

Identifying indicators of financial crises

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Dissertation submitted in fulfilment of the requirements for
the degree [Master of Commerce](#) in [Risk Management](#)
at the North-West University

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Graduation: May 2019

Student number: 23471336

Abstract

Early warning models have gained prominence after the global financial crisis of 2008 struck the world without remorse. The severity and the extent to which economies around the globe was affected resulted in massive costs. The notion of early warning indicators being able to identify areas of vulnerabilities with regard to oncoming financial crises justifies supplementary research into early warning indicators. Based on a dataset proposed by Rohn *et al.*, (2015), this thesis discusses potential vulnerabilities that can lead to financial crises. The dataset includes more than 70 vulnerability indicators for 34 OECD countries between 2005 and 2014. However, monitoring an extensive list of potential vulnerabilities is not always possible. Dynamic factor analysis was therefore applied to the dataset as a measure of data reduction in order to identify a suitable set of early warning indicators that can be monitored to signal oncoming financial crises.

Key words: financial crises; early warning indicators; dynamic factor analysis; co-movement

Acknowledgements

“Reflect upon your present blessings, of which every man has plenty; not on your past misfortunes, of which all men have some”

Charles Dickens

Words on paper cannot completely describe my gratitude towards the following people:

- My supervisors, Prof Waldo Krugell and Dr Carike Claassen for their guidance, inputs and patience during the course of this study. I thank you.
- My wife, Madeli du Toit, for the endless sacrifices that you made during the course of this study. Thank you for your support and love.
- My parents, Wilco and Mariza du Toit for teaching me to never give up. Thank you for your unconditional love and support in this process. Thank you for giving me the opportunity to pursue my dreams. I will always be grateful for what you have done for me.
- My friend, Johnny Jansen van Rensburg, who went through this process with me. Thank you for always being available and being a trusted confidant, I can always count on. I am grateful for your support.

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CHAPTER 1: INTRODUCTION

1.1 Background

Financial crises, as odd as it may seem, always start with new hope. The ultimate effects of financial crises are always dire, always driven by the self-interest of some party carried on the back of the hope of the masses. Hope comes in many forms and shapes. Hope of a better future, hope of financial stability, hope of wealth and even simply just hope of meeting basic needs. When it comes to financial crises, history tends to repeat itself as it has shown us time and time again. The most wide-ranging recent crises i.e. Turkish currency and debt crisis (2018), Venezuelan crisis (2017) and global financial crisis (2008) to name a few, are all excellent examples of history repeating itself. The context around the crises differs, but at the core of the crisis, the same fundamentals are always present; markets, despite their collective expertise, are destined to repeat history as irrational exuberance is followed by an equally irrational despair (Anderson, 2018), resulting in inevitable periodic bouts of chaos.

The specific causes of every crisis differ and are more often than not widely debated. Modern financial crises have several commonalities according to Anderson (2018) and often include one or more of the following symptoms: excessive exuberance, poor regulatory oversight, accounting irregularities, “herd” mentalities and deregulation of financial markets. However, one truth is certain; the aftermath of a financial crises is always costly, regardless of what caused the crisis.

The premise that policy-makers could be warned in advance of costly crisis events is giving academics, private and public sector and economists alike a renewed eagerness to develop successful early warning models. Early warning literature has been around for some time now and can be traced back to the late 1970s when a number of currency crises put the focus on leading indicators (Bilson & Frenkel, 1979) as well as theoretical models (Krugman, 1979) offering explanations for such crises. However, it was only in the 1990s that a wide-ranging methodological debate around early warning systems started (Alessi, Antunes, Babecky, Baltussen, Behn, Bonfim, Bush, Detken, Frost, Guimaraes, Havranek, Joy, Kauko, Mateju, Monteiro, Neudorfer, Peltonen, Rodrigues, Rusnak, Schudel, Sigmund, Stremmel, Smidkova, van Tilburg, Vasicek, Zigravova, 2014). This debate included literature from research on banking crises, balance of payments problems (Kaminsky & Reinhart, 1996) as well as currency crashes (Frankel & Rose, 1996).

Earlier models started off with the identification of single indicators where variable selection was mostly based on the early signalling models such as that of Kaminsky, Lizondo & Reinhart (1998). This quickly evolved into univariate signalling approaches which in effect, track and

record the historical time series data of a single indicator on historic crises and extract a threshold value where crises are most likely to happen. The univariate approach is simple and easy enough to apply and is therefore favoured by policy-makers. However, this approach contains a degree of underlying risk as several factors may be close to their associated crisis threshold values but because the threshold has not been reached, one might underestimate the probability of a crisis (Borio & Lowe, 2002). More recent models have addressed this problem by creating multi-variable early warning models by estimating the probability of a future crisis event from a set of several potential early warning indicators (Frankel & Saravelos, 2012 and Rose & Spiegel, 2009). It is unlikely that financial crises will be totally avoided, but with the help of ever-evolving early warning models, the associated costs and ultimate effects of financial crises can potentially be mitigated.

The global financial crisis of 2008 is significant for various reasons, most notably, the speed and severity with which it struck the global stage with (Rose & Spiegel, 2009). The global span of the crisis has also been notable; as, basically, every industrialised country has been affected in some way or another, be it on a small scale or severely. Developing and emerging economies were also not left unscathed. The crisis led policymakers to implement various costly policies to stimulate economies and mitigate the effects of the crisis. The actual cost of the global financial crisis of 2008 is a hotly debated topic and is likely to remain so. Early warning indicators are therefore an essential component that can help reduce the high losses associated with crises (Drehmann & Juselius, 2013:3).

For multi-variable early warning models, there are many possible indicators of a potential financial crisis, from simple rules of thumb like the deficit on the current account of the balance of payments, through to the 70 indicators posed by Röhn, Sanchez, Hermansen & Rasmussen (2015).

1.2 Problem statement

However, monitoring many indicators is costly. It may happen that different indicators present different signals. Therefore, monitoring an appropriate set of early warning indicators is crucial for reducing the risk of financial crises or at least mitigating their impact on the economy (Babecky, Havranek, Mateju, Rusnak, Smidkova & Vasicek, 2011:112).

This dissertation sets out to identify indicators that should be monitored to signal oncoming financial crises. In doing so, the aim is to re-examine the 70+ indicators identified by Röhn *et al.* (2015) to identify parsimonious indicators of financial crises. The focus is on identifying indicators of financial crises that experience similar movements during the build up to and times of crisis. A dynamic factor model will be applied to the existing Röhn *et al.* (2015) dataset

to establish co-movement among the indicators. Indicators that co-vary will be pooled to create a smaller number of factors that observers can monitor for oncoming crises.

1.3 Objectives

The main objective of this dissertation is to identify groups of indicators of financial crisis. As such, it is a data reduction exercise that aims to determine co-movement between indicators of crisis to group them as factors, or latent indicators, of crisis.

To achieve this objective, a number of secondary objectives need to be achieved:

- A review of the literature of the indicators of financial crises will place this dissertation in the context of the models that predict co-movement of indicators, and earlier empirical studies that find co-movement of indicators.
- An overview of the set of early warning indicators and a description of the data used by Röhn *et al.* (2015) will clarify the inputs to the empirical analysis.
- A description of the dynamic factor analysis will show that the method is appropriate for the question at hand and will inform the identification of the groups of indicators of financial crisis.
- An explanation of the results of the empirical analysis will demonstrate the scientific solutions to the research problem.

1.4 Research method

The methods employed in this study are a review of the literature as well as empirical analysis.

The empirical analysis will take the form of dynamic principle component analysis. The aim is to use the existing Röhn *et al.* (2015) dataset with 70 possible early warning indicators of financial crises and to apply this data reduction method to establish co-movement among the indicators (see Appendix A for list of variables). Groups of indicators that co-vary are factors, or so-called latent variables, that can then be monitored as indicators of crisis.

This application of the method draws on the so-called coupling/decoupling literature analysed by among other Claassen (2016).

1.5 Outline

Chapter 1 has described the background, problem statement, objectives and method of this study. Chapter 2 will present an overview of the literature on the indicators of financial crises. In Chapter 3 the 70 indicators used by Röhn *et al.* (2015) and the dataset will be described.

Chapter 4 will explain the method of analysis and presents the results. Chapter 5 will present a summary, conclusions and recommendations.

CHAPTER 2: REVIEW OF THE LITERATURE

2.1 Introduction

Regardless of their severity and origin, most financial crises are similar to past financial crises in many dimensions. The recurrence of financial crises throughout history suggests that it is unlikely that financial crises will be wholly prevented in the future (Allen, Babus & Carletti, 2009:14). The impact of financial crises can, however, be softened. The large costs associated with financial crises gave rise to the concept of early warning systems, where early warning indicators identify possible vulnerabilities in the economy most likely to be responsible for causing a financial crisis. One of the main objectives of early warning systems is also to predict the timing of crises (Kaminsky, *et al.*, 1998:3). From a historical perspective, early warning systems has had some measure of success at modelling the prevalence of crises across banks, private firms and countries (Rose & Spiegel, 2009:1).

According to the Economist (2012) there have been several financial crises in various shapes and forms throughout the 20th and 21st centuries. To give a brief overview of the most notable of these crises: the Knickerbocker crisis of 1907 occurred when trust companies acted in the likeness of banks, but these banks were inadequately regulated and when speculators tried to offset falling share prices with borrowed funds, they worsened the situation; the Wall Street crash of 1929 occurred due to the speculative boom that took place in the 1920s and ended when the Federal Reserve hiked interest rates to restore markets to normal conditions; the Oil Crisis of 1973 – 1974 took place due to the failure of the Bretton Woods system along with the trade embargo enforced by Arab oil exporters on the Western world; the 1987 crisis called Black Monday occurred due to significant drops in share prices and was amplified by automated trading systems and portfolio-insurance schemes causing markets all over the world to tumble; the 1997 Asian crisis where investors poured funds into emerging Asian economies that led to artificially high asset prices reaching unsustainable levels causing an inevitable crash of financial markets; the Dotcom crash of 2001 where shares in internet and telecom firms increased rapidly on a large scale during the start of the web, and eventually investors were not satisfied with the lack of profits of their investments in these companies, which caused share prices of these firms to fall significantly and led to a crash in financial markets. The most recent and familiar crisis, the sub-prime crisis of 2008 which eventually led to a global financial crisis, was caused by elaborate mortgage related securities envisioned to reduce risk but in effect, encouraged investors to stack up on investments in the American

housing market, the market eventually crashed (The Economist, 2012). The crises mentioned above exercised a strong negative aftermath for economies, but the severity of the effects on financial markets differed, and one truth comes forward: the majority of the financial crises had devastating effects within the immediate economies and most of these crises caused “spillovers” to other economies, hindering economic growth, destroying plans for the future and causing major setbacks throughout the world.

The history of financial crises indicates that the economic cost associated with crises is extremely high and any plausible solution is worth researching. The idea that a crisis can be predicted and therefore losses can be limited has led policy-makers and academics to take an interest in indicators of financial crises.

The focus of this chapter is to review existing literature on financial crises in order to identify possible indicators/measures of financial fragility. However, literature indicates that there is an extensive range of possible vulnerability indicators. This chapter will review the literature on the kinds of crises and the different indicators of crises. The analysis presented in the following chapters will attempt to identify and group the most significant indicators by means of data reduction through dynamic factor analysis.

2.2 Survey of the crisis literature

A financial crisis can be described as a disruption in financial markets taking the form of falling asset prices and insolvency among debtors and intermediaries. Disturbances such as this tend to spread through the financial system disrupting both the market’s capacity and ability to allocate capital (Eichengreen & Portes, 1987:1). Financial crises are more often than not linked to one or more of the following occurrences: severe disturbances in financial intermediation and the supply of external financing to various role players in the economy; considerable changes in the credit volume circulating in an economy along with substantial changes in asset prices; balance sheet complications on a large scale (including complications from firms, households, financial intermediaries along with sovereigns); large scale government support in the form of financing and policy adaptations, more specifically liquidity support and market recapitalisation (Claessens & Kose, 2013: 3).

Laeven and Valencia (2010:3) state that there are a number of resemblances when comparing past and recent crises, both in the underlying causes of the crisis and policy responses to the crisis. However, some noticeable differences in the economic as well as fiscal costs are linked to more recent crises. The economic cost associated with recent crises is on average much higher than the cost associated with past crises, in terms of both output losses and increasing public debt. It was concluded that the median output loss is 25 percent of GDP in recent crises,

compared to the historical median of 20 percent of GDP. The median increase in public debt (computed over a three-year period from the start of the crisis) is 24 percent of GDP for recent crises, while the historical median is 16 percent. The increases in losses can partly be attributed to the increase of interconnectedness and complexity of financial systems and the fact that the recent crises all took place in high income countries (Laeven & Valencia, 2010:4)

Financial crises have been inescapable occurrences throughout history and Bordo, Eichengreen, Klingebiel & Martinez-Peria (2001:53) found that the frequency of financial crises in recent decades has been effectively double that of the Bretton Woods period of 1945 to 1971 and the Gold Standard Era of 1880 to 1933. The most recent global financial crisis of 2008 caught most people by surprise, and what was primarily seen as problems in the US subprime mortgage market, rapidly escalated and spilled over to financial markets throughout the world. The crisis was repressed at extremely high cost and changed the financial landscape worldwide. The aftermath of the global financial crisis of 2008 has left policymakers, researchers and academics with the need to explore both new and existing options to predict and manage future financial crises. However, to explore these options, the economic drivers leading to financial crises need to be identified first.

Claessens & Kose (2013:3) claim that crises are to some extent indicators of the interactions and linkages between the financial sector and the real economy. These connections are often a mixture of events driven by a variety of factors. Therefore, grasping the concept of financial crisis requires an understanding of micro-financial linkages affecting an economy. Financial crisis literature has identified drivers of crises; however, it remains a challenge to definitively identify their deeper roots (Claessens & Kose, 2013:5). Numerous theories have been developed in the past decades concerning the underlying causes of financial crises. Fundamental factors such as macroeconomic imbalances and external or internal shocks are often identified as culprits; however, the exact causes of financial crises still remain questionable as financial crises appear to be occasionally driven by “irrational” drivers. Irrational drivers refer to factors that are considered to be related to financial turmoil, such as contagion and spill-overs in financial markets, credit crunches, sudden runs on banks and limits to arbitrage during times of distress. Common drivers of financial crises will be discussed in the following section.

2.2.1 Monetary policy

Literature has recognized several linkages that connect macroeconomic factors to financial crises. Monetary policy, being one of these factors, is said to contribute to the build-up of financial imbalances and Merrouche and Nier (2010:7) argue that for the 2008 global financial crisis, these linkages are thought to have worked through policy rates that were kept too low

for an extended period. Relaxed monetary policy may have led to reduced cost of wholesale funding for intermediaries, allowing these mediators to build up leverage (Adrian & Shin, 2008:2). This in turn caused banks and other financial institutions to take on higher levels of risk. In the form of both credit and liquidity risks (Borio & Zhu, 2008:9) this led to an increased supply as well as demand for credit, consequently inflating asset prices (Taylor, 2007:8).

2.2.2 Deregulation

Looking at the global financial crisis of 2008 in isolation, it could be argued that deregulation played an important part in the build-up to the crisis specific to the US (Amadeo, 2016:1). The repeal of Glass-Steagall Act¹ by the Gramm-Leach-Bliley Act permitted banks to use deposits to invest in derivatives and gave banks the authority for bank holding companies to be used as conduits for multi-office banking, subsequently penetrating new product markets (Bentley, 2015:36). Bankers stated that foreign firms posed a great threat as they could not compete at the same level as these firms. As a result, most bankers only offered low risk securities to their clients. The Commodity Futures Modernisation Act followed and allowed unregulated trading of credit default swaps as well as other derivatives, which was previously prohibited by state laws in the US and was considered to be gambling (Amadeo, 2016:2). The main problem with deregulation in the US seems to have been the repeal of the Glass-Steagall Act by the Gramm-Leach-Bliley Act as its passing allowed what would normally have been commercial banks to deal in the underwriting and trade of securities (Bentley, 2015:37). Consequently, banks took on higher levels of credit risk as the interconnected relationship between banks, securities exchanges and insurance firms strengthened. Large bank holding companies became major role players in investment banking and the strategies of leading commercial banks started to look like those of investment banks as they were associating themselves with securitisation, which was the main cause for their failures in 2008 (McDonald, 2016). At the time banks were growing larger while regulators were experiencing difficulties to effectively complete their function. Banks experienced such high levels of growth that the idea of “too big to fail” took over as these large banks came to realise that even in the event of financial distress, the government would have to bail them out (Stiglitz, 2010 B:4). In contrast with this mindset, banking regulations aim to promote competition between banks and forces them to utilize their resources efficiently to retain their customers and remain in business (Bentley, 2015:31). Supervision along with regulation of financial systems is a vital means to prevent financial crises, by controlling moral hazard to a certain extent and discouraging excessive risk taking on the part of financial institutions regulation is a key factor in maintaining a crisis free

¹ The Glass-Steagall act was authorized in 1933 as a response to the banking crisis of the US during the 1920s and early 1930s. It imposed the separation of investment banking from commercial banking (McDonald, 2016).

environment (Merrouche & Nier, 2010:9). Deregulation, however, serves the self-interest of financial institutions and the pursuit of self-interest can thus explain the drift toward deregulation prior to the global financial crisis.

2.2.3 Global Imbalances

Global imbalances can be described as imbalances between savings and investments in the world economy reflected in large and growing current account imbalances (Dunaway, 2009:3). Current account imbalances are normally maintained at a sustainable level, however in some cases countries with current account deficits start to feel increasing pressure in obtaining financing when deficits reach unsustainable levels. Limited financing as a result of large current account deficits applies pressure on economies which forces policymakers to adjust domestic interest rates putting downward pressure on the real exchange rate. This in turn hinders domestic economic activity. This is not only true for countries with deficits, as countries with surpluses face similar pressures in the opposite direction, causing increased economic activity leading to the appreciation of the real exchange rate. Literature on crises often does not include discussions regarding economic policies that foster and facilitate global imbalances. Dunaway (2009:13) takes this statement into account when looking back at the 2008 global financial crisis, and one can clearly see considerable and growing current account imbalances within major economies. US deficits were increasing while emerging Asian economies as well as oil exporting Middle Eastern countries were creating surpluses. Savings and investment imbalances led to the existence of the “savings glut” in developing countries where substantial amounts of capital flowed from developing countries to advanced economies, the US being the primary recipient of these inflows of capital. The so-called savings glut was followed by reduced interest rates around the world and simultaneously, a growing demand rose from these emerging Asian economies along with some Middle Eastern economies for official reserve assets. The great demand for such high quality, low risk assets, contributed to financial excesses that culminated in the turmoil of financial markets.

2.2.4 Asset price booms and busts

Drastic hikes in asset prices and the crashes that follow them, have been around for centuries (Laeven & Valencia, 2010:5). Asset prices occasionally diverge from what fundamentals would suggest to be normal or fair and display patterns varying from predictions of standard models operating in stable financial conditions. A bubble is an extreme form of such deviation and can be described as the part of a complete upward asset price movement that cannot be explained solely grounded on fundamentals (Garber, 2000:4). Patterns of extreme increases in asset prices followed by crashes feature in numerous accounts of financial instability and go back millennia for both emerging market and advanced countries (Laeven & Valencia, 2010:5).

In an attempt to explain asset price bubbles, several models have been developed over time. These models range from micro-economic distortions that cause mispricing, to considering the impact of rational behaviour causing collective mispricing of assets, whereas other models take irrationality of investors into account. Despite these attempts Laeven and Valencia (2010:7) state that anomalies cannot easily be credited to specific, institution-related distortions in asset prices.

2.2.5 Securitisation

Securitisation became an important role player in the 2008 global financial crisis as hedge funds in the US sold mortgage backed securities² such as collateralised debt obligations (CDO) and other derivatives. Once an individual receives a mortgage from a bank, the bank sells the mortgage to a hedge fund on the secondary market. Banks and Hedge funds then bundled these mortgages with similar mortgages to create CDOs.

What made securitisation troublesome was “tranching”³. Tranching was initially implemented to decrease the risk of upper tranches in order to achieve higher credit ratings (Bentley, 2015:13). Banks were allowed to tranche the mortgage pools and did so by dividing mortgage pools into different tranches; the toxic waste tranche, the mezzanine tranche and the senior tranche. A tranche bundle of securities is thus a collateralised debt obligation and most CDOs consisted of seven or even eight tranches (Bentley, 2015:14). CDOs like these were then sold to investors by hedge funds, which allowed banks to hand out new loans with the resources received from selling these mortgages, however the bank still collected the payments on these mortgages and sent them to the hedge funds who in turn sent these payments to investors (Amadeo, 2016). All of the intermediaries took a pre-determined percentage of profit for their part in the process, making this a popular investment and free of risk for the bank and hedge fund. Investors took on all the risk of default as they had a way of mitigating the risk called credit default swaps. These credit default swaps were sold by major insurance companies making investors believe these securities were safe investments as they were “backed” by mortgage bonds. Derivates backed by real estate and insurance were a profitable investment and demand for these securities was high and growing. More and more mortgages were needed to back the securities and to meet this high demand, banks as well as mortgage brokers offered home loans to almost everyone. Banks eventually offered subprime

² Mortgage backed securities are financial products where the price is based on the value of mortgages being used for collateral security.

³ A common feature of CDO's involves the division of the degree of credit risk pertaining to a pool of securities into different risk classes. The interval between two different classes of risk is called a tranche. This tranche then absorbs the initial loss (high risk tranche) and is called the equity tranche. The remaining tranches are known as mezzanine or senior tranches (FINCAD, 2017)

mortgages to cover the high demand as the derivatives were so profitable they did not need to make much money from the loans (Amadeo, 2016).

Due to low interest rates imposed by the Federal Reserve Bank (Fed), many homeowners who could not previously afford mortgages were approved for interest only loans. Consequently, the percentage of subprime mortgages doubled from 10% to 20% from 2001 and 2006 and unintentionally created an asset bubble in the real estate sector around 2005 (Amadeo, 2016). The high demand for mortgages drove up the demand for housing which construction contractors tried to meet. Because loans were cheap, speculators bought houses as investments to sell as prices went up. The Fed adjusted interest rates and many individuals could not repay their loans due to the higher interest rates, which in turn put pressure on housing prices as more and more houses were being sold. The housing market bubble resulted in a bust and contributed to the existence of the 2008 financial crisis.

2.2.6 Fear (Human sentiment/irrational driver)

Fear is aptly placed at the bottom of the list as it is not necessarily a driver or cause of a financial crisis in itself, but rather a psychological catalyst amplifying crises. Fear is manifested at the core of financial crises (Aldean & Brooks, 2010:1). Take a “bank run” as an example, in the event where one bank defaults, fear is triggered among depositors of other banks despite those banks being sound (Hoggarth, Reidhill & Sinclair, 2004:6). Similarly, fear can also be “exported” on an international level. Historical accounts suggest that fear and greed are at the roots of financial crises (Lo, 2011:622). Individuals, companies and financial institutions behave in a self-serving manner, meaning that they want to protect their resources despite taking on risk to enrich themselves. These groups will therefore always act conscientiously when it comes to their resources, both conscientiously rational or irrational, depending on what their perspective is.

As can be seen from the survey of financial crisis literature, there are numerous factors that can attribute or lead to the existence of financial crises. As is the case with the majority of crisis incidents, the root cause is intertwined and more often than not these root causes shift blame to one another. Indicators of financial crises should thus not be considered in isolation, but rather as a collective set of indicators as this would be a more meaningful measure regarding early warning models. The ideal solution would be to find a universal set of indicators that would be applicable in all crisis events to all countries, however considering the vast degree of diversity between countries, it seems unlikely that one would be able to put forth a set of indicators that provides consistent results for all countries. That being said, all financial crises do have homogenous drivers to some extent. The aim is thus to put forth a credible set of indicators to identify financial crisis crises at an early stage.

2.3 Types of crises

To better understand financial crises, it can be said that there are two types of crises; firstly, crises classified by means of quantitative definitions and secondly, crises that are mostly reliant on qualitative and judgemental analysis (Claessens & Kose, 2013:11). In addition to this, crises classified by quantitative means can further be sub-classified into currency and sudden stop crises, whereas financial crises reliant on qualitative and judgemental analysis can be sub-classified into debt and banking crises.

2.3.1 Sudden stops and reversals (capital account or balance of payments crisis)

Sudden stops refer to events where the domestic economy loses access to international capital markets as private foreign investors abruptly stop lending and investing to domestic residents and companies. This results in panic due to the financial turmoil and leads to an extreme shift of the supply of foreign funds to such an extent that the direction of capital flows completely turns around (Jeasakul, 2005:5). Whereas a crisis originating from current account deficits; in basic terms, a current account deficit implies that a country is spending more abroad than it is receiving from abroad. According to the IMF the current account can be expressed as the value of exported goods and services and the value of goods and services imported. Thus, a deficit means a country is importing more goods and services than it is exporting. The current account includes net income (in the likes of dividends and interests) along with transfers (such as foreign aid), however these sections only make up a small percentage of the of the total (Ghosh & Ramakrishnan, 2012). In the instance where a country runs a current account deficit, it is effectively borrowing from the rest of the world.

Obstfeld (2012:2) stated that even in an ideal world free from economic frictions, both foreign demand and supply conditions are constraints on the maximum welfare attainable by the national economy. As a result, governments face incentives to manipulate such constraints to benefit them. Basic neoclassical theory states that all entities will gain from free trade (which includes balanced trade), however theory and reality are two very different things. In a world filled with economic and political distortions, a government's apparent short run advantage may be heightened by policies focused on a trade surplus. Policies like these have adverse consequences for trade partners as a surplus in one country indicates a deficit in the corresponding trade partner. Government policies are also a key factor in current account deficits and surpluses.

According to Milesi-Ferretti and Razin (1996:65) persistent current account imbalances are often seen as a sign of weakness that implies the need for policy action. In contradiction to this, economic theory suggests that intertemporal borrowing and lending are natural pathways to achieve accelerated capital accumulation, the smoothing of consumption and a more

efficient investment allocation. Milesi-Ferretti and Razin (1996:65) conducted a study to determine to what degree persistent current account imbalances can be taken as a sign of an upcoming crisis. This particular study debated that traditional measures of sustainability, solely based on the notion of intertemporal solvency, may not always be suitable, due to the fact that they do not encompass the willingness of a country to meet its outstanding external obligations. Nor the willingness of foreign investors to keep lending on current terms. To compensate for these factors an alternative notion of sustainability that emphasizes the willingness to pay and lend in addition to simple solvency was proposed. A list of indicators based on theoretical considerations was compiled to shift the focus to the sustainability of external imbalances. From this list, a few conclusions were made: A specific threshold on a persistent current account deficit (such as the 5 percent of GDP for 5 years) is in itself not an adequately informative indicator of sustainability. Rather than using a specific threshold, the magnitude of current account imbalances should be taken into account along with exchange rate policy and structural factors such as the degree of openness, the condition of the financial system and the levels of investment and saving.

To add to literature regarding persisting current account imbalances, Edwards (2005:34) came to the conclusion that in his sample period of 30 years the vast majority of countries have run current account deficits. In this specific sample period, there had only been three regions where the average current account balance has been a surplus, these regions being some industrialised countries, the Middle East and Asia; however, all these surpluses have been small. Literature indicates that large current account deficits have not persisted for extended periods of time. A small number of countries have run prolonged deficits, however the degree of persistence of large surpluses has been higher. Major reversals in current account deficits have tended to be persistent throughout the sample period and are strongly associated to the sudden stop of capital inflow. Regarding financial crises and reversals, a significant likelihood of reversals leading to exchange rate crises exists. Additionally, evidence suggests that countries that attempt to deal with reversals by significantly running down reserves, typically do not succeed (Edwards, 2005:34).

Edwards (2005:12) analysed the working of current account movements throughout the global economy in the past three decades and his main findings can be summarised as follows: Firstly, large reversals in current account deficits tend to be linked to sudden stops of capital inflow. Secondly the probability of countries experiencing reversals can be explained by a smaller number of variables that include the current account to GDP ratio, the level of international reserves, the external debt to GDP ratio, debt services and domestic credit creation. Lastly current account reversals have been known to have negative effects on real growth that goes beyond their direct effect on investments. This evidence indicates that the

negative effects of reversals on growth will depend on a country's degree of openness, i.e. more open countries will not be affected as much as countries with limited openness. In the event where countries run large current account deficits for a prolonged period of time, concerns arise as to whether these deficits are sustainable. Milesi-Ferretti and Razin (1996:1) create some background regarding conventional wisdom on sustainable current account deficits by stating that conventional wisdom should indicate disturbing signs if deficits persist above 5 percent of GDP, especially when such a deficit is financed by making use of short-term debt or foreign exchange reserves. It is therefore worth questioning whether something such as the above-mentioned threshold on current account deficits should be taken seriously and if so, which factors would be worth determining to evaluate if prolonged external imbalances are likely to lead to external shocks. In regard to this question, history suggests that several countries such as Australia, Ireland, Malaysia and Israel to name a few have been able to run large current account imbalances for a number of years, however other countries such as Mexico and Chile have not been able sustain their deficits and subsequently suffered severe external crises. History thus suggests that there are more factors at work and grasp a better understanding regarding persisting current account imbalances, these factors should be identified and analysed. Another study even went as far as to claim that the prolonged current account deficit of the US reflects a technological shift that has led to prosperity rather than impose negative effects (Hervey & Merkel, 2001:12). This opens the door to possible two-sided effects of prolonged current account deficits. The solvency of individual countries can aid in explaining the differing results suggested by history and should therefore be considered a key factor to be taken into account when assessing external imbalances. The solvency of a country indicates its ability to generate a sufficient trade surplus to repay outstanding debt.

Obstfeld (2012:3) claims that the circumstantial evidence of current account deficits being a conduit of financial crises was preceded by historically large global imbalances in current accounts, which includes large deficits that were run by a number of industrial economies (including the U.S.) that consequently came to grief. What most debates miss regarding current account imbalances is the remarkable progression and integration of international financial markets during the past quarter century. Due to global imbalances financed by multifaceted patterns of gross financial flows, flows that are usually much larger than the current account gaps themselves, questions arise as to whether the commonly smaller net current account balance still matters. However, a lesson of recent crises is that globalised financial markets puts forward potential stability risks that people too often choose to ignore at their own peril. Current account imbalances can signal preeminent macroeconomic as well

as financial tensions as was arguably the case of the mid-2000s. Historically big and ongoing global imbalances deserve close attention from policymakers (Obstfeld, 2012:39).

Edwards (2005:1) put forward the argument that free capital mobility induces macro-economic instability and adds to the existing problem of financial vulnerability in emerging economies. Stiglitz (2010 A) reinforced this account in his critique of the Fed and the IMF by stating that pressure was put on emerging economies to relax capital mobility controls during the 90s. Stiglitz was of opinion that the easing of capital mobility control was at the centre of the majority of currency crises in emerging markets during the last decade; Mexico 1994, East Asia 1997, Russia 1998, Brazil 1999, Turkey 2001 as well as Argentina 2002. The IMF seems to have changed their opinion and offer some level of support for controls of capital mobility as the IMF managing director of 2003 (Horst Koehler) praised the policies of Prime Minister Mahatir and his particular use of capital controls in the aftermath of the 1997 currency crisis (Edwards, 2004). Supporters of capital mobility controls claim that there are two obvious benefits of restricting capital mobility: a) It reduces a country's vulnerability to external shocks and financial crises and b) it creates capacity for countries that have suffered a currency crisis to lower interest rates, implement pro-growth policies, and it allows a country to rid themselves of the effects of a crisis sooner than they would have done in any other case (Edwards, 2005: 1).

2.3.2 Currency crisis

Another crisis which can be described as a financial crisis is a currency crisis. A currency crisis can be defined as a speculative attack on the foreign exchange value of a currency that results in either a sharp depreciation of a currency or forces the government to defend their currency by means of selling foreign exchange reserves or raising domestic interest rates (Glick & Hutchinson, 2011:2). In most cases this causes the value of the currency to become unstable, resulting in the currency losing its creditability as a reliable medium of exchange.

In the instance where an economy makes use of a fixed exchange rate, a currency crisis refers to situations where the economy is under pressure to abandon the exchange rate peg used. A successful attack on the currency will mean that the currency will depreciate, whereas an unsuccessful attack may most likely leave the exchange rate unchanged, at a cost, the cost consisting of all the foreign reserves spent or a higher domestic interest rate. Speculative attacks on currencies often lead to a sharp depreciation in the exchange rate regardless of strong policy responses to defend the value of a currency (Glick & Hutchinson, 2011:2).

According to Claessens and Kose (2013:12) there are three generations of models that are normally used to explain currency crisis events that occurred throughout the past four

decades. The first-generation models were mainly driven by the collapse in the price of gold as it was an important nominal anchor before the rise of floating exchange rates in the 1970's. These models were largely applied to currency devaluations in Latin America as well as other developing markets. Described as "KFG" models they were inspired by seminal papers from Krugman (1979) as well as Flood and Garber (1984). These models stipulate that sudden speculative attacks on a fixed currency can be attributed to the rational behaviour on the side of investors/speculators who correctly anticipate that a government has been consecutively running excessive deficits with the use of central bank credit. Investors hold on to the currency until they start expecting the peg is about to end. Investors then get rid of the currency, causing central banks to rapidly lose their liquid assets or foreign currency on hand meant to support the local currency. Consequently, the currency collapses.

The second-generation models shift its focus to multiple equilibria in the sense that doubts concerning the extent to which a government is willing to maintain its exchange rate peg could lead to multi-equilibria and currency crises. These models are also different in the sense that self-fulfilling prophecies are a possibility. Basically, this means that the reason behind investors' mindsets to attack a currency is simply because investors anticipate other investors attacking the currency. Policies prior to the attack in first-generation models can transcend into a crisis, while changes in policies to answer in response to an attack can in itself lead to it, as drastic measures often tend to trigger a crisis (Claessens and Kose, 2013).

The third-generation of currency crisis models opts to explain the rapid deterioration of balance sheets linked to fluctuations in asset prices. This includes exchange rates and can often result in currency crises. The Asian crisis of the late 1990s gave rise to these models, as macroeconomic imbalances were rather small before the start of the crisis. Many Asian countries were in a surplus position and in those who were not, current accounts seemed to be manageable. However, vulnerabilities linked to financial and corporate sectors were present. Third-generation models indicate how a balance sheet mismatch in these sectors could result in a currency crisis (Claessens and Kose, 2013).

The above-mentioned types of crises are measured in quantitative measures whereas the following types of crises are measure in a qualitative manner:

2.3.3 Banking crises

Banking crises are another type of financial crises. Systemic banking crises can be described as disruptive events not only to financial systems but economies as a whole. Banking crises are usually headed by prolonged periods of high credit growth, often accompanied with large imbalances in the balance sheets of the private sector, more specifically factors such as

security mismatches and even exchange rate risk. Subsequently these factors tend to translate into credit risk for the banking sector (Laeven & Valencia, 2010:3).

Banks are in the business of borrowing short and lending long. By doing so, they deliver a vital service to the economy. Banks thus create credit that allows economies to grow and expand. This so-called credit creation service is, however, based on an inherent fragility of the banking system (Grauwe, 2008:2). In the case where depositors are absorbed by a collective movement of doubt and distrust and decide to withdraw their deposits in a short period of time, banks will be unable to satisfy such a high number of withdrawals as a large percentage of their assets are not liquid. This will lead to a liquidity crisis which will result in possible spill-over effects to other banks and can effectively bring an economy to its knees.

Due to the global integration of financial markets, banks are susceptible to a series of risks, which mainly include credit risk, liquidity risk and interest rate risk. Credit risk is the risk of non-performance of loans and other assets, liquidity risk is the risk of withdrawals exceeding the available funds and interest rate risk is the risk of rising interest rates leading to reduced bond values held by a bank, which will force the bank to pay more on its deposits than it receives from loans (The World Bank, 2016). Systemic banking crises are disruptive proceedings not exclusive to financial systems but also impacting the economy as a whole. Crises such as these are not specific to recent history or even specific countries as the majority of countries have not managed to avoid banking crises (Laeven & Valencia, 2010).

Deregulation of the banking system in the 1980s led to existence of bubbles and crashes in financial markets of capitalist countries (Grauwe, 2008:2). Due to deregulation, banks, which by their very nature are subject to liquidity risks, added major volumes of credit risk to their balance sheets. In addition, investment banks that typically take on large amounts of credit risk added the liquidity risks traditionally reserved to traditional banks to their balance sheets. This led to huge credit exposure to both commercial and investment banks, creating credit bubbles and eventually crashes in financial markets.

Laeven and Valencia (2010:2) presented a database regarding banking crises for the period 1970-2009. This database indicates that there are numerous commonalities between past and recent crises, both in terms of primary causes and policy responses. One commonality is the fact that all crises share a containment phase during which liquidity pressures are contained through liquidity support and in some cases even guarantees on bank liabilities. Banking crises are more often than not preceded by extended periods of rapid credit growth and are repeatedly associated with large imbalances on the balance sheets of private sector entities. These imbalances include maturity mismatches and exchange rate risk that ultimately creates credit risk for the banking sector.

2.3.4 Debt crises (domestic and sovereign)

External debt crises, like all debt related subjects, involve the outright default on payment of debt obligations incurred under foreign legal jurisdiction, repudiation or the restructuring of debt into such a manner that the creditor is in a worse financial position than terms originally stated (Reinhart & Rogoff, 2010:6).

Banking crises often either coincide with or precede sovereign debt crises as governments tend to take on immense levels of debt from private banks, effectively undermining their own solvency. Currency crises often also form part of banking crises as the latter precede currency crashes when the failing value of the domestic currency follows the banking crisis which undermines the solvency of both private and sovereign borrower who holds significant amounts of foreign currency debts. A definitive chain thus exists from sovereign debt crises to banking crises. Financial repression in conjunction with international capital controls allows governments to pressure otherwise healthy banks to buy government debt in substantial quantities. In the event where a government default does realise, these banks balance sheets are directly impacted, causing the start of two different financial crises simultaneously. Even in the instance where banks are not over-exposed to government interference/paper, the “sovereign ceiling” in which corporate borrowers are rated equally to national governments would translate into higher offshore borrowing costs and would most likely also affect the ease of acquiring offshore monetary resources. This in turn would incur a sudden stop of resources that will in theory relate to bank insolvencies (Reinhart & Rogoff, 2013:26)

Reinhart and Rogoff (2013:6) introduced the term multi-faced debt overhang when stating that the overall debt problem facing advanced economies at the time was difficult to overstate as several factors are at play; expanding social welfare dependence, an ageing society and stagnant population growth are some of these challenges.

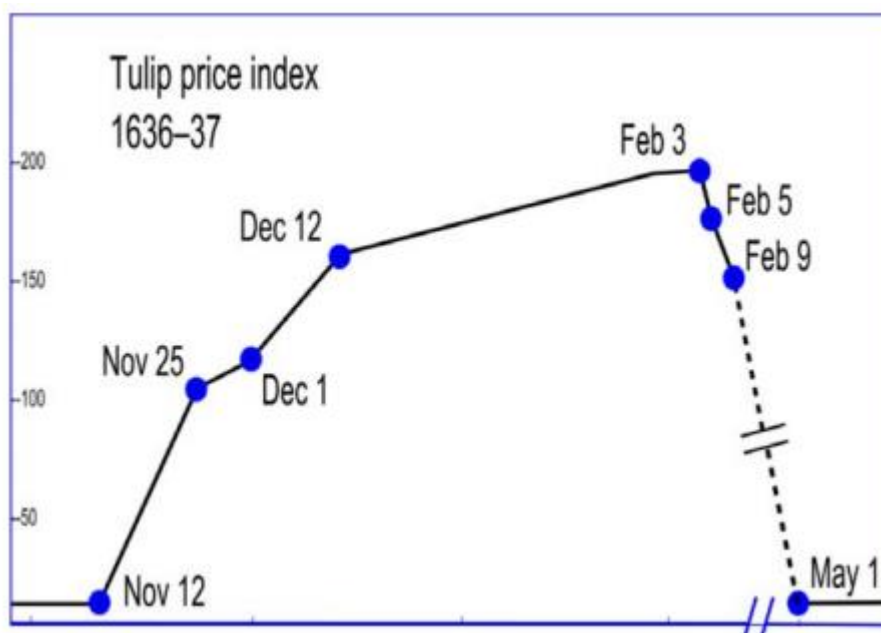
It is important to make the distinction between external and domestic debt as domestic debt issued in the local currency usually offers a wider range of partial default options than foreign currency-denominated external debt does. Financial repression can offer some extent of relief concerning debt as governments stuff debt into local pension funds as well as insurance companies and force them by means of regulation to accept lower rates of return than they would have otherwise demanded. Domestic debt can also be reduced by inflation. A combination between financial repression and inflation can be particularly effective in reducing domestic-currency debt (Reinhart & Rogoff, 2013:6).

2.3.5 Speculative bubbles and market failures

Speculative bubbles can be defined as the trade of high volumes at prices that are at considerable variance with intrinsic values of certain assets (Fetiniuc, Ivan & Gherbovet, 2014:1). Asset bubble bursts can lead to financial deprivation and liquidity crises which in turn translates into financial crises on a national or even global scale.

Speculative bubbles are not new and there have been several incidences throughout history, the first recorded nationwide instance being the Tulip mania of the Netherlands. The Tulip mania was a period in Dutch history where contract prices for tulip bulbs stretched to extraordinarily high levels and suddenly collapsed (Wang & Wen, 2009:2). At the height of the crisis during February 1637, tulip bulb contracts sold for more than ten times the annual income of a skilled craftsman. This amount exceeded the value of a fully furnished luxury house in seventeenth-century Amsterdam (Wang & Wen, 2009:2).

Figure 2.1: Tulip price index



Source: Wang and Wen (2009:2)

Figure 1 indicates the price movement of tulip contracts during the tulip mania financial crisis where the sharp growth and rapid plunge trend of speculative bubbles can be clearly seen. Investors bought tulips at higher and higher prices and even sold their possessions to purchase more tulips intending to resell the tulips for a profit. As tulip prices were growing faster than income, traders were no longer able to find new buyers willing to pay increasingly inflated prices. When the realization sank in, demand for tulips collapsed and prices plummeted.

The eventual crash after the asset bubble can destroy a large amount of wealth for both consumers and institutions, which in turn leads to financial panic transitioning into a fully-fledged financial crisis usually causing continuing economic disruption.

2.4 Indicators of financial crises

The prospect of being able to be warned of an oncoming financial crisis long before the crisis actually happens, or even to avoid a financial crisis as a whole gives purpose to early warning indicators. Indicators of financial crises, early warning indicators or vulnerability indicators however you want to name them, are the focus of this study. These indicators serve as a means to signal warning signs well before vulnerabilities have grown too large for policymakers to control. As previously mentioned, the different types of financial crises often go hand in hand, where the one crisis usually leads to the next. Several economists and writers have quantifiably demonstrated that a number of indicators pose a relative degree of correlation to the incidence of a financial crisis. Kaminsky *et al.* (1998:36) for one, set out to do a detailed study regarding indicators of a crisis and concluded that most crises have multiple indicators. From this study, a list of indicators said to be associated with financial crises was produced and these include: M2 multiplier, ratio of domestic credit to nominal GDP, real interest rate on deposits and the ratio of lending to deposit interest rates. Additional indicators include the excess of real M1 balances, real commercial bank deposits as well as the ratio of M2 or foreign exchange reserves. In this particular study, the indicators that suggested the likelihood of a financial crisis in order of correlation are a) real interest rates, b) real interest rate differential, c) terms of trade, d) reserves, e) outputs, f) exports as well as g) stock prices.

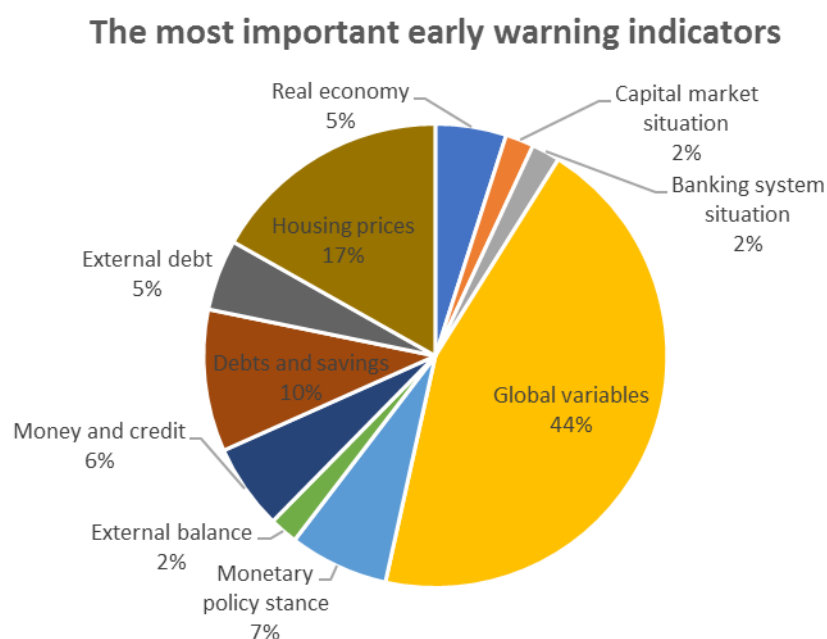
Reinhart and Rogoff (2010:12) conducted a similar study with more modern views regarding early warning indicators for both currency and banking crises and concluded that real exchange rates, real housing prices, short term foreign direct investment, the current account balance and real stock prices are the most effective indicators to signal an oncoming banking crisis, whereas the worst indicators were found to be ratings, along with terms of trade. For currency crises, the most effective indicators were identified to be real exchange rates, banking crisis, current account balance, exports and international reserves (M2). Whereas the least effective currency crisis indicators were found to be ratings, as well as domestic-foreign interest differential.

Another early warning indicator model was created by Lestano, Jacobs & Kuper, (2003:1) which distinguishes between three types of financial crises; currency crises, banking crises and debt crises. Furthermore, this model extracts four groups of early warning indicators that

are likely to influence the probability of financial crises. The four groups are external indicators, financial indicators, domestic indicators (real as well as public) and global indicators. A broad set of potentially relevant indicators was extracted from existing crisis literature which was then combined with the use of multi-factor analysis. The first two factors were identified as current account variables and variables associated with the capital account as external early warning indicators, whereas the third and fourth factors were financial variables and domestic indicators respectively. Financial variables correlate with flows (such as values and rate of growth) whereas the domestic indicators correlate with price. The global factor (fifth factor) captures variations in the Fed's interest rates and OECD output growth. More specifically, the study identified the growth of money (both M1 and M2), bank deposits, GDP per capita, as well as the flow and level of national savings are all indicators that correlate with all three different types of financial crises listed in this study, whereas the ratio of M2 to foreign reserves along with the growth of foreign reserves, the domestic real interest rate and inflation correlate with banking crises and some instances of currency crises.

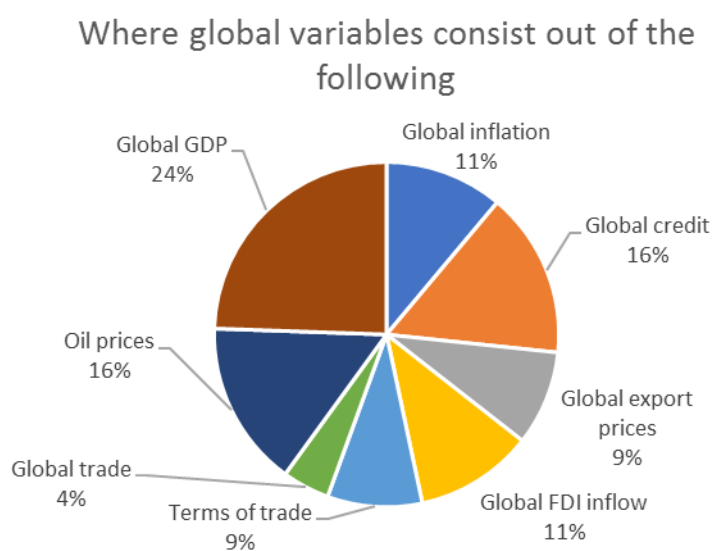
As early warning literature clearly depicts, it is crucial for the optimal timing of macroprudential measures aimed at reducing the level of exposure inculcated by a financial crisis or at the very least mitigating the impact of such a crisis on the economy. This can be accomplished by monitoring a suitable set of early warning indicators (Babecky *et al.*, 2011:1). Babecky *et al.* (2011:2) set out to identify early warning indicators that should be monitored with emphasis on robust indicators that are not dependent on the choice of crisis prediction models. Therefore, two mutually complementary crisis measures were combined; 1) The timing of the crisis event and the intensity of the impact of the crisis on the economy. The two-model system was created and applied to pre-crisis and crisis events for 40 advanced European Union and OECD countries. The model identified rising house prices and external debt as the best performing early warning indicators. The pie charts below indicate more specific results from the two-factor model.

Figure 2.2: Important early warning indicators



Source: Babecky *et al.* (2011:116)

Figure 2.3: Global early warning indicators



Source: Babecky *et al.* (2011:116)

These results imply that macroprudential policies should be implemented in such a manner that it would monitor global variables (such as global GDP and oil prices) as well as identified domestic variables (such as rising housing prices as well as debt and saving levels) to effectively identify the source of risk.

Vasicek *et al.* (2014:1) stated that researchers in academia, economists, as well as central banks have developed several early warning systems with a single goal: to warn policymakers and all relevant parties of potential oncoming financial crises. These early warning models are based on different approaches and empirical models, so Vasicek *et al.* (2014) set out to compare nine different models proposed by the Macroprudential Research Network (MaRs). To ensure comparability, a single database of crises was created by MaRs to be used by all the distinct models. The study found that multivariate models (in their many guises), have great potential of identifying early warning indicators to signal oncoming crises over simple signalling models.

Existing literature on early warning indicators does not offer a consensus on the process of defining a crisis for the specific purpose of early warning models. It is thus most suitable to make use of a multi-factor analysis model so that the choice of early warning indicators is as robust as possible. Literature on early warning indicators of financial crises has thus far mainly relied on one of two approaches, to be more specific; either the signalling approach or categorical dependent variable regression (Vasicek *et al.*, 2014:22). A great advantage of the signalling approach is that the approach is user-friendly as an early warning signal is issued when the relevant indicator breaches a pre-specified threshold with the help of historical data. The main drawback of the signalling approach is that it mainly considers early warning indicators in isolation whereas logit/probit regressions offer a multivariate framework where the relative importance of several indicators in conjunction with one another can be assessed. However, the logit/probit models offer an estimate of the contribution of each indicator to the increase in the overall probability of a crisis, rather than a threshold value for each factor as is the case with signalling models. The early warning threshold is then set in a second step with referral to the estimated probability of a crisis realising. Another challenge regarding logit/probit models is the fact that this type of framework is unable to process unbalanced panels, as well as missing data, effectively. Despite these shortcomings Vasicek *et al.* (2014:22) state that multivariate approaches, in their various forms, have significant potential in generating meaningful crisis predictions as they offer considerable advantages regarding prediction power over univariate signalling models. When opting to apply these results to macro-prudential policy and taking the strengths and weaknesses of the various approaches into account, multivariate models could be a superior approach in developing empirical macro-prudential policy instruments.

The non-structural, MIMIC (Multiple-Indicator Multiple Cause) model from Rose and Spiegel (2009:2) was applied to a cross-sectional dataset consisting of 107 countries. What makes this model unique is the fact that the MIMIC specification clearly recognizes that the severity of a financial crisis is an unceasing, rather than a distinct phenomenon, and of such a nature

that it can only be observed with error. This model also captures the severity of a financial crisis as an unobserved variable, detected imperfectly in terms of information displayed by the global financial crisis of 2008, where equity markets collapsed, exchange rates drastically depreciated, declines in the perception of countries' creditworthiness and recessionary growth. The MIMIC model links early warning indicators of financial crises to the possible causes of the crisis, allowing observers to attain estimates of the severity of each country's crisis experience along with estimates of the effect of probable drivers of the crisis. The broad spectrum of possible vulnerability indicators examined by Rose and Spiegel (2009:28) covers an extensive set of fundamentals including financial conditions, the regulatory framework and the macroeconomic, institutional and geographic features of a country. Despite this evidence indicated that nearly none of the suggested indicators seem to be statistically significant factors of crisis severity in the sense that these indicators do not include the occurrence of the crisis across countries. Despite being able to model the incidence of the crisis on a relatively successful basis, the model has not been able to link the severity of the crisis across countries to its causes. The potential flaw of the study was identified as possibly having poor measures of the fundamental determinants of the crisis. Other possible explanations for the weakness of results include a possibly problematic situation with the approach regarding modelling the cross-country incidence of the crisis due to national characteristics. This is not suitable if the fundamental causes of the specific crisis at hand are of international nature, for example because the crisis spreads contagiously or if it is the aftermath of a common shock. Results from the study imply that even though the crisis may have been transmitted through various channels, its incidence seems unrelated to national fundamentals.

Global risk indicators consistently outperform domestic risk indicators with regard to usefulness, emphasizing the importance of taking international development into account when assessing a country's vulnerabilities (Hermansen & Rhön, 2015:3). More specifically measures of the global credit to GDP ratio, a global equity price gap and a global house price gap perform exceptionally well both in sample as well as out of sample. This emphasises the importance of taking international developments into account when analysing a country's vulnerabilities. Due to the increasing integration of the world's financial markets, exposures that escalate to a global level have the potential to transmit to countries around the world. However, the successful performance of the global indicators is subject to a degree of caution as the indicators do not differ across countries - they are particularly suited to identify recessions that affect a large number of countries instantaneously, such as the global financial crisis of 2008. The success of these indicators can therefore be partially attributed to the fact that the global financial crisis encompasses a large share of all severe recessions in the sample and reinforces the choice of the global financial crisis as a test of the out of sample

performance. The majority of the vulnerability indicators proposed by Hermansen and Rhön, (2015) appear to be useful early warning indicators in the event of severe recessions when policymakers are focused on avoiding severe recessions at all cost. The study shows that the majority indicators issue the first warning signals on average more than 6 quarters in advance of the onset of a severe recession, providing policymakers with a sufficient lead to react to such abnormalities. The extent of signalling power does, however, vary across indicators and the results are sensitive to the exact specification of policymakers' preferences between missing crises and false alarms.

Another study worth mentioning is that of Cesaroni (2013). This study used the economic crisis classification with the hope to find a set of early warning indicators for each of the four crises types that would allow for the potential prediction of the occurrence of a crisis event.

General structure of an early warning model as proposed by Cesaroni (2013:9)

$t(\text{index of crisis}) = f(\text{early warning indicators})_{t-i}$

where the crisis index = $f(\text{monetary policy stance, fiscal stance, interest rates, housing prices etc.})$

The study also provides an evaluation criterion for early warning indicators:

- The timing of the crisis with respect to the crisis index (these indicators are expected to have leading properties).
- Frequency of which the specific early warning indicator makes an appearance.
- Timeliness of indicators.
- Reliability of indicators.

Cesaroni (2013:13) proceeded by creating main groups of indicators that consist of:

- Banking system condition/situation
- Capital market condition/situation
- Fiscal stance
- External balance
- Debt and savings
- Interest rates

- Money and credit supply
- Housing prices
- Real economy
- Global variables

As previously mentioned, the modern global economy is highly integrated and a disturbance in one factor or variable will most likely lead to a disturbance in several other areas as well. Due to this high degree of integration this study puts its main focus on measures for co-movements.

A variable is said to be pro-cyclical or countercyclical depending on the correlation displayed by the variable to economic activity, where a variable is pro-cyclical in the event where positive significant correlation is displayed with economic activity and vice versa.

Cesaroni (2013:48) concluded by stating that indicators are in fact useful for predicting crises, yet indicators do not provide the underlying reasons for financial crises. Crises tend to happen with the convergence of multiple global as well as domestic factors, which usually overwhelms the economy.

The following vulnerability indicators were identified as viable early warning indicators:

- Debt maturity profiles, interest rate sensitivity repayment schedules as well as currency composition are indicators of global and domestic debt.
- External debt to exports and to GDP ratios are suitable indicators of tendencies in debt and repayment capacity.
- Financial soundness indicators are important to assess the capital adequacy of financial institutions within a country as well as the quality of assets, off-balance sheet positions, profitability and liquidity as well as the quality and tempo of credit growth.
- Reserves adequacy indicators are viable early warning indicators, in particular the ratio of reserves to short term debt is central to assessing the susceptibility of counties with significant but uncertain access to capital markets.
- Corporate sector indicators are also useful with respect to foreign exchange and interest rate exposure of domestic companies. These indicators allow for the evaluation of the potential impact of exchange rate as well as interest rate movements on the corporate sector's balance sheets.

Drehmann and Juselius (2013:1) published a notable study on early warning indicators that specifically focuses on banking crises with respect to policy costs and implications. Early warning indicators are a central concept to the employment of time-varying macro-prudential policies such as countercyclical capital buffers, that can be helpful by reducing the high losses linked to banking crises. Deriving optimal empirical models for forecasting purposes requires a comprehensive knowledge regarding the underlying decision problem or challenge. Yet such detailed knowledge is at present not available in the context of macro-prudential policies as there exists limited experience from which the expected costs and benefits could be derived. However, one can still include the qualitative aspects of the policy-maker's decision problem into the estimation as well as evaluation measures for early warning indicators. The principal approach for this study was to lay down such a method and to apply it to a wide range of early warning indicators.

The most notable conclusions drawn from this study by Drehmann and Juselius (2013) include: The valuations of early warning indicators specifically focused on banking crises, should be based on the underlying decision problem of the policy maker as several features of this problem have consequences for the choice of statistical evaluation procedures. For example, vagueness around the costs and benefits of policy changes suggest that assessments need to be robust over a wide range of the policymaker's preferences. Early warning indicator's signals should be timely and the quality of these signals should not weaken in the build-up to a crisis. These criteria were built into the statistical evaluation procedure for early warning indicators used in the study.

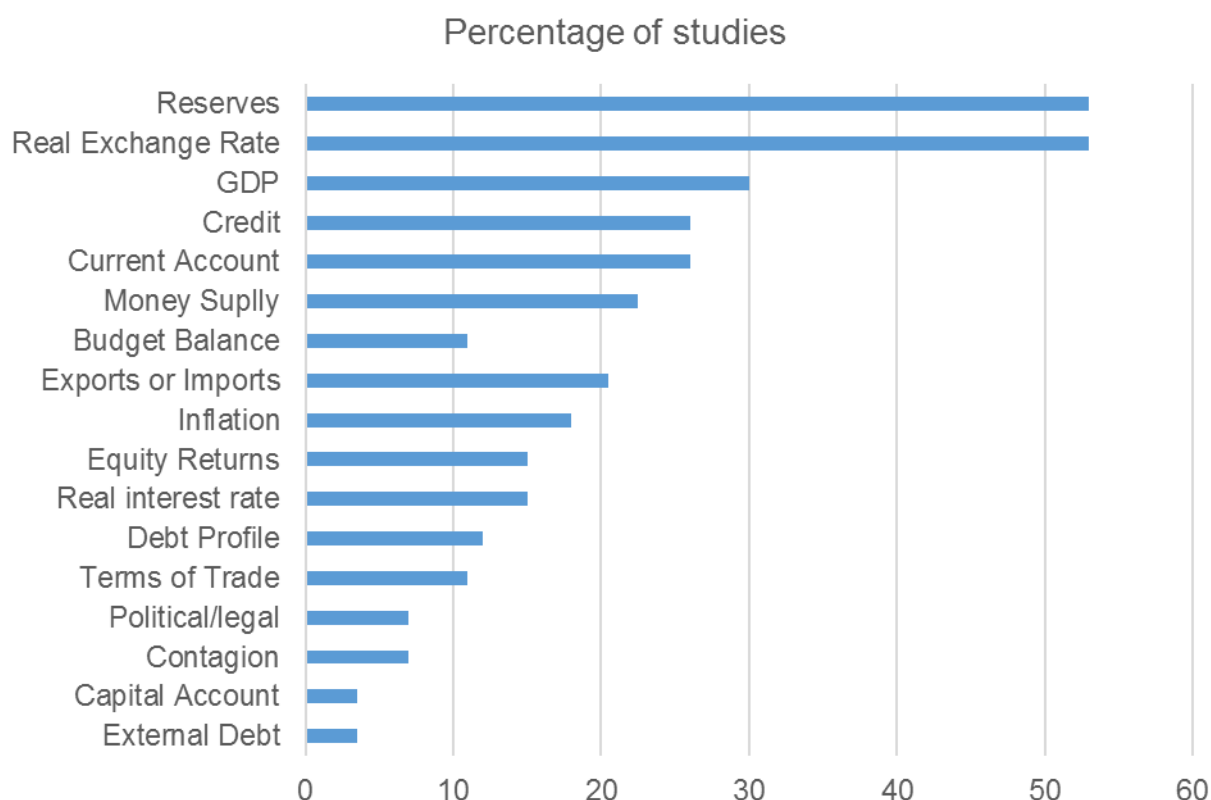
The above-mentioned approach was applied to several early warning indicators and outcomes and suggested that the credit-to-GDP gap, debt service ratios (DSR) and non-core liability ratios all comply with the standard set by the statistical evaluation procedure. However, the credit-to-GDP gap and debt service ratio consistently outperform the non-core liability ratio and the credit-to-GDP gap dominates the longer time horizons and the debt service ratio the shorter time horizons. The results obtained are robust in regard to changes in sample size and crisis specification.

A unique feature of this assessment is that greater attention is paid to the progressive dimension of early warning indicator signals. Results obtained from the study suggest that the signalling power of the various early warning signals can fluctuate sharply over a period of time. Therefore, greater consideration should be put into continuously well performing early warning indicators within the policy-relevant forecasting period.

Additional significant early warning literature reinforcing the statement that early warning indicators can indeed predict possible future crises was produced by Frankel and Saravelos

(2012). This paper examines literature concerning early warning indicators prior to the 2008 global financial crisis from more than 80 contributions. The variables were grouped into 17 categories of early warning indicators.

Figure 2.4: Percentage of studies where leading indicators were found to be statistically significant



Source: Frankel and Saravelos (2012)

Figure 2.4 indicates the percentage of studies where leading indicators were found to be statistically significant, covering a span of 83 studies in total over the period from the 1950s – 2009. The figure clearly indicates that there are two factors that stand out as being the most useful indicators - the most useful indicators being the level of international reserves and changes in the real exchange rate in the period preceding the crisis.

Due to the large sample period of the study and the results obtained, one can conclude that the results are consistent. The results hold across different types of crises, despite authors having varying definitions for “crisis” and “useful”.

This particular study made use of the 2008 global financial crisis to assess the prospect of early warning indicators as the crisis of 2008 was a near-perfect trial to examine the performance of vulnerability indicators. This is due to the crisis that originated as a liquidity

crisis in the US financial markets and then proceeded as an exogenous shock to most countries around the world. The crisis hit the world at more or less the same time, so there is no need to hover for concern over the issue of timing. Therefore, the main focus is to determine which variables indicate susceptibility to such a shock.

Frankel and Saravelos (2012:2) concluded that early warning indicators from crisis literature prior to the 2008 financial crisis did relatively well in predicting which countries would get hit by the crisis in 2008-2009. Foreign exchange reserve holdings, which was the top performing early warning indicator for past crises (as can be seen in figure 2.4) was also the top performer for the global financial crisis of 2008, particularly when it was expressed as a ratio e.g. with respect to debt. Despite some of the other variables not having such a high success rates, early warning indicators can be a useful tool for predicting future crises.

A more and recent contribution to this literature is the Vulnerability indicator set proposed by Rhön *et al.* (2015:28) from the Organisation for Economic Co-operation and Development (OECD).

This particular study deliberates on the foundation and nature of possible exposures that can cause financial crises in OECD countries, grounded on evidence collected from early warning literature regarding banking, sovereign debt and currency crises, as well as data gathered from the global financial crises of 2008. With the focus on learning from the past, Rhön *et al.*, (2015:5) proposed a new dataset consisting of more than 70 vulnerability indicators that can be observed with the goal to detect vulnerabilities at an early stage and evaluate country risks that can potentially cause a crisis. The dataset includes a broad set of countries consisting of the 34 OECD economies, the BRICS (Brazil, Russian Federation, India, China and South Africa) countries, Colombia, Latvia and Indonesia. To simplify the dataset, the vulnerability indicators were divided into 6 groups: 1) financial sector imbalances, 2) non-financial sector imbalances 3) asset market imbalances, 4) public sector imbalances, 5) external sector imbalances and 6) international spill overs, contagion and global risks.

In the chapters that follow, this study will specifically focus on the above-mentioned vulnerability indicators as set out by Rohn *et al.* (2015). Chapter 3 discusses the indicators in detail.

2.5 Other perspectives

Financial crises as a study field consist of broad opinions and different perspectives. There are various other perspectives not even touched on in this chapter due to the sheer volume

and extent of these studies, it is not possible to take all other opinions and perspectives into account. A good example of these studies includes a 2013 article of Shin.

Shin (2013:3) set out to find a group of early warning indicators that would be able to identify the vulnerabilities to financial turmoil that emerged from the outcome of the global financial crisis of 2008. To achieve this goal Shin (2013:3) looked at historical literature and found that there is extensive literature on early warning indicators for a crisis that is well defined by Chamon and Crowe (2012:500). The existing literature at the time could be described as being “eclectic” as well as “pragmatic”. Eclectic in the sense that the analysis enjoyed attention from a range of inputs that includes external, financial, real, institutional as well as political factors along with several measures of contagion. A problem with previous studies is such as one conducted by Kaminsky *et al.* (1998:22) where a catalogue of 105 variables was recorded in their overview of early warning literature at the time (1998). This was however, pragmatic in the sense that researchers put their focus their attention on improving measures of goodness of fit, rather than putting their focus on the underlying theoretical themes that could provide possible links between different crisis episodes (Shin, 2013:4).

For example, it has been the conventional method to differentiate between emerging economy crises and advanced economy crises by means of using different sets of variables for each category. Emerging economy studies tend to focus mainly on capital flow reversals linked to sudden stops, for which specific variables such as external borrowing denominated in foreign currency is most important, while for advanced economy studies, variables such as housing booms and household leverage take centre stage. The International Monetary Fund (IMF) also distinguishes between advanced and emerging economies. The IMF created separate vulnerability indicator sets for advanced and emerging economies. The Vulnerability Exercise for Advanced Economies (VEA) and Vulnerability Exercise for Emerging Economies (VEE), these two exercises can be combined to form a joint early warning exercise with the Financial Stability Board (FSB) (Shin, 2013:4).

While the compartmentalisation of emerging and advanced economies aids in improving measures regarding the goodness of fit, common linkages tends to be obscured (Milesi-Ferretti & Razin (1998). These linkages tie together emerging and advanced economy crises. For instance, the capital flow reversals in Spain and Ireland at the time of the European crisis indicated, similar to that of a sudden stop, except that the outflow of private sector funds was compensated for by the inflow of official funds. Although, since the Eurozone crisis took place within a monetary union (common currency area), the traditional classification of emerging market “currency crisis” where currency movements play an important role, do not necessarily fit in the empirical exercise. Given the common linkages that bind together apparent differing

crises, it can be beneficial to take a step back from the practical imperatives of maximising goodness of fit in exchange for considering the theoretical underpinnings of early warning models (Shin, 2013:4). The study suggests that the pro-cyclicality of the financial system offers an organising framework for the selection of indicators of vulnerability to crises, especially those that are associated with banks and financial intermediaries more often.

More specifically, the study focuses on assessing three extensive sets of vulnerability indicators as a means of early warning systems, and continues by determining their respective likelihood of success. These three indicators along with their results are:

- 1) Indicators based on market prices, such as Credit Default Swap (CDS) spreads, implied volatility and other price-based measures of default.

A notable fact implied by the study is how calm the CDS measure was before the global financial crisis of 2008. There was barely any movement in the data series for the period 2004 – 2006 when vulnerability indicators were supposed to start signalling. Other price-based measures such as Value-at-Risk (VaR), implied volatility and structural models of default based on equity price all gave similar results.

The disappointment of price-based measures as early warning indicators can be attributed to their implicit principle that the collaboration between market signals and the decisions led by these signals are always related in the sense that they stabilize the virtuous circle, rather than occasionally going awry and acting in concert in an amplifying malicious circle where market signals and decisions guided by these signals reinforce an existing tendency in the direction of pro-cyclicality.

- 2) Gap measures of the credit to GDP ratio.

Granting that credit booms are clear in hindsight, there are quite a lot of challenges to using the deviation of the credit to GDP ratio from trend as an early warning indicator in real time. One challenge is estimating the trend that serves as a measure for excessive growth. Ex-post revisions to the credit-to-GDP ratio gap in real time are considerable for the US and as large as the gap itself. However, the source of ex-post revisions is not the revision of the underlying data, but rather from the revision of the estimated trend that is measured in real time Shin (2013).

Another challenge is the fact that credit growth and GDP are affected and influenced by different factors throughout the cycle and this causes the ratios to occasionally issue misleading signals Shin (2013). For instance, bank lending may be influenced by pre-existing

contractual commitments, such as lines of credit, which contracts during periods of crisis. Lending may initially proceed for some time after the onset of the crisis.

Despite these challenges, the credit-to-GDP ratio, under the Basel III framework takes a principal role as the basis for the countercyclical capital buffer. This ratio has been found useful as an indicator of the current stage of the financial cycle.

3) Banking sector liability aggregates, including monetary aggregates.

When credit is being extended faster than the available resources that are normally drawn on by the bank (core liabilities), the bank will turn to other sources of funding to support the credit expansion. The ratio of non-core to core liabilities therefore serves as a signal of the degree of risk-taking that is undertaken by the bank and additionally the stage of the financial cycle.

Shin (2013:11) concluded that prices perform well as concurrent indicators of market conditions, although they are not viable early warning indicators due to the fact that they have no prediction value. Whereas total credit and liabilities suggest similar results, despite performing better as early warning indicators, liabilities are more transparent and the disintegration between core and non-core liabilities conveys significant information.

2.6 Summary of conclusions

One possible explanation for varying conclusions regarding early warning systems can be ascribed to differences in the selected data periods, for example, most of the papers that concluded negative results for early warning indicators predicting the global financial crisis of 2008, defined the crisis period as the year 2008. These studies lacked data on 2009 at the time they were conducted. Frankel and Saravelos (2012:4) made use of an extended period for consideration for an early crisis study, ranging through early 2009 as many facets of global financial markets and the real economy had at the time not yet started to recover until the second quarter of 2009. The results obtained therefore differ from some other studies possibly due to varying periods under consideration. This statement was reinforced by Frankel and Saravelos (2012:4) when their tests were rerun with the crisis period being 2008 such as that of Rose and Spiegel (2009:1). The new results suggested similar outcomes to that of Rose and Spiegel (2009:22); many indicators, such as reserves lose their significance.

Chamon and Crowe (2012:3) concluded that: 1) it is fairly clear which indicators tend to be associated with crises, and 2) to predict the timing of crises is challenging. For example, not many people would argue that an overvalued exchange rate peg is an important source of vulnerability (however, determining the extent of the overvaluation can be problematic), also than a large current account deficit that is financed through debt inflows is risky. The fact that

countries can be exposed to high levels of risk for extended periods without experiencing a crisis makes the prediction of the timing of a crisis particularly difficult. The delay before the onset of a crisis can possibly be ascribed to the time it takes for vulnerabilities to accumulate to a “breaking point” when they become unsustainable (for example, to run a series of current account deficits to such an extreme point that foreigners become unwilling to finance the deficits). However, some aspects of timing may be driven by exogenous triggers, such as foreign financed lending booms and foreign currency loans to households.

Therefore, predicting the timing of crises is most likely to remain an unsatisfactory exercise. Alternatively, it seems to be more viable to use these types of early warning indicators to aid in the identification of underlying vulnerabilities. It is important to distinguish between underlying vulnerabilities and crisis risks due to underlying vulnerabilities being present but not necessary for a crisis to occur. For example, underlying balance sheet vulnerabilities such as extreme borrowing and currency or maturity mismatches can be present for extensive periods without the occurrence of a crisis. Although, if this underlying vulnerability is combined with an appropriate crisis trigger, such as interest rate hikes by major economies or an asset reversal in financial markets, they can possibly lead to a crisis.

The focus of this study is to find parsimonious indicators of crisis through a data-reduction exercise. The next chapter presents the indicators and dataset proposed by Rhön *et al.* (2015) that will be used in the empirical analysis.

CHAPTER 3: EARLY WARNING INDICATORS

3.1 Introduction

Financial crises have several characteristics and cannot be attributed to a single event, but rather to the collective state of an economy or the global economy. Within the global economy there are wide-ranging factors at play, some of which can be useful as early warning indicators.

To enhance the effectiveness of such indicators, they should be considered as a comprehensive collection of variables that result in certain outcomes rather than be regarded in isolation (Rohn *et al.*, 2015:5). As the economic environment changes, many of these variables interact and, in some instances, even reinforce one another. Alternatively, the collapse of one variable can prompt other variables to follow. Hence, if policymakers address the shortcomings of one variable, they will most likely reduce the shortcomings of several variables across a range of sectors within the economy. Similarly, if a single variable unwinds, it can trigger the downfall of other variables as well.

Rohn *et al.* (2015) present the following diagram grouping different indicators of vulnerabilities⁴.

⁴ Note that this thesis draws heavily from Rohn, et al, (2015) as this study is an extension of the aforementioned study making use of the same dataset applied to the global financial crisis of 2008 as well as the proposed imbalance categories (Dataset available at https://www.google.com/url?q=http://www.oecd.org/eco/growth/Vulnerability_Indicators-15-02-21017.xlsx&sa=U&ved=0ahUKEwjuu6aBzoHgAhUPuRoKHa3dBilQFggKMAI&client=internal-uds-cse&cx=012432601748511391518:xzeadub0b0a&usg=AOvVaw0Z6Q0h68b-0bsRcYHt3wKM).

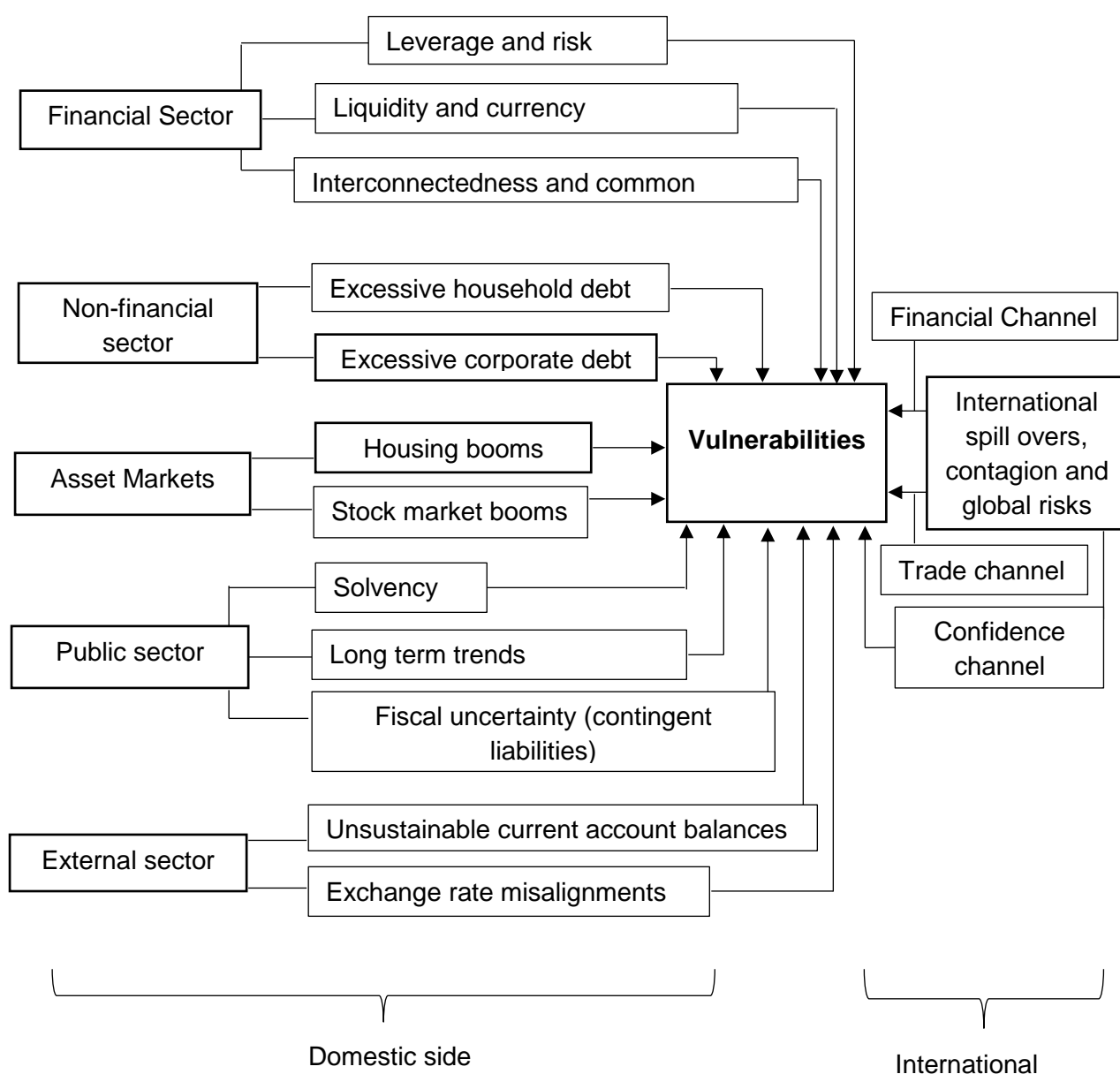


Figure 3.1 Description of vulnerabilities

Source: Rhön *et al.* (2015:6)

As can be seen from the diagram above, there are a significant number of areas that vulnerabilities could arise from. This once again reinforces the statement that early warning indicators should not be viewed in isolation. Hence the set of vulnerability indicators was created and empirical evidence from Hermansen and Rhön (2015:15) indicates that the majority of these indicators would in fact have been able to predict severe recessions in the 34 OECD countries the study was based on (as well as Latvia) over the period 1970 to 2014. Empirical evidence also indicated that most of the early warning indicators issue the first signs of warning on average 1.5 years before the start of severe recessions. This is an adequate period of time for policy makers to react. One drawback of this model is that the power of the

signals differs from indicator to indicator and the results are sensitive to the precise specification of policy maker's preferences amongst false alarms and missing crises.

Indicators that tend to interact in a similar way were grouped together to simplify the sheer number of possible explanatory early warning indicators. The discussion in this chapter makes use of the categories proposed by Rohn *et al.* (2015:1). In chapter 4, all the indicators will be used in a dynamic factor model in an attempt to identify parsimonious indicators of crises.

3.2 Financial sector imbalances

The failure of regulation in the financial sector along with the short-sightedness/greed of the private sector could be attributed as some of the root causes of the global financial crisis of 2008 (Bank for International Settlements, 2012:1). The emphasis had shifted from securing a sustainable financial sector which favours the people, to a self-centred short-term yield driven system which does not serve the broader goals of sustainable macroeconomic policy.

In theory, the connection between financial markets and output volatility is vague (Rohn *et al.*, 2015:7). Well-established financial markets can fortify role-players in an economy against idiosyncratic shocks through reductions in borrowing constraints allowing economic stimulation by means of consumption and investment. Countries with advanced financial markets could additionally reinforce monetary policy transmission to boost the effectiveness of monetary policy in absorbing these idiosyncratic shocks. However, simultaneously, financial markets could possibly intensify the output volatility caused by financial accelerator mechanisms. Asymmetric information between borrowers and lenders indicates that lenders pay attention to the financial capacity of borrowers, with the emphasis on the net worth of the borrower. In the boom phase of an economy, the net worth of both consumers and investors normally increases, which in turn lowers the agency costs, as the borrower's collateral has increased in value. This leads to an upsurge in the supply of credit, resulting in stimulation for investment and consumption levels acting as the driving force of the boom cycle. As a result of the higher levels of economic stimulation, asset prices will most likely keep on rising which will see the borrowers' financial position improving even more, further reducing borrowing constraints. During economic crises, this process is reversed as the effects of a negative shock turn into a "snowball", the effects amplifying one another.

To summarize, the majority of empirical literature indicates that more established financial markets tend to have reduced levels of consumption, output as well as investment rates during times of low economic activity (i.e. times of crisis) (Duval, Elmeskov & Vogel, 2007:41). However, these findings rest upon the conditions that economic crises do not arise in the financial sector and that financial dealings continue in a functional way. The financial sector

is. however, more often than not the focal point of economic crises. The global economic crisis of 2008 once again reinforced this statement.

A major challenge policymakers face in times of financial crises is the fact that monetary policies are less effective during periods of impairment in the financial sector as households and firms have to absorb shocks and do not necessarily have the capacity to do so effectively. Financial accelerator mechanisms worsen this case as it creates a snowball effect through the amplification and transmission of economic shocks throughout an economy. A shock to a fairly small sub-market of the financial sector such as defaults in the sub-prime mortgage market can result in a financial crisis through amplification (snowball effect). An amplifying effect such as this is related to the build-up of several vulnerabilities within the financial sector. Rohn *et al.* (2015:7) describe the most important vulnerabilities to be excessively large maturity mismatches, interconnectedness and common exposure.

3.2.1 Leverage and risk taking

Excessive leverage and risk taking are frequent features to be observed in the financial sector as role players within the financial sector are driven to maximise profits. This strong drive to accumulate as much profit as possible often causes role players in the financial sector to neglect building up sufficient buffer capital (acting as a risk cushion) during boom cycles in the economy. High levels of leverage within a financial sector amplify the effects of a shock, therefore indicators of leverage are useful as early warning indicators of banking crises (Barrell, Davis, Karim & Liazde, 2010:10). Leverage indicators can be used in conjunction with capital ratios as they account for the risk profile of assets. However, capital ratios were found to be less effective in limiting banks credit risk (Blundell-Wignall, Atkinson & Roulet, 2014:19). To use these indicators in isolation however, would most likely give an inaccurate view of leverage and risk taking within the financial sector as data on capital ratios and leverage are not widely available.

Rohn *et al.* (2015:8) made the observation that leverage increased significantly within the shadow banking system during the build-up to the global financial crisis. Therefore, indicators determining the magnitude of the shadow banking system would be useful. Periods of high banking profitability are generally characterised by higher levels of risk taking, increasing the probability of a banking crisis due to the nature of risks and higher levels of exposure (Behn, Detken, Peltonen & Schudel, 2013). Excessive risk-taking by institutions considered to be “too-big-to-fail” proved to be a significant vulnerability in the run-up to the global financial crisis.

3.2.2 Maturity and currency mismatches

Maturity mismatches on the balance sheets of financial intermediaries translate into liquidity risks as investments in long-term assets such as loans that are funded by short term liabilities which is the main function of most financial institutions. Maturity mismatches can become excessive if not properly managed. Deposits continue to be a dependable source of funding for financial institutions, even during times of financial crisis. The significant increase in credit growth during the build-up to the financial crisis proved to be problematic as the credit growth was mainly funded through short term borrowing in wholesale markets. Loans to borrowers are backed by collateral and if the value of collateral diminishes, lenders demand additional collateral. This creates liquidity risks in the financial sector. In the instance where the borrower is not in possession of sufficient liquid assets to cover the additional funding cost, the borrower may be forced to sell illiquid assets to compensate for the shortfall in funding. If several financial institutions are simultaneously hit by a shock, a wholesale market run may occur, resulting in liquidity challenges and ultimately solvency problems for the financial sector.

Barrel *et al.*, (2010:24) suggests that liquidity ratios could help predict banking crises. More specifically strong growth in the loan-to-deposit ratio can indicate that financial intermediaries are increasingly making use of more risky sources of funding such as wholesale markets, rather than stable sources of credit. Strong dependence on deposits from international sources may also indicate that liquidity shortages are at hand, whereas exchange rate risk could possibly amplify the shortages seeing that the shortages are funded from abroad.

3.2.3 Interconnectedness and spill-overs

The high degree of interconnectedness of banks raises concerns regarding financial contagion and spill-overs. Financial interconnectedness between economies insinuates direct as well as indirect relationship between financial institutions. Links between financial institutions range from contractual obligations (such as loans and derivatives) amongst them, this includes the interbank market where banks are linked to one another through borrowing and lending actions (Rohn *et al.*, 2015:10).

Financial interconnectedness is a concern regarding moral hazards and excessive risk taking for institutions or firms that are considered to be “too interconnected to fail”. Despite interconnectedness through financial obligations, contagion could also arise from other common linkages such as firms investing in similar asset classes.

Weaknesses within the financial sector can spread to other sectors. High levels of credit growth lead to increased levels of debt in the non-financial sector, possibly resulting in

increased non-financial sector vulnerabilities as the financial sector becomes impaired leading to credit crunches forcing constraints on investment as well as consumption.

Table 3.1.1 Indicators of financial sector imbalances

Table Indicators of financial sector imbalances			
Indicator	Description	Data Source	Available?
<i>Leverage and risk taking</i>			
Leverage ratio	Regulatory Tier 1 capital to total (unweighted) assets	IMF	Yes
Capital ratio	Regulatory Tier 1 capital to risk-weighted assets.	IMF	Yes
Shadow Banking	Other financial sector assets to GDP or to total financial sector assets.	IMF	Yes
Return on Assets	Net income before extraordinary items and taxes to total assets.	IMF	Yes
Return on Equity	Net income before extraordinary items and taxes to total capital and reserves.	IMF	Yes
Lending standards	Change in credit standards (tightened or eased) for enterprises the last three months.	ECB	Yes
Too big to fail			No
<i>Liquidity and currency mismatches</i>			
Liquidity ratio	Liquid assets to total assets or to short term liabilities.	IMF	Yes
Loan-to-deposit-ratio	Total (non-interbank) gross loans to customer deposits.	IMF	Yes
Deposits from abroad	Total liabilities to non-residents, currency and deposits, in per cent of total liabilities.	IMF	Yes
Foreign currency mismatch	Net open position in foreign exchange to capital.	IMF	Yes
<i>Interconnectedness and spill-overs</i>			
Interconnectedness			No
Housing loans	Residential real estate loans to total loans.	IMF	Yes
Commercial real estate loans	Commercial real estate loans to total loans.	IMF	Yes
Domestic sovereign bonds	Domestic government securities owned in per cent of total assets.	IMF	Yes

Source: Rohn *et al.* (2015)

3.3 Non-financial sector imbalances

Vulnerabilities in this sector originate from balance sheet imbalances within non-financial sectors resulting in financial instability. The main focus of the early warning literature is on non-financial sector imbalances as this sector includes credit. Extensive literature attempts to document the economic costs related to rapid increases in private sector credit. Through this literature one can identify that strong credit growth is of the most common and successful early warning indicators of financial crises (Kaminsky *et al.*, 1998:24 as well as Reinhart and Rogoff,

2010:17). Credit intensive economic expansion is costlier in this sense as it tends to result in deeper recessions and slower recoveries (Sutherland & Hoeller, 2012:29).

During the build-up of the global financial crisis of 2008 both private and household debt levels increased considerably. This sharp increase in these levels can be attributed to financial deregulation as well as financial innovation (Sutherland & Hoeller, 2012:23), more specifically the emergence of mortgage market securitisation enabled huge sums of money to be transferred to the mortgage market which included extended credit of lower income groups (considered to be risky loans as the means of lower income groups to repay loans are generally lower than those of medium or high-income groups).

High levels of private debt are often considered to be a useful vulnerability indicator as private debt can influence macroeconomic stability (Rohn *et al.*, 2015:12). High levels of private debt can also intensify and, in some instances, even prolong economic downturns. On the other hand, private debt can also reinforce macroeconomic stability as it facilitates consumption and investment as the credit allows households and firms to utilise resources that would in the absence of private debt not been possible. At excessive levels of private debt, this smoothing ability can be hindered as consumers and firms have to service their debt despite the state of the economy.

Non-financial sector vulnerabilities can in some instances also spread to the public and external sectors. During times of economic crisis, governments are often forced to rescue or “bail out” entities or stimulate areas worst affected by the crisis. This in turn affects governments’ budgets through the deleveraging of other sectors, automatic responsive budget reactions and counter-cyclical fiscal policy. Credit booms can also lead to the reorganisation of resources from a tradable to non-tradable status, such as residential investment during a housing boom. This outflow of resources may result in the weakening of the trade and current account balance. Jorda, Schularick & Taylor, (2012:13) noted that the correlation between significant increases in lending and current account imbalances have become more noteworthy in recent decades.

Table 3.1.2 Indicators of non-financial imbalances

Indicator	Description	Data Source	Available?
Total private credit	Lending from all sectors (this includes foreign sources) to private non-financial in per cent of GDP.	BIS	Yes
Private bank credit	Lending from the domestic bank sector to private non-financial sector in per cent of GDP.	BIS	Yes
External debt	Other sectors (such as households, non-financial corporations, non-deposit taking financial corporations) external debt as percentage of GDP.	World Bank	Yes
<i>Households</i>			
Household credit	Lending from all sectors (including foreign) to households in per cent of GDP.	BIS	Yes
Debt service costs	Household debt service cost and principal to gross disposable income	IMF	Yes
Foreign currency denominated liabilities	Outstanding amount at the end of the period; in per cent of GDP.	ECB	Yes
Short-term loans (<1 year)	Short term loans in per cent of total household liabilities.	OECD	Yes
<i>Non-financial corporations</i>			
Corporate credit	Lending from all sectors (including foreign) to non-financial corporations in per cent of GDP.	BIS	Yes
Foreign currency denominated liabilities	Outstanding amount at the end of the period; in per cent of GDP.	ECB	Yes

Source: Rohn *et al.* (2015)

3.4 Asset market imbalances

Asset market (more specifically equity and real estate) busts are regularly associated with economic downturns. Literature indicates that real estate market busts have had significant associated costs (Rohn *et al.*, 2015:13). In retrospect, forty per cent of real estate market slumps can be tied to systemic banking crises in advanced economies. The length and magnitude of the run-up to the housing booms before a correction takes place is noteworthy. This could also help in explaining why slumps associated with real estate market downturns tends to be worse and longer lasting than other slumps (Claessens, Kose & Terrones, 2011:17).

Once again financial accelerator mechanisms are central to financial crises as it can affect the economy through asset market imbalances. For example, increases in the market value of assets can lead to changes in the aggregate demand of these assets and encourage role players to acquire these higher value assets leading to additional spending.

The financial accelerator mechanism stimulates spending and ultimately economic activity as higher asset prices grant households and firms access to more credit (through higher collateral value). Eventually the asset price declines and the related constriction of accessible credit can

force households and firms to considerably deleverage, which includes defaults. The panic experienced by household and firms can rapidly spill over to the financial sector leading to stricter lending standards which can cause further private sector deleveraging.

Despite linkages with private sector balance sheets, real estate price booms can influence the real economy if they are connected to boom periods in residential investment. For instance, the construction boom in several European countries preceding the global financial crisis. While the long-term average for residential investment is usually between four and six per cent of GDP in OECD countries (André, 2010:22), it rose to more than 10% of GDP in Ireland and Spain during the peak of the boom period. Due to the labour-intensive nature of the real estate sector, the effect of housing booms on employment can be devastating. Real estate market busts can thus result in major reallocation of labour between sectors requiring significant adjustment costs.

Spill-overs to the public sector could also be at hand in this sense as asset price booms can generate considerable “bonus” revenues for governments which renders fiscal policy procyclical if these bonus revenues are not recognized to be temporary and instead used to fund extra spending or tax cuts (Rohn *et al.*, 2015:16). The additional spending can boost the economy temporarily, however, once the asset bubble busts, extra revenues will disappear effectively reducing fiscal space.

Asset imbalances can indicate fundamentals promoting increased demand, such as demographics, higher disposable income, mortgage market deregulation, lower interest rates and tax rates for house prices. Therefore, noticing asset imbalances with a rational degree of certainty in real time is difficult. Drastic changes in asset prices are also not necessarily related to asset bubbles. Fundamentals are thus very challenging to observe and interpret correctly in real time, however literature does identify that unsustainable asset price developments could be useful in predicting economic crises. More specifically, rapid real house and equity price growth as well as large deviations from historic trends tend to be useful in this sense (Borio & Zhu, 2008:9).

Large deviations of the price-to-income ratio and the price-to-rent ratio from their historical averages are usually reversed at some point in time (Girouard, Kennedy, Van den Noord & Andre, 2006:46). In the instance where real estate prices are rising at a more rapid rate than average disposable income, fewer households can afford to buy houses resulting in failing demand as well as prices. In a reversed situation where prices rise faster than rent, a correction would take place creating a substitution effect towards renting, resulting in lower house prices. History has indicated that house price misalignments can often be large and

prolonged, leading to unexpected corrections. Similarly, for equity markets, large deviations of price-to-earnings ratios from a long run trend could signal misalignments.

Table 3.1.3 Indicators of asset market imbalances

Indicator	Description	Data Source	Available?
<i>Housing markets</i>			
Real house prices	Deflated by CPI.	OECD	Yes
Price-to-disposable income ratio	Nominal house price to nominal net household disposable income per capita.	OECD	Yes
Price-to-rent ratio	Nominal house prices to rent prices	OECD	Yes
Residential investment as % of GDP	Gross fixed capital formation, housing, in per cent of GDP.	OECD	Yes
Share of employment in construction	As a percentage of total employment.	OECD	Yes
<i>Equity markets</i>			
Real stock prices	Share price index deflated by CPI	OECD	Yes
Price-to-earnings ratio (cyclically-adjusted)			No

Source: Rohn *et al.* (2015)

3.5 Public sector imbalances

Uncertainties regarding the continuous availability of public finances can result in significant costs for the economy as when sovereign solvency is perceived to be at risk, investors will demand a higher risk premium on their capital and ultimately government debt (Corsetti, Meier & Muller, 2012:16). This has an effect on private demand through interest rate and balance sheet channels. To elucidate, the degree to which private demand is affected depends on the monetary policy response. In the instance where policy rates are close to the zero lower bound monetary policy cannot be used as a counterweight to the increase in interest rates. The efficacy of monetary policy may also be limited by a fixed exchange rate regime. The situation is likewise in a monetary union where monetary policies may not respond to rising interest risk premiums in one country because the policy is implemented to suit the union as a whole and not country specific. The Eurozone crisis showed that when markets turn against a country believed to be at risk of insolvency, high risk premiums may influence the country to constrict the fiscal attitude to regain market confidence.

Basically, solvency risk is determined by the extent of debt, both current and future levels of the primary budget balance as well as the variance between interest rates linked to government debt and growth in GDP (Baldacci, Petrova, Belhocine, Dobrescu & Mazraani, 2011:33). Alterations to the level or future direction of these variables may lead to a reassessment of government solvency risk. The theoretically preferred debt concept to evaluate sustainability matters is government net debt (i.e. gross debt less government assets) as government assets can be sold to relieve debt levels during times of crisis. The liquidity of

assets, however, may differ and some assets may not be eligible to sell as they kept for specific purposes. Information regarding the liquidity of government assets are usually not available. Additionally, methods of valuation and accounting variances across countries as well as the lack of data regarding non-financial assets in many countries limits the effectiveness of comparisons on government assets. Gross debt is thus often used to determine sustainability and solvency risk.

In addition, early warning literature indicates that high levels of gross government debt to GDP ratio is a strong indicator of currency, banking as well as sovereign debt crises (Babecky, Havranek, Mateju, Rusnak, Smidkova & Vasicek, 2013:16) done on a sample of advanced economies. Whereas Baldacci *et al.* (2011:34) claim that the difference between the government interest rate and GDP growth is a robust predictor of fiscal stress events in advanced economies.

Sovereign solvency risk can be identified by monitoring demographic and economic trends as solvency does not only depend on the current fiscal position but also on some of the expected future economic positions (Rohn *et al.*, 2015:17), more specifically, future primary balances, projections of long-term fiscal challenges that could have adverse effects on the current solvency levels.

The composition of government debt could also have an impact on certain vulnerabilities. A greater need to access the market in the short-term translates into higher risks regarding adverse market reactions if solvency risk is high and the risk appetite does not allow for high levels of risk taking (Rohn *et al.*, 2015:17). High levels of short-term debt lead to a greater exposure to roll-over and interest rate risks in the near future, even more so when market conditions are unfavourable. The gross financing need (the sum of the total balance and the stock of maturing public debt), the share of short-term debt compared to total debt as well as the average maturity of outstanding government debt are all possible early warning indicators for these risks. Baldacci *et al.* (2011:17) have found the gross financing need to be a profound indicator of fiscal stress occurrences in advanced economies. Furthermore, countries with high levels of public debt denominated in foreign currency (mostly emerging markets) are exposed to exchange rate risk. Additionally, countries with high levels of public debt held by non-residents are more vulnerable to turnarounds in foreign investor confidence as the situation can be perceived as being more likely to address solvency challenges by “taxing foreigners” through default rather than through corrective measures.

It is also possible for vulnerabilities to appear due to the uncertainty associated with the outlook in public finances (Kopits, 2014:152). Contingent liabilities of the government are a source of vulnerabilities that arise from uncertain outlooks in public finances. Such liabilities

can be both implicit or explicit, where the latter have a contractual basis and includes government guarantees for depositors, exporters, farmers or investors in infrastructure (under public-private partnership contracts), state-owned enterprises or subnational governments. The opposite is true for implicit contingent liabilities, they are not based on a contractual basis but are rather driven by expectations created by past practises or pressure from interest groups. Implicit contingent liabilities normally include future liabilities of publicly funded pensions to all employees or guarantees for private pensions, bailout support for important industries that might experience distress, as well as costs related to natural disasters. Implicit contingent liabilities that arise from within the financial sector can have devastating effects on fiscal accounts (Rohn *et al.*, 2015:18).

Public sector imbalances are particularly sensitive vulnerabilities as they can easily spill over to other sectors of the economy (Rohn, *et al.*, 2015:19). Government finances and the balance sheet of the financial sector are intimately connected through (both implicit and explicit) public guarantees and bank's government bond holdings. Therefore, shocks to the public-sector solvency risk may rapidly spill over to the financial sector. Movement in the government budget balance will change total savings and ultimately the current account (Aizenman, Chinn & Ito, 2008:55). Literature put forth by Aizenman *et al.* (2008:55) suggests that a 1% of GDP change of the fiscal balance can change the current account balance by around 0.5% of GDP.

Table 3.1.4 Indicators of public sector imbalances

Indicator	Description	Data Source	Available?
<i>Basic fiscal solvency</i>			
General government debt	Gross government debt in per cent of GDP.	OECD	Yes
(r-g)	Real 10-year sovereign bond yield potential GDP growth rate differential.	OECD	Yes
<i>Government debt composition</i>			
Gross financing needs	Public budget deficit plus short term debt by original maturity plus long-term debt with payment due in one year or less, in per cent of GDP.	OECD, World Bank	Yes
Short-term debt	Short-term gross general government debt in per cent of gross general government debt.	World Bank	Yes
Weighted average maturity of general government debt			No
Debt denominated in foreign currency	In per cent of gross federal government debt.	World Bank	Yes
Debt held by non-residents	External gross general government debt in per cent of gross general government debt.	World Bank	Yes
Short-term external government debt	In per cent of gross general government debt.	World Bank	Yes
<i>Fiscal risks or uncertainties</i>			
Government contingent liabilities	Guarantees and liabilities recorded off-balance sheet of government; in per cent of GDP.	Eurostat	Yes

Source: Rohn *et al.* (2015)

3.6 External sector imbalances

External imbalances are one of the main potential causes responsible for the global financial crisis of 2008 (Chen, Curdia & Ferrero, 2012:59). The large-scale inflow of capital from emerging Asian economies into the US government bond market lowered long-term interest rates which caused investors to invest their resources into riskier assets in order to generate higher rates of return. More specific to the eurozone area, countries with surplus current accounts financed unsustainable consumption and housing booms in the short-term in high current account deficit countries. Economic crisis literature indicates that countries with the largest current account deficits during the build-up to the global financial crisis consequently experienced the largest reduction in GDP (Lane & Milesi-Ferretti, 2014:6). Empirical evidence from the global financial crisis of 2008 also suggests that greater current account deficits are interrelated to higher potential output losses, pointing towards misallocation of resources in the pre-crisis boom (Ollivaud & Turner, 2015:52). Surveys of early warning indicators regarding financial crises, propose that current account deficits are among the most profound vulnerability indicators (Frankel & Saravelos, 2012:227).

External imbalances (measured by the current account to GDP ratio), offer a summary of the net lending or borrowing position of a single economy for a specific point in time. This “summary” can then be used to compare the current position to that of the rest of the world. External imbalances can originate from both “good” or “bad” reasons (Blanchard & Milesi-Ferretti, 2009:23). This makes standardised valuations of external imbalances challenging. External balances can be caused by utility-maximising behaviour without distortions to disrupt this behaviour. To simplify, current account deficits are often observed in “catching-up” economies. These economies usually provide a satisfactory level of political and macro-economic stability as well as secure property rights, plentiful investment opportunities along with high returns for foreign investors, whereas current account surpluses can indicate an ageing society where accumulated savings for retirement are at hand. Nevertheless, external imbalances can also be the result of policy-induced domestic market distortions. To give an example, current account deficits can reflect underlying competitiveness challenges or may originate from asset price booms. Persisting current account surpluses can indicate a lack of domestic investment opportunities due to rigid product markets, export led growth strategies or extreme precautionary saving, owing to inadequate public social safety nets.

External deficits jeopardise the sustainability of economic growth if it reaches a substantial size, regardless of the underlying causes. The sustainability of current account deficits is determined by the ability of a country to attract foreign capital and the ability to repay loans (Rohn *et al.*, 2015:20). High current account deficits are thus sustainable, depending on the

availability of willing lenders. There is another limiting factor; the larger the stock of net foreign liabilities, the less sustainable a current account deficit is. This is true for trade deficits as well, taking into account that a surplus trade balance is required to bring the net foreign debt to a stable position. Countries with large current account deficits are more vulnerable to changes in foreign investment sentiment. Should foreign investors change their sentiment regarding repayment aspects, a foreign financing gap will emerge. This gap can be reduced/closed by reduced domestic demand and increased exports. Countries that make use of a flexible exchange rate system, are subject to exchange rate devaluations which can pose a serious threat to financial stability if the domestic debtors hold significant amounts of foreign currency denominated liabilities. Whereas a fixed exchange rate system often requires internal devaluations such as price and wage growth below that of the trading partners, in order to reach a sustainable current balance. This alteration may involve extended periods of high unemployment rates as can be observed from peripheral countries in the Eurozone.

The structure of inflows that fund the external gap has an impact on the sustainability of a country's current account deficit as well as its financial vulnerability. To be more specific, short-term loans and portfolio inflows are normally more susceptible to sudden reversals whereas, long-term loans and foreign direct investment (FDI) inflows are considered to be more stable. Furthermore, debt contracts entail regular repayments irrespective of the economic situation the borrower finds himself in, whereas the equity and FDI inflows and equity are mainly state-contingent liabilities. Furceri, Guichard & Rusticelli (2011:27) found that the effect of large capital inflows on crises probability differs depending on the type of inflows characterising the event. Particularly large debt-driven capital inflows considerably increase the odds of a banking, currency as well as balance of payments crises. While inflows driven by equity portfolio investment or FDI have an insignificant effect, literature by Ahrend and Goujard, (2012:34) suggests that the share of debt (particularly bank debt) in total external liabilities, short-term bank debt and currency mismatches between assets and liabilities is positively related to the occurrence of systemic banking crises. This conclusion is in line with that of Frankel and Saravelos (2012:19) who similarly found that external debt, particularly short-term debt, is related to higher crisis frequencies.

Official foreign reserves serve as a buffer to sudden stops and capital flow reversals as it can be drawn on during these events. According to Gourinchas and Obstfeld (2011:51) reserve accumulation served two main purposes in emerging economies observed during the aftermath of the global crisis; in the first place, it slowed down the appreciation of the domestic currency during the pre-crisis boom period and secondly, it served as a self-insurance mechanism throughout the crisis, preventing currency and banking panics. The so-called self-insurance mechanism eliminated concerns regarding debt roll-over complications which

limited incentives on investors side to attack domestic currencies. Foreign reserves also gave reserve banks the capacity to respond to the depreciation of currencies during the crisis. Official foreign reserves have often been found to reduce the occurrence of crises (Frankel and Saravelos, 2012:19), even though decreasing marginal effectiveness of reserves are at hand on the end of the day (Ahrend & Goujard, 2012:23).

Empirical literature suggests that persistent real exchange rate misalignments are one of the most profound vulnerability indicators to be used as an early warning indicator of financial crises (Frankel & Saravelos, 2012:24). Real effective exchange rates are mainly driven by the same fundamentals and policies as current account balances. Persisting real exchange rate appreciations do not necessarily need to signal distortions as emerging economies might experience price level convergence with advanced economies. In the absence of this convergence effect however, persistent real exchange rate appreciations can indicate both price and cost competitiveness losses. To capture non-price competitiveness such as product quality, real effective exchange rate measures can be enhanced with measures of export performance (Rohn *et al.*, 2015:21).

Table 3.1.5 Indicators of external imbalances

Indicator	Description	Data Source	Available?
Current account balance	In per cent of GDP.	OECD	Yes
External debt	In per cent of GDP or in per cent of external liabilities.	IMF	Yes
External bank debt	Debt liabilities towards BIS reporting banks in per cent of GDP.	BIS	Yes
External short-term bank debt	Short-term debt liabilities towards BIS reporting banks with residual maturity up to and including one year, in per cent of GDP or in per cent of total debt liabilities towards BIS reporting banks.	BIS	Yes
FDI liabilities	Direct investment liabilities, not seasonally adjusted, percentage of total external liabilities.	IMF	Yes
Official foreign exchange reserves	In per cent of GDP, in per cent of external debt, in per cent of M2, or in months of import.	IMF, World Bank	Yes
Real effective exchange rate	CPI or ULC based.	OECD	Yes
Export performance	Exports of goods and services relative to export market for goods and services.	OECD	Yes

Source: Rohn *et al.* (2015)

3.7 International spill-overs, contagion and global risks

3.7.1 The main channels

From the aftermath of the 2008 global financial crisis one could gather that countries with minimal domestic or external balances were not even shielded from external shocks. Integration, however, did play a crucial part regarding spill-over. The OECD economies are highly integrated, both in terms of trade and financial connections (Rohn *et al.*, 2015:22). Integration can create long-term benefits such as economic efficacy, opportunities to share

risk and puts countries in the favourable position to be less vulnerable against domestic shocks. On the other hand, integration causes countries to be more vulnerable to external shocks through spill-overs and contagion, particularly in times of global economic downturns. Changes in the certain parts of the world can spill-over to domestic economies through three main channels of contagion: the trade channel, the confidence channel and the financial channel.

3.7.1.1 The trade channel

This particular area of contagion picks up changes in the cross-border goods and services as a response to significant economic events in the rest of the world. For example, a negative demand shock abroad will affect the export demand for a country, reducing both the quantity and price of goods and services exported. Whereas import prices tend to increase due to negative external supply shocks (such as an oil supply shock) leading to reduced profits for firms and a reduction in the real disposable income of households. Spill-overs resulting from this channel can also rely on a country's degree of trade diversification as a country with more trade partners and a greater range of traded products and services will mitigate trade losses to a certain level. The more diversified a country's trade portfolio is, the less vulnerable a country will be to shocks regarding specific countries as well as specific goods and services (Rohn *et al.*, 2015:22).

The upsurge of global value chains (GVC) has had increasingly significant implications for trade channels. More specifically, indirect trade effects are more likely to have a greater effect. For instance, domestic economies might be more exposed to shocks in countries that are not direct trading partners, but which operate on the same supply chains. A significant implication regarding the upsurge of GVCs is that it may be a more suitable measure to identify weaknesses to external shocks on the domestic GDP by measuring trade exposures by value added rather than making use of traditional measure such as gross exports. Measuring value added trade exposures is a feasible concept with the help of the OECD-WTO trade in value added (TiVA) database (Rohn *et al.*, 2015:22). Moreover, due to high levels of connectivity as well as specialisation inside GVCs, a greater exposure to systemic risk for national economies are at play. GVCs are thus known for their part in acting as a channel for contagion. Despite their role in contagion, whether a shock in one link of the chain leads to a system-wide shock, rests on the redundancy in the system (whether the loss of one supplier can be compensated by other suppliers). Empirical evidence on this issue is scarce and not widely available. A final assessment on whether GVCs ultimately increase or reduce vulnerabilities would therefore be careless.

3.7.1.2 The financial channel

The financial channel captures movements of assets and liabilities on a cross-border basis. Taking the importance of the banking sector contagion during the global financial crisis of 2008 into account, it is beneficial to differentiate between a banking channel (where spill-overs are largely conveyed through bank balance sheets), and a non-banking channel. The banking channel can then be further broken down into an asset and liability channel. Spill-overs via the asset channel of banks' balance sheets arise, for instance, if a domestic bank suffers losses abroad. This causes a decrease in the domestic banks' asset-to-capital ratio and may cause the bank to decrease the size of its balance sheet by restricting lending in the local economy. Whereas spill-overs on the liability side of the bank balance sheet may arise if a domestic bank is dependent on funding from abroad. Specifically, via international inter-banking wholesale markets as shocks that occur abroad may limit foreign funding. Pressure is then put on the domestic bank to replace that "lost" funding. If there are no other sources of funding the bank may be forced to sell assets or reduce domestic lending. In addition to these direct connections, indirect contagion may also occur. For instance, banks may reduce lending to a country as a result of losses suffered on loans to another country. This common creditor contagion played a significant role in the global financial crisis (Ahrend & Goujard, 2012:19).

The non-banking channel functions via international equity and bond markets. A shock abroad may cause domestic residents' foreign held assets to decrease in value. By means of wealth and financial accelerator mechanisms these losses can result in contracted domestic demand on the side of firms and consumers. On the other hand, a shock abroad may motivate foreign investors to limit their resources in the domestic market, causing a drop in the domestic bond and asset markets, translating into reduced domestic demand through wealth and financial accelerator mechanisms.

The uncertainty/confidence channel captures changes within the level of uncertainty in the local economy as a result from shocks abroad. A negative shock may lead to a rise in the level of uncertainty experienced by households and firms due to vagueness around how the external shock might affect the domestic economy. Households will most likely reduce their spending habits as a result of uncertainty, while firms may reassess their projections for demand. Depending on the outcome of the assessment, firms may choose to suspend investment for the time being. Elevated uncertainty may result in higher borrowing costs for households and firms as investors seek greater returns for the higher levels of uncertainty they have to undertake. Uncertainty and confidence shocks can also be conveyed via foreign investors. The emergence of fiscal stress within a country may serve as warning signals to other countries to reassess the exposure of other countries in the same area or countries with

similar risk profiles (Goldstein, 1998:135). Sudden swings in investor sentiment, be it foreign or local investors, can occur when investors overestimate the economic interconnectedness between a country experiencing fiscal stress and others. Extrapolation of new information on countries experiencing fiscal stress to other countries can happen as well, this can also cause possible swings in sentiment. Sudden swings in investor sentiment and the subsequent reallocation of resources within portfolios can cause sudden reversals of capital flows and therefore lead to the transmission of financial stress abroad. The uncertainty/confidence channel is thought to be the main reason for the strong co-movement across countries during crisis periods.

The underlying shock will determine the relative importance of the various spill-over channels. For instance, financial shocks may mostly be conveyed through financial interconnectedness whereas, demand shocks (such as consolidation) may most likely be conveyed through trade channels (Rohn *et al.*, 2015:23). However, these channels almost never function in isolation. They interact and operate simultaneously. For instance, shocks spread by the uncertainty channel may cause domestic exporters to revise their export strategy. A shock conveyed via the financial channel may affect trade financing on a negative basis ultimately influencing trade. Alternatively, trade openness can serve to lessen the influence of a sudden stop. In a more open economy, the marginal propensity to import is larger. Therefore, a small drop in GDP or a small currency devaluation is required to close an external funding gap (Cavallo & Frankel, 2008:1449).

3.7.2 Measuring vulnerabilities to international spill-overs, contagion and global risks

Vulnerabilities regarding international spill-over and contagion can be captured in several ways. For instance, indicators of trade openness or financial openness can be made use of. These indicators will possibly measure vulnerabilities to global shocks or shocks arising in major trade or financial centres (such as the US, Eurozone or China). Despite the effectiveness of these measures in capturing global shocks, they are less effective in capturing vulnerabilities to spill-overs and contagion from localised shocks as they do not take specific exposure of countries into account (Rohn *et al.*, 2015:23).

Measures of global imbalance offer an additional approach of capturing spill-over and contagion risk. Global indicators are usually measured against a country's GDP weighted average of country specific imbalances. The reason behind the use of these indicators is that imbalances, such as credit or asset price booms, can form a build-up pattern in several countries at once. An unwinding effect in a single country can act as a spark to lead to the unwinding of the imbalance in other countries. Moreover, if several countries unwind

imbalances (deleverage) simultaneously, countries that do not have imbalances are prone to be affected through trade and financial channels (Chen *et al.*, 2012).

More recent early warning literature has started to include global measures such as these mentioned above with some degree of success (Rohn *et al.*, 2015:23). For instance, indicators of global liquidity (principally captured in terms of GDP-weighted credit averages) along with domestic variables have been shown to be useful in predicting crises or costly asset booms (Lo Duca & Peltonen, 2013:2192; Babecky *et al.*, 2013:31, and also Behn *et al.*, 2013:67). Early warning literature also suggests that heightened global risk aversion is normally accompanied by higher costs to the economy after crises (Babecky *et al.*, 2013:30). Behn *et al.* (2013:69) found that global equity price growth is positively correlated with future banking crises. The fact that global and regional indicators enable one to capture risks of contagion through the confidence channel along with the simplicity of use of the indicators is a huge advantage. The main drawback of these indicators is the fact that they do not vary by country and therefore do not give one the opportunity to assess country specific spill-over and contagion risk. Global indicators also tend to distort the build-up of geographically bound imbalances. For instance, global indicators, for the most part, missed the build-up of imbalances in a number of Asian countries preceding the East Asian crisis (Rohn *et al.*, 2015:24). It is therefore recommended to make use of regional indicators to complement global indicators when assessing vulnerabilities.

It is also possible to construct more relevant indicators of spill-over and contagion risk grounded on cross-border bilateral data. Unlike the indicators mentioned above, these more sophisticated indicators capture country specific spill-over or contagion risk. Bilateral trade (such as OECD TiVA), portfolio investment (IMF CPIS data) or bank lending data (BIS locational banking statistics) can be used in order to calculate a country's principal geographic exposures (Rohn *et al.*, 2015:24). To make these measures even more effective, the bilateral trade, portfolio investment or bank lending data can be used in conjunction with vulnerability indicators to measure the exposure of a domestic economy to shocks from abroad or vulnerabilities. Another approach suggested by Ahrend and Goujard (2012:33) is to generate measures of banks' balance sheet contagion by merging bilateral bank lending data with data on country risk ratings.

Cross-country correlations amid consumer and business confidence indicators can serve as a rough measure of spill-overs via the uncertainty channel. For example, a strong correlation amongst consumer confidence indicators across countries in Europe with some differences amid the core and peripheral countries was found arising in the midst of the global financial

crisis (Rohn *et al.*, 2015:24). This could possibly be the consequence of synchronised business cycles across the European continent, which serves as a confidence indicator proxy.

3.8 Conclusion

This chapter reinforces the statement that early warning indicators are a viable option to explore regarding mitigating risks from oncoming crises as early warning indicators can indeed be deployed to predict/forecast oncoming financial crises. There are several of these indicators that appear to be useful in this regard. These indicators often tend to connect on some underlying level and form a strong coherence between one another. Chapter 4 will therefore focus on processing the vulnerability indicators as set out by Rohn *et al.* (2015) through dynamic factor analysis to establish co-movement between these indicators.

CHAPTER 4: EMPIRICAL ANALYSIS

4.1 Introduction

Vulnerabilities to financial crisis can arise from a significant number of areas within an economy. As previously mentioned, early warning indicators should not only be viewed in isolation due to the high levels of interconnectedness and interaction between certain vulnerabilities. On the other hand, the vast number of possible early warning indicators also makes it difficult for decision-makers to effectively monitor all the variables. Therefore, indicators that tend to interact similarly are typically grouped together (see chapter 3) to simplify the sheer number of possible explanatory early warning indicators. Some indicators also point to similar vulnerabilities within an economy, hence further motivating the use of grouped measures. The literature does not explain how measures are grouped as Dynamic factor analysis does not necessarily explain the type of relationship between variables. The co-movement between the variables will however be identified in an attempt to group variables with high levels of co-movement. The grouped variables will form one factor that comprises out of several vulnerability indicators that can possibly be monitored to signal an oncoming financial crisis. This process reduces the large number of possible indicators that need to be monitored. This chapter will therefore explain how Dynamic factor analysis was used to identify indicators that co-vary between countries and over time in an attempt to identify parsimonious indicators of financial crises.

4.2 Dynamic factor analysis

Economists often have to work with diverging data structures as the number of years for which there are trustworthy and appropriate data available is limited and can only be increased by the passage of time. Fortunately, statistical agencies collected monthly/quarterly data during the post-war period on an extensive range of financial, macroeconomic and sectoral variables. Hence, economists have to process extensive data sets that contain several series, sometimes hundreds and thousands of series. The number of observations can however be relatively short for instance ten or 20 years of quarterly data. This is where dynamic factor analysis (DFA - sometimes referred to as dynamic latent variables) comes in as it is a method used to identify mutual patterns and relations within a set of time series data (Zuur, Fryer, Jolliffe, Dekker & Beuekema, 2003:542).

Dynamic factor models were initially posited by Geweke (1977) as a time-series expansion of factor models originally adapted for cross-sectional data, rather than time-series data (Stock and Watson, 2010:2). Early literature by Sargent and Sims (1977) indicated that just two dynamic factors could explain the variance of important U.S. quarterly macro-economic

variables, including output, employment, and prices to a certain level of accuracy. This vital empirical result indicated that a few factors can describe a significant portion of the variance of many macroeconomic series has been confirmed by several studies including Giannone, Reichlin, and Sala (2004) as well as Stock and Watson (2010) to name some.

The success of DFMs led to an upsurge in the use of DFM by economists to estimate “underlying” factors, as these factors often co-vary to a greater extent than perceived by economists when building models. This practice brought forth more accurate measures of underlying inflation. It has also been successfully applied to the real side of the economy and been used in arbitrage pricing theory models of financial decision making (Ajevskis & Davidsons, 2008:7).

The principal concept regarding a dynamic factor model is that a few latent dynamic factors act as a driving force, resulting in co-movement of a high-dimensional vector of time-series variables, which is also affected by a vector of mean-zero idiosyncratic disturbances. These idiosyncratic disturbances emanate from measurement error and from distinct attributes that are explicit to an individual series. The latent factors follow a time series course, which is generally considered to be a vector autoregression (VAR) (Stock & Watson, 2010:3).

DFA will be used in this thesis to examine covariation between macroeconomic variables (in this specific case, measures of vulnerabilities) across global economies. Usually within large databases, each individual series contains two equilateral latent fundamentals (Claassen, 2016:27). On the one hand, the fundamental movement is driven by common influences. These common influences are considered to be the underlying factors driving collective movement in a database. While on the other hand, an idiosyncratic disturbance is also at work, explicit to each series.

The fact that dynamic factor models can be functional in a wide range of applications makes it an appealing model to use. Factor models have previously been applied to explore areas such as finance and risk (Ross, 1977:24), consumer theory (Gorman, 1981:223); (Lewbel, 1991:714). It is also useful for short-term forecasting and monitoring of an economy (Clavel & Minodier, 2009); (Altissimo, Cristadori, Forni, Lippi & Veronese, 2010:1031). However, more specific to this study, the intention is to investigate the co-movement of variables within a dataset. There are several examples of dynamic factor models being applied in similar endeavours. Menden & Proano (2017:1) proposed the creation of financial cycle measures for the US based on a large data set of macro-economic and financial variables in order to estimate three synthetic financial cycle components that account for the majority of the variation in the specific data set using a dynamic factor model. The main goal being to analyse whether these financial cycle components have significant predictive power for economic

activity, inflation and short-term interest rates by means of Granger causality tests in a factor-augmented VAR setup. DFA has also been used by Koopman, Lucas and Schwaab (2011:25) to propose an innovative framework to investigate financial system risk by implementing a dynamic factor framework constructed on state-space approaches to create coincident measures. These measures serve as forward looking indicators for the probability of a synchronised collapse of a significant number of financial intermediaries. Another study developed a non-linear non-Gaussian dynamic factor model to estimate the breakdown of systematic default risk conditions into a set of components that reacts in parallel with macro-economic, financial and industry specific events Durbin and Koopman (2012:1). Jin and De Simone (2012:33) joined the previously mentioned Geske model with a Generalized Dynamic Factor Model and used the results by putting it into a dynamic t-copula as a technique for obtaining banks' interdependence. In doing so they developed a measure that produces an early warning indicator regarding banks' probability of default. Another study by Sheen, Truck, Truong & Wang (2016:11) also made use of dynamic factor analysis in a model to identify unobserved financial risk and ratings indicators for several regions by making use of observed expected default frequencies. Vasilenko (2018:3) studied systemic risk and financial fragility within the Chinese economy by means of a dynamic factor model approach. A dynamic factor model was estimated in order to forecast systemic risk that displays noteworthy out-of-sample forecasting power, accounting for the outcome of several macroeconomic factors on systemic risk, including; economic growth slowdown, high levels of corporate debt, increase in shadow banking as well as real estate market slowdown. The study proceeded to analyse the historical working of financial fragility within the Chinese economy over the course of the previous ten years. Results concluded that the level of financial fragility in the Chinese financial system declined after the global financial crisis of 2008. The level of financial fragility has, however, been systematically increasing since 2015.

For this study Dynamic factor analysis was selected over other models as DFA model simultaneously considers a wide variety of macro-economic factors that could possibly result in financial crises, whereas traditional models mostly consider single or occasionally multiple factors. Dynamic Factor Analysis is an established technique to empirically analyse co-movement (Claassen, 2016:28). DFA makes it possible to process the large data-series without the risk of lost degrees of freedom, in so doing overcoming what is generally acknowledged as the curse of dimensionality in data analysis.

4.2.1 The Model

As previously stated, the dynamic factor model is grounded on the concept that change in time-series variables are driven by a smaller number of latent factors (r). This can be called a

common component which is the driving force of co-movement among the variables (Zuur *et al.* (2003). Co-movement or variance among the variables can in some instances also be altered by specific features/events that are unique to individual data series. Variance caused by such features/events are called idiosyncratic components (Altissimo *et al.* 2010).

Consequently, it is possible to embody a vector of time series ($Y_t = y_{1t}, y_{2t}, \dots, y_{Nt}$)' as the sum of a common component, ($X_t = x_{1t}, x_{2t}, \dots, x_{Nt}$)' and an idiosyncratic component, ($E_t = e_{1t}, e_{2t}, \dots, e_{Nt}$)' (Claassen, 2016).

This results in:

$$Y_t = X_t + e_t$$

$$Y_t = \Lambda F_t + e_t \quad (1)$$

Where:

$X_t = \Lambda F_t$ exhibits the common component; the share of the series that is dependent on common factors;

e_t exhibits the idiosyncratic component; the part of each series that is variable specific and equilateral regarding the common component;

Moreover:

Λ symbolises the $N \times r$ matrix of factor loadings; comprising of the non-zero columns of Λ and with $r < N$; where N is the number of series within the dataset.

F_t symbolises the vector of r common factors.

Since $T, N \rightarrow \infty$ the common components can be recognised by making use of principal component analysis for the variance-covariance matrix of the perceivable data, $cov(Y_t)$. The variance-covariance matrix is then summarised by using a dimension reduction matrix where $N \times 1$ vector of eigenvalues from the variance-covariance matrix where the first largest eigenvalues and vectors have been calculated in such a way that:

$$X_t = VV'Y_t \quad (2)$$

With:

V' representing the $N \times r$ matrix of eigenvectors which coincide with the largest r eigenvalues of the correlation matrix for Y_t .

F_t , the common factors, are estimated using principal component analysis and can be embodied as follows (Stock & Watson, 2010):

$$F_t = V'Y_t \quad (3)$$

Where V is an estimate of factor loadings equal to Λ . The idiosyncratic factors can thus be defined as

$$e_t = X_t - Y_t \quad (4)$$

In a first attempt of this study, the number of static factors to be estimated was determined using the approach proposed by Bai and Ng (2002)⁵. This approach focuses on establishing the convergence rate for the factor estimate that enables a consistent estimation of the number of static factors. Panel criteria are then introduced suggesting that the number of factors can be consistently estimated through parameters presented by the criteria. The theory is developed with the concept of large cross-sections (N) and large time dimensions (T). There are no restrictions that constrain the relationship between the large cross-sections and large time dimensions. Results from this approach indicate that the proposed criteria have sufficient finite sample properties in many configurations of the panel data used in practice.

However, this approach was not successful as the Bai-Ng criteria do not converge and in this specific case give no precise answer. An alternative approach proposed by Alessi, Barigozzi & Capasso (2008) which is in effect a refinement of the criteria proposed by Bai and Ng, drawing on the Hallin and Liska (2007)⁶ criteria for dynamic factors was used instead. Basically, the penalty function is multiplied by a constant which brings the penalising power of the function itself into tune/harmony. By evaluating the criterion for a series of values for this constant factor, an estimation of the number of static factors can be reached. This process is empirically more robust than it would normally be with a fixed constant. The consistency properties' premises of this method are precisely the same as the original Bai and Ng method, the sole difference being the multiplicative constant.

4.2.2 Data and method

The data used in this dissertation is the same database used by Rohn *et al.* (2015) as the aim was to re-examine the 70+ indicators identified by Röhn *et al.* (2015) to identify parsimonious indicators of financial crises. The dataset contains OECD indicators of potential

⁵ For a more detailed explanation regarding the Bai-Ng approach to estimate the number of factors see: Bai and Ng (2002).

⁶ Focused on developing an information criterion for determining the number of common shocks in the general dynamic factor model rather than using the restricted model proposed by Bai and Ng. For a detailed explanation see Hallin and Liska (2007).

macroeconomic and financial vulnerabilities for 34 OECD countries, the BRICS countries (Brazil, Russian Federation, India, China, and South Africa), Indonesia, Colombia, Costa Rica, Latvia and Lithuania. The vulnerability indicator database was created from a number of data sources as part of an Economics Department project on Economic Resilience. As mentioned above, the choice of indicators is motivated in a related working paper, by Röhn *et al.* (2015), wherein the source and nature of potential vulnerabilities that can lead to costly economic crises, are also analysed. The dataset was compiled from a number of sources⁷ namely, the OECD, IMF, ECB, BIS, World Bank, Eurostat as well as Benetrix, Lane & Shambaugh (2015). The data observations in the dataset range from 1970 to 2015 depending on the indicator. The frequency of the observed indicators also ranges from annual to monthly (including quarterly) depending on the indicator observed. The number of countries for which data is available for a certain indicator also ranges from nine to 44 depending on which indicator is being observed. Due to the varying time-series and structure of the data within the dataset, the main focus was put on the last ten years of the data (2005 to 2014) as data for this period is more widely available which can be attributed to better record-keeping practices within the private as well as public sector. The time slot of this period also enables an overview of the build-up to the global financial crisis of 2008 right through to the actual crisis period as well as the start of the recovery process after the crisis. This crisis period is also a near-perfect experiment for testing the robustness of early warning indicators as the crisis started with a shock that was exogenous as far as many countries of the world are concerned, namely a liquidity crisis in US financial markets. The crisis hit everyone simultaneously, so it was not necessary to worry about the issue of timing. Focus can be put on what economic variables indicate vulnerability to such a shock.

The data was structured on a quarterly basis as this allowed more indicators to be included into the analysis. After the rearrangement of the data, 54 of the original 73 indicators could be used in the analysis. The sample size is 1468 (N) x 40 (T). The 54 indicators used amounted to 1468 total variables with 40 quarters of data each, therefore resulting in 58720 data points. To start off, the data was standardised in order make it easier to read results from regression analysis and to ensure that all the variables contribute to a scale when added together. This type of data can provide extremely important information about the relationship between the response and predictor variables, while it can also produce excessive amounts of multicollinearity. This could pose problematic as multicollinearity can hide statistically significant terms and cause the coefficients to switch signs as well as making it more difficult to specify the correct model. Standardizing the vulnerability indicator data is an effective way

⁷ See appendix for a detailed information regarding the source and frequency of specific vulnerability indicators.

to account for and reduce multicollinearity. The next step was to identify the number of static factors (r). As previously mentioned the number of static factors was estimated by making use of the ABC criterion put forth by Alessi *et al.* (2008). The criteria indicated that two factors should be estimated for the sample period identified. The estimated number of static factors was then set as parameters to be estimated within the Bai-Ng criterion to analyse co-movement through DFA and ultimately identify parsimonious indicators of financial crises.

4.3 Results from Hermansen and Rhon

To better explain the overall picture, the results from the creators of the database used will first be explained. Hermansen and Rhon (2015) set out to provide empirical evidence regarding the usefulness⁸ of the specific set of vulnerability indicators in predicting crises and recessions. The study makes use of a signalling approach. The signalling approach takes policy makers' choice between avoiding crises and false alarms into consideration. Empirical evidence gathered from the study indicates that the majority of vulnerability indicators would have assisted in predicting crises and severe recessions in the 34 OECD economies as well as Latvia between 1970 and 2014.

4.3.1 In-sample results

The study suggests that indicators of global risk outperform domestic indicators consistently regarding their usefulness as early warning indicators. Global vulnerability indicators such as an increasing (cumulative) global private bank credit-to-GDP ratio, a global equity price gap as well as a global house price gap performs particularly well in predicting crisis periods. This result is in line with findings from similar literature (e.g. Babecky *et al.*, 2013; Behn *et al.*, 2013; Lo Duca & Peltonen, 2013). This emphasises the significance of taking international events into consideration when assessing country specific vulnerabilities as economies become more integrated, causing a higher risk of spill-overs to other economies. The successful results regarding global indicators are however subject to a caveat. Global indicators do not vary across countries and are therefore more likely to be picked up as they influence a number of countries simultaneously. The good performance of global indicators of vulnerability is thus to a certain extent explained by the share of severe recessions constituted by the global financial crisis of 2008 within the sample. Global vulnerability indicators will therefore most likely be less effective serving as early warning indicators for locally confined severe recessions.

⁸ A relative usefulness criterion was created to measure the performance of indicators in forecasting severe recessions and financial crises. To see more detail regarding this criterion, see: Hermansen and Rhon, 2015. Economic Resilience: The Usefulness of Early Warning Indicators in OECD Countries. *OECD Economics Department Working Papers*. No. 1250: 1-30.

Useful domestic indicators of vulnerability include the house price-to-disposable-income ratio, the house-price-to-rent ratio as well as the real house price gap. Borio and Drehmann (2009) and Claessens *et al.* (2011) reinforce this outcome as unsustainable real estate booms tend to be followed by costly economic declines. Hermansen and Rhon (2015:12) state that in addition to the above domestic indicators, domestic credit related variables can also serve as useful early warning indicators. More specifically, increases in domestic bank-credit-to-GDP were found to be particularly useful. Early warning indicators of financial crisis literature suggests that credit variables are amongst the most robust indicators (e.g. Kaminsky *et al.* (1998), Reinhart and Rogoff (2008), Borio and Lowe (2002).

The Hermansen and Rhon (2015:12) study also suggests that official reserves (as a ratio of M2) is useful in predicting economic recessions although other public sector imbalances indicators fare poorly in predicting pre-severe recession periods.

4.3.2 Out-of-sample results

The out of sample results focus more on indicators that provide useful information regarding the detection of the global financial crisis of 2008. The sample period was therefore split into two samples, an estimation and evaluation sample. The starting date of the estimation for the Hermansen and Rhon (2015:13) study depended on the data availability of the indicators and the sample ends in 2004Q4 to exclude data from the global financial crisis. The starting date of the evaluation sample was specified to be 2005Q1 and the end date was specified as 2012Q4.

Indicators were tested for their relative usefulness with different thresholds. Higher thresholds indicated that the majority of the indicators were useful with several indicators performing even better out-of-sample than in-sample. Once again global indicators fared particularly well, reinforcing their success in the in-sample performance. The global equity price gap indicator indicated the best results followed by indicators of global credit and global real house prices.

Domestic indicators also showed success with credit and asset market indicators performing the best of the domestic indicators. Interestingly domestic credit gap indicators perform particularly well and achieved greater success than out-of-sample than in-sample. This can most probably be attributed to unsustainable domestic credit booms during the global financial crisis. The real equity price gap championed the asset market imbalance indicators with good performance, also performing better than in-sample. The residential investment-to-GDP ratio also indicated better success out-of-sample. House price related indicators showed worse performance than in-sample trials, although, the house-price-to-rent and house-price-to-

disposable income ratios gap perform better than the long-term trend. External imbalance indicators perform poorly out-of-sample as well as fiscal imbalance indicators.

4.3.3 Summary

To conclude the results produced by Hermansen and Rhon (2015): results indicate that the majority of early warning indicators would have aided in forecasting severe recessions in 34 OECD countries as well as Latvia between 1970 and 2014. It was found that most of the indicators issue warning signals on average 1.5 years before the onset of a severe recession. This allows policymakers to react with ample time, the signalling power differs between indicators and the results are sensitive to the exact specification of policymakers' preferences regarding false alarms and missing crises. The study highlights the finding that global vulnerability indicators consistently outperform domestic vulnerability indicators regarding their usefulness. This once again emphasises the importance of taking international developments into consideration when assessing a country's vulnerabilities. On the domestic side, indicators measuring asset market imbalances, more specifically, real house prices, real equity prices, house price-to-income Ratio as well as price-to-rent ratio also perform reliably out-of-sample as well as in-sample. Domestic credit associated indicators are successful in signalling oncoming banking crises as well as forecasting the global financial crisis out of sample.

The results are robust and wide-ranging depending on the definition of severe recessions and crises, varying forecasting periods as well as differing time and country samples. The early warning indicators identified to be useful can be a valuable input for monitoring future risks. The indicators should, however, be complemented with other successful monitoring tools (including expert judgement).

4.4 Results from this study

The ultimate objective of early warning indicators is to forecast future crisis events. The results from Hermansen and Rhön (2015) indicated that the majority of indicators from the set of vulnerability indicators they identified was indeed useful in predicting oncoming crises. Results from that study emphasise the effectiveness of some of the indicators, such as global indicators. However, the indicators should not be viewed in isolation as the indicators often tend to interact with one another. One indicator can reinforce other indicators, similarly indicators can affect other indicators adversely and lead to one imbalance triggering the unwinding of others ultimately leading to a downward spiral.

The aim of this study was therefore to re-examine the 70+ indicators identified by Röhn *et al.* (2015) to identify parsimonious indicators of financial crises. Rather than considering single

indicators, the process through DFA and data reduction created a group of variables that make out a single factor responsible for explaining the movement among the group of variables. This makes monitoring a wide variety of indicators easier as a single factor consists of an assortment of indicators.

As previously mentioned, a sample period (2005 to 2014, arranged quarterly) within the original dataset compiled by Rohn *et al.* (2015) was identified as having been processed by the DFA model. This was done to ensure that an adequate number of variables was available to be analysed as earlier data in the dataset tend to be distorted in the sense of data availability. The specific sample period also gives a sufficient overview of the build-up to the global economic crisis of 2008 as well as the actual effects of the crisis and the remedial process after the crisis.

The number of static factors was estimated to be two as per the ABC criteria (see Appendix B for an overview of how the number of static factors was estimated). Dynamic factor analysis groups the indicators into two factors. For each factor, the dynamic factor analysis model creates a list of covarying variables. These variables were then sorted according to their variance shares. For factor one variables with a variance share of less than 90 percent were left out as the higher variance shares assures a higher level of co-movement between variables. For factor two, the threshold was lowered to 75 percent as the DFM identified less variables with high variance shares. Factor one was identified as private non-financial sector imbalances including some asset market imbalances. Factor two was identified as private non-financial sector imbalances (more focused on private bank credit and external debt whereas factor one is more concerned with household and private credit as well as external sector imbalances. This is in line with the results from Hermansen and Rhon (2015) as credit and asset market indicators performed the best of the domestic indicators.

4.4.1 Factor 1

Below follows a table displaying the variance shares of each of the variables with a variance share of more than 90 percent identified to form part of factor one. A high degree of co-movement between the vulnerability indicators is present.

Table 4.1: Variance shares of factor 1, 2005Q1 – 2014Q4

Household credit_SWE	0.982276	Gross general government debt_HUN	0.962302	Household credit_CZE	0.950933	Private bank credit_CZE	0.944200
Total private credit_FRA	0.981634	Total private credit_FIN	0.962039	Financial openness_GRC	0.950189	Total private credit_CAN	0.943757
Commercial real estate loans_BRA	0.980687	External debt_GRC	0.961677	Corporate credit_FRA	0.949767	Short-term external bank debt_BEL	0.943085
Private bank credit_FIN	0.979815	Corporate credit_CHE	0.959817	External debt_POL	0.949038	Household credit_POL	0.942469
Residential investment_PRT	0.978384	FDI liabilities_BEL	0.958478	Tier 1 capital ratio_DEU	0.948326	Tier 1 capital ratio_GBR	0.940308
Household credit_BEL	0.978048	Gross general government debt_usa	0.958252	Household credit_CAN	0.948157	Private bank credit_BRA	0.939803
Household credit_FRA	0.974288	Real house prices_BRA	0.956557	Total private credit_GRC	0.947277	Gross government debt denominated in foreign currency_LVA	0.938540
Total private credit_CZE	0.973310	External government debt_usa	0.955669	Gross general government debt_GBR	0.946018	Private bank credit_GRC	0.937523
Residential investment_ESP	0.972382	Employment share in construction_IRL	0.954213	Leverage ratio_LTU	0.945725	Total private credit_BEL	0.937436
Private bank credit_SWE	0.971888	Residential investment_IRL	0.951532	Export performance_POL	0.945138	Gross general government debt_LUX	0.936757
Household credit_LUX	0.968510	Total private credit_POL	0.951481	Short-term external bank debt_GBR	0.944854	Capital ratio_LTU	0.936709
Household credit_FIN	0.964945	Short-term external bank debt_BEL	0.951374	House prices-to-rent ratio_PRT	0.944814	External government debt_LUX	0.934378
External debt bias_BEL	0.964077	Tier 1 capital ratio_NOR	0.951054	Real stock prices_SVK	0.944750	Household credit_TUR	0.932922

External debt bias_CHE	0.932105	Employment share in construction_KOR	0.923222	Tier 1 capital ratio_LTU	0.918573	Employment share in construction_usa	0.909494
Capital ratio_GBR	0.931715	Household foreign currency denominated liabilities_FRA	0.922902	Household credit_GRC	0.917451	Current account balance_usa	0.909266
Employment share in construction_ESP	0.930297	Real house prices_COL	0.922766	Employment share in construction_CAN	0.916936	Export performance_CHN	0.909226
Financial openness_CZE	0.929442	Liquidity ratio 1_EST	0.922698	Capital ratio_POL	0.916592	Gross general government debt_IRL	0.908567
Capital ratio_NOR	0.929302	Leverage ratio_GBR	0.922078	House prices-to-rent ratio_ISR	0.914790	Capital ratio_EST	0.908045
Household foreign currency denominated liabilities_GRC	0.929070	FDI liabilities_CRI	0.921933	Tier 1 capital ratio_POL	0.914425	External bank debt_BEL	0.906524
Total private credit_BRA	0.928356	External debt bias_CRI	0.921933	Corporate credit_PRT	0.913832	Corporate credit_IRL	0.906422
Capital ratio_DEU	0.928348	Household credit_KOR	0.921636	External debt_CZE	0.912711	Shadow banking 2_NOR	0.906299
Residential real estate loans_LUX	0.927126	Loan-to-deposit ratio_GRC	0.921561	Official foreign reserves_GBR	0.912261	Gross general government debt_AUT	0.905908
Financial openness_POL	0.926986	Yield-growth spread (r-g)_ISR	0.921246	Foreign currency mismatch_ISR	0.912172	Gross financing needs_ESP	0.905735
Export performance_ITA	0.926381	House prices-to-rent ratio_MEX	0.919514	Residential real estate loans_GRC	0.911531	Residential investment_ZAF	0.905656
Household credit_NOR	0.925353	Private bank credit_POL	0.919309	Liquidity ratio 2_usa	0.911487	Total private credit_KOR	0.905467
External government debt_DEU	0.924557	Trade openness_IRL	0.919148	Short-term external government debt_JPN	0.911084	Gross general government debt_NZL	0.905457
Export performance_ZAF	0.923832	Corporate credit_POL	0.918991	Liquidity ratio 1_usa	0.910486	External government debt_LVA	0.905354

Leverage ratio_POL	0.904269	Shadow banking 2_POL	0.902350	Total private credit_SWE	0.901197	Private bank credit_FRA	0.900380
						House prices-to- disposable income ratio_IRL	
FDI liabilities_DNK	0.903773	FDI liabilities_CHE	0.901402	Export performance_KOR	0.900578		0.900060
Corporate credit_FIN	0.902812						

Source: Authors own calculations

Factor 1 mainly consists of credit-related private non-financial sector imbalances, more specifically; household credit as percentage of GDP, total private credit as percentage of GDP, private bank credit as percentage of GDP, corporate credit as percentage of GDP along with some asset market imbalance indicators. The asset market imbalance indicators include residential investment, employment share in construction and the house-price-to-rent ratio.

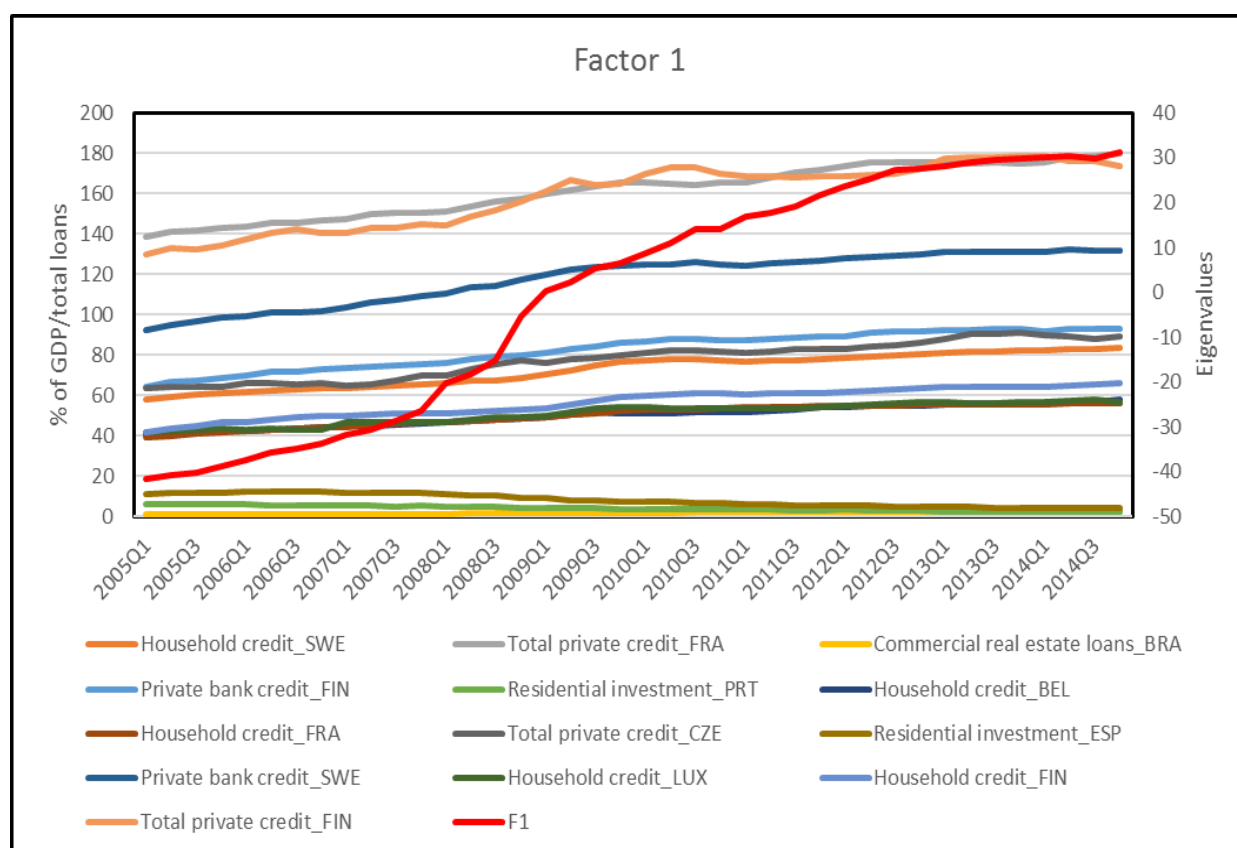


Figure 4.1: Factor 1

Source: Authors own calculations

Figure 4.1 indicates the co-movement of variables that form factor 1. All of the variables are measured in percentage of GDP except Commercial real estate loans_BRA which is measured against the percentage of total loans. The indicators that co-vary are of a similar nature and coincides with one another as can be observed from figure 4.1. The indicators are all credit related to a certain degree as even residential investment is often heavily dependent on credit extension to facilitate investment. Various forms of credit are included in factor one for instance, household credit, private bank credit, total private credit as well as commercial real estate loans and residential investment. The upsurge in credit can be explained by lower credit constraints due to stable inflation, decreasing risk premiums, the development of a more integrated market in financial services, higher and more differentiated credit supply, higher

future-income expectations, altering households' life-income function (Chmelar, 2013:1). The downward trend of residential investment and commercial real estate loans is logical in this regard as available funds for investment was limited due to financial institutions constraining credit extension due to concerns of borrower's abilities to service the loans as the effects of the financial crisis became clear. Despite affecting aggregate savings of households and firms on a negative basis, credit allows demand to expand in the short-term; increasing the immediate output translating into economic stimulation and the potential for future economic growth (FitzGerald, 2008). Considerable debt development during the early and mid-2000s was experienced by the majority of countries (OECD, 2017). Many single countries, however, recorded a significant rise in household debt in the period preceding the financial crisis. As was the case with the US, these countries were accumulating debt both in the corporate and household sector as a consequence of sizeable economic expansion and structural changes in monetary policy and financial markets. Factor one starts off in a slight upward trend until 2005Q3 when it gains some momentum. A clear spike can then be observed starting around 2007Q4 lasting until 2009Q3 when it loses some momentum. Around 2012Q3 factor one loses much of its upward momentum and starts moving sideward rather than upward. One can argue that the initial momentum gained around 2005Q3 could have been the first signs of an oncoming crisis especially when the strong upward hike of 2007Q4 reinforced this suspicion. The effects of the global financial crisis of 2008 are clear through the movement of factor 1. From the initial momentum gain, to the actual spike signifying the crisis, right through to the momentum subsiding around 2012Q3 where factor one is stable for the rest of the sample period except for another upward hike around 2014Q3. This can most probably be attributed to the shift in the balance of growth at the time as Chinese demand for raw material waned, and as higher wages and strong currencies made many emerging market economies less competitive (Woetzel, Chen, Manyika, Roth, Seong & Lee, 2015). Russia also experienced a financial crisis in 2014–2015. The Russian rouble collapsed in the beginning of the second half of 2014 as a decline in confidence in the Russian economy caused investors to sell off their Russian assets, which led to a decline in the value of the Russian rouble and posed a great threat to Russia with the looming aspect of a Russian financial crisis hanging in the air (Kitroeff & Weisenthal, 2014). The lack of confidence in the Russian economy can be attributed to two principal sources. The first is the fall in the oil price during 2014. The price of crude oil, a major export product of Russia, declined by almost 50% between its yearly high in June 2014 and 16 December 2014. The second is the result of international economic sanctions imposed on Russia following Russia's annexation of the Crimea along with the Russian military intervention in Ukraine. The Fed policy cycle was also changing at the time after four years of capital being pushed out in a quest for higher yields.

Although figure 4.1 indicates the co-movement of factor 1 with the variables forming it, it becomes somewhat distorted as the list of variables is quite large and the scale of the data vary from one another. This next section will focus on analysing these variables in conjunction with factor one. Through DFA the variance shares of all the variables were determined, however, as previously mentioned for factor one, only the variables with a variance share of 90 percent and upwards was used. Therefore, some vulnerability indicators such as household credit below will have a multitude of indicators, whereas commercial real estate loans for instance will only have one indicator.

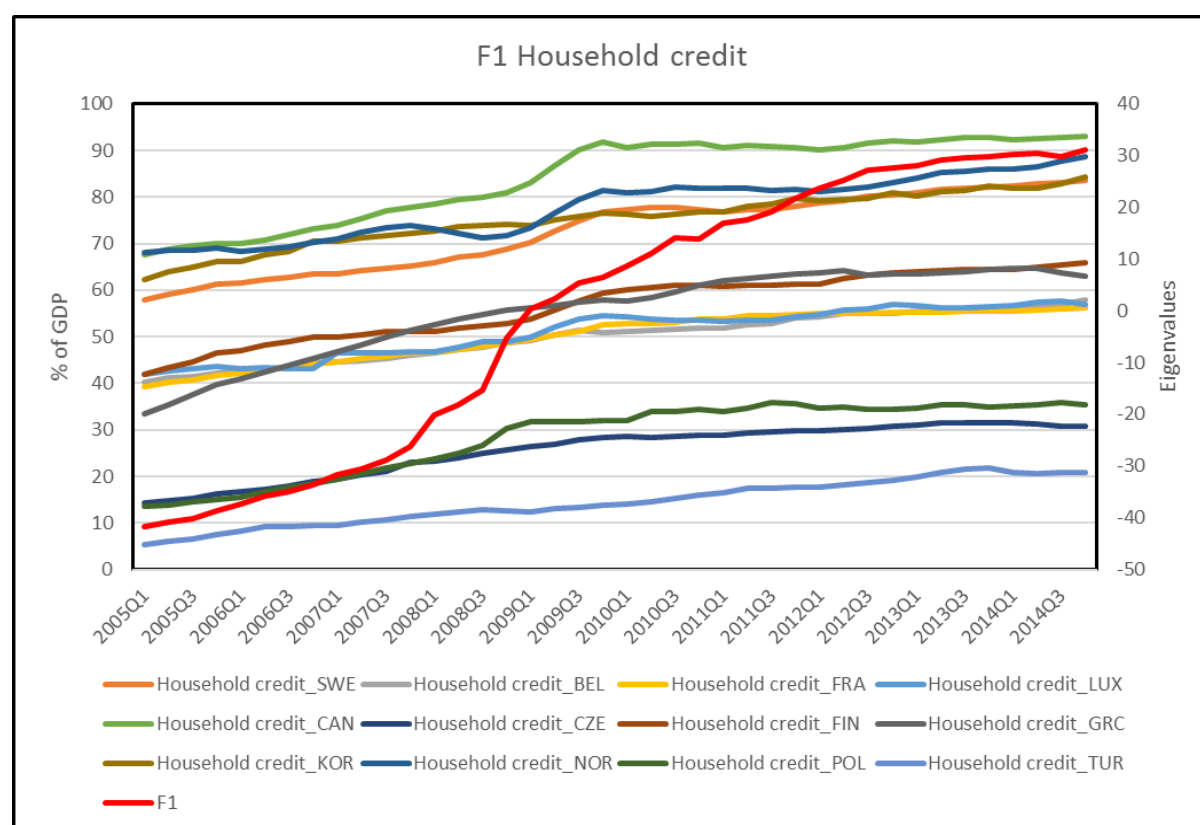


Figure 4.1.1: Factor 1 and Household credit

Source: Authors own calculations

The ability of households to make the most of their cash flows during their life cycle has been a long-standing focal point of future household expenditure and economic growth. An important factor to consider regarding household debt leverage is the decline in interest rates since the late 1990s which had a crucial effect on debt of households as the co-movement of interest rates with debt growth suggests (Chmelar, 2013:6). The low or even negative real interest rates have been often singled out as one of the major causes of extensive household debt expansion. The level and distribution of household debt affects the responsiveness of aggregate demand and aggregate supply within an economy to shocks. Consequently, this

has had implications for macro-economic and financial stability. Increasing household debt can translate into either stronger credit demand or an increased supply of credit from lenders, or some combination of the two. Unconstrained households can borrow in order to smooth consumption before an anticipated increase in income or after an unexpected temporary drop in income (such as illness, accidents, short-term unemployment). In addition, households borrow to finance investment in illiquid assets with high long-term returns such as housing. Credit demand might rise because households are optimistic about income prospects, or because costs (interest rates) are low. Distress among financial institutions came in to play due to the large exposure of the household sector.

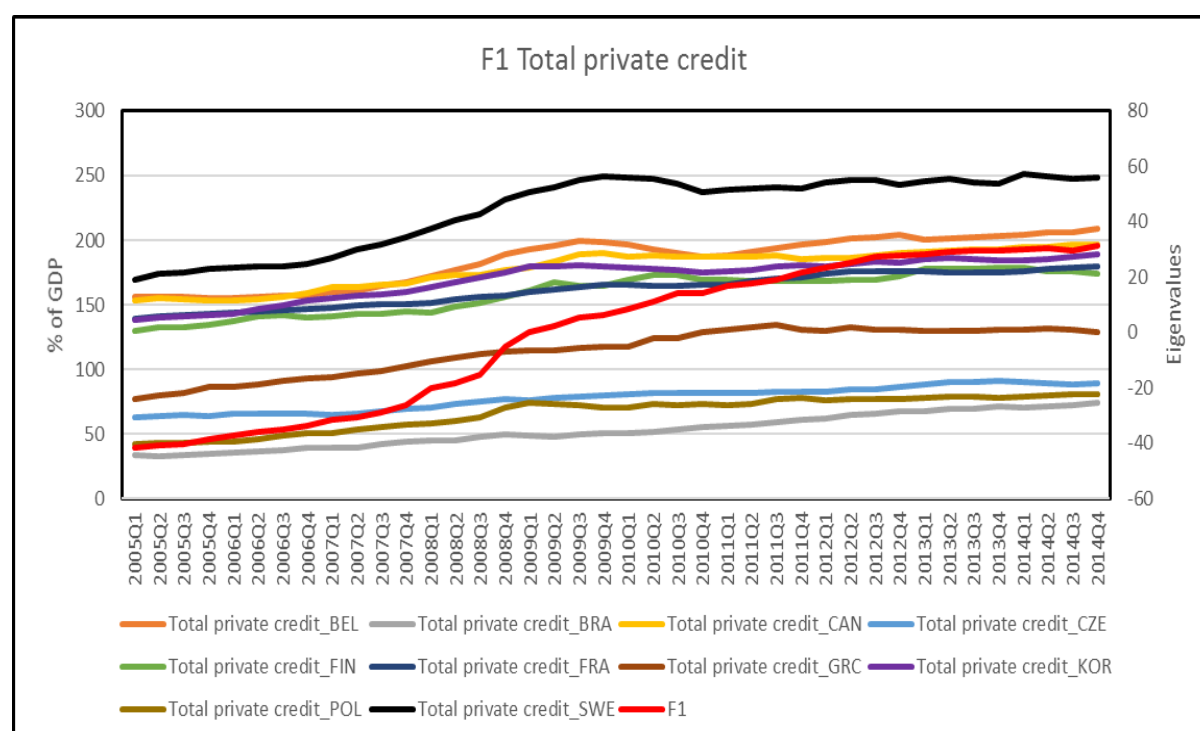


Figure 4.1.2: Factor 1 and Total private credit

Source: Authors own calculations

Total private credit is the total sum of lending from all sectors (including foreign) to private non-financial sector in per cent of GDP. The co-movement between factor 1 and the total private credit ratio is clear. It follows a similar pattern to household credit and indicates a gradual increase in the ratio until the start of the crisis around 2008Q1 when the ratio increases sharply for varying durations considering each individual country until the sharp increase eventually subsides to form a more stable ratio. Historical analysis shows that a private credit boom raises the odds of a financial crisis (Jorda *et al.*, 2012). Measured by balance sheets and private loan levels, the modern banking system is larger (compared to GDP) than at any other

point in history (Taylor, 2012:1). Taylor (2012:1) also stated that credit growth was a significant predictor of financial crises.

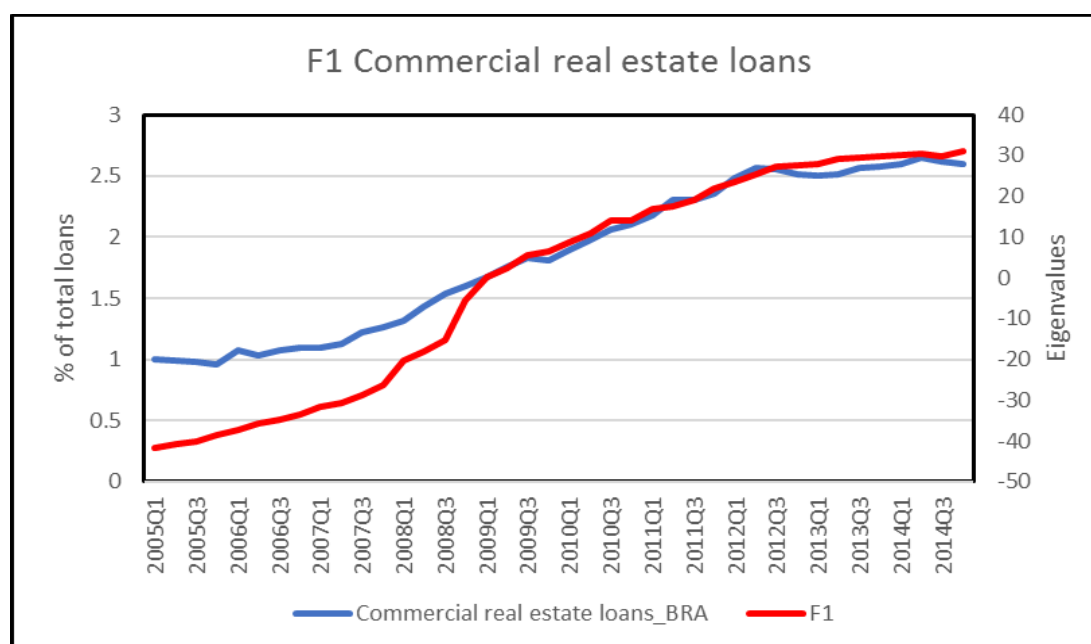


Figure 4.1.3: Factor 1 and Commercial real estate loans

Source: Author's own calculations

This ratio is regarded as the total commercial real estate loans to total loans. This vulnerability addresses interconnectedness and common exposures. The high degree of interconnectedness within modern institutions is a great risk regarding financial contagion and spill-overs. The share of commercial real estate loans to total loans more than doubled during the crisis period. This was most probably the result of the recession causing households to default on their residential real estate loans as these loans are in effect liabilities to households.

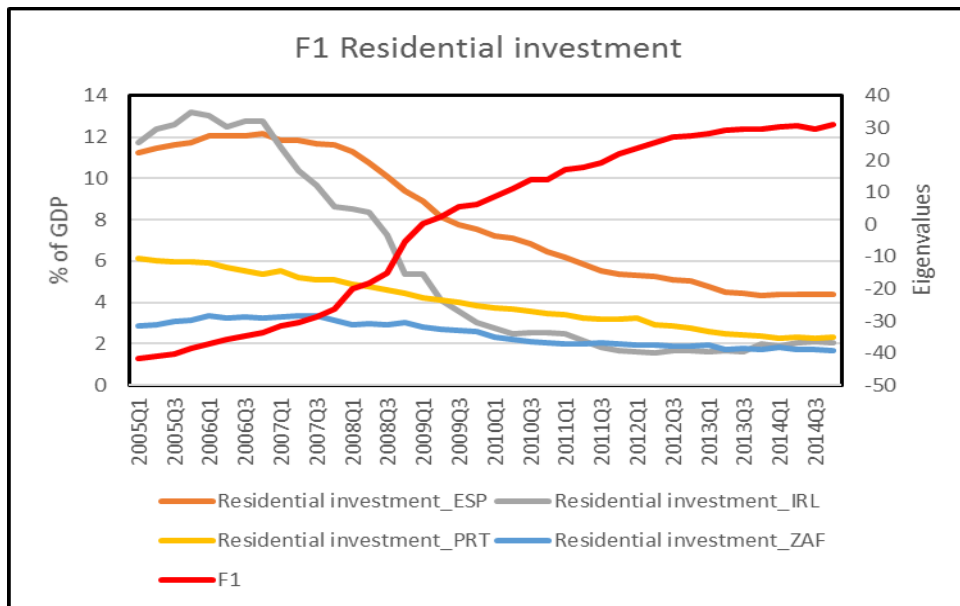


Figure 4.1.4: Factor 1 and Commercial real estate loans

Source: Author's own calculations

Figure 4.1.4 reinforces the statement made above that the adverse effects of the crisis led households to rid themselves of excessive burdens they could no longer afford. The drop in residential investment indicates inverse co-movement with factor one as one can clearly observe that the residential investment as percentage of GDP indicator takes a significant dive as the effects of the crisis becomes a reality. The first warning signals occur around 2006Q1 in Portugal and is then reinforced by the sharp downturn of residential investment in Ireland around 2007Q1.

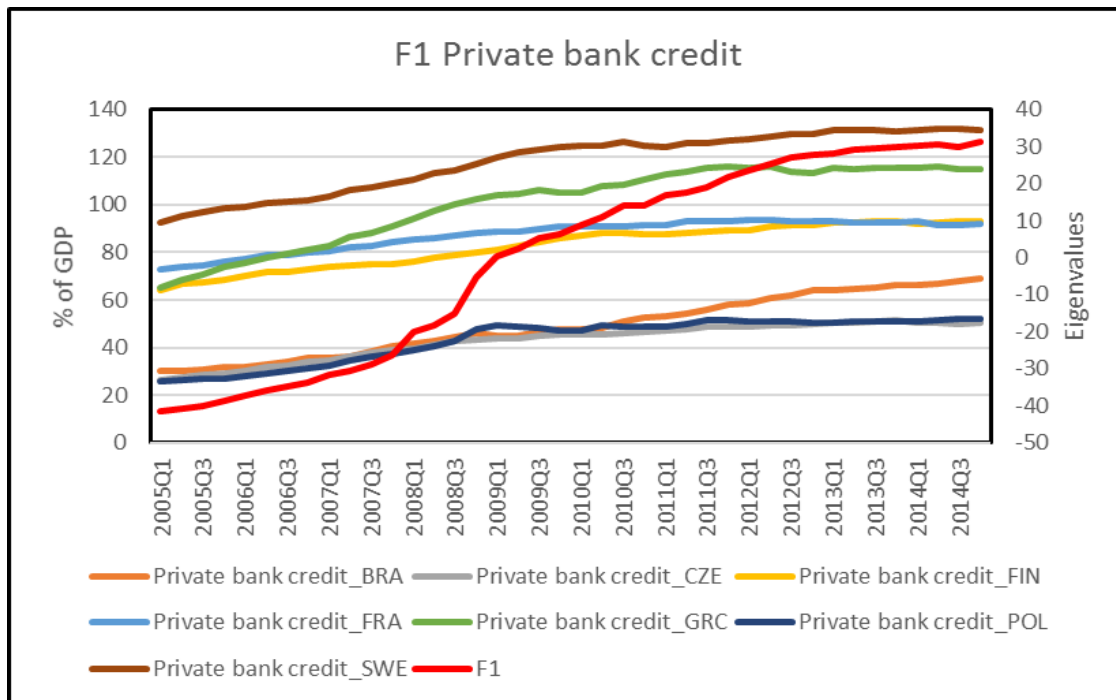


Figure 4.1.5: Factor 1 and Private bank credit

Source: Author's own calculations

Dynamic factor analysis also identified strong co-movement between private bank credit as a percentage of GDP and the aforementioned indicators that form factor 1. Private bank credit as a percentage of GDP indicates lending from domestic bank sectors to the private non-financial sector.

4.4.1.1 Summary on factor 1

Factor one is largely made up out of credit extension related non-financial sector imbalances such as household credit, total private credit and private bank credit. There are a number of other variables also embedded in factor one, with the second most prominent being asset market imbalances in the sense of residential investment, employment share in construction as well as the house-price-to-rent ratio. A more extensive range of figures for factor one can be found in Appendix C.

Strong credit growth has been recognised as one of the most robust early warning indicators of financial crises (e.g. Borio and Lowe (2002); Borio and Drehmann (2009); Kaminsky *et al.* (1998); as well as Reinhart and Rogoff (2008)). During the build-up to the global financial crisis, private and household debt grew rapidly (Sutherland & Hoeller, 2012:7). As discussed earlier in this dissertation, the rapid increase of private and household debt was largely triggered by financial deregulation and innovation of finance, such as the appearance of mortgage securitisation which allowed large amounts of money to be channelled into the

mortgage market. It also helped facilitate the extension of mortgage credit to lower income groups. Vulnerabilities on the balance sheets of non-financial firms and households can spill-over to the financial sector as was the case with the global financial crisis. Rapid credit growth tends to be accompanied by deregulation and a loosening of credit requirements to riskier clients such as lower income groups. This was exactly the case in the global financial crisis as it all started off with the defaults of borrowers in the subprime mortgage market of the US. This resulted in liquidity shortages as well as solvency issues in the financial sector. Ultimately, the financial sector amplified these vulnerabilities through the subsequent credit crunch forcing the non-financial sector to unwind on a global scale (Rohn *et al.*, 2015:13).

The strong presence of credit related vulnerabilities in factor 1 is therefore justified and consistent with the findings of Hermansen and Rhon (2015:13) that credit and asset market indicators prove to be particularly useful in predicting oncoming financial crises. Domestic credit indicators emphasise the importance of unsustainable domestic credit booms within the global financial crisis as early warning indicators.

4.4.2 Factor 2

The variance shares as per DFA for factor two will follow on the next page. Only variables with a variance share of 75 percent and higher were taken into account. The variance share threshold was lowered from 90 percent to 75 percent to make the pool of variables used to determine factor two larger to ensure more accurate results.

Table 4.2: Variance shares of factor two, 2005Q1 – 2014Q4

		Non-financial corporations foreign currency denominated					
External bank debt_HUN	0.918422	liabilities_HUN	0.846118	Short-term external bank debt_KOR	0.809440	Official foreign reserves_RUS	0.774998
Household credit_GBR	0.916403	External bank debt_IRL	0.837328	FDI liabilities_EST	0.805408	FDI liabilities_JPN	0.772934
External debt bias_EST	0.915772	External debt_NZL	0.824767	External debt bias_CZE	0.799668	Household credit_ESP	0.762068
Total private credit_GBR	0.910213	Corporate credit_GBR	0.816708	Short-term external bank debt_HUN	0.798864	Residential real estate loans_DNK	0.761601
Private bank credit_ESP	0.894439	External bank debt_LVA	0.815143	Household foreign currency denominated liabilities_GBR	0.793012	Household credit_IRL	0.760287
Non-financial corporations foreign currency denominated liabilities_DNK	0.882135	Private bank credit_HUN	0.813334	Private bank credit_IRL	0.784933	FDI liabilities_LTU	0.760083
External bank debt_KOR	0.855058	External debt_EST	0.812589	Private bank credit	0.775832		

Source: Authors own calculations

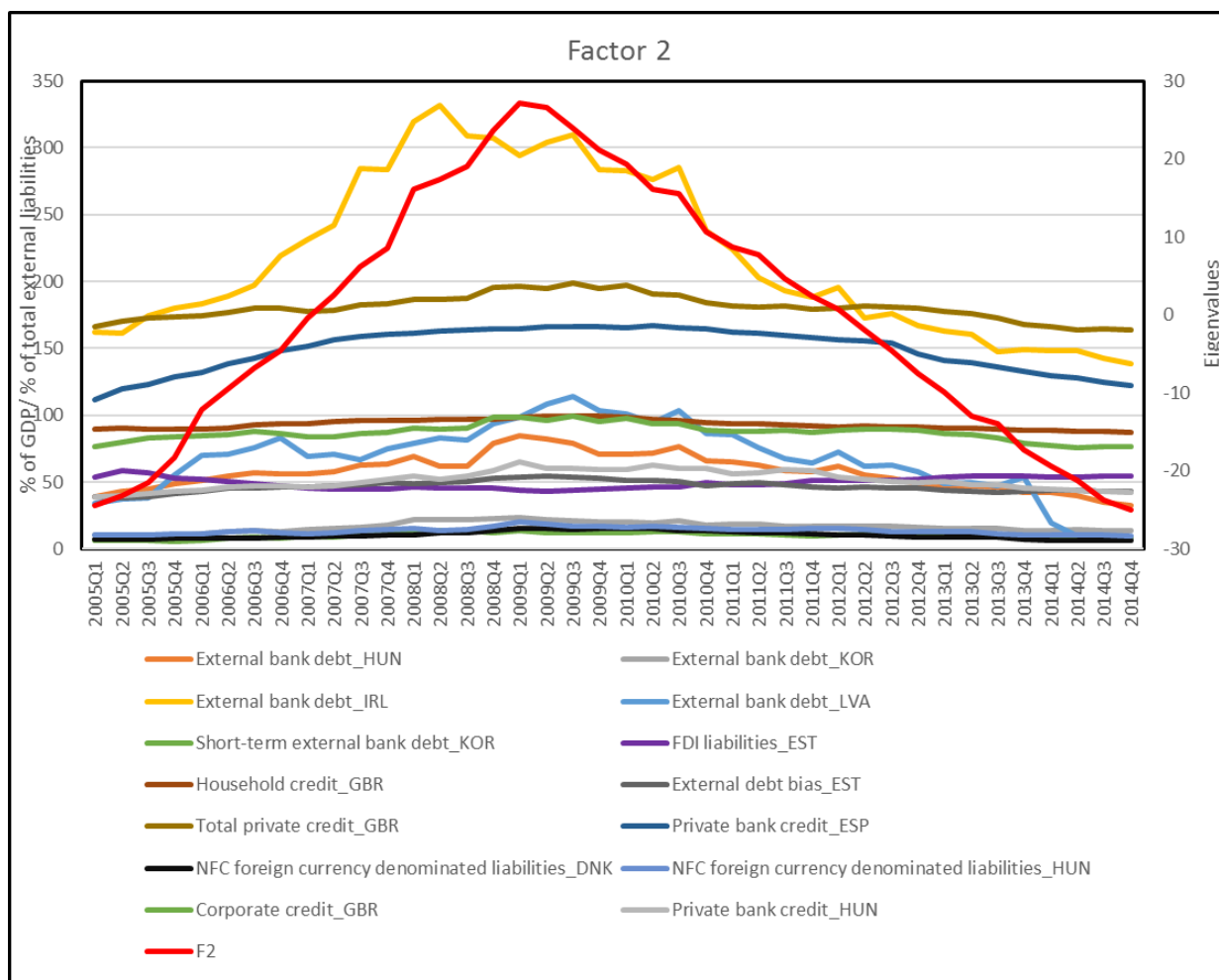


Figure 4.2: Factor 2

Source: Author's own calculations

Figure 4.2 indicates the co-movement of variables measured as percentage of GDP except for External debt bias_EST which is measured as a percentage of total external liabilities to form factor 2. Factor 2 starts off in a relatively strong upward trend and gains even more momentum around 2005Q3 forming a strong spike continuing up to 2009Q1 when it loses momentum and plunges back to the initial starting level of 2005Q1. Factor 2 starts off with some degree of upward momentum, but the strong spike starting 2005Q3 can be seen as an early warning sign well before the onset of the global financial crisis. This leaves policy makers with ample time to react on the oncoming crisis. The shape factor 2 takes on is also an accurate representation of the global financial crisis where the crisis started off gradually then gaining strong momentum to reach its peak at the end of 2008/early 2009. After the peak phase, the curve dies down as remedial policies take effect and their outcome becomes visible.

Factor 2 is made up out of credit related non-financial sector imbalances in conjunction with external sector imbalances. The core vulnerability indicators for factor 2 include private bank credit, household credit, total private credit and non-financial corporations' foreign currency denominated liabilities on the credit related non-financial sector side. For the external sector imbalance indicators, factor 2 includes external bank debt, FDI liabilities and short-term external bank debt.

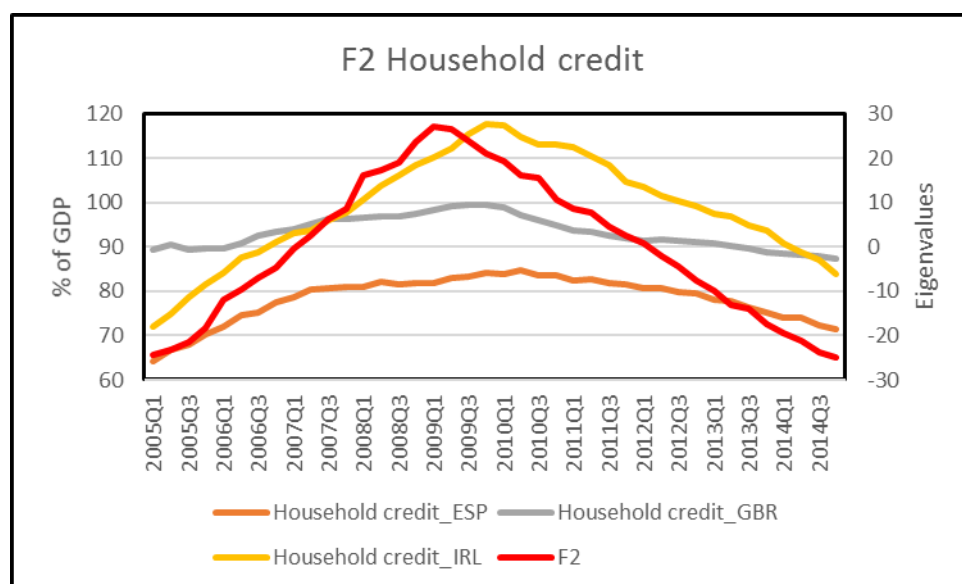


Figure 4.2.1: Factor 2 and Household credit

Source: Author's own calculations

A clear and relatively strong relationship can be observed between household credit and factor 2. The household credit ratio can be explained as follows; the lending from all sectors (including foreign) to households in per cent of GDP. The shape of the curves thus makes sense as household credit grew in a strong fashion in the build-up to the financial crisis, where it reached its peak in the height of the global financial crisis. Thereafter the ratio decreases as remedial policies bring relief for consumers.

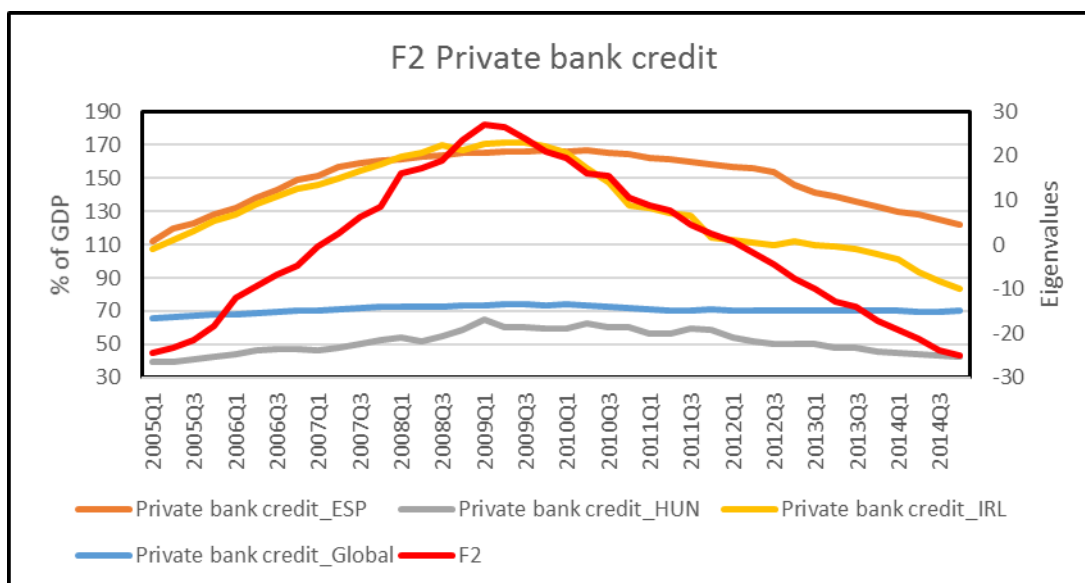


Figure 4.2.2: Factor 2 and Private bank credit

Source: Author's own calculations

Private bank credit can be seen as the counterpart to household credit as it is mostly private banks that extend credit to households. Therefore, a similar pattern than household credit can be expected.

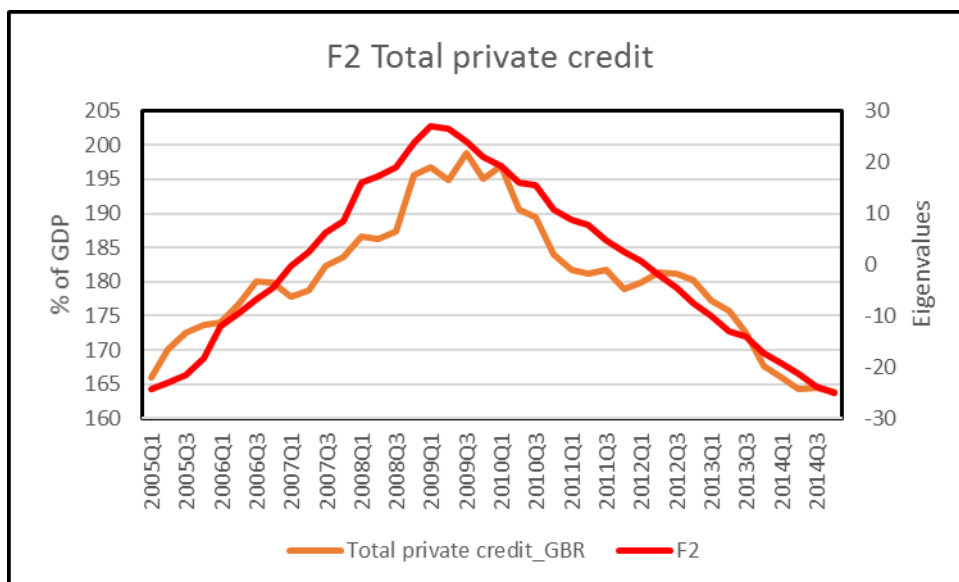


Figure 4.2.3: Factor 2 and Total private credit

Source: Author's own calculations

Total private credit is defined as the total sum of lending from all sectors (this includes foreign sources) to private non-financial borrowers in per cent of GDP. Co-movement with factor 2 and total private credit is clearly visible. High levels of private sector debt can threaten

sustainable economic growth. Within countries that are experiencing financial booms, households and firms are in a vulnerable position as the risk of financial distress and macroeconomic strains are ever present. Countries that were hit the hardest by the crisis, still have high levels of private debt relative to output, making households and firms sensitive to increases in interest rates. These countries could find themselves in a debt trap: seeking to stimulate the economy through low interest rates, which encourages the taking-on of even more debt, ultimately adding to the problem it is meant to solve.

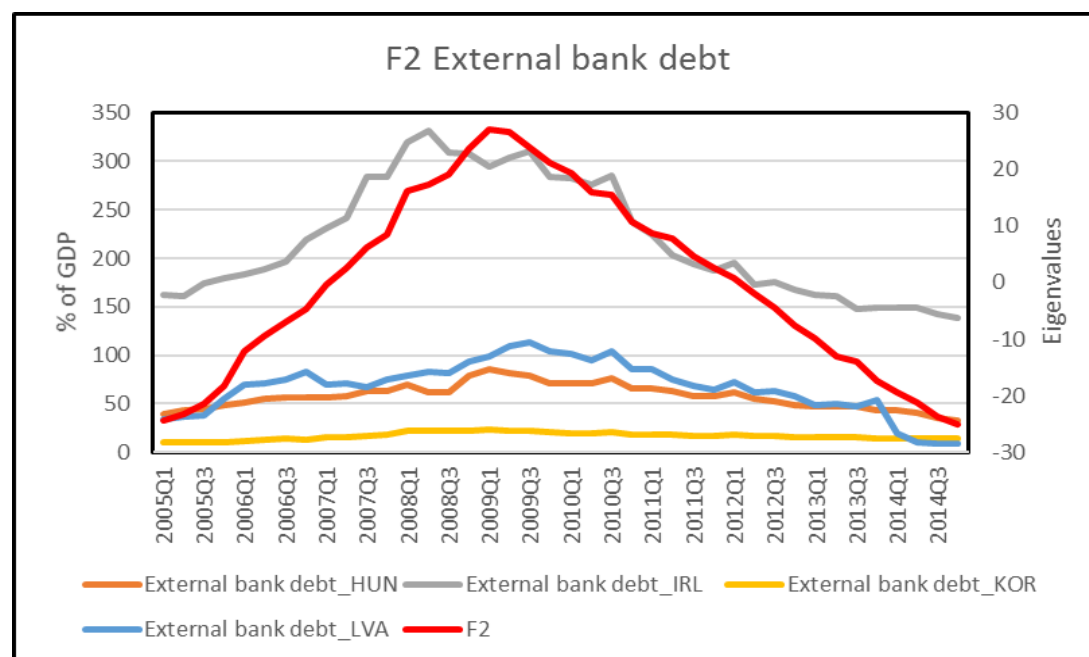


Figure 4.2.4: Factor 2 and External bank debt

Source: Author's own calculations

External bank debt is the total debt liabilities towards BIS reporting banks in per cent of GDP. Both external bank debt and short-term external bank debt are indicators of integration through international bank lending. International lending amplifies contagion shocks and increases the risk of financial crises.

4.4.2.1 Summary of factor 2

Factor 2 is derived out of external sector imbalances in the likes of external bank debt, short-term external bank debt, FDI liabilities as well as official foreign reserves. Factor 2 also includes similar vulnerability indicators to that of factor 1 as some of the non-financial sector imbalances were also identified to be useful early warning indicators. These vulnerability indicators include; household credit, total private credit and private bank credit. A more extensive range of figures for factor two can be found in Appendix C. The fact that these credit related vulnerabilities feature in both factors, emphasises the usefulness of these indicators

to serve as early warning indicators. As previously mentioned these findings are in line with results gathered from Hermansen and Rhon (2015) in the sense of being indicators that can be monitored to serve as early warning indicators. The DFA model also indicates that external sector imbalances can potentially serve as a useful early warning indicator. Bernanke (2009) found that external imbalances feature prominently among the potential causes of both the global financial crisis of 2008 as well as the sovereign debt crisis in the Eurozone (Chen, *et al.*, 2012).

4.5 Conclusion

By making use of Dynamic factor analysis, the core variables that can aid in forecasting future financial crises were identified. The DFA model facilitated the process of data reduction and grouped variables that co-vary with one another and can potentially serve as early warning indicators to warn policymakers of oncoming crises. Both factor one and two include credit related non-financial sector imbalance indicators as the main factors that tend to co-vary. More specifically, these factors include household credit, private bank credit and total private credit. However, the majority of the variables that were identified by the model as part of factors one and two, were also found to be useful as early warning indicators by Hermansen and Rhon (2015).

CHAPTER 5: CONCLUSION

5.1 Introduction

Financial crises have been an unfortunate part of financial industry since the start of the modern financial industry and even before that. History has painted a very clear picture regarding the costly and repetitive nature of financial crises. Reinhart and Rogoff (2010) described financial crises aptly when they claimed that financial crises can have domestic or external origins, and stem from the private or the public sector. They come in different shapes and sizes, evolve into different forms, and can rapidly spread across borders. They often require immediate and comprehensive policy responses, call for major changes in financial sector and fiscal policies, and can compel global coordination of policies. Due to the large costs associated with financial crises, the construction of a monitoring tool such as early warning systems are crucial. Early warning signals of a possible oncoming crisis can enable policy makers to act accordingly. Early warning signals in its own right will most probably not avoid an oncoming financial crisis as the signals will arise from vulnerability indicators suggesting that the symptoms are on the rise if not already existing. Early warning signals will however enable policy makers to react to possible warning signals, which can potentially limit the ultimate effects of a crisis.

To this end, this study analysed potential vulnerabilities that could be monitored to serve as early warning indicators of oncoming financial crises. A common feature of all existing early warning signals is the use of fundamental determinants of the domestic and external sectors as explanatory variables. These fundamental determinants were then grouped by Rohn *et al.* (2015) into five domestic areas: 1) financial sector imbalances, 2) non-financial sector imbalances, 3) asset market imbalances, 4) public sector imbalances and 5) external sector imbalances, and an additional international “spill-over” category was added to account for contagion as well as global risks. The grouping of fundamental determinants serves as a way to simplify the vast number of possible indicators that can be used as early warning indicators. In this study, further data reduction measures were applied with the help of a dynamic factor model to pool variables with similar co-movement together to create a smaller number of factors that encompasses a wider variety of indicators which indicate similar co-movement.

The dataset used (compiled by Rohn *et al.*, 2015) already included a number of significant indicators that can serve as early warning indicators as Hermansen and Rhön (2015) found that the majority of these vulnerability indicators included in their dataset could serve as plausible early warning indicators. With this dataset as a base, this study re-evaluated the data and processed the data through a dynamic factor model, allowing a large fraction of the data to be explained by a small number of factors (Sargent & Sims, 1977).

5.2 Conclusion

The main aim of the study was to re-examine the 70+ indicators identified by Rohn *et al.* (2015) to identify parsimonious indicators of financial crises. The dynamic factor model used identified indicators that co-vary between countries and over time. The ABC criteria implemented to determine the number of static factors suggested that two static factors be used. The two factors specified was then identified as i) factor 1; private non-financial sector imbalances which includes asset market imbalances and ii) factor 2; private non-financial sector imbalances however, more focused on private bank credit and external debt whereas factor 1 is more concerned with household and private credit.

More specifically, factor 1 mainly comprises credit-related private non-financial sector imbalances such as household credit as percentage of GDP, total private credit as percentage of GDP, private bank credit as percentage of GDP, corporate credit as percentage of GDP. Factor 1 is also strongly represented by asset market imbalance indicators. The asset market imbalance indicators include residential investment, employment share in construction and the house-price-to-rent ratio. These indicators are relevant in the build-up to periods of financial crisis as they would usually experience drastic changes from pre-crisis periods to times of actual financial crisis. These indicators were also pooled together because of their similar co-movement during periods of shock.

Factor 2 consists of similar credit-related non-financial sector imbalances in combination with external sector imbalances. The highest degree of co-movement between indicators for factor 2 includes private bank credit, household credit, total private credit and non-financial corporation's foreign currency denominated liabilities on the credit related non-financial sector side. For the external sector imbalance indicators, factor 2 includes external bank debt, FDI liabilities and short-term external bank debt. Once again, these vulnerability indicators are most likely to experience similar radical co-movement during the build-up phase to financial crises as well as times of actual financial crisis.

The majority of the indicators that were identified by the dynamic factor model as part of factors one and two, was also found to be useful as early warning indicators by Hermansen and Rhon (2015). However, the dynamic factor model simplified the monitoring process as the two factors identified encompasses a large number of useful early warning indicators proposed by Hermansen and Rhön (2015). Subsequently, these two factors could in theory be monitored rather than a large set of variables acting as a drain on precious resources.

5.3 Recommendations for future research

The majority of vulnerability indicators within the proposed dataset is domestic indicators. Whilst this is not necessarily bad, as country specific vulnerabilities can be addressed, the high level of interconnectedness of the global economy calls for more emphasis to be put on global vulnerabilities. Future research should include a wider variety of global vulnerability indicators to account for interconnectedness and contagion. Global indicators in this study were few and due to the nature of dynamic factor analysis, limited co-movement between the identified factors and global indicators could be established.

The study indicated that the process of data reduction through dynamic factor analysis whilst still achieving accurate results is plausible as the DFM pooled co-varying indicators together as indicators of financial crises. Indicators of financial crises are therefore confirmed; however, the actual usage of these indicators as early warning signals are still widely debated. Additional research regarding the implementation of these indicators as early warning signals should be investigated – more specifically, regarding the timing of crises.

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Appendix A – List of variables

List of vulnerability Indicators								
Sector	Indicator	Used in dissertation	No. countries	Earliest obs.	Latest obs.	Frequency	Detailed definition	Source
Financial	Financial sector gross financial liabilities	No	30	1970	2014	Annual	Liabilities less financial derivatives, and shares and other equity; in per cent of GDP. Based on consolidated data for most countries.	OECD National Accounts
Financial	Leverage ratio	Yes	37	2001M1	2015M8	A/Q/M	Regulatory Tier 1 capital to total (unweighted) assets. Note: Israel (2008q1, 2008q3, 2011q1, 2011q2) not shown because of abnormal values.	IMF Financial Soundness Indicators
Financial	Capital ratio (regulatory capital)	Yes	42	2001M1	2015M8	A/Q/M	Regulatory capital to risk-weighted assets.	IMF Financial Soundness Indicators
Financial	Capital ratio (regulatory Tier 1 capital)	Yes	42	2001M1	2015M8	A/Q/M	Regulatory Tier 1 capital to risk-weighted assets.	IMF Financial Soundness Indicators
Financial	Shadow banking 1 (in per cent of total assets)	Yes	23	2000	2015M8	A/Q/M	Other financial corporations' assets to total financial sector assets.	IMF Financial Soundness Indicators
Financial	Shadow banking 2 (in per cent of GDP)	Yes	25	2000	2015M8	A/Q/M	Other financial corporations' assets to GDP.	IMF Financial Soundness Indicators
Financial	Return on assets	Yes	42	1997Q1	2015M8	A/Q/M	Net income before extraordinary items and taxes divided by average value of total assets (financial and nonfinancial) over the same period.	IMF Financial Soundness Indicators
Financial	Return on equity	Yes	42	1997Q1	2015M8	A/Q/M	Net income before extraordinary items and taxes divided by average value of capital over the same period. Capital is measured as total capital and reserves reported in the sectoral balance sheet.	IMF Financial Soundness Indicators

Sector	Indicator	Used in dissertation	No. countries	Earliest obs.	Latest obs.	Frequency	Detailed definition	Source
Financial	Lending standards for enterprises	Yes	9	2003Q1	2015Q4	Quarterly	Change in credit standards (tightened or eased) for enterprises the last three months. Weighted net percentage change based on the share of each bank in the total loan outstanding amount of the banks in the sample.	ECB
Financial	Liquidity ratio 1 (in per cent of total assets)	Yes	40	2001M1	2015M8	A/Q/M	Liquid assets to total assets.	IMF Financial Soundness Indicators
Financial	Liquidity ratio 2 (in per cent of short-term liabilities)	Yes	39	2001M1	2015M8	A/Q/M	Liquid assets to short-term liabilities.	IMF Financial Soundness Indicators
Financial	Loan-to-deposit ratio	Yes	33	1996Q2	2015M8	A/Q/M	Total (non-interbank) gross loans to customer deposits.	IMF Financial Soundness Indicators
Financial	Foreign currency mismatch	Yes	33	2002Q4	2015M8	A/Q/M	Net open position in foreign exchange to regulatory capital.	IMF Financial Soundness Indicators
Financial	Housing loans	Yes	32	2000Q4	2015M8	A/Q/M	Residential real estate loans in per cent of total loans.	IMF Financial Soundness Indicators
Financial	Commercial real estate loans	Yes	21	1997Q1	2015M4	A/Q/M	Loans collateralized by commercial real estate, loans to construction companies and loans to companies active in the development of real estate; in per cent of total loans.	IMF Financial Soundness Indicators
Financial	Domestic sovereign bonds	Yes	7	2005Q4	2015Q1	A/Q/M	Domestic government securities owned (market value); in per cent of total assets.	IMF Financial Soundness Indicators

Sector	Indicator	Used in dissertation	No. countries	Earliest obs.	Latest obs.	Frequency	Detailed definition	Source
Non-financial	Total private credit	Yes	33	1970Q1	2015Q1	Quarterly	Lending from all sectors (including foreign lending) to private non-financial sector; in per cent of GDP.	BIS
Non-financial	Private bank credit	Yes	33	1970q1	2015Q1	Quarterly	Lending from domestic bank sector to private non-financial sector; in per cent of GDP.	BIS
Non-financial	Other sector external debt	Yes	43	1998Q1	2015Q2	Quarterly	Households, non-financial corporations and non-deposit taking financial corporations' external debt; in per cent of GDP.	World Bank Quarterly External Debt Statistics
Non-financial	Household credit	Yes	31	1970Q1	2015Q1	Quarterly	Lending from all sectors (including foreign) to households and NPISHs; in per cent of GDP.	BIS
Non-financial	Household gross financial liabilities	No	26	1970	2014	Annual	Liabilities less financial derivatives, and shares and other equity; in per cent of net household disposable income. Based on consolidated data for most countries.	OECD National Accounts
Non-financial	Household debt service costs	Yes	13	2000	2015Q2	A/Q	Household debt service payments (interest and principal) to gross disposable income.	IMF Financial Soundness Indicators
Non-financial	Household foreign currency denominated liabilities	Yes	23	1999Q1	2015Q3	Quarterly	Households and NPISHs. Outstanding amounts at the end of the period (stocks); in per cent of GDP. All currencies other than domestic (Non-euro and non-euro area currencies combined).	ECB
Non-financial	Household short term loans (<1 year)	Yes	25	1989Q4	2014Q1	Quarterly	Household short-term loans in per cent of total household loans.	OECD National Accounts
Non-financial	Corporate credit	Yes	31	1970Q1	2015Q1	Quarterly	Lending from all sectors (including foreign) to non-financial corporations; in per cent of GDP.	BIS

Sector	Indicator	Used in dissertation	No. countries	Earliest obs.	Latest obs.	Frequency	Detailed definition	Source
Non-financial	Non-financial corporation gross financial liabilities	No	30	1970	2014	Annual	Liabilities less financial derivatives, and shares and other equity; in per cent of GDP. Based on consolidated data for most countries.	OECD National Accounts
Non-financial	Corporate foreign currency denominated liabilities	Yes	23	1999Q1	2015Q3	Quarterly	Non-financial corporations. Outstanding amounts at the end of the period (stocks); in per cent of GDP. All currencies other than domestic (Non-euro and non-euro area currencies combined).	ECB
Non-financial	Non-financial corporation short-term liabilities	No	26	1970	2014	Annual	Short-term debt securities plus short-term loans; in per cent of total corporate liabilities. Based on consolidated data for most countries.	OECD National Accounts

Sector	Indicator	Used in dissertation	No. countries	Earliest obs.	Latest obs.	Frequency	Detailed definition	Source
Asset market	Real house prices	Yes	41	1970Q1	2015Q3	Quarterly	Deflated using the private consumption deflator from the national account statistics; index 2010 = 100.	OECD Housing Prices database
Asset market	Price to disposable income ratio	Yes	32	1970Q1	2015Q3	Quarterly	Nominal house prices to nominal net disposable income per capita; index 2010 = 100.	OECD Housing Prices database
Asset market	Price to rent ratio	Yes	35	1970Q1	2015Q3	Quarterly	Nominal house prices to rent prices; index 2010 = 100.	OECD Housing Prices database
Asset market	Residential investment	Yes	37	1970Q1	2015Q3	Quarterly	Gross fixed capital formation, housing; in per cent of GDP.	OECD Economic Outlook database
Asset market	Share of employment in the construction sector	Yes	33	1970Q1	2015Q3	Quarterly	Employment in construction sector in per cent of total employment (age 15+), seasonally adjusted.	OECD Labour Force Statistics
Asset market	Real stock prices	Yes	42	1970Q1	2015Q3	Quarterly	Broad share price index deflated by consumer price index.	OECD Monthly Economic Indicators

Sector	Indicator	Used in dissertation	No. countries	Earliest obs.	Latest obs.	Frequency	Detailed definition	Source
Fiscal	Primary budget balance	No	33	1970	2014	Annual	Cyclically adjusted government primary budget balance; in per cent of GDP.	OECD Economic Outlook database
Fiscal	Government budget balance	No	42	1970	2014	Annual	Government net lending; in per cent of GDP.	OECD Economic Outlook database
Fiscal	Government gross debt	Yes	32	1970Q1	2015Q2	Quarterly	General government gross financial liabilities; in per cent of GDP.	OECD Economic Outlook database
Fiscal	Real bond yield - potential growth rate (r-g)	Yes	38	1980Q2	2015Q3	Quarterly	Real 10-year sovereign bond yield less annualised growth rate of potential GDP.	OECD Economic Outlook database
Fiscal	Future public spending on pensions	No	39	2010	2060	Annual	Projections of public pension expenditures; in per cent of GDP.	OECD Pensions at a Glance 2013
Fiscal	Future public spending on health and long-term care	No	40	2060	2060	Annual	Projections of health and long-term care costs; in per cent of GDP.	de la Maisonnette and Oliveira Martins (2013)
Fiscal	Projected old-age support ratio	No	42	1950	2100	Annual	Number of people in working age (20-64) relative to the number of people in retirement age (65+).	OECD Pensions at a Glance 2013
Fiscal	Gross government financing needs	Yes	16	1995Q1	2015Q2	Quarterly	Public budget deficit + short-term debt + long-term debt with maturity < 1y; general government; in per cent of GDP.	World Bank Quarterly Public-Sector Debt and OECD Economic Outlook database
Fiscal	Short-term government debt	Yes	16	1995Q1	2015Q2	Quarterly	Short-term debt by original maturity + long-term debt with maturity < 1y; general government; in per cent of gross general government debt. Note: Spain not shown because of inconsistent series.	World Bank Quarterly Public-Sector Debt
Fiscal	Government debt denominated in foreign currency	Yes	21	1995Q1	2015Q2	Quarterly	Gross general government debt denominated in foreign currency in per cent of gross general government debt.	World Bank Quarterly Public-Sector Debt

Sector	Indicator	Used in dissertation	No. countries	Earliest obs.	Latest obs.	Frequency	Detailed definition	Source
Fiscal	External government debt	Yes	34	1998Q1	2015Q2	Quarterly	Gross external general government debt in per cent of total gross general government debt.	World Bank Quarterly External Debt Statistics; World Bank Quarterly Public-Sector Debt
Fiscal	Short-term external government debt	Yes	31	1998Q1	2015Q2	Quarterly	Gross short-term external general government debt in per cent of total gross general government debt.	World Bank Quarterly External Debt Statistics; World Bank Quarterly Public-Sector Debt
Fiscal	Government contingent liabilities (excl. guarantees to financial institutions)	No	21	2013	2013	Annual	Cumulative government contingent liabilities excluding guarantees to financial institutions; in per cent of GDP.	Eurostat
Fiscal	Government contingent liabilities (guarantees)	No	22	2010	2013	Annual	Government guarantees; in per cent of GDP.	Eurostat
Fiscal	Government contingent liabilities (PPP)	No	15	2010	2013	Annual	Liabilities related to private-public partnerships recorded off-balance sheet of government; in per cent of GDP.	Eurostat
Fiscal	Government contingent liabilities (gov.-controlled entities)	No	22	2012	2013	Annual	Liabilities of government-controlled entities classified outside general government; in per cent of GDP.	Eurostat
Fiscal	Government contingent liabilities (guarantees to financial institutions)	No	17	2007	2014	Annual	Guarantees to financial institutions; in per cent of GDP.	Eurostat

Sector	Indicator	Used in dissertation	No. countries	Earliest obs.	Latest obs.	Frequency	Detailed definition	Source
External	Current account balance	Yes	44	1970Q1	2015Q3	Quarterly	Current account balance in per cent of GDP.	OECD Economic Outlook database
External	External debt (in per cent of GDP)	Yes	43	1975Q1	2015Q2	Quarterly	External debt in per cent of GDP. Note: influenced by location of financial institutions. E.g. very high ratios for LUX, NLD and GBR.	IMF International Financial Statistics
External	External debt bias (in per cent of external liabilities)	Yes	43	1975Q1	2015Q2	Quarterly	External debt in per cent of total external liabilities.	IMF International Financial Statistics
External	External bank debt	Yes	44	1990Q2	2015Q1	Quarterly	Debt liabilities towards BIS reporting banks (consolidated, immediate borrower basis); in per cent of GDP.	BIS
External	Short-term external bank debt 1 (in per cent of GDP)	Yes	44	1990Q2	2015Q1	Quarterly	Short-term debt liabilities towards BIS reporting banks with maturity up to and including one year (consolidated, immediate borrower basis); in per cent of GDP.	BIS
External	Short-term external bank debt 2 (in per cent of total external bank debt)	Yes	44	1990Q2	2015Q1	Quarterly	Short-term debt liabilities towards BIS reporting banks with maturity up to and including one year (consolidated, immediate borrower basis); in per cent of total debt liabilities towards BIS reporting banks.	BIS

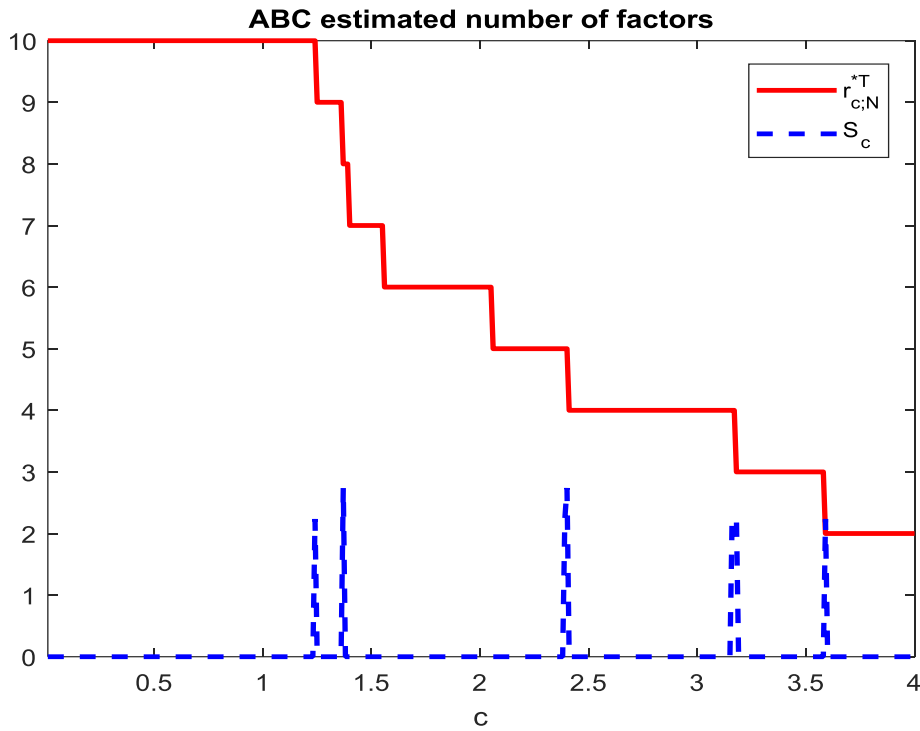
Sector	Indicator	Used in dissertation	No. countries	Earliest obs.	Latest obs.	Frequency	Detailed definition	Source
External	FDI liabilities	Yes	43	1975Q1	2015Q2	Quarterly	Direct investment liabilities, not seasonally adjusted, in per cent of total external liabilities.	IMF International Financial Statistics
External	Foreign currency exposure index	No	42	1990	2012	Annual	Index of the sensitivity of a country's portfolio to a uniform currency movement by which the domestic currency moves proportionally against all foreign currencies. Index between -1 (zero foreign-currency foreign assets and only foreign-currency foreign liabilities) and 1 (only foreign-currency foreign assets and only domestic-currency foreign liabilities).	Benetrix, Lane and Shambaugh (2015)
External	Quantitative foreign currency exposure	No	42	1990	2012	Annual	Quantitative exposure to a uniform shift in the value of the domestic currency against all foreign currencies. It is calculated as the foreign currency exposure index (see above) multiplied by the sum of foreign assets and liabilities in per cent of GDP.	Benetrix, Lane and Shambaugh (2015)
External	Official foreign exchange reserves	Yes	44	1970Q1	2015Q3	Quarterly	Official foreign exchange reserves in per cent of GDP.	IMF International Financial Statistics
External	Official foreign exchange reserves to total external debt	No	10	1971	2013	Annual	Official foreign exchange reserves in per cent of total external debt.	World Development Indicators
External	M2 (money and quasi money) to foreign reserves	No	44	1970	2014	Annual	Money and quasi money (M2) to official foreign exchange reserves ratio.	World Development Indicators

Sector	Indicator	Used in dissertation	No. countries	Earliest obs.	Latest obs.	Frequency	Detailed definition	Source
External	Official foreign exchange reserves in months of import	No	44	2005	2014	Annual	Official foreign exchange reserves in months of import.	World Development Indicators
External	Real effective exchange rate (consumer prices)	Yes	44	1970Q1	2015Q3	Quarterly	Competitiveness indicator. Relative consumer prices (CPI), overall weights based on exports of goods.	OECD Economic Outlook database
External	Real effective exchange rate (unit labour costs)	Yes	44	1970Q1	2015Q3	Quarterly	Competitiveness indicator. Relative unit labour costs (ULC) for overall economy and overall weights based on exports of goods.	OECD Economic Outlook database
External	Export performance	Yes	44	1975Q1	2015Q3	Quarterly	Exports of goods and services relative to export market for goods and services.	OECD Economic Outlook database

Sector	Indicator	Used in dissertation	No. countries	Earliest obs.	Latest obs.	Frequency	Detailed definition	Source
Global	Trade openness	Yes	44	1970Q1	2015Q3	Quarterly	Sum of export and import in per cent of GDP.	OECD Economic Outlook database
Global	Financial openness	Yes	43	2005Q1	2015Q2	Quarterly	Sum of total external assets and liabilities in per cent of GDP.	IMF International Financial Statistics
Global	Global weighted average: Total private credit	Yes	N/A	1970Q1	2015Q1	Quarterly	Weighted average of private credit indicator (see above) across countries for each quarter; weights defined by nominal GDP at Purchasing Power Parity (PPP).	BIS
Global	Global weighted average: Total private bank credit	Yes	N/A	1970Q1	2015Q1	Quarterly	Weighted average of private bank credit indicator (see above) across countries for each quarter; weights defined by nominal GDP at Purchasing Power Parity (PPP).	BIS
Global	Global weighted average: Real stock price index	Yes	N/A	1970Q1	2015Q3	Quarterly	Weighted average of real stock price index (see above) across countries for each quarter; weights defined by nominal GDP at Purchasing Power Parity (PPP).	OECD Monthly Economic Indicators
Global	Global weighted average: Real house prices	Yes	N/A	1970Q1	2015Q2	Quarterly	Weighted average of real house prices index (see above) across countries for each quarter; weights defined by nominal GDP at Purchasing Power Parity (PPP).	OECD Housing Prices database

Appendix B – Data Analysis

B.1 ABC criteria



The process for selecting the number of static factors explores the behaviour of the variance of the estimated number of factors for N and T going to infinity, for a whole interval of values for the constant c . When the constant is equal to zero, the variance is also equal to zero and the number of factors is set to the maximum number of static common factors. As the constant increases, stability intervals can be observed as well as values of c that vary significantly. As the constant increases, penalisation is applied. To ensure an effective penalty function, stability intervals for which no dependence on the sample size is present (where the variance is equal to zero) is chosen. Furthermore, a constant number of factors for N and T for all values of c in the considered intervals is required. This number is the estimated number of static factors. As the constant increases, the solid line provides the suggested number of factors. A plateau of the solid line means a region where the suggested number of factors is stable across different values of c . On the other side, the dashed line provides a measure of the instability when different subsamples of the dataset are considered. When the dashed line goes to zero, the value provided by the solid line is stable across different subsamples, i.e. is not biased by the whole sample size. Therefore, we have to choose the smallest value of c for which both a plateau of the solid line (not including the extreme left one) and a zero of the dashed line occurs (Alessi *et al.*, 2008:10)

B.2 Co-movement between crisis period and vulnerability indicators

Table B.2: Variance shares before DFA, 2005Q1 – 2014Q4

Liquidity ratio 2_USA	0.976104	Real house prices_ITA	0.960136	Short-term external bank debt_BEL	0.955529	Total private credit_GRC	0.971706
Household credit_USA	0.973149	House prices-to-rent ratio_ITA	0.953800	Short-term external bank debt_BEL	0.967681	Private bank credit_GRC	0.977617
Residential investment_USA	0.980990	Export performance_ITA	0.978455	FDI liabilities_BEL	0.966064	Household credit_GRC	0.954272
Gross general government debt_USA	0.974769	Gross general government debt_GBR	0.985340	Total private credit_CZE	0.974975	Corporate credit_GRC	0.964784
External government debt_USA	0.969628	Official foreign reserves_GBR	0.965031	Private bank credit_CZE	0.971232	Real house prices_GRC	0.986924
Total private credit_FRA	0.983038	Total private credit_CAN	0.962641	Household credit_CZE	0.981726	House prices-to-rent ratio_GRC	0.973022
Private bank credit_FRA	0.976785	Household credit_CAN	0.974456	Gross general government debt_CZE	0.987483	Employment share in construction_GRC	0.984513
Household credit_FRA	0.982844	Gross general government debt_AUS	0.995286	External debt_CZE	0.953110	External debt_GRC	0.971343
Corporate credit_FRA	0.966616	Short-term general government debt_AUS	0.979086	Total private credit_DNK	0.958144	Financial openness_GRC	0.952655
Gross general government debt_FRA	0.986837	Real house prices_AUT	0.970869	Private bank credit_DNK	0.954038	Household foreign currency denominated liabilities_HUN	0.965185
Capital ratio_ITA	0.970383	House prices-to-income ratio_AUT	0.979992	Household credit_DNK	0.955671	Employment share in construction_HUN	0.961484
Tier 1 capital ratio_ITA	0.970337	Gross general government debt_AUT	0.950933	Total private credit_FIN	0.970198	Gross general government debt_HUN	0.984725
Total private credit_ITA	0.978528	Total private credit_BEL	0.953370	Private bank credit_FIN	0.981915	External debt_ISL	0.962415
Household credit_ITA	0.965229	Household credit_BEL	0.978445	Household credit_FIN	0.964946	Total private credit_IRL	0.973149
Corporate credit_ITA	0.963071	External debt bias_BEL	0.977031	Gross general government debt_FIN	0.970722	Private bank credit_IRL	0.955712

Household credit_IRL	0.950170	Official foreign reserves_MEX	0.953663	Residential investment_PRT	0.983162	Total private credit_CHE	0.979500
Corporate credit_IRL	0.976382	Real house prices_NLD	0.971230	Employment share in construction_PRT	0.960569	Household credit_CHE	0.961480
Non-financial corporation's foreign currency denominated liabilities_IRL	0.951990	House prices-to-income disposable ratio_NLD	0.966933	Gross general government debt_PRT	0.969894	Corporate credit_CHE	0.967467
Residential investment_IRL	0.981374	House prices-to-rent ratio_NLD	0.980044	Gross general government debt_SVK	0.985441	Real house prices_CHE	0.985628
Employment share in construction_IRL	0.954214	Residential investment_NLD	0.978850	Household foreign currency denominated liabilities_SVN	0.973225	House prices-to-income disposable ratio_CHE	0.979696
Gross general government debt_IRL	0.988423	Gross general government debt_NLD	0.958143	Real house prices_ESP	0.961780	House prices-to-rent ratio_CHE	0.981277
Residential real estate loans_ISR	0.980172	Gross general government debt_NZL	0.950370	House prices-to-rent ratio_ESP	0.960823	FDI liabilities_CHE	0.957193
Real house prices_ISR	0.983121	Tier 1 capital ratio_NOR	0.952129	Residential investment_ESP	0.988776	Official foreign reserves_CHE	0.960685
House prices-to-rent ratio_ISR	0.962606	Total private credit_POL	0.980867	Employment share in construction_ESP	0.986754	Residential real estate loans_BRA	0.978531
Residential investment_ISR	0.958027	Private bank credit_POL	0.984445	Gross general government debt_ESP	0.981790	Commercial real estate loans_BRA	0.992143
Total private credit_KOR	0.957415	Household credit_POL	0.992613	Gross financing needs_ESP	0.994345	Total private credit_BRA	0.961314
Corporate credit_KOR	0.966383	Household foreign currency denominated liabilities_POL	0.964391	Total private credit_SWE	0.978833	Private bank credit_BRA	0.966463
Household credit_LUX	0.970730	Employment share in construction_POL	0.978597	Private bank credit_SWE	0.988266	Real house prices_BRA	0.957216
Gross general government debt_LUX	0.984005	Export performance_POL	0.951417	Household credit_SWE	0.982427	Total private credit_CHN	0.950986
External government debt_LUX	0.970108	House prices-to-rent ratio_PRT	0.966752	Corporate credit_SWE	0.966440	External debt bias_CRI	0.962994

FDI liabilities_CRI	0.962994	Shadow banking 1_DEU	0.904037	Capital ratio_GBR	0.932435	Corporate credit_BEL	0.921103
Household credit_IDN	0.966932	Liquidity ratio 2_DEU	0.901886	Tier 1 capital ratio_GBR	0.940403	External bank debt_BEL	0.942469
Real house prices_IDN	0.957964	Household debt service costs_DEU	0.942927	Total private credit_GBR	0.912298	Financial openness_CZE	0.935216
Leverage ratio_LTU	0.955525	Real house prices_DEU	0.927328	Household credit_GBR	0.945083	Corporate credit_DNK	0.924222
Tier 1 capital ratio_LTU	0.956178	House prices-to-disposable income ratio_DEU	0.924717	Short-term general government debt_GBR	0.932626	External debt_DNK	0.902624
Residential investment_ZAF	0.950093	House prices-to-rent ratio_DEU	0.931382	External bank debt_GBR	0.935243	FDI liabilities_DNK	0.910738
Liquidity ratio 1_usa	0.911611	Yield-growth spread (r-g)_DEU	0.930905	Short-term external bank debt_GBR	0.934225	Financial openness_DNK	0.900299
House prices-to-disposable income ratio_usa	0.932176	External government debt_DEU	0.924563	Short-term external bank debt_GBR	0.946942	Capital ratio_EST	0.908908
House prices-to-rent ratio_usa	0.925468	External bank debt_DEU	0.908652	Employment share in construction_CAN	0.922512	Liquidity ratio 1_EST	0.922784
Employment share in construction_usa	0.915969	Household foreign currency denominated liabilities_FRA	0.948684	External debt_CAN	0.929374	External debt bias_EST	0.926631
Current account balance_usa	0.920507	External debt_FRA	0.923983	External government debt_AUS	0.941817	Corporate credit_FIN	0.927807
Short-term external government debt_JPN	0.916140	Private bank creditv_ITA	0.946731	Total private credit_AUT	0.923413	External debt_FIN	0.945215
External debt_JPN	0.922331	Residential investment_ITA	0.944663	Corporate credit_AUT	0.930644	External debt bias_FIN	0.904097
Capital ratio_DEU	0.930314	Foreign currency exposure index_ITA	0.909408	House prices-to-rent ratio_AUT	0.910039	Shadow banking 2_GRC	0.900862
Tier 1 capital ratio_DEU	0.949191	Leverage ratio_GBR	0.924755	Gross government debt denominated in foreign currency_AUT	0.903891	Loan-to-deposit ratio_GRC	0.927414

Residential real estate loans_GRC	0.916932	Leverage ratio_IRL	0.909501	External debt_KOR	0.911228	Shadow banking 2_NOR	0.915636
Household foreign currency denominated liabilities_GRC	0.934318	Capital ratio_IRL	0.925624	External bank debt_KOR	0.927634	Residential real estate loans_NOR	0.901109
Residential investment_GRC	0.906985	Tier 1 capital ratio_IRL	0.935573	Export performance_KOR	0.915738	Total private credit_NOR	0.927344
FDI liabilities_GRC	0.919753	External debt_IRL	0.947931	Financial openness_KOR	0.911579	Household credit_NOR	0.936183
Shadow banking 2_HUN	0.900862	Household foreign currency denominated liabilities_IRL	0.904123	Residential real estate loans_LUX	0.935020	Gross general government debt_NOR	0.914053
Liquidity ratio 1_HUN	0.928095	Real house prices_IRL	0.904555	External debt bias_LUX	0.908194	Short-term external government debt_NOR	0.900296
Liquidity ratio 2_HUN	0.908220	House prices-to-disposable income ratio_IRL	0.917034	FDI liabilities_LUX	0.936697	Short-term external bank debt_NOR	0.905854
Total private credit_HUN	0.923523	External bank debt_IRL	0.917887	Liquidity ratio 1_MEX	0.900003	Leverage ratio_POL	0.911887
Private bank credit_HUN	0.915690	Trade openness_IRL	0.935600	House prices-to-rent ratio_MEX	0.927612	Capital ratio_POL	0.921261
Household credit_HUN	0.904406	Foreign currency mismatch_ISR	0.912300	Export performance_MEX	0.924524	Tier 1 capital ratio_POL	0.919033
Corporate credit_HUN	0.919330	Yield-growth spread (r-g)_ISR	0.921414	Leverage ratio_NLD	0.929267	Shadow banking 2_POL	0.910944
Current account balance_HUN	0.906094	Private bank credit_KOR	0.934426	Tier 1 capital ratio_NLD	0.913260	Liquidity ratio 1_POL	0.900217
External bank debt_HUN	0.924428	Household credit_KOR	0.922208	Employment share in construction_NLD	0.930625	Liquidity ratio 2_POL	0.900954
Financial openness_HUN	0.916064	House prices-to-rent ratio_KOR	0.906716	Capital ratio_NOR	0.930099	Residential real estate loans_POL	0.911131
Financial openness_ISL	0.900533	Employment share in construction_KOR	0.925367	Shadow banking 1_NOR	0.901027	Corporate credit_POL	0.927519

Gross general government debt_POL	0.925733	Yield-growth spread (r-g)_SVK	0.925267	Competitiveness indicator: Real effective exchange rate_ESP	0.919251	External debt_LVA	0.931074
External debt_POL	0.949292	Gross financing needs_SVK	0.906197	Short-term external bank debt_SWE	0.901687	Gross government debt denominated in foreign currency_LVA	0.947851
Financial openness_POL	0.933062	Official foreign reserves_SVK	0.943626	Private bank credit_CHE	0.932900	External government debt_LVA	0.923733
Loan-to-deposit ratio_PRT	0.943433	Competitiveness indicator: Real effective exchange rate_SVK	0.935069	External debt bias_CHE	0.932560	External debt_LVA	0.903830
Commercial real estate loans_PRT	0.916122	Residential investment_SVN	0.927083	Total private credit_TUR	0.929425	Financial openness_LVA	0.917823
Total private credit_PRT	0.927677	Gross general government debt_SVN	0.920101	Private bank credit_TUR	0.945273	Capital ratio_LTU	0.941559
Private bank credit_PRT	0.935816	Tier 1 capital ratio_ESP	0.929143	Household credit_TUR	0.946210	Liquidity ratio 1_LTU	0.902539
Corporate credit_PRT	0.919836	Total private credit_ESP	0.902280	Corporate credit_TUR	0.910004	Gross general government debt_LTU	0.912372
Real house prices_PRT	0.91277	Private bank credit_ESP	0.911765	External bank debt_BRA	0.909804	External debt_LTU	0.940314
House prices-to-disposable income ratio_PRT	0.902751	Household foreign currency denominated liabilities_ESP	0.938556	Competitiveness indicator: Real effective exchange rate_CHN	0.931474	External debt bias_LTU	0.936351
Gross government debt denominated in foreign currency_PRT	0.931702	Corporate credit_ESP	0.906026	Export performance_CHN	0.914660	FDI liabilities_LTU	0.920020
External debt_PRT	0.901395	House prices-to-disposable income ratio_ESP	0.935830	Real house prices_COL	0.934377	Export performance_LTU	0.936747
External bank debt_PRT	0.925338	Current account balance_ESP	0.933567	Competitiveness indicator: Real effective exchange rate_CRI	0.943263	Leverage ratio_ZAF	0.928310
Short-term external bank debt_PRT	0.919212	External debt_ESP	0.905592	Total private credit_IND	0.902322	Capital ratio_ZAF	0.915053
Real stock prices_SVK	0.947977	Official foreign reserves_ESP	0.926015	Export performance_IND	0.901219	Tier 1 capital ratio_ZAF	0.925076

Commercial real estate loans_ZAF	0.911079	External debt_usa	0.559336	FDI liabilities_usa	0.181199	Residential investment_JPN	0.657318
Export performance_ZAF	0.928199	Household debt service costs_usa	0.812587	Official foreign reserves_usa	0.747733	Employment share in construction_JPN	0.884405
Total private credit	0.912832	Household short-term loans_usa	0.073407	Competitiveness indicator: Real effective exchange rate_usa	0.591951	Real stock prices_JPN	0.583908
Leverage ratio_usa	0.886354	Corporate credit_usa	0.598049	Competitiveness indicator: Real effective exchange rate_usa	0.696730	Gross general government debt_JPN	0.166042
Capital ratio_usa	0.875398	Non-financial corporations foreign currency denominated liabilities_usa	0.435607	Export performance_usa	0.519409	Yield-growth spread (r-g)_JPN	0.447089
Tier 1 capital ratio_usa	0.894087	Real house prices_usa	0.888013	Trade openness_usa	0.390690	External government debt_JPN	0.700621
Shadow banking 1_usa	0.850450	Real stock prices_usa	0.365103	Financial openness_usa	0.633594	Current account balance_JPN	0.669517
Shadow banking 2_usa	0.865541	Yield-growth spread (r-g)_usa	0.114079	Total private credit_JPN	0.210296	External debt bias_JPN	0.713116
Return on assets_usa	0.872563	Gross government debt denominated in foreign currency_usa	0.668727	Private bank credit_JPN	0.820990	External bank debt_JPN	0.587454
Return on equity_usa	0.831915	Short-term external government debt_usa	0.628216	External debt_JPN	0.456421	Short-term external bank debt_JPN	0.730352
Loan-to-deposit ratio_usa	0.821594	External debt_usa	0.613916	Household credit_JPN	0.266953	Short-term external bank debt_JPN	0.814007
Residential real estate loans_usa	0.837565	External debt bias_usa	0.411708	Corporate credit_JPN	0.473025	FDI liabilities_JPN	0.865663
Commercial real estate loans_usa	0.811683	External bank debt_usa	0.679117	Real house prices_JPN	0.634002	Official foreign reserves_JPN	0.506583
Total private credit_usa	0.892198	Short-term external bank debt_usa	0.585655	House prices-to-disposable income ratio_JPN	0.659159	Competitiveness indicator: Real effective exchange rate_JPN	0.176444
Private bank credit_usa	0.833583	Short-term external bank debt_usa	0.680174	House prices-to-rent ratio_JPN	0.737018	Competitiveness indicator: Real effective exchange rate_JPN	0.154023

Export performance_JPN	0.890247	Private bank credit_DEU	0.823299	External debt_DEU	0.793160	External debt_FRA	0.894350
Trade openness_JPN	0.220317	External debt_DEU	0.813516	External debt bias_DEU	0.121683	Household debt service costs_FRA	0.721634
Financial openness_JPN	0.716939	Household credit_DEU	0.672627	Short-term external bank debt_DEU	0.860402	Household short-term loans_FRA	0.768706
Shadow banking 2_DEU	0.888207	Household foreign currency denominated liabilities_DEU	0.244188	Short-term external bank debt_DEU	0.702050	Non-financial corporation's foreign currency denominated liabilities_FRA	0.735857
Return on assets_DEU	0.339563	Household short-term loans_DEU	0.435607	FDI liabilities_DEU	0.042069	Real house prices_FRA	0.212962
Return on equity_DEU	0.284541	Corporate credit_DEU	0.817166	Official foreign reserves_DEU	0.485071	House prices-to-income ratio_FRA	0.045669
Lending standards for enterprises_DEU	0.300263	Non-financial corporation's foreign currency denominated liabilities_DEU	0.630551	Competitiveness indicator: Real effective exchange rate_DEU	0.730471	House prices-to-rent ratio_FRA	0.231044
Liquidity ratio 1_DEU	0.849137	Residential investment_DEU	0.131391	Competitiveness indicator: Real effective exchange rate_DEU	0.408393	Residential investment_FRA	0.735678
Loan-to-deposit ratio_DEU	0.874487	Employment share in construction_DEU	0.844631	Export performance_DEU	0.271801	Employment share in construction_FRA	0.821614
Foreign currency mismatch_DEU	0.772485	Real stock prices_DEU	0.712418	Trade openness_DEU	0.476638	Real stock prices_FRA	0.503014
Residential real estate loans_DEU	0.899992	Gross general government debt_DEU	0.292601	Financial openness_DEU	0.800217	Yield-growth spread (r-g)_FRA	0.490933
Commercial real estate loans_DEU	0.891667	Short-term external government debt_DEU	0.565246	Shadow banking 1_FRA	0.729591	Gross government debt denominated in foreign currency_FRA	0.775426
Total private credit_DEU	0.763957	Current account balance_DEU	0.798821	Shadow banking 2_FRA	0.718459	External government debt_FRA	0.831777

Short-term external government debt_FRA	0.599450	Return on equity_ITA	0.720818	Gross financing needs_ITA	0.262219	Financial openness_ITA	0.630833
Current account balance_FRA	0.488040	Loan-to-deposit ratio_ITA	0.655038	Short-term general government debt_ITA	0.755448	Return on assets_GBR	0.663978
External debt bias_FRA	0.085881	Foreign currency mismatch_ITA	0.764890	Gross government debt denominated in foreign currency_ITA	0.766261	Return on equity_GBR	0.639216
External bank debt_FRA	0.473043	Residential real estate loans_ITA	0.663952	External government debt_ITA	0.596342	Liquidity ratio 1_GBR	0.833432
Short-term external bank debt_FRA	0.602860	Commercial real estate loans_ITA	0.370759	Short-term external government debt_ITA	0.503983	Liquidity ratio 2_GBR	0.864590
Short-term external bank debt_FRA	0.676539	External debt_ITA	0.609146	Current account balance_ITA	0.674726	Loan-to-deposit ratio_GBR	0.816632
FDI liabilities_FRA	0.572286	Household debt service costs_ITA	0.877714	External debt_ITA	0.611794	Foreign currency mismatch_GBR	0.301055
Official foreign reserves_FRA	0.350561	Household foreign currency denominated liabilities_ITA	0.186134	External debt bias_ITA	0.590697	Residential real estate loans_GBR	0.818674
Competitiveness indicator: Real effective exchange rate_FRA	0.808073	Household short-term loans_ITA	0.652894	External bank debt_ITA	0.875595	Commercial real estate loans_GBR	0.737802
Competitiveness indicator: Real effective exchange rate_FRA	0.606318	Non-financial corporations foreign currency denominated liabilities_ITA	0.380229	Short-term external bank debt_ITA	0.798791	Private bank credit_GBR	0.736841
Export performance_FRA	0.837777	House prices-to-disposable income ratio_ITA	0.767585	Short-term external bank debt_ITA	0.385875	External debt_GBR	0.800811
Trade openness_FRA	0.472028	Employment share in construction_ITA	0.894581	FDI liabilities_ITA	0.818948	Household foreign currency denominated liabilities_GBR	0.796556
Financial openness_FRA	0.873422	Real stock prices_ITA	0.840940	Competitiveness indicator: Real effective exchange rate_ITA	0.562372	Household short-term loans_GBR	0.724774
Leverage ratio_ITA	0.866300	Gross general government debt_ITA	0.842863	Competitiveness indicator: Real effective exchange rate_ITA	0.476506	Corporate credit_GBR	0.817458
Return on assets_ITA	0.657223	Yield-growth spread (r-g)_ITA	0.560453	Trade openness_ITA	0.231492	Non-financial corporations foreign currency denominated liabilities_GBR	0.821123

Real house prices_GBR	0.338755	Competitiveness indicator: Real effective exchange rate_GBR	0.867181	Commercial real estate loans_CAN	0.522397	External bank debt_CAN	0.664585
House prices-to-income disposable ratio_GBR	0.427919	Export performance_GBR	0.599405	Private bank credit_CAN	0.887189	Short-term external bank debt_CAN	0.627721
House prices-to-rent ratio_GBR	0.189429	Trade openness_GBR	0.470086	External debt_CAN	0.679354	Short-term external bank debt_CAN	0.022389
Residential investment_GBR	0.890469	Financial openness_GBR	0.872390	Corporate credit_CAN	0.870465	FDI liabilities_CAN	0.779421
Employment share in construction_GBR	0.770450	Leverage ratio_CAN	0.006276	Real house prices_CAN	0.859310	Official foreign reserves_CAN	0.807108
Real stock prices_GBR	0.409317	Capital ratio_CAN	0.098718	House prices-to-income disposable ratio_CAN	0.770331	Competitiveness indicator: Real effective exchange rate_CAN	0.124327
Yield-growth spread (r-g)_GBR	0.701556	Tier 1 capital ratio_CAN	0.308253	House prices-to-rent ratio_CAN	0.837455	Competitiveness indicator: Real effective exchange rate_CAN	0.422530
Gross financing needs_GBR	0.742377	Shadow banking 1_CAN	0.405690	Residential investment_CAN	0.114593	Export performance_CAN	0.892698
External government debt_GBR	0.834225	Shadow banking 2_CAN	0.686692	Real stock prices_CAN	0.034809	Trade openness_CAN	0.749075
Short-term external government debt_GBR	0.791647	Return on assets_CAN	0.412967	Gross general government debt_CAN	0.892103	Financial openness_CAN	0.466717
Current account balance_GBR	0.294587	Return on equity_CAN	0.345500	Yield-growth spread (r-g)_CAN	0.214443	Leverage ratio_AUS	0.299916
External debt_GBR	0.891737	Liquidity ratio 1_CAN	0.436663	External government debt_CAN	0.887775	Capital ratio_AUS	0.510134
External debt bias_GBR	0.873578	Liquidity ratio 2_CAN	0.631080	Short-term external government debt_CAN	0.776151	Tier 1 capital ratio_AUS	0.672342
FDI liabilities_GBR	0.712620	Loan-to-deposit ratio_CAN	0.609058	Current account balance_CAN	0.856762	Shadow banking 1_AUS	0.229234
Competitiveness indicator: Real effective exchange rate_GBR	0.852332	Residential real estate loans_CAN	0.709667	External debt bias_CAN	0.653248	Shadow banking 2_AUS	0.166132

Return on assets_AUS	0.010865	Residential investment_AUS	0.802227	Competitiveness indicator: Real effective exchange rate_AUS	0.585102	Short-term external government debt_AUT	0.169188
Return on equity_AUS	0.022731	Employment share in construction_AUS	0.389032	Export performance_AUS	0.388114	Current account balance_AUT	0.433844
Liquidity ratio 1_AUS	0.766679	Real stock prices_AUS	0.413419	Trade openness_AUS	0.092975	External debt_AUT	0.744080
Liquidity ratio 2_AUS	0.790198	Yield-growth spread (r-g)_AUS	0.257296	Financial openness_AUS	0.502339	External debt bias_AUT	0.744080
Residential real estate loans_AUS	0.498851	Gross financing needs_AUS	0.715058	Private bank credit_AUT	0.452050	External bank debt_AUT	0.738942
Commercial real estate loans_AUS	0.362292	Short-term external government debt_AUS	0.379529	External debt_AUT	0.661667	Short-term external bank debt_AUT	0.789411
Total private credit_AUS	0.466310	Current account balance_AUS	0.553000	Household credit_AUT	0.466111	Short-term external bank debt_AUT	0.641524
Private bank credit_AUS	0.891653	External debt_AUS	0.603431	Household foreign currency denominated liabilities_AUT	0.723669	FDI liabilities_AUT	0.833198
External debt_AUS	0.245203	External debt bias_AUS	0.046898	Household short-term loans_AUT	0.724251	Official foreign reserves_AUT	0.692692
Household credit_AUS	0.807153	External bank debt_AUS	0.817747	Non-financial corporation's foreign currency denominated liabilities_AUT	0.638462	Competitiveness indicator: Real effective exchange rate_AUT	0.196132
Household debt service costs_AUS	0.394834	Short-term external bank debt_AUS	0.660278	Residential investment_AUT	0.552528	Competitiveness indicator: Real effective exchange rate_AUT	0.005146
Corporate credit_AUS	0.369007	Short-term external bank debt_AUS	0.071922	Employment share in construction_AUT	0.173987	Export performance_AUT	0.828704
Real house prices_AUS	0.689497	FDI liabilities_AUS	0.265828	Real stock prices_AUT	0.623136	Trade openness_AUT	0.242272
House prices-to-disposable income ratio_AUS	0.011732	Official foreign reserves_AUS	0.614388	Yield-growth spread (r-g)_AUT	0.740949	Financial openness_AUT	0.744735
House prices-to-rent ratio_AUS	0.040417	Competitiveness indicator: Real effective exchange rate_AUS	0.518945	External government debt_AUT	0.455639	Leverage ratio_BEL	0.832941

Capital ratio_BEL	0.878761	Real house prices_BEL	0.854680	Official reserves foreign_BEL	0.755266	Current account balance_CHL	0.386138
Tier 1 capital ratio_BEL	0.869560	House prices-to-income disposable ratio_BEL	0.853123	Competitiveness indicator: Real effective exchange rate_BEL	0.322652	External debt_CHL	0.581041
Return on assets_BEL	0.108662	House prices-to-rent ratio_BEL	0.823514	Competitiveness indicator: Real effective exchange rate_BEL	0.156478	External debt bias_CHL	0.349702
Return on equity_BEL	0.077504	Residential investment_BEL	0.664425	Export performance_BEL	0.329728	External bank debt_CHL	0.577969
Liquidity ratio 1_BEL	0.795003	Employment share in construction_BEL	0.379455	Trade openness_BEL	0.487470	Short-term external bank debt_CHL	0.329965
Liquidity ratio 2_BEL	0.784468	Real stock prices_BEL	0.546863	Financial openness_BEL	0.806974	Short-term external bank debt_CHL	0.142620
Loan-to-deposit ratio_BEL	0.516091	Gross general government debt_BEL	0.885867	External debt_CHL	0.146370	FDI liabilities_CHL	0.483642
Foreign currency mismatch_BEL	0.477315	Yield-growth spread (r-g)_BEL	0.689371	Household short-term loans_CHL	0.680690	Official reserves foreign_CHL	0.510086
Residential real estate loans_BEL	0.670957	Gross financing needs_BEL	0.513649	Real house prices_CHL	0.212078	Competitiveness indicator: Real effective exchange rate_CHL	0.098027
Private bank credit_BEL	0.806116	Short-term general government debt_BEL	0.681194	House prices-to-rent ratio_CHL	0.288321	Competitiveness indicator: Real effective exchange rate_CHL	0.801382
External debt_BEL	0.361653	External government debt_BEL	0.163480	Residential investment_CHL	0.691341	Export performance_CHL	0.873474
Household foreign currency denominated liabilities_BEL	0.377132	Short-term external government debt_BEL	0.508892	Employment share in construction_CHL	0.018960	Trade openness_CHL	0.431836
Household short-term loans_BEL	0.701252	Current account balance_BEL	0.046318	Real stock prices_CHL	0.603514	Financial openness_CHL	0.706802
Non-financial corporation's foreign currency denominated liabilities_BEL	0.508072	External debt_BEL	0.872164	Yield-growth spread (r-g)_CHL	0.606585	Leverage ratio_CZE	0.836922

Capital ratio_CZE	0.850722	Non-financial corporation's foreign currency denominated liabilities_CZE	0.719976	External debt bias_CZE	0.829467	Shadow banking 2_DNK	0.896288
Tier 1 capital ratio_CZE	0.860947	Real house prices_CZE	0.850666	External bank debt_CZE	0.002396	Liquidity ratio 1_DNK	0.043693
Return on assets_CZE	0.721242	House disposable income prices-to-income ratio_CZE	0.850057	Short-term external bank debt_CZE	0.325230	Liquidity ratio 2_DNK	0.503787
Return on equity_CZE	0.627846	House prices-to-rent ratio_CZE	0.765962	Short-term external bank debt_CZE	0.683395	Loan-to-deposit ratio_DNK	0.695126
Liquidity ratio 1_CZE	0.719602	Residential investment_CZE	0.701904	FDI liabilities_CZE	0.803916	Foreign currency mismatch_DNK	0.595484
Liquidity ratio 2_CZE	0.626832	Employment share in construction_CZE	0.648761	Official foreign reserves_CZE	0.687249	Residential real estate loans_DNK	0.819803
Loan-to-deposit ratio_CZE	0.771343	Real stock prices_CZE	0.697708	Competitiveness indicator: Real effective exchange rate_CZE	0.822090	Commercial real estate loans_DNK	0.792661
Foreign currency mismatch_CZE	0.020022	Yield-growth spread (r-g)_CZE	0.607966	Competitiveness indicator: Real effective exchange rate_CZE	0.695838	External debt_DNK	0.594595
External debt_CZE	0.889060	External government debt_CZE	0.708735	Export performance_CZE	0.859984	Household foreign currency denominated liabilities_DNK	0.844564
Household foreign currency denominated liabilities_CZE	0.733860	Short-term external government debt_CZE	0.786068	Trade openness_CZE	0.782432	Household short-term loans_DNK	0.871302
Corporate credit_CZE	0.874354	Current account balance_CZE	0.242360	Shadow banking 1_DNK	0.796049	Non-financial corporations foreign currency denominated liabilities_DNK	0.897292

External government debt_DNK	0.582668	Real stock prices_DNK	0.299510	External debt_EST	0.770816	Current account balance_EST	0.716110
Short-term external government debt_DNK	0.063189	Gross general government debt_DNK	0.865610	Household foreign currency denominated liabilities_EST	0.138913	External debt_EST	0.873681
Current account balance_DNK	0.706085	Yield-growth spread (r-g)_DNK	0.591418	Household short-term loans_EST	0.555036	External bank debt_EST	0.852017
External debt bias_DNK	0.746521	Competitiveness indicator: Real effective exchange rate_DNK	0.495380	Non-financial corporations foreign currency denominated liabilitiesv	0.773780	Short-term external bank debt_EST	0.808238
External bank debt_DNK	0.729627	Competitiveness indicator: Real effective exchange rate_DNK	0.592930	Real house prices_EST	0.391188	Short-term external bank debt_EST	0.691731
Short-term external bank debt_DNK	0.597049	Export performance_DNK	0.780034	House prices-to-disposable income ratio_EST	0.708278	FDI liabilities_EST	0.848158
Short-term external bank debt_DNK	0.518173	Trade openness_DNK	0.171955	House prices-to-rent ratio_EST	0.435431	Official foreign reserves_EST	0.753955
Official foreign reserves_DNK	0.802567	Tier 1 capital ratio_EST	0.829291	Residential investment_EST	0.708823	Competitiveness indicator: Real effective exchange rate_EST	0.791167
Real house prices_DNK	0.628059	Shadow banking 1_EST	0.892594	Employment share in construction_EST	0.222326	Competitiveness indicator: Real effective exchange rate_EST	0.602966
House prices-to-disposable income ratio_DNK	0.648543	Return on assets_EST	0.541447	Real stock prices_EST	0.466263	Export performance_EST	0.866865
House prices-to-rent ratio_DNK	0.697990	Return on equity_EST	0.406963	Gross general government debt_EST	0.803238	Trade openness_EST	0.700477
Residential investment_DNK	0.865053	Liquidity ratio 2_EST	0.889525	External government debt_EST	0.075498	Financial openness_EST	0.843270
Employment share in construction_DNK	0.854947	Loan-to-deposit ratio_EST	0.798707	Short-term external government debt_EST	0.800110	Leverage ratio_FIN	0.687098

Liquidity ratio 1_FIN	0.032179	House prices-to-rent ratio_FIN	0.628591	Competitiveness indicator: Real effective exchange rate_FIN	0.495763	Foreign currency mismatch_GRC	0.008251
Loan-to-deposit ratio_FIN	0.175207	Residential investment_FIN	0.319892	Competitiveness indicator: Real effective exchange rate_FIN	0.087235	Domestic sovereign bonds_GRC	0.785980
Residential real estate loans_FIN	0.782718	Employment share in construction_FIN	0.634510	Export performance_FIN	0.855783	External debt_GRC	0.040161
External debt_FIN	0.471425	Real stock prices_FIN	0.536560	Trade openness_FIN	0.080111	Household short-term loans_GRC	0.407853
Capital ratio_FIN	0.765880	Yield-growth spread (r-g)_FIN	0.698599	Financial openness_FIN	0.886122	Non-financial corporation's foreign currency denominated liabilities_GRC	0.822032
Tier 1 capital ratio_FIN	0.781143	External government debt_FIN	0.356686	Leverage ratio_GRC	0.841242	House disposable prices-to-income ratio_GRC	0.143963
Return on assets_FIN	0.314398	Short-term external government debt_FIN	0.447566	Capital ratio_GRC	0.834637	Real stock prices_GRC	0.856351
Return on equity_FIN	0.197792	Current account balance_FIN	0.684012	Tier 1 capital ratio_GRC	0.840383	Gross general government debt_GRC	0.763192
Household foreign currency denominated liabilities_FIN	0.575618	External bank debt_FIN	0.458877	Shadow banking 1_GRC	0.823343	Yield-growth spread (r-g)_GRC	0.644898
Household short-term loans_FIN	0.440438	Short-term external bank debt_FIN	0.370954	Return on assets_GRC	0.003148	Current account balance_GRC	0.818700
Non-financial corporations foreign currency denominated liabilities_FIN	0.440607	Short-term external bank debt_FIN	0.128145	Lending standards for enterprises_GRC	0.143618	External debt bias_GRC	0.870278
Real house prices_FIN	0.318716	FDI liabilities_FIN	0.719873	Liquidity ratio 1_GRC	0.806035	External bank debt_GRC	0.851452
House disposable prices-to-income ratio_FIN	0.250849	Official foreign reserves_FIN	0.261394	Liquidity ratio 2_GRC	0.824938	Short-term external bank debt_GRC	0.250440

Short-term external bank debt_GRC	0.372261	Non-financial corporations foreign currency denominated liabilities_HUN	0.862897	Short-term external bank debt_HUN	0.741581	Gross general government debt_ISL	0.492904
Official foreign reserves_GRC	0.811535	Real house prices_HUN	0.630751	FDI liabilities_HUN	0.558863	Yield-growth spread (r-g)_ISL	0.382309
Competitiveness indicator: Real effective exchange rate_GRC	0.708858	House disposable income prices-to-ratio_HUN	0.675821	Official foreign reserves_HUN	0.871613	Current account balance_ISL	0.666878
Competitiveness indicator: Real effective exchange rate_GRC	0.748764	House prices-to-rent ratio_HUN	0.592278	Competitiveness indicator: Real effective exchange rate_HUN	0.340203	External debt bias_ISL	0.086603
Export performance_GRC	0.873320	Residential investment_HUN	0.895942	Competitiveness indicator: Real effective exchange rate_HUN	0.742345	External bank debt_ISL	0.794472
Trade openness_GRC	0.510636	Real stock prices_HUN	0.627310	Export performance_HUN	0.705744	Short-term external bank debt_ISL	0.779728
Capital ratio_HUN	0.897045	Yield-growth spread (r-g)_HUN	0.571194	Trade openness_HUN	0.568688	Short-term external bank debt_ISL	0.771997
Tier 1 capital ratio_HUN	0.890499	Gross government debt denominated in foreign currency_HUN	0.814087	External debt_ISL	0.814614	FDI liabilities_ISL	0.420807
Shadow banking 1_HUN	0.823343	External government debt_HUN	0.871945	Real house prices_ISL	0.647903	Official foreign reserves_ISL	0.665449
Return on assets_HUN	0.257170	Short-term external government debt_HUN	0.402656	House prices-to-rent ratio_ISL	0.871408	Competitiveness indicator: Real effective exchange rate_ISL	0.887328
Foreign currency mismatch_HUN	0.803005	External debt_HUN	0.887658	Residential investment_ISL	0.829863	Competitiveness indicator: Real effective exchange rate_ISL	0.877149
External debt_HUN	0.511771	External debt bias_HUN	0.451042	Employment share in construction_ISL	0.697316	Export performance_ISL	0.593612
Household short-term loans_HUN	0.225609	Short-term external bank debt_HUN	0.845810	Real stock prices_ISL	0.814350	Trade openness_ISL	0.869560

Shadow banking 1_IRL	0.680315	Competitiveness indicator: Real effective exchange rate_IRL	0.896307	Current account balance_ISR	0.032682	Tier 1 capital ratio_KOR	0.692591
Foreign currency mismatch_IRL	0.161713	Export performance_IRL	0.546515	External debt_ISR	0.862715	Shadow banking 1_KOR	0.700047
Household short-term loans_IRL	0.886708	Leverage ratio_ISR	0.414560	External debt bias_ISR	0.719534	Shadow banking 2_KOR	0.687536
House prices-to-rent ratio_IRL	0.802213	Capital ratio_ISR	0.603682	External bank debt_ISR	0.471596	Return on assets_KOR	0.495913
Real stock prices_IRL	0.791860	Tier 1 capital ratio_ISR	0.476642	Short-term external bank debt_ISR	0.034459	Return on equity_KOR	0.507029
Yield-growth spread (r-g)_IRL	0.732066	Shadow banking 1_ISR	0.191530	Short-term external bank debt_ISR	0.450647	Liquidity ratio 1_KOR	0.688926
Gross financing needs_IRL	0.751345	Shadow banking 2_ISR	0.709173	FDI liabilities_ISR	0.766712	Liquidity ratio 2_KOR	0.692278
Short-term general government debt_IRL	0.518380	Return on assets_ISR	0.049223	Official foreign reserves_ISR	0.788801	Loan-to-deposit ratio_KOR	0.682898
External government debt_IRL	0.384214	Return on equity_ISR	0.191630	Competitiveness indicator: Real effective exchange rate_ISR	0.777208	Foreign currency mismatch_KOR	0.332055
Short-term external government debt_IRL	0.562836	Loan-to-deposit ratio_ISR	0.664011	Competitiveness indicator: Real effective exchange rate_ISR	0.585803	Residential real estate loans_KOR	0.696718
Current account balance_IRL	0.829279	Commercial real estate loans_ISR	0.760143	Export performance_ISR	0.443861	Commercial real estate loans_KOR	0.698474
Short-term external bank debt_IRL	0.875784	External debt_ISR	0.831188	Trade openness_ISR	0.726268	Domestic sovereign bonds_KOR	0.650980
Short-term external bank debt_IRL	0.886742	Employment share in construction_ISR	0.378494	Financial openness_ISR	0.050261	External debt_KOR	0.762190
Official foreign reserves_IRL	0.078177	Real stock prices_ISR	0.027562	Leverage ratio_KOR	0.691499	Real house prices_KOR	0.784653
Competitiveness indicator: Real effective exchange rate_IRL	0.730625	Gross general government debt_ISR	0.834451	Capital ratio_KOR	0.691054	House disposable income ratio_KOR	0.885110

Residential investment_KOR	0.824533	Lending standards for enterprises_LUX	0.264932	Employment share in construction_LUX	0.535968	Financial openness_LUX	0.809221
Real stock prices_KOR	0.251827	Liquidity ratio 1_LUX	0.885766	Real stock prices_LUX	0.571276	Leverage ratio_MEX	0.580208
Yield-growth spread (r-g)_KOR	0.259916	Liquidity ratio 2_LUX	0.887736	Yield-growth spread (r-g)_LUX	0.563781	Capital ratio_MEX	0.486936
Current account balance_KOR	0.507439	Loan-to-deposit ratio_LUX	0.836671	Gross financing needs_LUX	0.219096	Tier 1 capital ratio_MEX	0.081924
External debt bias_KOR	0.801922	Total private credit_LUX	0.859971	Short-term general government debt_LUX	0.694817	Return on assets_MEX	0.451204
Short-term external bank debt_KOR	0.878539	Private bank credit_LUX	0.833418	Current account balance_LUX	0.222297	Return on equity_MEX	0.731539
Short-term external bank debt_KOR	0.265583	External debt_LUX	0.632531	External debt_LUX	0.091681	Liquidity ratio 2_MEX	0.880649
FDI liabilities_KOR	0.769549	Household foreign currency denominated liabilities_LUX	0.318214	External bank debt_LUX	0.546691	Loan-to-deposit ratio_MEX	0.543270
Official foreign reserves_KOR	0.768919	Household short-term loans_LUX	0.740195	Short-term external bank debt_LUX	0.545463	Total private credit_MEX	0.872620
Competitiveness indicator: Real effective exchange rate_KOR	0.781014	Corporate credit_LUX	0.848075	Short-term external bank debt_LUX	0.354419	Private bank credit_MEX	0.854026
Competitiveness indicator: Real effective exchange rate_KOR	0.811094	Non-financial corporations foreign currency denominated liabilities_LUX	0.526323	Official foreign reserves_LUX	0.754229	External debt_MEX	0.179070
Trade openness_KOR	0.783223	Real house prices_LUX	0.742633	Competitiveness indicator: Real effective exchange rate_LUX	0.269061	Household credit_MEX	0.802022
Leverage ratio_LUX	0.898341	House prices-to-disposable income ratio_LUX	0.717190	Competitiveness indicator: Real effective exchange rate_LUX	0.794223	Corporate credit_MEX	0.871127
Capital ratio_LUX	0.879089	House prices-to-rent ratio_LUX	0.725466	Export performance_LUX	0.315925	Real house prices_MEX	0.381077
Tier 1 capital ratio_LUX	0.875668	Residential investment_LUX	0.067505	Trade openness_LUX	0.424154	Residential investment_MEX	0.706847

Real stock prices_MEX	0.531998	Trade openness_MEX	0.825797	Corporate credit_NLD	0.085158	Official reserves_NLD foreign	0.861551
Yield-growth spread (r-g)_MEX	0.140952	Capital ratio_NLD	0.895766	Non-financial corporations gross financial liabilities_NLD	0.773375	Competitiveness indicator: Real effective exchange rate_NLD	0.440547
Gross financing needs_MEX	0.607203	Return on assets_NLD	0.357755	Real stock prices_NLD	0.511189	Competitiveness indicator: Real effective exchange rate_NLD	0.524875
Short-term general government debt_MEX	0.298982	Return on equity_NLD	0.267258	Yield-growth spread (r-g)_NLD	0.505549	Export performance_NLD	0.270817
Gross government debt denominated in foreign currency_MEX	0.119757	Liquidity ratio 1_NLD	0.889401	External government debt_NLD	0.508415	Trade openness_NLD	0.753656
External government debt_MEX	0.627354	Liquidity ratio 2_NLD	0.854233	Short-term external government debt_NLD	0.651019	Financial openness_NLD	0.864629
Short-term external government debt_MEX	0.897257	Residential real estate loans_NLD	0.879877	Current account balance_NLD	0.722635	Household short-term loans_NZL	0.502720
Current account balance_MEX	0.153506	Total private credit_NLD	0.663941	External debt_NLD	0.784677	Real house prices_NZL	0.200362
External bank debt_MEX	0.728527	Private bank credit_NLD	0.648477	External debt bias_NLD	0.829714	House disposable income prices-to-income ratio_NZL	0.234537
Short-term external bank debt_MEX	0.738453	External debt_NLD	0.846678	External bank debt_NLD	0.507682	House prices-to-rent ratio_NZL	0.157515
Short-term external bank debt_MEX	0.499044	Household credit_NLD	0.841586	Short-term external bank debt_NLD	0.738659	Residential investment_NZL	0.736222
Competitiveness indicator: Real effective exchange rate_MEX	0.568656	Household foreign currency denominated liabilities_NLD	0.675534	Short-term external bank debt_NLD	0.833904	Employment share in construction_NZL	0.226733
Competitiveness indicator: Real effective exchange rate_MEX	0.452493	Household short-term loans_NLD	0.701100	FDI liabilities_NLD	0.879355	Real stock prices_NZL	0.793437

Yield-growth spread (r-g)_NZL	0.150321	Return on assets_NOR	0.898170	Residential investment_NOR	0.570008	Return on assets_POL	0.843745
Current account balance_NZL	0.583418	Return on equity_NOR	0.884940	Employment share in construction_NOR	0.529586	Return on equity_POL	0.802322
External debt_NZL	0.849854	Liquidity ratio 1_NOR	0.804748	Real stock prices_NOR	0.142661	Loan-to-deposit ratio_POL	0.889602
External debt bias_NZL	0.482107	Liquidity ratio 2_NOR	0.779094	Yield-growth spread (r-g)_NOR	0.416280	Foreign currency mismatch_POL	0.201064
External bank debt_NZL	0.512804	Foreign currency mismatch_NOR	0.635845	External government debt_NOR	0.839732	Commercial real estate loans_POL	0.831276
Short-term external bank debt_NZL	0.573110	Commercial real estate loans_NOR	0.740755	Current account balance_NOR	0.453495	External debt_POL	0.617492
Short-term external bank debt_NZL	0.753880	Private bank credit_NOR	0.865839	External bank debt_NOR	0.733359	Household short-term loans_POL	0.800539
FDI liabilities_NZL	0.802492	External debt_NOR	0.592825	Short-term external bank debt_NOR	0.795794	Non-financial corporations foreign currency denominated liabilities_POL	0.663902
Official foreign reserves_NZL	0.593891	Household debt service costs_NOR	0.825415	Official foreign reserves_NOR	0.658370	Residential investment_POL	0.680110
Competitiveness indicator: Real effective exchange rate_NZL	0.592401	Household short-term loans_NOR	0.483768	Competitiveness indicator: Real effective exchange rate_NOR	0.041958	Real stock prices_POL	0.047727
Competitiveness indicator: Real effective exchange rate_NZL	0.585854	Corporate credit_NOR	0.898806	Competitiveness indicator: Real effective exchange rate_NOR	0.830468	Yield-growth spread (r-g)_POL	0.380603
Export performance_NZL	0.697277	Real house prices_NOR	0.788000	Export performance_NOR	0.702851	Current account balance_POL	0.535733
Trade openness_NZL	0.217360	House prices-to-disposable income ratio_NOR	0.392849	Trade openness_NOR	0.473678	External debt bias_POL	0.041123
Financial openness_NZL	0.637972	House prices-to-rent ratio_NOR	0.741724	Shadow banking 1_POL	0.899247	External bank debt_POL	0.810166

Short-term external bank debt_POL	0.678764	Return on equity_PRT	0.773328	Yield-growth spread (r-g)_PRT	0.549899	Trade openness_PRT	0.568276
Short-term external bank debt_POL	0.136192	Lending standards for enterprises_PRT	0.611046	Gross financing needs_PRT	0.685538	Financial openness_PRT	0.844887
FDI liabilities_POL	0.354066	Liquidity ratio 1_PRT	0.431862	Short-term general government debt_PRT	0.897102	External debt_SVK	0.546467
Official foreign reserves_POL	0.863596	Liquidity ratio 2_PRT	0.846623	External government debt_PRT	0.330860	Household foreign currency denominated liabilities_SVK	0.657150
Competitiveness indicator: Real effective exchange rate_POL	0.240213	Residential real estate loans_PRT	0.754212	Short-term external government debt_PRT	0.761621	Household short-term loans_SVK	0.786782
Competitiveness indicator: Real effective exchange rate_POL	0.299498	Domestic sovereign bonds_PRT	0.829789	Current account balance_PRT	0.896305	Non-financial corporations foreign currency denominated liabilities_SVK	0.475003
Trade openness_POL	0.724891	External debt_PRT	0.444329	External debt bias_PRT	0.137919	Real house prices_SVK	0.635546
Leverage ratio_PRT	0.674683	Household credit_PRT	0.897339	Short-term external bank debt_PRT	0.616907	House prices-to-income ratio_SVK	0.698002
Capital ratio_PRT	0.764432	Household debt service costs_PRT	0.153934	FDI liabilities_PRT	0.814649	House prices-to-rent ratio_SVK	0.489906
Tier 1 capital ratio_PRT	0.891067	Household foreign currency denominated liabilities_PRT	0.460015	Foreign currency exposure index_PRT	0.440658	Residential investment_SVK	0.255713
Shadow banking 1_PRT	0.858735	Household short-term loans_PRT	0.781654	Competitiveness indicator: Real effective exchange rate_PRT	0.795849	Employment share in construction_SVK	0.798338
Shadow banking 2_PRT	0.483498	Non-financial corporation's foreign currency denominated liabilities_PRT	0.771677	Competitiveness indicator: Real effective exchange rate_PRT	0.850892	Short-term general government debt_SVK	0.881060
Return on assets_PRT	0.756929	Real stock prices_PRT	0.397410	Export performance_PRT	0.867812	Gross government debt denominated in foreign currency_SVK	0.098218

External government debt_SVK	0.719584	Non-financial corporation's foreign currency denominated liabilities_SVN	0.870675	Official reserves foreign_SVN	0.763142	Household short-term loans_ESP	0.569195
Current account balance_SVK	0.691573	Real house prices_SVN	0.683217	Competitiveness indicator: Real effective exchange rate_SVN	0.457289	Non-financial corporations' gross financial liabilities_ESP	0.649889
External debt_SVK	0.850715	House prices-to-disposable income ratio_SVN	0.681112	Competitiveness indicator: Real effective exchange rate_SVN	0.772486	Real stock prices_ESP	0.636353
External debt bias_SVK	0.653301	House prices-to-rent ratio_SVN	0.699604	Export performance_SVN	0.146431	Yield-growth spread (r-g)_ESP	0.892997
External bank debt_SVK	0.261117	Employment share in construction_SVN	0.368593	Trade openness_SVN	0.427166	Gross government debt denominated in foreign currency_ESP	0.752052
Short-term external bank debt_SVK	0.311274	Real stock prices_SVN	0.601215	Financial openness_SVN	0.887286	External government debt_ESP	0.554710
Short-term external bank debt_SVK	0.331434	Yield-growth spread (r-g)_SVN	0.741964	Leverage ratio_ESP	0.022986	Short-term external government debt_ESP	0.450374
FDI liabilities_SVK	0.577945	Current account balance_SVN	0.857839	Capital ratio_ESP	0.538702	External debt bias_ESP	0.735128
Competitiveness indicator: Real effective exchange rate_SVK	0.864322	External debt_SVN	0.897171	Return on assets_ESP	0.481400	External bank debt_ESP	0.893360
Export performance_SVK	0.701195	External debt bias_SVN	0.876079	Return on equity_ESP	0.586211	Short-term external bank debt_ESP	0.811115
Trade openness_SVK	0.435054	External bank debt_SVN	0.777573	Loan-to-deposit ratio_ESP	0.733686	Short-term external bank debt_ESP	0.329384
Financial openness_SVK	0.873336	Short-term external bank debt_SVN	0.616578	Residential real estate loans_ESP	0.655276	FDI liabilities_ESP	0.740661
External debt_SVN	0.714523	Short-term external bank debt_SVN	0.518773	External debt_ESP	0.739005	Competitiveness indicator: Real effective exchange rate_ESP	0.461554
Household short-term loans_SVN	0.753985	FDI liabilities_SVN	0.887515	Household credit_ESP	0.879555	Export performance_ESP	0.743285

Trade openness_ESP	0.568342	Gross financing needs_SWE	0.432202	Export performance_SWE	0.840082	Short-term external bank debt_CHE	0.858924
Financial openness_ESP	0.830030	Short-term general government debt_SWE	0.135441	Trade openness_SWE	0.187051	Short-term external bank debt_CHE	0.468378
External debt_SWE	0.618324	Gross government debt denominated in foreign currency_SWE	0.220874	Financial openness_SWE	0.856784	Competitiveness indicator: Real effective exchange rate_CHE	0.722018
Household foreign currency denominated liabilities_SWE	0.429187	External government debt_SWE	0.654694	External debt_CHE	0.438875	Competitiveness indicator: Real effective exchange rate_CHE	0.850019
Household short-term loans_SWE	0.425084	Short-term external government debt_SWE	0.335963	Residential investment_CHE	0.311429	Export performance_CHE	0.216897
Non-financial corporations foreign currency denominated liabilities_SWE	0.827390	Current account balance_SWE	0.242101	Employment share in construction_CHE	0.480262	Trade openness_CHE	0.573882
Real house prices_SWE	0.757543	External debt_SWE	0.792910	Real stock prices_CHE	0.236197	Financial openness_CHE	0.137660
House prices-to-disposable income ratio_SWE	0.374135	External debt bias_SWE	0.020230	Gross general government debt_CHE	0.680056	Leverage ratio_TUR	0.388820
House prices-to-rent ratio_SWE	0.705761	External bank debt_SWE	0.332431	Yield-growth spread (r-g)_CHE	0.431571	Capital ratio_TUR	0.229339
Residential investment_SWE	0.176412	Short-term external bank debt_SWE	0.723341	Gross financing needs_CHE	0.758976	Tier 1 capital ratio_TUR	0.194684
Employment share in construction_SWE	0.838033	FDI liabilities_SWE	0.760278	Short-term general government debt_CHE	0.793799	Shadow banking 1_TUR	0.367567
Real stock prices_SWE	0.266234	Official foreign reserves_SWE	0.801662	Current account balance_CHE	0.157618	Shadow banking 2_TUR	0.633024
Gross general government debt_SWE	0.756417	Competitiveness indicator: Real effective exchange rate_SWE	0.277952	External debt_CHE	0.535938	Return on assets_TUR	0.483830
Yield-growth spread (r-g)_SWE	0.526658	Competitiveness indicator: Real effective exchange rate_SWE	0.559465	External bank debt_CHE	0.832518	Return on equity_TUR	0.443638

Liquidity ratio 1_TUR	0.745172	External bank debt_TUR	0.552316	Return on equity_BRA	0.836864	Competitiveness indicator: Real effective exchange rate_BRA	0.630339
Liquidity ratio 2_TUR	0.757650	Short-term external bank debt_TUR	0.759334	Liquidity ratio 1_BRA	0.732276	Competitiveness indicator: Real effective exchange rate_BRA	0.722508
Loan-to-deposit ratio_TUR	0.648415	Short-term external bank debt_TUR	0.581835	Liquidity ratio 2_BRA	0.642103	Export performance_BRA	0.824165
Foreign currency mismatch_TUR	0.267391	FDI liabilities_TUR	0.532371	Loan-to-deposit ratio_BRA	0.747454	Trade openness_BRA	0.353471
Residential real estate loans_TUR	0.511299	Official foreign reserves_TUR	0.520628	Foreign currency mismatch_BRA	0.219525	Financial openness_BRA	0.741006
Commercial real estate loans_TUR	0.449507	Competitiveness indicator: Real effective exchange rate_TUR	0.288881	External debt_BRA	0.612815	Private bank credit_CHN	0.843638
Domestic sovereign bonds_TUR	0.769394	Competitiveness indicator: Real effective exchange rate_TUR	0.237048	Household debt service costs_BRA	0.843011	Household credit_CHN	0.865401
External debt_TUR	0.566756	Export performance_TUR	0.606931	Real stock prices_BRA	0.511675	Corporate credit_CHN	0.623349
Household short-term loans_TUR	0.718839	Trade openness_TUR	0.657530	Current account balance_BRA	0.839189	Real stock prices_CHN	0.325573
Employment share in construction_TUR	0.559652	Financial openness_TUR	0.570165	External debt_BRA	0.708731	Current account balance_CHN	0.759347
Real stock prices_TUR	0.132831	Leverage ratio_BRA	0.424953	External debt bias_BRA	0.583196	External bank debt_CHN	0.774011
Yield-growth spread (r-g)_TUR	0.458231	Capital ratio_BRA	0.300272	Short-term external bank debt_BRA	0.857825	Short-term external bank debt_CHN	0.862186
Current account balance_TUR	0.175732	Tier 1 capital ratio_BRA	0.399276	Short-term external bank debt_BRA	0.194516	Short-term external bank debt_CHN	0.822125
External debt_TUR	0.547661	Shadow banking 2_BRA	0.709570	FDI liabilities_BRA	0.845698	Official foreign reserves_CHN	0.866303
External debt bias_TUR	0.398977	Return on assets_BRA	0.827740	Official foreign reserves_BRA	0.837726	Competitiveness indicator: Real effective exchange rate_CHN	0.870712

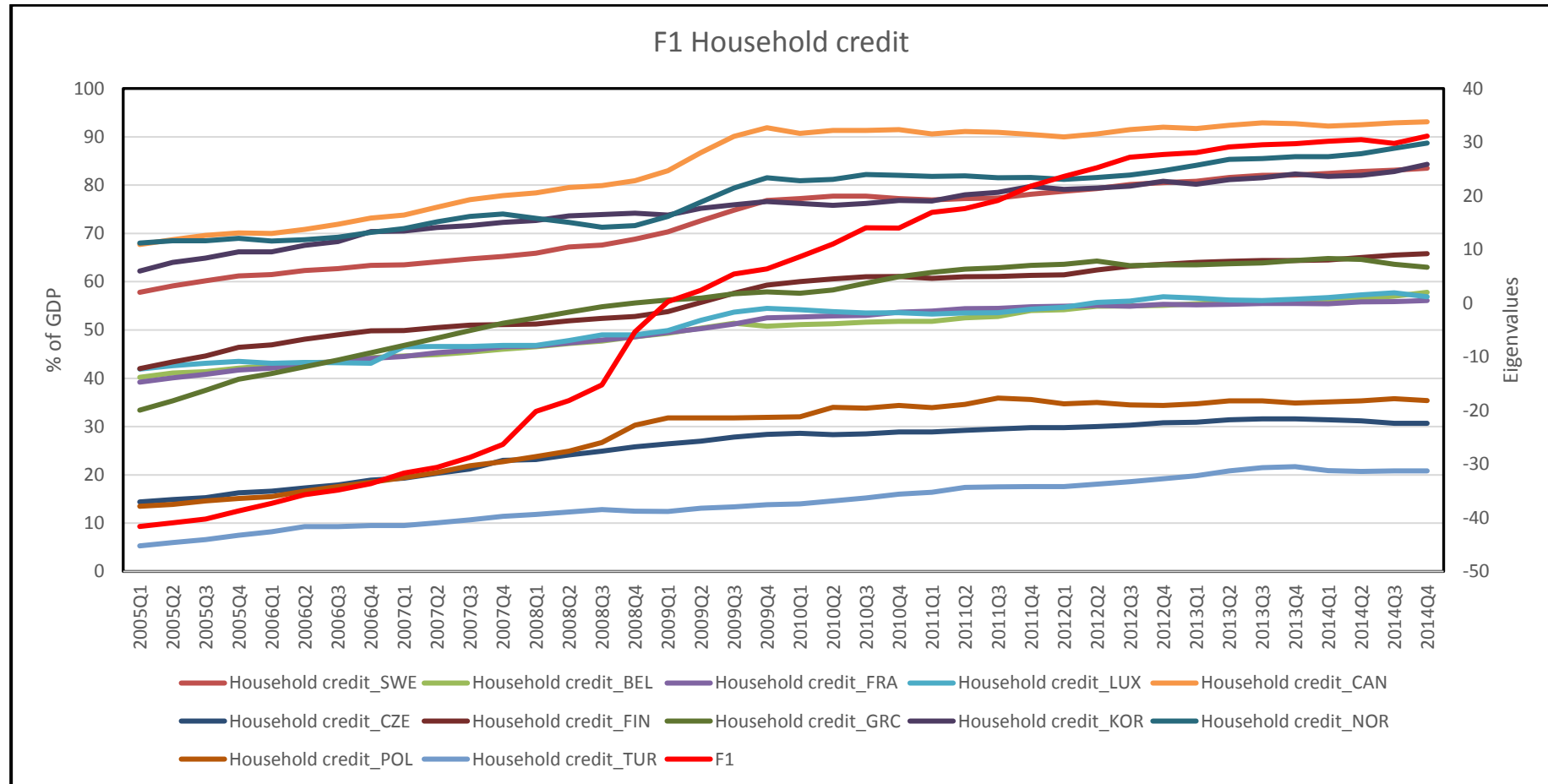
Trade openness_CHN	0.837479	FDI liabilities_COL	0.806230	Short-term external bank debt_CRI	0.594717	External debt_IND	0.746389
External debt_COL	0.660328	Official foreign reserves_COL	0.303828	Official foreign reserves_CRI	0.027683	Household credit_IND	0.693378
Residential investment_COL	0.689061	Competitiveness indicator: Real effective exchange rate_COL	0.815109	Competitiveness indicator: Real effective exchange rate_CRI	0.833676	Corporate credit_IND	0.847799
Real stock prices_COL	0.629741	Competitiveness indicator: Real effective exchange rate_COL	0.836089	Export performance_CRI	0.032551	Real stock prices_IND	0.093598
Yield-growth spread (r-g)_COL	0.069601	Export performance_COL	0.333124	Trade openness_CRI	0.885870	Yield-growth spread (r-g)_IND	0.671361
Short-term general government debt_COL	0.478585	Trade openness_COL	0.091048	Financial openness_CRI	0.171744	Current account balance_IND	0.343793
Gross government debt denominated in foreign currency_COL	0.857384	Financial openness_COL	0.599021	Capital ratio_IND	0.875632	External debt_IND	0.570546
External government debt_COL	0.866689	External debt_CRI	0.628996	Tier 1 capital ratio_IND	0.893735	External debt bias_IND	0.343457
Current account balance_COL	0.419962	Gross government debt denominated in foreign currency_CRI	0.784648	Return on assets_IND	0.855590	External bank debt_IND	0.842038
External debt_COL	0.642109	External government debt_CRI	0.869438	Return on equity_IND	0.879485	Short-term external bank debt_IND	0.816700
External debt bias_COL	0.803515	Current account balance_CRI	0.057972	Liquidity ratio 1_IND	0.761028	Short-term external bank debt_IND	0.301125
External bank debt_COL	0.375950	External debt_CRI	0.390482	Liquidity ratio 2_IND	0.721324	FDI liabilities_IND	0.773756
Short-term external bank debt_COL	0.117992	External bank debt_CRI	0.440315	Foreign currency mismatch_IND	0.794766	Official foreign reserves_IND	0.766756
Short-term external bank debt_COL	0.018654	Short-term external bank debt_CRI	0.301682	Private bank credit_IND	0.899885	Competitiveness indicator: Real effective exchange rate_IND	0.401507

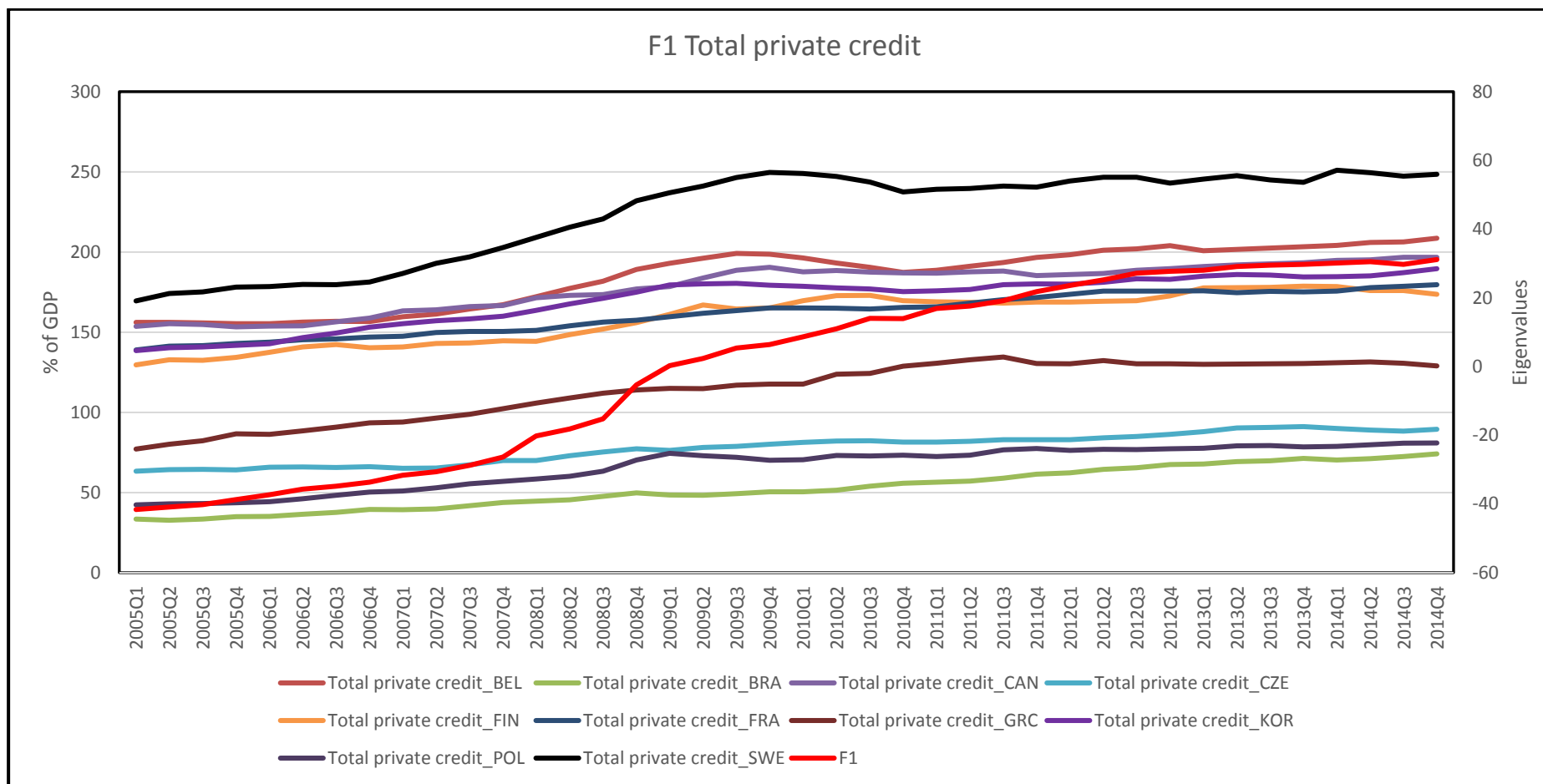
Competitiveness indicator: Real effective exchange rate_IDN	0.822707	Competitiveness indicator: Real effective exchange rate_IDN	0.716664	Short-term external bank debt_LVA	0.764642	House prices-to-income disposable ratio_LTU	0.266988
Trade openness_IDN	0.521829	Export performance_IDN	0.881776	FDI liabilities_LVA	0.878662	Residential investment_LTU	0.358442
Financial openness_IDN	0.632988	Trade openness_IDN	0.674454	Official foreign reserves_LVA	0.405988	Employment share in construction_LTU	0.559652
Total private credit_IDN	0.872072	Real house prices_LVA	0.159726	Competitiveness indicator: Real effective exchange rate_LVA	0.797459	Yield-growth spread (r-g)_LTU	0.529577
Private bank credit_IDN	0.891699	House prices-to-income disposable ratio_LVA	0.150452	Competitiveness indicator: Real effective exchange rate_LVA	0.416963	Gross government debt denominated in foreign currency_LTU	0.798119
External debt_IDN	0.695498	House prices-to-rent ratio_LVA	0.168200	Export performance_LVA	0.552517	External government debt_LTU	0.793090
Corporate credit_IDN	0.722200	Residential investment_LVA	0.494709	Trade openness_LVA	0.789469	Short-term external government debt_LTU	0.440633
Real stock prices_IDN	0.759118	Real stock prices_LVA	0.793091	Return on assets_LTU	0.260110	Current account balance_LTU	0.598650
Current account balance_IDN	0.733380	Gross general government debt_LVA	0.407445	Return on equity_LTU	0.190000	External bank debt_LTU	0.670803
External bank debt_IDN	0.593096	Yield-growth spread (r-g)_LVA	0.612810	Liquidity ratio 2_LTU	0.872131	Short-term external bank debt_LTU	0.320609
Short-term external bank debt_IDN	0.503049	Short-term external government debt_LVA	0.441365	Loan-to-deposit ratio_LTU	0.770554	Short-term external bank debt_LTU	0.348781
Short-term external bank debt_IDN	0.465249	Current account balance_LVA	0.597969	Foreign currency mismatch_LTU	0.642696	Official foreign reserves_LTU	0.373450
Official foreign reserves_IDN	0.360575	External debt bias_LVA	0.872182	External debt_LTU	0.734741	Competitiveness indicator: Real effective exchange rate_LTU	0.778836
Competitiveness indicator: Real effective exchange rate_IDN	0.240109	External bank debt_LVA	0.844340	Real house prices_LTU	0.244031	Competitiveness indicator: Real effective exchange rate_LTU	0.542507

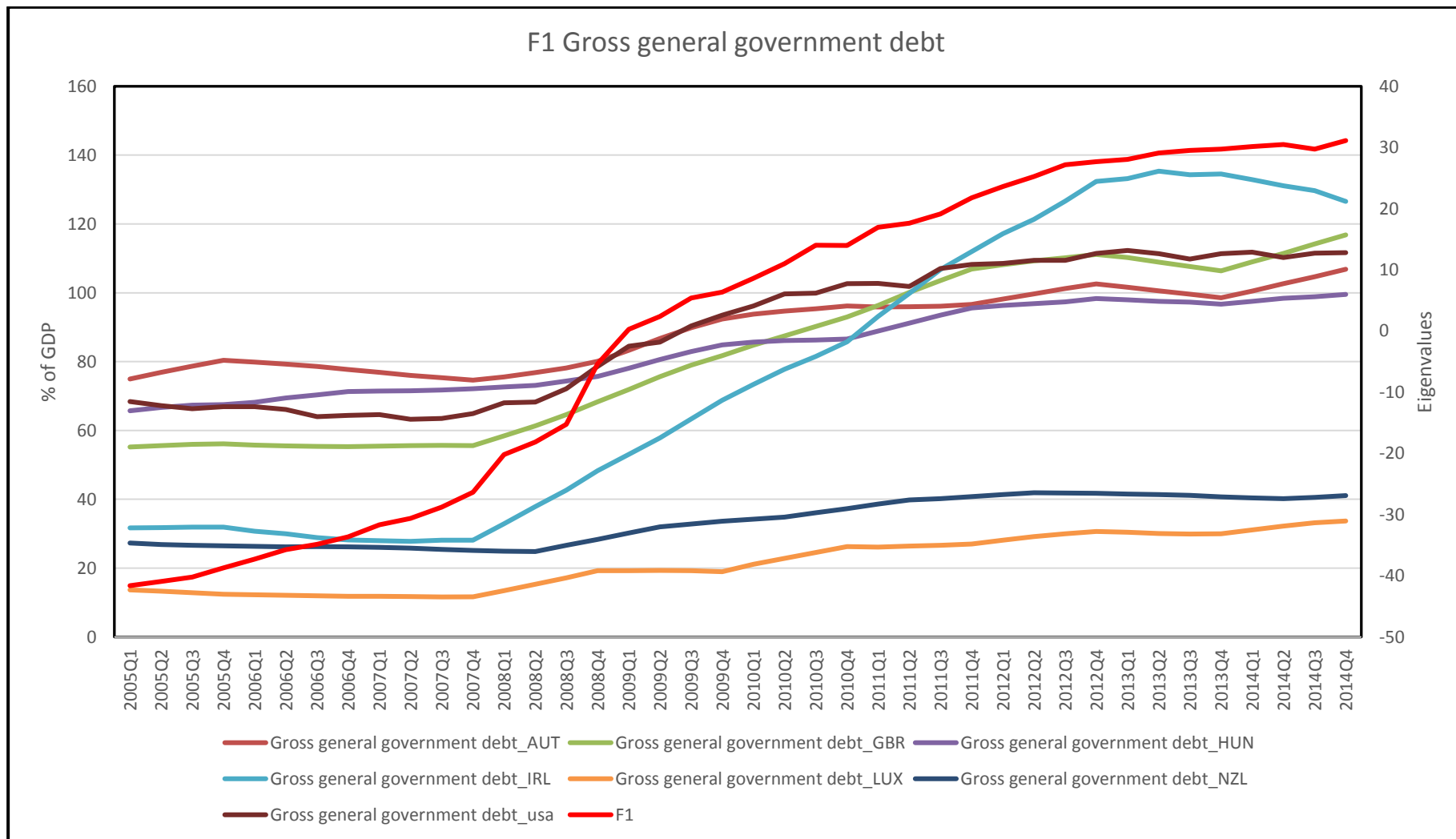
Trade openness_LTU	0.796532	External debt_RUS	0.505769	Return on assets_ZAF	0.781166	House prices-to-rent ratio_ZAF	0.316391
Financial openness_LTU	0.896711	Real house prices_RUS	0.695807	Return on equity_ZAF	0.705050	Real stock prices_ZAF	0.064845
Leverage ratio_RUS	0.898879	House prices-to-disposable income ratio_RUS	0.813687	Liquidity ratio 1_ZAF	0.781266	Current account balance_ZAF	0.097952
Capital ratio_RUS	0.858031	Real stock prices_RUS	0.310890	Liquidity ratio 2_ZAF	0.822624	External bank debt_ZAF	0.248316
Tier 1 capital ratio_RUS	0.882092	Yield-growth spread (r-g)_RUS	0.867911	Loan-to-deposit ratio_ZAF	0.835651	Short-term external bank debt_ZAF	0.241493
Liquidity ratio 1_RUS	0.863117	Current account balance_RUS	0.670080	Foreign currency mismatch_ZAF	0.011264	Short-term external bank debt_ZAF	0.198348
Liquidity ratio 2_RUS	0.863422	External bank debt_RUS	0.485793	Residential real estate loans_ZAF	0.884430	Official foreign reserves_ZAF	0.740956
Loan-to-deposit ratio_RUS	0.802370	Short-term external bank debt_RUS	0.643325	Total private credit_ZAF	0.549913	Competitiveness indicator: Real effective exchange rate_ZAF	0.182487
Foreign currency mismatch_RUS	0.580039	Short-term external bank debt_RUS	0.771147	Private bank credit_ZAF	0.703433	Competitiveness indicator: Real effective exchange rate_ZAF	0.034747
Residential real estate loans_RUS	0.860350	Official foreign reserves_RUS	0.802308	External debt_ZAF	0.456018	Trade openness_ZAF	0.025332
Commercial real estate loans_RUS	0.877072	Competitiveness indicator: Real effective exchange rate_RUS	0.634085	Household credit_ZAF	0.855098	Private bank credit	0.867499
Domestic sovereign bonds_RUS	0.749343	Competitiveness indicator: Real effective exchange rate_RUS	0.813308	Corporate credit_ZAF	0.821495	Real stock prices	0.351317
Total private credit_RUS	0.751873	Export performance_RUS	0.638962	Real house prices_ZAF	0.305757	Real house prices	0.630953
Private bank credit_RUS	0.839456	Trade openness_RUS	0.649792	House prices-to-disposable income ratio_ZAF	0.597014		

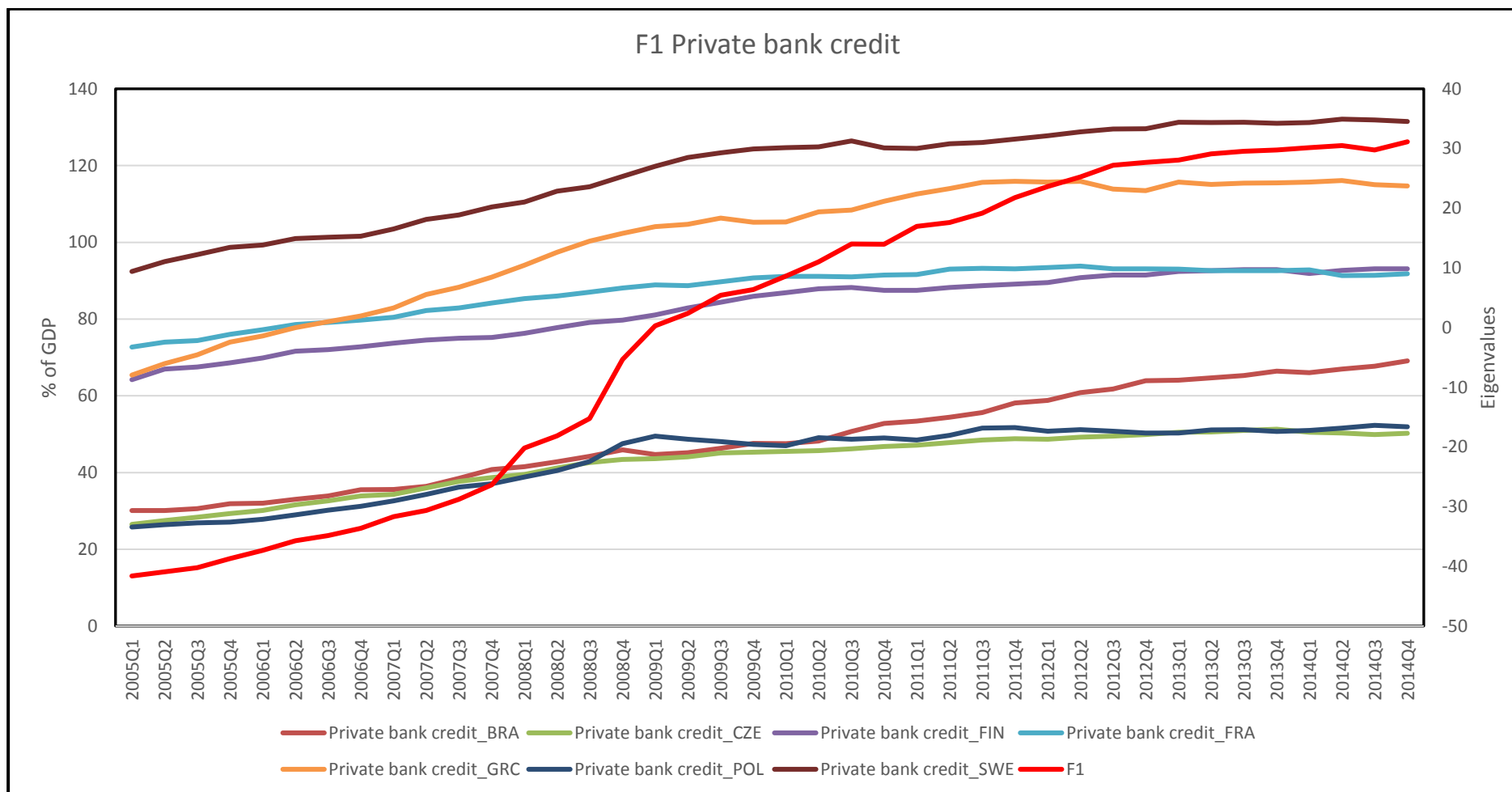
Appendix C: Factors

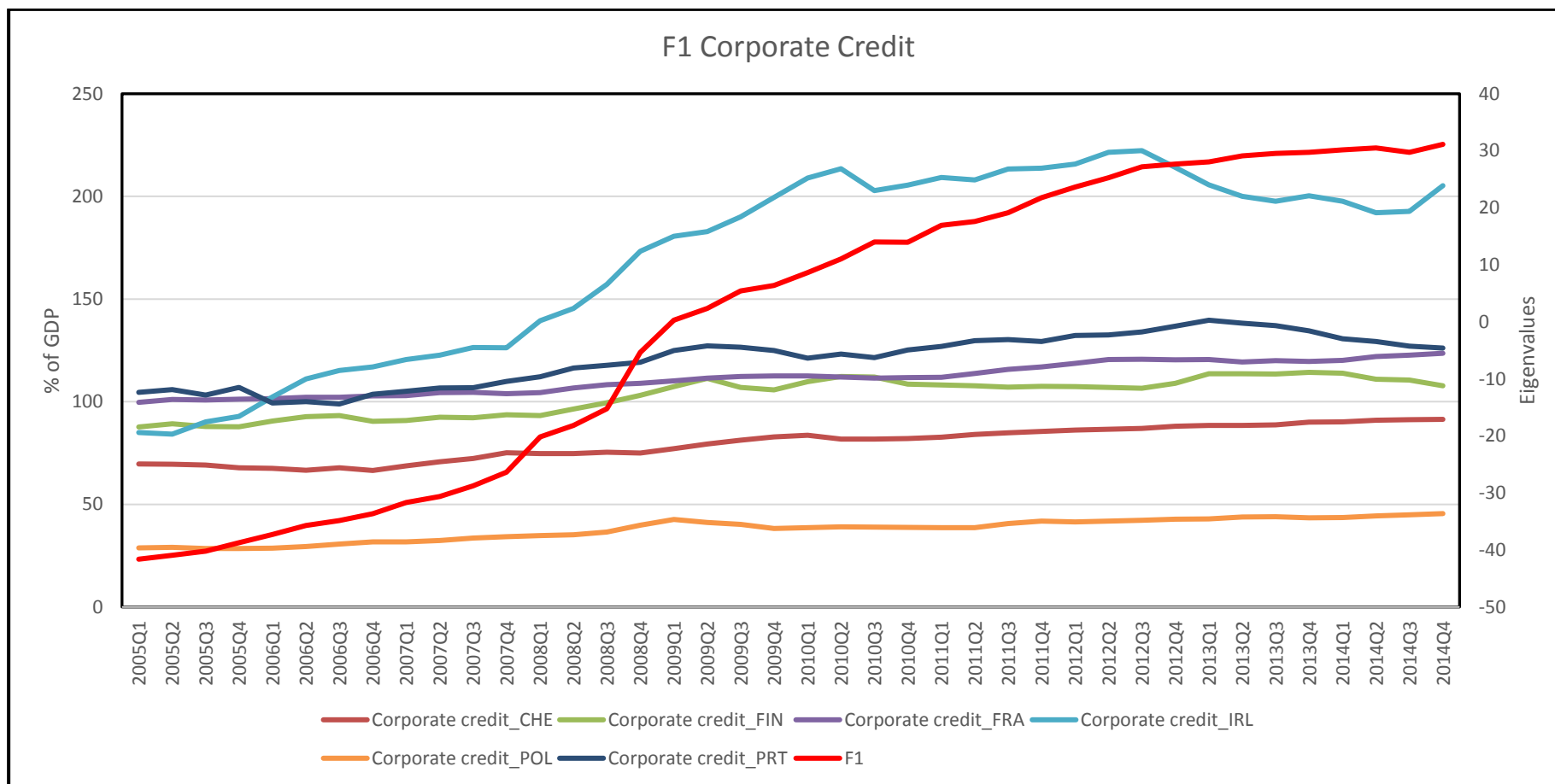
Factor 1

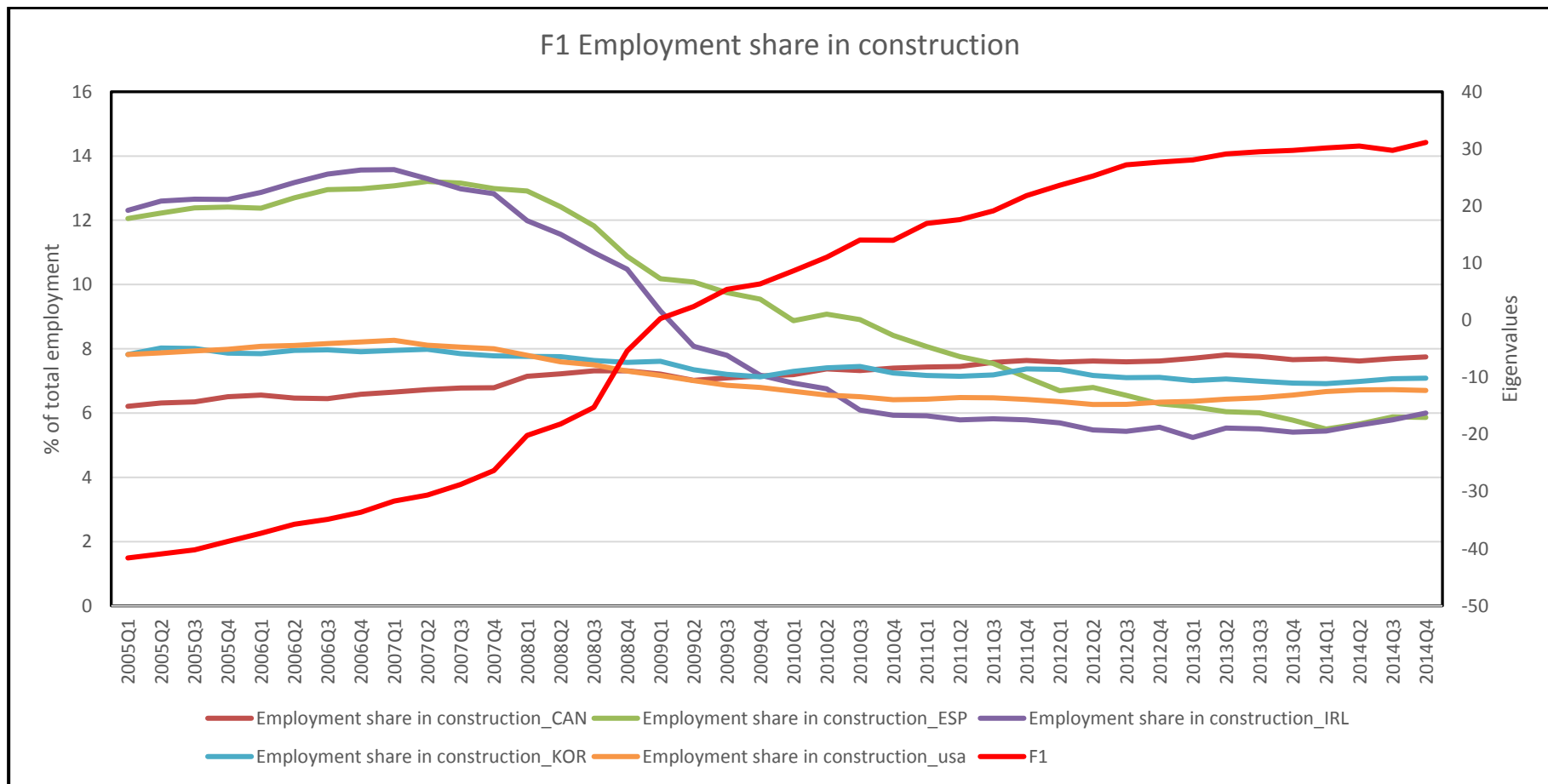


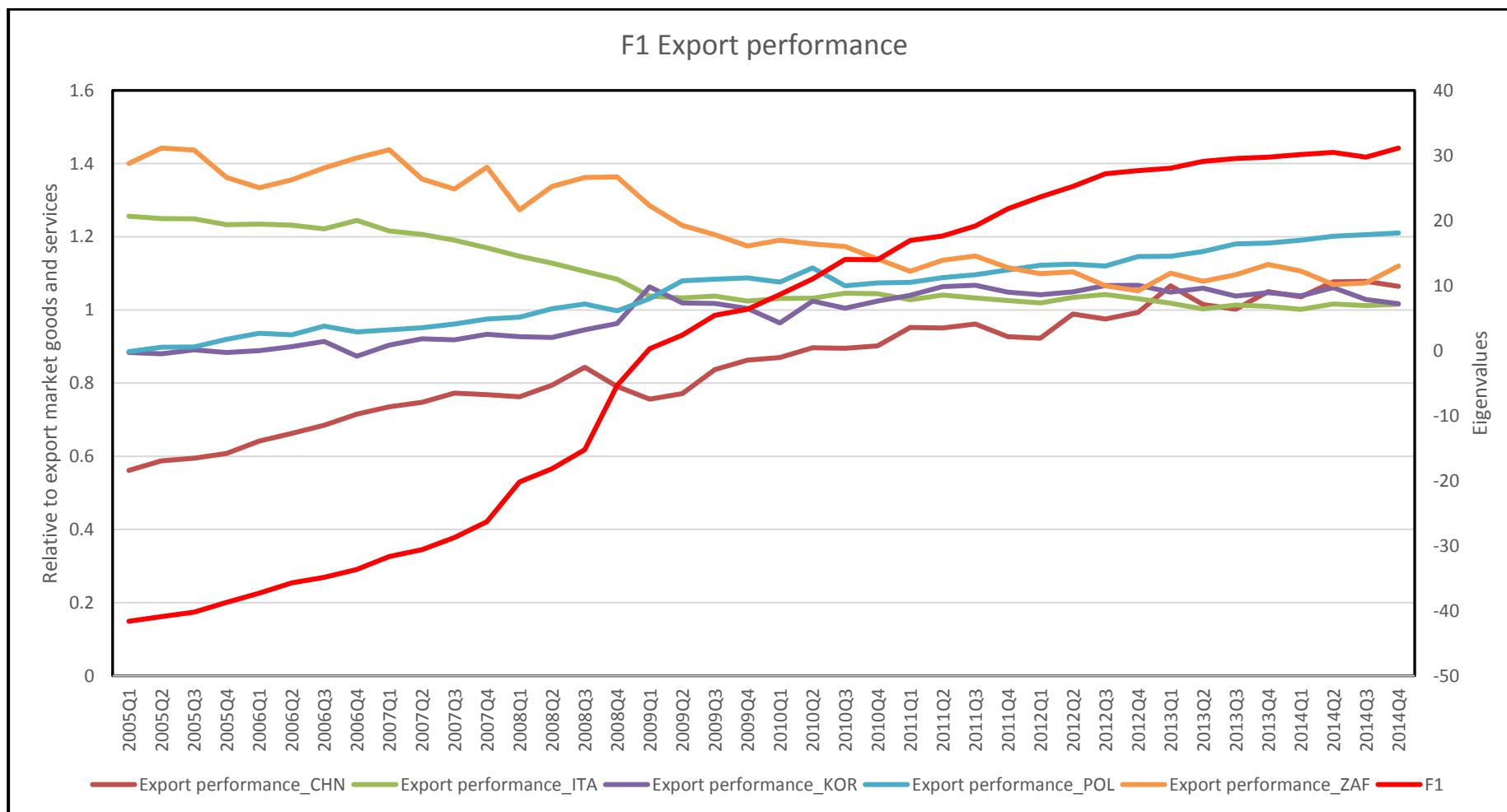


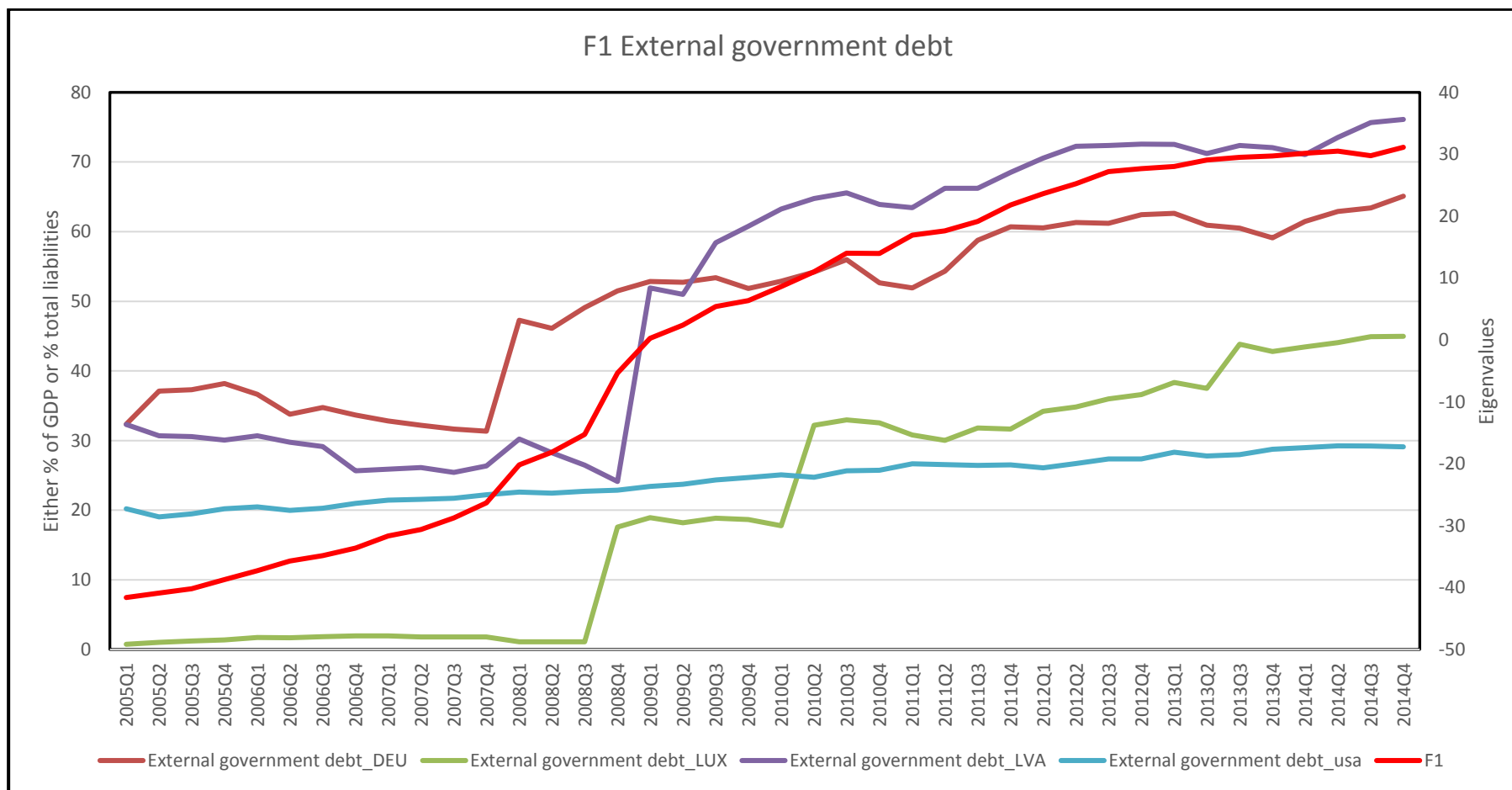


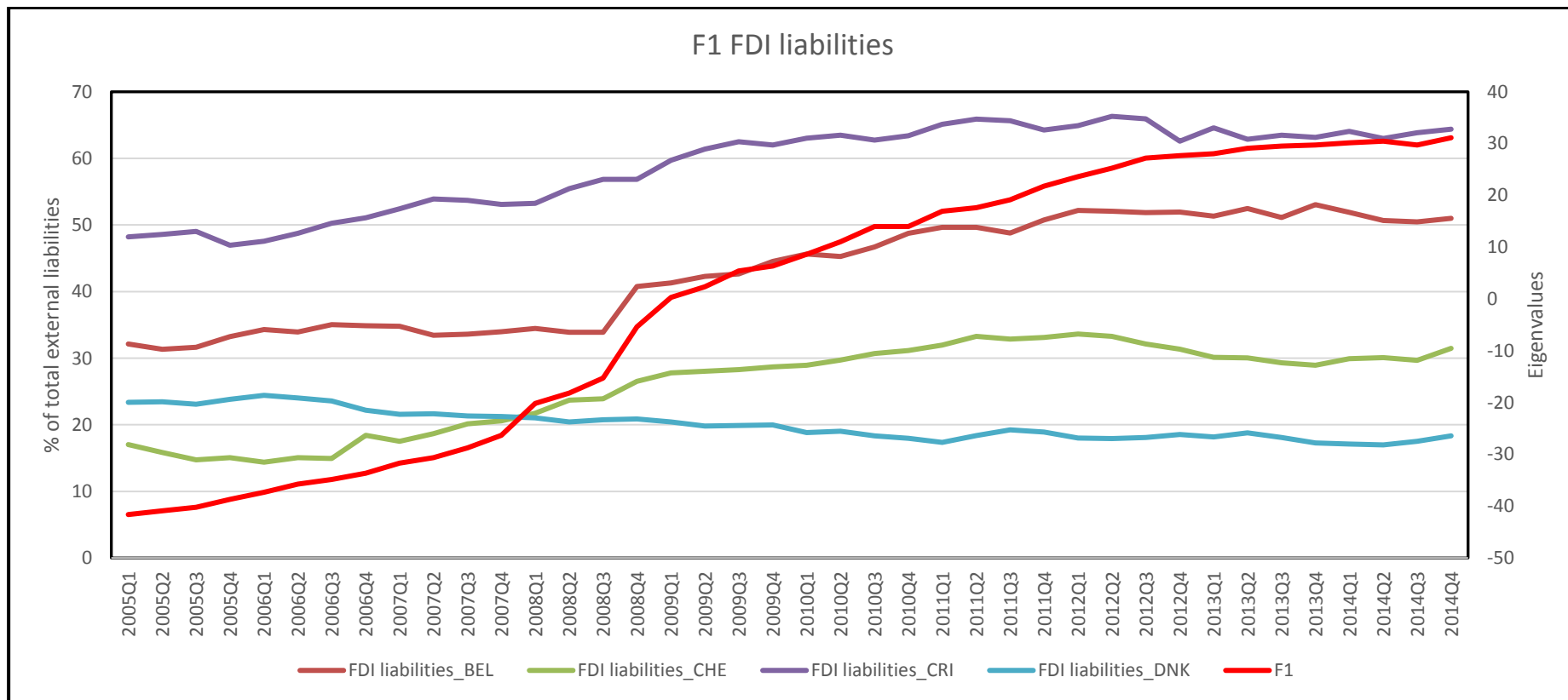


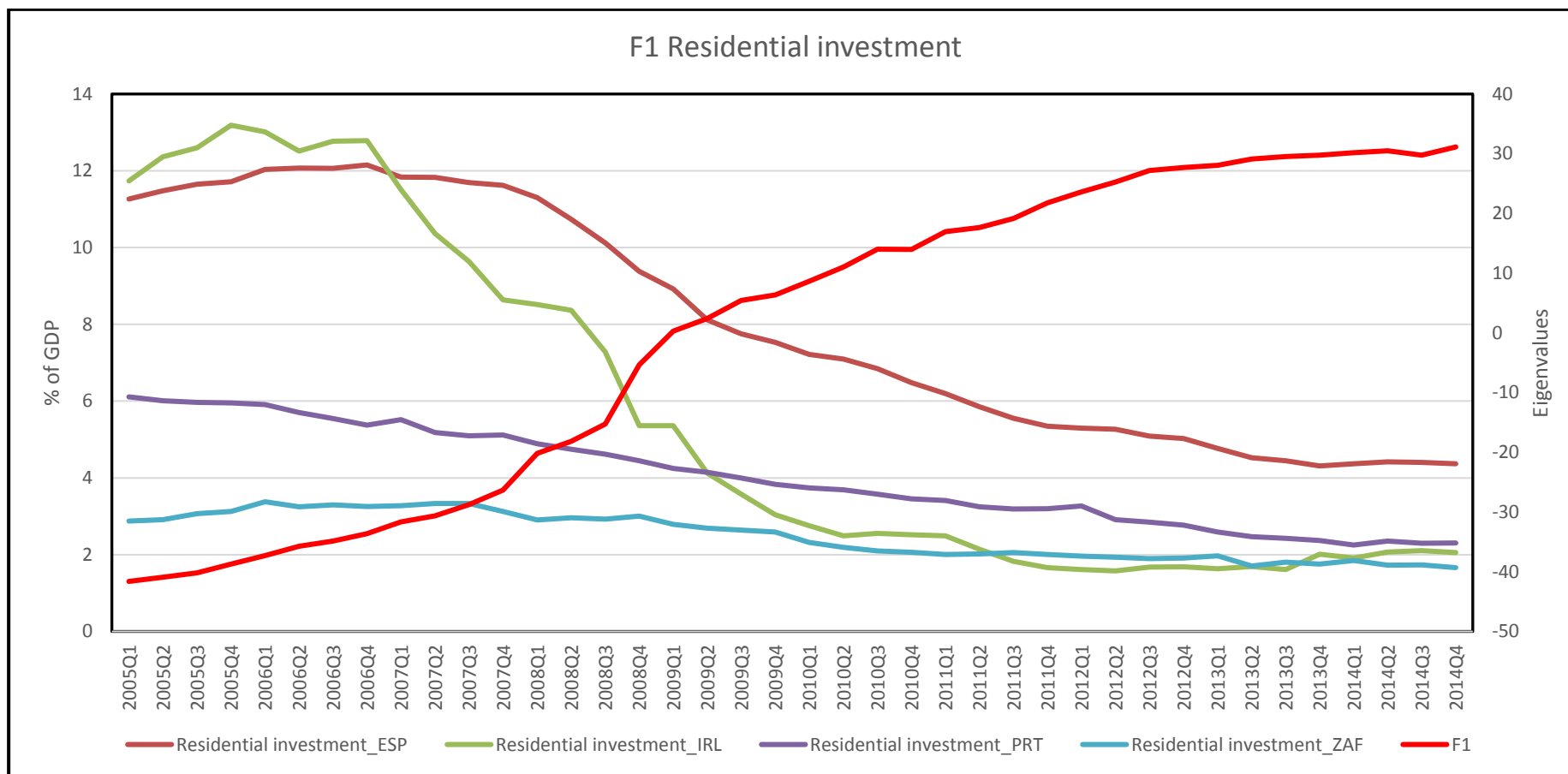


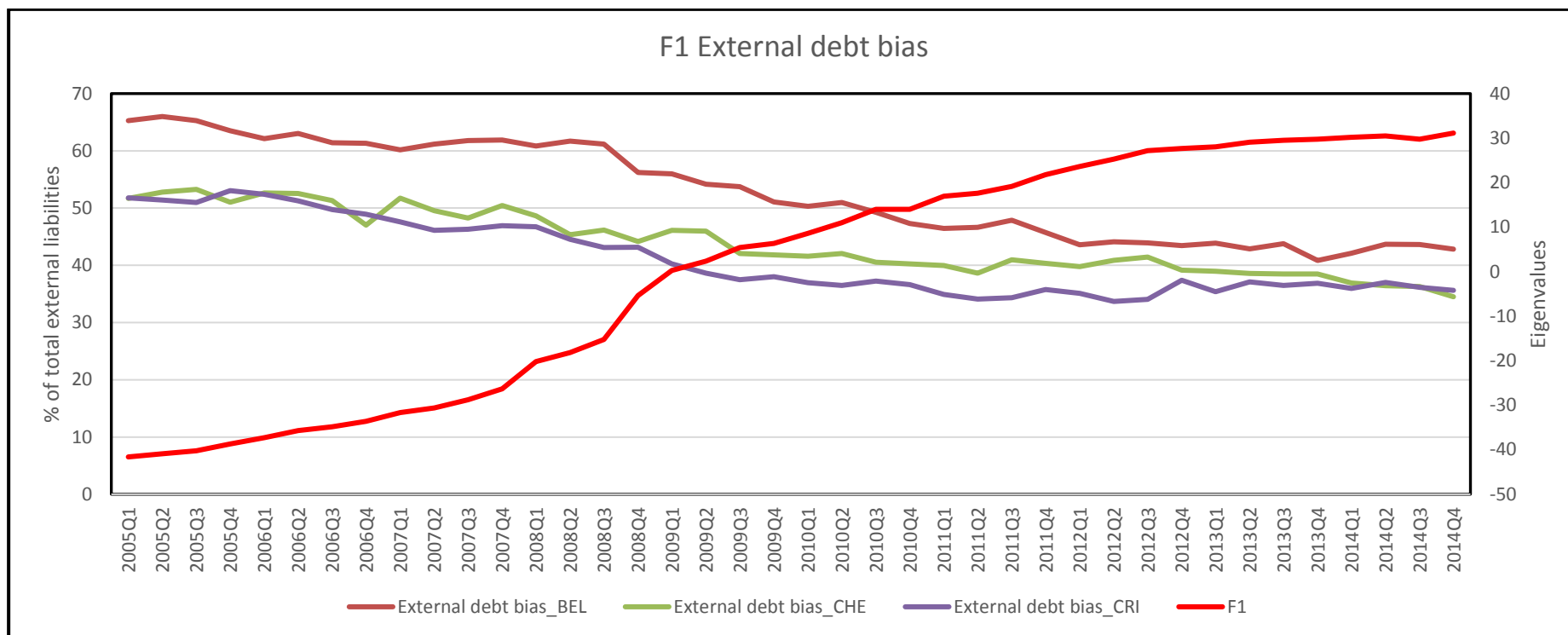


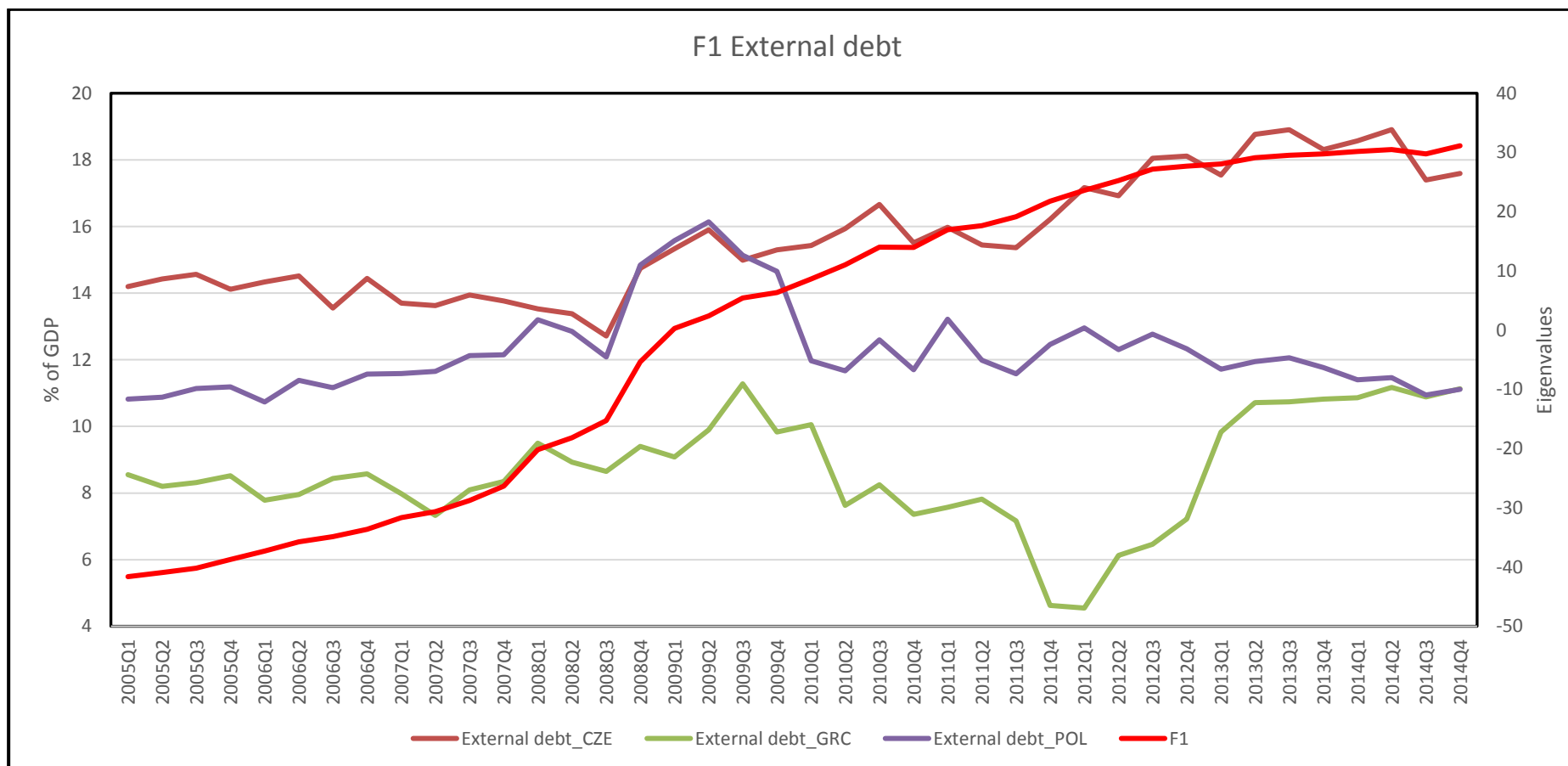


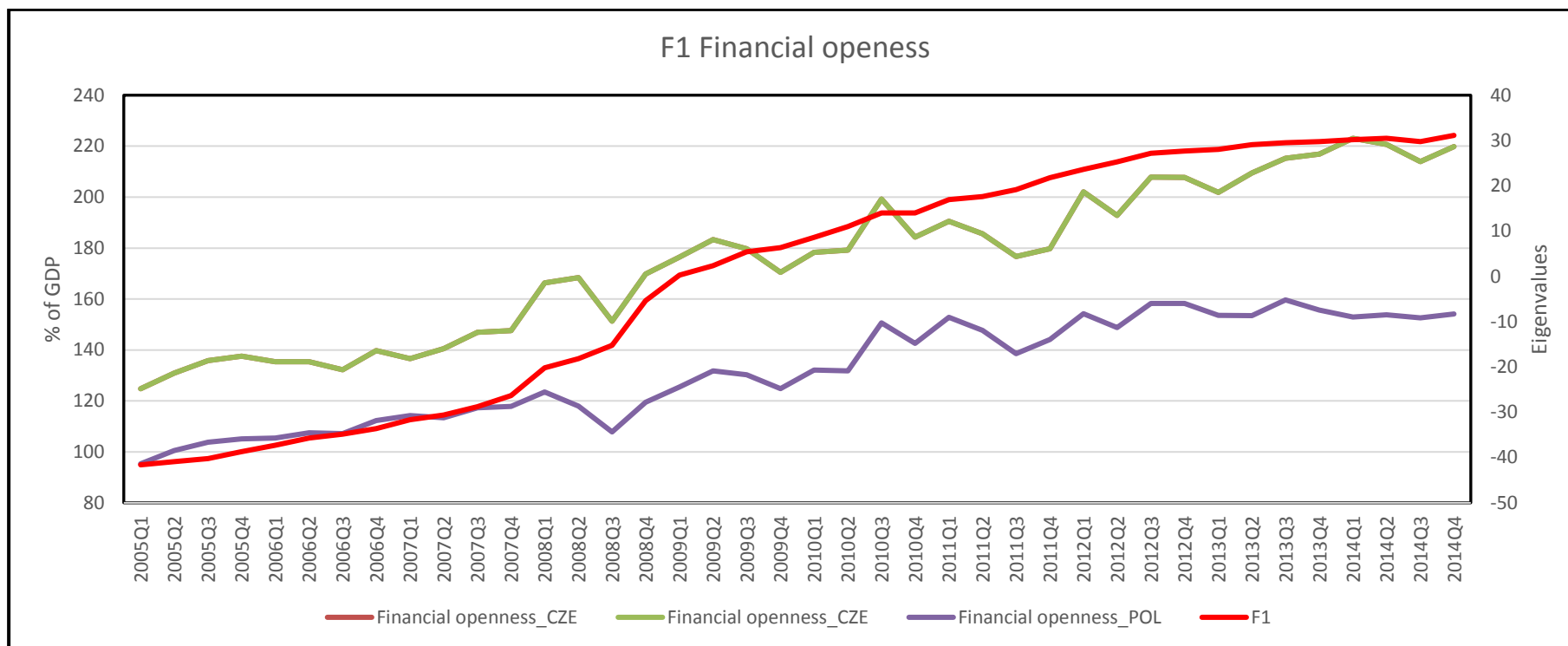


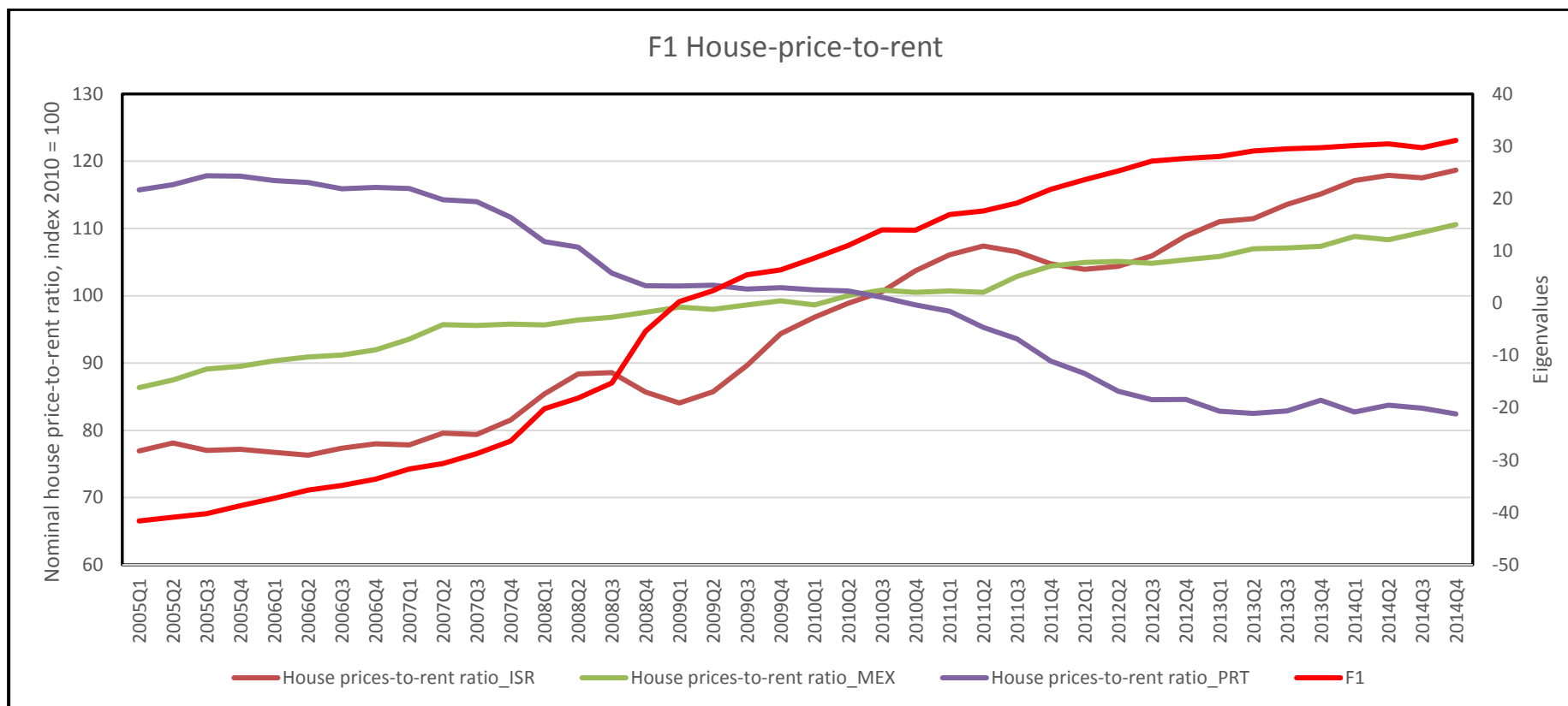












Factor 2

