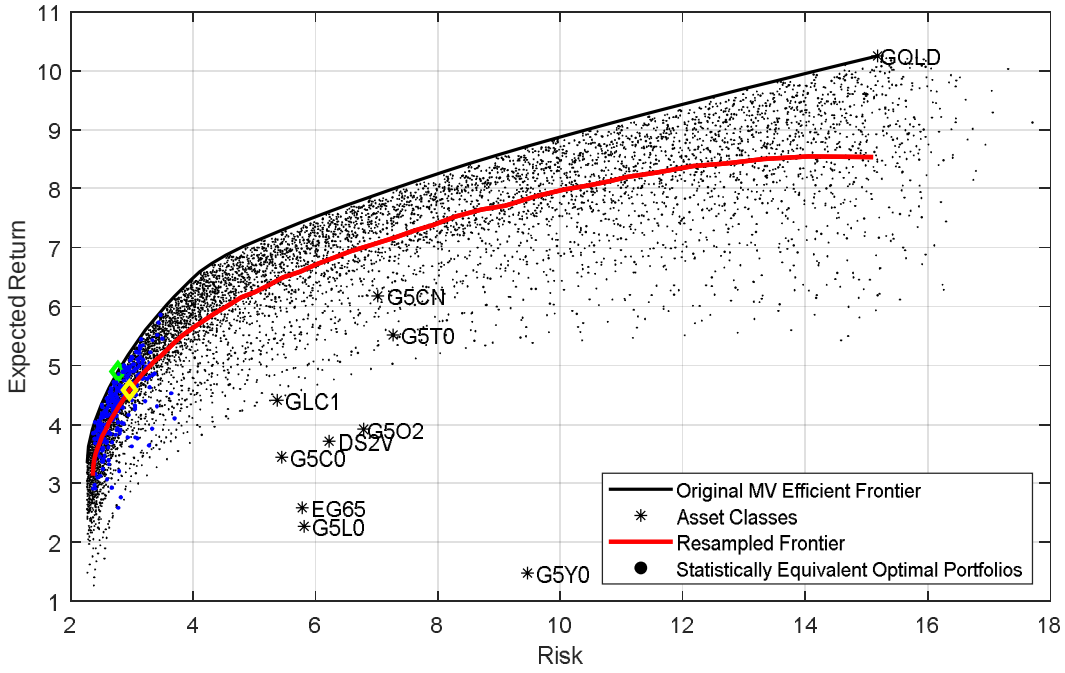

Figure 4.4 An Illustration of Resampled Optimization Process

Sources: ICE indices, Bloomberg. Author's calculations.

[90] Note that the yellow diamond may not be the average of blue dots (which is indeed not in this illustration), since the rank of blue dots are equal to the rank of original MS portfolio and the same rank resampled optimal portfolio on the red line may not be the MS portfolio on the resampled frontier.

Although it is seemingly sub-optimal from the perspective of classical efficient frontier, "RE optimization is the paradigm of choice for rational decision making under conditions of information uncertainty" (Michaud and Michaud, 2008:46), so that it produces safer, less concentrated (less extreme) alternatives. One obvious success of the process is the smoothness of weight distribution among the optimal portfolios on the frontier. Figure 5 shows weight distributions for the original MV frontier and resampled frontier. The rank of the optimal portfolio is on the x-axis and the associated weights for that rank are on the y-axis. The weights for the resampled optimal portfolios are smoothly changing across the ranks that represent different risk appetite levels, whereas the weights of the original MV optimal portfolios has sharp changes at some ranks, which will be less beneficial in terms of transaction costs and liquidity requirements when the investors decide to move along the spectrum of risk aversion[91].

[91] Michaud and Michaud (2008: 48) also emphasize on this point: "REF portfolios with more moderate bets on assets may have additional practical investment benefits, from reduced liquidity demands to lower trading costs."

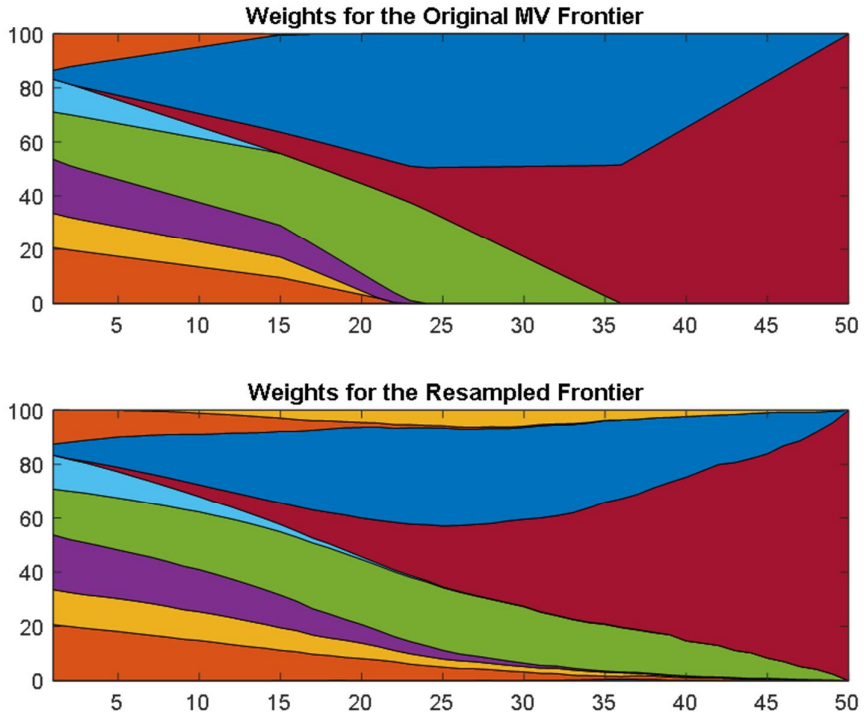

Figure 4.5 Weight Distributions of Frontiers along the spectrum of Risk aversion
Sources: ICE indices, Bloomberg. Author's calculations.

Table 6 summarizes the resulting MS optimal portfolio weights from resampling procedure. The first four columns of Table 6 show the average weights attributed to each asset class as in Table 4 above. The second four columns of Table 6 show the difference between the weights from TRY-based analysis and the average weights. To put things into perspective, the last four columns show the optimal portfolio weights for the resampled optimization based on USD returns. This table shows that the resulting portfolio weights from the resampled optimization based on return inputs in terms of a basket currency are even more diversified (all diversification ratios are higher, compare Table 4 and 6). Stability of weights across different currency based analyses also slightly increases. TRY-based weights are in the range of 3 percentage points of average weights, compared to 5 percentage points in the original MV optimization. USD based resampled optimization, on the other hand,

does not improve on the diversification side and on the stability side across different sets of investment universes[92].

	AVERAGE (7 Countries)				TRY-AVERAGE OF ALL				USD			
	Major Bonds	(+) Gold	(+) Other Bonds	(+) Equity	Major Bonds	(+) Gold	(+) Other Bonds	(+) Equity	Major Bonds	(+) Gold	(+) Other Bonds	(+) Equity
Rank of MS	13.0	9.0	13.7	12.0	1.0	1.0	0.3	0.0	2.0	3.0	3.0	3.0
US 1-10Y	17.4	18.5	0.0	0.4	0.7	2.4	0.0	-0.3	89.1	87.8	0.0	0.2
Canada 1-10Y	20.0	18.7	12.1	4.2	0.0	-1.0	-0.1	0.6	8.3	7.6	0.7	0.0
Euro 1-10Y	10.7	10.6	8.3	11.5	-0.6	-0.7	0.5	-1.2	0.0	0.0	0.0	0.0
UK 1-10Y	18.0	17.9	13.0	12.1	0.3	-0.6	-0.2	1.1	2.4	3.1	0.5	0.0
Australia 1-10Y	23.1	20.3	21.8	11.5	0.9	1.9	1.1	2.5	0.3	0.9	0.3	0.0
Japan 1-10Y	10.9	8.6	4.1	9.0	-1.3	-2.0	-0.8	1.3	0.0	0.0	0.0	0.0
Gold		5.4	7.8	7.4		0.0	-0.7	-1.9		0.6	0.7	0.3
China 1-10Y			27.6	24.0			-2.8	-2.6			21.4	17.9
Supra 1-5Y			3.3	5.7			2.5	1.1			76.3	76.5
Corporate			2.0	0.4			0.5	-0.2			0.1	0.0
SPX				5.4				-1.4				4.5
DAX				1.3				0.4				0.0
NIKKEI				1.0				1.3				0.4
FTSE100				1.0				0.1				0.0
ASX				2.0				-1.1				0.0
TSX				3.1				0.2				0.1
Diversification	92%	85%	54%	48%					5%	5%	7%	4%

Table 4.6. Average Optimal Portfolio Weights from Resampled Optimization Source: ICE indices, Bloomberg; Author's calculations.

Table 7 rearranges the results for optimal weights above considering the currency allocation of optimal portfolios, as in Table 5. The portfolio weights are again quite stable for TRY based analysis, when it is compared with the average results. The extreme weights attributed to CNY in the original MV optimization is trimmed slightly by the resampling procedure. In general, resampling process improves diversification in currency allocation further and improves stability of weights from different currency based analyses.

[92] This is partly related with the rank of MS portfolio, which is close to the rank of global minimum variance portfolio. Resampled optimization certainly improves diversification for higher ranks (see Appendix Figure A. 2 for the weight distribution comparison for the USD based optimization on "+Stocks" set).

	AVERAGE (7 Countries)				TRY-AVERAGE OF ALL			
	Major Bonds	(+) Gold	(+) Other Bonds	(+) Equity	Major Bonds	(+) Gold	(+) Other Bonds	(+) Equity
Rank of MS	13.0	11.0	12.6	12.5	1.0	-1.0	1.4	-0.5
USD	17.4	18.1	6.0	10.5	0.7	2.8	2.2	0.7
CAD	20.0	17.8	12.0	8.9	0.0	-0.2	0.0	-0.9
EUR	10.7	10.7	8.2	11.8	-0.6	-0.8	0.6	0.2
GBP	18.0	19.2	15.2	13.8	0.3	-1.9	-2.4	0.4
AUD	23.1	18.4	18.8	12.6	0.9	3.8	4.2	2.4
JPY	10.9	8.1	4.9	10.1	-1.3	-1.5	-1.6	2.6
GOLD		5.5	10.8	9.5		-0.1	-3.6	-4.0
CNY			27.3	24.1			-2.5	-2.7
Diversification	92%	90%	69%	84%				

Table 4.7. Currency Allocation from Resampled Optimization

Source: ICE indices, Bloomberg; Author's calculations.

Finally, Table 8 and Figure 6 illustrate how resampled optimal portfolio weights are changing across the closest seven rank above and below the rank of MS portfolio. This can be considered as constructing a confidence set for the selected (maximum-Sharpe) optimal weights[93]. The x-axis of Figure 6 is the rank of the asset class (as in tables, e.g. 7 for Gold, 10 for Corporate) and the y-axis is the weight corresponding to that asset class for different rank of optimal portfolios. The figure includes the optimal portfolios with ranks belong to the interval of [7,21], since the MS optimal portfolio has rank of 14. Table 8 shows how the MS portfolio weights should be adjusted for lowering or increasing the risk associated with the MS portfolio. Noting that Figure 6 illustrates a smooth change for the weights, proportional changes of weights (to the lower and higher risk range columns) will likely produce portfolios that will be belong to the confidence set.

[93] The choice of "seven" rank to describe a confidence set is a little bit arbitrary. We select those ranks by controlling for their Sharpe ratios and we managed to find quite close Sharpe-ratios for the 7-rank region.

	Resampled	Lower Risk Range	Higher Risk Range
Rank of Portfolio	14	7	21
US 1-10Y	0.0	0.0	0.1
Canada 1-10Y	12.0	4.7	-4.5
Euro AAA-AA 1-10Y	8.8	2.9	-3.8
UK 1-10Y	12.8	4.3	-6.8
Australia 1-10Y	23.0	-3.0	1.0
Japan 1-10Y	3.2	5.0	-2.5
Gold	7.2	-4.4	8.7
China 1-10Y	24.8	-10.5	9.8
Supra 1-5Y	5.7	3.2	-4.2
Corporate	2.5	-2.3	2.2

Table 4.8. Confidence Set for the Maximum-Sharpe Portfolio Weights

Source: ICE indices, Bloomberg; Author's calculations.

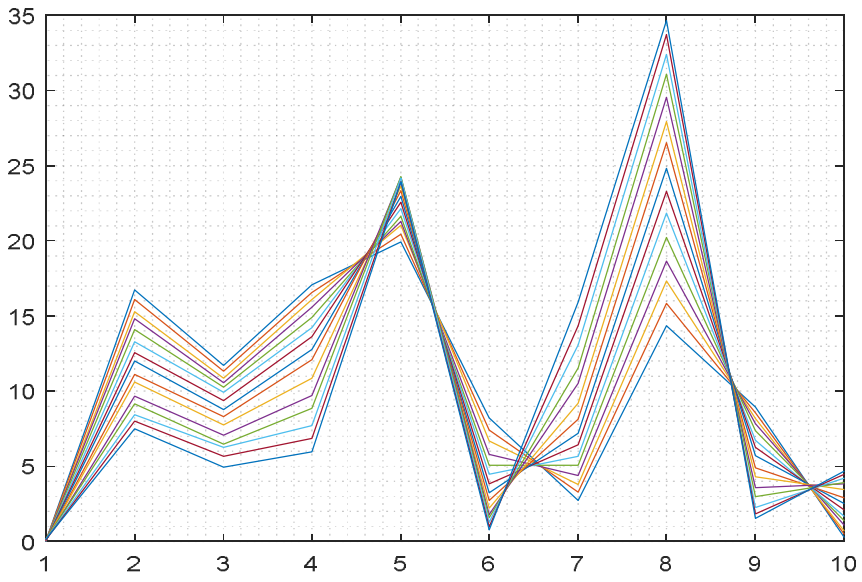

Figure 4.6 Confidence Set Construction for the Maximum-Sharpe Portfolio Weights

Sources: ICE indices, Bloomberg. Author's calculations.

4.2.4. In-sample and out-of-sample performance

In order to see how the basket currency based optimization performs compared to other allocations, we check in-sample performance results and carry out an out-of-sample performance analysis. We provide below one example of in-sample performance comparison with the investment set of expanded bonds[94] and with the choice of resampled optimization. In Figure 7, TRY index shows the in-sample performance of the resampled optimal MS portfolio from the analysis of TRY-based basket currency, whereas the USD index shows the in-sample performance of the resampled optimal MS portfolio from the analysis of USD returns. The performance comparisons are in terms of USD so that the optimization results based on USD returns are favored in this presentation. Interestingly, for this example, the TRY-based portfolio beats the USD-based portfolio in its own domain, even when the USD is appreciated against the BAS (basket currency) at the end of the period (green-dashed line)[95]. Notice that TRY-USD index difference (blue line) closely follows the ups and downs of the basket against USD, which explains much of the volatility of the TRY index compared to USD index. In order to separate the exchange rate effect, purple-dotted is drawn, which shows how TRY index would look like in terms of the basket. As is expected, TRY index has much lower volatility in its own domain, although it is more volatile than the USD index in terms of USD, which is an inevitable consequence of more balanced portfolio in terms of different currencies and the exchange rate volatility within the basket currencies.

[94] The results for the other sets are available upon request.

[95] This result changes only for the set of "bonds only". The reason behind the better performance of TRY-index is mostly related with the rank of MS portfolios.

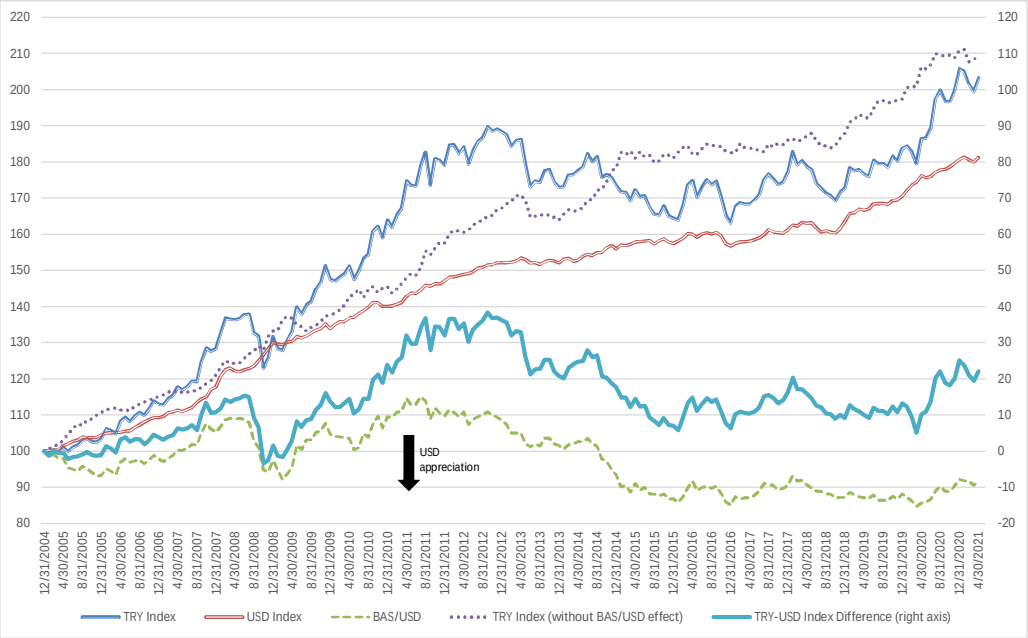

Figure 4.7 In-Sample Performance Comparison for TRY-based and USD-based optimizations

Sources: ICE indices, Bloomberg. Author's calculations.

In order to carry out an out-of-sample performance analysis, we take the first ten years of data (Dec. 2004 – Dec. 2014) as the initial period to apply optimization procedures. Unconstrained and the corresponding resampled optimization is applied for USD returns and TRY-based basket currency returns up to December 2014 for the four sets of investment universes. Then the performance is measured in terms of annualized returns based on USD and BAS (the basket currency). This analysis is carried out by changing the end-period from Dec. 2014 to Dec.2019 for the optimization processes so that we have six different out-of-sample investment periods. Table 9 shows the results for the "Expanded Bonds" set (see Appendix for the other three sets.) In the first block, the investor takes the weights from different optimizations, construct portfolios and keep them unchanged until the end of April 2021 (the last observation we have). In the second block, the investor takes the weights from the optimization processes for 201X, construct portfolios and rebalances and readjusts the portfolios with new weights derived from new

optimizations with additional data for each year-end. The performance of equal-weight portfolio is added as a reference point for each case.

Annualized Returns	Numeraire: USD					Numeraire: BAS				
NO REBALANCING	TRY-Uncons	TRY-REF	USD-Uncons	USD-REF	EqualW	TRY-Uncons	TRY-REF	USD-Uncons	USD-REF	EqualW
Started at the end of ...										
2014	1.8%	1.7%	2.4%	2.3%	2.3%	2.1%	2.0%	2.7%	2.7%	2.6%
2015	3.1%	3.1%	2.6%	2.7%	3.7%	2.0%	2.0%	1.6%	1.6%	2.6%
2016	4.4%	4.3%	3.4%	3.3%	4.4%	2.6%	2.5%	1.6%	1.5%	2.6%
2017	3.2%	3.4%	3.5%	3.5%	3.5%	3.0%	3.1%	3.2%	3.2%	3.2%
2018	6.1%	5.8%	4.2%	4.2%	5.9%	3.6%	3.3%	1.7%	1.7%	3.4%
2019	7.0%	6.6%	4.3%	4.0%	5.5%	3.9%	3.4%	1.2%	0.9%	2.3%
REBALANCED	Inv. Universe: Bonds Exp									
Started at the end of...										
2014	1.9%	1.8%	2.2%	2.1%	2.3%	2.2%	2.1%	2.5%	2.4%	2.7%
2015	3.2%	3.1%	2.4%	2.4%	3.7%	2.1%	2.1%	1.4%	1.3%	2.6%
2016	4.5%	4.4%	3.2%	3.1%	4.4%	2.8%	2.6%	1.5%	1.4%	2.6%
2017	3.4%	3.3%	3.4%	3.3%	3.5%	3.1%	3.0%	3.1%	3.0%	3.3%
2018	6.2%	5.9%	4.1%	4.1%	5.9%	3.7%	3.5%	1.6%	1.6%	3.4%
2019	7.1%	6.6%	4.3%	4.0%	5.5%	4.0%	3.5%	1.2%	0.9%	2.4%

Table 4.9. Out-of-Sample Performance Comparisons

Source: ICE indices, Bloomberg; Author's calculations.

Firstly, the table shows that the ultimate success of the portfolio depends too much on the initial period for investment and the researcher should be careful about interpreting the out-of-sample performance of different optimizations. In order to see one important factor that affect these results, Figure 8 shows the exchange rate movements within the major currencies by depicting the basket currency derived from TRY against the USD. The entire 2010s is characterized by the dollar strength against the other majors and this trend is eased in the second half of the 2010s and appears to change direction at the end of this decade. To understand how these trends are influencing upon our out-of-sample performance results, the second plot in Figure 8 closely looks at the period between December 2014 and April 2021. Within this period, except for 2014-end and 2020-end, the basket currency is appreciated at the end of April 2021 against the USD for all the year-ends from the second half of the 2010s. This explains why the returns are in terms of USD are generally higher than the returns in terms of BAS, except for 2014[96].

[96] Note that, the equal-weight portfolio is a much riskier portfolio compared to the optimal portfolios we have selected so that it can be expected to yield higher performance in terms of returns in general.

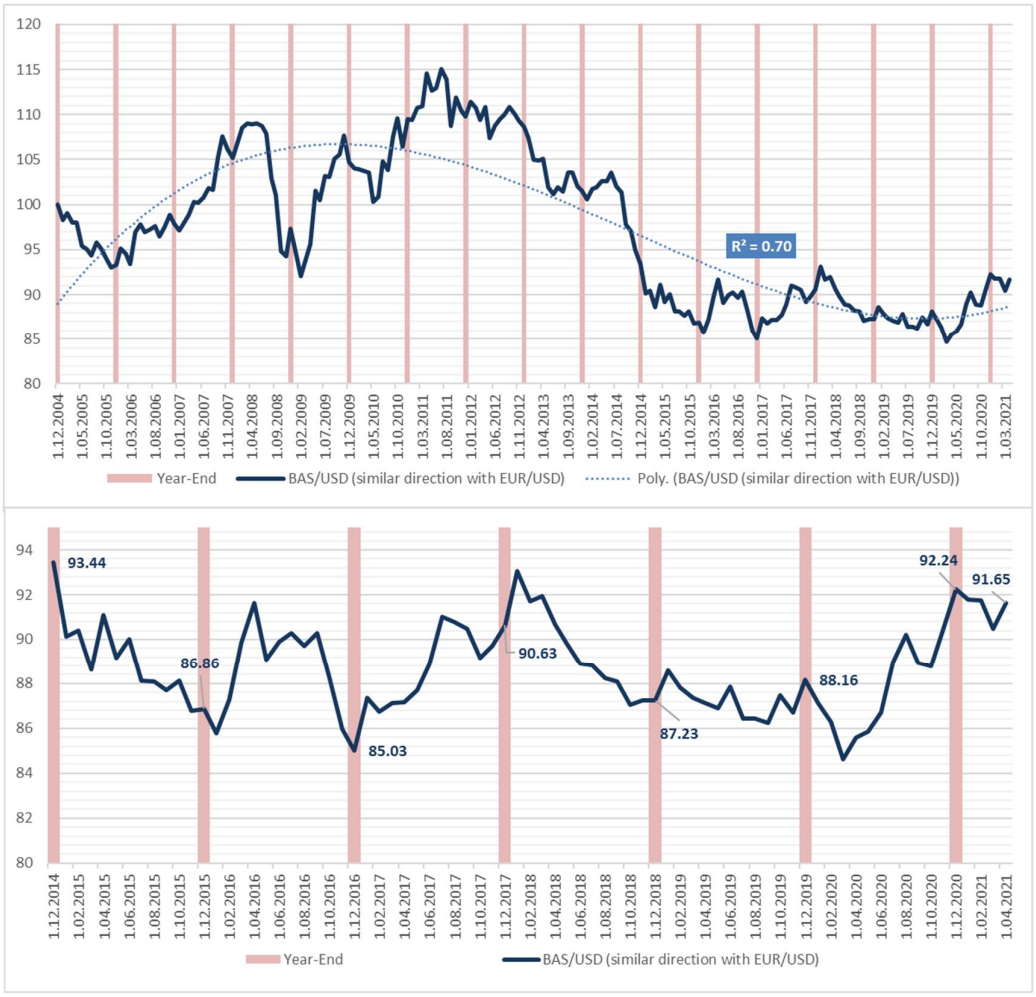

Figure 4.8 Exchange Rate Movements among the Majors: USD against the BASKET
Sources: ICE indices, Bloomberg. Author's calculations.

Although the table shows that TRY-based optimization performance is generally better than USD-based optimization performance, Figure 9 shows that much of the performance difference can be attributed to the exchange rate dynamics depending on the initial period. Figure 9 compares the performance indices constructed for resampled optimizations and for the rebalanced and readjusted portfolios and it shows that if we exclude the exchange rate dynamics that favor the BAS against USD, the USD-based optimization is, in fact, produces much better results. Nonetheless, overall, we can say that TRY-based optimization procedure that we developed performs quite well in different scenarios, by yielding comparable returns

to equal-weight portfolio and the global minimum variance portfolio in terms of USD. Its performance is even better than the resampled optimal portfolios. Moreover, rebalancing and readjusting the optimal portfolio improves the gains for TRY-based optimizations, as expected, whereas it is interestingly has the opposite effect for the USD-based optimizations. This implies that TRY-based optimization procedure better captures and adapts itself to the trend changes (especially with regard to exchange rate dynamics that determines much of the gains/losses in a globally diversified portfolio).

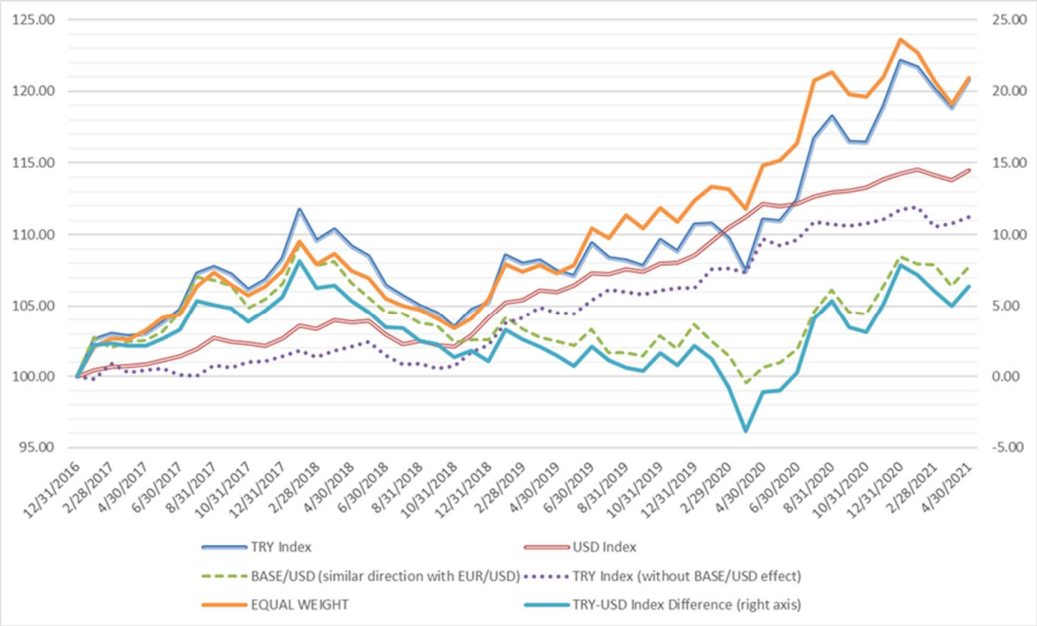

Figure 4.9 An illustration of the out-of-sample performance (starting period at the end of 2016)

Sources: ICE indices, Bloomberg. Author's calculations.

4.2.5. Constrained optimization: an illustration

In order to see how our basket currency based optimization works within a constrained optimization framework, we focus on the expanded bonds set, which consist of top-grade bonds and gold only. Since the investment universe is restricted to high quality (low risk, except for gold) assets, we ignore credit restrictions in our

constrained optimization setup and we rewrite the optimization problem with the addition of currency, liquidity and duration constraints:

$$\min \sigma_p^2 = \frac{1}{2} w_p' \times C \times w_p \qquad (3)$$

$$subject\ to\ w_p' \times r = r_p$$

$$w_p' \times \mathbf{1} = 1\ and\ 0 \leq w_i \leq 1, for\ each\ i\ (asset\ class)$$

$$Currency\ constraint: L_j \leq w_p' \times Cur_j \leq U_j\ for\ each\ currency\ j$$

$$Duration\ constraint: w_p' \times Dur_j \leq D_j\ for\ each\ currency\ j$$

$$Liquidity\ constraints: w_p' \times Liq^{Normal} \leq LN\ and\ w_p' \times Liq^{Distressed} \leq LD$$

where L_j and U_j are lower and upper bounds for the weight of each currency j within the optimal portfolio, Cur_j is a vector of ones and zeros that assign each asset class a currency, Dur_j is a vector consisting of durations for the asset classes with currency j, D_j is the corresponding duration limit set for each currency, Liq^{Normal} and $Liq^{Distressed}$ are vectors consisting of liquidity (transaction costs) parameters for each asset class for the normal market conditions and for the distressed conditions, and finally, LN and LD are total liquidity limits for the optimal portfolio for normal and distressed conditions.

There are infinite ways to construct a constrained optimization setup, so there will be no comparable outcome from this process. Nonetheless, it is important to compare the previous results from unconstrained analysis with the results from a typical CB constrained asset allocation problem and it is important to see how basket currency based optimization differ from USD based optimization in this context.

For the empirical study, we calibrate our model based on Turkey data from different periods and by employing several critical assumptions. We assume that the CB applies the strategic asset allocation problem for the sum of gross foreign exchange reserves and gold reserves. Since our framework is investment-oriented, we prefer that the CB should have positive net international reserves, so that this part will be

used as the investment portfolio (which will be subject to less restrictions). Since the net international reserves have been at very low levels or even negative for Turkey recently, we take 2014-end data for international reserves (TCMB, 2014) and assume that our CB in the model construct an "investment" sub-portfolio with 30 per cent share that corresponds to the share of net reserves in the total reserves. The remaining part is called as the "liquidity" portfolio and managed against the FX and gold liabilities of the CB. Since the liquidity portfolio is managed against the liabilities of the CB, we assume that the CB uses an asset-liability matching (ALM) framework in order to minimize exchange rate and interest rate risks, as is typically used by CBs (e.g Romanyuk, 2010; Koivu et al., 2009; Rivadeneyra et al., 2013; see also Appendix Table A.2).

For the exchange rate part, we focus on the recent figures (both from 2014-end and 2020-end) from the balance-sheet of Turkish CB and we note that the significant part (about 90 per cent) of the liabilities are against the domestic banking sector due to reserve requirements and other instruments (TCMB, 2014, 2020). Thus, we assume that the currency distribution of foreign exchange liabilities of the banking sector may be a good approximation for currency constraints that will be employed in our model[97]. Recent data show that roughly one half of those liabilities is in terms of USD, one third is in EUR, and 15 per cent is in terms of gold or other precious metals (due to recent trends). Relying on these figures, we impose the following currency restrictions in our model: (i) 30-70 per cent shares of lower and upper bounds for USD assets in the entire portfolio; (ii) 20-45 per cent shares of lower and upper bounds for EUR assets in the entire portfolio; and (iii) 5-25 per cent shares of lower and upper bounds for gold in the entire portfolio. Notice the lower bounds for USD and EUR are chosen as close as possible to the multiplication of the liquidity

[97] Lu and Wang (2019) develops a portfolio choice model, which is quite similar to our approach in building up the constrained optimization framework. They separate foreign reserves portfolio into an investment tranche, managed by the principles of MV optimization, and a liquidity tranche, managed by the principles of asset-liability matching. They find evidence that short-term debt structure of the country and import invoicing are critical determinants for currency composition of the liquidity tranche for central banks. For Turkey, both of those factors suggests roughly 60 – 40 (USD vs. EUR) composition, which is compatible with the banking sector liability composition when gold is excluded.

portfolio share (70 per cent) with the share of currencies in the banking sector liabilities[98].

For the interest rate risk management part, we analyzed the recent and historical data for the liabilities of the domestic banking sector and corresponding required reserves again. Although much of those banking sector liabilities are in short-term and implies a lower duration levels, controlling for the stability of those liabilities, we impose 50 months of duration limits for both USD and EUR asset classes in our constrained optimization example. Note that our original investment universe consist only USD Treasury Bonds and Notes with 1-10 years maturity and EUR AAA-AA Government Bonds with 1-10 years of maturity, and both of these two asset classes have only a single duration parameter. In order to create a rich optimization environment, we replace those two asset classes with the corresponding 0-1 years, 1-5 years and 5-10 years for each. Thus, instead of 10 asset classes, we work with 14 asset classes in the constrained optimization setup[99].

Finally, in order to construct liquidity constraints, we analyze transaction costs for each asset classes. The latest bid-ask spread data for the constituents of our bond indices are obtained and they are weighted by the amounts outstanding for each constituent in order to find a single parameter of liquidity for normal conditions. Some of these numbers are corrected after controlling historical data for related asset classes[100]. Then, for the construction of liquidity parameters for distressed conditions, we check historical data and multiply the parameter for normal conditions with 5, 10 or 15 depending on the historical behavior of liquidity conditions for each asset classes. Finally, we impose 0.1% as the upper limit for total

[98] Note that the sum of lower bounds for liquid portfolio is 55 per cent, which means we allow the liquid portfolio to have other assets. From a more conservative approach, it should be set as 70 per cent.

[99] These replacements do not have any significant impact on our previous results, as will be seen below.

[100] The historical data we use comes from a proprietary data set collected by the risk management department of the Central Bank of Turkey.

portfolio liquidity for the normal conditions and 0.8% for the distressed conditions (which are close to the average numbers for 14 asset classes).

We run the model for both TRY based returns and USD based returns. Figure 10 show the frontiers for each analysis, respectively. Both graph show that when liquidity, currency and duration constraints are predetermined, optimal allocations are confined to the less riskier side of the unconstrained frontier and they are sub-optimal from the perspective of original MV efficiency, allowing for the idea that reducing them is a way to improve the performance in terms of risk-adjusted returns (as in Fisher and Lee, 2004). However, as it can be seen much more clearly from TRY-based frontiers, those constrained frontiers are actually very close to the more conservative and less concentrated resampled frontiers, which implies that typical constraints of a CB actually aims to do the same job with the resampling and confine itself into the conservative side of optimal portfolio search[101].

[101] As for the resampling process, "constraints reduce the ability of MV optimizers to misuse extreme information" (Michaud and Michaud, 2008:36) and lead to a much more reasonable and less risky allocations.

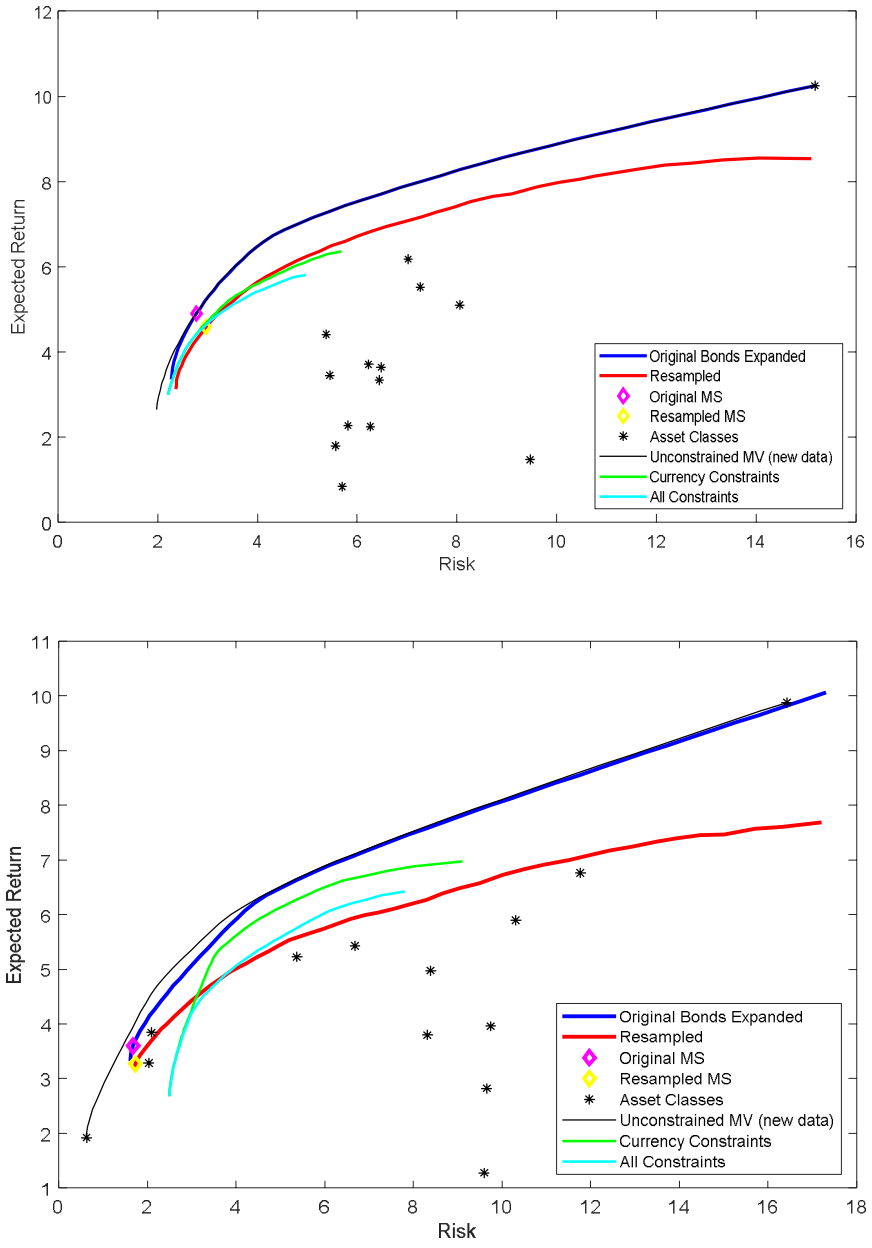

Figure 4.10 Efficient Frontiers from TRY Based and USD Based Constrained Optimization Processes

Sources: ICE indices, Bloomberg. Author's calculations.

Secondly, the comparison of frontiers show that constrained optimization in the USD space leads to a shift of the constrained frontiers to the right (particularly for the less

risky ends of the frontiers and for the area where MS portfolios lie). This is, however, not observed for the returns based on a basket currency (top panel), which implies again that typical constraints of CB are “sub-optimal” only when they are considered in a single major-currency based risk-return space. Moreover, basket currency based unconstrained optimization procedures and the associated results with respect to currency allocations that we presented before are actually in a very close environment with the example of constrained optimization with basket currency based returns. This enhances the possibility of practical use of basket currency based optimization in the strategic asset allocation process.

The comparison of weight distributions shows that constrained optimization forces the weights to become much more balanced for the highly concentrated distributions arising from USD based analysis (Figure 11, right-side plots). On the other hand, since our basket currency based analysis produce well-diversified portfolios for especially the higher risk aversion ranks even in the unconstrained optimization process, the addition of constraints barely affects the weight distribution and causes only minor adjustments for those low ranked portfolios. This can be read as, again, as an indicator for the inherent risk aversion within the process of asset allocation based on basket currency returns that allow for a significant diversification in terms of currency and asset classes. The risk aversion of a typical CB, represented by currency, liquidity and duration constraints we imposed, comes into play only for the higher ranked optimal portfolios (choices for a lower risk averse) within the USD based optimization, which is a consequence of the bias of this setup in favor of USD asset classes.

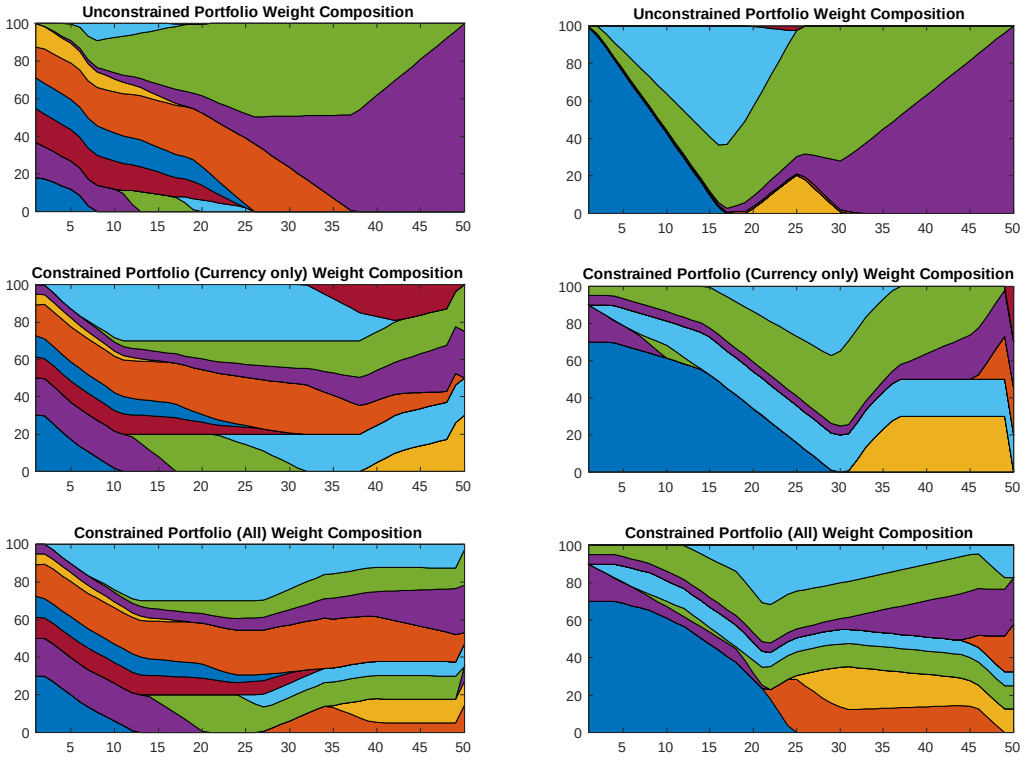

Figure 4.11 Weight Distributions from TRY and USD Based Constrained Optimizations

Sources: ICE indices, Bloomberg. Author's calculations.

Finally, we want to emphasize on one of the disadvantages that is created by the constrained optimizations. Although, with a smaller set of restrictions, it may be useful for customizing the optimization problem in line with the preferences of the CB, constrained optimizations typically produce non-smooth weight allocations. Figure 12 shows the weights attributed to 14 asset classes by the MS portfolio and the closest-ranked portfolios around the MS optimal portfolio for the constrained optimizations (with currency constraints only and with all constraints, respectively). Compared to Figure 6 that we have used as a basis for constructing a confidence set

for the optimal portfolio selection, these figures imply that there is no such smooth confidence regions for the optimal selections implied by constrained optimization[102].

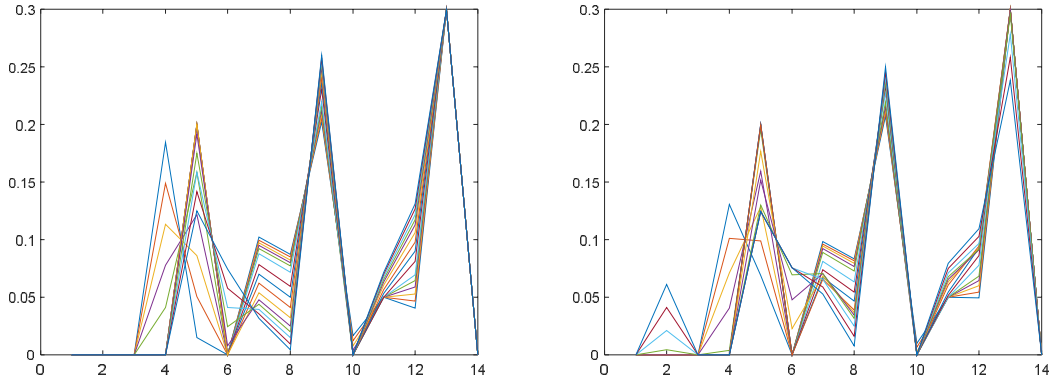

Figure 4.12 Weight Allocations around MS Portfolios from Constrained Optimizations

Sources: ICE indices, Bloomberg. Author's calculations.

4.3. Concluding remarks

This essay proposes a decision support framework for the strategic allocation of official reserves (especially on its currency allocation dimension) based on mean-variance optimization with input returns denominated in a basket of major currencies. The weights in the basket are derived from the principal component analysis of the exchange rates of those currencies with respect to the own currency of a developing country. This approach yields a synthetic numeraire with the following features: (i) it does not favor any currency in the multi-currency optimization framework; (ii) it relies on a reasonable and logical procedure that yields transformed return series with close features to the original own-currency returns; (iii) the outputs are compatible with different kind of unit of account selections practiced by CBs, i.e. the optimal allocations cannot specifically be punished in any

[102] This case is much worse for USD based analyses. Moreover, when we impose additional, simple but realistic, constraints on the constrained optimization problem, such as limiting the transaction costs for the USD assets for the distressed conditions, -a desired portfolio feature for a central bank, the weight distributions of optimal portfolios are getting much more distorted.

of the common numeraire selection of CBs (domestic currency, a basket of selected currencies, the USD and so on); (iv) it is useful in generating diversified portfolios via optimization procedures across major currencies and it is beneficial to reduce exchange rate volatility of the portfolio.

Overall, the results from our optimization framework suggest that enhancing the investment universe of a CB with gold, China government bonds and stock market indices lead to significant gains from diversification. Even the MV optimization with basic constraints based on return inputs in terms of a basket currency yield highly diversified, reasonable and quite stable optimal portfolios across several dimensions. Resampling procedures increase diversification and stability of weights further. The out-of-sample performance is also quite well in different scenarios, by yielding comparable risk-return structure to equal-weight portfolio and the global minimum variance portfolios. Finally, in our framework, typical predetermined liquidity, currency and duration constraints of a CB confine optimal allocations to the less riskier side of the unconstrained frontier and those constrained frontiers are actually very close to our unconstrained resampled frontier, which implies that typical constraints of a CB actually do the same job with the resampling and confine itself into the conservative side of optimal portfolio search.

The framework is open to further improvements by combining forward-looking inputs via yield curve forecasting and adding analyst views. In this study, we used historical means as an estimation of expected return inputs and we derived the basket currency based returns by separating the effect of domestic currency volatility from domestic currency based returns (the left-hand side of Eq.1). Instead, it is possible to use forecasted own-currency returns on bonds combined with exchange rate forecasts of major currency pairs in order to transform the return series (the right-hand side of Eq.1). Both of these has their own hardships though. Various alternatives exist in yield-curve forecasting, however the literature stress on difficulties related with forecasting the level component and time-dependency of the success of interest rate models (see e.g. Duffee, 2012; De Pooter et al., 2010). Exchange rate forecasting, on the other hand, is generally avoided due to its even

lower reliability. Koivu et al. (2009), for example, proposes a dynamic optimization framework for CBs that requires both yield curve and exchange rate forecasting, however, for practical reasons, leaving exchange-rate forecasting aside, focuses on a yield-curve forecasting procedure, enhanced by macroeconomic factors, in order to produce own-currency return inputs for the optimization process. In a similar way, when one leave exchange rate forecasting aside and predicting zero change on that side, the right hand side of Eq.1 implies that the basket currency based returns will be equal to own-currency returns, which can be derived from any of the alternative yield curve forecasting models. Moreover, our procedure allows for the addition of analyst view on the exchange rate side in a very simple way. The right hand side of Eq.1 can be used to construct alternative scenarios on the exchange rate dynamics.

CHAPTER 5

CONCLUSION

In this thesis, we focused on several important and challenging issues, such as financial development, credit booms and reserve management, for developing countries in three separate essays. This chapter summarizes main arguments and findings of this thesis. The first essay is about the low level of credit creation capacity in developing countries. It focuses on a particular impediment on the credit creation capacity, which is the hierarchical nature of monetary (financial) instruments. The concept of the hierarchy of money is put to use in order to discuss the structural forces that constrain domestic currency denominated credit creation and lead to massive foreign exchange reserves accumulation.

We argue that recognizing the credit nature of modern money and conceptualizing international monetary structure in a hierarchical manner may help capture the differences in credit creation capacity among different group of countries. The obvious demonstration of the hierarchical international monetary structure is the hierarchy of currencies and the existence of a regional reserve currencies and the reserve currency. The evolution of the international monetary hierarchy since the beginning of capitalism has always reflected the evolution of the hierarchy of trading centers, economic powers and nation-states. There is a close connection between the hierarchy among traders (also, trading centers and nation-states) and the hierarchy of liabilities issued by different-layer traders. Thus, the hierarchy of money reflects the fact that the demand for the liabilities issued by developing country financial institutions will be less compared to those issued by their advanced counterparts.

This, eventually, constrain the credit creation in developing countries in various ways and make domestic credit conditions dependent upon the developments in advanced country financial markets.

The first essay shows that under financial openness, the hierarchy of money generates binding constraints on the developing country banking sector balance sheets, such as funding and exchange rate risks that need to be managed, simply through the validation of payment commitments to the rest of the world. Furthermore, given that a country is open to international financial markets, having a lower layer national currency in the hierarchy requires the issuer of that currency either to hold international reserves or to ensure a credible access to such reserves. This is a way to increase the credibility, liquidity and safety of the liabilities supplied by developing country financial institutions. The evolution of the international and national hierarchy of money implies that creating new layers in the hierarchy and keeping a desirable position requires power struggle with the existing forces and accumulating/holding of money reserves issued by upper level agents. This implies that for a developing country to reduce its dependency on the international credit system and to economize on keeping its financial system intact, it requires increasing the economic and political power in the international arena, which is easier said than done. The only other alternative for a developing country is to keep going on accumulating reserve assets which will make its liabilities much more solid and desirable. This obviously does not end up with a better position in the hierarchy, but help protecting the existing position and it also explains why developing countries needed and depended on so much reserve accumulation for the last three decades when their economies were increasingly integrated into the global commerce and finance.

The second essay is related with one of the main challenges in the process of increasing credit creation capacity, which is credit booms. Credit booms are, arguably, the most prominent cause of severe financial distress episodes and crises. This essay particularly concentrates on the time-specific aspects of credit booms and develops a modified method for credit boom identification with that purpose. Then,

this novel method is applied for a large data set with the purposes of documenting the time-specific and country-group characteristics of credit booms and their relationships with banking crises.

The credit boom identification literature mostly relies on threshold approach in order to identify credit booms, defined and measured as excessive deviations of the cyclical component of credit from its "normal" levels. Although country-specific thresholds have been widely used in order to account for country-specific dynamics of credit cycles, time-specific dynamics, and thus, long-run changes in the financial markets are generally ignored. This study offers a novel method, a recursive application of Mendoza and Terrones' (2008, 2012) method, and shows that the variance of the cyclical component of credit variables increases over time. This implies that credit boom identification procedures based on thresholds derived from the variance of cyclical components of credit should necessarily take into account time-specific aspects of credit cycles. Our suggested method deals with this issue and construct thresholds based on both country-specific and time-specific variances.

Alongside its methodological contribution, the second essay employs this novel method for a large sample of advanced and developing countries (148 countries, 1950-2016) in order to analyze the characteristics of credit booms in the historical and country-group dimensions. In order to calibrate parameters for threshold coefficient and smoothing parameter of Hodrick-Prescott (HP) filter, we use a signal extraction analysis, following Kaminsky and Reinhart (1999) and Drehmann et al. (2010), for credit booms and banking crises. This preliminary analysis reveals that low and lower-middle income countries have higher missed-crisis and noise-to-signal ratios, which implies that credit booms and banking crises were not synchronized and possibly driven by different factors for such developing countries. This view is also supported by our finding that for the low income and lower-middle income countries, there are very few cases of credit booms that are followed by banking crises in our baseline analysis. All in all, credit booms followed by banking crises seem as an above-average developing country and advanced country phenomenon.

Following-up the identification of credit booms, we apply for event window analyses. We find that although credit booms, as we defined them, did not increase in number over time, their influence on the economy might have been higher in the most recent periods, since there has been an increasing trend of deviations of real credit per capita from trend values around credit boom peaks. The duration of credit booms has also extended from 3-5 years (pre-1970) to 5-7 years (post-1970) over the course of the history. Moreover, credit booms of different countries have become more clustered over time for smaller time periods, which suggests that global determinants of credit booms might have overweighed local ones as financial integration has prevailed. Combined with the findings and implications of the first essay, this implies that developing countries have to monitor the global financial cycles and/or reconsider the structure of financial integration with the rest of the world in order to manage their own financial cycles.

Country-group comparisons show that the evolution of credit booms around credit boom peaks are significantly different for different country groups. High credit-to-GDP ratio countries experience smoother cyclical fluctuations of credit. Therefore, the higher the credit-to-GDP ratios, the more likely the credit booms to emerge out even for smaller deviations. In addition, cyclical behavior of credit is more pronounced in more developed (both in financial and economic terms) countries.

We also re-confirm a common finding that most of the banking crises (60 percent in our baseline experiment) have been preceded by credit booms, although only a minority of credit booms (only one fifth) has been followed by a banking crisis. Furthermore, a comparison of the characteristics of credit booms followed by banking crises with those that are not followed by any crisis yields that the former type is characterized by much higher deviation levels (ranging from 1.5 to 2 times of the deviations in credit booms that do not end up with any crisis) at around boom peaks and they are more likely to end up with significant negative deviations from the trend in many cases. These findings are more pronounced in the middle income groups, particularly for upper-middle income countries. These suggests that middle-income developing countries need to carefully monitor the dynamics of credit

expansion periods in order to avoid from costly financial crises that would possibly follow up credit boom episodes.

Finally, the third essay is related to the reserve management and strategic asset allocation for central banks in developing countries. This essay focuses on developing an alternative framework for strategic asset allocation among multiple currencies by using common portfolio optimization methods. It suggests the use of a basket-currency (consisting of major currencies) as a numeraire by providing a formulation for constructing a basket with desired properties and, then, it presents the performance of optimization results in comparison to general practices.

In this study, we mainly offer a multi-currency portfolio optimization framework for developing country central banks, by which currency allocation of official reserves is optimally selected within the optimization framework. To this end, a numeraire is constructed as a basket of currencies selected from the investment universe. The weights are derived from the principal component analysis of the exchange rates of those major currencies with respect to the own currency of a developing country. Our approach yields a synthetic numeraire with the following features: (i) it does not favor any currency in the multi-currency optimization framework; (ii) it relies on a reasonable and logical procedure that yields transformed return series with close features to the original own-currency returns; (iii) the outputs are compatible with different kind of unit of account selections practiced by central banks, i.e. the optimal allocations cannot specifically be punished in any of the common numeraire selection of central banks (domestic currency, a basket of selected currencies, the USD and so on); (iv) it is useful in generating diversified portfolios via optimization procedures across major currencies and it is beneficial to reduce exchange rate volatility of the portfolio.

Mean-variance (MV) optimization based on a basket currency leads to several interesting results. Firstly, we show that there are significant gains from diversification with the addition of alternative instruments (such as gold, CNY bonds or stocks) to a typical investment universe that consists of only major bonds.

Secondly, we show that the resulting portfolio weights from a MV optimization based on return inputs in terms of a basket currency are highly diversified and quite stable across several dimensions, whereas USD based MV optimization yields too much concentrated portfolios with unstable weights. Moreover, the weight attributions from basket currency based optimization to each asset class is reasonable considering the main features of the recent two decades (the period of interest), but it would be impossible to reach such a conclusion from USD based optimizations. Thirdly, we show that the resampled optimization based on a basket currency increases diversification ratios further and the stability of weights also slightly increases. USD based resampled optimization, on the other hand, does not improve on the diversification side and on the stability side across different sets of investment universes (except for the low risk averse options of optimal portfolios). Fourthly, carrying out an out-of-sample performance analysis, we show that basket currency based optimization procedure that we invented performs quite well in different scenarios. Finally, constructing a constrained optimization framework, we show that predetermined liquidity, currency and duration constraints confine optimal allocations to the less riskier side of the unconstrained frontier and those constrained frontiers are actually very close to our unconstrained resampled frontier, which implies that typical constraints of a central bank actually do the same job with the resampling and confine itself into the conservative side of optimal portfolio search.

This essay contributes to the literature by developing a basic, flexible and practitioner-friendly optimization framework for the strategic asset allocation process of a developing country central bank with a specific focus on the optimal currency allocation of an investment portfolio. The framework is open to further improvements by using the state-of-the-art extensions to the Markowitz portfolio optimization framework by combining forward-looking inputs via yield curve forecasting, adding analyst views and constructing tailor-cut objective functions.

REFERENCES

Aizenman, J., Chinn, M. D., & Ito, H. (2011). Surfing the waves of globalization: Asia and financial globalization in the context of the trilemma. Journal of the Japanese and International Economies, 25(3), 290-320.

Aizenman, J., & Ito, H. (2012). Trilemma policy convergence patterns and output volatility. The North American Journal of Economics and Finance, 23(3), 269-285.

Altunbas, Y., Kara, A. & Olgu, Ö. (2009). Turkish Banking. Palgrave Macmillan Studies in Banking and Financial Institutions, Palgrave Macmillan.

Bank of Chile (2018). Annual Report 2018. Bank of Chile.

Bank of Korea (2019). Reserves management and FX intervention. BIS Papers chapters, in: Bank for International Settlements (ed.), Reserve management and FX intervention, volume 104, pages 163-170, Bank for International Settlements.

Barajas, A., Dell'Ariccia, G. & Levchenko, A. (2007). Credit Booms: the Good, the Bad, and the Ugly, unpublished paper. Accessed at: http://www.nbp.pl/Konferencje/NBP_Nov2007/Speakers/Dell_Ariccia.pdf

BCBS (Basel Committee on Banking Supervision). (2010). Guidance for national authorities operating the countercyclical capital buffer. Basel, Switzerland.

Beck T., and Levine R. (2005) Legal Institutions and Financial Development. In: Menard C., Shirley M.M. (eds) Handbook of New Institutional Economics. Springer, Boston, MA

Bell, S. (2001). The role of the state and the hierarchy of money. Cambridge Journal of Economics, 25(2), 149-163.

Benita, G., Baudot-Trajtenberg, N. & Friedman, A. (2019). The challenges of managing large FX reserves: the case of Israel. BIS Papers chapters, in: Bank for International Settlements (ed.), Reserve management and FX intervention, volume 104, pages 151-162, Bank for International Settlements.

Bindseil, U. (2004a). Monetary policy implementation: Theory, past, and present. OUP Oxford.

Bindseil, U. (2004b). The operational target of monetary policy and the rise and fall of reserve position doctrine. Available at SSRN 533132.

Binici, M., & Köksal, B. (2012). Determinants of Credit Booms in Turkey. MPRA Paper, 38032.

BIS (2019), 'Triennial Central Bank Survey of Foreign Exchange and OTC Derivatives Markets: Reporting guidelines for turnover in April 2019', Monetary and Economic Department, March.

Borio, C. (2019). On money, debt, trust and central banking. BIS Working Papers 763, Bank for International Settlements, Jan 2019.

Borio, C. (2012). The financial cycle and macroeconomics: What have we learnt?. BIS Working Papers no: 95.

Borio, C. & Disyatat, P., (2009). Unconventional monetary policies: an appraisal. BIS Working Papers no 292, Nov. 2009.

Borio, C. & Disyatat, P., (2011). Global imbalances and the financial crisis: Link or no link? BIS Working Papers no 346, May 2011.

Borio, C., Ebbesen, J., Galati, G., & Heath, A. (2008). FX reserve management: elements of a framework. BIS papers.

Borio, C., Galati, G., & Heath, A. (2008). FX reserve management: trends and challenges. BIS papers.

Borio, C. E., & Lowe, P. W. (2002). Asset prices, financial and monetary stability: exploring the nexus.

Bourva, J. L. (1992). Money creation and credit multipliers∗. Review of Political Economy, 4(4), 447-466.

Braudel, F. (1983) Civilization and Capitalism, 15th-18th Century, Volume II: The Wheels of Commerce.

Brennan, M., Kobor, A., & Rustaman, V. (2011). Diversifying market and default risk in high grade sovereign bond portfolios. Portfolio and risk management for central banks and sovereign wealth funds, BIS Papers no 58, 49-74.

Bruno, V. & Shin, H. S., (2011). Cross-border banking and global liquidity. BIS Working Papers no 458, Aug 2014.

Buzeneca, I., & Maino, M. R. (2007). Monetary policy implementation: Results from a survey (No. 7). International Monetary Fund.

Calderon, C. and Kubota, M. (2012). Gross inflows gone wild: gross capital inflows, credit booms and crises. Policy Research Working Paper Series 6270, The World Bank.

Capie F., Goodhart, C. & Schnadt, N. (1994). The Development of Central Banking. London: Bank of England.

Cardarelli, R., Elekdag, S., & Kose, M. A. (2010). Capital inflows: Macroeconomic implications and policy responses. Economic Systems, 34(4), 333-356.

Chick, V. (1992). The evolution of the banking system and the theory of saving, investment and interest (pp. 193-205). Palgrave Macmillan UK.

Chick, V. (1993). The evolution of the banking system and the theory of monetary policy (pp. 79-92). Palgrave Macmillan UK.

Chick, V., & Dow, S. (1988). A post-Keynesian perspective on the relation between banking and regional development. Thames Papers in Political Economy.

Cottarelli, C., Dell'Ariccia, G. and Vladkova-Hollar, I. (2005). Early birds, late risers, and sleeping beauties: Bank credit growth to the private sector in Central and Eastern Europe and in the Balkans. Journal of Banking & Finance, 29(1), 83-104.

De Conti, B., Biancarelli, A., & Rossi, P. (2013). Currency hierarchy, liquidity preference and exchange rates: a Keynesian/minskyan approach. Congrès de l'Association Française d'Économie Politique, Université Montesquieu Bordeaux IV, 1-22.

De Pooter, M., Ravazzolo, F., & van Dijk, D. J. (2010). Term structure forecasting using macro factors and forecast combination. FRB International Finance Discussion Paper, (993).

Dell'Ariccia, G., Igan, D., Laeven, L., & Tong, H. (2012). Policies for macrofinancial stability: How to deal with credit booms. IMF Staff Discussion Note.

Disyatat, P. (2008). Monetary policy implementation: Misconceptions and their consequences. BIS Working Papers. No. 269.

Djankov, S., McLiesh, C. & Shleifer, A., 2007. Private credit in 129 countries. Journal of Financial Economics, Elsevier, vol. 84(2), pages 299-329, May.

Dow, S. C. (2006). Endogenous money: structuralist. A Handbook of Alternative Monetary Economics, 35-51.

Drehmann, M. (2013). Total credit as an early warning indicator for systemic banking crises.

Drehmann, M., & Tsatsaronis, K. (2014). The credit-to-GDP gap and countercyclical capital buffers: questions and answers.

Drehmann, M., Borio, C. E., Gambacorta, L., Jimenez, G., & Trucharte, C. (2010). Countercyclical capital buffers: exploring options.

Drehmann, M., Borio, C. E., & Tsatsaronis, K. (2011). Anchoring countercyclical capital buffers: the role of credit aggregates.

Drehmann, M., Borio, C. E., & Tsatsaronis, K. (2012): Characterising the financial cycle: Don't lose sight of the medium term!, BIS Working Papers, no 380, June.

Drehmann M., Santos, M., & Pastor, J. M. V. (2016). Recent enhancements to the BIS statistics. The credit-to-GDP gap. BIS Quarterly Review, September 2016.

Drehmann, M., & Yetman, J. (2018). Why you should use the Hodrick-Prescott filter–at least to generate credit gaps. BIS Working Papers No 744.

Duffee, G. (2013). Forecasting interest rates. In Handbook of economic forecasting (Vol. 2, pp. 385-426). Elsevier.

Edge, R. M., & Meisenzahl, R. R. (2011). The unreliability of credit-to-GDP ratio gaps in real-time: Implications for countercyclical capital buffers. International Journal of Central Banking, 7(4), 261-298

Eichengreen, B. (2011). Exorbitant Privilege: The rise and fall of the Dollar and the Future of the International Monetary System. Oxford University Press.

Eichengreen, B., Hausmann, R., and Panizza, U., 'The Pain of Original Sin' (2003a), in Eichengreen, B. and Hausmann, R., Debt Denomination and Financial Instability in Emerging-Market Economies (Chicago: University of Chicago Press, 2005).

Eichengreen, B., Hausmann, R., and Panizza, U., 'The Mystery of Original Sin' (2003b), in Eichengreen, B. and Hausmann, R., Debt Denomination and Financial Instability in Emerging-Market Economies (Chicago: University of Chicago Press, 2005).

Eichengreen, B., Hausmann, R., & Panizza, U. (2007). Currency mismatches, debt intolerance, and the original sin: Why they are not the same and why it matters. In Capital controls and capital flows in emerging economies: Policies, practices, and consequences (pp. 121-170). University of Chicago Press.

Elekdag, S. & Wu, Y. (2011). Rapid Credit Growth; Boon or Boom-Bust?. IMF Working Papers 11/241.

Fernandes, J.L.B, Ornelas, J.R.H., Cusicanqui, O.A.M. (2011). Combining equilibrium, resampling, and analysts' views in portfolio optimization. Portfolio and risk management for central banks and sovereign wealth funds, BIS Papers no 58, 75-84.

Fisher, S. J., & Lie, M. C. (2004). Asset allocation for central banks: optimally combining liquidity, duration, currency and non-government risk. Risk management for central bank foreign reserves, 75.

Foley, D. (1989). Money in economic activity. J. Eatwell, M. Milgate and P. Newman (eds.), 248-62.

Furceri, D., Guichard, S., & Rusticelli, E. (2011). Episodes of large capital inflows and the likelihood of banking and currency crises and sudden stops.

Goodhart, C. (1988). The evolution of central banks. MIT Press Books.

Goodhart, C. (2001). The endogeneity of money. P. Arestis , M. Desai and S. Dow (eds.), Chapter 3, 14-24.

Gourinchas, P.-O., Valdes, R. O. & Landerretche, O. (2001). "Lending Booms: Latin Ameriaca and the World", Economía, 1(2), 47-99.

Grossman, R. S. (2010). Unsettled Account. Princeton University Press.

Hamilton, J. D. (2017). Why You Should Never Use the Hodrick-Prescott Filter. NBER Working Paper No 23429.

Hernández, L., & Landerretche, O. (2002). Capital inflows, credit booms, and macroeconomic vulnerability: the cross-country experience. Banking, Financial Integration, and International Crises, Central Bank of Chile Santiago, Chile, 199-233.

Hilbers, P., Otker-Robe, I., Pazarbasioglu, C. and Johnsen, G. (2005) Assessing and managing rapid credit growth and the role of supervisory and prudential policies. IMF Working Papers No. 05/151.

Hoguet, G., & Tadesse, S. (2011). The role of SDR-denominated securities in official and private portfolios. Portfolio and risk management for central banks and sovereign wealth funds, BIS Papers 58, 165-186.

Howells, P. (2001). The endogeneity of money. P. Arestis (ed.), Chapter 5, 134-178.

International Monetary Fund. (2014). Revised Guidelines for Foreign Exchange Reserve Management. Policy Papers.

Jordà, Ò., Schularick, M., & Taylor, A. M. (2011). Financial crises, credit booms, and external imbalances: 140 years of lessons. IMF Economic Review, 59(2), 340-378.

Kaldor, N. (1970). The new monetarism. Lloyds Bank Review, 97(1), 18.

Kaminsky, G. L., & Reinhart, C. M. (1999). The twin crises: the causes of banking and balance-of-payments problems. American economic review, 89(3), 473-500.

Kindleberger, C. P. (1984). A Financial History of Western Europe. London: George Allen & Unwin

Kiss, G., Nagy, M., & Vonnák, B. (2006). Credit growth in Central and Eastern Europe: convergence or boom? (No. 2006/10). MNB working papers.

Koivu, M., Lora, F. M. & Nyholm, K. (2009). Strategic asset allocation for fixed-income investors. In Risk Management for Central Banks and Other Public Investors (eds. Bindseil, U.,Gonzalez F. & Tabakis, E.), Chapter 2, 49-116. Cambridge.

Kolm, P. N., Tütüncü, R., & Fabozzi, F. J. (2014). 60 Years of portfolio optimization: Practical challenges and current trends. European Journal of Operational Research, 234(2), 356-371.

Lane, P. R., & McQuade, P. (2014). Domestic credit growth and international capital flows. The Scandinavian Journal of Economics, 116(1), 218-252.

Laeven, L. & Valencia, F. (2012). "Systemic Banking Crises Database: An Update", IMF Working Papers 12/163.

Lavoie, M. (1984). The endogenous flow of credit and the post Keynesian theory of money. Journal of Economic Issues, 18(3), 771-797.

Lavoie, M. (1985). The Post Keynesian theory of endogenous money: a reply. Journal of Economic Issues, 19(3), 843-848.

Lavoie, M. (2000). The Reflux Mechanism in the Open Economy. Available at http://aix1.uottawa.ca/~robinson/Lavoie/Courses/2007_ECO6183/reflux-open.pdf

Lavoie, M. (2006a). 2 Endogenous money: accommodationist. A Handbook of Alternative Monetary Economics, 17.

Lavoie, M. (2006b). Introduction to Post-Keynesian Economics. Palgrave MacMillan.

Lavoie, M. (2014). Post-Keynesian Economics: New Foundations. Edward Elgar.

Levy-Yeyati, E. (2006). Financial dollarization: evaluating the consequences. economic Policy, 21(45), 62-118.

Levy Yeyati, E. & Gomez, J.F. (2019). The Cost of Holding Foreign Exchange Reserves. CID Working Papers 353, Center for International Development at Harvard University.

Lu, M., & Wang, Y. (2019). Determinants of currency composition of reserves: a portfolio theory approach with an application to RMB. International Monetary Fund.

Macleod, H. D.(1896). Chapter III: The Theory and Mechanism of Banking, in A History of Banking in All the Leading Nations. VOLUME II, New York: Journal of commerce and commercial bulletin, pg.195-225.

Markowitz, Harry and Usmen, Nilufer, Resampled Frontiers vs Diffuse Bayes: An Experiment. Journal Of Investment Management, Vol. 1, No. 4, Fourth Quarter 2003.

Marx, K. (1867). Capital, volume I.

McLeay, M., Radia, A., & Thomas, R. (2014a). Money creation in the modern economy: an introduction. Bank of England Quarterly Bulletin, Q1.

McLeay, M., Radia, A., & Thomas, R. (2014b). Money creation in the modern economy. Bank of England Quarterly Bulletin, Q1.

Mehrling, P. (2000). Modern money: fiat or credit?. Journal of Post Keynesian Economics, 22(3), 397-406.

Mehrling, P. (2012a). The inherent hierarchy of money. Available at: http://ieor.columbia.edu/files/seasdepts/industrial-engineering-operations-research/pdf-files/Mehrling_P_FESeminar_Sp12-02.pdf

Mehrling, P. (2012b). A Money View of Credit and Debt. INET Working Paper.

Mehrling, P. (2013). Essential hybridity: A money view of FX. Journal of Comparative Economics, 41(2), 355-363.

Mendoza, E. G. & Terrones, M. E. (2004). “Are Credit Booms in Emerging Markets a concern?”, IMF - World Economic Outlook April 2004, Chapter 4, 147-166.

Mendoza, E. G. & Terrones, M. E. (2008). "An Anatomy Of Credit Booms: Evidence From Macro Aggregates And Micro Data," NBER Working Papers 14049.

Mendoza, E. G. & Terrones, M. E. (2012). "An Anatomy of Credit Booms and their Demise," NBER Working Papers 18379.

Michaud, R. O., & Michaud, R. O. (2008). Efficient asset management: a practical guide to stock portfolio optimization and asset allocation. Oxford University Press.

Minsky, H. P., (1986). Stabilizing an unstable economy. New York: McGraw-Hill.

Mise, E., Kim, T. H., & Newbold, P. (2005). On suboptimality of the Hodrick–Prescott filter at time series endpoints. Journal of Macroeconomics, 27(1), 53-67.

Montiel, P. J. (2000). What drives consumption booms?. The World Bank Economic Review, 14(3), 457-480.

Moore, B. J. (1988). The endogenous money supply. Journal of Post Keynesian Economics, 10(3), 372-385.

Niggle, C. J. (1990). The evolution of money, financial institutions, and monetary economics. Journal of Economic Issues, 24(2), 443-450.

Niggle, C. J. (1991). The endogenous money supply theory: an institutionalist appraisal. Journal of Economic Issues, 25(1), 137-151.

Nugée, J. (2000). Foreign Exchange Reserves Management, Handbooks in Central Banking, No 19, Centre for Central Banking Studies, Bank of England.

Nyholm, K. (2008). Strategic Asset Allocation in Fixed Income Markets: A Matlab Based User's Guide. John Wiley & Sons.

Orhangazi, Ö. (2014). Capital Flows and Credit Expansions in Turkey. Review of Radical Political Economics, 46(4), 509-516.

Ottens, D., Lambregts, E., & Poelhekke, S. (2005). Credit Booms in Emerging Market Economies: A Recipe for Banking Crises?. De Nederlandsche Bank.

Öztürk, Ö. (2008). Türkiye'de Büyük Sermaye Grupları Finans Kapital ve Faaliyet Çeşitliliği Üzerine Bir İnceleme (Doctoral dissertation, Marmara Universitesi (Turkey)).

Pozsar, Z. (2014). Shadow banking: The money view. Available at SSRN 2476415.

Ravn, M. O., & Uhlig, H. (2002). On adjusting the Hodrick-Prescott filter for the frequency of observations. Review of economics and statistics, 84(2), 371-376.

Reinhart, C. M., & Reinhart, V. R. (2008). Capital flow bonanzas: an encompassing view of the past and present (No. w14321). National Bureau of Economic Research.

Reinhart, C. M., & Rogoff, K. S. (2008). Banking Crises: An Equal Opportunity Menace." National Bureau of Economic Research Working Paper 14587. Retrieved February, 13, 2009.

Rey, H. (2015). Dilemma not trilemma: the global financial cycle and monetary policy independence (No. w21162). National Bureau of Economic Research.

Rivadeneyra, F., Jin, J., Bulusu, N., & Pomorski, L. (2013). Modelling the asset-allocation and liability strategy for Canada's foreign exchange reserves. Bank of Canada Review, 2013(Spring), 29-36.

Rochon, L. P., & Rossi, S. (2013). Endogenous money: the evolutionary versus revolutionary views. Review of keynesian economics, 1(2), 210-229.

Rodrik, D. (2006). The social cost of foreign exchange reserves. International Economic Journal, Taylor & Francis Journals, vol. 20(3), pages 253-266.

Romanyuk, Y. (2010). Asset-liability management: An overview. Bank of Canada Discussion Paper No. 2010-10.

Romanyuk, Y. (2012). Liquidity, risk, and return: specifying an objective function for the management of foreign reserves. Applied Stochastic Models in Business and Industry, 28(3), 175-193.

Ryan-Collins, J., Greenham, T., Werner, R., & Jackson, A. (2011). Where does money come from. London: New Economics Foundation.

Sa, S. (2006). "Capital flows and credit booms in emerging market economies?," Financial Stability Review, Banque de France, 9, 49-66.

Schumpeter, J. A. (1974). The Theory of Economic Development: An Inquiry into Profits, Capital, Credit, Interest, and the Business Cycle [1912/1934]. Oxford University Press.

Tobin, J. (1963). Commercial banks as creators of 'money' (No. 159). Cowles Foundation for Research in Economics, Yale University.

Tornell, A. & Westermann, F. (2002). Boom-Bust Cycles in Middle Income Countries: Facts and Explanation. IMF Staff Papers, 49(Special i), 111-155.

Türkiye Cumhuriyet Merkez Bankası (2014). Yıllık Rapor 2014. TCMB, Ankara. http://www3.tcmb.gov.tr/yillikrapor/2014/tr/

Türkiye Cumhuriyet Merkez Bankası (2020). Yıllık Faaliyet Raporu 2020. TCMB, Ankara. http://www3.tcmb.gov.tr/yillikrapor/2020/tr/

Usher, A. P. (1934). The Origins of Banking: The Primitive Bank of Deposit, 1200–1600. The Economic History Review, 4(4), 399-428.

Wray, R. L. (1990). Money and Credit in Capitalist Economies: the Endogenous Money Approach. Edward Elgar.

Wray, L. R. (1998). Understanding modern money. Books.

Wray, L. R. (2015). Modern money theory: A primer on macroeconomics for sovereign monetary systems. Springer.

Young, A. A. (1999 [1924]). Money and growth: selected papers of Allyn Abbott Young. Psychology Press.

Zhang, Z., Chau, F. & Xie, L., (2012). Strategic Asset Allocation for Central Bank's Management of Foreign Reserves: A new approach. MPRA Paper 43654, University Library of Munich, Germany.

APPENDICES

A. DATA SOURCES, ADDITIONAL FIGURES AND TABLES

The construction of data sets for credit boom identification is as follows: using IMF-IFS database, two credit series are downloaded for all countries, for 1950-2016: (i) "Non-standardized Presentation (Deposit Money Banking), Claims on Private Sector" and (ii) "Depository Corporations Survey, Domestic Claims, Claims on Other Sectors, Claims on Private Sector", both of which are denominated in national currency. The first time-series is ended up at 2008 for most of the countries, while the second series starts from 2001 for most of the countries. By merging these two series, we obtained a combined series of what we called "Bank Credit to Private Sector" (BCPS). We consider the first series as the main credit variable so that the other series is considered as a patch to the first one in order to cover the most recent observations. These two series are perfectly compatible for more than half of the countries in our final sample, nonetheless, there are incompatibilities, too. To complete the credit series for each country, the year for merging two series is chosen as the one that gives the smallest difference between each series. In the end, we obtained a data set of nominal BCPS for all countries that have available data in IFS.

Secondly, using WB-WDI database, "Domestic credit to private sector by banks (as % of GDP)" series are downloaded for all countries. Note that these credit-to-GDP ratios are based on the IFS database that we used for constructing nominal BCPS data set. Then, by calculating the maximum value of credit-to-GDP ratio for all countries, we eliminated the countries with maximum credit-to-GDP ratio below 20 percent from our baseline nominal BCPS data set since such countries are considered

as financially underdeveloped. Finally, using the CPI index, we constructed "real BCPS" data set for all countries.

The "real BCPS" data set is examined in a detailed way and we have made necessary modifications, which are as follows. First, the countries which have less than or equal to 15 observations are dropped from the real BCPS data set. Second, due to the use of CPI, there were significantly many number of observations lost in real BCPS for some countries, though the country may have more than enough observations if we had used GDP deflator or WPI. When this is the case, we used GDP deflator or WDI to make real BCPS series for that country. For the UK only, we used GDP deflator index from country sources. Third, for a small number of countries, there were too many missing observations either at the end of the time-span we covered or in the middle of real BCPS series, so those countries are dropped from the real BCPS data set. Fourth, for all Eurozone countries, there are significant breaks or missing and incompatible observations in the original data set due to the initiation of common currency around the 2000s. Thus, all such countries are dropped from the real BCPS data set. Instead, we used credit-to-GDP ratios from WDI database to construct real BCPS series for these countries by simply multiplying the credit-to-GDP ratio by the nominal GDP obtained from WDI. Since there is no available bank credit data for the US in the IFS database, the real BCPS data is also constructed in a similar fashion. In the end, we were left with 150 countries in the real BCPS data set. Finally, after our preliminary analyses, for four advanced countries, namely Belgium, Canada, Denmark and Sweden, we detected unreasonable jumps at some points resulting from the use of IFS database. Thus, the real BCPS series are reconstructed for those countries by using the BIS database to obtain nominal BCPS series.

To further adjust those real credit series with population, we used mainly WDI database. Since there are no data available for two countries, we were left with 148 countries. Finally, for 37 countries, we have real BCPS data available for the years before 1960. For those countries, I replaced the WDI population data with the data obtained from "World Population Prospects, the 2015 Revision", which is released

by the UN - Department of Economic and Social Affairs – Population Division. Additionally, for Kuwait, the WDI data contains some missing observations, so we replaced the WDI data with the UN data.

After all these steps, we were left with 148 countries and 6600 observations, which implies that there are nearly 45 observations for each country on average. Since some of the real BCPS series still contained missing observations and HP filter requires no missing values in the middle of a time series, we used linear interpolation to fulfill those series.

The following table, Table A.1, lists the countries in real BCPS per capita data set we have constructed for the periods 1950-2016. Two columns next to the country names show the credit-to-GDP group and income group of countries. The final column shows whether the country is present in the banking crisis data set obtained from Laeven and Valencia (2012).

	Credit-to-GDP Group	Income Group	Banking Crisis		Credit-to-GDP Group	Income Group	Banking Crisis		Credit-to-GDP Group	Income Group	Banking Crisis		Credit-to-GDP Group	Income Group	Banking Crisis
Albania	Low	UM	1	Czech Republic	LM	High	1	Mongolia	LM	LM	1	Togo	Low	Low	1
Algeria	Low	UM	1	Denmark	High	High	1	Mozambique	Low	Low	1	Tonga	LM	LM	0
Angola	Low	UM	1	Dominican Republic	Low	UM	1	Namibia	LM	UM	1	Trinidad and Tobago	LM	High	1
Antigua and Barbuda	UM	High	0	Egypt	LM	LM	1	Nepal	LM	Low	1	Tunisia	UM	LM	1
Argentina	Low	UM	1	Equatorial Guinea	Low	UM	1	New Zealand	High	High	1	Turkey	LM	UM	1
Armenia	Low	LM	1	Estonia	UM	High	1	Nicaragua	Low	LM	1	Ukraine	LM	LM	1
Aruba	LM	High	0	Ethiophia	Low	Low	1	Nigeria	Low	LM	1	United Kingdom	High	High	1
Australia	High	High	1	Fiji	LM	UM	1	Norway	High	High	1	United States	LM	High	1
Bahamas	UM	High	0	Gabon	Low	UM	1	Oman	LM	High	0	Uruguay	LM	High	1
Bahrain	LM	High	0	Gambia	Low	Low	1	Pakistan	Low	LM	1	Vanuatu	LM	LM	0
Bangladesh	LM	LM	1	Georgia	Low	UM	1	Panama	UM	UM	1	Venezuela	Low	UM	1
Barbados	UM	High	1	Greece	UM	High	1	Papua New Guinea	Low	LM	1	Vietnam	UM	LM	1
Belize	LM	UM	1	Grenada	UM	UM	1	Paraguay	Low	UM	1	Zambia	Low	LM	1
Benin	Low	Low	1	Guatemala	Low	LM	1	Peru	Low	UM	1	Austria	High	High	1
Bhutan	Low	LM	1	Guyana	LM	UM	1	Phillippines	LM	LM	1	Belgium	UM	High	1
Bolivia	LM	LM	1	Honduras	LM	LM	1	Poland	LM	High	1	Colombia	LM	UM	1
Botswana	Low	UM	1	Hungary	LM	High	1	Qatar	LM	High	0	Congo, Rep. Of	Low	LM	1
Brazil	LM	UM	1	Iceland	High	High	1	Romania	Low	UM	1	Dominica	LM	UM	1
Brunei	LM	High	1	India	LM	LM	1	Russian Federation	LM	UM	1	Finland	UM	High	1
Bulgaria	LM	UM	1	Indonesia	Low	LM	1	Samoa	LM	LM	0	France	UM	High	1
Burkina Faso	Low	Low	1	Israel	UM	High	1	Sao Tome and Principe	Low	LM	1	Germany	High	High	1
Burundi	Low	Low	1	Jamaica	Low	UM	1	Saudi Arabia	LM	High	0	Iran	LM	UM	1
Cabo Verde	LM	LM	0	Japan	High	High	1	Senegal	Low	Low	1	Ireland	High	High	1
Cambodia	Low	LM	1	Jordan	UM	UM	1	Serbia	LM	UM	1	Italy	UM	High	1
Cameroon	Low	LM	1	Kazakhstan	LM	UM	1	Seychelles	Low	High	1	Kuwait	UM	High	1
Canada	High	High	1	Kenya	Low	LM	1	Singapore	High	High	1	Latvia	UM	High	1
Central African Republic	Low	Low	1	Korea, Rep.	High	High	1	Slovak Republic	LM	High	1	Lesotho	Low	LM	1
Chad	Low	Low	1	Kyrgyz Rep.	Low	LM	1	Solomon Islands	Low	LM	0	Lithuania	LM	High	1
Chile	UM	High	1	Lao PDR	Low	LM	1	Sri Lanka	LM	LM	1	Luxembourg	UM	High	1
Hong Kong	High	High	1	Libya	Low	UM	1	St. Kitts and Nevis	LM	High	0	Maldives	LM	UM	1
Macao	LM	High	0	Macedonia	LM	UM	1	St. Lucia	High	UM	0	Morocco	LM	LM	1
China	High	UM	1	Malaysia	High	UM	1	St. Vincent and Grenadines	LM	UM	0	Netherlands	High	High	1
Comoros	Low	Low	1	Mali	Low	Low	1	Suriname	Low	UM	1	Portugal	High	High	1
Costa Rica	LM	UM	1	Malta	High	High	0	Swaziland	Low	LM	1	Rwanda	Low	Low	1
Cote dIvoire	Low	LM	1	Mauritius	UM	UM	1	Sweden	High	High	1	Slovenia	LM	High	1
Crotia	LM	High	1	Mexico	Low	UM	1	Switzerland	High	High	1	Spain	High	High	1
Cyprus	High	High	0	Moldova	Low	LM	1	Thailand	High	UM	1	South Africa	UM	UM	1

Table A.1. Countries included in the data set of real credit per capita and country groups

Source: IFS, WDI, BIS, Laeven and Valencia (2012).

Notes: “LM” means “lower-middle” and “UM” means upper-middle. Banking crises are obtained from Laeven and Valencia (2012). If a country is also included in the banking crises data set, then it takes the value of 1; otherwise, it takes 0. The credit-to-GDP groups (constructed by taking 30, 60 and 90 per cent as thresholds), from low to high, include 52, 50, 21 and 25 countries, respectively. The income groups, from low to high, include 14, 37, 43 and 54 countries, respectively.

Additional tables and figures, and data descriptions mentioned in Chapter 4 are shown below.

Methods for Currency Allocation in Reserve Management			**Countries**
Asset – Liability Matching*	Balance-Sheet (main)		Canada, Chile, Romania, Philippines(1), Russia, Thailand, Turkey
	External Debt	Government	Indonesia, S. Africa, Romania, Turkey
		Short-Term	Hungary(2)
		Total	Brazil, S. Korea
	Foreign Trade		Indonesia, Romania
		Import only	Botswana, S. Africa
	Balance of Payments		Botswana, S. Korea, Colombia
Intervention Currency			Australia, Colombia, Indonesia, New Zealand
Peers Analysis or Global Bond Market Weights			Indonesia, Norway, S. Korea
Optimization			Canada, Colombia(3,4), Israel, Mexico(4), Poland, S. Africa(3), S. Korea

* Includes expected cash flows and/or flow variables.
(1) Banking system and country balance sheet also matter.
(2) Member of European System of Central Banks; no exchange rate exposure other than EUR.
(3) Only investment sub-portfolio.
(4) Reporting currency (numeraire) is USD.

Table A.2. Methods for Currency Allocation in Reserve Management

Source: Various Annual Reports and/or documents from central bank websites.

Returns are based on…	Exchange rate series start at …	Bonds series start at …
TRY	Jan 1999	Dec 2004
BRL	May 1999	Dec 2005
INR	May 1996	Dec 1998 (China, Dec 2004)
KRW	Oct 1996	Jun 2000 (China, Dec 2004)
MXN	Jan 1999	Dec 2001 (China, Dec 2004)
RUB	Dec 1999	Jun 2005
ZAR	Jan 1999	Jun 1997 (China, Dec 2004)
USD	-	Dec 1996 (China, Dec 2004)

Table A.3. Starting points of exchange rate and bond returns data

Source: ICE indices, Bloomberg.

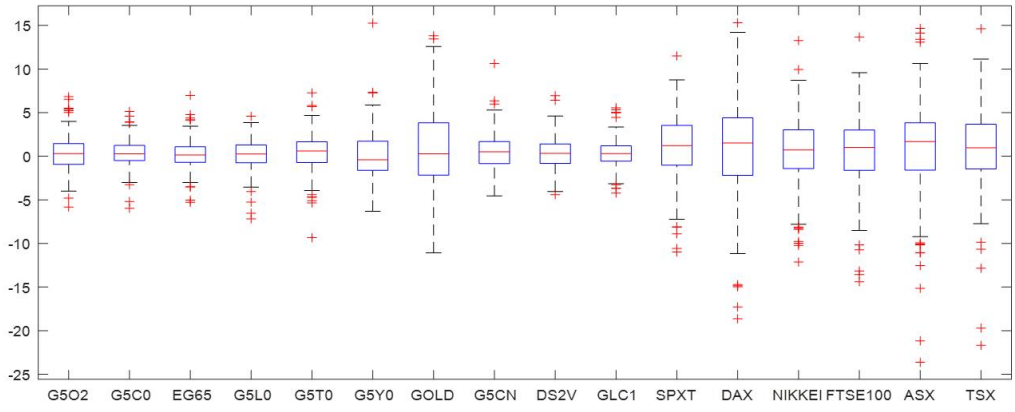

Figure A.1 Boxplots of Asset Classes (Basket Currency Returns based on TRY)

Sources: ICE indices, Bloomberg. Author's calculations.

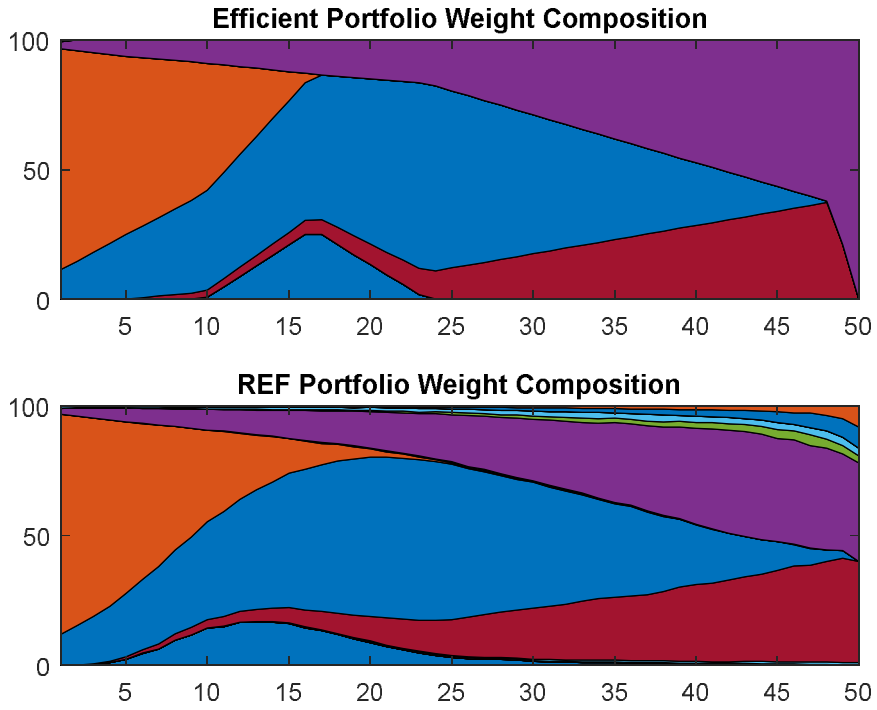

Figure A.2 Weight Distributions from MV and Resampled Optimizations (based on USD returns)

Sources: ICE indices, Bloomberg. Author's calculations.

Annualized Returns	Numeraire: USD					Numeraire: BAS				
NO REBALANCING	TRY-Uncons	TRY-REF	USD-Uncons	USD-REF	EqualW	TRY-Uncons	TRY-REF	USD-Uncons	USD-REF	EqualW
Started at the end of ...										
2014	1.2%	1.1%	2.0%	2.0%	1.2%	1.6%	1.4%	2.4%	2.3%	1.5%
2015	2.7%	2.6%	2.5%	2.4%	2.6%	1.6%	1.6%	1.5%	1.4%	1.5%
2016	3.5%	3.5%	2.8%	2.8%	3.3%	1.8%	1.7%	1.0%	1.1%	1.6%
2017	2.5%	2.4%	3.1%	3.1%	2.1%	2.2%	2.1%	2.9%	2.8%	1.9%
2018	5.2%	5.0%	4.2%	4.2%	4.4%	2.7%	2.5%	1.7%	1.7%	1.9%
2019	5.3%	5.1%	3.4%	3.4%	4.5%	2.1%	2.0%	0.3%	0.3%	1.4%
REBALANCED	Inv. Universe: Bonds									
Started at the end of...										
2014	1.3%	1.2%	2.0%	2.0%	1.2%	1.6%	1.5%	2.3%	2.3%	1.6%
2015	2.7%	2.7%	2.5%	2.4%	2.6%	1.6%	1.6%	1.4%	1.4%	1.6%
2016	3.6%	3.5%	2.8%	2.8%	3.3%	1.8%	1.8%	1.0%	1.1%	1.6%
2017	2.6%	2.5%	3.1%	3.1%	2.2%	2.3%	2.2%	2.9%	2.8%	1.9%
2018	5.2%	5.1%	4.2%	4.2%	4.4%	2.7%	2.6%	1.7%	1.7%	1.9%
2019	5.2%	5.2%	3.4%	3.4%	4.5%	2.1%	2.0%	0.3%	0.3%	1.4%

Table A.4. Out-of-Sample Performance Comparisons (Investment Universe: Bonds Only)

Source: ICE indices, Bloomberg; Author's calculations.

Annualized Returns	Numeraire: USD					Numeraire: BAS				
NO REBALANCING	TRY-Uncons	TRY-REF	USD-Uncons	USD-REF	EqualW	TRY-Uncons	TRY-REF	USD-Uncons	USD-REF	EqualW
Started at the end of ...										
2014	1.2%	1.1%	2.0%	2.0%	1.2%	1.6%	1.4%	2.4%	2.3%	1.5%
2015	2.7%	2.6%	2.5%	2.4%	2.6%	1.6%	1.6%	1.5%	1.4%	1.5%
2016	3.5%	3.5%	2.8%	2.8%	3.3%	1.8%	1.7%	1.0%	1.1%	1.6%
2017	2.5%	2.4%	3.1%	3.1%	2.1%	2.2%	2.1%	2.9%	2.8%	1.9%
2018	5.2%	5.0%	4.2%	4.2%	4.4%	2.7%	2.5%	1.7%	1.7%	1.9%
2019	5.3%	5.1%	3.4%	3.4%	4.5%	2.1%	2.0%	0.3%	0.3%	1.4%
REBALANCED	Inv. Universe: Bonds									
Started at the end of...										
2014	1.3%	1.2%	2.0%	2.0%	1.2%	1.6%	1.5%	2.3%	2.3%	1.6%
2015	2.7%	2.7%	2.5%	2.4%	2.6%	1.6%	1.6%	1.4%	1.4%	1.6%
2016	3.6%	3.5%	2.8%	2.8%	3.3%	1.8%	1.8%	1.0%	1.1%	1.6%
2017	2.6%	2.5%	3.1%	3.1%	2.2%	2.3%	2.2%	2.9%	2.8%	1.9%
2018	5.2%	5.1%	4.2%	4.2%	4.4%	2.7%	2.6%	1.7%	1.7%	1.9%
2019	5.2%	5.2%	3.4%	3.4%	4.5%	2.1%	2.0%	0.3%	0.3%	1.4%

Table A.5. Out-of-Sample Performance Comparisons (Investment Universe: Gold included)

Source: ICE indices, Bloomberg; Author's calculations.

Annualized Returns	Numeraire: USD					Numeraire: BAS				
NO REBALANCING	TRY-Uncons	TRY-REF	USD-Uncons	USD-REF	EqualW	TRY-Uncons	TRY-REF	USD-Uncons	USD-REF	EqualW
Started at the end of ...										
2014	1.2%	1.1%	2.0%	2.0%	1.2%	1.6%	1.4%	2.4%	2.3%	1.5%
2015	2.7%	2.6%	2.5%	2.4%	2.6%	1.6%	1.6%	1.5%	1.4%	1.5%
2016	3.5%	3.5%	2.8%	2.8%	3.3%	1.8%	1.7%	1.0%	1.1%	1.6%
2017	2.5%	2.4%	3.1%	3.1%	2.1%	2.2%	2.1%	2.9%	2.8%	1.9%
2018	5.2%	5.0%	4.2%	4.2%	4.4%	2.7%	2.5%	1.7%	1.7%	1.9%
2019	5.3%	5.1%	3.4%	3.4%	4.5%	2.1%	2.0%	0.3%	0.3%	1.4%
REBALANCED	Inv. Universe: Bonds									
Started at the end of...										
2014	1.3%	1.2%	2.0%	2.0%	1.2%	1.6%	1.5%	2.3%	2.3%	1.6%
2015	2.7%	2.7%	2.5%	2.4%	2.6%	1.6%	1.6%	1.4%	1.4%	1.6%
2016	3.6%	3.5%	2.8%	2.8%	3.3%	1.8%	1.8%	1.0%	1.1%	1.6%
2017	2.6%	2.5%	3.1%	3.1%	2.2%	2.3%	2.2%	2.9%	2.8%	1.9%
2018	5.2%	5.1%	4.2%	4.2%	4.4%	2.7%	2.6%	1.7%	1.7%	1.9%
2019	5.2%	5.2%	3.4%	3.4%	4.5%	2.1%	2.0%	0.3%	0.3%	1.4%

Table A.6. Out-of-Sample Performance Comparisons (Investment Universe: Stocks included)

Source: ICE indices, Bloomberg; Author's calculations.

B. CURRICULUM VITAE

Personal Information

GÜNEY DÜZÇAY
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Education

- **Ph.D. in Economics,** June 2022, Middle East Technical University, Department of Economics, Ankara / Türkiye; Thesis Title: "Essays on Credit and Reserves"; Thesis Supervisor: Assoc. Prof. Hasan Cömert
- **M.Sc. in Economics**, August 2013, Middle East Technical University, Department of Economics, Ankara / Türkiye; Thesis Title: "A critical survey on four distinctive approaches over the causes of the recent global crisis"; Thesis Supervisor: Asst. Prof. Hasan Cömert
- **B.Sc. in Mathematics**, May 2010, Bilkent University, Department of Mathematics, Ankara / Türkiye

Employment and Training

- **Teaching and Research Assistant,** 2013 Sep – 2014 May, Department of Economics, Ardahan University, Ardahan, Türkiye.
- **Teaching and Research Assistant,** 2014 May – 2017 Nov, Department of Economics, Middle East Technical University, Ankara, Türkiye.
- **Editorial Assistant,** 2014 Sep – 2017 Nov, METU Studies in Development, METU, Ankara, Türkiye
- **Assistant Specialist,** 2017 Dec - …, Markets Department (for a period, Corporate Risk Management Department), Central Bank of the Republic of Türkiye, İstanbul, Türkiye

Fields of Academic Interests

- Banking and Finance
- Central Banking

- Financial Markets and Institutions
- International Finance
- Monetary Theory and Policy
- Development Economics
- History of Economic Thought

Grants and Awards

- YSI Antalya Workshop fellowship, 2014, Oct 16-17
- 2005 – 2010: TUBITAK-BIDEB Scholarship
- 2005 – 2010: Full scholarship from Bilkent University

Publications and Presentations

Articles in Academic Journals

- "The Relative Performance of the Turkish Economy after 2002" (in Turkish: 2002 Sonrası Türkiye Ekonomisinin Performansı: Karşılaştırmalı Bir Analiz) (with Ahmet Benlialper and Hasan Cömert), METU Studies in Development, **2016**.
- "Understanding Developments in Current Accounts and Financial Flows in Light of Discussions on Global Imbalances and Recent Crises" (with Hasan Cömert), Ekonomik Yaklasim, 26(96), 59-90. Turkish. doi:10.5455/ey.35901, **2015**.

Working Papers

- "2002 Sonrasi Türkiye Ekonomisinin Performansi: Karsilastirmali Bir Analiz" (with Ahmet Benlialper and Güney Düzçay), ERC Working Paper, No: 15/4, http://www.erc.metu.edu.tr/menu/sayfa.php?icerik=15_04&lang=eng&nav=ye s, **2015**
- "Understanding Developments in Current Accounts and Financial Flows in Light of Discussions on Global Imbalances and Recent Crises" (in Turkish: Kuresel Dengesizlikler ve Kriz Tartismasi Isiginda Cari Denge ve Sermaye Hesabini Anlamak) (with Hasan Cömert), ERC Working Paper, No:14/16, http://www.erc.metu.edu.tr/menu/sayfa.php?icerik=14_16&lang=eng&nav=ye s, **2014**.

Presentations

- "2002 Sonrasi Türkiye Ekonomisinin Performansi: Karsilastirmali Bir Analiz" (with Ahmet Benlialper and Hasan Cömert), Fikret Şenses Onuruna Türkiye Ekonomisi Çalıştayı, 2-5 April **2015**, Northern Cyprus.
- "An analytical and empirical assessment of Marxist approaches to the recent crisis", with Hasan Cömert, *presented at the conference of Eastern Economics Association-Union for Radical Political Economics* in March, **2014**.

Skills

- English (advanced)
- Computer languages: Matlab, R, STATA

C. TURKISH SUMMARY / TÜRKÇE ÖZET

Bu tez, gelişmekte olan ülkelerin (GOÜ) parasal alanda karşılaştıkları bazı zorluklarla ilgili üç ayrı makaleden oluşmaktadır. İlk makalenin konusu, gelişmekte olan ülkelerdeki düşük kredi yaratma kapasitesidir. Bu makale kredi yaratma kapasitesi üzerindeki belirli bir engele, parasal (finansal) araçların hiyerarşik doğasına, odaklanmaktadır. Para hiyerarşisi kavramı, yerli para cinsinden kredi oluşumunu kısıtlayan ve büyük döviz rezervleri birikimine yol açan yapısal güçleri tartışmak için kullanılmaktadır. İkinci makalenin konusu, şiddetli finansal sıkıntı dönemlerinin ve krizlerin en belirgin nedeni olan kredi patlamalarının tespit edilmesidir. Bu makale, özellikle kredi artışlarının zamana özgü yönlerine odaklanmakta ve bu amaçla kredi patlamalarının tespit edilmesi için modifiye edilmiş bir yöntem geliştirmektedir. Bu yeni yöntem, kredi patlamalarının zamana özgü ve ülke gruplarına özgü karakteristik özelliklerini ve kredi patlamalarının bankacılık krizleriyle ilişkilerini belgelemek amacıyla geniş bir veri kümesi için uygulanmaktadır. Son olarak, üçüncü makale gelişmekte olan ülkelerdeki merkez bankaları için rezerv yönetimi ve stratejik varlık tahsisi konuları ile ilgilidir. Bu makale, yaygın olarak kullanılan portföy optimizasyon yöntemlerini kullanarak çoklu para birimleri arasında stratejik varlık tahsisi için alternatif bir çerçeve geliştirmeye odaklanmaktadır. Çalışma, istenen özelliklere sahip bir kur sepeti oluşturmak için bir formül sağlayarak, majör para birimlerinden oluşan bir kur sepetinin hesap para birimi olarak kullanılmasını önermekte ve ardından ABD doları bazlı genel optimizasyon uygulamalarına kıyasla önerilen yöntemin performansını ortaya koymaktadır.

Bu üç makale, genel olarak parasal ve finansal ekonomi alanı altına konulabilir. Tüm konular (kredi yaratma kapasitesi, kredi patlamaları ve rezerv yönetimi) bir dereceye kadar gelişmiş ekonomiler için de geçerli olsa da, çoğunlukla gelişmekte olan ülkelerin sorunlarıyla ilgilidir. Bunlar, bu makalelerdeki ortak yönlerdir ve her üç

makalenin de finansal gelişme, kredi döngülerinin yönetimi ve rezerv yönetiminde politika oluşturma süreçlerine olumlu katkılar sağlaması beklenmektedir.

Bu tez, kredi yaratma ile ilgili temel konuları tartışan ve gelişmekte olan ülkelerin kredi yaratma kapasitesinin eksikliğini para hiyerarşisi bağlamında inceleyen, parasal ekonomi alanında temel ve betimleyici bir çalışma ile başlamaktadır. Kredi yaratma ve ilgili parasal konular üzerine geliştirilmiş ekonomik teorilerin büyük çoğunluğu, gelişmiş ülkelerin tarihsel ve mevcut deneyimlerinden beslenen bir perspektife dayanmaktadır ve çoğu zaman bu teoriler ve arkalarında yatan varsayımlar gerçek dünya pratiğinden kopukturlar (bkz örn. Bindseil, 2004; Lavoie, 2014). Tezin ilk makalesinde, gelişmekte olan ülkelerin, farklı bir tarihsel bağlamda, kredi yaratma konusunda gelişmiş ülkelerin karşılaştığından çok daha farklı ve kendine has kısıtlamalarla karşı karşıya olduğu vurgulanmakta ve parasal alanda gerçek-dünya mekaniklerini önemseyen fikir ve kavramlardan yararlanılmaktadır.

İlk makalenin konusu olan kredi yaratımı ile mevcut uluslararası parasal yapı arasındaki etkileşimler, "orijinal günah" kavramı etrafında oluşan uluslararası makro-finans literatüründe kendine yer bulmaktadır (Eichengreen vd., 2003a; 2003b; 2007). Ayrıca, bu çalışmanın temel konusu olan gelişmekte olan ülkelerdeki düşük kredi yaratma kapasitesi, finansal gelişmenin belirleyicileri bağlamında analiz edilmiştir (bkz örn., Beck ve Levine, 2005, Djankov vd., 2007).

Post-Keynesyen literatür gerçek dünyadaki kredi yaratma mekanizmasına dair yaptığı ısrarlı vurgu sebebiyle iyi bir çıkış noktası olarak durmaktadır. Buna rağmen, bu makalede, bu literatürün GOÜ'lerdeki düşük kredi yaratma kapasitesine kapsamlı bir açıklama sunamadığı iddia edilmektedir. Post-Keynesyen literatür, özetle, içsel para teorisini ortaya atmakta ve kredilerin iktisadi talebe göre belirlendiğini ve banka kredilerine olan talebin esas olarak gelir yaratan üretim sürecine bağlı olarak ticaret hacmiyle ilgili olduğunu iddia etmektedir. Sistemdeki kredi miktarını reel ekonomideki talep düzeyine bağlayan bu argüman, doğal olarak, kredi-GSYİH düzeylerinin tüm ülkeler için benzer olması gerektiğini ima etmektedir. Fakat bu ima, kredi-GSYİH oranlarına ilişkin gözlemlerle çelişmektedir. Post-Keynesyen

literatür, ülkeler arası farklılıkları kısmen açıklayabilen kredi tayınlaması ve kurumsal faktörler üzerinde dursa da, bu literatürde uluslararası parasal mimarinin doğasından kaynaklanan yapısal engeller pek dikkate alınmamaktadır. Eğer bu tür engeller varsa, o zaman kredi yaratmanın genel olarak ekonomik talep tarafından belirlendiği şeklindeki post-Keynesyen iddia, gelişmekte olan ülkeler için hikayenin sadece bir kısmını açıklamaktadır.

Bu makale, ilk olarak, modern paraların özünde kredi olarak tanınması gerektiği vurgusuyla başlamaktadır. Schumpeter'den Post-Keynesyenlere, modern merkez bankacılardan iktisat tarihçilerine, geniş bir literatüre dayanarak, kredi (ve paranın) ne olduğunu, kredinin (ve paranın) nasıl hiçbir iktisadi öncüle gereksinim duymadan yaratılabildiğini ve teknik olarak sınırsız miktarda kredi yaratılabileceğini tartışmaktadır. Sonrasında ise, risk yönetimi, yasal ve düzenleyici çerçeve, makroekonomik koşullar ve yapısal güçler olmak üzere dört kategoriye ayırabileceğimiz, kredi yaratımına gevşek bir sınır çizen kısıtlar vurgulanmakta ve bu kısıtların varlığı altında "kredi yaratma kapasitesi" kavramı tanımlanmaktadır. Son olarak, bu kısıtlardan bir tanesi, parasal enstrümanların hiyerarşik doğası ve GOÜ'lerce ihraç edilen finansal enstrümanların bu hiyerarşide düşük seviyelerde bulunması ön plana çıkarılmakta ve GOÜ'lerin düşük kredi yaratma kapasitesinin önemli sebeplerinden biri olduğu açıklanmaktadır.

Bu çalışmanın temel aracı olan para hiyerarşisi kavramı, bazı post-Keynesyenler (örn. Bell, 2001; Minsky, 1986; Wray, 1998; 2015) ve Marksistler (Foley, 1989) tarafından kullanılmıştır. Bununla birlikte, bu çalışmanın temelini oluşturan parasal hiyerarşinin uluslararası boyutu, bu çalışmalarda çok az ilgi görmüştür. Özellikle, Bell (2001) ve Wray (1998), bu kavramı, "paranın devlet teorisi"nin (state theory of money) modern bir versiyonu olan Modern Para Teorisi'ne (MMT yaklaşımı) yerleştirerek kullanmışlardır. Bu çalışmada, bu görüşe karşıt olarak, gelişmekte olan bir ülkenin para biriminin, o ülkenin uluslararası finansal piyasalara açık olduğu göz önüne alındığında, para hiyerarşisinde en üst noktada olamayacağı, dolayısıyla maliyetsiz, karşılıksız para olarak kabul edilemeyeceği; ve bahsi geçen yaklaşımın

gelişmekte olan ülkelerdeki modern parasal meselelere ilişkin tartışmalar için iyi bir başlangıç noktası olmadığı savunulmaktadır.

Öte yandan, Perry G. Mehrling (2000, 2012a, 2012b ve 2013), tüm ulusal para birimlerinin ve banka parasının kredi karakterini, mübadeleye dayalı bir ekonomide para hiyerarşisinin içsel olarak geliştiğini vurgulayarak ve her türlü kredi enstrümanının bir arada çalışması için gerekli koşulların neler olduğunu açıklayarak para hiyerarşisi kavramını detaylandırmış ve çok daha kullanışlı hale getirmiştir. Tüm bu çalışmaların eleştirel bir değerlendirmesini yapan bu makale, büyük oranda Mehrling'in (ve daha sonra Zoltan Pozsar'ın) hiyerarşi kavramsallaştırmasından faydalanmaktadır. Buna ek olarak, bu makale, para hiyerarşisinin tarihsel evrimini ve bunun "tüccarlar hiyerarşisi" (Braudel, 1983) ile bağlantısını ortaya koymakta ve para piramidinde yeni katmanların nasıl oluşturulduğuna odaklanarak para hiyerarşisi kavramını da zenginleştirmektedir.

Bütün olarak bakıldığında bu makalenin dört temel argümanı vardır. İlk olarak, modern paranın kredi niteliğini tanımanın ve uluslararası parasal yapıyı hiyerarşik bir şekilde kavramsallaştırmanın, kredi yaratma kapasitesindeki farklılıkları açıklamaya yardımcı olabileceğini savunmaktadır. Kapitalizmin başlangıcından bu yana uluslararası para hiyerarşisinin evrimi, her zaman ticaret merkezleri, ekonomik güçler ve ulus devletler hiyerarşisinin evrimini yansıtmıştır. Tüccarlar arasındaki hiyerarşi (aynı zamanda ticaret merkezleri ve sonraları ulus devletler arasındaki hiyerarşi) ile farklı katmanlardaki tüccarlar tarafından ihraç edilmiş yükümlülüklerin hiyerarşisi arasında yakın bir bağlantı vardır. Bu nedenle, para hiyerarşisi, gelişmekte olan ülke finansal kurumları tarafından ihraç edilen yükümlülüklere olan talebin, gelişmiş ülkeler tarafından ihraç edilenlere olan talepten daha az olacağı gerçeğini yansıtmaktadır. Bu da nihayetinde, gelişmekte olan ülkelerde kredi oluşumunu çeşitli şekillerde kısıtlamakta ve yurtiçi kredi koşullarını gelişmiş ülke finansal piyasalarındaki gelişmelere bağımlı hale getirmektedir.

"Orijinal günah" (Eichengreen vd., 2003a; 2003b; 2007), yani GOÜ'lerin kendi para birimi cinsinden borçlanamaması, para hiyerarşisinin tezahürlerinden biridir ve ilgili

yazında bunun çıktı istikrarsızlığı, sermaye akımları volatilitesi, kredi dereceleri vb. üzerindeki olumsuz etkileri sıralanmıştır. Tüm bunların kredi yaratma kapasitesi üzerinde sınırlayıcı etkileri bulunmaktadır. Para hiyerarşisinin doğal bir diğer tezahürü GOÜ'lerin bitmeyen derdi olan dolarizasyondur. İlgili yazında, dolarizasyonun istikrarsız para talebine, aktarım mekanizmalarının çalışmamasına, bankacılık krizi olasılığının artmasına ve büyüme oynaklığına yol açtığı vurgulanmaktadır (Levy-Yeyati, 2006). Tüm bu faktörlerin de yine GOÜ kredi yaratama kapasitesi üzerine olumsuz etkileri olacağı açıktır. Son olarak, yakın dönem yazında, finansal döngülerin küreselleştiği ve gelişmiş ülke merkezli finansal döngülerin GOÜ'lerin finansal ve iktisadi döngüleri üzerinde belirleyici olduğu vurgulanmaktadır (Rey, 2013; Bruno and Shin, 2014). Bu tip bulgular da, bu makalenin uluslararası para hiyerarşisinin finansal entegrasyon koşullarında etkinliğinin daha fazla olacağı iddiasını ve hiyerarşinin varlığı sebebiyle üst kademedeki parasal dinamiklerin alt kademelerdeki dinamikler üzerinde belirleyici olacağı beklentisini desteklemektedir.

İkinci olarak, bu makale, finansal açıklık koşullarında, para hiyerarşisinin, sadece dünyanın geri kalanına olan ödeme taahhütlerinin gerçekleşmesi yoluyla, yönetilmesi gereken fonlama ve döviz kuru riskleri gibi risklerin açığa çıkmasına sebep olarak gelişmekte olan ülke bankacılık sektörü bilançoları üzerinde bağlayıcı kısıtlar oluşturduğunu göstermektedir. GOÜ iktisadi aktörleri, yabancı ülke iktisadi aktörleriyle herhangi bir sebepten ödeme ilişkisi içine girdiğinde, GOÜ bankacılık sektörü genel olarak bilançosunu genişletmek ve bunu da genel olarak döviz açık pozisyonu yaratarak gerçekleştirmek durumundadır. GOÜ bankacılık sektörü, bu türden işlemlerin sonucunda, bilançosunda yönetilmesi gereken bir döviz kuru riski ve döviz cinsinden fonlama riski ile karşı karşıya kalmaktadır. Bu durum, para hiyerarşisinde alt kademede yer alan ve genel olarak diğer ülke iktisadi aktörleri tarafından ödeme aracı olarak talep görmeyen GOÜ para birimleri ile para hiyerarşisinin üst kademelerinde yer alan ve uluslararası ödemelerde geçerliliği yüksek olan bazı gelişmiş ülke para birimleri arasındaki hiyerarşinin doğal bir sonucudur.

Üçüncü olarak, yine uluslararası finansal piyasalara entegrasyon koşulları altında, hiyerarşide daha alt seviyelerde yer alan bir ulusal para birimine sahip olmak, o para birimini ihraç edenin ya uluslararası rezerv tutmasını ya da bu rezervlere güvenilir bir erişim sağlıyor olmasını gerektirmektedir. Bu, gelişmekte olan ülke finans kurumları tarafından ihraç edilen yükümlülüklerin güvenilirliğini ve likiditesini artırmanın bir yoludur. Nasıl ki, bir ülkedeki hane halkı ve firmalar, finansal sektöre olan ödemelerini gerçekleştirmek için para hiyerarşisinde kendi ihraç ettiği borçlanma araçlarının üstünde yer alan finansal sektör tarafından ihraç edilmiş araçları kullanmak ve bu kaynaklara erişimlerini bir şekilde garanti altına almak durumundaysa; nasıl ki, bankacılık sektörü kendi ihraç ettiği yükümlülükleriyle kendi aralarındaki veya merkez bankasına yapacağı ödemeleri gerçekleştiremiyor ve merkez bankasının ihraç ettiği sistemik rezerv paraya ihtiyaç duyuyorsa; uluslararası alanda da alt kademede yer alan merkez bankaları ve/veya bankacılık sistemi yerel para ile iş yapamamakta ve uluslararası rezerve ihtiyaç duymaktadır. Küreselleşme ve finansal entegrasyonun doğal sonucu olarak da GOÜ'lerde geçtiğimiz çeyrek yüzyılda hummalı bir rezerv biriktirme faaliyeti gözlemlenmiştir. Uluslararası rezervlerin kredi yaratma kapasitesi üzerinde doğrudan bir itici güç ya da kısıt olduğu öne sürülemese de; uluslararası rezervlerin GOÜ finansal sistemlerinin dayanıklılığını artırdığı ve bu anlamda kredi yaratma kapasitesini artırdığı; tersinden ise GOÜ'lerde kredi yaratma kapasitesinin sınırlarının zorlandığı durumlarda enflasyon ve dolarizasyon baskılarının uluslararası rezervleri tehdit edebileceği, böylece aşırı kredi yaratma süreçlerinin menzilinin rezervlerce sınırlandığı söylenebilir.

Dördüncü olarak, uluslararası ve ulusal para hiyerarşisinin evrimi, hiyerarşide yeni katmanlar yaratarak yükselmenin veya arzu edilen bir konumu korumanın, mevcut güçlerle güç mücadeleleri vermeyi gerektirdiğini ve/veya daha üst düzeyde olanlar tarafından ihraç edilen para rezervlerini biriktirmeyi/elde tutmayı gerektirdiğini ima eder. Bu, gelişmekte olan bir ülkenin uluslararası kredi sistemine olan bağımlılığını azaltabilmesi ve kendi para birimi cinsinden borçlanma araçlarını artırarak maliyetlerini düşürebilmesi için uluslararası arenada ekonomik ve siyasi gücünü artırması gerektiğini ima etmektedir. Ekonomik ve siyasi gücü artırmak ise

söylemesi kolay, başarması zor işlerdendir. Bu durumda, gelişmekte olan bir ülke için geriye kalan tek alternatif, ihraç edeceği yükümlülükleri daha güvenilir ve istenir hale getirmesine yardımcı olacak rezerv varlıkları biriktirmeye devam etmektir. Bu elbette hiyerarşide daha iyi bir konuma ulaşmak ile sonuçlanmaz, ancak mevcut konumun korunmasına yardımcı olur. Meselenin bu tarafı da, gelişmekte olan ülkelerin, son otuz yılda ekonomileri küresel ticaret ve finansa giderek daha fazla entegre olurken, neden bu kadar çok rezerv birikimine ihtiyaç duyduğunu ve buna bağımlı olduğunu açıklamaktadır.

İkinci makale, kredi yaratma konusundaki temel tartışmalardan uzaklaşarak özellikle kredi yaratma kapasitelerini artırarak iddialı büyüme hedeflerine ulaşmaya çalışan GOÜ'ler için bir baş ağrısı olan kredi patlamalarına odaklanmaktadır. Kredi patlamaları ve finansal krizler arasındaki bağlantı fazlasıyla belgelenmiştir. Özellikle, BIS araştırmacıları tarafından son yıllarda yapılan çalışmalar, kredi patlamalarının bankacılık krizlerini öngörme hususunda en başarılı gösterge olduğunu vurgulamaktadır. Bu nedenle, kredi patlamalarının dinamiklerini anlamak ve kredi patlamalarını önceden veya gerçekleşmesi sırasında fark edebilmek politika yapıcılar için kritik bir öneme sahiptir. Özellikle küresel mali krizden sonra, kredi patlamalarının erken teşhis edilmesine yönelik artan bir ilgi oluşmuştur. 2010 yılında, Basel Komitesi, özel sektör "kredi-GSYİH açığı" oranının, kredi patlamalarının bir ölçüsü olarak, döngüsel sermaye tamponlarının miktarını belirlemek için bir rehber olarak kullanılmasını tavsiye etmiştir (BCBS, 2010). Yakın zamanda, Uluslararası Ödemeler Bankası (BIS), bazı gelişmiş ve gelişmekte olan ülkeler için çeyreklik kredi-GSYİH açığı zaman serilerini gösteren bir veri tabanını yayınlamaya ve güncellemeye başlamıştır.

Yazında, genel olarak, kredi patlamalarını belirlemek için iki ana yaklaşım bulunurken, bu yaklaşımların altında gruplanabilecek çok sayıda farklı yöntem kullanılmaktadır. Bu iki yaklaşım, (i) "iktisadi temel yaklaşımı" ve (ii) "istatistiksel yaklaşım" (veya "eşik yaklaşımı") olarak isimlendirilebilir. İlk yaklaşımda, iktisadi temelleri temsil edebilecek göstergelerin ima ettiği kredi düzeyi ile gerçek kredi düzeyi arasında farka odaklanılmaktadır. İkinci yaklaşımda ise, genel olarak, kredi

değişkeninin tek değişkenli istatistiksel analiz veya zaman serisi analizi yoluyla elde edilen trendinden ne ölçüde saptığına odaklanılmaktadır. İkinci yaklaşım bu çalışmanın temelini oluşturmaktadır. Bu yaklaşımda, genel olarak, kredi patlaması, bir kredi değişkeninin döngüsel bileşeninin önceden belirlenmiş bir eşik düzeyine göre "normal" düzeyinden aşırı sapması olarak tanımlanmaktadır.

HP-filtresi ile kredi serisinin trendden arındırılması ve kredi serisinin döngüsel bileşeni üzerinde bir eşik stratejisinin belirlenmesi yoluyla kredi patlaması tespiti, bu yöntemin kredi patlaması tespiti için kolay ve tekrarlanabilir bir uygulama sunması ve bankacılık krizleri için iyi bir sinyal performansı sağlaması nedeniyle son zamanlarda yaygın bir uygulama haline gelmiştir (Drehmann vd., 2011). Ancak, bu yaklaşımı kullanmanın tek bir yolu yoktur. Gerçek zamanlı kredi patlaması tespiti açısından pratikteki yararı ve performans göz önüne alındığında "tek taraflı HP filtreleri" ön plana çıkmakta ve "tam örneklem HP filtresine" göre tercih edilebilir gibi görünmektedir. Öte yandan, tek taraflı filtreler trend bileşeninin karakterini bozmakta, kredi patlamalarının doğru tarihlendirilmesi konusunda zayıflık göstermekte ve farklı kredi değişkenleri kullanıldığında istikrarsız sonuçlar üretmektedir. Bu açıdan bakıldığında, tam örneklem HP filtresi kredi patlamalarının özelliklerini analiz etmek açısından daha uygun görünmektedir (Mendoza ve Terrones, 2008; Edge ve Miesenzahl, 2011). Kredi patlamalarının belirlemesine ilişkin literatürün çoğunluğu erken uyarı göstergeleri bağlamında yer tutarken, bu çalışma esas olarak kredi patlamalarının tarihsel ve ülke grubu dinamiklerinin daha kapsamlı bir analizini sunmayı hedeflemektedir. Bu tür bir analizin, esas olarak tahmin performansına odaklanan bu çalışmaları tamamlayacağı ve bunlar için bir temel oluşturacağı düşünülmektedir. Bu bölümde amaç, özellikle tarihsel ve ülke-grup boyutlarına odaklanarak kredi patlamalarının karakteristik özelliklerini ortaya çıkarmaktır. Bu sebeple, tam örneklem HP filtreleri temel alınmıştır.

Montiel (2000) ve Mendoza ve Terrones (2004) çalışmaları, literatürde kredi döngülerinin ülkeye özgü dinamiklerine daha fazla önem verilmesini ve dolayısıyla, kredi patlamasının belirlenmesinde ülkeye özgü eşik değerlerin kullanılmasının yaygın bir uygulama haline gelmesini sağlamıştır. Bir kredi genişlemesi sürecinde,

kredilerin trend değerden belirli bir eşiğin üstünde sapması kredi patlamasını tanımlayan temel unsurdur. O halde, bu eşik değerin belirlenmesi bu türden yöntemlerin ana meselesidir. Bu literatürün oluşum aşamasında kullanılan ve rastgele belirlenen ve bütün ülkeler için aynı şekilde kullanılan eşik değerler yerine, her bir ülkenin kendi kredi döngüsünün varyansını temel alan bir eşik değer belirlenmesi yaklaşımı önemli bir ilerlemedir.

Öte yandan, literatürde kredi döngülerinin zamana özgü dinamikleri ve bunların eşik değer belirleme üzerindeki etkileri şimdiye kadar neredeyse hiç ilgi görmemiştir. Bir kredi değişkeninin döngüsel bileşeni, zaman içinde aynı büyüklükte dalgalanmalar göstermeyebilir. Kredi değişkeninin döngüsel bileşenin varyansı zamanla anlamlı biçimde değişiyorsa, eşik değerlerin farklı ülkeler için kendi kredi döngülerinin varyansına göre ayarlanması gibi, herhangi bir ülke için eşik değerin farklı zamanlar için de ayarlanması gereklidir. Nitekim Mendoza ve Terrones'in (2008, 2012) yöntemi başlangıç yılı sabit tutularak farklı bitiş yıllarıyla tekrarlandığında, kredi değişkeninin döngüsel bileşeninin varyansının zamanla arttığı görülmektedir. Kişi başına reel kredinin döngüsel bileşeninin standart sapması, medyan ülke için 1980 ile 2000'ler arasında yüzde 2-3 puan düzeyinde büyümektedir, ki bu son dönemlerde gerçekleşen kredi büyümelerinde trend bileşenden daha büyük sapmalar olduğu anlamına gelmektedir. Bu durum mevcut çalışmaların güvenilirliğinin sorgulanmasını gerektirmektedir. Bu soruna çözüm üretmek adına, bu çalışmada, kredi patlamalarının daha sağlıklı bir şekilde belirlenmesi için Mendoza ve Terrones yönteminin özyinelemeli (recursive) bir versiyonu önerilmektedir. Bu yeni kredi patlaması tespiti yöntemi detaylı bir şekilde açıklanmakta ve yeni bir kredi patlaması tanımı sunulmaktadır.

Bahsedilen metodolojik katkısının yanı sıra, ikinci makale, kredi patlamalarının özelliklerini tarihsel ve ülke-grupları boyutlarında analiz etmek için geniş bir veri seti üzerinde çalışmaktadır. Derlenen veri seti, 1950-2016 dönemini kapsamakta ve toplamda 148 gelişmiş ve gelişmekte olan ülkeyi içermektedir. Hodrick-Prescott (HP) filtresinin düzleştirme (smoothing) katsayısını ve (kredilerin döngüsel bileşeninin varyansının çarpılacağı) eşik katsayısı parametrelerini kalibre etmek

amacıyla, kredi patlamaları ve bankacılık krizleri için Kaminsky ve Reinhart (1999) ve Drehmann vd. (2010) çalışmalarını takip ederek sinyal çıkarma analizi kullanılmaktadır. Bu çalışmada kullanılan bankacılık krizi verileri Laeven ve Valencia (2012) ve Drehmann vd. (2011) çalışmalarına dayanmaktadır. Bu ön analiz sonucunda, düşük ve düşük-orta gelirli ülkelerin daha yüksek kaçırılmış-kriz ve gürültü-sinyal oranlarına sahip olduğu ortaya konulmaktadır. Bu tip ülkelerde kredi patlamalarının ve bankacılık krizlerinin senkronize olmadığı ve düşük gelirli GOÜ'ler için bankacılık krizlerinin muhtemelen kredi patlamalarından farklı dinamikler tarafından yönlendirildiğini ima etmektedir. Bu görüş, ilerleyen bölümlerde, düşük gelirli ve düşük-orta gelirli ülkeler için, bankacılık krizlerinin izlediği az sayıda kredi patlaması vakası olduğuna dair bulgumuzla da desteklenmektedir. Sonuç olarak, kredi patlamalarını takip eden bankacılık krizleri olgusu, ortalamanın üzerindeki gelişmekte olan ülkelere ve gelişmiş ülkelere özgü bir olgu olarak görünmektedir. Yüksek-orta gelir grubundaki GOÜ'ler ve gelişmiş ülkelere dair sinyal çıkarma analizi, bu görüşü destekleyen oldukça başarılı sonuçlar üretmektedir. Elimizdeki bankacılık krizi veri setlerinde yer alan ve kriz dönemi öncesinde kredilerin trendlerinden pozitif olarak saptığı neredeyse tüm kriz dönemleri tespit ettiğimiz kredi patlamalarının bazılarıyla ilişkilendirilmiştir.

Düşük kaçırılmış-kriz rasyosu ve düşük gürültü-sinyal rasyosu hedefleyerek yaptığımız tarama sonucunda, HP filtresi düzleştirme katsayısı 100, eşik katsayısı ise 1 olarak seçilmiştir. Bu seçimlerle kredi patlamalarının tespit edilmesinin ardından olay penceresi analizine geçilmektedir. Bulgular, kredi patlamalarının zaman içinde sayıca arttığını gösterse de, tespit edilen kredi patlamaları elde edildiği dönemin gözlem sayısına bölündüğünde, kredi patlamaları zaman içinde sayıca değişim göstermiyor olarak görünmektedir. Öte yandan, kişi başına reel kredinin kredi patlaması zirveleri etrafındaki trend değerlerinden sapmasına bakıldığında, zaman içinde, sapma büyüklüğünün artış eğilimine sahip olduğu görülmektedir. Bu da kredi patlamalarının özellikle yakın geçmiş dönemlerde ekonomi üzerindeki etkilerinin daha yüksek olabileceğini ima etmektedir. Kredi patlamalarının süresi de zaman içerisinde 3-5 yıldan (1970 öncesi) 5-7 yıla (1970 sonrası) kadar uzamıştır. Ayrıca, farklı ülkelerin kredi patlamaları zaman içinde daha küçük zaman dilimleri içine

daha fazla kümelenmiş hale gelmektedir, ki bu da finansal entegrasyona bağlı olarak kredi patlamalarının küresel belirleyicilerinin yerel olanlardan daha ağır basmış olabileceğini düşündürmektedir. Önceki makalenin bulguları ile birleştirildiğinde, bu, gelişmekte olan ülkelerin kendi finansal döngülerini yönetmek için küresel finansal döngülerini dikkatle izlemesi ve/veya dünyanın geri kalanıyla finansal entegrasyon yapısını yeniden gözden geçirmesi gerektiği anlamına gelmektedir.

Ülke grubu karşılaştırmalarına bakıldığında, kredi patlamalarının patlama zirveleri etrafındaki evrimlerinin farklı ülke grupları için önemli ölçüde farklı olduğunu görülmektedir. Yüksek kredi/GSYİH oranı olan ülkelerde, krediler döngüleri daha düzgün ve yumuşak dalgalanmalar göstermektedir. Bir diğer ifadeyle, kredi/GSYİH oranları yükseldikçe, reel kredi döngüsünün varyansı azalmakta, bu da daha küçük eşik değerler oluşmasına mahal vermektedir. Dolayısıyla, daha düşük düzeyli sapmalarda bile kredi patlamalarının ortaya çıkma olasılığı artmaktadır. Ayrıca, kredinin döngüsel davranışı (hem finansal hem de ekonomik açıdan) daha gelişmiş ülkelerde daha belirgindir. Öte yandan, bugün daha düşük kredi/GSYİH oranlarına sahip ülkeler, kredi patlaması zirvelerinde hem çok daha yüksek kredi sapmaları göstermekte, hem de kredi/GSYİH oranı küçüldükçe ülkelerin yaşadıkları deneyimler arasındaki farklılaşma artmakta, dolayısıyla kredinin döngüsel davranışı belirsizleşmektedir. Bu bulgular, ülke gelir grupları ile kredi patlamaları arasındaki ilişkiler incelendiğinde de büyük oranda tekrarlanmıştır.

Seçmiş olduğumuz parametrelerle elde etmiş olduğumuz kredi patlamalarının yalnızca küçük bir kısmını (yalnızca beşte biri) bir bankacılık krizi izlemiş olmasına rağmen, çoğu bankacılık krizinin (temel analizimizde yüzde 60) öncesinde kredi patlamaları yaşandığına dair literatürün ortak bulgusu bu çalışmada da yeniden teyit edilmiştir. Bu sonuçlar, seçilen parametrelere ve ele alınan ülke grubuna göre oldukça farklılaşabilmektedir. Önceden de söylendiği gibi, düşük ve düşük-orta gelir grubu ülkeleri, bizim sonuçlarımızı zayıflatan tarafta olup, yüksek-orta gelir grubu ve yüksek gelir grubu ülkelerinde bu kredi patlaması ve bankacılık krizi ilişkisi çok daha belirgindir. Ayrıca, bankacılık krizleri tarafından takip edilen kredi patlamalarının özelliklerinin, herhangi bir kriz tarafından takip edilmeyenlerle

karşılaştırılması; ilkinin patlama zirvelerinde çok daha yüksek (krizle sonuçlanmayan kredi patlamalarındaki sapmaların 1,5 ila 2 katı arasında değişen) sapma seviyelerine sahip olduğunu göstermektedir. Kredi patlaması zirvesi görüldükten sonra ise, krizle biten örneklerde çoğunlukla hızlı bir şekilde trendin altına geri dönüşler görülmektedir. Bu bulgular orta gelir gruplarında, özellikle üst-orta gelirli ülkelerde daha belirgindir. Bunlar, orta gelir gruplarında yer alan gelişmekte olan ülkelerin, kredi patlaması dönemlerini takip edebilecek maliyetli finansal krizlerden kaçınmak için kredi genişleme dönemlerinin dinamiklerini dikkatli bir şekilde izlemeleri gerektiğini göstermektedir.

Özetle, kredi değişkenlerinin döngüsel bileşeninin "normal" seviyelerinden aşırı sapması olarak tanımlanan ve ölçülen kredi patlamalarını belirlemek için literatürde çoğunlukla eşik belirleme yaklaşımı kullanılmaktadır. Ülkeye özgü eşik değer, ülkeye özgü kredi döngüleri dinamiklerini hesaba katmak için yaygın olarak kullanılırken; zamana özgü dinamikler ve dolayısıyla finansal piyasalardaki uzun vadeli değişiklikler genellikle göz ardı edilmektedir. Bu çalışma, kredi patlama dönemlerinin tespiti için zamana özgü eşik değer kullanılması gerekliliğini ortaya koymakta ve bunun daha sağlıklı sonuçlar vereceğini savunmaktadır. Bu çalışmada, zamana özgü dinamikleri yakalayan (Mendoza ve Terrones'in (2008, 2012) yönteminin özyinelemeli bir uygulamasına dayanan) ve kredi değişkenlerinin döngüsel bileşeninin varyansının zamanla arttığını gösteren yeni bir yöntem sunulmuştur. Bu yöntemle, geniş kapsamlı bir veri seti üzerinde yapılan çalışmalar sonucunda, kredi patlaması dönemleriyle bankacılık krizleri arasındaki bağlantılar tespit edilmiş ve sunulan yöntemin özellikle üst-orta gelir grubu ve yüksek gelir grubu ülkeleri için oldukça başarılı olduğu görülmüştür.

Finans dünyasının alanına giren son makale, gelişmekte olan ülkeler için uluslararası rezervlerin yönetimindeki bazı zorluklara odaklanmaktadır. Makroekonomik açıdan, gelişmekte olan ekonomilerin artan miktarlarda uluslararası rezerv tutması meselesi ve büyük miktarda uluslararası rezerv tutmanın yararları ve maliyetleri uzun süredir tartışılmaktadır (örn. farklı görüşler için bkz. Rodrik, 2006; Levy-Yeyati ve Gomez, 2019). Gelişmekte olan bir ülke için rezerv tutma maliyeti, temel olarak, merkez

bankaları (MBler) tarafından tutulan rezerv varlıklarının düşük getirisi ile GOÜ'ler için tipik olarak daha yüksek olan dış borçlanma maliyeti arasındaki farktan kaynaklanmaktadır. Uluslararası rezerv tutmanın beklenen faydaları ise; küresel finansal şokların ve/veya sermaye akışındaki ani duruşların/tersine dönüşlerin olası maliyetlerini azaltmak, kredibiliteyi artırarak kamu ve genel olarak tüm yerleşikler için borçlanma maliyetlerini düşürmek ve rezervlerin döngü karşıtı olarak kullanılması durumunda döviz kuru oynaklığını azaltmak olarak sayılmıştır.

İşin finansal tarafına bakıldığında ise, büyük miktarda uluslararası rezerv bulundurmak, MB'leri zorunlu olarak risk-getiri özelliklerini de dikkate almaya zorlamaktadır. Genel olarak, merkez bankası rezerv yönetimi uygulamaları için öncelikler sıralaması şu şekildedir: (i) tanımlanmış, belirlenmiş rezerv tutma hedeflerini gerçekleştirebilmek için yatırımları likit varlıklarda tutmak, (ii) çeşitli riskleri yöneterek sermayenin korunmasının sağlamak ve (iii) diğer koşullar sağlandıktan sonra makul düzeyde riske göre ayarlanmış getiri elde etmek (IMF, 2014). Dolayısıyla, likidite ve risk yönetimine ilişkin öncelikler, merkez bankası stratejik varlık tahsis süreci için yatırım evrenini zorunlu olarak daraltmaktadır. Merkez bankaları muhafazakar yatırımcılar oldukları için, tipik varlık yönetimi çerçevesi, önceden belirlenmiş likidite, para birimi ve/veya ülke tahsisleri ile oldukça dar bir yatırım evreni oluşturmayı kapsamaktadır. Bu çerçevede rezerv yönetimi faaliyeti, tipik olarak, yüksek kredi dereceli rezerv-para hükümet tahvillerinden oluşan alt portföylerin piyasa riskini (özünde yalnızca durasyon riskini) yönetmeye indirgenmiştir.

Küresel krizden bu yana ise, yüksek kredi dereceli hazine tahvillerindeki düşük getiri (hatta negatif getiri) ortamı ve büyük rezerv miktarları, merkez bankalarının rezerv yönetim pratiklerinin evrimini hızlandırmış ve pek çok merkez bankası daha fazla getiri odaklı (maliyet azaltma odaklı) bir perspektife bürünmüştür. Bazı GOÜ merkez bankaları optimizasyon temelli stratejik varlık tahsisine geçiş yaparak rezerv portföylerinin tümünü ya da yatırım alt portföylerini bu temelde yönetmeye başlamıştır (bkz. Tablo A.2).

Markowitz ortalama-varyans (OV) portföy optimizasyonu, stratejik varlık tahsis süreci sırasında nicel bir araca güvenmek isteyen bir portföy yöneticisi için doğal başlangıç noktasıdır (Koivu vd., 2009). Bununla birlikte, Markowitz ortalama-varyans portföy optimizasyonu pratikte oldukça sorun yaratan bir model olarak görülmüş ve şu gerekçelerle eleştirilmiştir: (i) portföy yöneticisinin fayda fonksiyonunun veya hedef fonksiyonun ortalama getiri ve standart sapma ile temsil edilmesi uygun ve güvenilir olmayabilir, (ii) modelin girdisi olan varlıkların getiri dağılımlarının normal olduğu varsayılır, ki bu pek çok varlık sınıfı için kesinlikle geçerli değildir, (iii) OV optimizasyonu statik bir modelleme sunmakta ve portföyde ayarlamalara ve yeniden dengelemeye izin vermemektedir, (iv) OV optimizasyonu sezgilere ters portföy tahsisleri üretmekte ve girdi değişkenlerindeki küçük değişiklikler için oldukça farklı çıktılar üretmektedir (Michaud ve Michaud, 2008; Koivu vd, 2009).

Ortalama-varyans (OV) portföy optimizasyonuna yönelik yeni yaklaşımlar ve çalışmalar, bu sorunları azaltmayı amaçlamaktadır. Bu çalışmalar, girdi tahmini geliştirmeleri, sağlam (robust) optimizasyon yöntemleri, analist görüşlerinin eklenmesi, alternatif risk-getiri ölçütleri kullanılması ve dinamik çok dönemli optimizasyon prosedürleri gibi iyileştirmeleri kapsar (yakın tarihli bir literatür incelemesi için bkz. örn. Kolm vd., 2014). Merkez bankaları için stratejik varlık tahsisi bağlamında, Fernandes vd. (2011), “daha iyi” girdi tahmininden (Black-Littermann modeli aracılığıyla), yeniden örneklemeye dayanan optimizasyondan ve analist görüşü dahil edilmesinden elde edilen sonuçları orijinal OV optimizasyonu ile karşılaştırmaktadır. Bu geliştirmelerin her birinin orijinal OV optimizasyonunu iyileştirdiğine dair kanıtlar sunmuşlardır. Zhang vd. (2013), Black-Littermann'dan elde edilen getiri tahminlerini, tüm portföyü farklı hedefler ve risk tercihleri ile alt portföylere ayıran davranışsal portföy teorisi yaklaşımıyla birleştiren bir stratejik varlık tahsis süreci geliştirmektedir. Koivu vd. (2009), verim eğrisi tahmininden türetilen girdileri kullanan bir dinamik optimizasyon çerçevesi geliştirmiştir. Romanyuk (2012), müdahale maksadıyla merkez bankası rezervlerinin gerekli olduğu durumlarda ortaya çıkacak likidasyon maliyetleri ile net getiriler arasındaki

ödünleşmeyi dikkate alan bir hedef fonksiyonu geliştirerek stokastik bir modelleme çerçevesi geliştirmeyi amaçlamaktadır.

Bu çalışmada, temel olarak, orijinal OV optimizasyonu kullanılmakta ve orijinal OV optimizasyonuyla bile çeşitlendirme, istikrar ve akla yatkınlık açısından olumlu sonuçlar üretilebileceği gösterilmektedir. Literatürdeki geliştirmelerden ise özellikle yeniden örneklemeye dayanan prosedürün kullanılmasının makul olduğu düşünülmüş ve bu iyileştirmeden yararlanılmıştır. Yeniden örnekleme fikri, optimizasyonda kullanılacak girdilerin her halükarda değişkenlik gösteren ve tahmin hatası barındıran istatistiksel tahminler olduğu gerçeğinden yola çıkmaktadır. Bu nedenlerle, OV optimizasyonu çıktıları, yani etkin portföyler, istatistiksel bir karaktere sahip olmalı veya orijinal etkin portföylerden ayırt edilemeyen "istatistiksel olarak eşdeğer" etkin portföyler olmalıdır (Michaud ve Michaud, 2008). Yeniden örneklemeye dayanan optimizasyonun faydaları, optimal portföylerdeki ağırlık dağılımları açısından ekstrem olmayan sonuçlar, daha iyi örneklem dışı performans ve daha düşük yeniden dengeleme/yeniden ayarlama maliyetleri olarak sayılmıştır (Michaud ve Michaud, 2008; Markowitz ve Usmen, 2003).

Merkez bankası stratejik varlık tahsis süreci, yatırım evreninin, genel yönetim kılavuzlarının ve rezerv yönetimi faaliyetlerine ilişkin yetkilerin belirlenmesini ve hedefleri ve sapma limitlerini içeren bir model portföyü içermektedir. Makul getiri elde etmeyi (veya rezerv tutma maliyetini düşürmeyi) hedefleyen merkez bankaları, model portföy belirlerken çeşitli para birimlerinde ve çeşitli varlık sınıflarında çeşitlendirmeden yararlanmak istemektedir. Çeşitli para birimlerinin işin içine girmesi ise para birimi bazında tahsis problemini ve hangi para biriminin hesap para birimi olarak seçileceği sorusunu beraberinde getirir. Farklı para birimlerinden ihraç edilmiş enstrümanların getirileri, hesap para birimi seçimine göre değişmektedir. Dolayısıyla, farklı hesap para birimi seçimine karşılık gelen farklı optimal alokasyonlar ortaya çıkmaktadır. Borio vd. (2008a; 2008b) hesap para birimi seçiminin rezerv tutmanın ana amaçları ve rezervlerin temel kullanımları ile uyumlu olması gerektiğini önermektedir. Bu yaklaşım, yani hesap para birimi seçimini rezerv tutma ve kullanma amacına bağlamak, "likidite" perspektifinden makul olsa da,

"yatırım" perspektifinden en iyi veya en uygun öneri olmayabilir. Bir merkez bankasının "yeterli olandan fazla" yabancı para rezervleri olduğunda veya yerel para birimine karşı tutulan net döviz rezervleri olduğunda, rezervlerin bu kısmının nasıl yönetilmesi gerektiği ve en iyi hesap birimi seçiminin ne olduğu sorularının yanıtı bulunmamaktadır. Bu makalede, biz "likidite" perspektifini bir kenara bırakarak, merkez bankasını "yatırım" perspektifinden ele alıyor ve bir dizi majör döviz cinsi varlıklar üzerinden riske göre ayarlı getirilerini maksimize etmek istediğini varsayıyoruz. Bu da bizi herhangi bir majör para birimine karşı yanlı olmayan bir çoklu para birimi optimizasyonu ve hesap para birimi seçimi problemine getirmektedir.

Pratisyenler, çoklu para birimi optimizasyonundan genel olarak kaçınma taraftarıdır. Hesap para biriminin tipik olarak USD (veya EUR) olması neticesinde, diğer para birimi cinsinden ihraç edilmiş olan varlıkların USD (veya EUR) bazlı getirileri, kur volatilitesinin faiz oranları volatilitesine göre yüksek olması sebepli, oldukça yüksek oynaklığa sahip olarak görünmektedir (bkz. örn. Koivu vd., 2009). Sonuç olarak, USD hesap birimi bazlı optimizasyon egzersizlerinde diğer para birimleri cinsinden ihraç edilmiş olan varlıklar risk-getiri özellikleri bakımından cezalandırılmaktadır. Dahası, uygulamalı literatürde hesap para biriminin ne olacağı sorunsalı genellikle göz ardı edilmekte ve tipik olarak USD hesap para birimine dayalı analizlerin sonuçlarının ne kadar bozuk olabileceğine dikkat edilmemektedir (bkz. örn. Fisher ve Lee, 2004; Fernandes vd., 2011). Bu makalenin ampirik bölümünde gösterildiği üzere, hesap para birimi seçimi ihmal edilebilir, zararsız bir seçim değildir ve USD bazlı analizler sezgilere aykırı, yüksek oranda yoğunlaşmış portföyleri optimal olarak sunmaktadır.

Majör para birimlerine dayalı varlıklar arasında tahsis probleminde majör para birimlerinden herhangi birinin hesap para birimi olmasının olumsuz sonuçları olduğuna göre geriye iki alternatif kalmaktadır. İlki, bu majör para birimleri dışında bir para biriminin hesap para birimi olarak seçilmesidir, ki Borio vd.'nin (2008a; 2008b) de önerdiği gibi yerel para birimi makul bir alternatiftir. Fakat GOÜ'lerin yerel para birimlerinin majörler karşısında oldukça oynak olması, yerel para birimi

cinsinden yabancı varlıkların getirilerini kur etkisi sebebiyle oldukça oynak hale getirecek, bu da yeni sorunlara yol açacaktır. Bariz bir diğer alternatif ise majör para birimlerinden oluşan kur sepeti oluşturmaktır. Bu durumda da akla ilk gelen SDR (IMF özel çekme hakkı) sepetinin hesap para birimi olarak kullanılmasıdır. Hoguet ve Tadesse (2011), büyük kurumsal yatırımcıların SDR sepetini hesap para birimi olarak kullanmasının faydalarını tartıştığı makalelerinde, SDR bazlı yatırım sürecinin portföy volatilitesini önemli ölçüde azalttığını ortaya koymuştur. Fakat, biz bu makalede, SDR sepeti ağırlıklarının tüm gelişmekte olan ülkeler için optimal sepet olmayabileceğinden hareket etmekteyiz. Bunun yerine, yerel para birimi cinsinden getirilerdeki kur oynaklığının arındırılması durumunda elde edilecek kur sepetinin veya bundan türetilen alternatiflerin hem GOÜ'nün kendi dinamiklerini de kapsayacağını hem de çok daha esnek bir yöntem olacağını savunmaktayız. Aslında, bizim önerimiz SDR gibi sepetleri de kapsayacak genel bir yaklaşım olup, her GOÜ'nün kendi özel koşullarına uygun kur sepetini üretmesidir.

Bu makalede, majör para birimlerinde ihraç edilmiş rezerv varlıkların Türk lirası (TRY) getirileri alınmış, daha sonra bu getiriler TRY oynaklığının etkisinden Temel Bileşen Analizi (Principal Component Analysis) yoluyla arındırılmıştır. Bu şekilde sentetik olarak majör para birimlerinden oluşan bir kur sepeti elde edilmiştir. Başka bazı gelişmekte olan ülkelerin para birimlerinden türetilen kur sepetleri de, optimizasyon sonucunda elde ettiğimiz optimal portföy ağırlıklarının istikrarını kontrol etmek amacıyla analize dahil edilmiştir. Bu şekilde elde ettiğimiz kur sepetlerinin hesap para birimi olarak alınması durumunda; (i) çoklu para birimi optimizasyonunda herhangi bir majör para birimine dayalı varlık sınıfı kayırılmamakta, (ii) dönüştürülen getirilerin, varlık sınıflarının kendi para birimi cinsinden getirilerinin karakteristiğini yansıttıkları makul ve mantıklı bir prosedür izlenmekte, (iii) optimizasyon çıktılarına dayalı portföyler merkez bankalarının yaygın olarak kullandığı muhasebe para birimleriyle (USD, kendi para birimi veya herhangi bir sepet) bakıldığında cezalandırılmamakta, (iv) en temel optimizasyon uygulamalarından bile yeterince çeşitlendirilmiş optimal portföyler üretilmesi olanaklı hale gelmekte ve bu şekilde rezerv yönetimine içkin olan kur riskinin azaltılması sağlanmaktadır.

Bu makalede yapılan sepet kura dayalı OV optimizasyonu uygulamaları birkaç ilginç sonucu beraberinde getirmiştir. İlk olarak, merkez bankalarının yalnızca majör para birimi cinsinden devlet tahvillerinden oluşan tipik yatırım evrenine, altın, Çin devlet tahvilleri ve majör hisse senedi endeksleri eklenmesiyle portföy çeşitlendirmesi anlamında önemli kazanımlar elde edileceği gösterilmiştir. Altın ve Çin hazine tahvilleri gibi varlık sınıfları, pratikte merkez bankalarınca yaygın şekilde tercih ediliyor (edilecek) olmasına rağmen, önceki optimal stratejik varlık tahsisi çalışmalarına genellikle dahil edilmemişlerdir. Bu çalışmada merkez bankalarının optimizasyon çalışmalarında kullanabileceği yatırım evreninin altın ve Çin hazine tahvilleri ile büyütülmesinin olumlu olacağı gösterilmiştir.

İkinci olarak, sepet kura dayalı OV optimizasyonundan elde edilen optimal portföylerde bulunan varlık sınıfı ağırlıklarına bakıldığında, fazlasıyla çeşitlendirilmiş portföyler üretildiği görülmüş ve bu ağırlıkların farklı koşullarda kararlılık gösterdiği izlenmiştir. Öte yandan, USD bazlı OV optimizasyonlarından elde edilen optimal portföy ağırlıkları fazlasıyla yoğunlaşmış portföyler üretmekte ve farklı analizlerde istikrarsızlık göstermektedir. Dahası, sepet kura dayalı OV optimizasyonundan elde edilen varlık sınıfı ağırlıkları, bu çalışmanın incelediği dönem olan son iki on yılda yaşanan gelişmeleri yansıtma açısından makul görünmektedir. USD bazlı optimizasyondan elde edilen ağırlıklar içinse benzer yorumlar yapmak imkânsızdır.

Üçüncü olarak, yeniden örneklemeye dayanan OV optimizasyonunun portföy çeşitlendirmesini her koşulda artırdığı ve optimal ağırlıkların kararlılığını da biraz daha iyileştirdiği görülmüştür. USD bazlı yeniden örneklemeye dayanan analizlerde ise düşük riskten-kaçınma seçeneğinin olduğu optimal portföyler haricinde çeşitlendirme ve kararlılık anlamında pek fazla gelişme görülmemiştir. Dördüncü olarak, yapılan örneklem dışı performans analizlerinde, sepet kura dayalı OV optimizasyonunun farklı senaryolara adapte olabilen oldukça başarılı sonuçlar ürettiği görülmüştür. Son olarak, merkez bankalarının tipik portföy yönetimi kısıtlarını dikkate alan bir kısıtlı optimizasyon modeli oluşturulmuş ve merkez bankalarının tipik olarak kullandığı bu kısıtlar altında oluşan optimal sınırın (optimal

frontier) orijinal OV optimizasyonu optimal sınırının riskten kaçınma bölgesinde oluştuğu gözlenmiştir. Dahası, kısıtlı optimizasyon modeliyle elde optimal sınırın, bizim daha önce ürettiğimiz yeniden örneklemeye dayanan modelden edilen optimal sınıra çok yakın konumlandığı görülmüştür. Bu durum tipik merkez bankası portföy yönetimi kısıtlarının, risk yönetimi anlamında aslında yeniden örnekleme yapma süreciyle aynı işi yaptığını göstermektedir. Yeniden örneklemeye dayanan optimizasyonun bu anlamda merkez bankalarının rezerv yönetiminde gösterdiği muhafazakarlığı barındırdığı söylenebilir.

Özetle, bu makale, GOÜ merkez bankalarında stratejik varlık tahsisi süreçleri için, özellikle de yatırım portföylerinde optimal para birimi tahsisi problemine odaklanan, temel düzeyde, esnek ve kullanımı ve uygulaması kolay bir optimizasyon çerçevesi geliştirerek literatüre katkı sunmaktadır. Bu çerçeve, Markowitz portföy optimizasyon çerçevesine yönelik en yeni ilerlemeleri kullanarak, verim eğrisi tahmininden elde edilen ileriye-dönük girdileri sürece katarak, analist görüşlerini modele dahil ederek ve/veya hedeflerin en uygun şekilde formüle edildiği amaç fonksiyonları ile çalışarak geliştirmeye açık ve esnek bir çerçevedir.

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