# The state of decoupling before and during the Great Recession

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## Abstract

This thesis examines the decoupling debate, which gained special prominence during the Great Recession years. Since the credit crunch that started in 2007 seemed initially to be contained within advanced economies, it was speculated that emerging market business cycles had decoupled from those in advanced economies. A theoretical review on business cycle comovement highlights the fact that there are many possible transmission mechanisms through which the Great Recession could have been transmitted to emerging markets. These include international trade and finance. Though the high levels of globalisation which characterised the world economy at the onset of the Great Recession meant that many of these transmission mechanisms were well established, the theory predicts unclear outcomes. For instance, while international finance could have been a channel through which the crisis was transmitted, it could also have allowed emerging markets to diversify and thereby shield themselves from the crisis. As the theory on business cycle comovement reaches no clear conclusion, so too the literature review of prior empirical studies is inconclusive. While some studies find evidence of decoupling, others find evidence of increased business cycle comovement worldwide. Using dynamic factor analysis and rolling regressions to analyse data spanning the period between 1979Q3 and 2011Q2, it is investigated whether emerging market economies did indeed decouple or not. The period covered allows for a long-run view of business cycle comovement development between emerging market and advanced economies. The analysis is carried out for 15 emerging market and 17 advanced economies, and for China as a standalone economy. Sub-Saharan African economies are also analysed. Results show that, broadly speaking, emerging market economies display increased comovement with advanced economies during the Great Recession years. This becomes evident from the decade-by-decade analysis which breaks the overall sample of 1979Q3 to 2011Q2 down into three smaller samples, each spanning roughly a decade, or forty quarters. The coupling, or greater levels of comovement, between emerging market and advanced economies, is further corroborated by rolling regressions. There are certain exceptions though, such as India and Indonesia which displayed low levels of comovement throughout the Great Recession. Australia, New Zealand and Norway are advanced economies that also displayed low levels of comovement during this

time. Dynamic factor analysis and rolling regressions for China and 17 advanced economies show that the Chinese economy has also gradually coupled to advanced economies on a decade-by-decade basis, with comovement increasing toward the Great Recession years. For emerging markets as a group and for China as a standalone economy, various factors emerge as explanatory factors for the comovement seen in each sub-period. It is noteworthy however that international trade consistently stands out as an important factor. This ties in to theory on business cycle transmission which identifies trade as an important channel through which business cycle comovement is transmitted between economies. Sub-Saharan Africa is also analysed using dynamic factor analysis, though data restrictions necessitate the use of lower frequency data which cover the period between 1980 and 2011. African economies are divided into groups based on income. These groups display different patterns when it comes to comovement with the G7, as a proxy for advanced economies. For example, middle-income African countries display higher levels of comovement than other groups, indicating that they are more integrated with the global economy. Oil-exporting African countries interestingly display low levels of comovement. Low-income African countries also display lower levels of comovement than that of middle-income counterparts. Fragile African states do not appear to comove with advanced economies, but rather with other African groups. This suggests the possible existence of an ‘Africa factor’ for these countries. Overall, this thesis finds that the global economy has become much more integrated since 1980. Trade has played an especially important role in fostering business cycle comovement between advanced economies and emerging markets, and between advanced economies and African economies. It is this interconnectedness which meant that decoupling was not possible during the Great Recession, barring a few exceptions.

*Key words: decoupling; comovement; business cycle; emerging market economies; advanced economies; Great Recession; China; Africa; dynamic factor analysis.*

# Acknowledgements

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Dedicated to the memory of my mother, Alida Elizabeth Claassen, who would have turned 51 on graduation day.

*Oh me! Oh life! of the questions of these recurring,*

*Of the endless trains of the faithless, of cities fill'd with the foolish,*

*Of myself forever reproaching myself, (for who more foolish than I, and who more faithless?)*

*Of eyes that vainly crave the light, of the objects mean, of the struggle ever renew'd,*

*Of the poor results of all, of the plodding and sordid crowds I see around me,*

*Of the empty and useless years of the rest, with the rest me intertwined,*

*The question, O me! so sad, recurring—What good amid these, O me, O life?*

*Answer.*

*That you are here—that life exists and identity,*

*That the powerful play goes on, and you may contribute a verse.*

*--Walt Whitman--*

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# List of abbreviations

| | |
|---|---|
| ADF | Augmented Dickey Fuller |
| BICS | Brazil, India, China, South Africa |
| BRICS | Brazil, Russia, India, China, South Africa |
| CPI | Consumer Price Index |
| DCC | Dynamic Conditional Correlations |
| DFA | Dynamic Factor Analysis |
| EAC | Eastern African Community |
| ECB | European Central Bank |
| EM | Emerging Market |
| EU | European Union |
| FDI | Foreign Direct Investment |
| FSVAR | Factor Structural Vector Autoregressive |
| FTSE | Financial Times Stock Exchange |
| GDP | Gross Domestic Product |
| GVAR | Global Vector Autoregressive |
| GVC | Global Value Chain |
| HP-filter | Hodrick-Prescot filter |
| IMF | International Monetary Fund |
| MSCI | Morgan Stanley Capital International |
| NAFTA | North American Free Trade Area |
| ODA | Official Development Assistance |
| OECD | Organisation for Economic Cooperation and Development |
| PPI | Producer Price Index |
| RBC | Real Business Cycle |
| SACU | Southern African Customs Union |
| SSA | Sub-Saharan Africa |

| | |
|---|---|
| US | United States of America |
| VAR | Vector Autoregressive |
| WEO | World Economic Outlook |
| WTO | World Trade Organisation |

# CHAPTER 1: PROBLEM STATEMENT AND METHOD OF INVESTIGATION

## 1.1. Introduction and background

In a globalised world, it often seems inevitable that economies will increasingly follow shared trends and patterns of economic activity. On the other hand, it could also be argued that intensified globalisation opens up new possibilities for diversification, so that economies need not share the same global fate.

These two opposing views on business cycle comovement had come to the forefront of economic events especially around 2008. The debate, of course, was on the likelihood that emerging market economies (EM) had decoupled from advanced economies following the credit crunch of 2008. The debate was held particularly along two lines: real and financial. Where decoupling generally refers to the idea that EMs are no longer dependent on advanced economies to fuel their economic growth, financial decoupling specifically refers to the level of independence achieved by EMs in their financial markets. Real decoupling, on the other hand, refers to a greater degree of EM insensitivity to advanced economy business cycle fluctuations, and implies that EM output will be less drastically influenced when advanced countries experience a recession. Yeyati and Williams (2012) argue that there is real decoupling between EM economies and advanced economies, but that in terms of financial linkages, EMs are coupling with advanced markets, becoming more dependent on them. Note that, while financial variables are controlled for in the empirical analyses, the emphasis of this thesis is on the real side of the debate. The focus of discussions will therefore be on how variables such as business cycles, trade and GDP in EMs were influenced by the Great Recession.

Proponents of the decoupling debate have argued that the downturns experienced by EMs were not as severe as those experienced in advanced economies were. While growth in advanced economies averaged negative 7.2 and negative 8.3 per cent in the fourth quarter of 2008 and first quarter of 2009, respectively, growth in EMs was not as strongly influenced, averaging negative 1.9 per cent and negative 3.2 per cent during the corresponding time (Blanchard, Faruqee, Das, Forbes & Tesar, 2010). On the other hand, sceptics of the decoupling hypothesis have argued that the fact that these economies experienced downturns at all was proof that

decoupling was only a myth, and EMs were still exceedingly vulnerable to business cycle fluctuations in advanced demand (Wälti, 2010).

Though the credit crunch lent a new intensity to the debate around the comovement between EM and advanced economies, the debate was not entirely new and business cycle synchronisation had been gaining more attention as EM economies rose to global prominence in the decade preceding the global financial crisis.

Kose, Otrok and Prasad (2008), for example, investigated the change in business cycle synchronisation that had occurred in a sample of 106 countries during the period 1960 to 2005. The authors divide their sample into three different country groupings: developing economies, EMs and industrial countries. Analysing fluctuations in investment, output and consumption using dynamic factor analysis (DFA), the authors find that business cycles within individual EM economies are synchronising with each other, just as business cycles within individual industrial economies are coupling with each other. EMs and industrial countries, however, are decoupling from each other.

Stock and Watson (2005), while focusing only on business cycle synchronisation amongst G7 economies, proposed an early solution to the conundrum that would later be posited by Roach (2008). The authors found that it was indeed possible to have globalisation and decoupling at the same time, as their analysis of comovement amongst G7 economies showed that the business cycles of these economies had become less synchronised, even though trade and openness had increased. The reason for this was that the magnitude of common international shocks had declined.

While much attention was paid to EM economies during the time of the global financial crisis, and indeed over the past few decades as economies such as China contributed more toward global GDP, a further concern remained about the susceptibility of developing economies to the global financial crisis. Developing countries, while experiencing economic growth, are not necessarily as integrated with global financial markets as EM economies are.

Africa, in particular, remains the largest developing region in the world and concerns arose that the Great Recession would bring a reversal of strides made toward increased growth and development on the continent. In 2015, after the worst of the global financial crisis has passed, questions still remain on whether EM economies

and Africa did in fact decouple from advanced economies during that time. Though many studies have analysed real comovement between EM and advanced economies, few samples include data that have since become available for the years of the financial crisis and those immediately after. As for Africa, there is in general a dearth of studies on comovement for the continent as a whole, and in particular with samples covering the years of the global financial crisis.[1]

This thesis addresses this knowledge gap by empirically analysing real comovement between EM and advanced economies, with China as a standalone EM; and Sub-Saharan Africa (SSA) and advanced economies. In the rest of this chapter, the problem statement behind the study is discussed, and the research design and delimitation is presented.

## 1.2 Problem statement, rationale and research question

When the credit crunch of 2008 hit, what started as trouble largely in the US market eventually spread to become a global problem. In 2008, average global economic growth averaged just 2.21 per cent; compared with 4.87 per cent in 2007 and 5 per cent in 2006 (IMF, 2015a). By 2009, growth had turned negative, with the global economy experiencing average growth of negative 0.35 per cent (IMF, 2015a). This period of global contraction soon came to be known as the Great Recession. The financial shock that stemmed from the credit crunch was described by the IMF (2008b) as the largest since the Great Depression of the 1930s. As economists tried to understand the causes and potential consequences of this Great Recession, it seemed that a number of interrelated factors were at play. The US Federal Reserve was accused of maintaining too much of an accommodative policy following the US recession of 2001. This fuelled the housing bubble that eventually led to the subprime crisis (White, 2009). On the other hand, financial innovation in the form of collateralised debt obligations also played a part in the crisis. This was made possible by the fact that regulation in financial markets had not kept pace with these financial innovations, and rating agencies such as Standard and Poor, Moody's and others turned out to be ill-positioned to rate these instruments (Acharya & Richardson, 2009; Stiglitz, 2009). Globally, however, there had also for some time been concern over the imbalances in savings that existed between economies such

1 A literature review of studies on comovement between Africa and advanced economies is presented in Chapter 5.

as China and the US (Obstfeld & Rogoff, 2009). This problem was referred to as a global savings glut and seems to have further added to the perfect storm that had been brewing in US markets for some time (Verick & Islam, 2010).

The unfolding of the Great Recession is evident from about 2005 onward, in World Economic Outlook (WEO) reports provided biannually by the IMF. These reports sketch a picture of an emerging crisis. The September 2005 edition of the report cautions, with regard to the US, that *"… recent house price increases have raised concerns that the market could be increasingly susceptible to a correction.*" In September of the following year, projections for global growth still looked positive, however. The IMF (2006a&2006b) predicted global growth of 5.1 per cent for 2006, which was a quarter of a percentage point higher than forecast in its April report for 2006. The September 2006 report (IMF, 2006b:1) does, however, warn that US growth is expected to slow, due to *"… a cooling housing market."* The potential negative impact of global imbalances is also pointed out in this report. By October 2007, however, the first subprime rumblings in global credit markets had already occurred and the WEO (IMF, 2007d:xi) states that "*The world economy has entered an uncertain and potentially difficult period.*" While US growth was expected to be subdued, a hopeful tone emerges in the report as the strong performance of EM economies is highlighted. China and India in particular are emphasised as making *"… the largest country-level contributions to world growth* (IMF, 2007d:xi)." By January 2008, the IMF (2008b) had revised its projection for global growth downward: global growth would reach only 4.1 per cent in 2008; a projection that is 0.3 percentage points lower than estimated in October 2007.

The severity of the unfurling crisis is evidenced by the fact that three WEO updates were published throughout 2008, along with the full WEO reports at the beginning and end of the year. The October 2008, WEO (IMF, 2008e) revised growth projections downward from what had been forecast in the July update, with global growth expected to drop to 3.9 per cent during 2008, from the 5 per cent experienced during 2007. The IMF further forecast that advanced economies would be in recession by the end of 2008, with EM and developing countries experiencing growth below trend (IMF, 2008d). In the final WEO update for 2008, published in November that year, the IMF(2008c) adjusted growth projections for 2009 downward by three quarters of a percentage point, to just above 2 per cent. It also stated that

the downturn was led by advanced economies. Though EMs were expected to experience slower growth, they would still grow by 5 per cent. By January 2009, the IMF(2009a) had again revised its growth forecasts in a WEO update, stating that global growth was now expected to reach just 0.5 per cent in 2009. This would be the lowest growth experienced since the Second World War.

The decoupling debate, which raged during the time of the credit crunch, is implicit in a reading of these WEOs. Clearly, EM economies managed to perform quite well during the crisis. Mention had even been made of the important role that China, in particular, was playing in driving global growth. With the benefit of hindsight, though, what is also clear is that the crisis did eventually hit EM economies. These economies did manage average growth of 3.29 per cent during 2009, the most intense year of the crisis. This was impressive when compared with the negative 3.59 per cent achieved by advanced economies, but still represented a significant decline in previous growth of 5.38 per cent in 2008 and 8.31 per cent in 2007 (IMF, 2015a). Was this decline in EM growth attributable to the crisis in advanced economies? Or, was the very fact that EMs as a group, and China in particular, had not experienced such deep downturns, indicative of decoupling?

Though new data have since been made available, few studies have been done that focus very closely on the crisis years and whether EM business cycles did, in fact, become more or less synchronised with those of advanced economies during the years of the Great Recession.

Taking this into account, this thesis aims to address the knowledge gap by addressing the real side of the debate. In other words, this thesis focuses on whether business cycle comovement, as opposed to stock market comovement, intensified before and during the crisis. This comovement is analysed for three sets of countries: A variety of individual advanced and EM economies; China and a variety of individual advanced economies; and SSA economies (based on income group) and G7 economies. A brief explanation for the rationale behind looking at these economies is needed. First, since the speculation around decoupling at the time of the crisis was centred on EM and advanced economies, it is necessary to look at these economies before and during the crisis years in order to prove whether the pattern of comovement had changed or not. Second, given the prominence of China as an EM and growing world economic power, this economy warrants some

standalone attention. Indeed, much of the little global growth that was experienced during the Great Recession was attributed to China. Third and finally, Africa has been neglected in the international debate. In general, there is a lack of studies on comovement between Africa and advanced economies.

The specific research question can now be formalised as:

*What was the status of real decoupling in EM economies, China as a prominent EM by itself, and Africa before and during the global recession of 2008 and beyond?*

This overarching research question can be further divided into smaller research questions and aims which will be answered throughout this thesis. First, it can be asked what the theoretical foundation for decoupling is. Second, we wish to know how business cycle comovement between EM and advanced economies, China and advanced economies, and SSA and advanced economies changed in the years leading up to, during, and immediately after the global financial crisis. Third, having established patterns of comovement in the relevant economies, it may be asked which factors were responsible for driving the comovement between economies.

Briefly, then, though there are a few specific research questions that need to be answered in the course of this thesis, the aim that the study wishes to accomplish is two-pronged: First, the study aims to determine whether new data available after the onset of the global financial crisis can shed more light on whether EM in general, China specifically, and African economies did indeed decouple from advanced economies during the Great Recession. Second, the study aims to determine which factors have been responsible for potential comovement between EM and advanced economies, China and advanced economies, and African and advanced economies. Given the number of countries investigated, this thesis does not aim to formulate policy recommendations, which would need to be made following in-depth country-level analysis. Instead, the aim is to analyse the situation before, during and immediately after the Great Recession in order to determine how business cycle comovement has changed.

There are analysts who believe that the Great Recession was the very impetus behind a restructuring of the current global economic order that had been a long time in the making. Verachia (2010), for example, argues that the old world order has changed after the financial crisis, stating that the most significant consequence of the

2008 crisis has been a global economic and political realignment, with EMs taking centre stage. Shedding light on the decoupling hypothesis will, therefore, provide us with more insight into these global power shifts, which have important implications for foreign policy, as well as global trade, investment, and growth.

### 1.2.1 Disambiguation of terms

It is necessary to pause here and clarify some terms which will be commonly used throughout this thesis. These are comovement, decoupling, and coupling. First, comovement is a well-established term within business cycle research. In general, a dictionary definition of comovement reads as: The correlated or similar movement of two or more entities (Wordsense, 2016). Economically, it has been established that business cycles are characterised by the comovement of many economic variables over the course of the cycle (Burns & Mitchell, 1946; Zarnowitz, 1992). That is to say, certain variables tend to be positively correlated with one another during different phases of the cycle. This comovement can occur between domestic economy variables and between variables in different economies.

Second, decoupling refers to a departure from this positive correlation. According to Merriam-Webster (2015), “to decouple” means “to eliminate the interrelationship of; to separate.” In terms of business cycle comovement, it refers to the idea that, where variables such as the business cycles of economies might previously have been highly correlated, they are not any more. Third, where this thesis refers to coupling, it refers to the idea that variables are highly correlated once again. In this sense, comovement and coupling can be seen as interchangeable concepts.

## 1.3 Research design and method

This thesis will commence by providing a review of business cycle theory and transmission mechanisms in order to develop a theoretical basis for decoupling. This will serve as the foundation from which to analyse the decoupling hypothesis and the possible drivers thereof. This will be followed by an explanation of DFA, which is the empirical method used throughout this thesis.

After the dynamic factor model has been introduced, empirical analysis is done. Each empirical analysis is preceded by a literature review specifically for each group of countries being investigated. This will provide an overview of empirical work that has already been done on decoupling, in order to provide a clearer view of where the

debate currently stands and what has been proven so far. An empirical investigation will follow the literature study for each chapter. First, business cycle comovement between EM and advanced economies is analysed. Then, given the prominence of China as an EM, comovement strictly between China and advanced economies is analysed. Finally, an empirical analysis of business cycle comovement between Africa and advanced economies is conducted.

Each set of countries (EM and advanced economies; China and advanced economies; African and advanced economies) will be analysed using DFA. Rolling regressions are also used to provide more insights into the evolution of business cycle comovement.

Empirical investigations into EM and advanced economies, and China and advanced economies, will focus on the period between 1979Q3 and 2011Q2. This period includes important new data which will shed more light on how the Great Recession affected business cycle comovement between advanced economies and EMs. This overall period is analysed and additionally divided into sub-periods spanning 1979Q3 to 1990Q4, 1991Q1 to 2000Q4, and 2001Q1 to 2011Q2. These sub-periods are analysed for the set of EM and for China, with the aim of providing a decade-by-decade look at comovement developments. Data for EM economies, and China in particular, are often limited and this also delimits the period being focused on. The data for the analyses include quarterly data on various real and financial indicators. The data for the analysis on the broad set of EM and for China as a standalone EM are obtained mostly from the GVAR database administered by Cambridge University, and the IMF's International Financial Statistics (IFS).

It is important to note that the EM countries used in this thesis are classified as such according to the IMF, and following on the study by Kose, Otrok and Prasad (2008). Countries, therefore, do not necessarily reflect a financially EM, as classified by the MSCI or FTSE EM indices.

For the analysis on Africa, available data are much more restricted and annual real variables for the period between 1980 and 2011 are analysed. These are obtained from the World Bank's Africa Development Indicators and UNCTAD.

## 1.4 Outline of the study

The rest of this thesis will be structured as follows:

**Chapter 2: Theoretical base**

This chapter provides the theoretical base of the study. International business cycle theory and the theory behind transmission mechanisms are discussed. These theories often provide conflicting views on how business cycle comovement is triggered. For instance, trade integration can be seen as a channel through which comovement will be increased, or it can serve as a way of reducing comovement, if trade openness is used to diversify trade partners.

**Chapter 3: Method of investigation**

This chapter outlines the dynamic factor model which will be used in this thesis. Dynamic factor models are well suited to analysis of large macroeconomic datasets. The factor analysis enables the researcher to distinguish between common components and idiosyncratic components, which indicate whether variance in observed variables is caused by underlying latent components, or not.

**Chapter 4: Decoupling between EM and advanced economies**

This chapter discusses comovement between EM and advanced economies by providing a literature review of the issue, as well as a basic graphical analysis of growth trends in EMs. DFA is then used to investigate comovement between 15 EM and 17 advanced economies between 1979Q3 and 2011Q2. Real and financial variables are investigated, with a sample size of 225 (N) x 128 (T). This overall period is divided into smaller, decade-long sub-periods in order to give a more nuanced view on comovement. Finally, further factor analyses in the form of ten-year rolling regressions are employed in order to zoom in on patterns of comovement that specifically dominated during the crisis years.

Broadly speaking, the results show that the global economy has become more integrated on a decade-by-decade basis. EM economies display increased comovement with advanced economies during the credit crunch.

**Chapter 5: Decoupling between China and advanced economies**

Though China is included in the EM economies analysed in Chapter 4, it is such a prominent EM that it warrants closer inspection. Therefore, China is isolated from the

other EM economies and comovement between China and advanced economies is analysed in this chapter. A literature review on the issue of Chinese comovement with the rest of the world is provided. DFA is employed. Since the interest lies in comparing comovement between China as a standalone economy, and China as part of a larger group, the data used remain largely the same. The same overall and sub-periods are investigated, with a sample size of 172 observations (N) over 128 quarters (T).

Results show that the Chinese economy has gradually been coupling to the global economy. Comovement between China and advanced economies reached a zenith during the crisis years.

**Chapter 6: Decoupling between Africa and advanced economies**

Here, the attention turns to comovement in the developing world. Sub-Saharan Africa in particular is scrutinised in order to determine how comovement between African and advanced economies has changed over time. A literature review of the issue is presented. Analysis of growth trends in Africa shows that economic performance can vary greatly according to region and income group.

For the empirical analysis, DFA is used. The lack of high frequency data for African economies limits the analysis to the years between 1980 and 2011. The focus is once again on real comovement, with variables being obtained mostly from the World Development Indicators and UNCTAD. Annual data for the G7, as proxy for advanced economies, is also used. The sample of 37 observations (N) over 31 years (T) shows that comovement also differs according to income group, with middle-income African economies being much more integrated with the global economy and therefore displaying higher levels of comovement. Oil exporters, interestingly, show low levels of comovement, while low-income countries can be seen to still be very dependent on trade with advanced economies. Fragile African states seem to rather comove with other African groups rather than advanced economies, pointing to the possible existence of an ‘Africa factor’.

**Chapter 7: Synthesis and conclusion**

The final chapter synthesises the broad findings of the study. Generally speaking, the evidence suggests that EM did not escape the effects of the Great Recession.

This is true for EM as a group, and for China specifically, which is often seen as the most prominent EM.

For African economies, the decoupling hypothesis seems to hold more strongly as comovement between SSA countries and advanced economies is generally lower than comovement displayed by EM and China. This depends on income group, though, with middle-income African economies showing greater responsiveness to advanced economy business cycles than low-income and fragile African states.

Throughout the study, trade emerges as a very important factor in fostering real comovement. This lends credence to the "imported business cycle" school of thought, in which greater trade integration does lead to higher levels of comovement.

## 1.5. Conclusion

In an interconnected global world, it remains important to understand if and how individual economies synchronise with other economies. The global financial crisis of 2008 emphasised this fact all the more; as what started as a housing market crisis in the US soon spilt over into other regions of the world.

At the time of the crisis, the possibility that business cycles in EM economies had decoupled from those in advanced economies was much discussed in both the popular media and by analysts. In short, the reasoning behind this was that EM business cycles would not be as sensitive to the downturns in advanced economies as previously might have been the case. For Africa, the Great Recession naturally bought with it concerns that growth on the continent might stall as the crisis spread to that region.

Since the most intense years of the crisis passed, new data which encompasses the crisis years have become available. Few studies have incorporated this new data in order to analyse whether it is indeed true that EM economies decoupled from advanced economies during the crisis years. For Africa, there is also a lack of studies looking into this phenomenon.

This thesis contributes to this knowledge gap by using DFA to analyse trends in comovement between EM and advanced economies, China and advanced economies, and African and advanced economies. Samples generally range from 1979 to 2011, providing enough data to compare how real comovement has changed in the years leading up to the crisis, as well as during and immediately after

the crisis. Specifically, the contribution of this thesis lies in the fact that the decade-by-decade evolution of comovement is analysed, providing a much more nuanced picture of the decoupling phenomenon.

# CHAPTER 2: BUSINESS CYCLE THEORY

## 2.1. Introduction

Financial crises, as pointed out by authors such as Kindleberger and Aliber (1978), Eichengreen (2002), and Eichengreen and Bordo (2002), are persistent features of capitalist societies. As far back as the 1600s, a stock market crash related to tulips in Amsterdam led to severe recession in the Netherlands (Wang & Wen, 2012). Other such crises repeatedly emerged, the most serious of which was the Great Depression which lasted throughout the 1930s. The most recent global financial crisis started in 2008 and, given the occurrence of financial crises over the years, was nothing new (Reinhart & Rogoff, 2008).

The crisis originated in the subprime housing market in the US and was therefore financial in nature. Though the occurrence of such a financial crisis was not new, the speed of transmission was unprecedented (UNIDO, 2009; Blanchard *et al*., 2010:263). The crisis at first struck mostly advanced economies, spreading from the US to the UK and on into Europe. Gorton and Metrick (2012:133) trace a time line of the crisis to show the transmission between advanced economies. The speed of transmission is illustrated by the fact that a run on the US subprime originator, Countrywide, on 17 August 2007, was swiftly followed by a run on Northern Rock in the UK on 9 September. By October of 2008, the financial crisis had spread to Europe. The ECB, along with central banks in the US, UK, Sweden, Switzerland and China, collectively lowered interest rates on 8 October.

The globalised nature of the modern economy facilitated the spread of the financial crisis. The fact that the financial crisis was contained to advanced economies led to speculation that EMs might decouple. EM equities were not as exposed to odious US stocks and generally outperformed US counterparts (Dooley & Hutchison, 2009:3), while growth contractions, on average, in these economies were not as severe as those seen in advanced economies (Blanchard *et al*., 2010:265).

However, the crisis did not remain within financial markets, and inevitably spilled over into the real sector of advanced economies, as financial intermediaries started lending less (Gorton & Metrick, 2012:146). As global trade plummeted, many

countries were sent into recession. It became clear that the crisis was not just an advanced country, financial phenomenon and EM policymakers therefore took an interest in the possible impact that the crisis could have on their real economy. To observers who had initially supported the notion of decoupling, it now was less likely that business cycle decoupling would occur (Bems, Johnson & Yi, 2010:296).

Nevertheless, some debate surrounding real decoupling remained, especially since many EMs had enviable fiscal and monetary policy room with which to counter the worst growth effects, thanks to years of prior macroeconomic prudence (Buelens, 2013:26; Kose & Prasad, 2010:5). In this chapter, the aim is to provide a brief review of the theory explaining how the crisis that originated in the US might have spilt over to the real economies of EMs, and why, theoretically, there might have been a basis for the real decoupling of EMs from advanced economies.

The rest of this chapter therefore proceeds as follows: Section 2.2 provides a brief background to business cycle theory and discusses international business cycle theory in more depth. This is followed by Section 2.3, which delves deeper into transmission mechanisms of business cycles between countries. Section 2.4 concludes.

## 2.2. Business Cycle synchronisation theory

### 2.2.1 A brief history of business cycle theory

Since the focus of this thesis is on comovement across countries, international business cycle theory naturally receives much emphasis in the discussion of business cycle theory. Much of the theory about international business cycles was developed from the 1990s onwards. The majority of the theoretical review provided in this chapter therefore refers to works from the 1990s through to the 2000s. In order to provide some historical context as to how theories had developed up until international business cycle theory became prominent, a brief overview of the earlier evolution of business cycle theory is provided here. This overview by no means claims to be exhaustive and serves merely as background for later business cycle theories, which will receive closer attention because of their direct relevance for this thesis.

The concept of a business cycle was alluded to at least as far back as Adam Smith (1776), who observed that "overtrading" became common during periods when "…

*the profits of trade happen to be greater than ordinary ….*" Marshall (1881) also observed that a lack of confidence often led to poor markets for goods. Initially, the exact causes for these events were not really questioned. This could have been because, even though some dissenting voices had emerged from analysts such as Marx and Malthus, there still was general adherence to Say's Law (Shukla, 1968:67-88). Profits which were greater than ordinary, on the one hand, or confidence that was low, on the other, were also often ascribed to random events such as bad weather, wars and poor harvests. It is only since the latter half of the 19$^{th}$ century, when technological innovation during the Industrial Revolution placed investment in fixed capital at the centre of production processes, that a need arose to understand what exactly might drive the cyclicality that could be observed in investment (Zarnowitz, 1992:5). From around 1890, then, advances were made in understanding the causal factors behind the trade cycle, which would later come to be known as the business cycle.

The 1930s, especially, brought with it a decade of great upheaval in economic thought with the onset of the Great Depression. The sea change in thought that started during this time culminated with Keynes' publication of the *General Theory*, which gave great prominence to the consumption function and the role that demand played in driving the business cycle. In Keynes' view, the business cycle was essentially a phenomenon that could be observed during times of disequilibrium, with the disequilibrium being caused via the multiplier by rigidities in the economy (Laidler, 1992:85-104; Zarnowitz, 1992:12). Analysts such as Samuelson, Metzler and Hicks built further on dynamic disequilibrium models based on Keynes' investment accelerator and consumption multiplier throughout the 1930s and into the 1950s (Shukla, 1968:213-234;256-272).

Further economic upheaval in the 1970s spurred a new wave of thought about business cycles. During this time, questions regarding the real economy remained. However, the popularity of the Keynesian framework waned. As the OPEC oil price shock of the early 1970s spurred stagflation, the theoretical underpinning of Keynesian economics was called into question (Backhouse, 2006:30-31). Authors such as Lucas and Phelps made important contributions during this time, with assumptions such as rational expectations and continuous market clearing influencing their view of the business cycle. Lucas' theory of the business cycle was

therefore an equilibrium theory, with external random shocks seen as being responsible for output fluctuations (Barro, 1989:1-16; Mullineux, 1990:38-39).

Over time, these two major schools of thought came to be known as the New Keynesian and the New Classical views on the economy. While New Keynesians stressed market rigidities, New Classicals adhered to the notion of continuous market clearing. Within each broad school of thought, many individual authors made contributions that expanded on the works of authors such as Keynes and Lucas (Altug, 2009:1-5). By 1982, Kydland and Prescott's paper had merged some elements of these major schools. Keeping the rational expectations hypothesis of classic Lucasian models, Kydland and Prescott proposed that real, as opposed to unanticipated monetary, shocks were the major drivers of business cycle fluctuation. Their paper gave birth to Real Business Cycle (RBC) theory (Mullineux, 1990:37-60). In Kydland and Prescott's (1982) view, technology shocks were the main drivers of business cycle fluctuations. In that sense, one might consider Kydland and Prescott as disciples of Schumpeter, who originally proposed that innovation was the reason for cycles. Kydland and Prescott proposed that leisure time and the time required to build in investment were key propagation mechanisms that would translate technology shocks into cycles. In a closed economy with competitive markets, full factor employment and market clearing, a single representative agent would have the choice between work and leisure. If the substitution effect dominates the agent's income effect, then a temporary negative technology shock will cause the agent to work less, and also consume and produce less. Moreover, the agent will also save less, thereby influencing future capital stock, so that the shock persists. To summarise, then, the model proposed by Kydland and Prescott postulates that technology shocks will cause fluctuations in labour supply, investment and employment. In this manner, the domestic economy experiences output fluctuations.

RBC theory did have its opponents (McCallum, 1986; Summers, 1986; Singleton, 1988) and business cycle theory has continued to expand after the 1980s. As modern globalisation started increasing, theory attempted to explain not only the factors which might cause business cycles within domestic economies, but also to understand which factors caused business cycles across countries. The following section therefore provides more background on international business cycle theory.

### 2.2.2 International Business Cycle theory

Burns and Mitchell (1946) defined a business cycle as:

*[…] a type of fluctuation found in the aggregate economic activity of nations that organise their work mainly in business enterprises: a cycle consists of expansions occurring at about the same time in many economic activities, followed by similarly general recessions, contractions, and revivals which merge into the expansion phase of the next cycle; this sequence of changes is recurrent but not periodic; in duration business cycles vary from more than one year to ten or twelve years; they are not divisible into shorter cycles of similar character with amplitudes approximating their own.*

This definition of a business cycle, though seen as pioneering modern business cycle analysis, was criticised for not having a statistical basis. Harding and Pagan (2005) extended the business cycle concept by clarifying that business cycle concepts were either classical, deviation, or growth rate cycle concepts. Classical cycles are cycles as referred to by Burns and Mitchell (1946), who look at cycles in the level of relevant variables. Deviation cycles, on the other hand, look at the level of relevant variables minus a permanent component. Growth rate cycles investigate cycles in the growth rates of variables (Harding & Pagan, 2005). Following Burns and Mitchell, Harding and Pagan (2002) propose an algorithm to locate turning points and therefore provide the statistical underpinning that was lacking in Burns and Mitchell's original analysis.

While later innovations such as those described above contributed new ways of identifying business cycles, the basic idea behind a business cycle is that it is a pattern in aggregate economic activity. Burns and Mitchell's (1946) definition of a business cycle, for example, shows that national economies are characterised by expansions and contractions. It has also been observed, however, that these expansions and contractions often occur across nations (Centoni, Cubadda & Hecq, 2007:149). So, for example, what started as a primarily advanced crisis in 2008 became a global contraction (Dées & Zorell, 2011:5; Bayoumi & Bui, 2010:32). As globalisation has brought economies ever closer together, it has become apparent that world GDP also shows periods of expansions and contractions.

Theoretical models aiming to explain why these expansions and contractions would take place are varied. Predictions across different models are not always the same, with many contradictions. For example, some theories explain that financial integration will lead to greater comovement between countries, while others argue that financial integration can aid economies in shielding themselves from fluctuations in other economies. The following paragraphs provide an overview of some of these opposing schools of thought.

A seminal investigation into the empirical facts and theories behind the international business cycle was done by Backus, Kehoe and Kydland (1992). Their work builds on theory developed by Kydland and Prescott (1982), who investigated why comovement occurs across variables in a domestic economy.

In the Backus *et al*. (1992) model, the global economy consists of two countries with complete markets for state-contingent claims, each producing one homogenous product. These economies are subject to technology shocks in different periods. Economic agents furthermore participate in international capital markets and trade is frictionless, though labour is immobile. Allowing for this participation in capital markets moves the original real business cycle model of Kydland and Prescott (1982) toward one in which globalisation plays an important role and is more consistent with what we might expect to happen in today's economy.

As Backus *et al.* (1992) point out, introducing openness to the model allows agents to make use of international markets to share risk and smoothen consumption. This leads to negative output correlations across countries, since a positive technology shock in one economy will encourage capital flows from others. In this manner, events occurring in one economy may influence the real economy of another. However, for EMs in particular, the assumption of complete markets might not be reasonable. Baxter and Crucini (1995:821-823) therefore investigate the impact that incomplete integration with global financial markets might have on comovement between economies. The Baxter-Crucini model investigates a restricted asset market, where only non-contingent bond trading is possible. In contrast to the negative correlations predicted by Backus *et al.* (1992), the authors find that output between economies will comove (showing positive correlations) under circumstances where one economy in this two-economy world is not fully integrated with global financial markets. This happens owing to the wealth effect that comes into play when

output in one country increases as a result of a productivity shock. In a complete market, residents of a foreign economy would be able to lower their labour input when a positive production shock occurs in their neighbouring economy. This would happen because the foreign residents anticipate the positive wealth effect that will accompany this increased productivity when it reaches their own economy. If the wealth effect is not as large as expected, residents have access to complete asset markets with which to smooth consumption. In the absence of this insurance that is presented by complete markets, however, the tendency for foreign labour input to decline is less. For these reasons, Baxter and Crucini find that output does actually comove across countries. The authors conclude, however, that the sizes of these comovements are still not large enough to theoretically explain the trends observed in empirical data.

Though the previously mentioned models focus on participation in global capital markets, another channel through which international business cycle theory postulates comovement might occur between countries is that of international trade. Backus, Kehoe & Kydland (1994) set up a model to investigate this. In this two-country model, countries produce specialised goods using both capital and labour. There is imperfect substitutability of goods produced between countries and labour is immobile. The good produced in each country will have both domestic and foreign contents, with the exact share of domestic to foreign inputs being determined by an Armington aggregator, which is a measure of elasticity of domestic to foreign goods.

The net exports of each country in this model will be countercyclical. This is because net exports can be seen as the difference between output and the sum of consumption and investment in each economy, so that whatever is not consumed or invested locally is exported. Since consumers wish to smooth consumption between economies, investment will be procyclical: when output increases, it is possible to invest more, so that the difference between output and the sum of consumption and investment narrows. Net exports therefore decline. Conversely, when output decreases locally, it is not possible to invest as much. The difference between output and the sum of consumption and investment increases, and net exports increase.

In the theoretical framework postulated by Backus *et al.* (1994), comovement between economies therefore decreases when they trade intensively. If output in a domestic economy decreases and net exports therefore increases, the trading

partner now has more inputs with which to produce and output in the other economy will increase, and vice versa.

In contrast to the theoretical predictions of the abovementioned model, Canova and Dellas (1993) set up the two-country model so that each country specialises in the production of a different good. It is possible to either consume a good, or use it as an input in the production of another good. Complete markets exist with reference to state-contingent claims once again.

In this framework, when output in a country increases, it is possible for that country to export more. Conversely, the importing country now has more goods that can be used as inputs in their production process, and output in that country will therefore increase. In this manner, it is possible to see that trade allows output to comove between countries, as opposed to the negative output correlations predicted by Backus *et al.* (1994). The degree to which comovement occurs will depend on how strong the bilateral trade ties are between economies. Thus, economies that trade extensively will experience more synchronised business cycles (Canova & Dellas, 1993; Frankel & Rose, 1998; Clark & van Wincoop, 2001). It can also be concluded that business cycle synchronisation will intensify when foreign goods account for a large proportion of inputs used in local production.

This idea of the imported business cycle, as it was referred to by Canova and Dellas, might be particularly relevant to modern EMs, as the world has seen increased vertical specialisation of trade (Hummels, Ishii & Yi, 2001). The formation of regional production networks, or Global Value Chains, has been identified as a challenge in understanding the transmission of macroeconomic shocks across countries (Saito, Ruta & Turunen, 2013:3). Kose and Yi (2001) proposed that vertical specialisation might be the solution to the theoretical puzzle posited by the Backus *et al.* (1994) model. While that model theorised that output correlations between countries that trade with one another should be low, empirical evidence has mostly found that countries that trade more intensively experience higher levels of business cycle correlation, in line with the theory of Canova and Dellas (1993).

Kose and Yi (2001) therefore extend the Backus *et al.* (1994) model by incorporating transport costs and allowing for the back and forth trade of goods between the two economies in the standard international business cycle theory, so that one country

can sell a good to another country which uses it as an input in the production process, whereafter selling the final good back to the original country. The results of their extended model remain counterfactual: countries with lower transportation costs display lower levels of comovement. Intuitively, one would expect low transportation costs to be indicative of greater trade integration and therefore, greater comovement. Kose and Yi, however, explain that low transportation costs could also more easily enable resource shifting between countries, so that business cycle comovement decreases. In this theoretical model, the conclusion therefore is that the resource shifting effect of transportation costs dominates the trade integration effect.

In summary, the expectations that can be formed about decoupling between EM and advanced economies is not clear. The discussion in the preceding paragraphs shows that standard international business cycle theory would argue that increased financial integration would cause lower synchronisation, as it becomes possible for countries to share risk on international capital markets. This leads to the expectation that EM economies could have decoupled by diversifying risks on capital markets. On the other hand, the model developed by Baxter and Crucini (1995) showed that a low degree of financial integration would likely lead to greater comovement with advanced economies.

The other factor to take into consideration here would be the fact that these very financial markets, which should serve to diffuse risk between economies, were during the credit crunch years the very source of risk, so that countries that were very financially integrated might have seen higher levels of business cycle synchronisation, after all. Some more is said on finance as a transmission mechanism of business cycles in the following section.

Regarding trade, the theoretical expectations are also unclear. It is possible that the higher levels of trade integration seen in the global economy could have served to lower levels of business cycle comovement; again, thanks to the risk sharing that is possible within an open economy framework. It is possible, therefore, that EM economies could have shown lower business cycle correlations owing to consumption smoothing made possible by trade and vertical specialisation. On the other hand, there is the possibility that countries that trade intensively likely would import business cycles, implying that EM economies would experience higher levels of business cycle synchronisation during the credit crunch.

## 2.3. The role of transmission mechanisms

International business cycle theory allows for the synchronisation of business cycles across countries due to shared technological, production and trade shocks. In this section, some of these propagation or transmission mechanisms are discussed. Empirical studies on previous crises suggest that trade (Eichengreen, Rose & Wyplosz, 1996; Glick & Rose, 1998; De Gregorio & Valdes, 2001), finance (Calvo & Mendoza, 1998; Kodres & Pritsker, 1999) and the interplay between trade and finance (Kaminsky & Reinhart, 1998) are important transmission mechanisms for international business cycles. These will be discussed in the paragraphs that follow. Attention is also paid to the role that common shocks play in fostering comovement.

### 2.3.1. Trade

In a globalised world, trade is an important transmission mechanism because, when a country experiences a change in output, changes in imports and exports automatically follow (Dornbusch, 1980).

This sensitivity of trade was an observable fact during the 2008 credit crunch, when global trade collapsed (Levchenko, Lewis & Tesar, 2010:214). Bems *et al.* (2010) argue that the structure of trade would be important when considering the role of trade as a transmitter of the credit crunch, since the tendency in recent years has been toward vertical specialisation. This is corroborated by Kose and Prasad (2010) who point out that, in recent years, EMs have experienced higher levels of intra-regional trade and therefore exposure to trade linkages were somewhat diminished when the crisis struck.

Taking these effects into account, Bems *et al.* (2010) reach the conclusion that trade still played an important role in transmitting the credit crunch from the US to other economies. As much as 27 per cent of lower demand in the US and 18 per cent of lower demand from the EU was carried by foreign trading partners. These effects were stronger for economies that are geographically closer to these economies, though economies in Emerging Asia also saw declines in imported intermediary goods. Levchenko *et al*. (2010) confirm the fact that sectors which provide mostly intermediate products experienced much higher reductions in imports and exports.

Berkmen, Gelos, Rennhack and Walsh (2009) analysed growth forecast revisions after the global credit crisis struck in order to explain some initial cross-country

differences that were emerging. The composition of trade seems to have been important for these countries – manufactured exports were more negatively influenced than food and other primary exports were – with countries exporting more advanced goods experiencing sharper declines in demand for their products than those of primary exporters. A preliminary analysis of the possibility for decoupling done by the IMF in 2007 finds that the major spillover channel of what started as a housing market crisis in the US was via trade linkages. As US demand slumped, so did imports, and countries exporting to the US experienced some decline. At that stage, the impact appeared to be modest, as the slowdown had been driven by US-specific developments, which made the decoupling hypothesis seem promising as long as contagion did not spread to asset or confidence channels.

### 2.3.2. Finance

Finance is another important transmitter of shocks, since economic agents do not only trade but also share risks on international capital markets (Evans & Hnatkovska, 2007:262).

Changes in these international financial markets can transmit to the domestic economy by influencing the balance sheets and, therefore, net worth and household wealth of firms and households (Blanchard & Fischer, 1989; Obstfeld & Rogoff, 2000). These changes can impact on output by influencing the ability to consume by making it either easier or more difficult to borrow (Claessens, Kose & Terrones, 2009).

In terms of the 2008 credit crunch, Berkmen *et al*. (2009) analysed growth forecast revisions after the global credit crisis struck in order to explain some initial cross-country differences that were emerging. The authors found that highly leveraged domestic financial systems and rapid credit growth left many countries vulnerable to the crisis. Furthermore, Cetorelli and Goldberg (2009) investigate the role that global banks played in transmitting the global financial crisis to EMs. The authors find that lending supply in EMs was influenced by a contraction in direct lending by foreign banks, as well as contractions in lending by affiliates of these banks in EMs. The contraction of lending supply by domestic banks also played a role in the transmission of the crisis to EMs, though openness to international banking is not found to be a factor in transmitting the crisis per se.

Financial integration can also cause shocks to be transmitted by economies owing to changes in exchange rates. Shocks to economies may lead to portfolio shifts on global financial markets, causing exchange rate changes which influence domestic economies. The more financially integrated economies are, the larger are the exchange rate influences that can be caused by a shock to a trading partner (Fratzscher, 2008).

Foreign Direct Investment (FDI) inflows are often important sources of finance for emerging and developing economies. As FDI flows to these economies have increased over time, it is possible that another channel for business cycle transmission has been established. As determined by Jansen and Stokman (2004), countries with intensive FDI relations have more synchronised business cycles. Macroeconomic disturbances in the home country could lead to lower investment in host economies, as lower profitability of the parent company forces cutbacks in employment, wages and, ultimately, investment.

### 2.3.3. Trade and finance

Trade and finance are important transmitters of business cycles in and of themselves, but as economies become more integrated, both financially and in terms of trade, it is also important to consider the interconnections that often exist between trade and finance.

The level of financial integration in an economy can influence trade since insufficient access to trade finance can negatively influence export performance. Crises originating in the financial sector can be translated to trade in this manner.

As mentioned above, exchange rate changes brought about by portfolio rebalancing between countries can also influence exports and imports. Trade integration, on the other hand, can also influence the financial vulnerability of different economies. For instance, Fratzscher (2008) finds that countries that trade intensively with the US might be similarly influenced by negative demand shocks from the US, so that bilateral exchange rates do not change much. Alternatively, negative demand shocks from the US might be beneficial for intensive bilateral trading partners if the shock reflects a change in competitiveness.

### 2.3.4 Common shocks

In previous paragraphs, the emphasis has been on channels through which a shock in one economy might be transmitted to another. Trade and finance were discussed as transmission mechanisms. It is, however, also important to consider that not only the transmission of the shock, but the very nature of the shock, could cause comovement between economies. This happens where shocks are “common”, in other words, where external disturbances influence economies simultaneously (Stockman, 1988). Think, for instance, of the shared impact that a change in oil price has on oil-dependent economies globally. Dellas (1986) found that business cycles of the UK, Japan, Germany and the US tended to comove owing to shared supply shocks and the adoption of similar policies in order to cope with such shocks.

Therefore, if economic shocks are common, output changes will tend to comove (Jansen & Stokman, 2004). If economic shocks are idiosyncratic, movements in output between countries will be more asymmetrical. Idiosyncratic shocks can still be transmitted between countries via trade and finance, as discussed in previous paragraphs.

## 2.4 Conclusion

This chapter has presented a theoretical base from which to empirically analyse the phenomenon of decoupling. A brief history of business cycle theory showed that economists as far back as Adam Smith commented on periods of apparent prosperity and depression that were evident in commercial economies, that is economies that were characterised by basic commerce and not heavy industry. These events were, however, often seen as natural to commerce-dominated economies, in which random events such as bad weather could be expected to influence trade. Strong emphasis on trying to explain exactly why economies are characterised by periods of boom and bust therefore took centre stage after the industrial revolution. It is interesting to note that theories often developed out of a need to understand particular economic disturbances. So, for example, the Great Depression brought about a new era of (Keynesian) economic thought. The stagflation of the 1970s prompted new classical economists to develop theories about the role that money plays in influencing output fluctuations. The 1980s heralded the start of modern business cycle theory, with RBC theory taking centre stage. The evolution of early business cycle theory shows what also becomes

evident from an analysis of more modern theory: that consensus is difficult, if not impossible, to achieve. Throughout time, various schools of thought have been dominant at one point or another, only to be usurped by a new theory formed in reaction to new events in the economy.

The true interest in this theoretical review, however, lies not in explaining how business cycles are propagated in domestic economies, but rather that in order to grasp the potential for decoupling, one needs to understand how it comes to be that business cycles *between* economies are propagated. International business cycle theory is the workhorse model in which comovement between economies is analysed. The original two-country model has been variously extended to allow for financial integration and trade between economies, and generally shows that economies will experience lower levels of output correlation when trading and taking part in international financial markets, because these options provide mechanisms for consumption smoothing and risk sharing. However, consensus once again proves difficult to obtain, since other theories have been put forward to argue that higher trade and financial links will increase business cycle synchronisation between countries. This happens because trade and finance open up channels through which shocks in one country can be transmitted to another.

A brief survey of preliminary investigations that had been done into the role that transmission channels such as trade and finance played in propagating the Great Recession showed that trade had been an important transmitter of the credit crunch. It is likely, though, that trade could have been a more or less dominant channel, depending on the exact trading structure of a country. Manufactured trade, for instance, seems to have been a much more important transmitter than primary goods. Finance likewise seemed to be important, with international banks transmitting the crisis to foreign countries.

In general, then, a review of business cycle theory shows a dynamic field which is constantly changing as new information comes to light. Since theory has not achieved a strict consensus, it is also difficult to identify a definite theoretical motivation for decoupling. In general, though, if it is true that greater trade and financial linkages provide greater avenues for diversification, then EMs might have decoupled based on the fact that they could have diversified trade and financial links away from advanced trading partners.

# CHAPTER 3: DYNAMIC FACTOR ANALYSIS

## 3.1 Introduction

Factor analysis gained prominence as a method of investigation in psychometrics, where it was observed that various observed personality traits could actually be driven by a small number of unobserved characteristics. Spearman's (1904) discovery that one factor, namely mental ability, underlies children's test scores on various unrelated subjects, is probably the most famous example of this.

In economics, it is also likely that much of the variance we see in observed variables is actually being driven by a small number of unobserved, or latent, variables. This was confirmed by Sargent and Sims (1977) who found that much of the variance that could be observed in quarterly macroeconomic variables, such as prices, output and employment in the US, could be explained by just two factors.

For this reason, these models are efficient in large macroeconomic datasets, in which the number of series used often exceeds the number of time series observations. Geweke (1977) first proposed a time-series extension of the factor models that were previously developed for cross-sectional data, resulting in the creation of DFA.

DFA will be used in this thesis to investigate the comovement between different macroeconomic variables across countries. In a large dataset, each series contains two orthogonal latent components, one of which is driven by common factors. These are the underlying factors behind comovement in the panel. The other latent component is the idiosyncratic component which is specific to each series. Examining these factors will show whether decoupling has occurred or not: if variables are largely explained by idiosyncratic factors, then decoupling has occurred. If, on the other hand, factors are largely common, this means that variables are explained by underlying components and decoupling has not occurred. The rest of this chapter introduces the model to be used for analysis in the empirical studies which follow in Chapters 4, 5 and 6.

## 3.2 Literature review on DFA

Part of the appeal of dynamic factor models is their suitability to diverse applications. Factor models have been used to study fields such as finance and risk (Ross, 1976) and consumer theory (Gorman, 1981; Lewbel, 1991), as well as for short-term forecasting and monitoring of an economy, as in Clavel and Minodier (2009) and Altissimo, Cristadoro, Forni, Lippi and Veronese (2010).

For the purpose of this thesis, however, the focus is solely on analysing comovement within a large dataset. There are many examples of dynamic factor models being used in such applications. Mansour (2003) employs factor models to analyse comovement across 113 countries in order to determine whether a global business cycle exists. Kose, Otrok and Whiteman (2003) use dynamic factor models to analyse common components in data for 60 countries across world regions and find evidence of a world business cycle. In a later study (Kose, Otrok & Whiteman, 2008) dynamic factor models are used to analyse comovement amongst the G7 economies. Helbling and Bayoumi (2003) also investigate business cycle synchronisation amongst the G7 by using dynamic factor models. Crucini, Kose and Otrok (2011) use dynamic factor models to show that G7 business cycles are driven by common factors such as the oil price and productivity. Marcellino, Stock and Watson (2000) investigate comovement between Economic and Monetary Union (EMU) economies using dynamic factor models. Kose, Otrok and Prasad (2012) investigate the possibility of decoupling between global economies using DFA and find evidence that the global factor has become less important in explaining business cycles between EM and industrial economies.

DFA has also been used to more closely investigate comovement between individual countries. Eickmeier (2007) employs factor models to investigate how business cycles are transmitted between the US and Germany. Kabundi and Loots (2010) find that prices are important in the transmission of Germany supply shocks to South Africa. Kabundi and Mouchili (2009) use dynamic factor models to investigate how integrated South Africa's stock market is with EMs, while Çakir and Kabundi (2013b) show that South Africa's business cycle has become synchronised with the BRIC economies.

The literature review above shows that DFA is an established method for empirically analysing comovement. Specifically, DFA is suited to large panels such as the one

employed in this study. DFA can accommodate the large number of series without the risk of lost degrees of freedom, thereby overcoming what is commonly known as the curse of dimensionality in data analysis.

### 3.3. The model

As mentioned in the introduction, the dynamic factor model is based on the idea that variance in time-series variables are driven by a few latent factors $(r)$, which we can call a common component. Comovement or variance in the variables can also be influenced by certain features that are specific to individual data series, which can be called an idiosyncratic component.

Therefore, we can represent 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, $e_t = (\varepsilon_{1t,} \varepsilon_{2t \dots} \varepsilon_{Nt})'$

This gives:

$Y_t = X_t + e_t$

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

Where:

$X_t = \Lambda F_t$ represents the common component; the part of the series that depends on common factors;

$e_t$ represents the idiosyncratic component; that part of each series that is variable specific and orthogonal to the common component;

And:

$\Lambda$ is the $N \times r$ matrix of factor loadings; consisting of the non-zero columns of $\Lambda$ and with $r < N$; where $N$ is the number of series in the dataset.

$F_t$ represents the vector of $r$ common factors.

Since $T, N \to \infty$ the common components can be identified using principal component analysis for the variance-covariance matrix of the observable data, $cov(Y_t)$. The variance-covariance matrix is summarised by a dimension reduction matrix with $N \times 1$ vector of eigenvalues from the variance-covariance matrix wherein the first largest eigenvalues and vectors have been calculated so that:

$X_t = VV'Y_t$ (2)

With:

$V'$ representing the $N \times r$ matrix of eigenvectors which correspond to 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 represented as:

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

Where $V$ is an estimate of factor loadings equal to $\Lambda$. The idiosyncratic factors can therefore be defined as

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

Throughout this thesis, the number of factors to be estimated is determined using the approach proposed by Bai and Ng (2002). In instances where the Bai-Ng criteria do not converge, the approach proposed by Alessi, Barigozzi and Capasso (2010) [2]is used.

### 3.4. Data and method

While specific data used for empirical analysis will be detailed on a chapter-by-chapter basis, a brief overview will be provided here. For the analysis that follows in Chapters 4 and 5, data are taken mostly from the IMF's International Financial Statistics database, and the GVAR database, as compiled by Cambridge University. Chapter 4 focuses on comovement between EM and advanced economies. Quarterly data on various real and financial variables spanning the period between 1979Q3 and 2011Q2 are used. The data period is necessitated due to data restrictions. High frequency real data for many EMs is often lacking. At the time of finalising this thesis in June 2015, a check of databses such as the IFS and GVAR databases confirmed that no newer data was available. Fifteen EMs and 17 advanced economies are analysed. The sample size is 225 (N) x 128 (T). Chapter 5 isolates China in the analysis in order to focus on comovement between China and 17 advanced economies. Quarterly data on real and financial variables result in a sample size of 172 observations (N) over 128 quarters (T).

[2] For full details regarding these methods, see:

Bai,J. and Ng, S., 2002. Determining the number of factors in approximate factor models. *Econometrica*, 70(1):191-221.

Alessi, L., Barigozzi, M. and Capasso, M., 2010. Improved penalization for determining the number of factors in approximate factor models. *Statistics & Probability Letters*, 80(23):1806-1813.

For the analysis in Chapters 4 and 5, data are logged, except in the case of percentages or negative values. Data are checked for seasonality using the X12 method and for non-stationarity using the Kwiatkowski–Phillips–Schmidt–Shin (KPSS) and Dickey Fuller Generalised Least Squares (DF-GLS) methods. Where necessary, data are differenced accordingly. In both Chapter 4 and 5, DFA is performed on four periods: an overall period covering the entire sample (1979Q3–2011Q2), and then three sub-periods covering 1979Q3 to 1990Q4, 1991Q1 to 2000Q4, and 2001Q1 to 2011Q2. The overall period is selected based on data availability, but is also selected to take into account the evolution in comovement for the entire period, including the 2008 financial crisis. These periods are chosen based on the idea that EMs generally only started to become more globalised during the 1990s. Keeping these separate decades then allows us to analyse what happened to comovement between EM and advanced economies prior to and during these periods of intensified globalisation. It also enables estimation of the levels of comovement that occurred prior to and immediately after the 2008 global financial crisis, which falls within the last sub-period. These sub-periods are more or less the same in size, covering roughly forty quarters, or a decade. The purpose behind these sub-periods is to provide a more nuanced view on comovement, enabling us to see how business cycle synchronisation has evolved over time. Where business cycles are analysed, these cycles are extracted from the quarterly GDP series using the Hodrick-Prescott filter[3].

Chapter 6 analyses comovement between Africa and advanced economies. Data restrictions here necessitate the use of annual data, covering the period 1980 to 2011. The period covered extends only until 2011 because of a lack of newer data. Data restrictions are often problematic for African economies. At the time of finalising this thesis, in June 2015, a check of the World Bank and UNCTAD databases used for the analysis confirmed that no newer data was available. Data are on real and financial variables and are taken from the World Bank's African Development Indicators and UNCTAD's Trade Statistics. This provides 37 observations (N) over 31 years (T). Data are logged where appropriate and checked for stationarity using the Augmented Dickey Fuller (ADF) test. Where necessary, data are differenced in order to ensure stationarity. African economies are analysed in groups according to

[3] Full information on this method can be obtained in: Hodrick, R.J. and Prescott, E.C., 1997. Postwar US business cycles: an empirical investigation. *Journal of Money, credit, and Banking*, pp.1-16.

the IMF's classification of economies as middle-income, low-income, oil-exporting and fragile African economies. These groups are compiled by weighting variables according to their GDP (PPP).

## 3.5. Conclusion

This chapter introduced the dynamic factor model that will be used to analyse comovement between EM and advanced economies. This will be done using quarterly data for various individual advanced and EMs. DFA will also be used to empirically investigate comovement between China, as a standalone EM, and advanced economies. Finally, DFA is also used to investigate comovement between African country groups and the G7. DFA enables the analyst to distinguish between common and idiosyncratic factors that drive comovement between variables. If idiosyncratic factors dominate, then variables are not driven by underlying or common components, and decoupling can be said to have occurred. This approach is suited to large datasets and has been used in many similar applications, as indicated in the literature review.

# CHAPTER 4: DECOUPLING BETWEEN EM AND ADVANCED ECONOMIES

## 4.1 Introduction

In late 2007, the first rumblings of what would come to be the Great Recession were starting to be felt. As the crisis started to unfold at this time, it was difficult to estimate the full scale it might take on and the extent to which the crisis might spill over to other economies. Hopes were, however, that the sub-prime crisis brewing in the US would remain contained within the US and that, even as the crisis broke, strong growth in EM economies would support global growth and help to avert a global recession (Pisani-Ferry & Santos, 2009).

The aim of this chapter is to empirically investigate whether these hopes were realised or not. DFA is used to analyse comovement between EM and advanced economies. The research question that is addressed is therefore: What was the status of real decoupling in EM economies during the global recession of 2008 to 2009, and immediately after? In order to provide a broad background to this empirical analysis, a literature review and general description of growth trends in EMs is also provided.

The IMF's World Economic Outlook (WEO), published in October 2007, stated that *"The good news is that EM and developing countries weathered the recent financial storm and are providing the basis for strong global growth in 2008."* (IMF, 2007d). This outlook was founded largely on the fact that most EMs displayed solid macroeconomic fundamentals at the onset of the crisis. Domestic demand in EMs was strong. Individual giants, such as China, India and Russia, had taken the lead on the global economic stage and, between these three individual economies, contributed half of global growth in the year leading up to October 2007 (IMF, 2007d).

Solid growth was not restricted only to these three countries, however. By the publication date of the 2007 WEO, EM and developing economies were contributing two-thirds of global growth, and growth displayed low levels of volatility.

Though financial markets in emerging economies at the time were not impervious to the financial upheaval in the US, these economies did show lower vulnerability to financial shocks. This was ascribed largely to the fact that EMs in general were not

exposed to the sub-prime assets which had been at the heart of the crisis in the US, and also to the fact that public balance sheets in these economies were strong enough to counter whatever upheaval might have spilled over (IMF, 2007d; IMF, 2008d).

The largest downward revisions in growth prospects were made by the IMF to the US, as the seat of the crisis, and to Canada and Mexico, having much tighter trade and financial linkages to the US. It was also expected that some problems might spill over to certain emerging Asian markets (IMF, 2007c). For the most part, the crisis seemed contained.

Throughout 2008, these predictions seemed to be proving true. Advanced economies experienced recessions while developing and EMs showed resilient growth. Then came the demise of Lehman Brothers in September of 2008 and the outlook started changing.

By 2009, the picture looked quite different. During the fourth quarter of 2008, real GDP in advanced economies had declined by 7.5 percentage points, while emerging economies as a group saw a decline of four percentage points (IMF, 2009a). Emerging Asian economies that were heavily reliant on manufactured exports seemed particularly hard hit, as global trade had contracted when the initial financial crisis in advanced economies eventually spilled over into the real economy.

By this time, the crisis had indeed become a global one – the IMF (2009b) estimated that per capita GDP had declined in three-quarters of the global economy. EMs were no longer as shielded from the financial turmoil, as general risk aversion increased. Trade also served as a conduit for the crisis. China and India saw exports decline, though the impact of this was mitigated by stronger domestic demand in the Asian giants. China's relatively strong growth (compared with that of other economies at the time) was further supported by interventionist government policies.

Latin America also felt the effects of the crisis during this time owing to lower external demand and sinking commodity prices. It seemed that the crisis might finally have caught up to EMs (IMF, 2009b).

Throughout the ensuing years, protracted crises in Europe continued to drag on global economic growth until, by 2014, the picture presented in the WEO differed substantially from the one painted in the initial report in 2007. EMs now were

displaying sluggish growth, while advanced economies showed good signs of recovery (IMF, 2014b). EMs still contributed two-thirds of global growth, though in this report performance was described as disappointing and much of the growth recovery estimated for 2014 and 2015 was ascribed to advanced economies this time.

The dynamics sketched out above point to the intricacies of business cycle comovement.[4] At first, it was expected that EMs would carry the global economy through the financial storm, as these economies seemed to have decoupled from business cycles in advanced economies. As the crisis played itself out, however, it became clear that EMs were not immune to developments in the advanced world – though their growth did continue strongly relative to the major slowdowns experienced in advanced countries. By 2014,[5] when the crisis had subsided, the picture looked entirely different, with EMs this time being the disappointing growth performers.

The results of the DFA presented in this chapter confirm that EMs had not been isolated from the crisis which started in advanced countries. In the years between 1979Q3 to 2011Q2, which are the sample years for this thesis, it is evident that business cycle comovement between advanced and EM countries has increased. Instead of decoupling during the crisis years, EM business cycles co-moved more strongly with those of advanced economies.

These findings are further elaborated on in this chapter, as follows: in Section 4.2, a literature review on the issue of comovement between EM and advanced economies is presented. In Section 4.3, economic growth trends of EM are elaborated on in order to provide broader background to the empirical analysis. Section 4.4 details the results of the factor analysis. Section 4.5 concludes this chapter.

4 A review on the theory behind comovement is covered in Chapter 2.

5 Note that, while IMF projections from 2014 onward are discussed here to provide broader background to the issue, analyses are run for the period between 1979Q3 and 2011Q2 owing to data restrictions.

## 4.2 Literature review

This section provides an overview of empirical work that has already been conducted on business cycle comovement between EM and advanced economies, in line with the delimitation of the study. Studies published between 2000 and 2014 are reported in order to provide an overview of the most recent work done.

The research question is clearly popular in the literature, with many studies on comovement being done. Some, such as that of Mumtaz, Simonelli and Surico (2011), take a long-term view on the issue of business cycle comovement. Mumtaz *et al.* (2011:192) analyse data as far back as the nineteenth century in order to establish certain stylised facts on international comovement. Using a dynamic factor model, emerging and advanced economies across four continents are analysed. The authors find that the global business cycle has become less important in explaining output fluctuations after the Second World War, while regional factors have become very important in explaining output fluctuations. This shows that, while global economies have historically decoupled, the trend has been toward coupling on a regional level.

Further historical studies of decoupling include those of Aiolfi, Catão and Timmermann (2011) and Artis, Chouliarakis and Harischandra (2011:204-205). Aiolfi *et al.* (2011:227) employ DFA to analyse long-term data for Argentina, Brazil, Chile and Mexico spanning the period between 1870 and 2004 and also find evidence of strong regional comovement, driven mainly by changes in output and interest rates of advanced economies. These global factors explain as much as 70 per cent of the regional business cycle in Latin America before 1930, and up to 40 per cent of the regional cycle after 1930. Artis *et al*. (2011:204-205) use Factor Structural Vector Autoregressive (FSVAR) modelling to study comovement between advanced and emerging economies between 1880 and 2006 and conclude that certain European and English-speaking countries have become more synchronised, while other regions of the world show that country-specific factors are the driving force behind their business cycles, pointing to the fact that countries have been decoupling.

Other studies focus more on recent decades when analysing comovement. For example, Kose *et al*. (2003) estimate a Bayesian dynamic latent factor model to investigate business cycle comovement in the world. Their sample comprises countries across regions and macroeconomic aggregates between 1960 and 2003.

The authors find that advanced countries have been much more sensitive to global shocks, whereas comovement in developing countries is generally spurred by idiosyncratic factors, showing evidence of decoupling for these economies.

Kose, Otrok and Prasad (2008:25-26) also present evidence of real decoupling in their study which covers the period 1960 to 2005, and includes various advanced and emerging economies in the sample. Their dynamic factor model investigates the driving forces behind macroeconomic fluctuations in output, consumption and investment. The authors reach the conclusion that there have been increased levels of synchronisation between the business cycles of EM and advanced economies individually, meaning that advanced economies have become more synchronised with each other while EMs have also become more synchronised with each other. Again, there is evidence for decoupling between these groups and coupling within the groups.

Nachane and Dubey (2013:4419) divide the period between 1974 and 2010 into a pre-globalisation and post-globalisation period and employ wavelet correlations to analyse how business cycle comovement has changed over time between countries. The focus of the study is on seven emerging Asian economies and a group of 16 advanced OECD countries. The authors find evidence that these EMs have decoupled in terms of both the trend and cycle of their business cycles.

Given the dominance of East Asia as an emerging region, Park and Shin (2009:137) study business cycles for East Asian countries in order to determine whether these economies have decoupled from the US and the EU. The period covered by this study is 1990 to 2006 and the authors construct cyclical measures of output for each region in order to compare trends. Results show that East Asian output has become more idiosyncratic, meaning that East Asia has shown decoupling, mainly due to increased intraregional trade. Asia's decoupling is confirmed by He and Liao (2011) in their structural factor model.

There are also those studies that find no evidence for decoupling. Wälti (2010), for instance, argues that interdependence is the order of the day in today's global economy. The author estimates business cycle comovement using the Euclidean distance to determine structural breaks in a sample of emerging and advanced

economies for which annual data was analysed between 1980 and 2008 and finds no evidence of decoupling.

Yeyati and Williams (2012:2125) also argue against decoupling. The authors analyse quarterly data on real and financial variables for a group of EM countries and compare it to G7 data. Their study covers the period between 1993 and 2010 and employs correlation analysis and panel regression. The authors find little evidence that real decoupling has occurred between emerging and advanced economies. Instead of real decoupling, the authors suggest that EMs have managed merely to reduce the level of their dependency on G7 economies and have diversified away to become more integrated with emerging Asia. This move can be ascribed to the emergence of China, which has become an ever-increasing driver behind global output fluctuations. Strong commodity prices and trade diversification have also contributed to the gradual decoupling that EMs are experiencing.

Botha's (2010) principal component analysis of business cycles between advanced and developing countries shows that developing countries have become more synchronised with the world business cycle in this latest globalisation phase. Quarterly data on output, investment and consumption from 1961 to 2008 were used for the analysis. The author establishes that both idiosyncratic and common shocks influence various countries in different ways, but that the major trend has been for most economies to synchronise with the global business cycle during large shocks, such as the credit crunch, indicating that the tendency has been for developing countries to couple.

Flood and Rose (2010:723-724) support the view of a more interdependent world. They study business cycle synchronisation amongst inflation targeting countries. This sample includes various emerging and advanced economies between 1974 and 2007. The authors use various filters, such as the Hodrick-Prescott (HP) and Baxter King (BK) filters, and regression analysis to analyse business cycles for various countries and conclude that business cycles have become more integrated over time. Trancoso (2014:509) also finds evidence of more synchronised business cycles. The author investigates the decoupling hypothesis over the period between 1952 and 2011 using dynamic conditional correlations and network analysis. Results do not support the decoupling hypothesis, showing instead that all countries are becoming more interdependent over time. This interdependence intensified

especially between 1996 and 2011. With regard to the credit crunch, it is found that the crisis transmitted to other economies owing to more integrated real and financial systems between economies.

Male (2011) suggests that certain individual countries display higher comovement with others. The author studies 32 developing countries, benchmarked against the US, UK and Japan, and finds that there is no significant comovement between developing country business cycles and advanced country business cycles. The author uses a concordance statistic to establish cycle synchronisation and this, however, does show a few individual developing countries which tend to comove with particular advanced counterparts. Bangladesh, Hong Kong, India, Israel, Mexico, South Korea and Uruguay are much more influenced by the US business cycle, while the business cycles of Brazil and the Philippines are more closely linked to the Japanese business cycle.

It could also be that countries are continually coupling and decoupling with one another. Yetman (2011:13) studies comovement between global economies using a more refined version of the Pearson correlation coefficient. GDP data between 1971 and 2007 are analysed and it is found that the norm, overall, is decoupling. It is only during periods of recession that economies show clear trends in comovement as business cycles become more synchronised. The expectation then would be that decoupling would not have occurred for EMs during the credit crunch. This pattern of decoupling and coupling was confirmed by Pesce (2014:51-55) who employs a time-varying VAR model to investigate the decoupling hypothesis for EM and advanced economies. Between 1978 and 2010, EMs show a pattern of decoupling, followed by coupling. Kose, Loungani and Terrones (2013:370) find further evidence to support the idea that most countries couple to the global business cycle during recessions, with advanced countries being more sensitive than developing countries.

With regard to comovement between emerging and advanced economies during the crisis years specifically, Pesce (2014:51-55) finds that between 2006 and 2010, EMs had become more vulnerable to changes in advanced country business cycles. The years leading up to, during, and immediately after the crisis thus show some coupling of EMs to advanced economies. Imbs (2010) studies monthly industrial production data for a sample of 39 advanced and EMs over the period 1980 to 2009 in order to analyse the dynamics at play during the credit crunch. Bilateral business

cycle correlations are estimated in order to establish the distribution of international business cycle correlations since the 1980s. The author finds that the crisis has led to a strong increase in the correlation of business cycles worldwide, with OECD countries in particular demonstrating increased levels of business cycle synchronisation. This increased synchronisation among advanced economies is ascribed in particular to greater financial openness. Developing countries, on the other hand, are found to display significantly lower levels of synchronisation. Imbs (2010) concludes that the shock of the credit crisis had diffused slowly to developing countries, leaving them more insulated than their advanced country counterparts. This lagged effect is corroborated by Fernández and Nikolsko-Rzhevskyy (2010:207-208) who look at the transmission of US business cycles to important trading partners between 1960 and 2007, using quarterly data. Using the Baxter King bandpass filter, the authors find that the long-term impact of US business cycle fluctuations on other economies has not been decreasing. Rather, the full effects of these changes are felt later, after a lag. This lag effect might explain why many observers formed the impression, for the first year or so after the credit crunch hit in the US, that EMs were decoupling from the US.

Table 4.1 below presents a summary view of studies discussed in this section.

**Table 4.1: Literature on comovement between EM and advanced economies**

| Authors | Period covered | Method used | Main conclusion |
|---|---|---|---|
| Aiolfi et al (2011) | 1870-2004 | Dynamic factor model | Leading Latin American countries show high levels of regional comovement, driven by advanced interest rates and output. |
| Artis et al (2011) | 1880-2006 | FSVAR | Only certain English speaking countries show long-term evidence of coupling, while most other economies worldwide are driven by idiosyncratic changes. |
| Botha (2010) | 1961-2008 | Principal component analysis | Most countries show greater business cycle synchronisation during periods of global shocks. |
| Fernández & Nikolsko-Rzhevskyy (2010) | 1960-2007 | Baxter King bandpass filter | Though shocks from the US may transmit to EMs with a lag, changes in US output still have a large impact on these economies. Over the long term, they are not decoupling from the US. |
| Flood & Rose (2010) | 1974-2004 | BK bandpass filters and HP filter | EM and advanced economy business cycles have become more integrated. |
| Imbs (2010) | 1980-2009 | Bilateral business cycle correlations | The credit crunch led to increased levels of business cycle comovement worldwide, especially among OECD economies. Developing economies displayed lower levels of synchronisation during the credit crunch. |
| Kose et al (2003) | 1960-2003 | Bayesian dynamic latent factor model | Advanced and developing countries are decoupling from one another. |
| Kose et al (2008) | 1960-2005 | Dynamic factor model | Advanced economies comove with one another, as do EM economies. EM and advanced economies however have decoupled from one another. |
| Kose et al (2013) | 1960-2012 | Business cycle dating and regressions | Business cycles of individual countries become more synchronised with the global cycle during recessions. |
| Male (2011) | 1980-2004 | Concordance statistics | EMs generally show decoupling from advanced economies, with only a few individual economies commoving much more with advanced trading partners. |
| Mumtaz et al. (2011) | 1860-2007 | Dynamic factor model | Economies have decoupled from one another globally and coupled regionally. |
| Nachane & Dubey (2013) | 1974-2010 | Wavelet analysis | Asian EMs have decoupled from advanced OECD economies. |
| Park & Shin (2009) | 1990-2006 | Structural factor model | East Asian EMs have decoupled from the US and EU. |
| Pesce (2014) | 1978-2010 | Time-varying VAR | Over time, EM and advanced economies show a pattern of decoupling followed by coupling. |

| | | | |
|---|---|---|---|
| Trancoso (2014) | 1952-2011 | DCC and network analysis | Business cycle synchronisation has increased over time, becoming strong especially in the years leading up to, during and immediately after the credit crunch (2006-2010) |
| Wälti (2010) | 1980-2008 | Euclidian distance | EM and advanced economies have become more interdependent – there is no decoupling. |
| Yetman (2011) | 1971-2007 | Pearson correlation coefficient | Decoupling is the norm – EMs show higher levels of comovement with advanced economies only during recessionary periods. |
| Yeyati & Williams (2012) | 1993-2010 | Correlation analysis; panel regression | EMs are gradually decoupling by diversifying trade partners toward other emerging partners. |

An overview of the literature presented shows no clear empirical consensus about the decoupling phenomenon. Depending on the period covered and method used, studies find either a clear case for decoupling, a clear one against it, or some combination in which it seems that episodes of decoupling followed by coupling (especially during recessions) is the norm. Often, the period covered by studies mentioned here stops at 2007 or 2008, thus not providing an in-depth picture of business cycle dynamics that would have been at play during the most intense years of the credit crunch and the period following immediately after.

Though some studies do cover the crisis years of 2008 to 2009 and beyond, there are still gaps that need to be filled. For instance, some studies use data that is of a lower frequency or does not look at sub-periods (Kose *et al*. 2013; Pesce, 2014; Trancoso, 2014). Others, though investigating the crisis years, focus only on a narrow handful of EMs, such as Asian economies (Nachane & Dubey, 2013), or look only at EM comovement with a narrow set of advanced economies, such as the G7 (Yeyati & Williams, 2012). The study done by Imbs (2010) provided an initial analysis of real comovement during the crisis, but used monthly data only until May of 2009 and therefore does not include some of the dynamics that would still play out later in that year.

It is this gap in the literature that will be addressed by the empirical analyses presented in this chapter. The use of quarterly data and decade-by-decade sub-periods specifically provide a new view on the gradual evolution of business cycle comovement before and during the Great Recession. This analysis also includes a broad range of both EM and advanced economies, moving away from a regional or strictly G7-oriented approach.

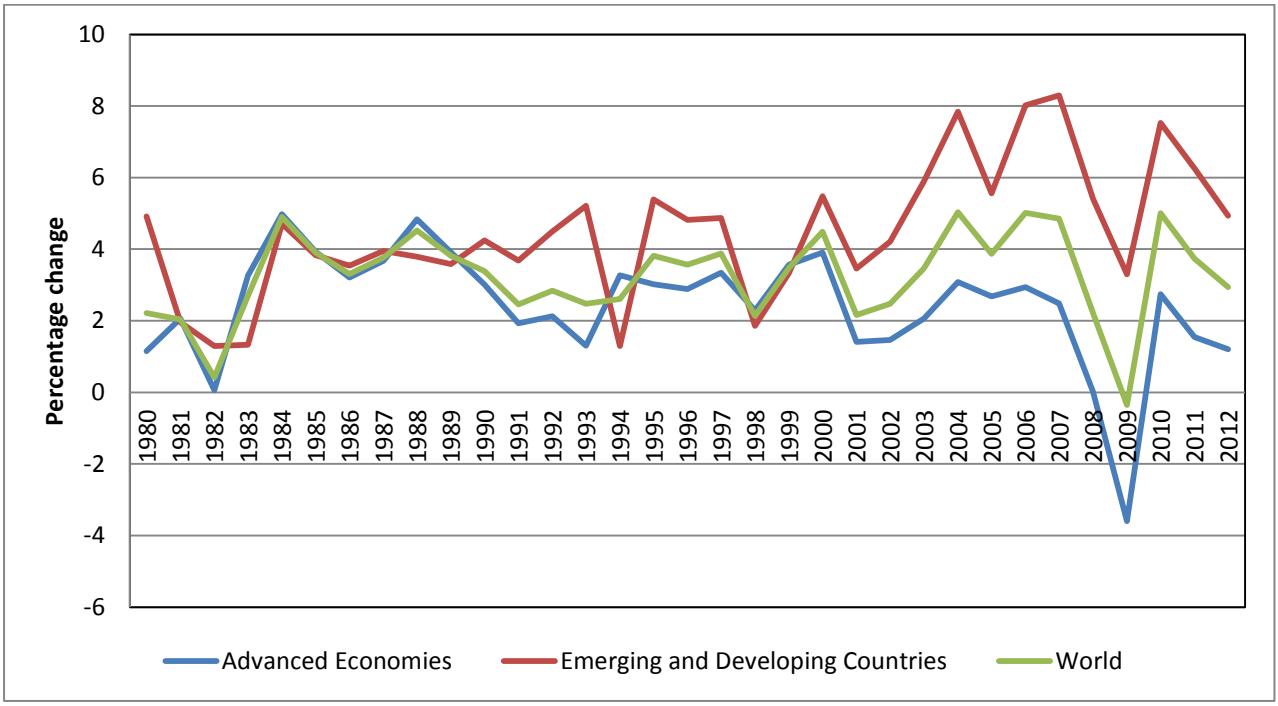
## 4.3 Background: Performance of EM and advanced economies before, during and after the 2008 crisis

This section provides an overview of the growth performance of EM and advanced economies in the years leading up to, during, and immediately after the financial crisis. The aim is to provide a background perspective against which the empirical results presented later on can be analysed, and the trends depicted here therefore focus on the period between 1980 and 2012.

### 4.3.1 Economic growth

Firstly, a visual inspection of GDP growth rates confirms that EM economies[6] experienced an upward growth trend between 1980 and 2012. This is shown in Figure 4.1 below.

**Figure 4.1: Global, advanced and EM growth, 1980-2012**




**Source: IMF International Financial Statistics**

In the decade between 1980 and 1990, EM growth marginally outpaced world and advanced growth, with an average growth rate of 3.5 per cent compared with 3.1 per cent for advanced economies and a global average of 3.2 per cent (IMF, 2014a). EMs continued their stronger, but more volatile, growth throughout the 90s, with average growth of 4 per cent up until 2000, when it is evident that EM growth rates are constantly higher than those of advanced economies. Between 2000 and 2010, EMs averaged a growth rate of 6.3 per cent, compared with 1.9 per cent for advanced economies and 3.8 per cent for the world (IMF, 2014a). In the run-up to the crisis, between 2000 and 2007, EM economies grew by an average of 6.6 per cent compared with 2.6 per cent for advanced economies (IMF, 2014a). The IMF (2010) points out that the strong growth experienced by EMs during the 2000s were

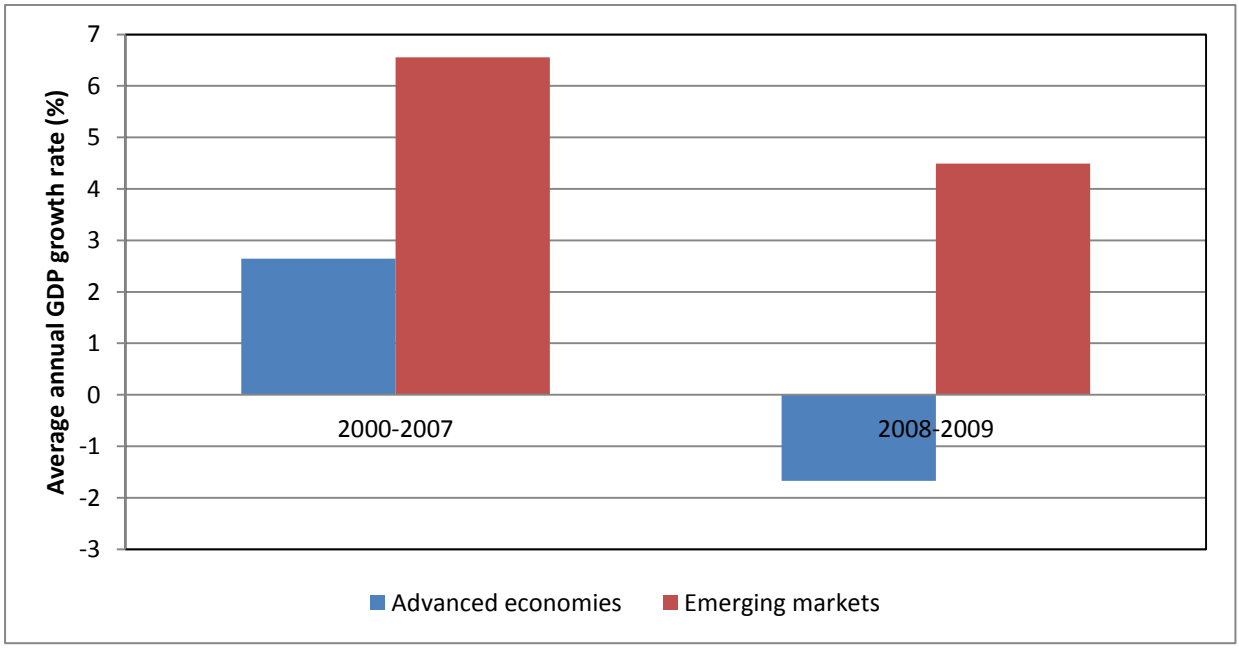
6 Note that the "EM", "advanced" and "world" country groupings depicted in this graph and all other graphs to follow are aggregates obtained from the IMF, and do not necessarily refer to the exact countries used in the empirical analysis later on. The purpose here is to provide a broad background of global trends before and during the Great Recession.

broad-based, with sixty per cent of EMs showing higher growth than they had in the previous decade. The outstanding growth experienced by EMs at this time was driven by a confluence of external and internal events. Firstly, the 2000s saw global trade and commodity prices increasing. Financing conditions during this time were also easy. These factors combined to boost productivity in EMs. Secondly, the favourable external conditions were supplemented by policy and structural reforms in EMs (IMF, 2010).

What can also be seen from Figure 4.1 is that EM growth outpaced that of advanced economies during the crisis years, though growth was not unaffected by the crisis. EM growth, coming off a high base, outpaced advanced country growth between 2008 and 2009, but evidently also experienced a dip which seems to follow the pattern of global and advanced country growth at that time.

Figure 4.2 below illustrates the strong growth that was still enjoyed by EM economies before and during the worst of the crisis years, when these economies as a group continued to grow by an average of 4.5 per cent, while advanced economies contracted by 1.7 per cent.

**Figure 4.2: Average EM and Advanced growth rates: Before and during the crisis.**

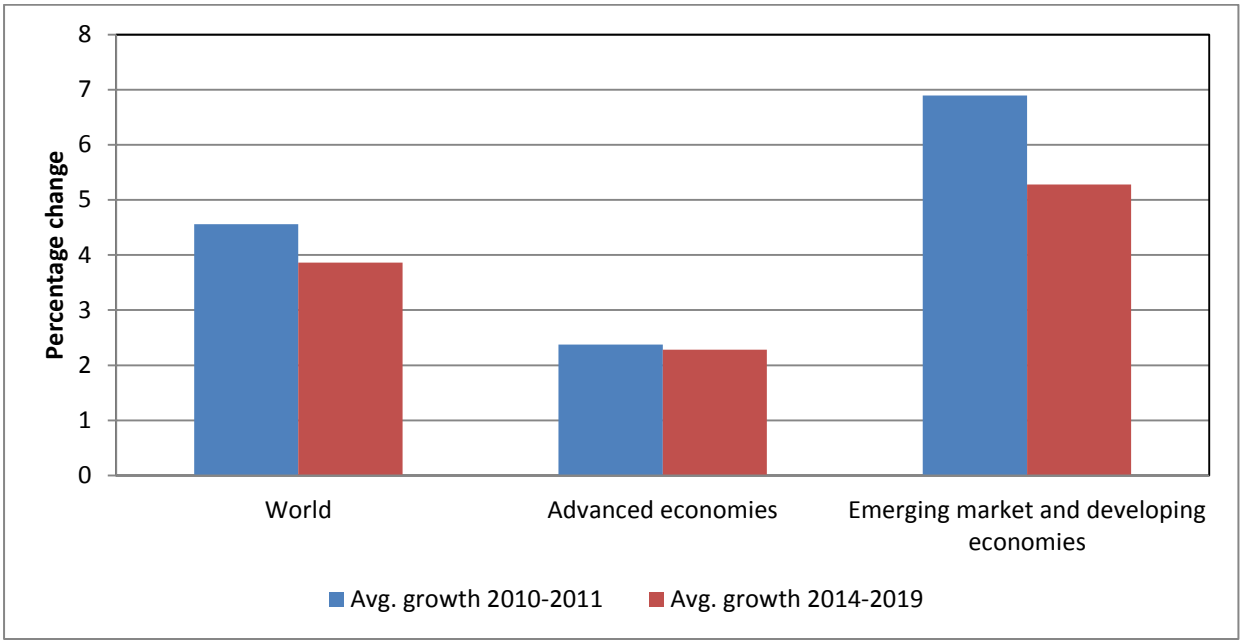



**Source: IMF International Financial Statistics**

Indeed, growth rates in EMs continued to grow throughout 2008 and 2009, although reaching a post-crisis peak in 2011, with average growth for the two years

immediately following the global credit crunch at nearly 7 per cent. This far outpaced growth in advanced economies between those years, which managed to expand by just slightly more than two per cent. This is illustrated in Figure 4.3 below, which also shows that, despite concerns about growth slowdowns in EM economies at the time of writing this thesis, this group of economies is still expected to grow by an average of 5 per cent between 2014 and 2019.

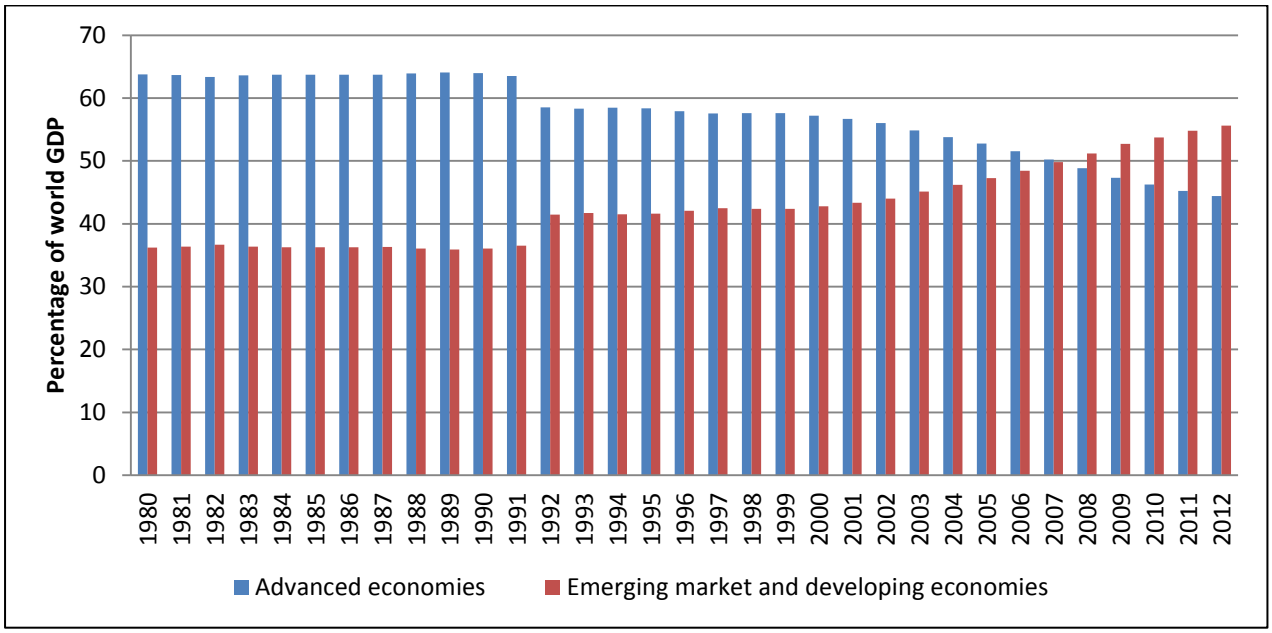
**Figure 4.3: Projected growth for EM and advanced economies, 2014-2019**




**Source: IMF International Financial Statistics**

The figures above show high growth rates for EM economies during much of the 1990s and 2000s, with growth continuing quite strongly during and after the 2008 credit crunch. It is also important to note that, not only have these economies been experiencing high growth rates, but their share of global GDP has been increasing as well. This is illustrated in Figure 4.4 below.

**Figure 4.4: Advanced versus EM economies: Share of global GDP, 1980-2012**




**Source: IMF International Financial Statistics**

By 2007, EM economies were responsible for 49 per cent of global GDP, in Purchasing Power Parity terms. This represents a significant shift from a contribution of about 35 per cent in 1980. Figure 4.4 above shows a clear turnabout in trends, where EM economies have been contributing more and more to global GDP, particularly since the early 1990s. According to IMF estimates (2015a), this trend is set to continue, with EMs accounting for 60 per cent of global GDP by 2019.

This changing trend is a large part of what spurred hopes, at the onset of the crisis, that the subprime crisis would not turn global – if nearly half of global output were determined by economies that were not influenced by the problem, as was the case in 2007, then a global recession might have been avoided.

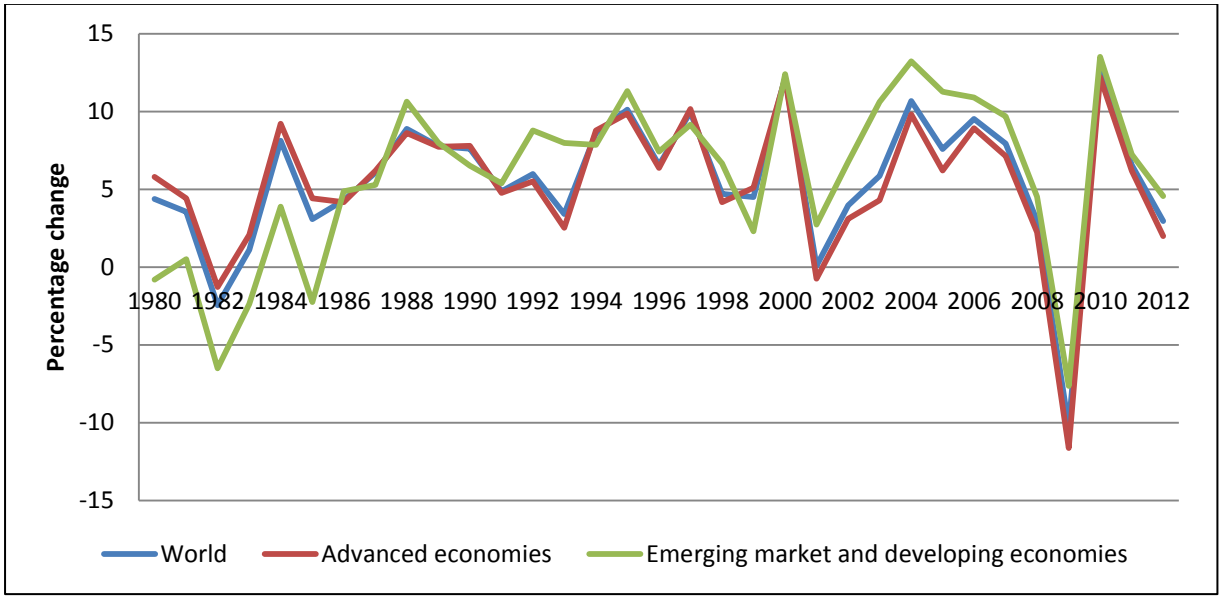
### 4.3.2. Trade

Another important trend that has changed during the past two decades is the composition of global trade. Many EMs were originally quite isolated, but as these economies opened up, they were able to fuel their growth and to also become important trading partners that started to replace traditional trading partners like the US.

Figure 4.5 below shows that export volumes of EMs have grown since the early 1980s, when growth in export volume for EMs was below that of the world and advanced economy averages. It was towards the end of the 1980s when export

growth for these economies started outpacing export growth for advanced economies.

**Figure 4.5: Global, advanced and EM export growth: 1980-2012**

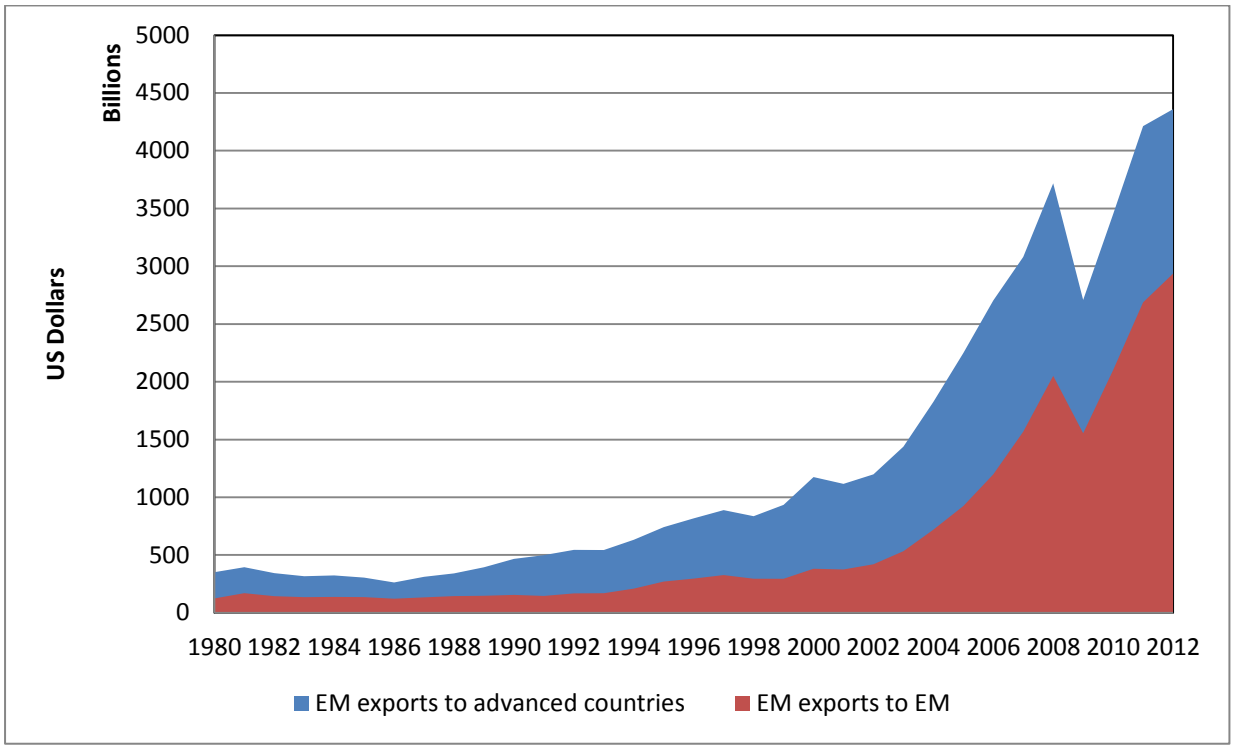



**Source: IMF International Financial Statistics**

Global exports declined in 2009 as the worst of the crisis hit. EMs were not to escape this decline, though the impact was not as harsh for these economies. Where global exports contracted by 10 per cent in 2009, and advanced exports contracted by 12 per cent, EMs experienced a relatively moderate decline of 8 per cent in exports.

This trend can be ascribed to the fact that the composition of trading partners has changed in recent decades, according to Kose and Prasad (2010). In 2012, roughly 60 per cent of EM exports flowed to advanced economies, while the remaining 40 per cent went to other EM and developing economies (IMF, 2015c). Intra-EM trade has increased in recent years and could possibly have served to shield EMs to some extent, at least at the onset of the crisis. Figure 4.6 below shows the trends in EM exports to advanced economies and to other EMs.

**Figure 4.6: EM export trends, 1980-2012**




**Source: IMF Direction of Trade Statistics (DOTS)**

### 4.3.3 Concluding remarks

EM economies had therefore managed to drastically improve economic growth and diversify trading partners in the years between 1980 and 2012. These economies also managed to combine strong, largely export-fuelled growth with sound macroeconomic management, so that many of these economies met the global financial crisis with strong macroeconomic fundamentals in place.

Many advanced economies found themselves with especially little fiscal and monetary policy room at the onset of the crisis, as already low interest rates did not provide much opportunity for traditional stimulatory monetary policy, and government debt escalated. Many EMs, on the other hand, found themselves in a position where inflationary pressures being posed outweighed recessionary pressures and they could afford to cut interest rates and increase government expenditure (IMF, 2010).

The background sketched above paints a picture of EM economies that were in a position to meet the credit crisis of 2008 with strong growth rates, diversified trading partners, and the ability to implement the necessary countercyclical policies. It seems, indeed, on the face of it, as though EM economies did manage to survive the financial crisis much better than their advanced counterparts did.

Yet, it is also clear that economic growth in these economies still did decline from the previous heights it had achieved and the exact dynamics behind comovement remain unclear.

## 4.4. Data and results

The following sections introduce and analyse the empirical estimations that were carried out in order to determine the level of comovement between EM and advanced economies, and whether decoupling had occurred or not.

### 4.4.1. Data

The economies investigated in this empirical analysis are as follows, and are classified as such following the classification used in Kose, Otrok and Prasad (2008:35):

- Advanced economies: Australia, Austria, Belgium, Canada, Finland, France, Germany, Italy, Japan, the Netherlands, New Zealand, Norway, Spain, Sweden, Switzerland, the United Kingdom and the United States.
- EM economies: Argentina, Brazil, Chile, China, India, Indonesia, South Korea [7] (referred to herein as 'Korea'), Malaysia, Mexico, Peru, Philippines, Singapore, South Africa, Thailand and Turkey.

Quarterly data for these economies on real and nominal variables such as real GDP, CPI, short-term interest rates and exchange rates are gathered mostly from the GVAR database (CFAP, 2013). The oil price index is also included to proxy for world prices. Quarterly data on trade, namely imports and exports, is gathered from the IMF's International Financial Statistics. Using the HP filter, the business cycles for the available countries are also extracted from the real GDP in order to analyse the level of business cycle comovement which took place between emerging and advanced economies. Given the importance of the United States in the global economy, accounting on average for 21 per cent of global GDP between 1980 and 2012, additional variables for the United States, including industrial production, unemployment rate, real effective exchange rate, PPI and the value of the S&P 500 are included. These quarterly variables were obtained from the IMF's International Financial Statistics, as well as the OECD. Data on the S&P500 were gathered from

[7] Following Kose et al. (2008), Korea is classified as emerging. The IMF in 2016 classifies Korea as an advanced country. The inclusion here as an EM economy makes no difference to the DFA analysis since all countries are included in the panel and not separated according to classification.

the S&P500.The resultant sample has a size of 225 observations (N) over 128 quarters (T). Full information on variables used is available under Appendix E.

Factor analysis is conducted, following the model introduced in Chapter 3. The variance shares obtained from the factor analysis are reported. This is a variable similar to the R-squared in traditional regression analysis, which shows the degree of variation in the data that is attributed to the common component. Where variance shares are high, variables can be said to comove. Where variance shares are low, the idiosyncratic component dominates in explaining variables. Results are reported in Section 4.4.2 below.

Once the factor analysis is concluded, rolling regressions are estimated in order to once again investigate the changing dynamics of comovement over the sample period. The rolling regressions regress the business cycles of individual economies on the factors obtained for the overall sample. This is done in order to show how much of variance in business cycles is explained by these factors.

### 4.4.2. Factor analysis results for overall period: 1979Q3-2011Q2

The available data for the sample of 32 emerging and advanced economies are used to extract the common factors during the entire period under investigation. After standardisation of the data, the Bai-Ng criteria show that three factors[8] should be specified for this period. Results for these tests are available in Appendices A and B.

The variance shares for individual country variables over this period shows low levels of variance which can be ascribed to a common component. The variance share referred to here and in the analysis that follows is the overall variance share for all three factors, which is similar to the R-squared in regression analysis. Only a handful of variables show variance of which 80 per cent or more can be ascribed to a common component, and these tend to be the exchange rates for a handful of notably European advanced economies. Some trade variables (imports and exports) show a variance share of 50 and above which can be ascribed to a common component. These variables are once again trade variables linked to advanced economies and show the importance of trade as a transmission mechanism causing comovement.

8 Note that three factors will be estimated for all sub-periods, as well. This is done in order to ensure that any changes in factors cannot be ascribed to changes in the number of factors specified.

Though a full table of these variance shares is reported in Appendix A.1, a brief summary of variance shares is reported in Table 4.2 below. To simplify, BICS[9] countries are reported along with the G7 advanced economies. The economies summarised here are chosen because of the amount of attention that BICS generally receive as a sub-group of EMs. The focus is on real variables such as GDP, imports, exports and business cycles.

**Table 4.2: Summary of variance share results for major EM and advanced economies, 1979Q3-2011Q2**

| | Brazil | China | India | South Africa | Canada | France | Germany | Italy | Japan | UK | USA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **GDP** | 0.22 | 0.09 | 0.01 | 0.32 | 0.30 | 0.33 | 0.28 | 0.35 | 0.22 | 0.15 | 0.33 |
| **Exports** | 0.03 | 0.23 | 0.07 | 0.11 | 0.47 | 0.81 | 0.78 | 0.63 | 0.52 | 0.58 | 0.56 |
| **Imports** | 0.03 | 0.22 | 0.27 | 0.27 | 0.16 | 0.84 | 0.76 | 0.67 | 0.49 | 0.62 | 0.61 |
| **Business cycle** | **0.31** | **0.04** | **0.12** | **0.50** | **0.55** | **0.49** | **0.45** | **0.78** | **0.43** | **0.53** | **0.58** |

For the overall period, results thus show low levels of comovement among EM and advanced economies, while a handful of advanced economies show strong comovement brought about by trade. For example, between 1979 and 2011, only about 4 per cent of the Chinese business cycle could be attributed to a common component. By contrast, as much as 58 per cent of the US business cycle and 78 per cent of Italy's business cycle can be ascribed to a common component. The other advanced country variables, such as exports and imports, also show much higher variance shares than their EM counterparts do. Interestingly, among the BICS economies summarised here, South Africa shows the highest real comovement, with 50 per cent of the South African business cycle being explained by a common component, while variance share for the Brazilian and Indian business cycles are 31 per cent and 12 per cent, respectively.

Thus, as can be seen from Table 4.2, EMs generally show real decoupling from advanced economies, with low variance shares. The advanced economies in the sample show some coupling, indicated by high variance shares for advanced country variables.

As discussed earlier, three factors $(r)$ are specified for this overall period. Comparing the values obtained for each of these factors with the values of the

9 BRICS countries excluding Russia; for which quarterly data is unavailable.

macroeconomic variables under investigation (as seen in the graphs featured in the Appendix[10]) shows that:

- Factor one corresponds closely to imports and exports of countries in the sample, leading to the conclusion that this is a global trade factor.
- Factor two corresponds closely to global business cycles.
- The third factor corresponds to European exchange rates (indicated by the local currency expressed in US dollars).

These factors show the importance of global trade in establishing comovement, a fact that is well established in the literature. As for the European exchange rate factor, this shows that trade between the US and Europe is particularly important, given the exchange rate factor, and this is not surprising given the importance of the trade relationship not only between these two regions, but their respective importance as trading partners to others as well. The emergence of a global business cycle factor shows the influence that globalisation has had during this overall period, making economies more interdependent.

#### 4.4.3. Factor analysis results for first sub-period: 1979Q3-1990Q4

After conducting the DFA on the sample as a whole, DFA is performed again. This time, the analysis is performed only for the period from 1979Q3 to 1990Q4. This period of time is commonly seen as one during which few emerging economies had yet started to expand their participation in the global economy and the analysis will shed light on what happened to levels of comovement during this time.

In order to rule out the possibility that any changes in results are driven by a change in the number of factors specified, the number of factors is again specified as three, for this sub-period and both the others.

The variance shares for this period show low levels of comovement between EM and advanced economies, as can be seen in Table 4.3. Advanced economies display higher variance shares than EMs do, with trade-related variables, in particular, showing high variance shares. In order to simplify the presentation of results, Table 4.3 highlights the results for the BICS and G7 economies.

[10] Note that these graphs show how the factors match the original macroeconomic series. Discussion of the graphs per se is not provided in the appendix, as the discussion of factors takes place in following paragraphs.

**Table 4.3: Summary of variance share results for major EM and advanced economies, 1979Q3-1990Q4**

| | Brazil | China | India | South Africa | Canada | France | Germany | Italy | Japan | UK | USA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **GDP** | 0.19 | 0.39 | 0.01 | 0.29 | 0.43 | 0.16 | 0.15 | 0.44 | 0.08 | 0.37 | 0.45 |
| **Exports** | 0.16 | 0.05 | 0.10 | 0.28 | 0.38 | 0.77 | 0.66 | 0.39 | 0.22 | 0.46 | 0.35 |
| **Imports** | 0.12 | 0.10 | 0.14 | 0.22 | 0.37 | 0.82 | 0.76 | 0.44 | 0.30 | 0.45 | 0.37 |
| **Business cycle** | **0.49** | **0.22** | **0.11** | **0.53** | **0.49** | **0.10** | **0.21** | **0.35** | **0.06** | **0.57** | **0.47** |

Globalisation had not yet become a dominant force during this sub-period, with many EM economies yet to undertake reforms and trade liberalisation that would later become crucial in shaping the global economy we have come to know today. The low levels of comovement during this sub-period, relative to those obtained for the overall period, are therefore not surprising. Among the EMs summarised in the table above, South Africa's business cycle once again displays the highest variance share, with 53 per cent of the business cycle attributable to a common component. Full results for all EM economies reported in Appendix A.2 show similar trends – EM performance in the decade between 1979 and 1990 could mostly be explained by the idiosyncratic component.

In this sub-period, the three factors correspond to:

- Advanced country trade.
- Short-term German interest rates.
- A real factor related to advanced economies.

Trade is known to be an important transmission mechanism for comovement, and the dominance of advanced markets during this sub-period is expected, attributable to the fact that many EM economies were less open. Interest rates represent monetary policy, which is important for macroeconomic stabilisation. Given Germany's dominance in Europe and globally, German monetary policy is important in fostering comovement. The third factor is the weakest factor and does not explain as much of comovement as others do. The fact that the factor corresponds closely to business cycles and GDP of various advanced economies shows, nevertheless, that production across economies was important in fostering comovement.

The results for the first sub-period clearly show the low levels of integration that still dominated the global economy between the eighties and nineties. Comovement is generally low in this sub-period, showing decoupling between EM and advanced economies, and some slight coupling between advanced economies, driven mainly

by trade. In this pre-globalised world, economies were not yet as sensitive or vulnerable to changes in trading partner conditions, and comovement was being driven by individual advanced countries rather than country groups.

### 4.4.4. Factor analysis results for second sub-period: 1991Q1-2000Q4

The next sub-period investigated is for the period between the first quarter of 1991 and the final quarter of 2000. During this sub-period, a picture emerges of a world that is gradually integrating with the wider participation of EMs in the global economy. Variance shares obtained for this period are higher than they were in the previous sub-period. This can be seen in Table 4.4. Extensive results are reported in Appendix A.3.

**Table 4.4: Summary of variance share results for major EM and advanced economies, 1991Q1-2000Q4**

| | Brazil | China | India | South Africa | Canada | France | Germany | Italy | Japan | UK | USA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **GDP** | 0.26 | 0.16 | 0.04 | 0.53 | 0.48 | 0.31 | 0.09 | 0.23 | 0.01 | 0.52 | 0.13 |
| **Exports** | 0.11 | 0.10 | 0.18 | 0.20 | 0.29 | 0.85 | 0.83 | 0.79 | 0.37 | 0.55 | 0.27 |
| **Imports** | 0.08 | 0.09 | 0.22 | 0.13 | 0.14 | 0.82 | 0.67 | 0.78 | 0.59 | 0.61 | 0.62 |
| **Business cycle** | **0.50** | **0.28** | **0.33** | **0.46** | **0.62** | **0.01** | **0.23** | **0.28** | **0.41** | **0.69** | **0.01** |

From 1991 to 2000, 28 per cent of the Chinese business cycle can be ascribed to a common component, as opposed to 22 per cent in previous sub-periods. The variance share for the Brazilian business cycle has increased too, from 49 to 50 per cent. Thirty-three per cent of the Indian business cycle is now explained by a common component, as opposed to only eleven per cent in the previous sub-period. South Africa displays a somewhat lower variance share, at 46 per cent in comparison with 53 per cent previously.

For advanced economies, too, variance shares can generally be seen to increase, though in the US and France idiosyncratic factors dominate during this period. The general increase in variance shares ties in to the fact that globalisation was starting to take hold during this sub-period, as labour and capital became more mobile and trade integration increased (WTO, 2008). Between 1991Q1 and 2000Q4, the three factors driving comovement are:

- Advanced country trade;
- An Asian factor driven by Singaporean interest rates; and
- The British business cycle.

Again, the importance of advanced economies as trading partners is shown here. The Asian factor that comes into play here reflects the impact of the Asian financial crisis that took place in this sub-period. Singapore, especially, was a regional financial hub at the time of the Asian crisis. Yue (1998:298) states that Singapore was, during the time of the Asian financial crisis, a very important link in the Asian Dollar Market. It was in this market that global funds for onlending to the rest of the Asian region were mobilised. Though Singapore fared much better during that crisis than its Asian neighbours did, the Singaporean economy was not unaffected by the crisis, and regional trade and investment served as important transmission mechanisms of the crisis (Yue, 1998; Ngiam, 2000). As for the British business cycle, the UK, as a member of the G7, is an important advanced economy and prominent trading partner. This sub-period comes after the departure of Thatcher in November of 1990 (Crafts, 1993). Though the British economy had been booming in the decades leading up to this particular period, the early 1990s was a period of severe recession for Britain (Chamberlin, 2010) and could be responsible for the emergence of the British business cycle as an important factor here.

#### 4.4.5. Factor analysis results for the final sub-period: 2001Q1-2011Q2

The third and final sub-period is 2001Q1 to 2011Q2. It is in this sub-sample that much of the interest lies, as it is during this time that globalisation saw the world becoming smaller than ever, and also when the financial crisis of 2008 occurred.

As would be expected, the variance shares obtained in this period show much higher levels of comovement. Variance shares remain highest for the advanced economies in the sample, and trade remains an important transmission mechanism. For EM economies, trade and business cycle variables also show higher levels of comovement than in the previous decade, though not as strong as for advanced economies. These trends can all be seen in the full results listed in Appendix A.4. Table 4.5 below summarises the real variables for selected EM and advanced economies.

**Table 4.5: Summary of variance share results for major EM and advanced economies, 2001Q1-2011Q2**

| | Brazil | China | India | South Africa | Canada | France | Germany | Italy | Japan | UK | USA |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **GDP** | 0.51 | 0.37 | 0.02 | 0.68 | 0.66 | 0.69 | 0.72 | 0.66 | 0.62 | 0.56 | 0.74 |
| **Exports** | 0.49 | 0.69 | 0.64 | 0.72 | 0.63 | 0.87 | 0.85 | 0.83 | 0.74 | 0.64 | 0.89 |
| **Imports** | 0.75 | 0.68 | 0.51 | 0.60 | 0.29 | 0.93 | 0.83 | 0.91 | 0.73 | 0.76 | 0.86 |
| **Business cycle** | **0.71** | **0.58** | **0.16** | **0.87** | **0.84** | **0.82** | **0.82** | **0.85** | **0.87** | **0.88** | **0.84** |

It is clear from Table 4.5 above that the majority of EM economies did couple to advanced economies in the decade between 2000 and 2011. The increase in variance shares from previous sub-periods is noticeable. During this sub-period, for example, 58 per cent of the Chinese business cycle could be explained by a common component, as opposed to 4, 22 and 28 per cent for the other periods analysed. The variance share for Brazil's business cycle increases to 71 per cent, up from 50 per cent in the previous period. The South African business cycle is very sensitive to global developments between 2000 and 2011, with a variance share of 87 per cent.

India is an exception to this trend, with its business cycle variance share being much lower. The variance share declines to 16 per cent from 33 per cent in the previous period. During this last sub-period, India's business cycle was therefore shaped mostly by idiosyncratic factors. It is worth keeping in mind that India was quite a late reformer. While China, for instance, had since 1978 already been gradually liberalising its economy, India only really started with reforms in the 1990s. When the credit crunch did hit India, the impact was not as severe. The reason for this is most likely the structure of India's trade. Firstly, India is not particularly dependent on exports (IMF, 2008a; Kumar & Vashisht, 2009). Secondly, India's exports are not the result of value chain processing to the extent that other Asian economies are (Beltramello, De Backer & Moussiegt, 2012). Thirdly, Indian exports are dominated by service exports, which were found to be much more buoyant than manufactured exports were (Ghosh & Chandrasekhar, 2009; Borchert & Mattoo, 2009).

Variance shares for advanced economies also increase during this period, especially for imports, exports and business cycles. The variance shares for advanced economies are much higher than for EMs, showing that advanced economies had much stronger coupling to one another. This is particularly evident when looking at variance shares for the individual G7 economies' business cycles, the lowest of

which are France and Germany, for which 82 per cent of their business cycles is due to a common component.

In the full variance share results provided in the Appendix, it is interesting to note that the few EM economies which show very high variance shares are Mexico and Chile, which most likely reflects the geographical proximity to the US – the epicentre of the financial crisis.

The three factors driving comovement in this final sub-period are:

- Global trade.
- Global business cycles.
- European exchange rates (once again expressed in terms of the US dollar).

In this final sub-period, then, it is clear that EM and advanced economies had become more interrelated. Whereas the factors in previous sub-periods corresponded largely to advanced country variables, the three factors in this last decade are global. The results show that global trade and business cycle upswings and downswings are difficult, if not impossible, to evade in a world that has become increasingly globalised since the 1980s. The downturn caused by the credit crunch in 2008 and subsequent declines in import demand would have been felt by all. Import demand from the US and Europe remain especially important, once again reflecting the prominence of the US and Europe as global trading partners.

#### 4.4.6. A comparison of sub-periods

Examining the variance shares for various sub-periods shows a clear picture of integration and increased comovement in the global economy during the past three decades. The first sub-period covered a time when the global economy was not yet globalised and many economies, particularly EMs, were still closed and protectionist. During this time, the idiosyncratic component dominates in explaining business cycles in EM economies.

The picture gradually starts to change as the decades pass. As EMs embarked on policies of trade and financial liberalisation during the 1990s, variance shares gradually become higher for more countries and more variables. It is true that, compared with the variance shares for advanced economies, those of EMs are not as high. Variance shares for EM variables do show large increases by the last sub-period in comparison with the first sub-period, though.

The discussions above clearly show that the dynamics taking place over the course of a longer sample, such as the overall sample which covered 1979Q3 to 2011Q2, might not always be adequately captured. In order to provide extra insight into exactly how EMs have co-moved with their advanced counterparts between 1979 and 2011, rolling regressions are performed on the data.

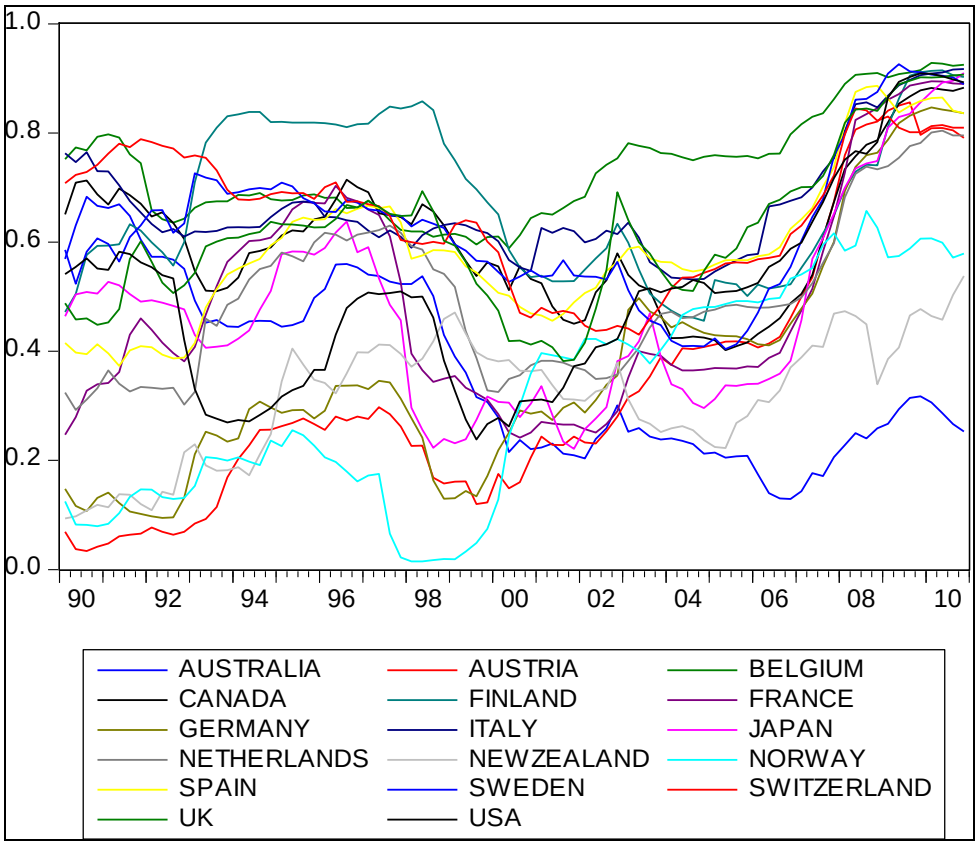
### 4.4.7. Rolling regression results

This section presents the results obtained from the rolling regressions estimated for the entire sample. The reason for performing rolling regressions is to sketch a wider picture of how comovement has changed between EM and advanced economies over time.

The three factors obtained from the DFA conducted for 1979Q3-2011Q2 are regressed against the business cycles of the countries in the sample based on a ten-year rolling window. Recall that these were global trade, global business cycles and European exchange rates in terms of the US dollar. Also note that these regressions are performed on stationary cycles and factors.

The graphs presented below show the variance share values obtained from this analysis. Figure 4.7 below depicts the results of rolling regressions from the overall period. Note that the t-statistics indicating the significance of these regressions is available under Appendix A.6.

**Figure 4.7: Ten-year rolling regression variance share results for advanced economies, 1990-2010**

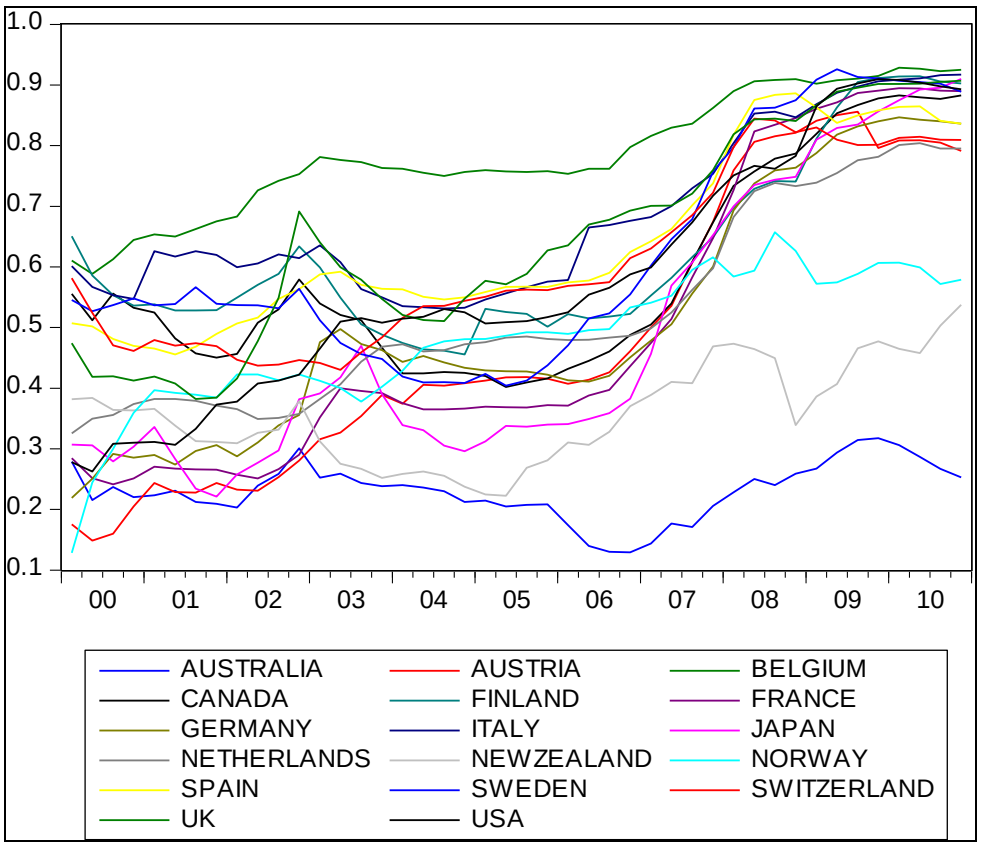



The graph above shows the result of rolling regressions for the group of advanced economies between 1990 and 2010. Consistent with the results obtained from the analysis of sub-periods, it is only from 2000 onward that a strong pattern begins to emerge, with advanced economies showing strong comovement. Looking at the overall period, it is clear that comovement has fluctuated, being relatively high at the beginning, decreasing somewhat around 2000, and then increasing strongly from about 2005 onward. It is from this point, post-2005, that a very strong pattern emerges. This reflects the impact of the credit crunch and the ensuing aftermath. Three countries can immediately be spotted as outliers in these latter years, with Norway, New Zealand and Australia showing much lower comovement than the other advanced economies depicted on the graph. Closer attention will be paid to the possible reasons for this in later sections, where the dynamics emerging in Figure 4.7 are discussed in more depth.

As a first step in a more in-depth analysis, we zoom in on Figure 4.7 to take a closer look at the dynamics that emerge between 2000 and 2010, the decade leading up to and including the credit crunch years. From the general picture in Figure 4.7, it is

clear that 2000 is the year during which a strong and identifiable pattern starts emerging amongst advanced economies and this can be seen again in Figure 4.8 below.

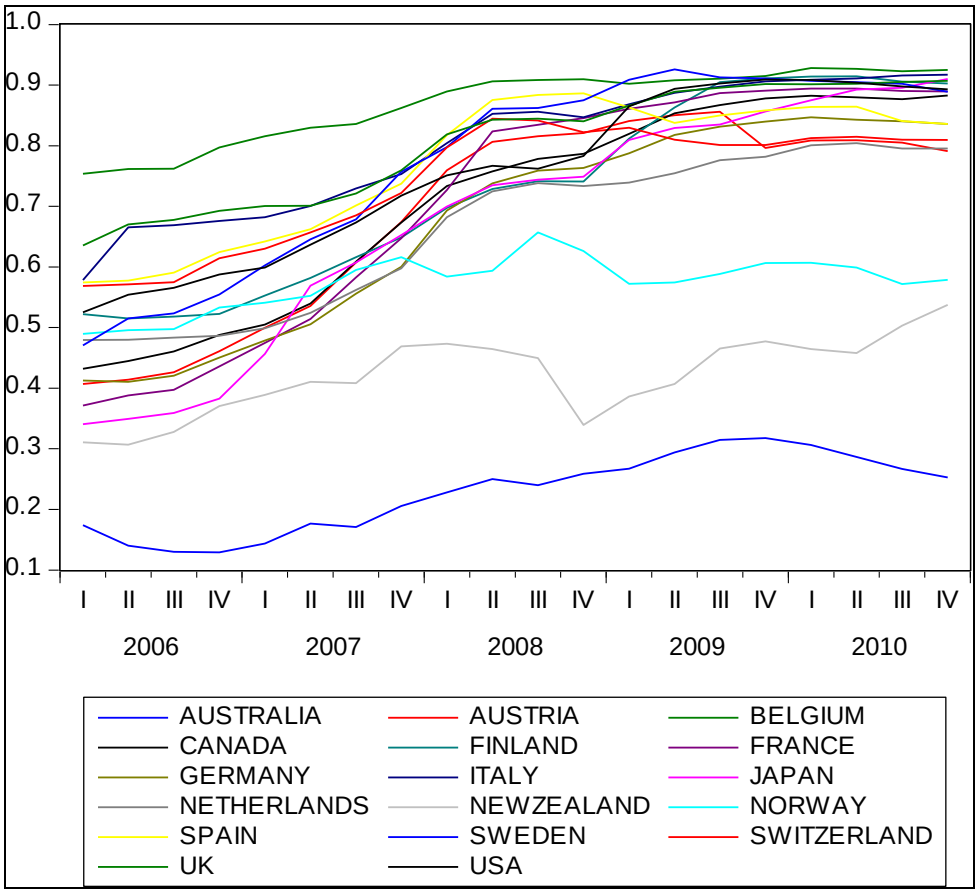
**Figure 4.8: Ten-year rolling regression variance share results for advanced economies, 2000-2010**




Advanced economies show very high variance shares between 2000 and 2010, jumping up to around 90 per cent during the crisis years. This means that global trade, business cycles and European exchange rates are responsible for explaining as much as 90 per cent of the variance seen in business cycles of these economies.

Australia, New Zealand and Norway, the outliers mentioned previously, do not move along with the strong pattern emerging for the rest (this can be seen in Figure 4.7, as well). Possible explanations for this pattern are provided in the paragraphs following Figure 4.9, in which it is possible to see exactly how comovement changed in the years directly leading up to and following the crisis (2006 to 2010). Note that the comovement depicted in Figure 4.9 is still the result of ten-year rolling regressions. The author has merely zoomed in on the graph in order to provide a clearer picture of the Great Recession years specifically.

**Figure 4.9: Ten-year rolling regression variance share results for advanced economies, 2006-2010**




Between 2006 and 2010, advanced economies converge very clearly. It is evident, from this graph and the previous one, that advanced economies had already started moving in tandem in the years leading up to the crisis. Comovement increases late in 2007 and early 2008, and remains very high up until the end of the sample in 2010.

As mentioned earlier, Norway, Australia and New Zealand are the only advanced economies with low levels of comovement and show evidence of decoupling during these crisis years. Australia, for instance, was hailed by the IMF (2011a) as one of the few advanced economies that did not enter into a recession during the global financial crisis. The reasons for this include a sound financial system that had limited exposure to dubious sub-prime assets, and a fiscal stimulus amounting to 8 per cent of GDP over five years (IMF, 2008f&2009c). The large fiscal stimulus was made possible, in part, by the fact that Australia entered the credit crunch on the back of a global commodity price boom (IMF, 2008f). Given its geographical location, Australia largely trades with Asian and other Oceanic countries, further shielding it from the crisis. In fact, an IMF (2011a) report finds that Asian shocks have overtaken US shocks in the impact they have on the Australian business cycle. On top of this,

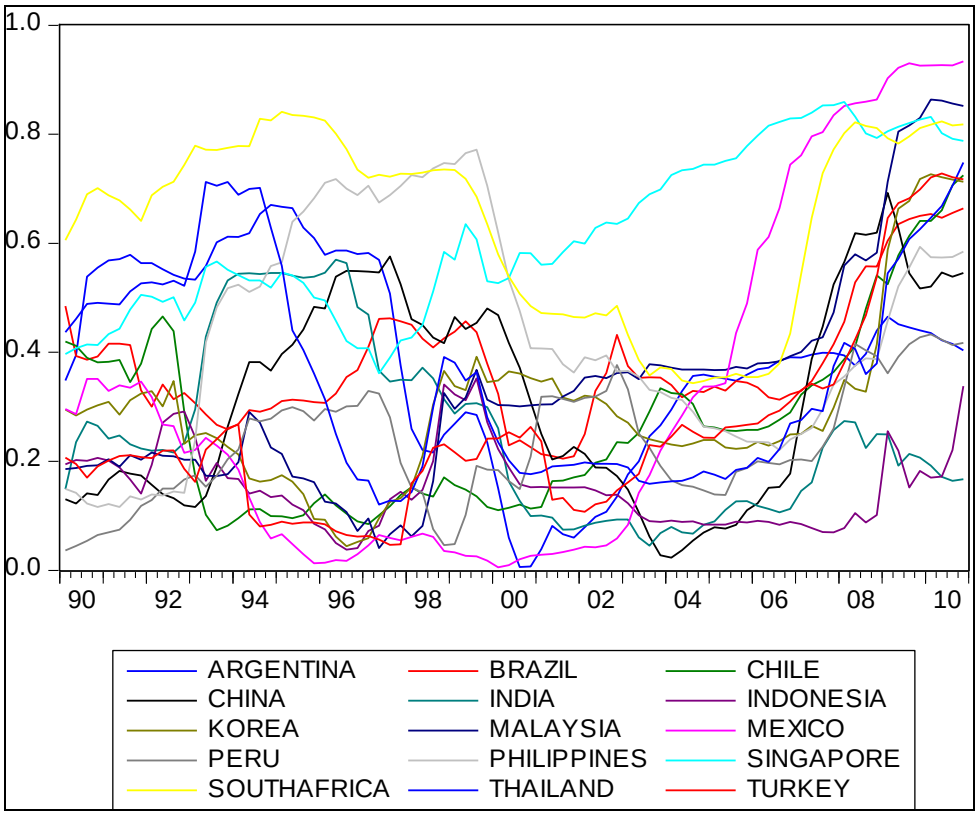
private consumption in Australia remained strong throughout the crisis and did not contract as much as it did in other advanced economies, such as the UK and the US (IMF, 2009c).

New Zealand seemingly owes its resilience to the crisis directly to Australia, with Australian shocks being transmitted to New Zealand nearly one-to-one (Sun, 2011). Furthermore, the four largest banks in New Zealand are whole subsidiaries of Australian banks, which had very sound systems in place at the time of the crisis. The banking sector in New Zealand therefore pulled through the crisis quite successfully. The previous decade's commodity boom, and the fact that it had the lowest public debt among all advanced economies at the onset of the crisis, further allowed New Zealand to weather the financial crisis by implementing a strong countercyclical fiscal policy (IMF, 2011b). In terms of trade, New Zealand's exports continued quite strongly through the crisis. This was largely attributable to continued strong demand from Australia and China, which are New Zealand's major trading partners.

The Norwegian economy also managed to pull through the global financial crisis, having experienced only a mild recession (IMF, 2010). The decade preceding the crisis had been one of strong economic growth, high employment and low inflation for Norway. Norway was also not as exposed to, or reliant on, those sectors of global manufacturing that had been hardest hit by the crisis, while continued investment in oil and gas and a sound and stable financial sector also contributed to the Norwegian economy's resistance (IMF, 2010). Norwegian policymakers stepped in to apply strong countercyclical policy at the onset of the crisis, with Norway even being in a position to contribute $4.5 billion to the IMF's bailout fund in 2009. Norway's exports consist mainly of primary products, of which oil is very important. Though oil prices were volatile during the crisis years, oil-exporting countries still managed to grow by an average of 5.5 per cent during 2008 (WTO, 2009).

Having examined the rolling regressions for advanced economies, the focus turns in the following graphs to the story for EM economies. The same analysis is followed.

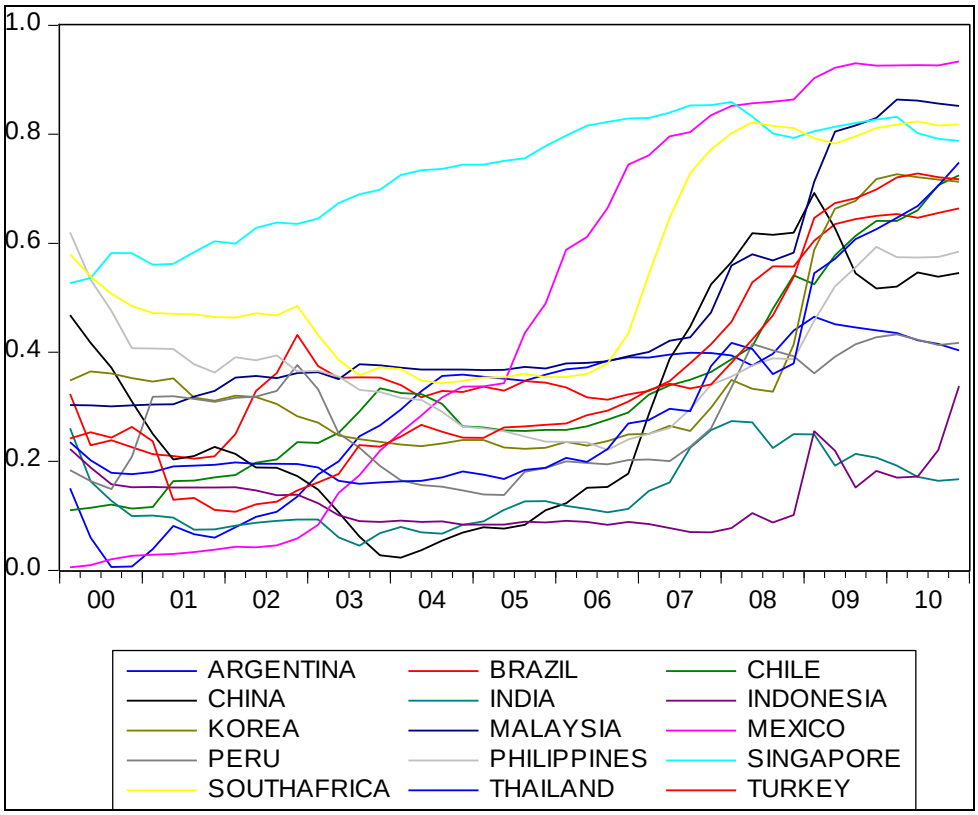
**Figure 4.10: Ten-year rolling regression variance share results for EM economies, 1990-2010**




Overall, variance shares depicted in the graph above are lower than those obtained for advanced economies are. Comovement declines around 2000, and increases strongly around the crisis years. Toward the latter years investigated here, there are some outliers as well. It can be seen that South Africa, Singapore and Mexico display much higher variance share values, while India and Indonesia display lower values. These dynamics will be analysed in more detail later on.

Keeping the ten-year window, but zooming in closer on the 2000s, it can be seen that EMs were not untouched by the intense globalisation and credit crunch experienced during the 2000s. This is depicted in Figure 4.11 below.

**Figure 4.11: Ten-year rolling regression variance share results for EM economies, 2000-2010**




It can be seen in Figure 4.11 above that Mexico, Singapore and South Africa display much higher correlation with the three factors than the other EMs do at this time. These three EMs, then, were much more sensitive to changes in the global business cycle, trade and exchange rate than their counterparts were. A brief analysis of the structure of each of these economies sheds light on why this is the case.

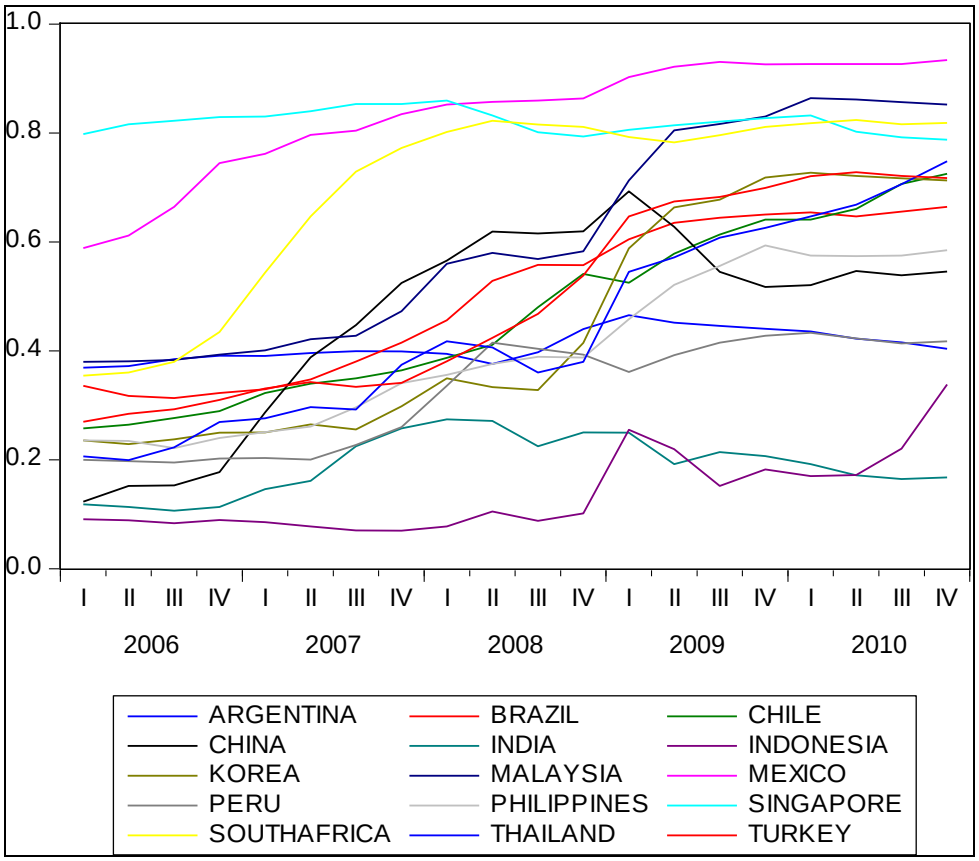
Mexico, for instance, is particularly susceptible to crises originating in the advanced world, and in the US in particular, because of its geographical location and integration with NAFTA (the North American Free Trade Area). At the onset of the crisis, when the first rumblings of uncertainty were being felt in the US in 2007, the IMF (2007b) cautioned about the impact that this would likely have on Mexico. Previous studies have found very high levels of business cycle synchronisation between the Mexican and US economies (Herrera & Castillo, 2003; Torres & Vela, 2003). At the onset of the crisis, Mexican exports to the US accounted for 85 per cent of that country's total exports (IMF, 2007b), further illustrating the country's vulnerability to US fluctuations. It is therefore not surprising that Mexico shows higher variance shares than do the other EM economies depicted in Figure 4.11 above.

As for South Africa, financial and trade openness of the economy increased significantly after the election of a new democratic government in 1994. Kabundi and Loots (2007), Boshoff (2010), and Botha (2010) all find evidence of increased comovement between South Africa and developed economies.

Singapore's comovement in the graph above is generally higher than that of other EMs, though in the years during and immediately the Great Recession it can be seen that variance shares actually decrease somewhat and do not shoot up to levels as high as 90 per cent, as they did for many advanced economies during this time. The higher than average comovement reported for Singapore might be attributable to the fact that the economy has a remarkably developed financial sector with strong ties to global markets. Singapore is also an export hub, and the economy's trade in goods and services amounts to three times its GDP (IMF, 2012), which renders Singapore's economy very susceptible to global trade developments. Given the importance of trade and global business cycles estimated in the rolling regressions here, it is clear why Singapore's economy displays such higher levels of comovement.

Of particular interest is the dynamics that evolved during the crisis years specifically, and Figure 4.12 focuses in on the years leading up to, during, and immediately after the crisis (2006-2010) for that reason.

**Figure 4.12: Ten-year rolling regression variance share results for EM economies, 2006-2010**




The graph above clearly shows that business cycles in most emerging economies did become increasingly responsive to global trade, global business cycles and advanced exchange rates at the time of the crisis. Variance shares started generally low and moved up to as much as 80 per cent. This is not as strong as the trend that was established with the advanced economies, but confirms the gradual coupling of EM economies. This coupling intensified especially during the period between 2001 and 2011, as seen in the final sub-period for which DFA analysis was done, and confirmed here by the rolling regression.

The countries which do not conform to the general EM trend here are again Singapore, Mexico and South Africa, with much higher variance shares than the other EM economies. Showing much lower levels of comovement are India and Indonesia. Though EMs in general, therefore, seemed quite resilient to global trade and business cycles, India and Indonesia for some reason seemed particularly resilient, with not much more than 20 per cent of variance in business cycles being explained by these three factors. The following paragraphs present some explanations for this.

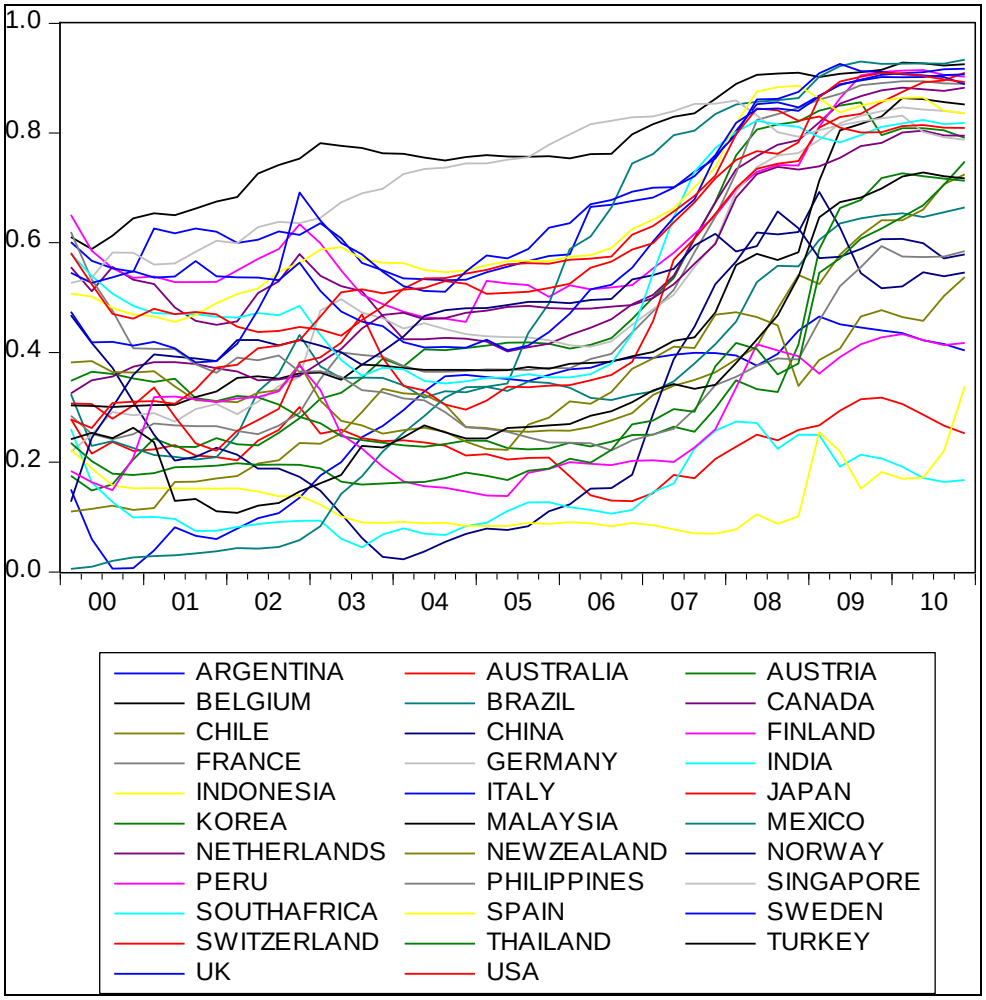
India, along with China, is the other behemoth amongst EM economies. The Indian economy has grown impressively over the last few decades, with growth averaging 8.5 per cent in the four years leading up to the crisis. Though well known for its exports of services in particular, India is not an economy that is overly reliant on exports. Strong domestic demand in India also served to carry the economy through the worst of the crisis (IMF, 2007c). Though public debt at the time of the crisis was high, policymakers in India had succeeded in initiating fiscal reform which provided much-needed fiscal stability. General government debt had declined in 2007 to 6 per cent of GDP from a previous high of 10 per cent in 2001 (IMF, 2007c). India was further shielded from the worst of the crisis by the fact that its financial system was still quite undeveloped at the time of the credit crunch. The IMF (2008a) compares India's financial openness with other EM economies, such as Turkey, South Africa, and China, based on the Chinn-Ito index and finds India to be the least financially open in the sample.

Indonesia, which is the other economy here that displays very low levels of comovement, is one of the least trade-integrated economies in Asia. This finding is confirmed by an IMF study (2007c) which used not only exports as a ratio to GDP, but a gravity model as well. Following the devastating impact that the 1997 to 1998 EM crisis had on Indonesia, great care was taken to reduce that country's external vulnerability. By the time the first signs of the sub-prime crisis appeared in 2007, Indonesia's macroeconomy was described by the IMF (2007c) as "sound". Debt was declining and fiscal deficits were not large, while the country's current account showed a surplus. The current account surplus had also enabled Indonesia to build up foreign reserves that amounted to 13.5 per cent of GDP and stood at a level of $59 billion. Indonesia's low exposure to global trade and financial markets, coupled with sound macroeconomic fundamentals, therefore serve to explain the country's resilience during the 2008 financial crisis.

For simplification, EM and advanced economies were discussed separately in the preceding paragraphs. It was evident that certain trends emerged between countries in the EM group and countries in the advanced group. Most noticeably, the graphs show that EM comovement with global factors (in other words, coupling) did increase over time. This increase followed a trend that was quite similar to that of advanced economies, with variance shares peaking at the time of the Great Recession. While

these trends are similar, it was also clear that the effect was somewhat weaker for EM, with variance shares not reaching the high levels of around 90 per cent that advanced economies experienced. Combining the graphs for EM and advanced economies show this, as can be seen in Figure 4.13 below. The variance shares seen here are the same as reported in previous paragraphs and the result of a ten-year rolling regression. In order to show how dynamics had evolved in the period leading up to and during the crisis, the graph for 2000 to 2010 is reported. The same individual outliers, India, Indonesia, Norway, Australia and New Zealand, can be seen here as well.

**Figure 4.13: Ten-year rolling regression variance share results for EM and advanced economies, 2000-2010**

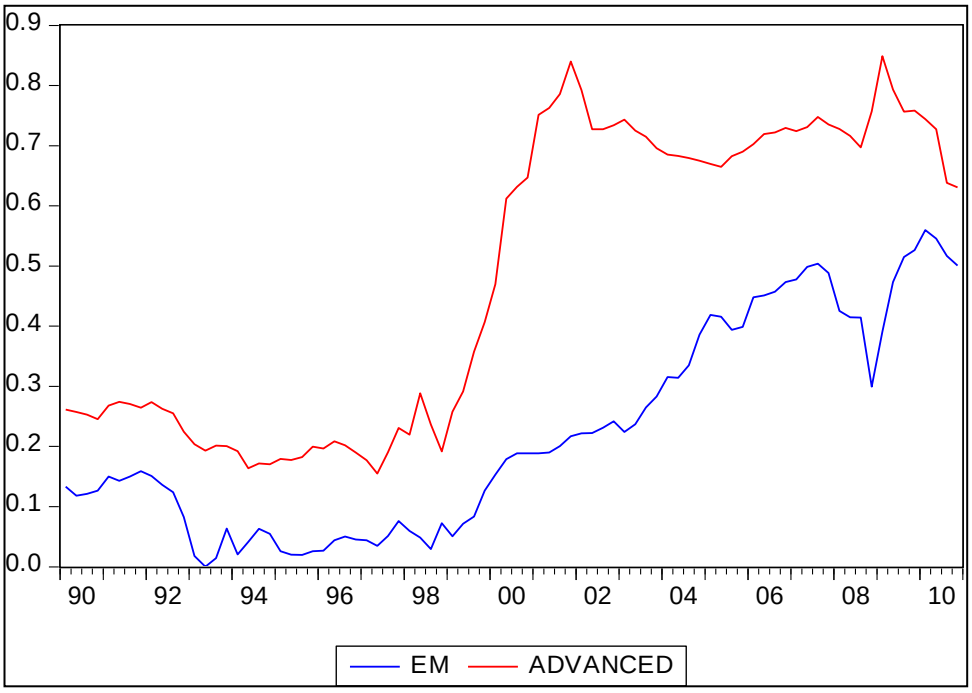



As a final analysis, another rolling regression is performed, this time using aggregate values for EM and advanced economies' business cycles.[11] The cyclical component

11 Note that these aggregated values do not necessarily consist of the exact same countries used in earlier analysis. Aggregated values here are obtained from the IMF for Emerging and Developing countries and Advanced economies.

of GDP growth for these economies is extracted using the HP filter, and the three factors found for the overall period used in the rolling regression. The results, presented in Figure 4.14, confirm the findings thus far. Both EM and advanced economies as a group display higher levels of comovement over time.

**Figure 4.14: Ten-year rolling regression variance share results for aggregated EM and advanced economies, 1990-2010**




The trend for EM is remarkably similar to that of advanced economies. The rolling regression results show a clearer downturn in business cycle activity for both groupings during 2008, with correlations increasing again around 2009, which was the most intense year of the crisis. Comparing the results found for EM and advanced economies also indicate a lag effect which has not been apparent in the rolling regressions reported previously. This suggests that much of the initial evidence for decoupling that was pointed out during the very early stages of the credit crunch was shown too early – the transmission of the crisis was still playing itself out.

## 4.5. Conclusion

The aim of this chapter, as stated in the introduction, was to analyse whether business cycles in EM economies had decoupled from advanced economies during the Great Recession. The emphasis was on the real economy, as opposed to investigating comovement in financial markets. Particular interest in this question revolves around the real comovement between EM and advanced economies during the global credit crunch. To answer this question, some general macroeconomic trends were first discussed in order to provide broad background on the economic performance of EM economies. Between 1980 and 2012, these economies have shown impressive growth rates as they continually outpace both average advanced and average world growth. The growth rates have become stronger from the mid-1990s onwards. For many EM economies, this growth stemmed from policies which encouraged liberalisation and exports. Indeed, EM economies have become important trade partners to both advanced and other EM economies, especially during the past 15 to 20 years. They have grown their share in total global trade consistently.

While the liberalisation undergone by these economies has had positive effects, it also leaves them potentially vulnerable to global shocks. One such global shock was the Great Recession, which is the focus of this thesis. In order to gain a broader understanding of comovement between EM and advanced economies, two empirical analyses are carried out. First, DFA investigates levels of comovement between a sample of 17 advanced and 15 EM economies for the period between 1979Q3 and 2011Q2. This period is chosen in order to provide some scope on comovement as globalisation takes force between various decades. This analysis is repeated for three sub-periods spanning a decade each, in order to gain a better understanding of various dynamics that might have been at play during different times over the sample. Second, ten-year rolling regressions are used to show the amount of variance in individual EM and advanced economy business cycles that are attributable to the three factors of global trade, business cycles and exchange rates that emerged from the factor analysis.

The findings reflect a world that has gradually shifted from almost no interdependence at the beginning of the sample, to one in which no economy is an island by itself. The decade-by-decade look at comovement emphasises this very

strongly. Though EMs can be seen to decouple from advanced economies for the overall period, it is clear that this has not been the case as time has passed. In each sub-period analysed, variance shares gradually increased. During the final sub-period, between 2001Q1 and 2011Q2, variance shares reach their highest levels for both advanced and EM economies. The decade leading up to the Great Recession clearly represents a zenith in globalisation.

Looking at the variables which consistently showed the highest variance shares, it becomes clear that trade plays an important role in fostering comovement. This finding supports the theoretical idea of imported business cycles. For policymakers, this is important to bear in mind. Rolling regression estimations showed, for example, that the few advanced economies which did not experience the recession as intensely were economies, such as New Zealand and Australia, which have deeper trade relations with China than with other advanced economies. Conversely, Mexico was one of the EM economies that displayed relatively higher levels of comovement. This is due to its trade dependence on, and geographical proximity to, the US. Diversifying trade partners could therefore serve to shield economies from spillovers. India and Indonesia, interestingly, show much lower levels of comovement throughout and warrants more attention in future research on business cycle comovement.

Furthermore, the rolling regressions showed how business cycles had fluctuated in response to global factors throughout the sample. Though global factors initially did not explain much of individual business cycles, the Great Recession years show a marked increase in variance shares. The individual advanced and EM economies show the same trend of increased comovement over the years, though the effect was slightly smaller for EM, whose variance shares do not reach as high levels as advanced countries do.

In conclusion, then, though decoupling might have been a hot topic at the onset of the credit crunch, decoupling is clearly not a once-off event. Economies continuously decouple and couple, driven by historical and global events and local policy responses and environments that dominate at various times. With regard to the issue of decoupling between advanced and EMs during the Great Recession, it is found that EMs actually experienced more intense comovement during this time. This was

attributable to higher levels of trade interdependence caused by their participation in globalisation.

# CHAPTER 5: DECOUPLING BETWEEN CHINA AND ADVANCED ECONOMIES

## 5.1 Introduction

In the previous chapter, comovement between EM and advanced economies was investigated. Though EMs attract much attention as a group, China is arguably the individual EM that elicits the most attention. Economists, as well as political analysts, closely follow China's growing global influence (Christensen, 1996; Waldron, 2005). For this reason, China is now isolated in this chapter in order to focus solely on the issue of comovement between China and advanced economies. Thus, using the same data as for the analysis in Chapter 4, but dropping the other EM economies, DFA is used to investigate the comovement between China and advanced economies.

In the past twenty years, China has made impressive strides in transforming its economy. From a starting point of low economic growth and high poverty levels, to average GDP growth rates of ten per cent a year, China has taken centre stage in the global economy and is considered by analysts such as Subramanian (2011) to be an "inevitable superpower".

During the 1800s, China rose to prominence as an economic powerhouse for the first time, accounting for as much as 32 per cent of global GDP by 1820. China's progress after that was hampered, however, by low levels of technology and limited political influence. Modern China has made significant strides in both these arenas (Hale & Hale, 2003). Furthermore, China's liberalisation strategy has bought the previously isolated economy into much closer contact with its Western counterparts. All these factors, combined, make China a force to be reckoned with.

As China continues to grow, so does its need for resources. Demand from China now influences various important commodity prices, with its economy consuming 24 per cent of total world metal production. Added to this is the fact that China consumes 13 per cent of world energy, and that it is the world's largest consumer of various agricultural products, including palm oil, wheat and rice (Roache, 2012). In terms of global prices and inflation, too, China is becoming an influential role-player in the global economy. As mentioned above, Chinese demand has in recent years become more important for explaining changes in commodity prices observed. On

the other hand, China's position as a leading supplier of many inputs could also lead to lower international prices and, therefore, inflation. Eickmeier and Kühnlenz's (2013) analysis of China's role in global inflation dynamics reveals that prices in other countries are indeed influenced significantly by Chinese shocks. Specifically, changes in Chinese demand have a large impact on producer prices. Chinese shocks are translated into price changes both directly and indirectly, and the extent to which prices in other countries are influenced by Chinese movements depend on overall trade exposure to China, as well as the level of commodity dependence of various countries. Capital goods and commodity exporters, such as Australia, Japan and Korea, stand to gain much more from continued Chinese growth than countries that merely export processing components to China, such as Malaysia and Taiwan.

Apart from high growth rates and rising demand, China's increasing importance in the global economy is further illustrated by the fact that its currency, the renminbi, is becoming an ever more popular reference currency. This is true especially for other EMs. Subramanian and Kessler (2013) argue that a renminbi bloc has already been established in East Asia, where the US dollar is no longer the dominant reference currency. This can be seen by the fact that 7 out of the 10 currencies studied comove much more strongly with the renminbi than they do with the dollar.

The potential shift from the dollar to the renminbi as a favoured reference currency is one of the many ways in which China's emergence seems to be reshaping the global economy. As the country continues to grow, the traditional pattern of economic dominance is set to change, and China's demand for commodities and other products could open up a way for other economies to grow, as well. According to Bussolo, De Hoyos, Medvedev and Van der Mensbrugghe (2008), China, along with fellow emerging Asian giant India, will account for as much as 18 per cent of global output growth in the next quarter century. As consumers in these economies continue to increase their living standards, global demand for certain products and commodities are set to increase. China alone will add an estimated 310 million new participants to the global middle class in years to come. This increased consumer demand could have a significant impact on suppliers of various goods and commodities, with Bussolo *et al.* (2008) estimating that China and India will be responsible for as much as 46 per cent of real output growth in current low to high middle-income countries.

Though the Bussolo *et al*. (2008) study of China's emergence bodes well for the potential future growth of current low to high middle-income countries, the exact influence that China will have on various economies across the world remains unclear to a large extent. This is attributable to the fact that China's integration into the world economy has opened up a number of transmission mechanisms whereby changes in China can spill over into the global economy (Arora & Vamvakidis, 2010). These include China's import demand, as well as the export competition it provides to other countries, welfare effects gained by access to cheap inputs from China, China's influence on commodity prices, and the impact that capital flows to and from China can have on bonds and securities. This issue has gained particular attention in the context of China's holdings of US treasury bonds. Though it is unclear how large China's influence on bonds and securities are as compared to its influence in commodity markets, Warnock and Warnock (2009) do find that international capital flows from China, amongst other economies, have had a statistically significant influence on US interest rates. China's emergence as a trading partner could also influence other countries either positively or negatively, depending on whether China's role as major exporter and favoured FDI destination is competitive with, or complementary to, developments in other economies (Jenkins, Peters & Moreira, 2008; Eichengreen & Tong, 2006).

Just as China's integration into the global economy has opened up new questions regarding the various ways in which Chinese growth might influence other economies, so too do questions remain regarding the influence that other economies have on China. As discovered in Becker and Wang's (2013:4003) analysis of the Chinese business cycle since 1952, China's business cycle has become more susceptible to external influences, whereas before economic reforms took hold in 1978, the business cycle in China was determined only by government policy. Similar results are found by Chen, Quan and Liu (2013:80). These studies highlight the importance of understanding the growing interrelationships between China and other economies.

Empirical research on the levels of comovement between China and various advanced economies is, however, still very limited, especially for the years during and subsequent to the 2008 financial crisis. Add to that the increasing fears regarding a possible hard landing in Chinese economic growth in years to come, and

it is evident that China's role in the global economy, as well as the extent to which the Chinese business cycle is coupled to the global cycle, has become a very important research question.

This chapter will therefore explore the issue of comovement between China and advanced economies. DFA conducted for the period between 1979Q3 and 2011Q2 for China and 17 advanced economies confirms that China has become much more integrated with the global economy. Results show that the Chinese economy did not decouple from these economies during the credit crunch. These results are elaborated on in the remainder of this chapter.

Section 5.2 and 5.3 present a literature review and background on the performance of the Chinese economy prior to and during the 2008 financial crisis. Section 5.4 takes a closer look at the 2008 credit crunch and its impact on China. Section 5.5 presents the data and method used. Section 5.6 discusses the results obtained from the empirical analysis, while Section 5.7 concludes.

## 5.2 Literature review: Comovement between China and other economies

As China's position in the global economy has become more prominent, so too has the need to understand the possible implications that Chinese growth might have on the rest of the world. It has also become important to understand the impact that growth in other countries might have on China. This section provides an overview of the literature available on the topic. The focus is on studies published between 2000 and 2014, in order to provide a background picture of China's integration into the global economy in the years leading up to the financial crisis.

Cashin, Mohaddes, and Raissi (2012) use the GVAR approach to confirm that China's importance in global commodity markets increased between 1979 and 2011. The importance of China as a trading partner to many Middle East and North African economies has increased significantly since the 1980s. Whereas China in the 1980s was still in the initial phases of its "opening up" policy, a negative GDP shock in China now would translate into non-negligible repercussions for many global economies. This would be especially true of commodity exporters who have not succeeded in diversifying their economies. Oil exporters, especially, would be influenced by the impact that lower Chinese demand would have on global oil prices.

For countries depending on oil exports to fuel growth, the impact on growth would be negative.

China's impact on growth is not restricted solely to commodity exporters, however. Cashin *et al*. (2012) also find that a decline in Chinese GDP would have a statistically significant and negative impact on the US and the Euro Zone.

Fidrmuc, Korhonen and Bátorová's (2013) dynamic correlation analysis of business cycles in China and selected OECD countries shows that only a few countries displayed high correlation in long-run cycles with China. For the period between 1992 and 2006, Korea, the US, Japan and Australia display high levels of business cycle correlation with China. Contrary to this, most European countries analysed do not show high correlation with China's business cycle. Of the few European countries which do show some correlation, Denmark, Norway, Italy and the UK are identified. The fact that China trades more intensely with the non-European countries could serve as a possible explanation for this phenomenon. Generally, these countries are found to have negative correlations with the Chinese business cycle over traditional business cycle frequencies, which run between 1.5 and 1.8 years. Many countries display higher levels of correlation over shorter frequencies, which might point to the importance of China as a base in the production chain of transnational companies. Trade emerges as an important transmission mechanism, as countries that have more intense trade linkages with China (such as Korea, Japan and the US) display higher correlations with China over all frequencies.

Jia and Sinclair (2009) use a two-series correlated unobserved components model to investigate China's relationship with the US, as well as the G7 and OECD (Jia & Sinclair, 2010). Data spanning 1978 to 2009 show that China and the US do share important macroeconomic fluctuations. Roughly half of the correlation observed in the real output of these two economies can be ascribed to shared shocks in these economies. This applies for both permanent shocks (originating from changes in technology, for example) and temporary or transitory shocks. Interestingly, controlling for real Chinese output increases the magnitude of transitory fluctuations in US GDP, while the contribution of US GDP in explaining temporary Chinese output fluctuations is not as large. When looking at the advanced world more generally, though, Chinese GDP does not show much correlation with either G7 or OECD aggregates, implying that idiosyncratic factors, such as Chinese domestic

demand and economic reforms, are more important in explaining macroeconomic fluctuations in China.

The increasingly influential role of China as a global trading partner is illustrated by Cesa-Bianchi, Pesaran, Rebucci, Xu and Chang (2012) who use a GVAR model spanning the period between 1979 and 2009 and find that the long-term impact of a shock to US GDP on Latin America has halved since the mid-1990s. Meanwhile, the long-term impact of a Chinese GDP shock has intensified by a factor of three for an average Latin American economy. Interestingly, this does not seem to be the result of increased direct bilateral ties between China and Latin America. Rather, China's emergence as a trading partner with many of Latin America's largest and most influential trading partners seems to be the issue at play. Chinese GDP, therefore, is indirectly influencing Latin American GDP, via trade with traditional partners such as the US.

Calderón (2007) investigates the changes in output comovement between China, India and various Latin American economies between 1965 and 2004 using panel regression methods. The focus is specifically on the role that trade flows play in synchronising business cycles between these economies. As China and India have emerged as strong performers in the global economy, their demand for Latin American commodities, and increased direct bilateral trade relationships with Latin American economies, have served to synchronise business cycles.

Dreger and Zhang's (2011) GVAR analysis of business cycles between China and advanced economies tests the response of economies, such as those of Japan, the US and the Euro area, to a Chinese demand shock between 1979 and 2009. The impact of such a shock, such as the one originated by China's stimulus programme after the credit crunch, is substantial. Output growth in advanced economies changes in reaction to the Chinese demand shock. In the US, output can be seen to increase by up to 0.7 per cent, and in Japan as well. In the Euro area, output is likely to increase by up to 0.5 per cent. Economies in the Asian region are especially influenced by a Chinese demand shock, since trade linkages in the region are more intense than those between China, the US and the Eurozone.

Haltmaier, Ahmed, Coulibaly, Knippenberg, Leduc, Marazzi and Wilson (2007) estimate Vector Autoregressive (VAR) models which confirm the important role that

China has come to play in East Asian growth during recent years. Their analysis covers the years between 1993 and 2006 and shows that Chinese imports especially from Korea, Thailand, Taiwan and Singapore have a large influence on growth in those countries. More and more Asian economies are co-moving in growth with China, even when controlling for growth in the US.

When comparing the influence that Chinese demand has on growth in the East Asian region with that of the US, it is interesting to note that the influence of the US generally tapers, where China becomes stronger. According to gravity models estimated for the period between 1997 and 2005, less-developed Asian economies in particular are more sensitive to Chinese growth than to US growth (Ma, Van Assche & Hong, 2009). The US has remained an important trader with the region, though, with Malaysia, Indonesia and the Philippines being much more vulnerable to US demand shocks than to Chinese. Even controlling for the fact that China might not be directly influencing growth in Asian economies, but rather is doing so via its derived demand of US products, results show that China has become an increasingly important driver of growth in the East Asian region.

Arora and Vamvakidis (2010) confirm, using VAR and Vector Error Correction model (VECM) estimations for the period between 1960 and 2007, that trade has become a major channel through which Chinese shocks spill over to the rest of Asia. That is not to say that Chinese trade does not influence non-Asian trading partners, but the effect seems to decline with distance. For instance, a one per cent increase in Chinese growth correlates to a much larger increase in growth for geographically close Asian countries than it does for more geographically removed countries. While Asian growth has always been particularly susceptible to Chinese fluctuations, Arora and Vamvakidis (2010) stress the fact that Chinese growth has also become increasingly important for global growth during the past two decades. A one percentage point increase in Chinese growth during the past two decades correlates to an increase of 0.5 per cent growth in other countries, on average.

Not only has China become an increasingly important trading partner for other East Asian economies, and the US, but for African countries as well. Relations between China and South Africa have been growing and Çakir and Kabundi (2013a) find that export shocks from China have an influence on South African imports and growth. Using DFA to investigate different sources of Chinese shocks between 1995 and

2009, it is concluded that a positive real export shock from China translates into an immediate one per cent increase in South African imports. Real output from South Africa also reacts positively to a Chinese export shock. South African exports and output do not react significantly to a Chinese import shock, however. Chinese supply shocks also have significant impacts on the output of other major EMs such as Brazil and Russia.

A key driver behind China's increasing importance in the global economy has been that country's spectacular economic growth. China's export- and investment-led growth has fuelled the economy's demand for imports. If investment, and therefore growth, in China does slow down, many economies in China's supply chain will thus face the risk of growth deceleration themselves. Ahuja and Nabar (2012) estimate the extent of China's investment spillovers in the global economy spanning the period between 2002 and 2011 with regression analysis. China's increasing importance in the global economy is illustrated in the fact that a one percentage point decrease in Chinese investment will cause a reduction of global growth by one-tenth of a percentage point. Different economies are influenced in different ways, with commodity-reliant exporters and regional supply chain countries being most vulnerable to a Chinese slowdown. Among China's G-20 trading partners, capital goods manufacturers with extensive exports to China are also at risk. China's importance in global commodity markets is also illustrated by the fact that if Chinese fixed asset investment were to decline by one per cent, commodity prices would drop by 0.8 to 2.2 per cent, up to a year after the shock.

Clearly, Chinese growth has important consequences not only for the rest of Asia, but also for various advanced economies and the global economy in general. The increasing influence that China has on the rest of the world points to greater integration of China into the world economy. If changes in Chinese growth have a spillover effect on other economies, then what is the spillover effect of growth in other economies on China? This question lies at the heart of the expectation that China had decoupled from advanced economies especially.

N'Diaye, Zhang and Zhang (2010) use the Global Integrated Monetary and Fiscal (GIMF) model to confirm that the Chinese economy is still sensitive to economic shocks originating from the US or the G3 (Japan, Euro zone and the US). Depending on policy responses and initial conditions, a one percentage point decline in US or

G3 demand translates to a 0.25 to 2 percentage point drag on output growth for China.

Allegret and Essaadi (2011:357) find that China is an important transmitter of business cycles to other East Asian countries, since Chinese trade is responsive to American GDP. The study looked at real GDP for various East Asian economies between 1975Q1 and 2007Q1 using time varying coherence functions. The East Asian region's dependence on external demand and China's role as integrator with global production chains has been confirmed by Haltmaier *et al.* (2007) and Dufrénot and Keddad (2014:196).

The growing interdependence between China and advanced countries is confirmed by Kim, Lee and Park (2010:42-43) who estimate impulse response functions from a VAR model covering the period between 2001 and 2007, and find that US as well as European output shocks have positive effects on Chinese output. Conversely, Chinese output shocks also have large positive effects on US and European output.

Lam and Yetman (2013:323) use various rolling correlation measures to analyse the comovement between individual East Asian economies and the US between 1990 and 2007. For China, the fact of growing interdependence is confirmed again as results show low levels of comovement throughout the 1990s, which started spiking in the 2000s and reached a high point during the credit crunch years.

Leduc and Spiegel (2013:354) estimate two-year rolling correlations of Chinese and US GDP between 1997Q1 and 2012Q3 and find that business cycle synchronisation between China and the US and China and the EU have increased subsequent to the credit crunch, while decreasing with the rest of Asia and the global economy.

Table 5.1 below presents a summary of the studies, methods and main results on Chinese comovement between 2000 and 2014.

**Table 5.1: Literature on comovement between China and advanced economies**

| Authors | Period covered | Method Used | Main conclusion |
|---|---|---|---|
| Ahuja & Nabar (2012) | 2002-2011 | Regression analysis | Chinese investment has significant spillovers on global growth. |
| Allegret and Essaadi (2011) | 1975-2007 | Time varying coherence functions | China transmits US shocks to East Asian neighbours. |
| Arora & Vamvakidis (2010) | 1960-2007 | VAR and VECM | Chinese demand has become increasingly important for regional (Asian) growth as well as global growth. |
| Çakır & Kabundi (2013a) | 1995-2009 | DFA | South African output reacts positively to positive export shocks from China. Other 'BRIS' economies display similar patterns. |
| Calderón (2007) | 1965-2004 | Panel regressions | Chinese trade flows have served as impetus which synchronises business cycles between China, India and Latin America. |
| Cashin *et al*. (2012) | 1979-2009 | GVAR | Commodity exporters are particularly vulnerable to Chinese demand shocks. |
| Cesa-Bianchi *et al.* (2012) | 1979-2009 | GVAR | The US has become less important in explaining Latin American output fluctuations, while China has become more important. |
| Dreger & Zhang (2011) | 1979-2009 | GVAR | Chinese demand shocks have substantial impacts on the US, the Eurozone and Japan. |
| Fidrmuc, Korhonen & Bátorová (2013) | 1992-2006 | Dynamic correlation analysis | Countries, such as Japan, Korea and the US, which trade intensely with China show higher correlations with the Chinese business cycle than most European countries. |
| Haltmaier *et al*. (2007) | 1993-2006 | VAR | Chinese trade has been an important determinant in East Asian growth. |
| Jia & Sinclair (2009) | 1978 -2009 | Two-series correlated unobserved components model | About half of the output fluctuations observed between the US and China can be ascribed to common shocks. |
| Sinclair & Jia (2010) | 1978 -2009 | Two-series correlated unobserved components model | When using OECD and G7 aggregates as proxies for the advanced world, Chinese output does not share common factors. China is more sensitive to the US in particular than advanced countries in general. |
| Kim, Lee and Park (2010) | 2001-2007 | VAR | Relationships between China, the US and EU are interdependent: US and EU shocks positively influence Chinese output, and vice versa. |
| Leduc and Spiegel (2013) | 1997-2012 | Two-year rolling correlations | Chinese business cycle correlations with the EU and US have intensified, while decreasing with other East Asian economies. |
| Ma, Van Assche & Hong, 2009 | 1997-2005 | Gravity models | Chinese trade has been a more important determinant of East Asian growth than US growth has. |
| N'Diaye, Zhang & Zhang (2010) | | GIMF | Changes in US demand have a significant impact on Chinese output. |

The available literature on China's real comovement with other economies, and impact on trading partners, shows increasing global interdependence where China is often a driving force, especially in the East Asian region. Moreover, China's prominence as a global trading partner has caused the importance of Chinese demand to increase over time. This is to be expected, given the level of trade that China partakes in globally and its importance as consumer in global commodity markets. In fact, China overtook the US to become the world's largest trader in January of 2014 (Bloomberg, 2014).

While the literature on China in general has expanded substantially as the Chinese economy becomes much more prominent worldwide, some important questions remain. In terms of the comovement between China and other economies, the focus on China's synchronisation with advanced economies has only become a pertinent issue in recent years and therefore has not received as much attention. Many of the studies available in the literature therefore focus on China's impact on fellow BRIS economies or other emerging regions such as Latin America and Asia. Of the studies analysed in the literature which do pay attention to the issue of Chinese comovement with advanced economies, the advanced economies are restricted to a small subset of countries such as the US, Eurozone and Japan. Furthermore, few studies look at a time period which encompasses the credit crunch years, often stopping in 2007 or 2009, when it can be argued that much of the after-effects of the credit crunch were still playing out. Leduc and Spiegel (2013) do look at this period, but investigate China as part of Asia and focus mainly on the US as an advanced partner.

In order to bridge this gap in the literature, this chapter presents an extensive analysis of comovement between China and various advanced economies from different regions. The data analysed also encompasses a wide period, beginning at the end of the 1970s, when China first embarked on its open door policy, through the 1990s as globalisation continued apace, and up until 2011. This gives a broad perspective of how China's comovement with advanced economies has changed throughout various decades and during and shortly after the credit crunch of 2008. In order to provide a deeper understanding of the context within which China currently operates, the following section provides a brief economic background to China.

## 5.3. Background to the Chinese economy

China's path to becoming the economic power it is in 2015 started in 1978, when the first of many structural reforms were launched. Previously very much a closed economy with low levels of growth and development, these reforms opened up the Chinese economy considerably and set it on the growth trajectory that was the envy of many a developing economy throughout the 2000s. Reforms focused on various issues such as liberalising trade, followed by a step-wise liberalisation of investment and a gradual reduction in state ownership (Buckley, Clegg, Cross, Liu, Voss & Zheng, 2007).

These reforms showed a large growth dividend. In 1980, for instance, China's per capita GDP (in purchasing power parity terms) was $524. By 2012, that had risen to $7958. That level of income places China within the World Bank's lower middle-income grouping (World Bank, 2014). China has also made impressive strides towards reducing poverty. In 1981, China's poverty rate was 84 per cent. By 2008, the number had dropped to 13 per cent. In the years between 2000 and 2012, China averaged an economic growth rate of 10 per cent per year (World Bank, 2014). During this time, China also joined the World Trade Organisation (WTO), becoming the world's largest exporter and the largest oil importer. In 2010, China also overtook Japan to become the world's second-largest economy (Bloomberg News, 2010). By October 2014, the IMF announced that China had overtaken the US as the world's largest economy, in purchasing power parity terms (IMF, 2014). The Chinese economy is ranked 28$^{th}$ out of 144 economies in terms of Global Competitiveness (WEF, 2015) and 91$^{st}$ out of 187 countries in terms of its Human Development Index (HDI) (UNDP, 2015). With a HDI of 0.719 in 2014, compared with 0.40 in 1980, China has clearly made important strides in increasing the quality of life of its citizens.

Much of China's success has been ascribed to the steady, gradual pace at which reforms took place in that economy. The Chinese government ensured that certain key industries still remained under the government's protection, and therefore state-owned enterprises (SOEs) played a much larger role in China's economic development than would traditionally be considered prudential. This prompted *The Economist* (2012) to refer to the Chinese model of development as "state capitalism".

The market reforms that have occurred, though, were carefully engineered to target key issues that the Chinese government felt, at various times, to be important. The use of Five Year Plans was a hallmark of this strategic approach to economic development. So, for example, the latest Five Year Plan released by China focuses heavily on the issues of sustainable growth, strengthening domestic consumption and industrial advancement (KPMG, 2013).

Much of the development strategy implemented by the Chinese government in its various Five Year Plans since 1978 centred on industrialisation. For example, the effective use of import substitution in strategically identified sectors has been successfully implemented. By 2012, industry accounted for 45 per cent of Chinese GDP (World Bank, 2014).

Though these achievements are impressive, it should be remembered that China is still a developing country with many challenges that remain to be addressed. Prime amongst China's development challenges is the growing belief that the high levels of growth seen throughout the 2000s in China are going to become ever more difficult to sustain (Roubini, 2011; Eichengreen, Park & Shin, 2012).

These worries are fuelled by various concerns regarding China's macroeconomic fundamentals, which are sturdy in many respects, but still need reform in others. Some fears regarding China's ability to grow include the rapid aging of the population, the regional inequalities which persist, and the lack of domestic demand which can serve as a driver of growth (Akhmat & Bochun, 2010:157; Sato, Sicular & Yue, 2013:2).

Some critics have also voiced the opinion that the Chinese economy is overheating and that this will inevitably lead to a painful correction in the market. Eichengreen *et al.* (2012) investigate the possibility of a Chinese growth slowdown and find that China is nearing a turning point where this is increasingly likely to happen.

One of the primary concerns for the Chinese economy's ability to continue growing at the rate it has enjoyed up until now, is the imminent demographic transition that China will soon experience. The Chinese population is aging rapidly, due in large part to the infamous one-child policy[12] that has been in effect in China for decades.

[12] The Chinese government announced at the end of 2015 that this policy would be scrapped. Effective from 1 January 2016, couples will be allowed to have two children.

This means that the young, working-age population in China is shrinking, which raises concerns about China's future productivity. According to the UN (2013), the growth of China's working age population could turn negative as early as 2020.

The aging demography of the Chinese population couples with the fact that, for decades, labour mobility in China has been strictly controlled by means of the *hukou*[13] system. These demographic challenges have led Cai (2010) to the conclusion that China will soon be reaching its Lewis turning point. This means that the supply of cheap, excess rural labour is close to being fully utilised as urbanisation progresses and the strictures of the *hukou* system are relaxed. Wage growth will accelerate, adding additional pressure to profit margins, above that of the declining productivity that can be expected from the aging population. In fact, higher labour costs are already putting a damper on China's manufacturing sector, combined with a lack of high-skilled human capital and inexperienced management. Das and N'Diaye (2013) confirm that China is likely to reach this turning point between 2020 and 2025.

China's aging labour force does not only foretell of increasing pressures on productivity, but also of a social safety net that will be increasingly stretched. And with fewer young workers to pick up the slack that will be experienced in taxation, the Chinese fiscus will probably find itself in increasingly troubled waters (Cai & Wang, 2006; Banister, Bloom & Rosenberg, 2010).

The Chinese economy has also been one whose growth has largely been driven by investment (IMF, 2013). The challenge for China in future will be to move toward an economy that is more consumption driven. China also faces serious problems in environmental sustainability, as the country's urbanisation drive continues to pick up pace.

While China's process of slow and steady reforms, accomplished with heavy government supervision, has been successful up until now, the next wave of reforms need to be addressed and government's role in the economy should be reformulated. With waning economic growth, China also risks losing out on economic development opportunities in coming years. Though China's growth since the 1980s

13 This refers to a system of population registration, described by Cheng and Selden (1994) as "a code of laws, regulations and programmes whose effect was formally to differentiate residential groups as a means to control population movement and mobility and to shape state developmental priorities." The Chinese government announced plans for reform of the hukou system in July 2014.

has seen a decline in poverty rates, there are still many developmental concerns, such as the fact that an estimated 170 million people still live below the international $1.25 poverty line (World Bank, 2014).

## 5.4. China's general macroeconomic performance before and during the credit crunch

The industrialisation drive that had been emphasised since the start of reforms in 1978 had paid off with average annual real GDP growth of 9.8 per cent between 1979 and 2012 (World Bank, 2014). In the decade leading up to the financial crisis, China had supported this impressive growth by building up a track record of solid macroeconomic management which would stand it in good stead (Vincelette, Manoel, Hansson & Kuijs, 2010). During the mid-nineties to early 2000s, China faced the Asian crisis, which led to growth slow-downs. By 2001, most Asian economies had recovered quite well and, amid a period of favourable global economic circumstances, developing countries in general experienced a boom in growth. Trade and investment in EM and developing countries accelerated and commodity prices soared.

It was during this time that China positioned itself as the key exporter it is today, supporting the focus on exports with certain key domestic reforms. These included the privatisation and restructuring of state-owned enterprises, major infrastructure investments, a large urbanisation drive, and focus on improved macroeconomic management (Vincelette *et al*., 2010). Much emphasis was placed on industrialisation, which was supported in various respects by government, such as making allowance for low interest rates on commercial loans, and gearing government expenditure heavily towards infrastructure expenditure. This capital-intensive growth model, combined with a continually undervalued exchange rate, boosted China's production capacity. In the years leading up to the global financial crisis, China's high economic growth rates reflected its true underlying growth potential (Guo & N'Diaye, 2009).

That does not mean that the economy was not vulnerable to cyclical fluctuations, however. Though China's export focus has served it well, it also leaves the economy more susceptible to declines in external demand. The managed nature of the exchange rate also inhibits monetary policymakers' ability to respond to domestic needs, and the growing housing bubble in China may open up another potential

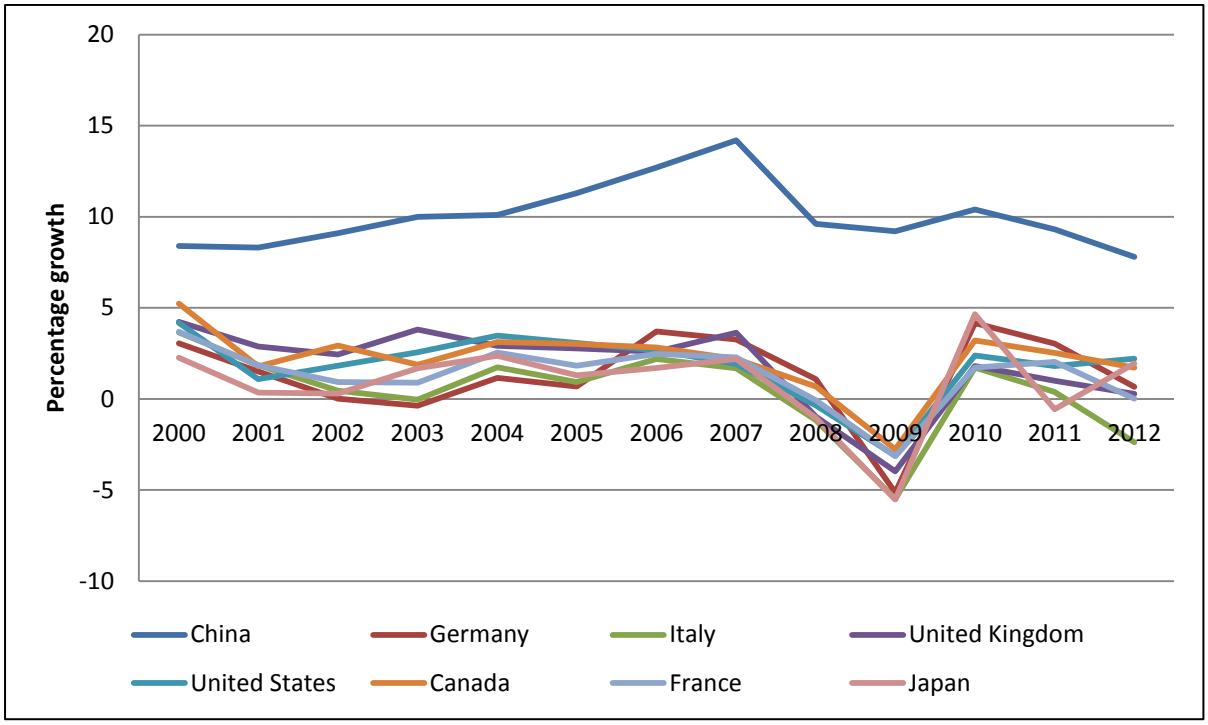
transmission mechanism for crises. Notwithstanding these potential concerns, prudent fiscal and monetary management in the years leading up to the crisis left Chinese policymakers with much room to manoeuvre when the crisis struck. Accumulated foreign reserves of $2 trillion, combined with low budget deficits and low levels of external debt, enabled the Chinese government to enact strong countercyclical measures at the onset of the crisis (Gou & N'Diaye, 2009).

The countercyclical measures undertaken by Beijing were indeed swift and strong. A fiscal stimulus package of 3.1 per cent of GDP was deployed in 2009, followed by another one of 2.7 per cent of GDP in 2010. This package focused very much on classic Keynesian-style infrastructure, with roads, airports and railroads being built (Schüller & Schüler-Zhou, 2009:169).

Studies by He, Zhang and Zhang (2009) and Cova, Pisani and Rebucci (2010) show the fiscal stimulus to have been successful, with fiscal multipliers of up to 1.1 and the potential to create up to 20 million non-farming jobs. The policy action undertaken in this time has also been lauded by the OECD (2013) for having mitigated the impact of the global crisis on the Chinese economy. The stimulus plan enacted by Beijing kept average yearly GDP growth in China above nine per cent during 2008, 2009 and 2010. Growth did slow down somewhat in 2012, bottoming out at 7.8 per cent. This was largely attributable to corrective action undertaken by Chinese policymakers in 2011, as concerns were growing about overheating in the Chinese economy (OECD, 2013).

Comparing Chinese with G7 growth during the Great Recession shows that, while the US economy shrank by an average of 0.37 per cent between 2008 and 2010, the Chinese economy still managed to grow at an average rate of 9.7 per cent during the same time period. This growth, which came from a low base, was impressive in comparison with what much of the rest of the world was experiencing at the time, it still represented a significant drop from the growth experienced in previous years. These trends are illustrated in Figure 5.1 below.

**Figure 5.1: Chinese and G7 economic growth, 2000-2012**




**Source: World Development Indicators**

From the figure above, it can be seen that China's economic growth rate throughout the 2000s was indeed impressive. From the much higher level of GDP growth that China had been experiencing compared with that of its G7 counterparts, the Chinese economy did experience a downturn starting in 2007, along with the G7. The Chinese downturn was not as steep, though interestingly the graph also shows that Chinese growth had not returned to its pre-crisis levels by 2012, either.

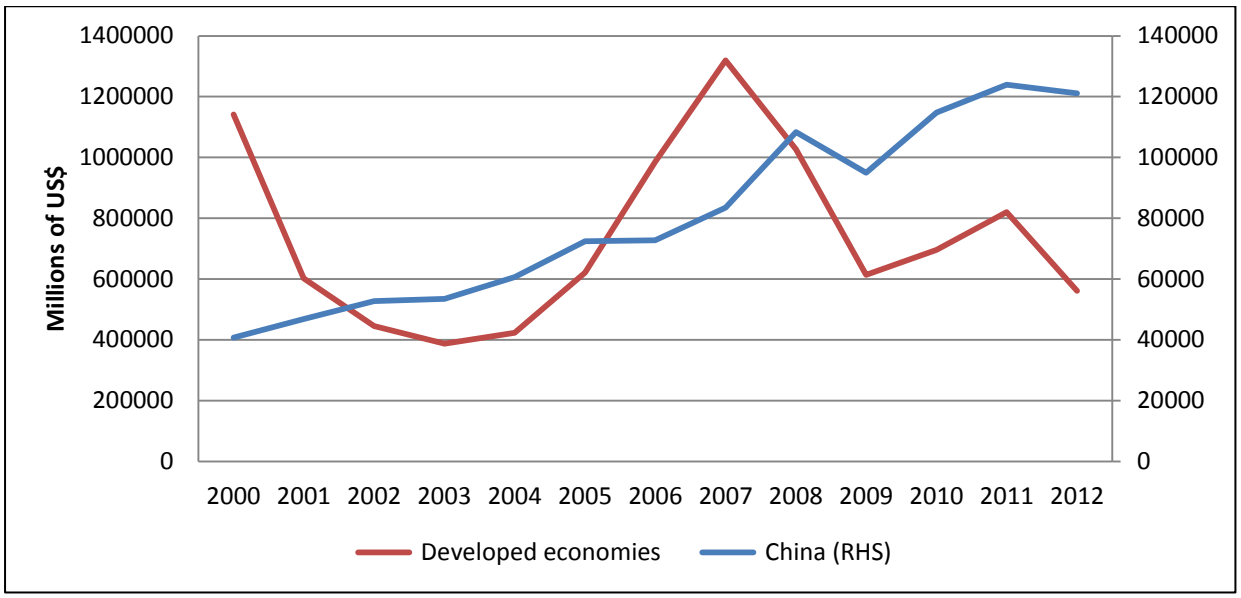
It seems, in fact, that Chinese growth might not recover to those pre-crisis levels at all. By 2013, Chinese economic growth stood at 7.7 per cent for the year, with estimates for growth in 2014 and 2015 showing that growth will slow to 7.4 and then 7.1 per cent (IMF, 2015a).

During the crisis years, it was not only China's growth that continued while the rest of the world experienced a decline. Another indicator of China's seeming resilience to the credit crunch is Foreign Direct Investment (FDI). While FDI flows tend to diminish during crises, China's FDI flows continued more or less unabated throughout the crisis.

This is depicted in Figure 5.2 below, which shows China as a steady recipient of FDI inflows. Compared with the trend in FDI inflows to advanced economies since 2000,

the Chinese economy has steadily attracted increasing levels of FDI inflows, while FDI inflows to developed economies have been much more volatile. There was a slight dip in FDI receipts at about 2008, as would be expected, though China quickly rebounded from this and continued receiving FDI inflows. In contrast, the FDI inflows to advanced economies declined much more drastically and did not rebound quite as strongly.

**Figure 5.2: Net FDI inflows to China and advanced economies,[14] 2000-2012**

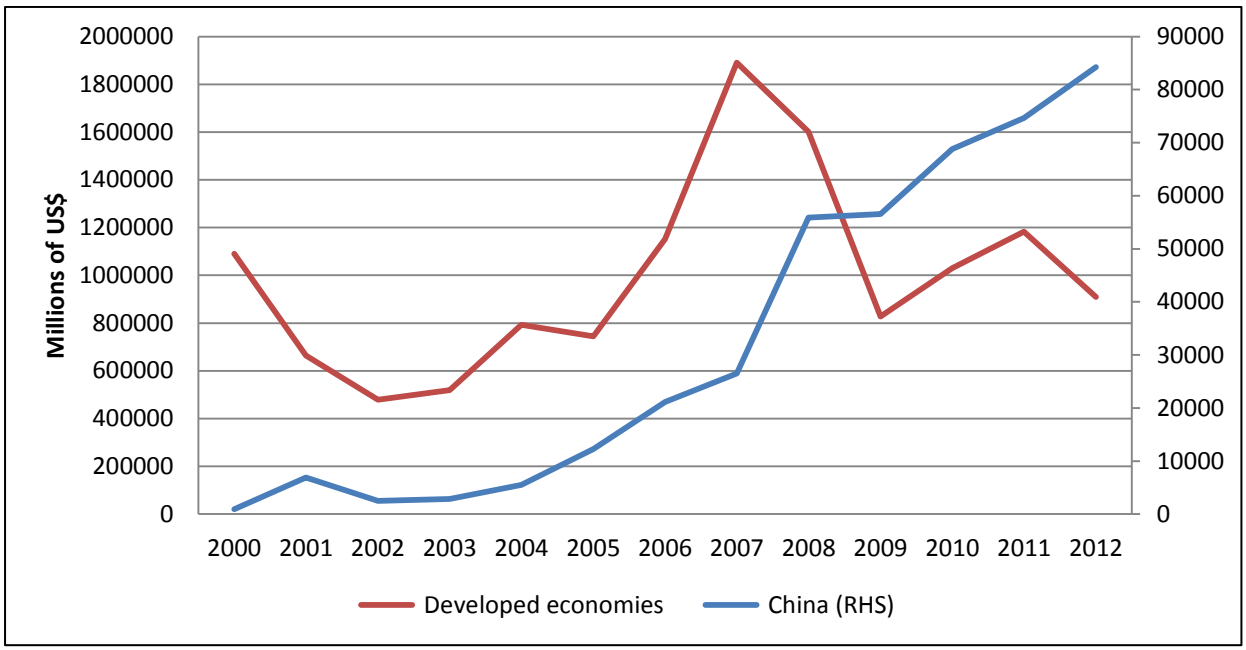



**Source: UNCTAD FDI Statistics**

Similarly, a glance at patterns in FDI outflows reveals that China continued investing in other countries throughout the crisis. This is illustrated in Figure 5.3 below, which shows China steadily increasing its FDI outflows from a very low base in 2000. Interestingly, during the crisis years, Chinese FDI outflows level off but do not decrease. FDI outflows from China then pick up pace once again, compared to FDI outflows from advanced economies, which take a drastic downturn during the crisis years and do not recover to pre-crisis levels.

14 Note that 'Developed Economies' in this graph and the graphs to follow refers to the group of economies as aggregated by UNCTAD and is not necessarily the same as the economies that will be used in econometric analysis later on. The purpose here is solely to provide a broad overview of global trends.

**Figure 5.3: FDI outflows from China and advanced economies, 2000-2012**

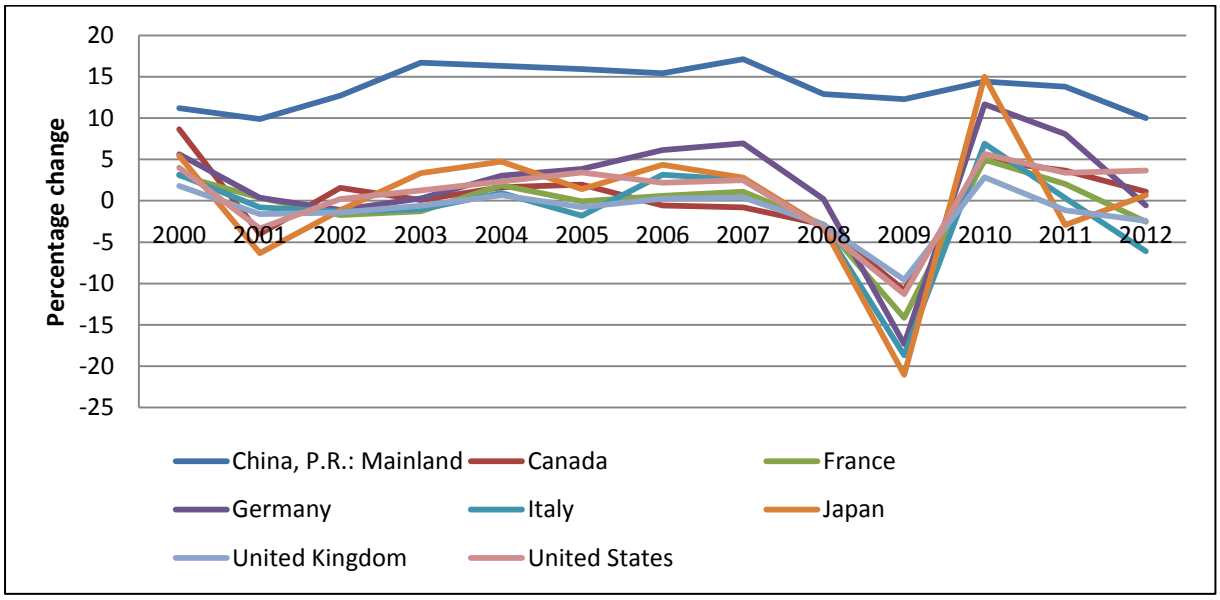



**Source: UNCTAD FDI Statistics**

According to the 2013 World Investment Report (UNCTAD, 2013), the trends to be seen in Chinese FDI flows above are part of a larger one in recent years in which developing and EM countries surpassed advanced economies as recipients of FDI.

A look at other indicators of real activity, such as industrial production and household consumption expenditure, also shows China coming through the crisis at much higher levels than its G7 counterparts do.

**Figure 5.4: Industrial production growth in China and the G7, 2000-2012**

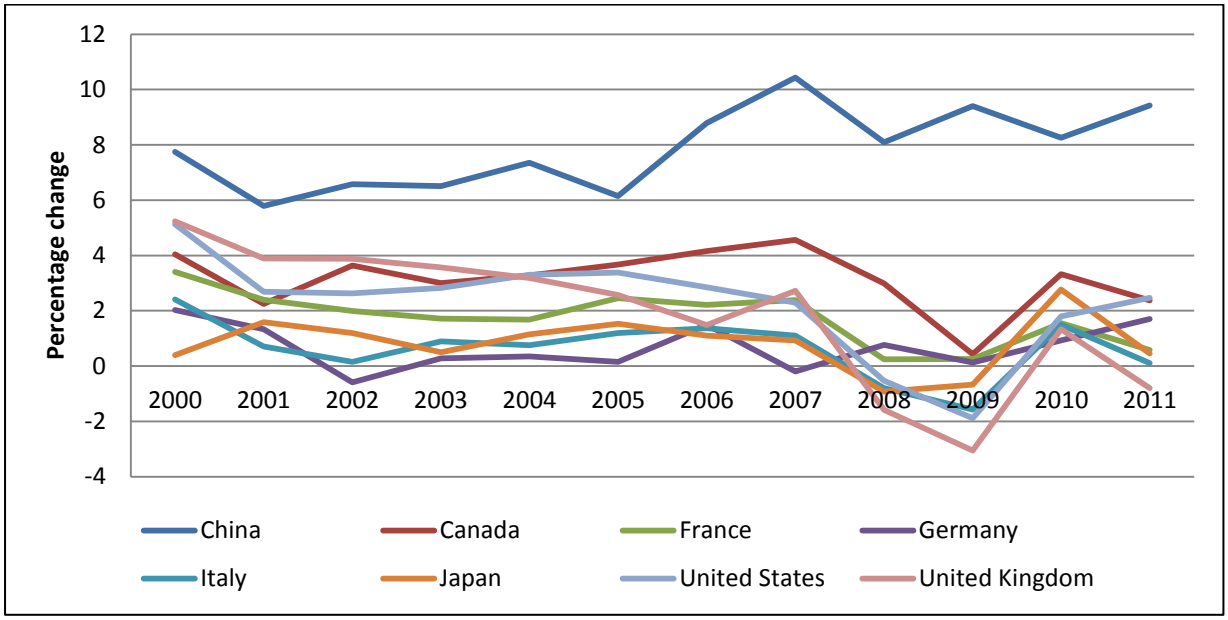



**Source: IMF International Financial Statistics**

Figure 5.4. above shows that China's downturn in industrial production was not as severe as that of the G7 was. It can also be seen that Chinese industrial production growth has been much higher and steadier than that of G7 counterparts since 2000, with growth rates staying more or less in a band of between 10 and 15 per cent.

In terms of household consumption expenditure, Figure 5.5 below shows that household consumption expenditure in China did slow, but then recovered and increased between 2008 and 2009, when it was declining in the G7. It is also noticeable that China's household consumption expenditure has displayed much more of an upward trend since 2000, while household consumption in the G7 did not grow much during the same period. The ability for domestic demand to continue relatively unabated through the crisis has been identified by Kose and Prasad (2010) as a key reason behind the resilience of many EMs during the crisis.

**Figure 5.5: Final household consumption expenditure growth in China and the G7, 2000-2012**

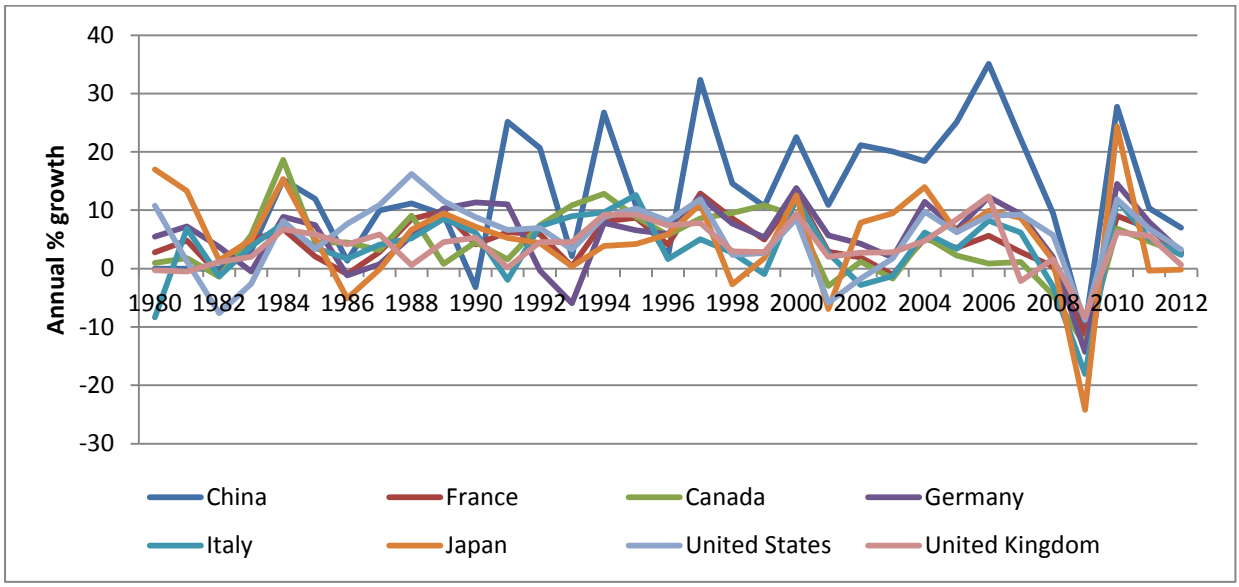



**Source: World Development Indicators**

Given China's prominence as a global trading partner, another important element to take into consideration is China's trade performance during this time. Figure 5.6 below shows that Chinese exports showed significant growth after liberalisation. Export growth strongly outpaced export growth in G7 economies during the 1990s and early 2000s in particular. Export growth did fall sharply during the recession years, though it is noticeable that growth also recovered quickly, with Chinese export

growth in 2010 reaching 27 per cent. The G7 economies recovered, too – though not to the heights achieved by China.

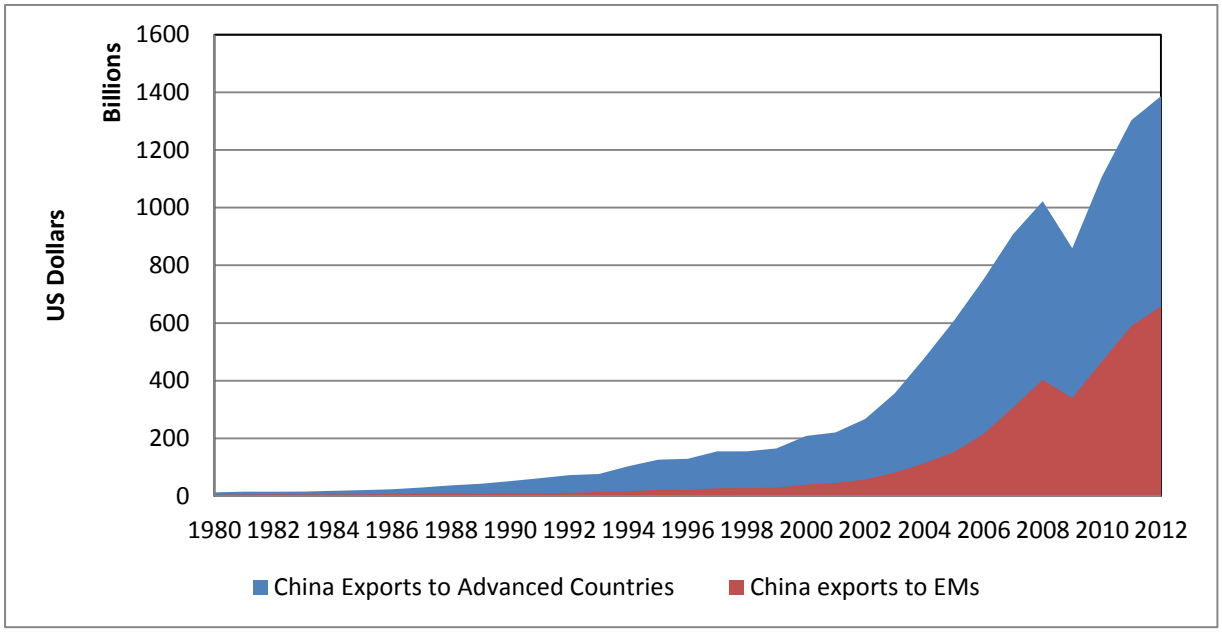
**Figure 5.6: Export growth in goods and services between 1980 and 2012: China versus G7**




**Source: World Development Indicators**

A key reason for China's impressive export performance during the crisis might lie in exactly who its trading partners are. Figure 5.7 below shows that China had started exporting much more to other EMs after 2000. While China still exported mostly to advanced economies in 2012, with roughly 68 per cent of exports flowing to advanced economies, exports to other EMs had also increased and stood at 32 per cent in 2012 (IMF, 2015c).

**Figure 5.7: Chinese exports to various destinations, 1980-2012**




**Source: IMF Direction of Trade Statistics (DOTS)**

Though diversification of trading partners could have shielded China from some of the decline in global demand, the downturn in advanced trading partners, such as the US, EU and Japan, did cause concern during the crisis years (Liu, Pannell & Liu, 2009). Evidently, exports to advanced countries still dominate Chinese exports, though there were differing views on how exactly trade would come to influence the Chinese economy during the Great Recession. For instance, Ma and Van Assche (2009) argue that China's export dependence as a driver of growth has been over exaggerated. When analysing Chinese exports at a more nuanced level, by taking into consideration the domestic content share of exports, the picture looks different. Many Chinese exports rely heavily on imported inputs, which are only assembled in China before being shipped out. The Chinese economy, according to their analyses, is therefore much less vulnerable to declines in external demand.

This is supported by Horn, Singer and Woetzel (2010), who argue that traditional measures of export dependency are problematic. Looking at the share that export growth contributes to economic growth gives the distinct impression that China's economy would be drastically influenced by slow-downs in key trading partners. This is because exports can be seen to have accounted for as much as 60 per cent of China's economic expansion in recent decades. And, though China did experience some slowdown in economic growth during the global financial crisis, it was not as

drastic as might have been expected for an economy with a GDP more than 60 per cent reliant on exports.

Insight into this phenomenon is provided by the analysis by Horn *et al.* (2010) of domestic value added exports, which investigates exports and imports based solely on products which are further processed in China in order to export. This analysis provides a much different picture. Based on this metric, exports would only have contributed about 33 per cent of Chinese GDP growth between 2002 and 2008. Though that number is significant, the argument is that exports had not been the dominant driver of Chinese growth. Investment and domestic demand in China had strengthened, and Chinese producers were moving up the value chain, becoming more than mere assemblers of products for export.

For the East Asian region, however, the picture might look very different. In fact, Chinese demand for inputs from its neighbouring economies could serve as a conduit of crises (Kim *et al*., 2010). Manova and Zhang (2008) find that between 2000 and 2006, China used roughly half of all goods it imported from East Asian neighbours as intermediate inputs, so that final demand from the US remained a very important driver in East Asian exports. Asian exports consumed by Japan and other OECD countries also remained high. Chinese demand for East Asian exports is therefore unlikely to buffer these economies from the impact of the global financial crisis.

This initial analysis of some real Chinese data shows that, compared with the leading industrial countries of the G7, China did perform very well in the years leading up to, during, and immediately after the Great Recession. It is interesting to note, however, that while the downturn might not have been as steep for China, there was a definite decline in growth. At face value, one can understand, then, that the debate on decoupling was so speculative. While the very fact that the Chinese growth pattern mimics that of the G7 and seems indicative of coupling, the fact that the downturn was not as steep and that FDI inflows continued unabated might suggest decoupling. The empirical analyses which follow will shed more light on this.

## 5.5 Data

To analyse comovement between China and advanced economies, DFA is employed. The period under investigation remains 1979Q3-2011Q2, with the sub-periods of 1979Q3-1990Q4, 1991Q1-2000Q4, and 2001Q1-2011Q2.

Recall that the aim of this chapter is to zoom in on China. Though China was included in the previous chapter's analysis of EMs, the global interest in China warrants closer inspection. Isolating China in the analysis now allows us to determine whether Chinese comovement (with China as a standalone country) differs from comovement where China forms part of the larger group of EMs.

To this extent, the data remain largely the same. The difference is that the other EM countries are left out of the sample. Factor analysis in this chapter is thus done on China and seventeen advanced economies: Australia, Austria, Belgium, Canada, Finland, France, Germany, Italy, Japan, Norway, the Netherlands, New Zealand, Spain, Sweden, Switzerland, the United Kingdom and the United States. Quarterly data for real GDP, CPI, short-term interest rates, imports, exports, exchange rates and business cycles are used. The oil price is included as a global variable. These data remain the same as those used in Chapter 3, and are thus obtained from the GVAR Toolbox and IMF's International Financial Statistics (See Section 3.3 in Chapter 3 for a review of DFA and the data used.)

Since China is the economy of interest here, some additional variables, such as total reserves, lending rates and deposit rates, are added to the sample. Where available, data for China's Share Price Index, Industrial Production Index and Producer Price Index are added, too. Additional variables are added in order to ensure that China, as the reference economy in this case, has sufficient real and financial variables. The size of China's total reserves could have helped buffer the economy against the global economic downturn. Financial variables such as interest rates and share prices capture financial linkages that China may have had with advanced economies. Industrial production provides further information on how the real economy performed throughout the sample. The resultant sample consists of 172 observations (N) over 128 quarters (T). The additional data were collected from the IMF's IFS Database.

Finally, it is noted that there is much debate around the quality of available Chinese macroeconomic data. Unfortunately, it is also true that high-frequency Chinese data is often difficult to obtain and it is not clear that there does exist quality, high-frequency data on China which would not be regarded as dubious. For now, this study therefore has to make do with what is available. The quality of Chinese data should improve in the future and allow for comparative analysis, given that China subscribed to the IMF's Special Data Dissemination Standard at the end of 2015.

## 5.6 Empirical analysis

### 5.6.1 Factor analysis for overall period: 1979Q3-2011Q2

Inspecting the variance shares for this overall period shows low levels of comovement. Chinese variables, in particular, have very low variance shares and China can therefore be seen as decoupling from advanced economies during this overall period. For simplification, a summary table of variance shares for selected variables for China and the G7 are reported in Table 5.2 below. Full variance share results are available in Appendix B.1, where it can be seen that most variables with higher variance shares belong to advanced economies and are mostly trade-related (exchange rates and/or imports and exports).

**Table 5.2: Summary of variance share results for major advanced economies and China, 1979Q3-2011Q2**

| | China | Canada | France | Germany | Italy | Japan | UK | USA |
|---|---|---|---|---|---|---|---|---|
| **GDP** | 0.07 | 0.46 | 0.46 | 0.42 | 0.57 | 0.24 | 0.45 | 0.55 |
| **Exports** | 0.22 | 0.48 | 0.85 | 0.83 | 0.68 | 0.49 | 0.63 | 0.52 |
| **Imports** | 0.22 | 0.19 | 0.86 | 0.78 | 0.70 | 0.45 | 0.66 | 0.62 |
| **CPI inflation** | 0.08 | 0.25 | 0.28 | 0.39 | 0.18 | 0.11 | 0.09 | 0.35 |
| **Business cycle** | **0.09** | **0.53** | **0.57** | **0.49** | **0.78** | **0.42** | **0.54** | **0.59** |

The variance share results show that China's economic performance since the late 1970s has been dominated by the idiosyncratic component, with a variance share of only 9 per cent for the Chinese business cycle between 1979 and 2011. This makes sense, given the fact that China's economy operated under a system of "state capitalism" (*The Economist*, 2012) for much of the time under investigation, with the true increased participation in the global economy only happening in the 2000s, toward the latter part of this sample.

The G7 countries represented here, on the other hand, show much higher levels of sensitivity to global events. The business cycle of China's advanced neighbour, Japan, for instance, shows a variance share of forty-two per cent.

According to the Bai-Ng criteria, the number of factors to be specified for this period is four.[15] These factors correspond to:

- Global trade.
- European/US exchange rates.
- Advanced country business cycles.
- Advanced country inflation.

The trade and exchange rate factors show that, though China has certainly become a very important trading partner in this overall period, trade by advanced economies was most responsible for driving comovement between 1979 and 2011. Advanced country business cycles were also important in driving comovement, confirming again the dominance of these economies during the period under investigation. Advanced inflation could be an important factor, since increased inflation rates often prompt interest rate hikes. These interest rate changes in turn spur changes in exchange rates and asset prices that are important in driving comovement.

It is interesting to note that the results here echo the findings for comovement between EM and advanced economies, suggesting that China's dominance as an EM economy might be driving the group's comovement. Given the low variance shares for Chinese variables in this overall period, the implication would be that China would not be very much influenced by events such as the global credit crunch that the world experienced in 2008. As mentioned earlier, though, China's participation in the global economy only really reached its zenith in 2001, while many changes had occurred in each decade since the announcement of the Open Door Policy. The following sections therefore present a decade-by-decade look at comovement between China and advanced economies, again using factor analysis.

### 5.6.2 Factor analysis results: 1979Q3-1990Q4

China's eventual rise to the second-largest economy in the world began as a process of gradual liberalisation. One of the most significant steps in this process

15 The amount of factors to be specified for this period are, according to the Bai-Ng criteria, four. Four factors are estimated in all subsequent sub-periods so that changes in factors and variance cannot be attributed to a change in the number of factors specified.

started in 1978, when the country's Open Door Policy was instituted and gradual reforms started.

This first sub-period is therefore one in which it is expected that the common component will not be as important in explaining variance. Similarly, this period represents an era for advanced economies when policies might have been liberalised, but globalisation had not yet become the global force it currently is.

An analysis of the variance shares found for this sub-period confirms these expectations. Variance shares in general are low, with only a handful of advanced economy trade variables showing variance shares of 80 per cent or more. The full variance share results can be found in Appendix B.2. Here, a brief summary of results for China and the G7 economies is presented.

**Table 5.3: Summary of variance share results for major advanced economies and China, 1979Q3-1990Q4**

| | China | Canada | France | Germany | Italy | Japan | UK | USA |
|---|---|---|---|---|---|---|---|---|
| **GDP** | 0.49 | 0.57 | 0.51 | 0.29 | 0.53 | 0.17 | 0.54 | 0.53 |
| **Exports** | 0.08 | 0.44 | 0.78 | 0.72 | 0.45 | 0.43 | 0.45 | 0.30 |
| **Imports** | 0.15 | 0.43 | 0.83 | 0.78 | 0.44 | 0.34 | 0.45 | 0.50 |
| **CPI inflation** | 0.17 | 0.07 | 0.08 | 0.08 | 0.10 | 0.07 | 0.66 | 0.20 |
| **Business cycle** | **0.24** | **0.47** | **0.36** | **0.32** | **0.45** | **0.11** | **0.59** | **0.50** |

It can be seen from the summary presented above that China's business cycle comovement with advanced economies was low during this sub-period, as would be expected since the country had only just embarked on its Open Door Policy. Becker and Wang (2013:4003) and Chen *et al*. (2013:80) also find evidence that China's business cycle was mostly dominated by domestic economic policy up until the 2000s. The variance share on China's GDP is noticeably higher than that of other variables. Recall that the business cycle variable is de-trended GDP. The general trend of output in China, therefore, might have been attributable to a common component, but deviations from that trend were not.

For advanced countries as well, variance shares are generally low. Given the low levels of globalisation during this period, the results for advanced countries are not surprising. Four factors are specified again. These are:

- Advanced country trade.
- Advanced country inflation.
- US production.

- Chinese short-term interest rates.

The fact that advanced country trade and inflation respectively emerge again as an explanatory factor emphasises the important role that advanced countries played in trade and monetary events in the early 1980s. The US production factor points to the importance of the US as the dominant world economy during this time. This sub-period comes shortly after the global economy had undergone two large oil price shocks, and other economies might have been particularly sensitive to declines in US demand. The final factor, Chinese short-term and lending rates, explains less of the comovement than the first three factors do. It shows that Chinese monetary policy was important during this time.

The next sub-period looks at comovement between China and advanced economies between 1991Q1 and 2000Q4.

### 5.6.3 Factor analysis results: 1991Q1-2000Q4

It is during the 1990s that one would expect China's sensitivity to global events to increase, given increased globalisation and stronger reforms in China. This expectation is confirmed by the variance shares obtained. Chinese variables still show low levels of comovement, though variance shares have increased from the previous sub-period. For advanced economies, variance shares increase as well. It is still mostly exchange rates and imports/exports that show the highest variance shares, though other variables, such as business cycles and interest rates, begin showing higher variance shares, too (This can be seen in the full variance share results available in Appendix B.3).

Table 5.4 below presents a brief summary of these results for real variables for China and the G7 economies.

**Table 5.4: Summary of variance share results for major advanced economies and China, 1991Q1-2000Q4**

| | China | Canada | France | Germany | Italy | Japan | UK | USA |
|---|---|---|---|---|---|---|---|---|
| **GDP** | 0.21 | 0.53 | 0.50 | 0.21 | 0.37 | 0.25 | 0.64 | 0.20 |
| **Exports** | 0.20 | 0.30 | 0.85 | 0.84 | 0.78 | 0.44 | 0.62 | 0.22 |
| **Imports** | 0.24 | 0.26 | 0.83 | 0.71 | 0.81 | 0.62 | 0.61 | 0.69 |
| **CPI inflation** | 0.57 | 0.37 | 0.44 | 0.20 | 0.15 | 0.08 | 0.15 | 0.51 |
| **Business cycle** | **0.66** | **0.74** | **0.82** | **0.75** | **0.73** | **0.53** | **0.66** | **0.06** |

The four factors that are responsible for driving comovement in this sub-period are:

- Advanced economy trade.
- European business cycles.
- North American industrial production (referring to Canada and the US).
- US consumer inflation.

It is evident that advanced economies still dominate during this sub-period. The importance of trade as a transmission mechanism is highlighted again, along with the importance of having advanced economies as trading partners. The prominence of the US also is evident to see from the important role that US industrial production and inflation play during this time.

It can be seen from the variance shares that China's integration with the world economy had increased between 1991 and 2000. Variance shares for China are higher than they were in the previous sub-period, with the Chinese business cycle showing 66 per cent variance share, as opposed to 24 per cent in the previous period. China's increasingly open economy during the 1990s is also evident in the fact that the variance share for China's exports increases from 8 per cent in the previous sub-period to 20 per cent in this sub-period.

The results confirm the importance of intensive policy reforms for China during this time, and especially at the start of the 1990s (Wang, Gao & McNown, 2009:94). The Chinese government announced major reforms to commercial and central banking, trade, investment, exchange rates and corporate governance in 1993 (Tsang & Chen, 1994:769; Rawski, 1995). Labour market reforms in the 1990s also saw large layoffs of employees in the state sector (Yueh, 2004).

### 5.6.4 Factor analysis results: 2001Q1-2011Q2

China's gradual reform processes reached a zenith during this time, as the country became a member of the WTO in 2001. One would therefore expect to see much more comovement in Chinese variables during this sub-period.

This expectation is confirmed by the variance shares. Though the variance shares for China remain rather low in comparison with those for advanced economies, the country does show movement towards coupling to advanced economies during this period. See Table 5.5 below for a summary view (full variance share results are available in Appendix B.4).

**Table 5.5: Summary of variance share results for major advanced economies and China, 2001Q1-2011Q2**

| | China | Canada | France | Germany | Italy | Japan | UK | USA |
|---|---|---|---|---|---|---|---|---|
| **GDP** | 0.38 | 0.70 | 0.78 | 0.79 | 0.85 | 0.66 | 0.76 | 0.76 |
| **Exports** | 0.72 | 0.67 | 0.92 | 0.90 | 0.89 | 0.72 | 0.67 | 0.85 |
| **Imports** | 0.69 | 0.35 | 0.94 | 0.83 | 0.92 | 0.72 | 0.78 | 0.85 |
| **CPI inflation** | 0.47 | 0.58 | 0.32 | 0.73 | 0.65 | 0.51 | 0.54 | 0.79 |
| **Business cycle** | **0.59** | **0.85** | **0.94** | **0.87** | **0.94** | **0.90** | **0.92** | **0.87** |

For China, imports and exports especially show variance shares that are much higher than they have been in previous sub-periods. For example, between 1979Q3 and 1990Q4, the variance share for Chinese exports was only around 8 per cent, with imports showing a variance share of 15 per cent. This increased somewhat between 1991Q1 and 2000Q4, to 20 per cent for exports and 24 per cent for imports. In this final sub-period, the variance share for exports jumps to 72 per cent, and 69 per cent for imports. Clearly, trade became very important for China as its economy liberalised. The variance share of about 60 per cent for the Chinese business cycle is slightly lower than that of the previous sub-period, suggesting that idiosyncratic factors were more dominant for China during this time. This value is still much higher than the 24 per cent seen in the first sub-period, confirming that the Chinese business cycle has become more integrated with the global economy.

For advanced economies, it is clear that this period brought about very high levels of comovement. Imports, exports and exchange rates remain strong transmitters of comovement between these economies, while many also display high variance shares for business cycles (as seen in the full results reported in Appendix B). Evidently, no one could really escape the global economy in the decade after 2000.

The four factors driving comovement for this sub-period are:

- Global trade.
- Global business cycles.
- Advanced country exchange rates.
- Advanced country inflation.

While trade and business cycles had been important factors in other sub-periods, it is in this final sub-period that the factors reflect global influence, instead of only advanced countries. Given China's emergence as a trade and growth giant during this particular phase of economic history, this is not surprising. As with other sub-

periods investigated in this thesis, advanced country exchange rates point once again to the importance of these trading partnerships for the global economy. The inflation factor underlines the importance of monetary policy in comovement. Between 2001 and 2011, then, the Chinese economy experienced a coupling with advanced economies. This effect is much stronger than it had been for previous sub-periods, showing that the sensitivity to global economic events has increased.

### 5.6.5 A comparison of sub-periods

An analysis of the various sub-periods makes it clear to see that, since China embarked on its gradual reform path in the late 1970s, the economy has also been gradually coupling to advanced economies. By the end of the sample, between 2000 and 2011, China's trade and, to a lesser extent, business cycle are also helping to drive the comovement between advanced economies and China. For the overall period and the various sub-periods that are investigated, trade, business cycles and inflation are prominent factors in explaining comovement between China and advanced economies.

A further interesting trend that emerges when comparing the three sub-periods is the emergence of an apparent give-and-take relationship between China and the US. While the other G7 economies show consistently higher business cycle variance shares between 1979Q3 to 1990Q4, 1991Q1 to 2000Q4, and 2001Q1 to 2011Q2, the same does not apply to the US. Between the first (1979Q3-1990Q4) and second (1991Q1-2000Q4) sub-periods, China's business cycle variance share increases drastically, from 24 to 66 per cent. Conversely, the US experiences a drastic decrease in business cycle variance share, from 50 per cent to 6 per cent. In the third and final sub-period (2001Q1-2011Q2), the Chinese business cycle sees a small decline in variance share, while the US again experiences a drastic increase in variance share. The existence of this trend does not imply any causality, and should not be interpreted as such. It is likely that this pattern merely reflects the dominance of idiosyncratic factors in the US during the 1990s. This trend is noted for interest's sake, however, as it does raise the question of the influence that Chimerica has on global business cycles. 'Chimerica' is the term coined by Ferguson and Schularick (2007) to describe the growing interrelationship between China and the US since the 1990s. In this relationship, China supplied money to increasingly indebted Americans, who used that 'easy' money to consume many Chinese exports. This

relationship enabled higher consumption of cheap Chinese goods, which kept inflation low and allowed asset prices to increase (Ferguson & Schularick, 2011). However, this imbalance, according to many analysts, ultimately led to the credit crunch. An in-depth analysis of this situation falls outside the scope of this thesis. The question of Chimerica is noted as a question for future research, which will be further highlighted in the final chapter.

In conclusion, then, it is evident that China has not completely decoupled from advanced economies. As China's gradual reforms have opened the economy up to trade, the Chinese economy has inevitably become more integrated with advanced economies. This can be seen in the evolution of China's business cycle variance shares. In the first decade after embarking on its open door policy (1979Q3-1990Q4), China's business cycle variance share was only 24 per cent. In following decades, this increased to roughly 60 per cent. Specifically, the variance shares were 66 per cent between 1991Q1 and 2000Q4, and 59 per cent between 2001Q1 and 2011Q2. The fact that business cycle variance share did decline somewhat for China during this last sub-period might be evidence of slight decoupling during that time, though it could be that this difference is not statistically significant.

For the Chinese economy, this means that domestic policy has increasingly become less important in driving economic performance. Evidently, trade and global prices are very important factors that are driving the comovement between China and advanced economies. This is not surprising, given China's importance as a global trading partner. The picture that emerges from comparing the sub-periods above is one of a world that has increasingly become interrelated, especially in the years between 1990 and 2011. To illustrate the changing dynamics of this comovement more clearly, rolling regressions are presented in the following section.

### 5.6.6 Rolling regressions

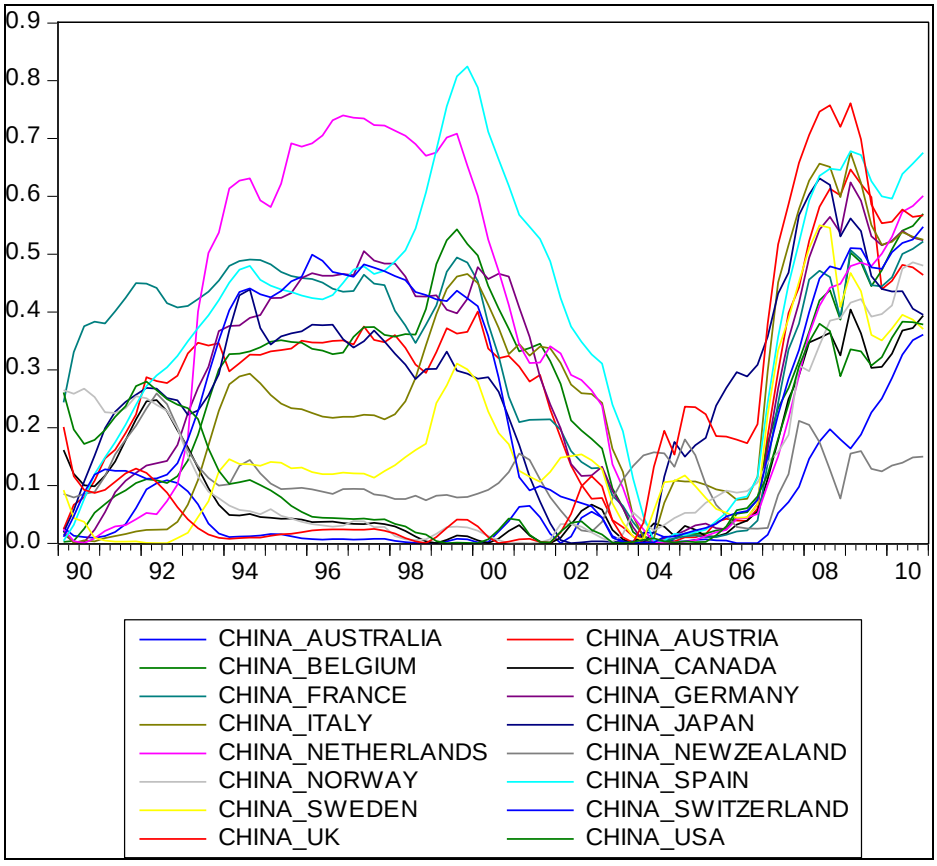
In addition to the conclusions drawn from the factor analyses, further estimations are done in order to gain a deeper insight into the relationship between China and various advanced economies over time. This is done by estimating a ten-year rolling regression, specified as:

$$Business\ Cycle_{China} = f\left(Business\ Cycle_{Advanced\ Economy}\right)$$

Business cycle data here are extracted from logged quarterly GDP for China and the 17 advanced economies in the sample, using the HP filter. Quarterly data are available from 1979Q3-2011Q2 and obtained from the Cambridge GVAR Toolbox.

The regression is rolled on a ten-year window in order to show how the amount of the Chinese business cycle that is explained by various advanced economy business cycles has changed over time. The results of this rolling regression are shown in Figure 5.8 below, where the variance share from each regression is plotted. T-statistics for these regressions are reported in Appendix B.6.

**Figure 5.8: Ten- year rolling regression variance share result: Advanced economy and Chinese business cycles, 1990-2010**

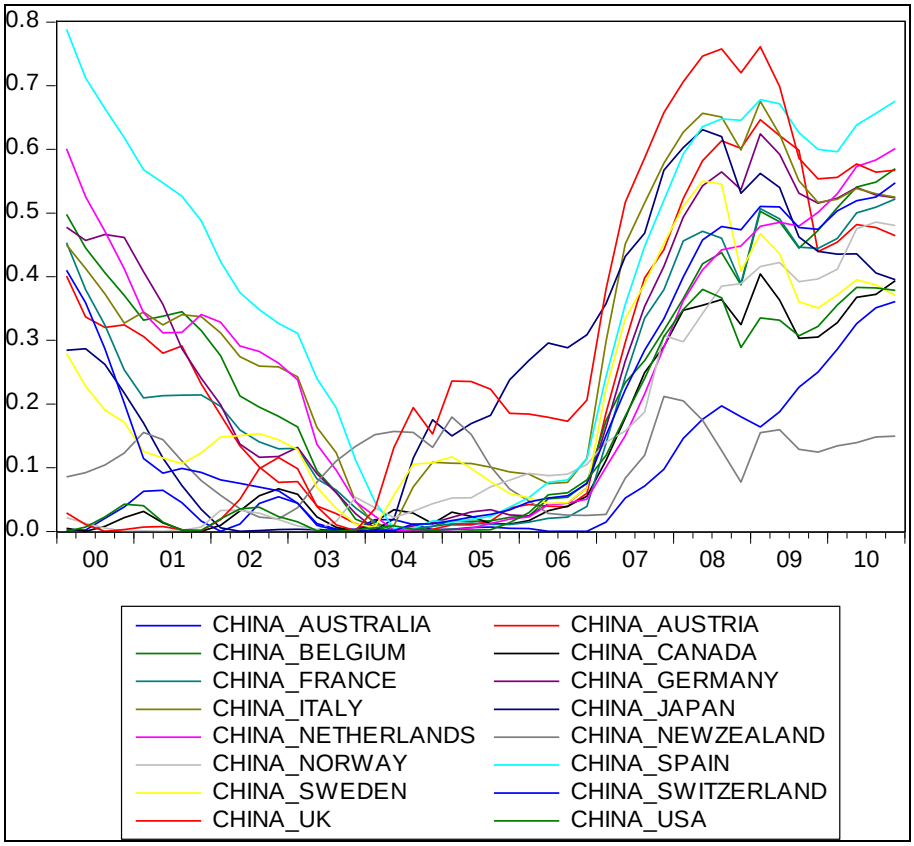



The graph above shows that, throughout the 1990s, the extent to which advanced country business cycles explained the Chinese cycle was quite heterogeneous. Comovement decreased after 2001 and increased quite drastically during the Great Recession. It is interesting to note the decrease in comovement around 2001, as this was the time during which China joined the WTO. It is likely that the trade boost that followed China's accession to the WTO allowed the country to diversify trade. As China traded more and more with other emerging countries, its reliance on advanced economies declined. Furthermore, Chinese reforms were not yet complete in 2001.

For instance, complete Chinese financial reform only took place some time after WTO accession, with only limited foreigners being allowed to buy Chinese A-shares since 2003. China's "Go Out" policy also only really took off in 2003 – prior to then, private Chinese companies could not invest overseas (Buckley *et al*., 2007). There were also important idiosyncratic factors at play in China during the early 2000s, such as the outbreak of SARS in 2002 and the outbreak of Avian flu in 2003 (WHO, 2014).

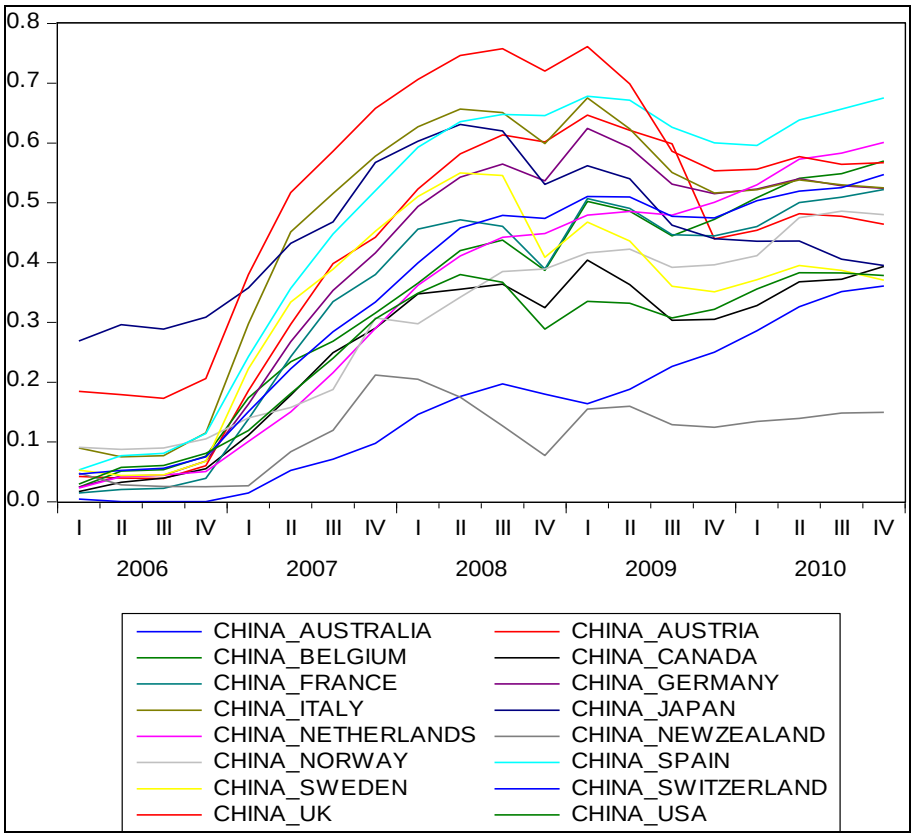
By 2006, however, the picture clearly changes and the variance share values climb to as high as 76 per cent, remaining high during the crisis years and immediately beyond. These trends can be seen more clearly when zooming into the picture between 2000 and 2011, the decade leading up to the credit crunch. In Figure 5.9 below, it is clear to see that China coupled quite strongly to the majority of advanced economies as a result of the crisis.

**Figure 5.9: Ten-year rolling regression variance share results: Advanced economy and Chinese business cycles, 2000-2010**



In order to focus specifically on the dynamics at play in the years immediately leading up to, during, and after the 2008 credit crunch, Figure 5.10 presents the results obtained from the rolling regression for the years 2006 to 2010.

**Figure 5.10: Ten-year rolling regression variance share results: Advanced economy and Chinese business cycles, 2006-2010**

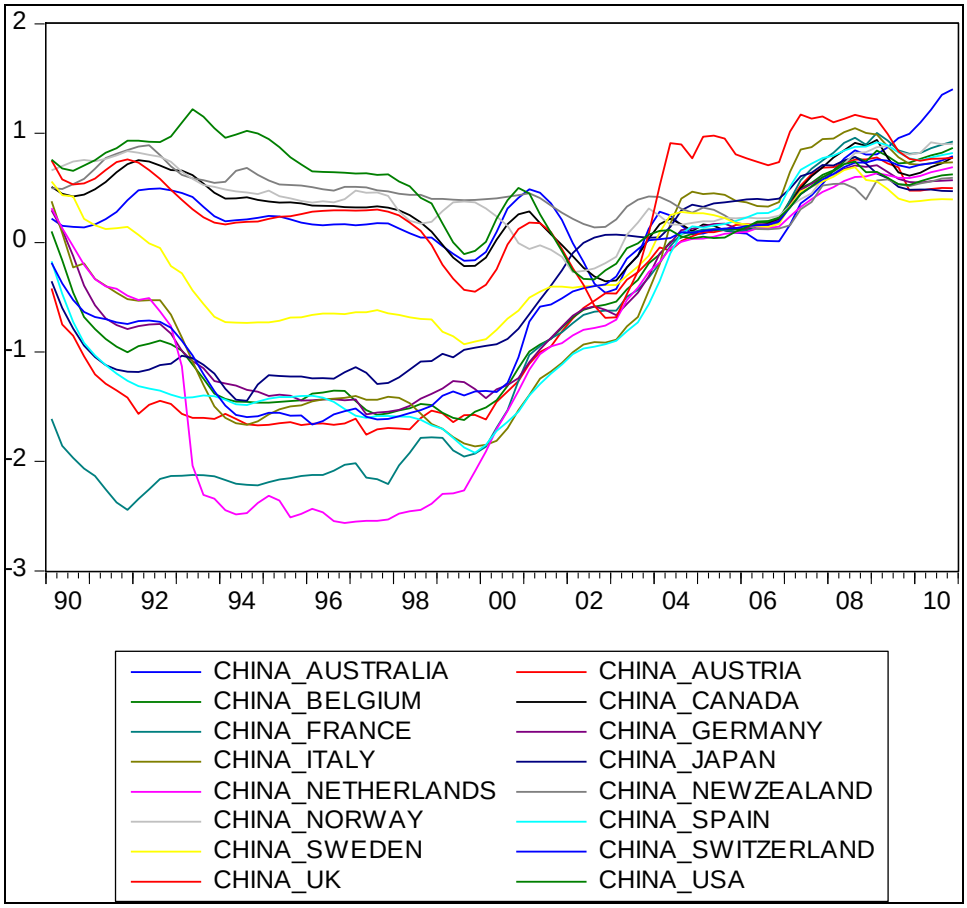



As the rolling regressions above confirm, advanced economy business cycles became more important in explaining China's business cycle in the years leading up to and during the credit crunch of 2008. Though the coupling experienced was arguably quite weak, with at most 76 per cent of the Chinese business cycle being explained by an advanced economy's cycle (the UK, in this instance), these values are much higher compared with the 20 and 30 per cent values during the mid-2000s, and show that the Chinese economy did not decouple from advanced economies during the credit crunch.

It is also interesting, however, to ask not just which percentage of the variance in China's business cycle can be attributed to changes in advanced countries' business cycles, but also how sensitive China's business cycle has become to these changes.

We can obtain a simple picture of this sensitivity by looking at the coefficients obtained from the rolling regressions. These represent the magnitude of the impacts that a one per cent change in advanced business cycles will have on China's business cycles and are illustrated in Figure 5.11 below.

**Figure 5.11: Coefficients of the ten-year rolling regression of advanced economy and Chinese business cycles, 1990-2010**




Initially, some negative values during the 1990s suggest that changes in advanced economies would hit China with considerable lag. As globalisation speeds up, the picture starts to change, however, and the impact of changes in advanced economies on the Chinese business cycle increases.

For instance, in 1990Q4, a one per cent increase in the UK's business cycle would have translated into a 0.6 per cent increase in the Chinese business cycle, while by 2008Q4 that number had increased to 1.15 per cent. Interestingly, it seems that the impact of the US has remained pretty constant throughout, echoing findings presented in the literature review that the US was a dominant trading partner for China. A one per cent increase in the US business cycle correlated to a 0.7 per cent increase for China in 1990Q4 and 0.64 per cent in 2008Q4.

In contrast to the steady impact of the US economy on China throughout the years in this sample, the impact of China's advanced regional neighbour, Japan, has shifted over time: whereas an increase in the Japanese business cycle had a negative 0.94 per cent impact on China in 1990Q4, by 2008Q4 that number was positive 0.72 per cent. These impact coefficients do show some levelling off after 2009, though the impact of advanced economies on the Chinese business cycles still remains much higher than it was during the 1990s.

Taken together, the graphs presented in Figures 5.10 and 5.11 show that business cycles in advanced economies have become important determinants of China's business cycle, and also that the impact of changes in these economies has become larger. Idiosyncratic factors may have dominated Chinese business cycles in earlier years, but as China has globalised, the events in advanced economies have had an increasing impact on the Chinese economy.

This fact represents significant challenges for China in the coming years, since China faces not only domestic challenges, such as an aging population and regional inequalities, but continued economic troubles in major advanced economies as well – in both the US and the Eurozone.

## 5.7 Conclusion

This chapter narrowed the attention to real comovement between China, as a prominent EM, and advanced economies. A graphical view of key macroeconomic indicators, such as Chinese GDP growth and exports, showed that the Chinese economy had experienced strong growth in the decade leading up to the Great Recession. DFA and rolling regressions were employed to investigate the comovement between China and a set of seventeen advanced economies between 1979Q3 and 2011Q2.

The results paint a picture of gradual integration between China and advanced economies. While factor analysis results for the overall period of 1979Q3 to 2011Q2 show evidence of decoupling, that is to be expected, given the fact that much of this period is dominated by gradual Chinese reforms. A decade-by-decade view, on the other hand, clearly shows that the Chinese economy has experienced increasing levels of comovement as reforms have proceeded along. It is evident from the high variance shares continuously seen in trade variables, such as imports and exports,

that international trade has been a very important mechanism for establishing this comovement. It was, therefore, interesting to note, with the rolling regressions, that the period immediately after 2001 displayed low levels of comovement. Since this is the period immediately after China's accession to the WTO, it might be indicative of an initial diversifying away from advanced economies as trade partners. This suggests that diversified trading partners could be important in shielding EM economies against the vagaries of global markets. Also of note is the fact that advanced country inflation emerged as a driver of comovement during the process of analysis. This underlines the international importance of monetary policy in these economies.

Rolling regressions, which looked at how important individual advanced economy business cycles were in explaining the Chinese business cycle, confirm the trend that was established in the factor analysis: As reforms in China have picked up speed, so too has comovement between China and advanced economies. The Great Recession years, especially, brought with them more intensified business cycle comovement. This refutes the decoupling hypothesis for China, which would have shown lower levels of comovement had there been decoupling. Instead, it is clear that, as the Chinese economy has participated ever more in globalisation, its business cycle has become more susceptible to impacts from downturns in advanced economy business cycles. The findings in this chapter are in line with other empirical studies which have found that comovement between economies fluctuates, with a tendency toward higher levels of comovement during recessionary episodes. The importance of trade in fostering comovement, furthermore, is support for the imported business cycle theory.

# CHAPTER 6: DECOUPLING BETWEEN AFRICA AND ADVANCED ECONOMIES

## 6.1. Introduction

In 1999, Collier and Gunning published an article entitled "Why has Africa grown slowly?" The authors' research highlights the weak growth performance experienced by the majority of African countries up until that point. Post-independence growth for much of Africa had indeed been unsatisfying until then, even though much of Sub-Saharan Africa (SSA) started out the 1950s and 1960s displaying impressive economic potential (Calamitsis, Basu & Ghura, 1999). Between 1961 and 1969, annual GDP growth on the continent averaged 4.6 per cent. Between 1970 and 1979, African growth averaged 4.8 per cent (World Bank, 2014). Average annual growth rates declined to 2.9 per cent between 1980 and 1989 and 2.5 per cent between 1990 and 1999 (World Bank, 2014). Growth gains that had been hard won during the 1970s were reversed in subsequent years, as 32 economies in SSA were poorer in 1999 than they were in 1980. Collier and Gunning (1999:4) make the statement that "It is clear that Africa has suffered a chronic failure of economic growth."

This evaluation of African growth up until the 1990s is supported by other research such as that of Easterly and Levine (1997), Sachs and Warner (1997), Bertocchi and Canova (2002) and Artadi and Sala-i-Martin (2003). The studies all stress the dismal growth performance of Africa up until the 1990s and focus variously on issues such as colonial heritage, ethnic diversity, fiscal policy and geography as explanations for this growth performance.

More than a decade after many of these studies were published, however, the new narrative surrounding Africa[16] is that of a booming continent. In recent years, popular publications such as *Time* magazine (2012) have devoted front pages to the rise of Africa, illustrating the prominence that the continent's economic revival is enjoying. African growth in the years especially between 2000 and 2007 was a significant departure from the poor growth experienced in the 1980s and 1990s. Between 2000

[16] Note that, in the discussions to follow, Africa is discussed broadly in order to provide general background. However, the empirical analysis focuses on Sub-Saharan Africa.

and 2007, annual economic growth in Africa averaged 4.7 per cent (World Bank, 2014).

The shift in growth momentum that revived a new interest in Africa came from decisive action of African leaders on the policy front. Macroeconomic stability was pursued and many African economies that had been rather isolated in previous decades opened up and traded more. FDI inflows and higher tourist arrivals followed. These adjustment policies were often carried out with the support of the IMF and World Bank and particularly took effect from the mid-1990s onward (Calamitsis *et al*., 1999).

Especially since the 1990s, then, a previously very closed off Africa become much more integrated with the global economy (Sahn & Younger, 2004). For this reason, the Great Recession caused much concern for African growth and development (Fallon & Lucas, 2002; Rama, 2003). Progress had been made by many African countries up until that point and it was feared that improvements in poverty reduction and human development could be halted or reversed by the crisis (Friedman & Schady, 2009). Concerns revolved especially around the impact that the crisis would have on African export revenues and capital inflows, as well as the possibility that developmental progress would be set back if households were to adopt adverse coping mechanisms (Naudé, 2009).

Africa, however, seemed to be very resilient during the crisis years. IMF director Dominique Strauss-Kahn issued a statement in early 2010 saying that African economies had shown faster than expected recovery from the global economic slump (IMF, 2010). Average annual GDP growth on the continent declined to 5 per cent in 2008, down from 5.9 per cent in 2007. Growth then slumped further to 2.9 per cent in 2009, after which it recovered to 4.7 per cent in 2010 (World Bank, 2014).

Because of the need to better understand Africa's macroeconomic performance during the Great Recession, this chapter will analyse business cycle comovement between African and advanced economies between 1980 and 2011. The period is selected since the reform and globalisation of African economies started gathering momentum in the mid-1990s, whereafter growth took off in the early 2000s. Since data availability is a concern, it will not be possible to do a decade-by-decade empirical analysis. The period furthermore encompasses the years before, during,

and immediately after the global financial crisis of 2008 and therefore provides an overall view of African comovement during the past three decades. DFA is employed to investigate business cycle comovement.

Results from DFA carried out in this chapter confirm that the level of business cycle comovement between African and advanced economies was low in the period under investigation. Results do, however, differ between different income groups. Middle-income African economies display higher levels of comovement than low-income and fragile economies.

These results are unpacked in the rest of this chapter. First, a literature review of comovement between African and advanced economies is presented in Section 6.2. This is followed in Section 6.3 by an overview of Africa's growth history from the mid-1990s up to and immediately after the Great Recession. Section 6.4 presents the empirical analysis and results for this chapter. Section 6.5 concludes.

## 6.2. Literature review: Comovement between Africa and advanced economies

The existing analysis of African comovement tends to take a regional focus, or to focus specifically on the comovement between one specific African country and an advanced partner (see, for example, Kabundi and Loots, 2007).

The aim of the analysis in this chapter, however, is to investigate African comovement more broadly. The literature in the following paragraphs therefore discusses previous studies conducted on the issue of African comovement with advanced and BRIC economies, covering the period 2000 to 2014, in order to provide broad background to the issue. Studies cited range from investigating Africa as a whole, to SSA and the Eastern African Community (EAC) specifically.

Ndulu and O'Connell (2007) used pooled conditional regressions to analyse the sensitivity of African growth rates to exogenous shocks between 1960 and 1997. The authors conclude that trading partner growth is a significant determinant of African growth, with African economies expanding by 0.4 per cent in reaction to a 1 per cent increase in trading partner growth.

Drummond and Ramírez (2009) study 40 SSA economies between 1980 and 2008 using dynamic panel growth regressions and find further evidence that global growth slowdowns will indeed cause growth slowdowns in SSA. Results show that a one

percentage point slowdown in the rest of the world leads, on average, to a 0.4 percentage point slowdown in SSA growth. Income effects from changes in non-fuel commodity prices and oil prices are also found to have a significant impact on growth in SSA.

Gurara and Ncube (2013) estimate a GVAR model for 46 African economies and 30 foreign economies between 1980Q1 and 2011Q2. General impulse response functions indicate that Africa is still very sensitive to European economic conditions, with a one per cent decline in Eurozone growth decreasing African growth by as much as 0.6 percentage points. The BRIC economies also have significant impacts on African economies, though the magnitude of these are found to be only about half of the equivalent decline in European countries.

Diallo and Tapsoba (2014) show that SSA does display high levels of comovement with the rest of the world. The authors investigate comovement by using instrumental variables for 44 SSA economies between 1970 and 2010 using panel methods. Results show that the patterns of comovement have shifted somewhat, as SSA is now less sensitive to G7 developments but co-moves more and more with BRIC partners. The increased trade between SSA and BRIC countries has contributed especially to this shift.

A further study by Ncube, Brixiova and Meng (2014) takes a more regional approach to the issue of comovement. Annual GDP data spanning 1980 to 2011 is used to construct an SVAR (Structural Vector Autoregressive) model for countries in SSA and 34 advanced economies. Results show that idiosyncratic factors are most responsible for driving output fluctuations in SSA economies. Regional factors are much more significant in explaining output in the EAC than they are in the Southern African Customs Union (SACU), whose domestic growth rates are much more likely to be influenced by global shocks. South Africa's globalised financial system especially played a role in transmitting the shocks from the global financial crisis to SACU member countries.

Bangwayo-Skeete (2012) employs a Generalised Method of Moments approach covering the period between 1961 and 2005 to determine whether common global factors are important in explaining Africa's economic growth. The author finds that global factors are significant, with the global business cycle having a positive

influence on African economic growth. This shows that African economies are still dependent on developments in advanced economies. Table 6.1 below provides a summary of the studies discussed here.

**Table 6.1: Literature on comovement between Africa and advanced economies**

| Authors | Period covered | Method used | Main conclusion |
|---|---|---|---|
| Bangwayo-Skeete (2012) | 1961-2005 | GMM | The global business cycle significantly influences Africa's economic growth. |
| Diallo and Tapsoba (2014) | 1970-2010 | Instrumental variables | SSA displays less sensitivity to G7 shocks but is co-moving more with BRIC countries. |
| Drummond and Ramírez (2009) | 1980-2008 | Dynamic panel growth regressions | A 1.0 percentage point decline in world growth slows SSA growth by 0.4 percentage points on average. |
| Gurara and Ncube (2013) | 1980-2011 | GVAR | African growth is still very responsive to European slowdowns, with 1.0 per cent lower European growth leading to 0.6 per cent lower growth for Africa. |
| Ncube, Brixiova and Meng (2014) | 1980-2011 | SVAR | Idiosyncratic factors, not common components, explain output fluctuations in African economies. |
| Ndulu and O'Connell (2007) | 1960-2007 | Pooled conditional regression | Trading partner growth is a significant determinant of African growth |

As seen above, the literature on comovement between Africa and the rest of the world, especially advanced economies, is sparse. In general, though, the picture that emerges from the available literature is one of an Africa that is still very susceptible to changes in trading partners' economic conditions. Europe especially has traditionally been an important trading partner for much of SSA and the literature shows that this has remained largely true, with changes in European growth having important spillover effects on SSA growth. This is not to say that trading partners have remained the same throughout, though. What also emerges from the literature is a picture very much in accordance with those painted in previous chapters – one where there has been a shift in global trading relations. While advanced countries in the Eurozone especially still have an important impact on growth in African economies, the literature suggests that the US and other G7 trading partners have become less dominant players as African trade shifts increasingly toward other developing and emerging partners.

Though a few studies do include samples which cover the Great Recession years, these have been for more narrow sets of countries, not necessarily focusing on Africa as a whole. Ncube *et al*. (2014), for instance, focus only on the Southern African Customs Union (SACU) and Eastern African Community (EAC) countries. None of these studies have used factor analysis or looked at SSA countries on the basis of income group rather than region. The focus of VAR models used in many of these studies is on estimating the size of spillover effects. Analysis does therefore not necessarily aim to determine what exactly the factors are that drive comovement. The use of factor analysis and income groups for a period spanning the Great Recession is the contribution made in this thesis' empirical analysis.

Before moving on to the empirical analysis, however, closer inspection is made of African growth performance in the years leading up to, during, and immediately after the Great Recession. The following section provides a short macroeconomic overview which highlights important trends in African economies in recent decades.

## 6.3. African growth performance before, during and immediately after the crisis

This section focuses specifically on African growth performance in the years leading up to the crisis in order to provide background to the possible impacts of the crisis. Macroeconomic trends that emerge during the crisis and immediately after are also discussed in order to determine whether, at face value, African economies seem to have decoupled during the crisis or not. The discussion is kept broad and therefore focuses on Africa as a whole. The focus will be narrowed to SSA economies during the empirical analysis.

The Collier and Gunning (1999) article referred to in the introduction ended on an optimistic note regarding the future of African growth. By 1999, it was clear that, although SSA had failed at achieving lift-off for sustained growth since the 1990s, things were gradually starting to change. Policy reform had gained momentum in many African states, whose economic policies up until then had been the despair of institutions such as the World Bank (Sachs, Warner, Åslund & Fischer, 1995).

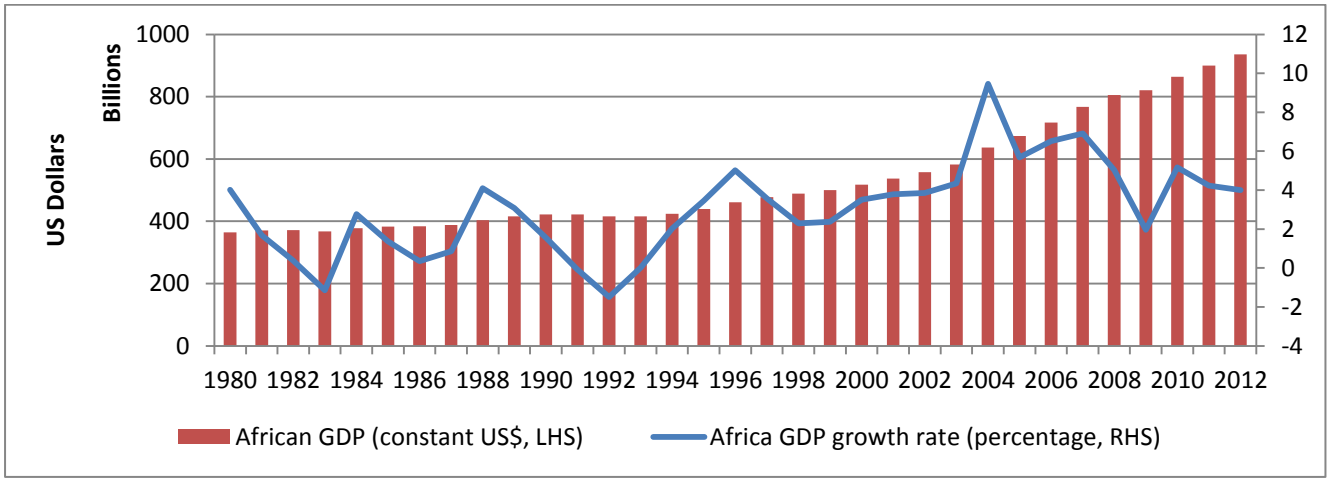
Reforms focused on macroeconomic stability and the liberalisation of markets. Privatisation was also a key issue on the reform agenda for many African economies. A further boon to economic growth was the increased political stability

on the continent, as governments started negotiating, war and civil unrest began to decline, and more democratic elections were held (Sahn, Dorosh & Younger, 1999).

Carmody (2011) confirms that improved governance and lower incidence of civil war have been important in fuelling African growth since 2000. The author furthermore highlights the encouraging global economic environment within which Africa found itself during this time. Within this global environment lie initiatives, such as debt relief for many highly indebted African countries, the boom in commodity prices caused especially by China's rise in the global economy, and a concomitant need on the part of the US in particular to diversify its reliance on oil. Because African markets had been liberalised, the benefits of this global environment and globalisation in general could be enjoyed. These include access to technology which has opened up new markets for Africa, and the opportunity to attract foreign investment.

All of these encouraging factors added up to strong economic growth on the continent. The growth rates experienced by Africa between 1980 and 2012 are shown in Figure 6.1 below.

**Figure 6.1: African GDP trends, 1980-2012**



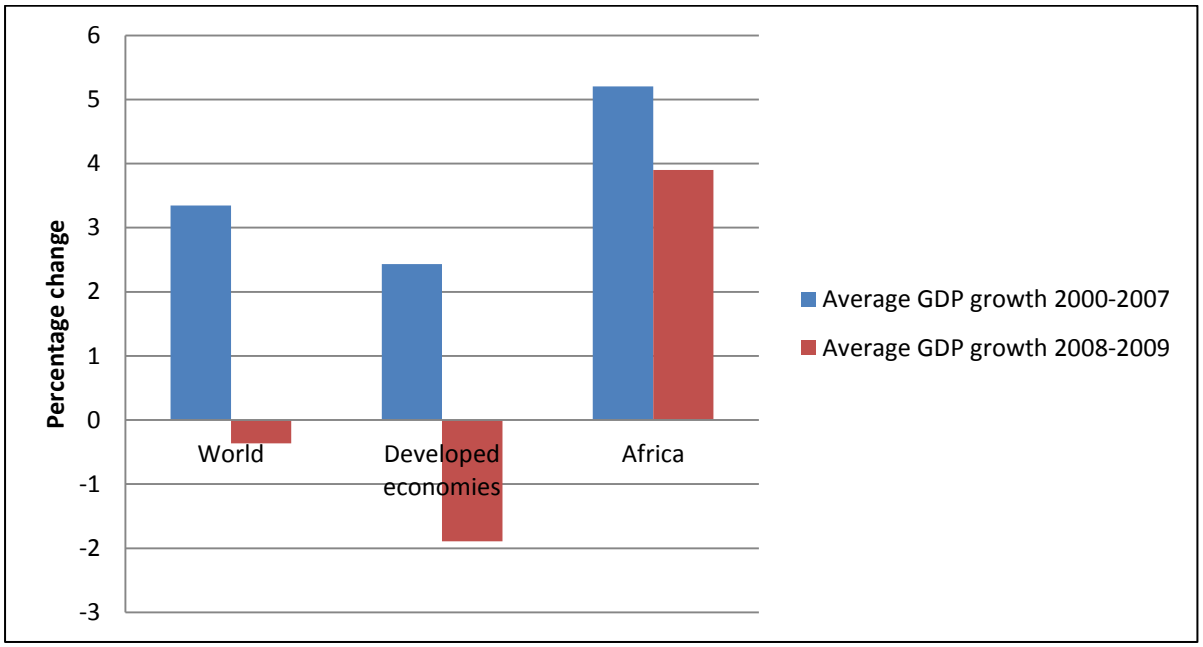

**Source: World Development Indicators**[17]

African GDP growth has evidently been rather erratic, with many up and downturns to be seen in an inspection of Figure 6.1 above. Africa's poor growth performance during the 1990s, which was elaborated on in the introduction to this chapter, can

17 Note that all graphs referring to 'Africa' here are based on figures for the continent as a whole that are available from the World Development Indicators and UNCTAD databases. Graphs therefore do not necessarily reflect the countries that are studied in the empirical analysis. The aim is to provide a general picture of economic trends on the continent.

also be clearly seen. By 1992, growth on the African continent had dipped to far below its 1980 level, only recovering around 1996. Growth then plummeted once more, though not as drastically as during the early nineties, and remained close to about 3 per cent until the early 2000s. Only then does it become evident that the reforms implemented during the 1990s had started paying dividends, with the favourable global environment discussed by Carmody (2011), plus African policy reforms, helping to put growth on a much stronger path. African growth shoots up in 2003, with the continent's GDP standing at almost US$800 billion right before the credit crunch in 2007. African growth clearly was influenced by the credit crunch, as the growth rate declines in 2008 and 2009, when it reached a low point of just about 2 per cent. This is compared with average annual growth of almost 7 per cent in 2007. After 2009, growth did recover, though not to pre-crisis levels. The growth contraction experienced by African economies is shown more clearly in Figure 6.2 below, which depicts the average growth rates that African and developed economies experienced during the worst of the crisis years, namely 2008 and 2009.

**Figure 6.2: African growth versus advanced growth: Before and during the credit crunch**



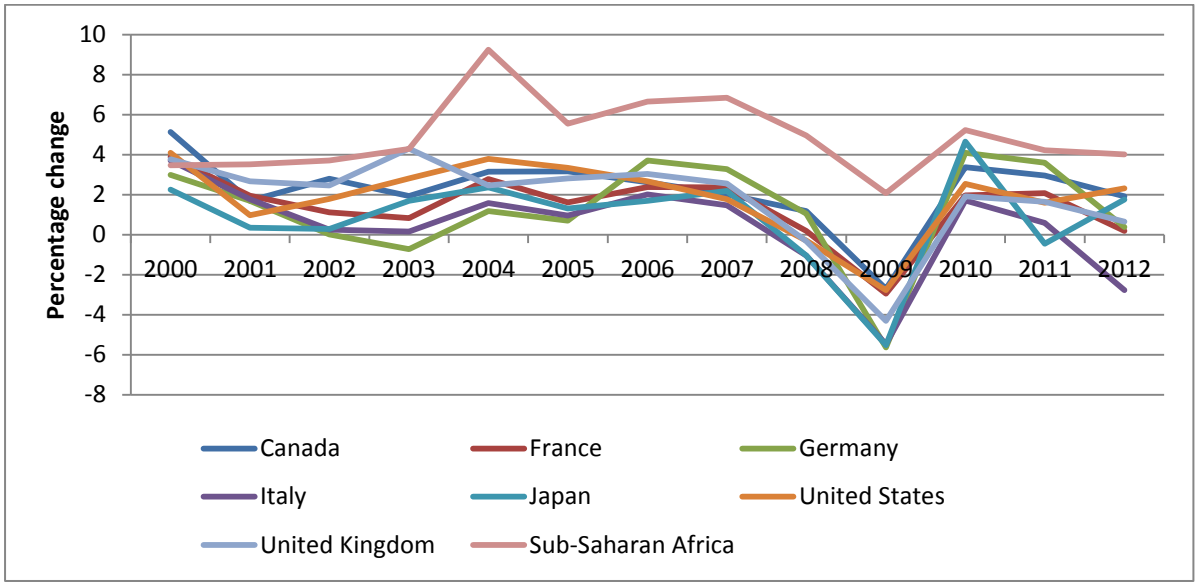

**Source: World Development Indicators**[18]

Compared with global growth, and growth in advanced economies especially, African growth during the Great Recession was lower than before, but still performing well.

18 Note that groups such as "World", "Africa" and "Developed countries" here and in further discussions are group figures as presented in the World Development Indicators.

Advanced countries as a group experienced contractions in their economies in these years, with average GDP growth of negative 2 between 2008 and 2009. During the same time, Africa as a whole still managed to grow by an average of almost four per cent. In order to focus-in even more on the growth trends that dominated during the crisis years, Figure 6.3 compares average SSA growth to economic growth experienced in the G7 economies.

**Figure 6.3: African growth compared with G7 growth, 2000-2012**




**Source: World Development Indicators**

Figure 6.2 shows that African economies had not experienced such strong declines in growth during the Great Recession as developed economies had. However, Figure 6.3 makes it clear that growth in SSA was following a similar pattern to that of the G7 economies. Growth in SSA may have been at a higher level, but it did decrease when growth in the G7 decreased.

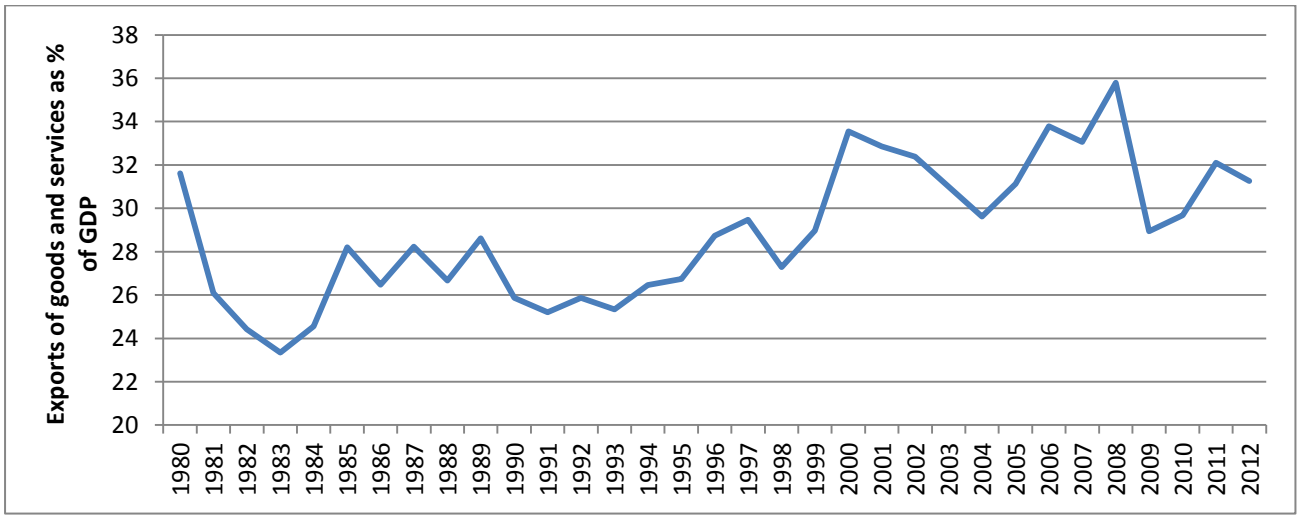
Looking at just the growth performance during this time does not leave one with clear conclusions about possible decoupling. While the much higher growth experienced by Africa during this time could suggest decoupling, it is worth remembering that African growth had been at a higher level for much of the 2000s. Looking at the trend in growth as compared with that of the G7, it is evident that SSA specifically did follow the same growth pattern – suggesting that coupling might have occurred.

It is therefore first important to gain a deeper understanding of macroeconomic vulnerabilities that dominated in Africa at the time of the credit crunch, and the policy decisions made during those crisis years.

In general, developing countries did seem greatly affected by the 2008 crisis. Though financial markets in these countries were not as exposed to the odious sub-prime investments behind the financial crisis, stock markets in developing countries did nevertheless show significant losses as investments were withdrawn (Griffith-Jones & Ocampo, 2009). As banks reduced their lending, investment was reduced, resulting in lower growth and higher unemployment. Furthermore, the lower growth rates experienced meant less revenue for governments, making policy action against poverty difficult to implement (Griffith-Jones & Ocampo, 2009; Frenkel & Rapetti, 2009).

For Africa specifically, scholars such as Naudé (2010) aimed to identify Africa's vulnerability to the crisis as it unfolded. One important aspect highlighted by Naudé (2010) was that much of Africa's growth performance had been driven by exports, which were likely to decline as major trading partners sunk into recession. Figure 6.4 below shows that exports had indeed become an important contributor to African GDP in the decades leading up to the start of the crisis in 2007.

**Figure 6.4: African exports as percentage of GDP**




**Source: World Development Indicators**

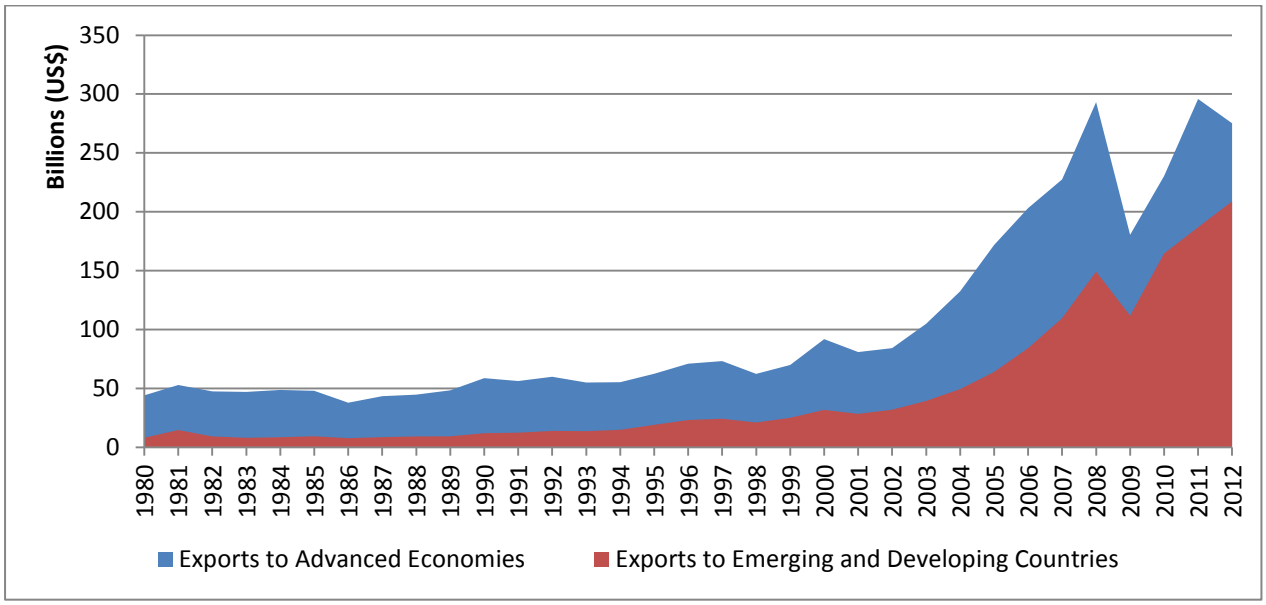
As can be seen in the figure above, exports of goods and services contributed just under a quarter of African GDP throughout the early 1980s. This represents the lowest level of contribution to GDP. Since 2000, the export contribution increased to

above 30 per cent of GDP. By 2007, just before the credit crunch in 2008, that figure had risen to 33 per cent of GDP. The fact that just over a third of Africa's GDP at that time was derived from exports could potentially have left many African economies particularly vulnerable to declines in demand from trading partners as the credit crunch hit. The contribution of exports to GDP did decline marginally during the Great Recession years, with exports accounting for about 31 per cent of GDP by 2012.

The literature review presented earlier also confirms Africa's susceptibility to changes in European demand especially. What also emerged from the literature review, however, is the changing composition of African exports. Carmody (2011) argues that the emerging dominance of Asia as a trade and investment partner in Africa has created an interesting new global triangle in which Africa supplies the resources, which are manufactured by China, and demanded by the US. In fact, as Ndulu (2007) argues, African growth rates have converged with those in Asia. Though the increasing relations between Africa and Asia could provide room for potential decoupling between Africa and advanced economies, it is noteworthy that the trade triangle postulated by Carmody still has the US as the dominant source of demand, implying that it would be difficult for Africa to completely escape the harmful effects of a downturn in the US economy (Kinfack & Bonga-Bonga, 2015).

Figure 6.5 below shows that, though exports to advanced economies dominate, African exports have diversified since the 1980s, with more exports going to EM and other developing economies. It is clear, however, that Africa's exports to advanced economies were much more influenced by the credit crunch. Exports to advanced economies plummet in 2008, dropping from around $300 billion to almost half, at $150 billion. Though African exports to other EM and developing countries also decline in 2008, it is not as drastic as the trend in exports to advanced trading partners.

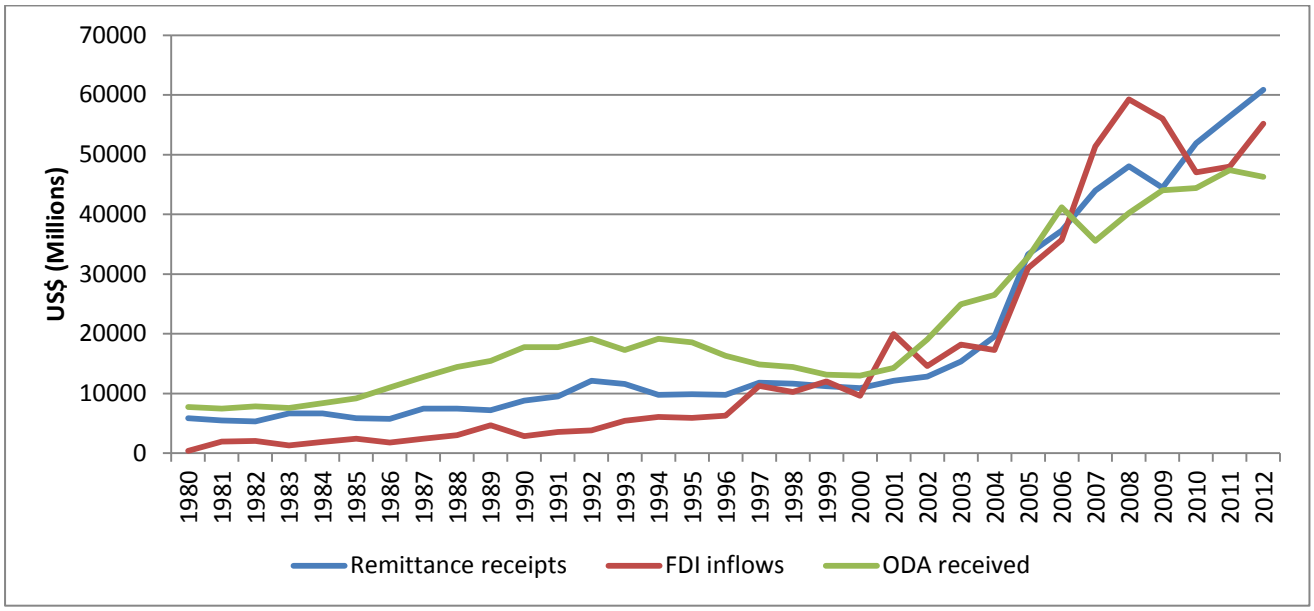
**Figure 6.5: African exports to advanced and emerging economies, 1980-2012**




**Source: IMF Direction of Trade Statistics (DOTS)**

Another potential vulnerability lies in Africa's historical dependence on capital inflows. For decades, the continent has struggled to bridge the gap between the level of investment that could be provided by the state and private sector, and the level of investment needed to fuel growth. This gap has traditionally been filled by capital inflows, such as FDI and aid, with FDI tending to be allocated to oil-exporting African economies (Loots, 2005; Asiedu, 2006; Loots & Kabundi, 2012). At the onset of the crisis, analysts feared that these capital inflows would decline as donor countries experienced shrinking demand due to the recession. Commentators focused on the likely inability of the G7 in particular to honour the promises made at Gleneagles in 2005, when the G8 and other donors pledged that official development assistance (ODA) to Africa would increase to $55 billion by 2010. This figure represented a doubling of the ODA commitments that had been made to Africa in 2004 (Allen & Giovannetti, 2011). Figure 6.6 below shows trends in important capital inflows to Africa, namely FDI, ODA and remittance inflows.

**Figure 6.6: African capital inflows, 1980-2012**




**Source: UNCTAD FDI Statistics**

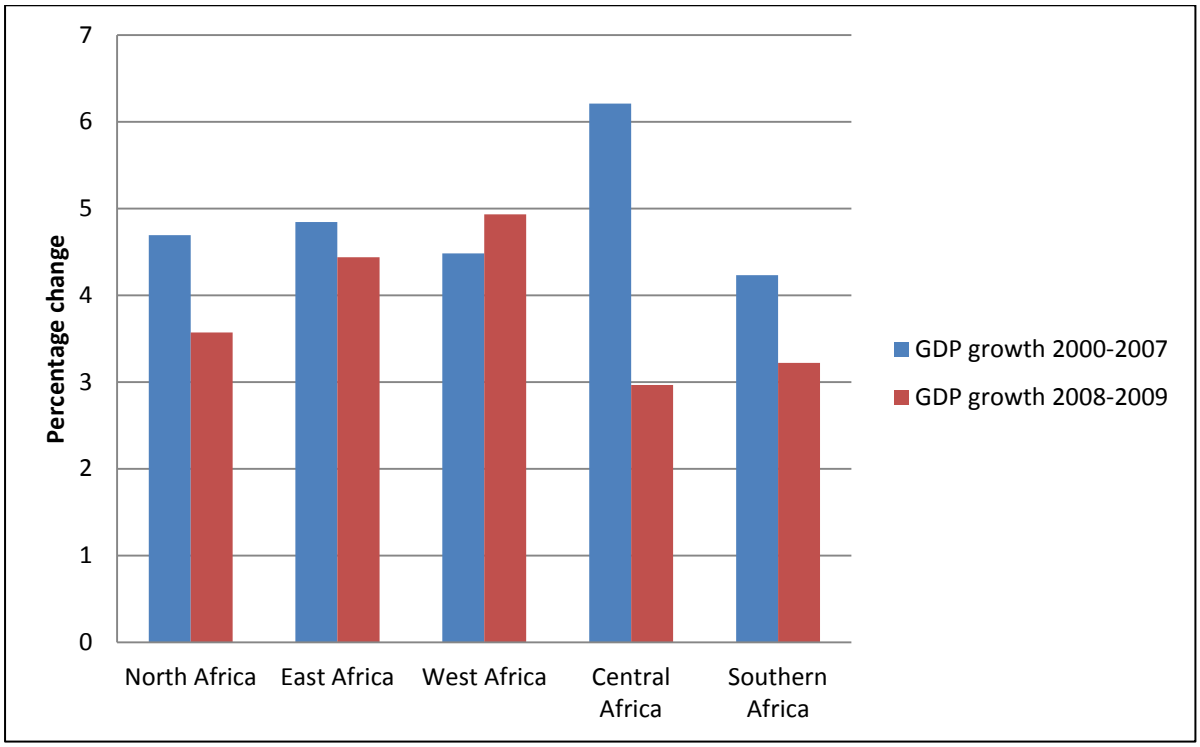
African FDI inflows show a steadily increasing trend after the 1980s, when FDI inflows comprised just 0.09 per cent of African GDP (UNCTAD, 2014). FDI inflows to Africa clearly took off in the early 2000s. By 2007, FDI inflows stood at an all-time high of US$50 billion. Remittance inflows had been above FDI receipts during the 1980s and 1990s, and also show a drastic increase since 2000. The figure above also shows that ODA inflows have historically been important for Africa, with ODA being higher than both FDI and remittance inflows throughout the 1980s and 1990s. With regard to the Great Recession years, it is noticeable that FDI inflows especially continued rather strongly throughout. In fact, FDI inflows to Africa in 2008 were at the highest point ever. After that, FDI inflows did decline in 2009 and 2010, indicating that there was a lag in the effects of the crisis on FDI. By 2012, FDI inflows show an upward trend again. Remittance inflows from the African migrant diaspora also remained strong during the crisis years. This generally tends to be the case for remittance flows, which are considered to be less volatile than other forms of capital inflow (Ratha, 2005). ODA receipts reflect the earlier impact of the credit crunch in advanced economies, already declining in 2007. However, after this point, ODA receipts increased again in the years up to 2012.

The graphs presented in Figures 6.5 and 6.6 above thus show that Africa was not entirely impervious to the effects of the credit crunch. Exports to advanced partners especially show a drastic decline at the time of the crisis. With regard to capital

inflows, it seems that the crisis hit Africa after a slight lag – inflows had continued strongly during 2008, but experienced a setback in 2009. These declines in exports and capital inflows would have contributed to the lower economic growth experienced during the Great Recession (Kasekende, Brixova & Ndikumana, 2010).

Africa did not display only vulnerabilities as the crisis struck, however. As Naudé (2009) emphasises, many African countries were in a very strong fiscal position when the crisis struck. Thanks to decades of prior reform and improvement in governance, it was within the reach of many African governments to take strong countercyclical action when the crisis broke in 2008. When discussing policy action undertaken by African governments, and the impact of the crisis, it is good to bear in mind that African countries are very heterogeneous and that impacts of the crisis might have differed between regions and individual countries. Figure 6.7 below illustrates the regional[19] growth performance in Africa during this time.

**Figure 6.7: African GDP growth by region, 2000-2009**




**Source: African Development Indicators**

It can be seen in the figure above that Central Africa, from its high annual average growth of six per cent up until 2007, experienced a strong decline in growth, with GDP growth averaging about three per cent for the two crisis years. Other regions

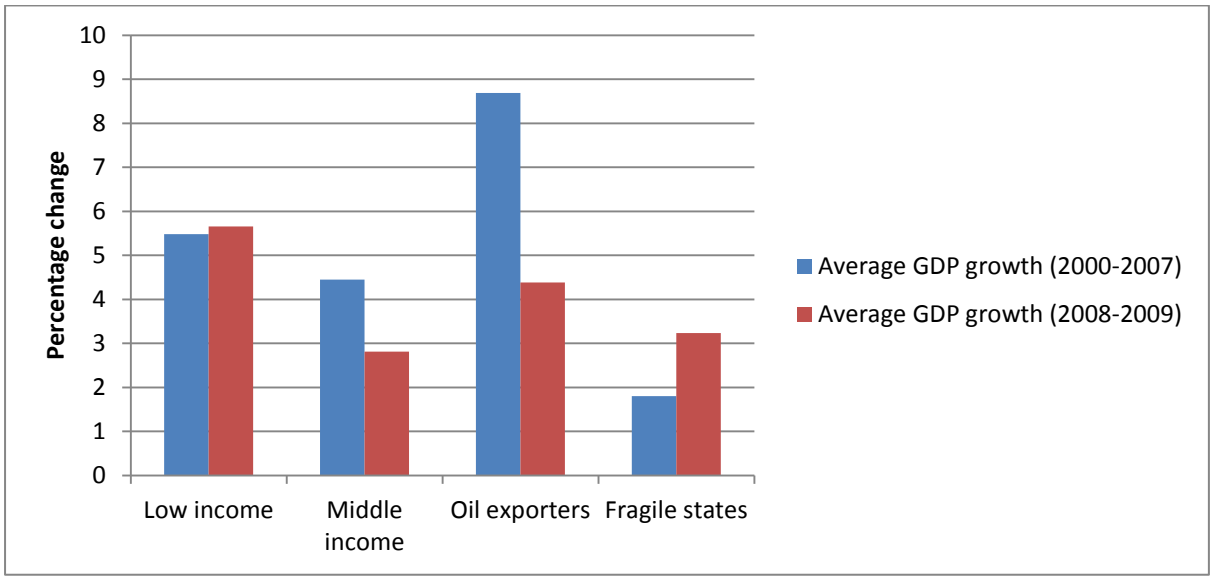
19 Regions here are aggregates as defined by the World Bank.

seemed to have fared somewhat better. West African GDP growth notably increased during the crisis years, from an average of around 4.5 per cent in the years up until 2007, to an average annual rate of 5 per cent during the crisis years. The reason behind this is likely that West Africa is still not much integrated with the global economy. Seck (2010) points out that West Africa's share of global trade has been steadily declining and that the region is not a popular destination for FDI inflows. It is also likely that the good growth performance seen for West Africa as a region here can largely be attributed to Nigeria, which fared well throughout the credit crunch owing to proactive government policy and an expanding non-oil sector that had shielded the Nigerian economy from the worst of the volatility in oil markets at the time of the crisis. East Africa also experienced a decline in GDP growth, though the contraction was much smaller than that experienced by Central Africa. North and Southern Africa both experienced growth declines in those two years, with North Africa contracting from average annual pre-crisis growth of just below 5 per cent to just above 3 per cent. Southern Africa's economic growth declined from just above 4 per cent to just above 3 per cent.

It should be noted, though, that this regional averaging of growth does not accurately illustrate the expected impact of the crisis on individual countries. The presence of some of Africa's largest economies, such as Nigeria and South Africa, mean that the regional averages are weighted towards these large economies. Examining GDP growth by income group and oil-exporting status[20] gives further insight into the differing ways in which various African economies were influenced by the crisis, as can be seen in Figure 6.8 below.

20 Classifications according to International Monetary Fund (2014).

**Figure 6.8: African GDP growth by group, 2000-2009**




**Source: African Development Indicators**

In the years leading up to the crisis, middle- and low-income economies in Africa had displayed steady economic growth, with average annual rates of 4.6 and 5.5 per cent, respectively. During the initial crisis years of 2008 and 2009, however, it seems that middle-income economies were more influenced than their low-income counterparts were. Middle-income economies experienced a growth slowdown during those years, with annual growth averaging 2.8 per cent. Low-income economies, on the other hand, managed to increase average annual growth very slightly, to 5.6 per cent.

Oil-exporting countries clearly suffered large contractions during the crisis years. Pre-crisis growth had averaged 8.7 per cent per year for this group. During the crisis years, growth contracted and oil exporters grew by an average of four per cent. This points to the important linkage that commodities provide to global financial markets for many oil-exporting countries (Cramer, Johnston & Oya, 2009). Kasekende *et al*. (2010) also find that resource-rich economies in Africa were much more strongly influenced than their other counterparts were.

Fragile states managed to increase growth during the crisis years. This is likely attributable to the fact that these economies are not integrated with the global economy. Trade disruptions that had severe growth implications for other African economies would not have figured as strongly.

The varying growth rates on the continent throughout the crisis reflect the fact that policy responses to the crisis also varied. Many African economies had managed to build up solid surpluses and reserves in the years leading up to the crisis. For these economies, it was possible to institute the necessary counter-cyclical policies. Other economies, especially of the continent's fragile states, were not in the same position (Kasekende *et al.*, 2010). Still other African economies applied expansionary monetary policy in reaction to the global economic downturn. These were mostly the emerging economies in Africa, most of which used a policy mix of fiscal and monetary measures to attempt to stimulate their local economies.

For example, South Africa, Mauritius, Uganda, Tanzania and Egypt increased fiscal expenditure on public investment, such as infrastructure, while at the same time also lowering interest rates. Botswana's fiscus suffered large revenue losses due to the crisis and government therefore focused on accommodating monetary policy as the main means with which to counteract the effects of the economic downturn (AfDB, 2009). Tunisia and Morocco also tabled expansionary budgets in reaction to the crisis, focusing on increasing the government's public investment in local economies. Kenya increased government expenditure in 2009, but focused on supply-side issues, and also responded by removing duties on maize and maize products, and lowering the VAT rate on electricity.

Other countries also implemented more financially oriented policies, such as Nigeria's government which boosted funds in the banking system after five major banks in that country suffered major setbacks (AfDB, 2009). In Angola, low oil prices led to drastic revenue losses and the government aimed to redress this issue by issuing the country's first international bond. Other economies, such as Ethiopia and Ghana, were not in the position to apply countercyclical policies, given their low reserves and concerns regarding macroeconomic stability.

Though the ability to implement anti-cyclical policies varied between economies, the seriousness of the crisis was acknowledged and a concerted effort made to act timeously. This is reflected especially in the establishment, under the leadership of the African Development Bank, of a committee of ten African finance ministers and central and regional bank governors in November 2008 to discuss possible policy responses to the crisis (Arieff, Weiss & Jones, 2010). The hope, certainly, was that

swift policy action would soften the blow of the crisis as it spilt over, and enable quick recovery for those African economies that were influenced.

The discussions above have provided a background against which to analyse comovement between Africa and advanced economies. The literature review covered important aspects, such as trade partner performance which need to be considered, while the macroeconomic overview that followed painted a picture of Africa's increased global integration and improved growth performance after 1980.

What now remains to be answered is the empirical question regarding Africa's comovement with advanced economies. Have the past two decades of reform and growth meant that Africa's real economic performance is more susceptible to global developments, or do idiosyncratic factors dominate? The empirical analyses and results which answer this question are now presented in the following section.

## 6.6 Data and results

In order to investigate the decoupling hypothesis for SSA, DFA is employed. Two steps are followed: First, factor analysis is conducted on real variables for SSA countries and the G7. Second, in order to control for the possible effect of the G7 as trading partner for SSA economies, the G7 factor is removed from the data. This is done by extracting the common factors for G7-only data and regressing them against SSA data. The residuals from these regressions capture effects that are not caused by the G7, and these are used to perform a factor analysis taking only SSA into account.

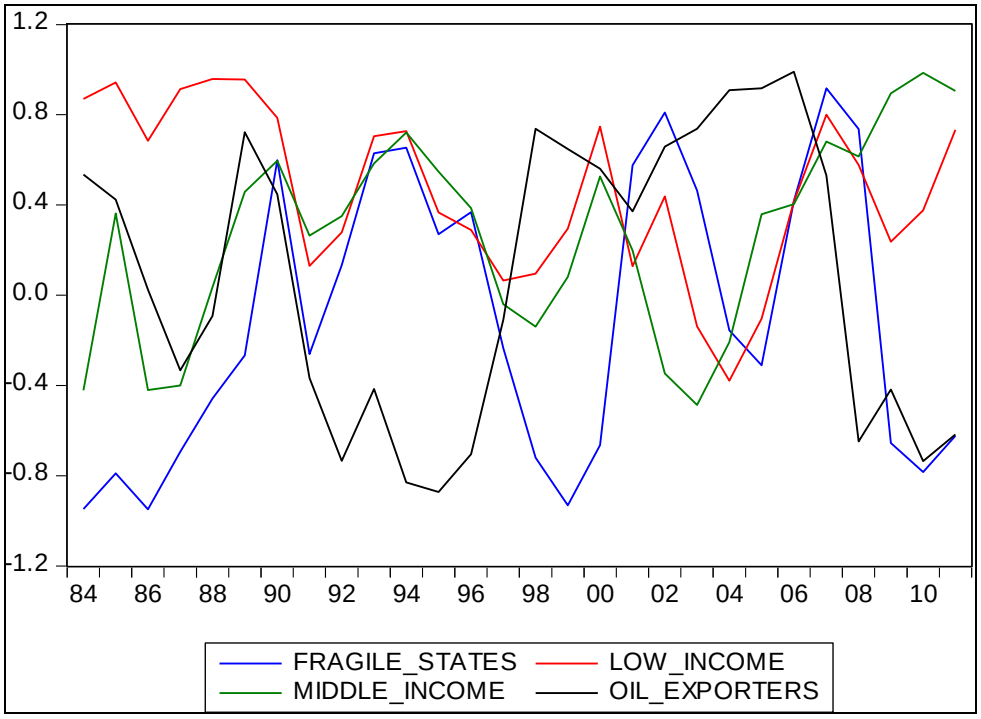
Given the diverse performance of various groups of SSA economies, individual SSA economies are grouped together into middle-income countries, low-income countries, fragile states and oil-exporting economies. Aggregated variables for these income groups are constructed using GDP PPP weights. Weights used for aggregation are reported in Appendix C.2. The classification of countries according to these groups is that of the IMF, and the following countries are included:

- Oil exporters: Nigeria, Angola, Cameroon, Chad, Congo (Rep), Equatorial Guinea, Gabon.
- Middle-income countries: Botswana, Cape Verde, Ghana, Lesotho, Mauritius, Namibia, Senegal, Seychelles, South Africa, Swaziland, Zambia.

- Low-income countries: Benin, Burkina Faso, Ethiopia, Gambia, Kenya, Madagascar, Malawi, Mali, Mozambique, Niger, Rwanda, Sierra Leone, Tanzania, Uganda.
- Fragile states: Burundi, Central African Republic, Comoros, Congo (DRC), Côte d'Ivoire, Eritrea, Guinea, Guinea Bissau, Liberia, Sao Tome, Togo.

The performance of these groups is illustrated in the basic 5-year moving correlations shown below. The graph shows five-year moving average correlations of business cycles against the G7 business cycle. Business cycles have been extracted from logged real GDP using the HP filter.

**Figure 6.9: 5-year moving correlations, African versus G7 business cycles**




In the graph above, it can be seen that low-income SSA economies and middle-income SSA economies show high correlations with the G7 business cycle. Interestingly, oil-exporting African states, as well as fragile countries, display a different pattern, with correlations tending to be lower.

High business cycle correlations might indicate comovement, but do not necessarily identify the causes (or factors) driving that comovement. Therefore, DFA is performed on a panel of SSA and G7 data so as to determine whether variables are driven by common components and to determine what the factors are that make up such common components.

Annual data for the period between 1980 and 2011 is obtained from the World Bank's African Development Indicators database. These data are for GDP, imports, exports, CPI, FDI inflows, ODA receipts and the business cycle. Business cycles are extracted from GDP using the HP filter. Indices for oil prices, as well as food and mineral prices, are also included as global variables. Annual data for G7 variables, such as imports and exports, GDP, CPI, PPI and unemployment, are obtained from the FRED (Federal Reserve Economic Data) database. This results in a sample of 37 observations (N) over 31 years (T).

All data is logged (except in the case of negative values) and checked for stationarity using the ADF test. Where necessary and as indicated by the ADF, data are differenced in order to ensure stationarity before proceeding with the factor analysis (See Chapter 3 for a full discussion of DFA.) Two factors are specified according to the Alessi, Barigozzi and Capasso (ABC) criteria (Alessi, Barigozzi & Capasso, 2010). The results of the ABC test are reported in Appendix C. Table 6.2 below presents a summary of variance shares obtained for this analysis.

**Table 6.2: Variance share results for Africa and G7, 1981-2011**

| | G7 | Low income | Middle income | Fragile states | Oil exporters |
|---|---|---|---|---|---|
| **GDP** | 0.27 | 0.35 | 0.45 | 0.22 | 0.35 |
| **Imports** | 0.75 | 0.62 | 0.41 | 0.39 | 0.11 |
| **Exports** | 0.68 | 0.69 | 0.23 | 0.15 | 0.31 |
| **ODA** | | 0.00 | 0.39 | 0.07 | 0.08 |
| **FDI** | | 0.06 | 0.04 | 0.13 | 0.14 |
| **CPI** | 0.25 | 0.05 | 0.05 | - | 0.12 |
| **Business Cycle** | 0.26 | 0.12 | 0.38 | 0.34 | 0.05 |
| **PPI** | 0.59 | | | | |
| **Unemployment** | 0.23 | | | | |

The variance shares above paint a general picture of decoupling between the particular SSA groups and the G7, with variance shares being generally low. It is noticeable that the highest variance shares can be seen in global variables such as G7 imports and exports. Low-income SSA economies also show high variance [21] shares in imports and exports.

Matching the factors produced from the analysis to the original macroeconomic series shows that G7 trade and low-income country trade were the two factors

[21] Setting an objective level for when variance shares are 'low' or 'high' is difficult. Generally speaking, African variables do however show variance shares which are low, *compared to* variance shares for the G7 variables.

driving the comovement between G7 and SSA economies. The dominance of the G7 trade factor is not surprising, given the importance of this group of economies globally. Taking the G7 as a proxy for advanced nations, these results therefore show that trade demand from advanced nations is an important driver of comovement for the SSA groups that were studied.

The high variance shares attributed to low-income imports and exports highlight the trade dependence of these economies. It is noteworthy that trade-related variance shares for the other SSA groups are not as high.

Inspecting the remaining variance shares reveals another noticeable trend. After the high variance shares reported for low-income trade variables, the next SSA group that displays higher relative variance shares comprises middle-income countries. Middle-income variance shares related to GDP, imports and ODA are higher than variance shares for other groups. Of the variance shares related to business cycles of SSA groups, middle-income countries display the highest variance shares. Thirty-eight per cent of the middle-income business cycle is explained by a common component, as opposed to 34 per cent for fragile states, 12 per cent for low-income countries, and just 5 per cent for oil exporters. Furthermore, up to 45 per cent of middle-income GDP is explained by a common component, as opposed to only 35 per cent for low-income countries and oil exporters, and just 22 per cent for the GDP of fragile SSA states. These patterns illustrate the fact that business cycles of middle-income SSA economies are strongly integrated with the G7.

Two further interesting facts stand out from the variance share results. First, that some variables relating to fragile states display higher variance shares. For example, 39 per cent of fragile states' imports are explained by a common component and so is 34 per cent of the business cycle. This is much higher than, for instance, the variance explained in the business cycle of oil-exporting economies. Given the low development levels of these economies, the conclusion is drawn that fragile states are susceptible to global shocks. Second, the fact that variance shares for oil exporters are rather low is interesting. It is true that almost a third of their exports is explained by a common component, as might be expected. The variance share for the business cycle is low, however. This shows that oil-exporting countries' business cycles are still dominated by idiosyncratic factors. As pointed out by the IMF (2008e:7), for example, growth in oil exporters' GDP in 2008 could be ascribed to

factors such as ongoing instability and violence in Nigeria and Chad, rather than to global events taking place during that time.

From the variance shares presented above, the conclusion can be drawn that SSA groups in general have decoupled from the G7, with clearly different experiences among groups such as middle-income countries, oil exporters, low-income and fragile states. A final caveat needs to be investigated, however. Given the aggregation of countries into income groups, it is possible that the comovement seen above is not necessarily the strict comovement of SSA groups with the G7. So, for example, middle-income SSA economies might display higher variance shares than their fragile counterparts do because of the fact that many economies included in this group trade with the G7 and comovement is therefore attributable to a shared trading partner rather than to anything else.

In order to control for the abovementioned influence of the G7, another DFA is conducted, but this time using only G7 data. These variables include G7 aggregates for imports, exports, GDP, business cycles, and CPI, as well as imports, exports, GDP, business cycles and CPI for each individual member country of the G7. Following this, the factors obtained from the factor analysis are regressed against the variables for the SSA groups (GDP, business cycle, CPI, imports, exports, ODA and FDI flows for low-income, middle-income, fragile and oil-exporting states.) The residuals obtained from this regression are then used for another factor analysis. Having now controlled for the common influence of the G7, it is possible to see what comovement looks like between these SSA groups by analysing the variance shares obtained. These are presented in Table 6.3 below.

**Table 6.3: Variance share results for Africa and G7 (excluding the G7 factor)**

| | Low income | Middle income | Fragile states | Oil exporters |
|---|---|---|---|---|
| **GDP** | 0.08 | 0.40 | 0.65 | 0.02 |
| **Imports** | 0.16 | 0.02 | 0.69 | 0.00 |
| **Exports** | 0.25 | 0.02 | 0.11 | 0.00 |
| **ODA** | 0.26 | 0.13 | 0.00 | 0.01 |
| **FDI** | 0.03 | 0.14 | 0.01 | 0.01 |
| **CPI** | 0.05 | 0.00 | - | 0.32 |
| **Business Cycle** | 0.11 | 0.40 | 0.03 | 0.04 |
| **PPI** | | | | |
| **Unemployment** | | | | |

When comparing the results in Table 6.3 above with the results reported in Table 6.2, it can be seen that variance shares are generally smaller after having controlled for the G7 influence. This shows that the comovement that could be seen in variance shares reported previously in Table 6.2 was largely attributable to the influence of the G7. SSA groups are therefore not co-moving with one another, indicating that financial integration across the continent is low and that intraregional trade is also limited.

There are two exceptions to the generally lower variance shares that can be seen here. First, removing the G7 influence causes the variance share for certain fragile state variables to increase quite drastically. Whereas in the previous estimation, low-income SSA countries showed the highest variance shares, here that is true for fragile states. For GDP, 65 per cent of fragile GDP is now explained by a common component, as opposed to 22 per cent previously. Sixty-nine per cent of fragile state imports are now explained by a common component, compared with 39 per cent before the G7 influence was controlled for by conducting a DFA on the residuals which remain after G7 factors were regressed against SSA variables. The fact that the variance share on imports is now much higher suggests that fragile states are more integrated in trade with other SSA groups than they are with the G7. However, business cycle variance share has now declined to just 3 per cent. This means that idiosyncratic factors drive the variance seen in the business cycle here. Given the political instability and economic fragility experienced by these economies, it is possible that the trend depicted here can be ascribed to an ‘Africa factor’ for these countries.

The second exception pertains to middle-income countries. Forty per cent of the middle-income business cycle, as well as 40 per cent of middle-income GDP, is explained by a common component. These findings are close to those reported in the original analysis, when 45 per cent of middle-income GDP and 38 per cent of the middle-income business cycle were explained by a common component. The analysis performed after controlling for the G7 variables therefore confirms results obtained earlier: Middle-income SSA countries are closely linked to the business cycle in advanced economies.

Variance shares for oil exporters are still low after controlling for the G7, once again highlighting the importance of idiosyncratic factors for these countries. As for low-

income countries, the business cycle variance share does not change much when controlling for the G7. Variance shares for imports and exports decline substantially, however, suggesting that low-income countries still rely very much on G7 trade.

In summary, then, the dynamic factor analyses conducted for SSA and the G7 show that African economies are still very dependent on the G7. This is seen in the fact that, while variance shares were generally low when including the G7, they declined even further when controlling for the G7. Middle-income SSA countries showed the strongest coupling to the G7, with variance shares for the business cycle being robust to controlling for the G7. Low-income and oil-exporting countries also show business cycle variance shares that are robust to this change, though the variance shares are so low as to suggest a decoupling. Fragile SSA states seem to be much more reliant on trade with other SSA groups than with the G7, though the fact that business cycle variance shares decline when controlling for the G7 could be indicative of coupling between these economies and the G7. The unique pattern displayed by fragile states leaves room for future research to be conducted.

## 6.7. Conclusion

The impact that the 2008 credit crunch would have on African economies was unclear from the outset. First, it seemed that the underdeveloped financial markets of this region would serve to shield African economies from the worst impacts. Then, there was concern, however, for the health of African economies, given the high levels of trade dependence in many of them.

The possible negative effects seemed particularly severe, given the disastrous implications that reduced economic growth could have for human development efforts on the continent. As the crisis unfolded, it seemed that the impacts of the crisis varied between regions in Africa, bearing in mind how heterogeneous the countries on that vast continent are. For some, swift policy action was possible, and fiscal and monetary steps were taken to counteract the worst effects. For others, the same leeway was not available and it seemed that the credit crunch would indeed have a very negative effect on economic growth, especially given the decline in trading partners' demand.

This chapter analysed comovement between SSA and advanced economies by using a dynamic factor model. An important caveat to note regarding the empirical

analysis in this chapter is that the lack of high frequency African data inhibits in-depth analysis of the Great Recession years. It is not possible to make any definitive conclusions about decoupling during those years. What the results do suggest however is that levels of comovement depend on income level. The empirical analysis concludes that middle-income SSA countries are the only group that show consistent business cycle variance shares, both before and after controlling for the influence of the G7. This implies that while middle-income SSA countries have experienced high comovement with the G7 business cycle during the period under investigation, they have also co-moved among themselves. This points to higher levels of intraregional finance and trade amongst these economies. Before controlling for the G7, low-income economies showed high variance shares for imports and exports. This shows that trade is an important transmission mechanism for low-income SSA economies, whose trade is not as diversified as that of other SSA countries are. When controlling for the G7, however, variance shares diminish. This confirms the trade dependency of low-income SSA countries on advanced trading partners. Fragile states display an interesting pattern. Business cycle comovement for this group is comparable to that of middle-income countries when including the G7, indicating that fragile states are more coupled to the G7 than are oil exporters and low-income economies. However, when controlling for the G7, business cycle variance share decreases drastically. This suggests that the initial coupling seen was entirely due to the common effect of the G7 as a shared trading partner for these economies. While removing the G7 decreases business cycle variance shares, it increases variance shares in GDP and imports, suggesting that fragile states rely much more on trade with other SSA groups than with the G7. Oil exporting economies show low variance shares throughout the analysis – both when including and excluding the influence of the G7. There has been quite strong decoupling for oil exporters, therefore. This result suggests that idiosyncratic disturbances in these economies are most important for business cycles. Oil exporters should focus policy on ensuring stable macroeconomic and political environments.

Finally, the fact that G7 trade emerges as an explanatory factor in the empirical analysis underlines a recurrent theme throughout this thesis. That is, namely, that trade fosters comovement. For the SSA groups studied here, trade with the G7 still

dominates, as seen in the impact that the removal of the G7 factor had on variance shares. The management of trade policies should therefore be important for African policymakers. Diversified trade could shield economies from future advanced economy crises.

# CHAPTER 7: SYNTHESIS AND CONCLUSION

## 7.1 Introduction

This thesis set out to analyse real comovement between advanced economies and EM economies, advanced economies and China, and advanced economies and African economies, respectively, against the backdrop of the Great Recession. Although there was much debate surrounding the possibility of decoupling at the onset of the crisis, few subsequent studies have taken a look at the issue of real comovement with the new data that are available for the crisis years.

This thesis contributed to the debate by analysing comovement between these economies using DFA to look at new data that have become available since the onset of the crisis. EM economies as a group were analysed, as well as China as a prominent EM. Real comovement of African economies was also investigated. The unique contribution of this thesis lies in the decade-by-decade look at comovement which allows one to see the evolution of comovement, as well as the impact of the Great Recession.

In this chapter, research results will be synthesised in order to answer the main research question that was formulated at the outset of the study. This synthesis is presented in section 7.2, followed by a review of the study's main research aims in 7.3, and the main conclusions and recommendations for future research are given in section 7.4.

## 7.2 Synthesis

From the outset, the decoupling debate that emerged around the Great Recession was contentious. It seemed at first that EM economies were surprisingly resilient to the credit crunch. Likewise, Chinese and African economies also appeared sheltered from the crisis that was brewing in global financial markets. But, how could decoupling possibly be a reality in a globalised world economy?

This thesis addressed the issue of decoupling before and during the Great Recession. The aim was to determine whether business cycles had decoupled during that time, or not. A review of business cycle theories related to comovement, such as Real Business Cycle theory, showed that it was a complex issue. While greater economic openness might, on one hand, provide transmission mechanisms

such as trade and finance through which the Great Recession would spill over to EMs, this greater openness might, on the other hand, also theoretically have allowed EMs to diversify and therefore evade the global economic downturn. Literature reviews on previous empirical studies done were also carried out for each group investigated, namely EM economies, China as a standalone EM economy, and SSA economies. Given the attention that EM economies have enjoyed in recent years, there is wide literature available on the topic. Less research on business cycle comovement has been done for SSA and literature was therefore more limited. Generally, the literature reviews showed that there is no consensus on decoupling. Few studies previously done have covered the Great Recession years or offered a decade-by-decade look into how business cycle comovement had evolved in the years leading up to the Great Recession.

DFA and rolling regressions were used in all three empirical chapters of this thesis to empirically investigate the decoupling phenomenon. The DFA model was introduced before empirical results were discussed. EM economies from various regions were analysed. China received special attention, while SSA was also investigated. The period analysed in each instance provided a long-run view of patterns in business cycle comovement. Beginning in the 1980s and continuing through to 2011, a clear picture of the evolution of business cycle comovement was obtained. It is this decade-by-decade approach which also provides a new contribution.

It was evident from the analyses that EM economies have become more integrated with the global economy as time has passed. Though some outlying individual countries were identified in the analysis, generally, splitting the sample into decades made it clear that in each decade, comovement as indicated by variance shares has increased between EM and advanced economies. This is true for EMs as a group, and also for China as a standalone EM economy. While data limitations hinder a decade-by-decade approach for Africa, it was clear that especially middle-income African economies are quite integrated with the global economy. During all the analyses, trade emerged as an important factor responsible for fostering comovement. This is in keeping with theory on transmission channels of business cycles, and also ties in to the idea of an imported business cycle. The empirical findings in this thesis therefore lend credence to the theories on real international business cycles which argue that greater trade openness will lead to higher levels of

comovement. This is contrary to other schools of thought which would argue that greater trade openness in economies allows for diversification, which could reduce business cycle comovement. The emergence of trade as an explanatory factor in these analyses also implies that, though regional production networks or GVCs have been increasing in EMs, these networks have not managed to shield EMs from demand fluctuations in advanced trade partners. Goods produced within these value chains still rely on advanced economies as end markets. As EM economies have opened their economies, they have not been able to escape the vagaries of the global economy. This was generally true for the Great Recession, as well.

Graphs depicting the variance shares obtained from rolling factor analyses for EM economies illustrated how comovement between EM and advanced business cycles has trended higher over time. The same trend emerged for China. Data limitations did not allow the same analysis for Africa. In all the rolling analyses conducted, comovement reached a peak during the years of the Great Recession. Instead of decoupling, then, EM economies generally coupled to advanced economies during the Great Recession, with the exception of a handful of outlying economies.

## 7.3 Accomplishment of main research aims

At the start of this thesis, it was stated that there were two main research aims to accomplish. The first was to determine whether new data available after the global financial crisis could shed more light on whether EM, China and African economies did indeed decouple from advanced economies during the crisis. The second was to determine which factors had been responsible for comovement between EM and advanced economies.

This thesis has accomplished the first aim by applying dynamic factor models and rolling regressions to analyse real and financial variables for EM and advanced economies up to the second quarter of 2011. This period includes the worst years of the crisis and the year following immediately thereafter. The analysis made it clear that the majority of EM economies generally experienced coupling, rather than decoupling, during this time. In fact, the trend that emerged was one in which comovement has increased decade by decade. It was noteworthy that among the group of EM economies, certain individual countries were outliers in this trend. India and Indonesia were two exceptions, displaying much lower levels of comovement than their other EM counterparts did. India and Indonesia therefore did experience

decoupling during the period under investigation. Interestingly, among the group of advanced economies, New Zealand, Australia and Norway displayed lower levels of comovement than other advanced economies did. In the individual analysis of China, the world's second-largest economy also displayed increasing levels of business cycle comovement around the time of the Great Recession, meaning that China did not manage to strongly decouple during the crisis. Though a lack of high-frequency data for African economies hinders a similar in-depth look into African patterns of comovement, analyses of comovement between various African income groups and the G7 shed some light on the issue. In general for the overall period, which includes the Great Recession years, African economies displayed low levels of comovement with the G7. Middle-income African economies were the exception, with variance shares which were relatively higher than those for other income groups, showing that middle-income African countries in particular experienced greater integration with advanced economies. Fragile states and oil exporters, on the other hand, did not display high variance shares, suggesting that events in these economies are shaped by idiosyncratic factors.

This thesis has accomplished the second aim by analysing, for different sub-periods, the factors that were responsible for driving comovement at certain times. These results were obtained from the DFA performed. During the final sub-period of 2001Q1 to 2011Q2, during which the Great Recession occurred, the factors which drove comovement between EM and advanced economies were global trade, global business cycles, and European/USA exchange rates. These indicate the interconnectedness of the modern global economy. For China, the factors which drove comovement in the final sub-period were global trade, global business cycles, advanced country exchange rates and advanced country inflation. Again, the importance of global trade links was highlighted. Though the lack of high-frequency data for African countries did not allow for a decade-by-decade analysis, G7 trade emerged as an important factor in explaining African comovement. Indeed, international trade was the one factor that continually arose for all countries, groups and sub-periods studied. Trade is therefore clearly an important transmission mechanism of business cycles, as discussed in the theory presented in Chapter 2.

## 7.4 Main conclusions and recommendations for future research

The accomplishment of the research aims discussed in the previous section allows for an answer to be proposed to the study's main research question, namely: *What was the status of real decoupling in EM economies, China as a prominent EM by itself, and Africa before and during the global recession of 2008 and beyond?*

The answer to the research question, and therefore the main conclusion from this thesis, is that EM economies have generally displayed increasing levels of comovement with advanced economies since the 1980s. This comovement reached a zenith around the time of the global financial crisis, indicating that decoupling had not taken place. This holds for EMs as a group, as well as for China as a single EM. There is some evidence, however, that the decoupling hypothesis is true for a few outlying individual countries, such as India, Indonesia, Norway, Australia and New Zealand. With regard to African economies, the main conclusion is that different groups of African economies are differently integrated with the global economy. Middle-income African economies in particular display higher levels of comovement than other income groups do. Oil-exporting and fragile African states display low levels of comovement, suggesting a decoupling for these groups. Overall, the conclusion is that globalisation has ensured an ever more interconnected and interdependent world.

With regard to areas for future research, a few suitable themes emerged during this thesis. First, there is room for further investigation into the relationship between China and advanced economies. In this thesis, China was first included as part of the EM group, and then analysed on its own. Controlling for the influence of China among EMs could provide deeper insights into the dynamics between China, emerging counterparts, and advanced economies. Secondly, within the EM economies that were analysed, certain individual countries stood out as outliers. India, for instance, displayed very low levels of comovement with advanced economies and a more country-specific study could illuminate the possible reasons for this. New Zealand and Australia, on the other hand, are two advanced economies that displayed different patterns of comovement than other advanced economies did. Thirdly, given the global prominence of the interrelationship between China and the US, further research is needed on how exactly the relationship between these two economies influences decoupling. Fourthly, an analysis of higher frequency data for

African economies could shed more light on the decoupling debate for these economies. There is particular need for such analyses with regard to the African income groups which showed interesting results. For example, middle-income African economies showed higher levels of comovement than low-income counterparts did, which would be expected. But an analysis which controlled for the influence of the G7 found an interesting pattern among fragile African states, suggesting the existence of an 'Africa factor' which dominates business cycle comovement among these economies. Fifthly, since trade emerged as an important factor in fostering comovement, future policy-oriented studies could analyse the policy implications of decoupling for individual countries.

Looking at more general themes for future research, events currently unfolding point to issues which will need to be clarified in future research. For example, the current slowdown in the Chinese economy and the implications that this will have for global business cycles. Still broader questions which could warrant future research include: What are the microeconomic foundations of decoupling? Are there any benefits or drawbacks to coupling versus decoupling? And finally, from a political economy perspective, one wonders whether political systems have an influence on comovement and whether policymakers can 'choose' to couple or decouple with other economies.

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# Appendix

## Appendix A: Co-movement between EM and advanced economies (Chapter 4)

### Table A.1: Variance shares, 1979Q3-2011Q2

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Oil price | 0.377936 | Cycle_Belgium | 0.75782 | Exports_china | 0.234022 | RGDP_india | 0.01324 | Imports_japan | 0.493114 | CPI_netherlands | 0.083261 |
| RGDP_Arg | 0.10251 | Exch.rate_belgium | **0.904604** | Imports_china | 0.215344 | CPI_india | 0.019209 | Cycle_japan | 0.431322 | Rshort_netherlands | 0.355828 |
| CPI_Arg | 0.025764 | RGDP_Brazil | 0.222275 | Cycle_china | 0.039724 | Rshort_india | 0.1245 | Exch.rate_japan | 0.25128 | Exports_netherlands | 0.803021 |
| Rshort_Arg | 0.02803 | CPI_Brazil | 0.000838 | Exch.rate_china | 0.027055 | Exports_india | 0.072456 | RGDP_korea | 0.107304 | Imports_netherlands | 0.779965 |
| Exports_Arg | 0.083342 | Rshort_brazil | 0.0462 | RGDP_finland | 0.2561 | Imports_india | 0.271957 | CPI_korea | 0.028705 | Cycle_netherlands | 0.525196 |
| Imports_Arg | 0.079089 | Exports_brazil | 0.032153 | CPI_finland | 0.160533 | Cycle_india | 0.122347 | Rshort_korea | 0.069401 | Exch.rate_netherlands | 0.915918 |
| Cycle_Arg | 0.051178 | Imports_brazil | 0.031032 | Rshort_finland | 0.215942 | Exch.rate_india | 0.2795 | Exports_korea | 0.421915 | RGDP_newzealand | 0.183802 |
| Exch.rate_Arg | 0.041044 | Cycle_brazil | 0.314144 | Exports_finland | 0.48501 | RGDP_indonesia | 0.072592 | Imports_korea | 0.494977 | CPI_newzealand | 0.037891 |
| RGDP_Austral | 0.128984 | Exch.rate_brazil | 0.118776 | Imports_finland | 0.374962 | CPI_indonesia | 0.042357 | Cycle_korea | 0.208208 | Rshort_newzealand | 0.011866 |
| CPI_Austral | 0.017573 | RGDP_Canada | 0.296809 | Cycle_finland | 0.63363 | Rshort_indonesia | 0.065506 | Exch.rate_korea | 0.289848 | Exports_newzealand | 0.378734 |
| Rshort_Austral | 0.101561 | CPI_Canada | 0.092403 | Exch.rate_finland | 0.799856 | Exports_indonesia | 0.299247 | RGDP_malaysia | 0.324537 | Imports_newzealand | 0.423981 |
| Exports_Austral | 0.068485 | Rshort_canada | 0.231439 | RGDP_france | 0.332225 | Imports_indonesia | 0.159682 | CPI_malaysia | 0.154727 | Cycle_newzealand | 0.176163 |
| Imports_Austral | 0.474956 | Exports_canada | 0.471621 | CPI_france | 0.139212 | Cycle_indonesia | 0.090106 | Rshort_malaysia | 0.085947 | Exch.rate_newzealand | 0.503197 |
| Cycle_Austral | 0.238663 | Imports_canada | 0.158205 | Rshort_france | 0.25192 | Exch.rate_indonesia | 0.113797 | Exports_malaysia | 0.484333 | RGDP_norway | 0.061091 |
| Exch.rate_Austral | 0.386961 | Cycle_canada | 0.547112 | Exports_france | 0.807134 | RGDP_italy | 0.348683 | Imports_malaysia | 0.494355 | CPI_norway | 0.032775 |
| RGDP_Austria | 0.136319 | Exch.rate_canada | 0.321979 | Imports_france | 0.840933 | CPI_italy | 0.130678 | Cycle_malaysia | 0.258602 | Rshort_norway | 0.109894 |
| CPI_Austria | 0.149526 | RGDP_chile | 0.160085 | Cycle_france | 0.486735 | Rshort_italy | 0.292824 | Exch.rate_malaysia | 0.179204 | Exports_norway | 0.533326 |
| Rshort_Austria | 0.458133 | CPI_chile | 0.002923 | Exch.rate_france | 0.891587 | Exports_italy | 0.633641 | RGDP_mexico | 0.271162 | Imports_norway | 0.519501 |
| Exports_Austria | **0.800223** | Rshort_chile | 0.019071 | RGDP_germany | 0.278111 | Imports_italy | 0.666012 | CPI_mexico | 0.059634 | Cycle_norway | 0.172829 |
| Imports_Austria | 0.700816 | Exports_chile | 0.302729 | CPI_germany | 0.098149 | Cycle_italy | 0.775632 | Rshort_mexico | 0.051598 | Exch.rate_norway | 0.767428 |
| Cycle_Austria | 0.412646 | Imports_chile | 0.137138 | Rshort_germany | 0.528367 | Exch.rate_italy | 0.815069 | Exports_mexico | 0.04546 | RGDP_peru | 0.025888 |

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| Exch.rate_Austria | **0.907426** | Cycle_chile | 0.255452 | Exports_germany | 0.778885 | RGDP_japan | 0.224655 | Imports_mexico | 0.305181 | CPI_peru | 0.099007 |
| RGDP_Belgium | 0.385302 | Exch.rate_chile | 0.221784 | Imports_germany | 0.761049 | CPI_japan | 0.099384 | Cycle_mexico | 0.20759 | Rshort_peru | 0.084814 |
| CPI_Belgium | 0.182921 | RGDP_china | 0.093333 | Cycle_germany | 0.445098 | Rshort_japan | 0.118743 | Exch.rate_mexico | 0.140746 | Exports_peru | 0.011694 |
| Rshort_Belgium | 0.236418 | CPI_china | 0.049884 | Exch.rate_germany | 0.905103 | Exports_japan | 0.52362 | RGDP_netherlands | 0.261375 | Imports_peru | 0.053922 |
| Cycle_peru | 0.007987 | Exch.rate_spain | 0.817063 | RGDP_uk | 0.148273 | | | | | | |
| Exch.rate_peru | 0.037906 | RGDP_sweden | 0.366164 | CPI_uk | 0.057694 | | | | | | |
| RGDP_Philippines | 0.053485 | CPI_sweden | 0.094434 | Rshort_uk | 0.252444 | | | | | | |
| CPI_philippines | 0.042527 | Rshort_sweden | 0.136208 | Exports_uk | 0.584757 | | | | | | |
| Rshort_philippines | 0.034919 | Exports_sweden | 0.682186 | Imports_uk | 0.623591 | | | | | | |
| Exports_philippines | 0.12668 | Imports_sweden | 0.712333 | Cycle_uk | 0.532411 | | | | | | |
| Imports_philippines | 0.114113 | Cycle_sweden | 0.653933 | Exch.rate_uk | 0.603073 | | | | | | |
| Cycle_philippines | 0.133995 | Exch.rate_sweden | 0.720458 | RGDP_usa | 0.327421 | | | | | | |
| Exch.rate_philippines | 0.07862 | RGDP_switzerland | 0.408639 | CPI_usa | 0.184668 | | | | | | |
| RGDP_singapore | 0.384387 | CPI_switzerland | 0.144171 | Rshort_usa | 0.267616 | | | | | | |
| CPI_singapore | 0.285561 | Rshort_switzerland | 0.119384 | Rlong_usa | 0.306729 | | | | | | |
| Rshort_singapore | 0.162094 | Exports_switzerland | 0.726055 | Exports_usa | 0.556769 | | | | | | |
| Exports_singapre | 0.658666 | Imports_switzerland | 0.649629 | Imports_usa | 0.605181 | | | | | | |
| Imports_singapore | 0.58767 | Cycle_switzerland | 0.64592 | Cycle_usa | 0.579394 | | | | | | |
| Cycle_singapore | 0.496416 | Exch.rate_switzerland | 0.844093 | Iprod_usa | 0.426148 | | | | | | |
| Exch.rate_singapore | 0.43483 | RGDP_thailand | 0.248035 | Sp500_usa | 0.196307 | | | | | | |
| RGDP_southafrica | 0.319487 | CPI_thailand | 0.194385 | Unemployment_usa | 0.238362 | | | | | | |
| CPI_southafrica | 0.019452 | Rshort_thailand | 0.119053 | Ppi_usa | 0.402471 | | | | | | |
| Rshort_southafrica | 0.089734 | Exports_thailand | 0.271742 | Rer_usa | 0.780456 | | | | | | |
| Exports_southafrica | 0.106204 | Imports_thailand | 0.354475 | | | | | | | | |
| Imports_southafrica | 0.274621 | Cycle_thailand | 0.212608 | | | | | | | | |
| Cycle_southafrica | 0.500304 | Exch.rate_thailand | 0.192352 | | | | | | | | |
| Exch.rate_southafrica | 0.306082 | RGDP_turkey | 0.136312 | | | | | | | | |
| RGDP_spain | 0.250096 | CPI_turkey | 0.01216 | | | | | | | | |
| CPI_spain | 0.090427 | Rshort_turkey | 0.028324 | | | | | | | | |

| | | | |
|---|---|---|---|
| Rshort_spain | 0.013074 | Exports_turkey | 0.039943 |
| Exports_spain | 0.339736 | Imports_turkey | 0.148785 |
| Imports_spain | 0.602729 | Cycle_turkey | 0.162441 |
| Cycle_spain | 0.560149 | Exch.rate_turkey | 0.108357 |

## Table A.2: Variance Shares, 1979Q3-1990Q4

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Oil price | 0.138076 | RGDP_Brazil | 0.188283 | RGDP_finland | 0.064811 | RGDP_indonesia | 0.129264 | Exch.rate_korea | 0.089685 |
| RGDP_Arg | 0.262521 | CPI_Brazil | 0.015416 | CPI_finland | 0.439303 | CPI_indonesia | 0.024477 | RGDP_malaysia | 0.322317 |
| CPI_Arg | 0.07636 | Rshort_brazil | 0.16143 | Rshort_finland | 0.091318 | Rshort_indonesia | 0.158746 | CPI_malaysia | 0.352913 |
| Rshort_Arg | 0.051124 | Exports_brazil | 0.158368 | Exports_finland | 0.315372 | Exports_indonesia | 0.133366 | Rshort_malaysia | 0.165052 |
| Exports_Arg | 0.080227 | Imports_brazil | 0.118351 | Imports_finland | 0.188365 | Imports_indonesia | 0.179832 | Exports_malaysia | 0.175793 |
| Imports_Arg | 0.065361 | Cycle_brazil | 0.492825 | Cycle_finland | 0.429963 | Cycle_indonesia | 0.223544 | Imports_malaysia | 0.323215 |
| Cycle_Arg | 0.373646 | Exch.rate_brazil | 0.108768 | Exch.rate_finland | 0.745679 | Exch.rate_indonesia | 0.143193 | Cycle_malaysia | 0.227837 |
| Exch.rate_Arg | 0.091084 | RGDP_Canada | 0.428836 | RGDP_france | 0.16368 | RGDP_italy | 0.443902 | Exch.rate_malaysia | 0.213356 |
| RGDP_Austral | 0.304659 | CPI_Canada | 0.100299 | CPI_france | 0.075607 | CPI_italy | 0.084479 | RGDP_mexico | 0.383849 |
| CPI_Austral | 0.224929 | Rshort_canada | 0.479587 | Rshort_france | 0.275917 | Rshort_italy | 0.267387 | CPI_mexico | 0.108901 |
| Rshort_Austral | 0.076828 | Exports_canada | 0.377555 | Exports_france | 0.768991 | Exports_italy | 0.390456 | Rshort_mexico | 0.06918 |
| Exports_Austral | 0.199214 | Imports_canada | 0.372649 | Imports_france | 0.824163 | Imports_italy | 0.441899 | Exports_mexico | 0.469887 |
| Imports_Austral | 0.306179 | Cycle_canada | 0.493863 | Cycle_france | 0.101373 | Cycle_italy | 0.352726 | Imports_mexico | 0.582516 |
| Cycle_Austral | 0.416327 | Exch.rate_canada | 0.076449 | Exch.rate_france | 0.859625 | Exch.rate_italy | 0.81236 | Cycle_mexico | 0.420892 |
| Exch.rate_Austral | 0.070938 | RGDP_chile | 0.3634 | RGDP_germany | 0.147699 | RGDP_japan | 0.078943 | Exch.rate_mexico | 0.22512 |
| RGDP_Austria | 0.089007 | CPI_chile | 0.075012 | CPI_germany | 0.05772 | CPI_japan | 0.056704 | RGDP_netherlands | 0.209469 |
| CPI_Austria | 0.427383 | Rshort_chile | 0.046979 | Rshort_germany | 0.491552 | Rshort_japan | 0.266611 | CPI_netherlands | 0.151447 |
| Rshort_Austria | 0.433119 | Exports_chile | 0.149839 | Exports_germany | 0.656087 | Exports_japan | 0.215867 | Rshort_netherlands | 0.25101 |
| Exports_Austria | 0.776778 | Imports_chile | 0.413244 | Imports_germany | 0.760154 | Imports_japan | 0.298504 | Exports_netherlands | 0.644039 |
| Imports_Austria | 0.662707 | Cycle_chile | 0.327419 | Cycle_germany | 0.211442 | Cycle_japan | 0.061343 | Imports_netherlands | 0.593439 |
| Cycle_Austria | 0.129733 | Exch.rate_chile | 0.377675 | Exch.rate_germany | 0.890078 | Exch.rate_japan | 0.411775 | Cycle_netherlands | 0.390563 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Exch.rate_Austria | 0.88017 | RGDP_china | 0.38674 | RGDP_india | 0.009658 | RGDP_korea | 0.119406 | Exch.rate_netherlands | 0.889603 |
| RGDP_Belgium | 0.482208 | CPI_china | 0.111538 | CPI_india | 0.018655 | CPI_korea | 0.108679 | RGDP_newzealand | 0.138423 |
| CPI_Belgium | 0.124065 | Exports_china | 0.051409 | Exports_india | 0.098412 | Rshort_korea | 0.096797 | CPI_newzealand | 0.119246 |
| Rshort_Belgium | 0.216632 | Imports_china | 0.099764 | Imports_india | 0.140193 | Exports_korea | 0.243473 | Rshort_newzealand | 0.314573 |
| Cycle_Belgium | 0.7432 | Cycle_china | 0.22382 | Cycle_india | 0.110017 | Imports_korea | 0.163217 | Exports_newzealand | 0.19903 |
| Exch.rate_belgium | 0.881901 | Exch.rate_china | 0.061817 | Exch.rate_india | 0.326097 | Cycle_korea | 0.374103 | Imports_newzealand | 0.279873 |
| Cycle_newzealand | 0.045607 | Exch.rate_singapore | 0.425033 | RGDP_thailand | 0.237057 | Sp500_usa | 0.077623 | | |
| Exch.rate_newzealand | 0.296213 | RGDP_southafrica | 0.292036 | CPI_thailand | 0.007329 | Unemployment_usa | 0.622803 | | |
| RGDP_norway | 0.077219 | CPI_southafrica | 0.111893 | Rshort_thailand | 0.385741 | Ppi_usa | 0.085797 | | |
| CPI_norway | 0.030776 | Rshort_southafrica | 0.523837 | Exports_thailand | 0.253116 | Rer_usa | 0.809116 | | |
| Rshort_norway | 0.072497 | Exports_southafrica | 0.280609 | Imports_thailand | 0.210813 | | | | |
| Exports_norway | 0.378505 | Imports_southafrica | 0.220386 | Cycle_thailand | 0.469359 | | | | |
| Imports_norway | 0.393951 | Cycle_southafrica | 0.527449 | Exch.rate_thailand | 0.227556 | | | | |
| Cycle_norway | 0.102541 | Exch.rate_southafrica | 0.217362 | RGDP_turkey | 0.277517 | | | | |
| Exch.rate_norway | 0.775582 | RGDP_spain | 0.41284 | CPI_turkey | 0.333721 | | | | |
| RGDP_peru | 0.008027 | CPI_spain | 0.022849 | Rshort_turkey | 0.045467 | | | | |
| CPI_peru | 0.011622 | Rshort_spain | 0.026621 | Exports_turkey | 0.022077 | | | | |
| Rshort_peru | 0.01404 | Exports_spain | 0.130189 | Imports_turkey | 0.019464 | | | | |
| Exports_peru | 0.191683 | Imports_spain | 0.407071 | Cycle_turkey | 0.217544 | | | | |
| Imports_peru | 0.133266 | Cycle_spain | 0.186948 | Exch.rate_turkey | 0.071032 | | | | |
| Cycle_peru | 0.057156 | Exch.rate_spain | 0.728127 | RGDP_uk | 0.367736 | | | | |
| Exch.rate_peru | 0.057965 | RGDP_sweden | 0.091456 | CPI_uk | 0.479061 | | | | |
| RGDP_Philippines | 0.008991 | CPI_sweden | 0.422172 | Rshort_uk | 0.14396 | | | | |
| CPI_philippines | 0.234856 | Rshort_sweden | 0.066681 | Exports_uk | 0.458537 | | | | |
| Rshort_philippines | 0.074119 | Exports_sweden | 0.518633 | Imports_uk | 0.4525 | | | | |
| Exports_philippines | 0.197704 | Imports_sweden | 0.546379 | Cycle_uk | 0.568121 | | | | |
| Imports_philippines | 0.124535 | Cycle_sweden | 0.526354 | Exch.rate_uk | 0.598949 | | | | |
| Cycle_philippines | 0.00899 | Exch.rate_sweden | 0.659638 | RGDP_usa | 0.450933 | | | | |
| Exch.rate_philippines | 0.114892 | RGDP_switzerland | 0.46 | CPI_usa | 0.195082 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| RGDP_singapore | 0.237612 | CPI_switzerland | 0.530836 | Rshort_usa | 0.445752 |
| CPI_singapore | 0.082408 | Rshort_switzerland | 0.090414 | Rlong_usa | 0.445752 |
| Rshort_singapore | 0.278245 | Exports_switzerland | 0.68576 | Exports_usa | 0.348172 |
| Exports_singapre | 0.406276 | Imports_switzerland | 0.602315 | Imports_usa | 0.369885 |
| Imports_singapore | 0.302978 | Cycle_switzerland | 0.665142 | Cycle_usa | 0.473869 |
| Cycle_singapore | 0.230772 | Exch.rate_switzerland | 0.824458 | Iprod_usa | 0.626337 |

## Table A.3: Variance Shares, 1991Q1-2000Q4

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Oil price | 0.034451 | RGDP_Brazil | 0.259982 | RGDP_finland | 0.477177 | Exch.rate_india | 0.169738 | Cycle_korea | 0.040537 |
| RGDP_Arg | 0.056115 | CPI_Brazil | 0.48071 | CPI_finland | 0.049221 | RGDP_indonesia | 0.235846 | Exch.rate_korea | 0.210939 |
| CPI_Arg | 0.121825 | Rshort_brazil | 0.02618 | Rshort_finland | 0.479992 | CPI_indonesia | 0.376951 | RGDP_malaysia | 0.435584 |
| Rshort_Arg | 0.271713 | Exports_brazil | 0.110389 | Exports_finland | 0.444666 | Rshort_indonesia | 0.441066 | CPI_malaysia | 0.362451 |
| Exports_Arg | 0.391473 | Imports_brazil | 0.075676 | Imports_finland | 0.458178 | Exports_indonesia | 0.417919 | Rshort_malaysia | 0.578675 |
| Imports_Arg | 0.110538 | Cycle_brazil | 0.500089 | Cycle_finland | 0.613686 | Imports_indonesia | 0.361869 | Exports_malaysia | 0.477975 |
| Cycle_Arg | 0.100012 | Exch.rate_brazil | 0.027463 | Exch.rate_finland | 0.798212 | Cycle_indonesia | 0.094423 | Imports_malaysia | 0.516886 |
| Exch.rate_Arg | 0.040255 | RGDP_Canada | 0.481007 | RGDP_france | 0.313743 | Exch.rate_indonesia | 0.344682 | Cycle_malaysia | 0.071085 |
| RGDP_Austral | 0.10996 | CPI_Canada | 0.110222 | CPI_france | 0.210305 | RGDP_italy | 0.226367 | Exch.rate_malaysia | 0.33774 |
| CPI_Austral | 0.072237 | Rshort_canada | 0.367416 | Rshort_france | 0.087811 | CPI_italy | 0.052465 | RGDP_mexico | 0.102862 |
| Rshort_Austral | 0.333924 | Exports_canada | 0.289101 | Exports_france | 0.848206 | Rshort_italy | 0.435206 | CPI_mexico | 0.037975 |
| Exports_Austral | 0.262208 | Imports_canada | 0.141035 | Imports_france | 0.820435 | Exports_italy | 0.791418 | Rshort_mexico | 0.036762 |
| Imports_Austral | 0.410822 | Cycle_canada | 0.62235 | Cycle_france | 0.014622 | Imports_italy | 0.782094 | Exports_mexico | 0.245901 |
| Cycle_Austral | 0.574268 | Exch.rate_canada | 0.013738 | Exch.rate_france | 0.848714 | Cycle_italy | 0.281671 | Imports_mexico | 0.064454 |
| Exch.rate_Austral | 0.254864 | RGDP_chile | 0.082109 | RGDP_germany | 0.085244 | Exch.rate_italy | 0.712574 | Cycle_mexico | 0.00464 |
| RGDP_Austria | 0.050453 | CPI_chile | 0.127084 | CPI_germany | 0.083195 | RGDP_japan | 0.009581 | Exch.rate_mexico | 0.114106 |
| CPI_Austria | 0.040799 | Rshort_chile | 0.07234 | Rshort_germany | 0.311076 | CPI_japan | 0.101663 | RGDP_netherlands | 0.349337 |
| Rshort_Austria | 0.323607 | Exports_chile | 0.181404 | Exports_germany | 0.831734 | Rshort_japan | 0.490834 | CPI_netherlands | 0.069209 |
| Exports_Austria | 0.804326 | Imports_chile | 0.171861 | Imports_germany | 0.669753 | Exports_japan | 0.374655 | Rshort_netherlands | 0.335175 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Imports_Austria | 0.68645 | Cycle_chile | 0.228188 | Cycle_germany | 0.234562 | Imports_japan | 0.588062 | Exports_netherlands | 0.793802 |
| Cycle_Austria | 0.080551 | Exch.rate_chile | 0.076043 | Exch.rate_germany | 0.840361 | Cycle_japan | 0.414945 | Imports_netherlands | 0.779731 |
| Exch.rate_Austria | 0.841735 | RGDP_china | 0.158848 | RGDP_india | 0.044598 | Exch.rate_japan | 0.320138 | Cycle_netherlands | 0.220532 |
| RGDP_Belgium | 0.202519 | CPI_china | 0.430677 | CPI_india | 0.380987 | RGDP_korea | 0.393586 | Exch.rate_netherlands | 0.851958 |
| CPI_Belgium | 0.050014 | Exports_china | 0.10402 | Rshort_india | 0.059106 | CPI_korea | 0.308556 | RGDP_newzealand | 0.516872 |
| Rshort_Belgium | 0.145773 | Imports_china | 0.094052 | Exports_india | 0.181596 | Rshort_korea | 0.505822 | CPI_newzealand | 0.191645 |
| Cycle_Belgium | 0.198441 | Cycle_china | 0.284264 | Imports_india | 0.215942 | Exports_korea | 0.225216 | Rshort_newzealand | 0.24598 |
| Exch.rate_belgium | 0.848892 | Exch.rate_china | 0.012585 | Cycle_india | 0.331784 | Imports_korea | 0.576709 | Exports_newzealand | 0.339513 |
| Imports_newzealand | 0.33128 | Cycle_singapore | 0.298651 | Exch.rate_switzerland | 0.803481 | Iprod_usa | 0.241315 | | |
| Cycle_newzealand | 0.516888 | Exch.rate_singapore | 0.638946 | RGDP_thailand | 0.426552 | Sp500_usa | 0.132662 | | |
| Exch.rate_newzealand | 0.528517 | RGDP_southafrica | 0.533367 | CPI_thailand | 0.235697 | Unemployment_usa | 0.208705 | | |
| RGDP_norway | 0.074052 | CPI_southafrica | 0.21691 | Rshort_thailand | 0.455135 | Ppi_usa | 0.252971 | | |
| CPI_norway | 0.034245 | Rshort_southafrica | 0.355116 | Exports_thailand | 0.204888 | Rer_usa | 0.678818 | | |
| Rshort_norway | 0.081461 | Exports_southafrica | 0.201988 | Imports_thailand | 0.471459 | | | | |
| Exports_norway | 0.560534 | Imports_southafrica | 0.128287 | Cycle_thailand | 0.034238 | | | | |
| Imports_norway | 0.543476 | Cycle_southafrica | 0.461723 | Exch.rate_thailand | 0.232214 | | | | |
| Cycle_norway | 0.547067 | Exch.rate_southafrica | 0.300748 | RGDP_turkey | 0.012538 | | | | |
| Exch.rate_norway | 0.774411 | RGDP_spain | 0.550898 | CPI_turkey | 0.150516 | | | | |
| RGDP_peru | 0.066646 | CPI_spain | 0.072513 | Rshort_turkey | 0.094643 | | | | |
| CPI_peru | 0.213748 | Rshort_spain | 0.016715 | Exports_turkey | 0.075097 | | | | |
| Rshort_peru | 0.279584 | Exports_spain | 0.593538 | Imports_turkey | 0.026711 | | | | |
| Exports_peru | 0.32325 | Imports_spain | 0.702356 | Cycle_turkey | 0.318085 | | | | |
| Imports_peru | 0.510453 | Cycle_spain | 0.18947 | Exch.rate_turkey | 0.085281 | | | | |
| Cycle_peru | 0.588032 | Exch.rate_spain | 0.771647 | RGDP_uk | 0.522943 | | | | |
| Exch.rate_peru | 0.06923 | RGDP_sweden | 0.314392 | CPI_uk | 0.14265 | | | | |
| RGDP_Philippines | 0.355001 | CPI_sweden | 0.32309 | Rshort_uk | 0.714646 | | | | |
| CPI_philippines | 0.136891 | Rshort_sweden | 0.555806 | Exports_uk | 0.554558 | | | | |
| Rshort_philippines | 0.724761 | Exports_sweden | 0.735889 | Imports_uk | 0.613024 | | | | |
| Exports_philippines | 0.02062 | Imports_sweden | 0.747094 | Cycle_uk | 0.687256 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Imports_philippines | 0.303871 | Cycle_sweden | 0.234692 | Exch.rate_uk | 0.646274 |
| Cycle_philippines | 0.389084 | Exch.rate_sweden | 0.681134 | RGDP_usa | 0.132207 |
| Exch.rate_philippines | 0.360586 | RGDP_switzerland | 0.203146 | CPI_usa | 0.280673 |
| RGDP_singapore | 0.411927 | CPI_switzerland | 0.097074 | Rshort_usa | 0.383056 |
| CPI_singapore | 0.243754 | Rshort_switzerland | 0.182364 | Rlong_usa | 0.302102 |
| Rshort_singapore | 0.628431 | Exports_switzerland | 0.722588 | Exports_usa | 0.274386 |
| Exports_singapre | 0.45922 | Imports_switzerland | 0.737536 | Imports_usa | 0.621565 |
| Imports_singapore | 0.492107 | Cycle_switzerland | 0.123619 | Cycle_usa | 0.005972 |

## Table A.4: Variance shares, 2001Q1-2011Q2

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Oil price | 0.621222 | RGDP_Brazil | 0.508157 | RGDP_finland | 0.585434 | Exch.rate_india | 0.504469 | Cycle_korea | 0.739597 |
| RGDP_Arg | 0.256343 | CPI_Brazil | 0.068332 | CPI_finland | 0.666737 | RGDP_indonesia | 0.214555 | Exch.rate_korea | 0.734773 |
| CPI_Arg | 0.059369 | Rshort_brazil | 0.087955 | Rshort_finland | 0.842739 | CPI_indonesia | 0.087124 | RGDP_malaysia | 0.714026 |
| Rshort_Arg | 0.149281 | Exports_brazil | 0.494143 | Exports_finland | 0.673842 | Rshort_indonesia | 0.07829 | CPI_malaysia | 0.421594 |
| Exports_Arg | 0.287701 | Imports_brazil | 0.75242 | Imports_finland | 0.897659 | Exports_indonesia | 0.679966 | Rshort_malaysia | 0.70379 |
| Imports_Arg | 0.29867 | Cycle_brazil | 0.7077 | Cycle_finland | 0.905664 | Imports_indonesia | 0.48869 | Exports_malaysia | 0.774924 |
| Cycle_Arg | 0.39251 | Exch.rate_brazil | 0.3062 | Exch.rate_finland | 0.92008 | Cycle_indonesia | 0.424217 | Imports_malaysia | 0.787896 |
| Exch.rate_Arg | 0.041185 | RGDP_Canada | 0.664915 | RGDP_france | 0.692185 | Exch.rate_indonesia | 0.363341 | Cycle_malaysia | 0.881504 |
| RGDP_Austral | 0.112404 | CPI_Canada | 0.347751 | CPI_france | 0.105896 | RGDP_italy | 0.658936 | Exch.rate_malaysia | 0.609559 |
| CPI_Austral | 0.294675 | Rshort_canada | 0.340385 | Rshort_france | 0.831739 | CPI_italy | 0.513021 | RGDP_mexico | 0.632467 |
| Rshort_Austral | 0.859386 | Exports_canada | 0.626799 | Exports_france | 0.868098 | Rshort_italy | 0.819013 | CPI_mexico | 0.058272 |
| Exports_Austral | 0.573762 | Imports_canada | 0.2907 | Imports_france | 0.925155 | Exports_italy | 0.826411 | Rshort_mexico | 0.099322 |
| Imports_Austral | 0.855122 | Cycle_canada | 0.835168 | Cycle_france | 0.819738 | Imports_italy | 0.906011 | Exports_mexico | 0.505828 |
| Cycle_Austral | 0.354865 | Exch.rate_canada | 0.628129 | Exch.rate_france | 0.920272 | Cycle_italy | 0.846054 | Imports_mexico | 0.891258 |
| Exch.rate_Austral | 0.837221 | RGDP_chile | 0.362783 | RGDP_germany | 0.71555 | Exch.rate_italy | 0.914063 | Cycle_mexico | 0.887089 |
| RGDP_Austria | 0.27081 | CPI_chile | 0.69843 | CPI_germany | 0.517526 | RGDP_japan | 0.620462 | Exch.rate_mexico | 0.370695 |
| CPI_Austria | 0.525727 | Rshort_chile | 0.381897 | Rshort_germany | 0.831739 | CPI_japan | 0.523283 | RGDP_netherlands | 0.736496 |

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| Rshort_Austria | 0.831739 | Exports_chile | 0.604914 | Exports_germany | 0.851121 | Rshort_japan | 0.475982 | CPI_netherlands | 0.063698 |
| Exports_Austria | 0.816263 | Imports_chile | 0.857427 | Imports_germany | 0.825416 | Exports_japan | 0.739711 | Rshort_netherlands | 0.831739 |
| Imports_Austria | 0.743545 | Cycle_chile | 0.71466 | Cycle_germany | 0.823566 | Imports_japan | 0.728632 | Exports_netherlands | 0.905495 |
| Cycle_Austria | 0.76776 | Exch.rate_chile | 0.416686 | Exch.rate_germany | 0.915504 | Cycle_japan | 0.869178 | Imports_netherlands | 0.93033 |
| Exch.rate_Austria | 0.914522 | RGDP_china | 0.368824 | RGDP_india | 0.023905 | Exch.rate_japan | 0.10811 | Cycle_netherlands | 0.850609 |
| RGDP_Belgium | 0.798072 | CPI_china | 0.475358 | CPI_india | 0.013576 | RGDP_korea | 0.489297 | Exch.rate_netherlands | 0.912617 |
| CPI_Belgium | 0.502186 | Exports_china | 0.687541 | Rshort_india | 0.517798 | CPI_korea | 0.278291 | RGDP_newzealand | 0.25717 |
| Rshort_Belgium | 0.831739 | Imports_china | 0.684417 | Exports_india | 0.644754 | Rshort_korea | 0.79049 | CPI_newzealand | 0.241242 |
| Cycle_Belgium | 0.905308 | Cycle_china | 0.578717 | Imports_india | 0.514496 | Exports_korea | 0.784286 | Rshort_newzealand | 0.772863 |
| Exch.rate_belgium | 0.927348 | Exch.rate_china | 0.597548 | Cycle_india | 0.164019 | Imports_korea | 0.842387 | Exports_newzealand | 0.637141 |
| Imports_newzealand | 0.783326 | Cycle_singapore | 0.74098 | Exch.rate_switzerland | 0.765386 | CPI_usa | 0.638165 | | |
| Cycle_newzealand | 0.536326 | Exch.rate_singapore | 0.66628 | RGDP_thailand | 0.699237 | Rshort_usa | 0.405769 | | |
| Exch.rate_newzealand | 0.748979 | RGDP_southafrica | 0.68307 | CPI_thailand | 0.522924 | Rlong_usa | 0.219804 | | |
| RGDP_norway | 0.109262 | CPI_southafrica | 0.274438 | Rshort_thailand | 0.295229 | Exports_usa | 0.893466 | | |
| CPI_norway | 0.050562 | Rshort_southafrica | 0.344204 | Exports_thailand | 0.516416 | Imports_usa | 0.864026 | | |
| Rshort_norway | 0.696614 | Exports_southafrica | 0.719506 | Imports_thailand | 0.544859 | Cycle_usa | 0.843166 | | |
| Exports_norway | 0.762105 | Imports_southafrica | 0.597115 | Cycle_thailand | 0.801949 | Iprod_usa | 0.71436 | | |
| Imports_norway | 0.59617 | Cycle_southafrica | 0.866459 | Exch.rate_thailand | 0.500885 | Sp500_usa | 0.627783 | | |
| Cycle_norway | 0.571914 | Exch.rate_southafrica | 0.477279 | RGDP_turkey | 0.480514 | Unemployment_usa | 0.667205 | | |
| Exch.rate_norway | 0.805869 | RGDP_spain | 0.431851 | CPI_turkey | 0.015386 | Ppi_usa | 0.572273 | | |
| RGDP_peru | 0.443538 | CPI_spain | 0.546737 | Rshort_turkey | 0.217852 | Rer_usa | 0.852758 | | |
| CPI_peru | 0.258995 | Rshort_spain | 0.836932 | Exports_turkey | 0.550571 | | | | |
| Rshort_peru | 0.585776 | Exports_spain | 0.852899 | Imports_turkey | 0.673634 | | | | |
| Exports_peru | 0.669178 | Imports_spain | 0.844617 | Cycle_turkey | 0.727875 | | | | |
| Imports_peru | 0.706366 | Cycle_spain | 0.806414 | Exch.rate_turkey | 0.238838 | | | | |
| Cycle_peru | 0.63428 | Exch.rate_spain | 0.909258 | RGDP_uk | 0.563166 | | | | |
| Exch.rate_peru | 0.384246 | RGDP_sweden | 0.606999 | CPI_uk | 0.268948 | | | | |
| RGDP_Philippines | 0.339383 | CPI_sweden | 0.536948 | Rshort_uk | 0.782002 | | | | |
| CPI_philippines | 0.31459 | Rshort_sweden | 0.763855 | Exports_uk | 0.64495 | | | | |

| | | | | | |
|---|---|---|---|---|---|
| Rshort_philippines | 0.027223 | Exports_sweden | 0.873884 | Imports_uk | 0.75898 |
| Exports_philippines | 0.525756 | Imports_sweden | 0.891402 | Cycle_uk | 0.880836 |
| Imports_philippines | 0.575507 | Cycle_sweden | 0.808347 | Exch.rate_uk | 0.77073 |
| Cycle_philippines | 0.692156 | Exch.rate_sweden | 0.904082 | RGDP_usa | 0.73632 |
| Exch.rate_philippines | 0.291168 | RGDP_switzerland | 0.64311 | | |
| RGDP_singapore | 0.495856 | CPI_switzerland | 0.503421 | | |
| CPI_singapore | 0.462298 | Rshort_switzerland | 0.325286 | | |
| Rshort_singapore | 0.256414 | Exports_switzerland | 0.75682 | | |
| Exports_singapre | 0.85011 | Imports_switzerland | 0.75173 | | |
| Imports_singapore | 0.839276 | Cycle_switzerland | 0.786203 | | |

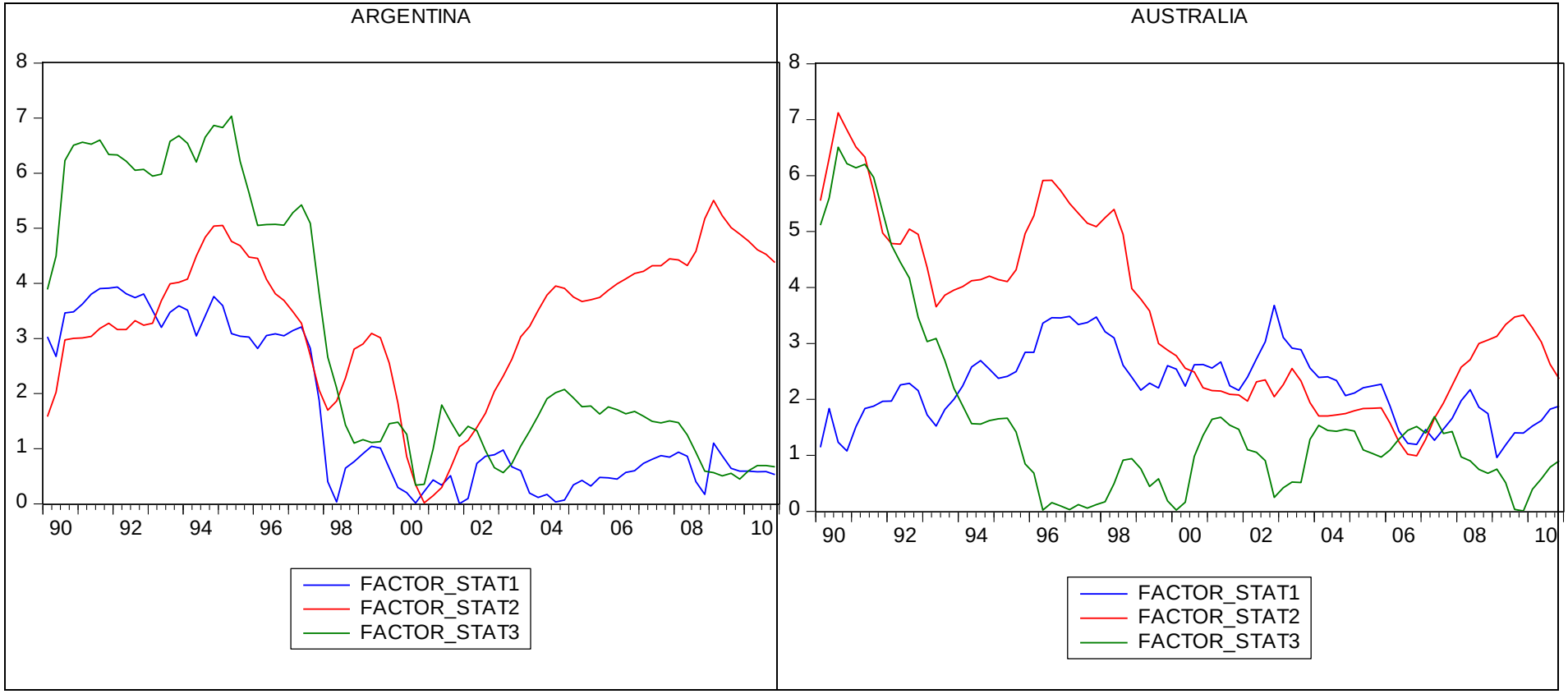
## Table A.5: Bai-Ng criteria

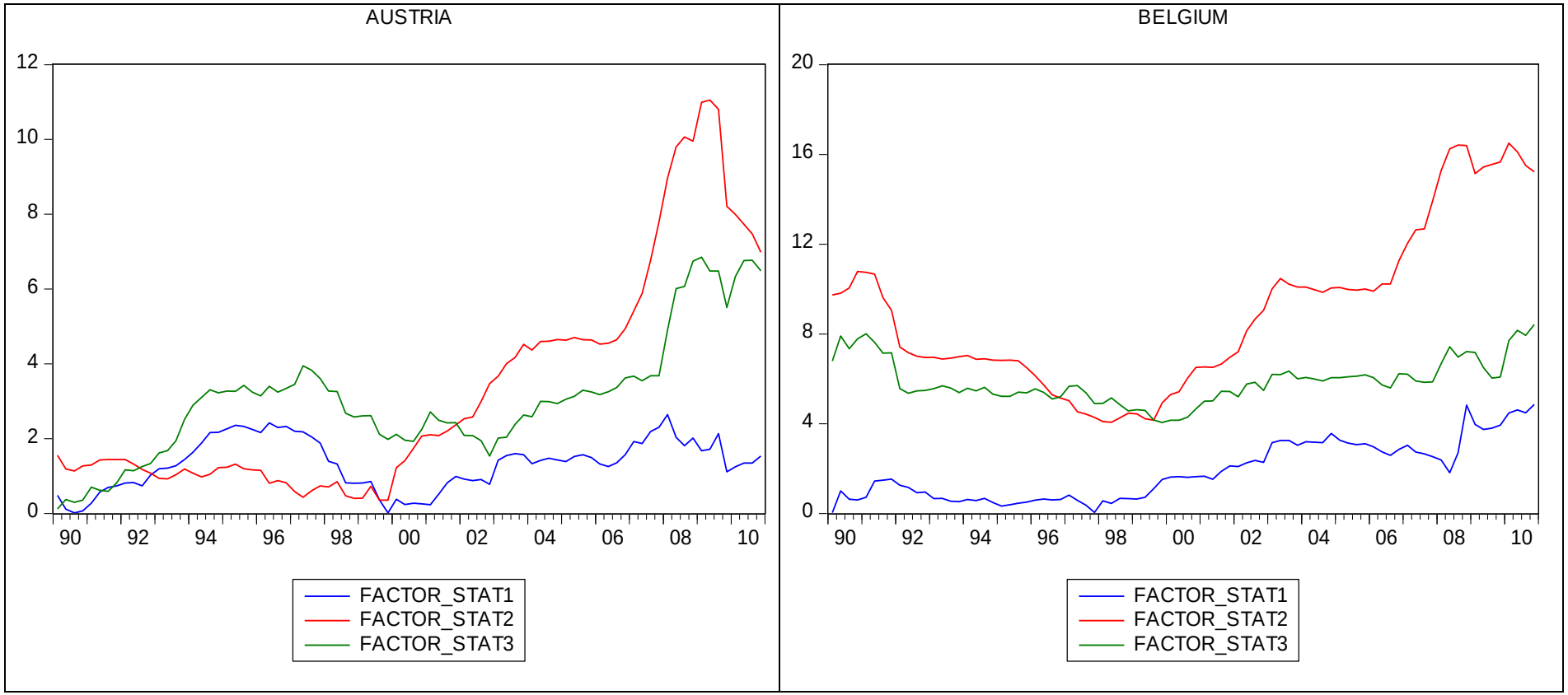
An asterisk denotes the ideal number of factors. The ICp criteria especially converge strongly around 3 factors and this is also supported by the fact that cumulative variance share diminishes to less than 5% after 3 factors.

| | **Criteria** | | | | | | |
|---|---|---|---|---|---|---|---|
| *r* | *PCp1* | *PCp2* | *PCp3* | *ICp1* | *ICp2* | *ICp3* | *Cum. Variance* |
| 1 | 0.849633 | 0.852445 | 0.841446 | -0.14227 | -0.13681 | -0.15818 | 0.17 |
| 2 | 0.805533 | 0.811156 | 0.789158 | -0.17985 | -0.16893 | -0.21168 | 0.07 |
| 3 | 0.777026 | 0.78546 | 0.752463 | -0.20391* | -0.18752* | -0.25165 | 0.06 |
| 4 | 0.770511 | 0.781757* | 0.73776 | -0.20065 | -0.1788 | -0.26429 | 0.03 |
| 5 | 0.768628* | 0.782685 | 0.727689 | -0.1927 | -0.16538 | -0.27226 | 0.03 |
| 6 | 0.770062 | 0.78693 | 0.720934 | -0.18145 | -0.14867 | -0.27692 | 0.03 |
| 7 | 0.774577 | 0.794257 | 0.717262 | -0.16677 | -0.12853 | -0.27815 | 0.02 |
| 8 | 0.779342 | 0.801833 | 0.713839 | -0.15324 | -0.10953 | -0.28053 | 0.02 |
| 9 | 0.785109 | 0.810412 | 0.711419 | -0.13952 | -0.09035 | -0.28272 | 0.02 |
| 10 | 0.791541 | 0.819655 | 0.709662 | -0.1262 | -0.07156 | -0.28531 | 0.02 |

## A.6: T-statistics of rolling regressions

The t-statistics for Factor 1, Factor 2 and Factor 3 are reported here graphically for each country analysed. The critical t-value is 1.66, 2.37 and 3.19 at 5%, 10% and 1% significance, respectively.

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FACTOR_STAT1
FACTOR_STAT2
FACTOR_STAT3
BELGIUM
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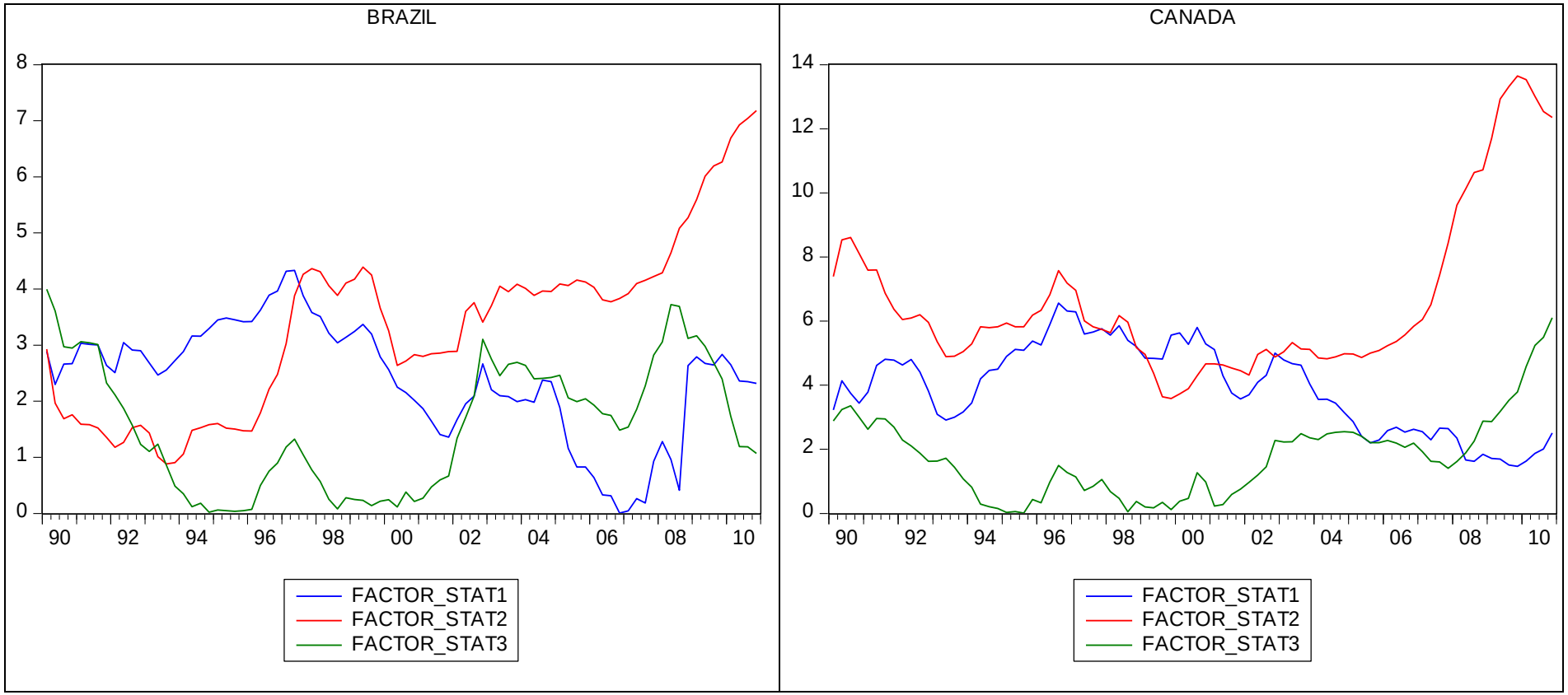
FACTOR_STAT2
FACTOR_STAT3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FACTOR_STAT1
FACTOR_STAT2
FACTOR_STAT3
CANADA
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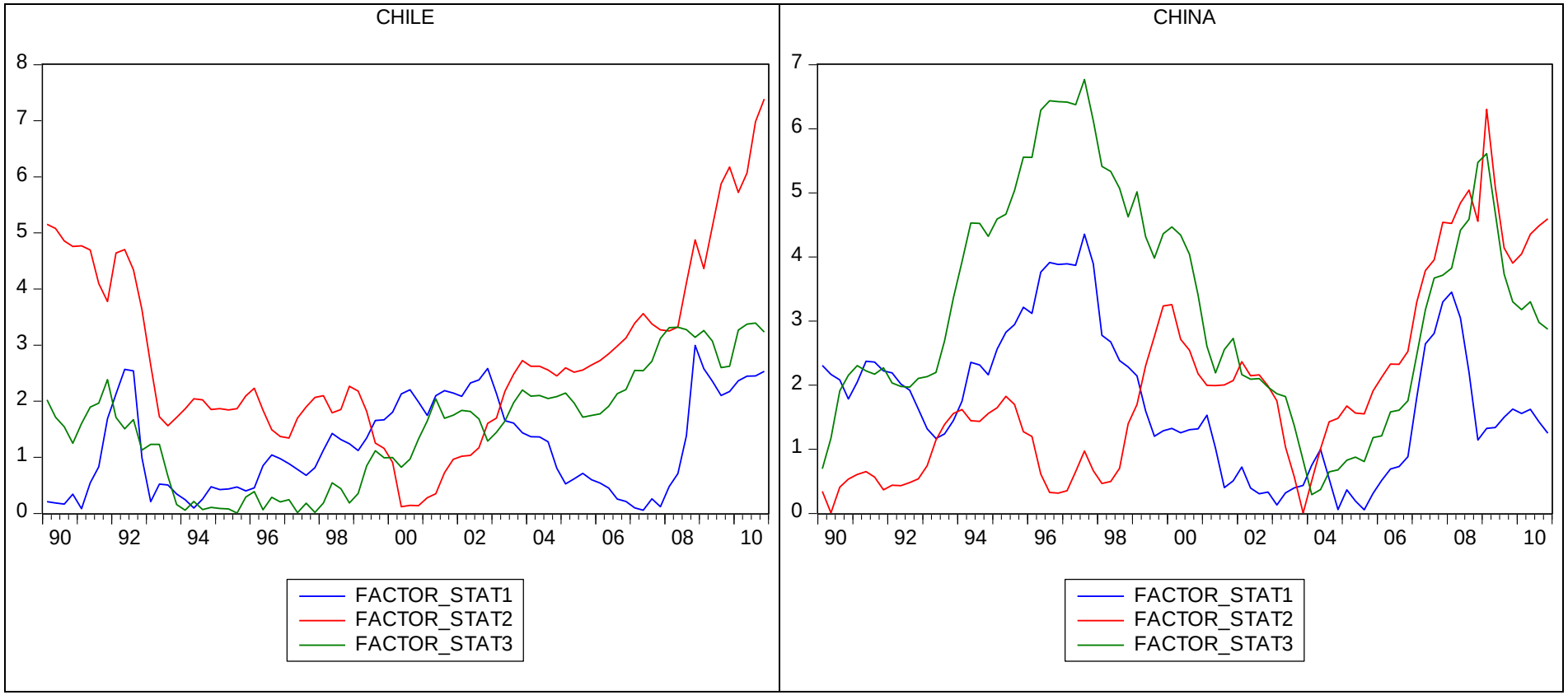
FACTOR_STAT2
FACTOR_STAT3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FACTOR_STAT1
FACTOR_STAT2
FACTOR_STAT3
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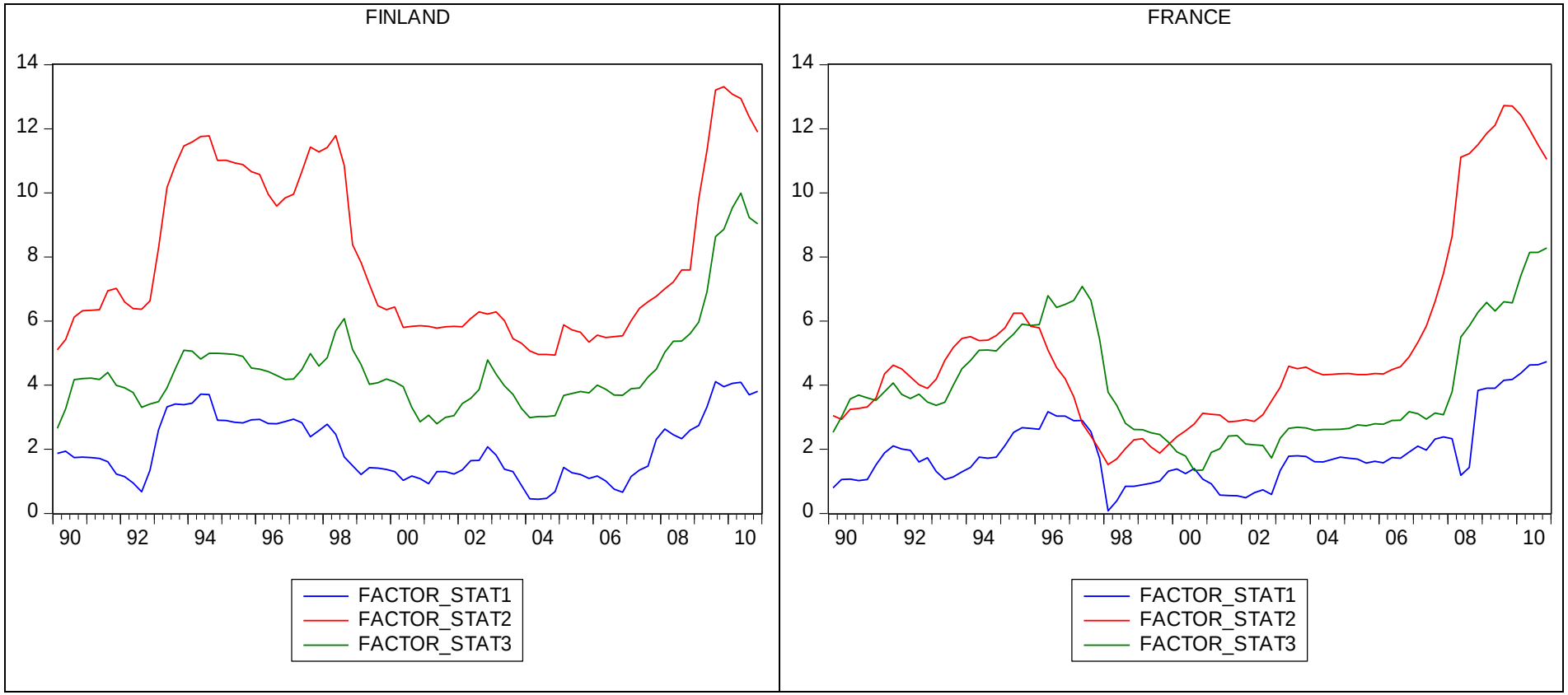
FACTOR_STAT3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FRANCE
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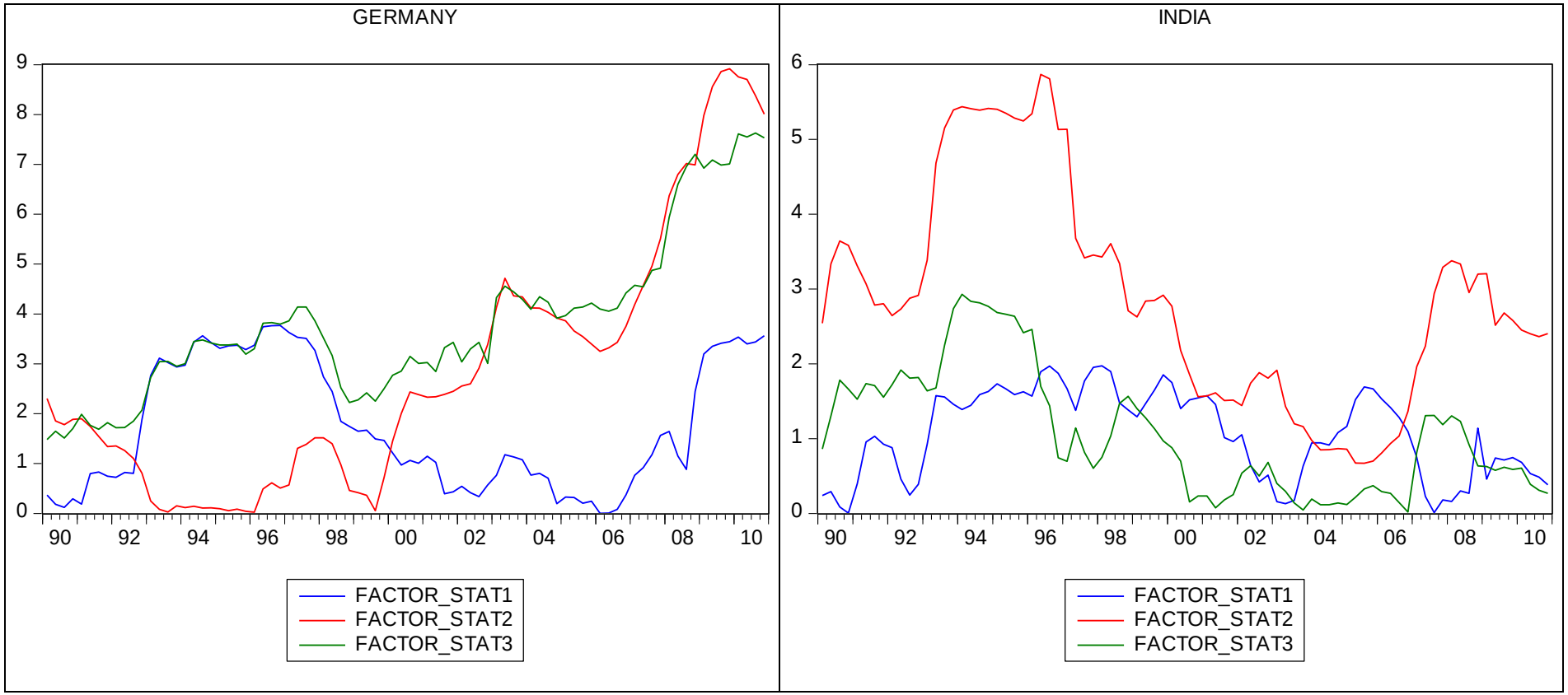
FACTOR_STAT3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FACTOR_STAT1
FACTOR_STAT2
FACTOR_STAT3
INDIA
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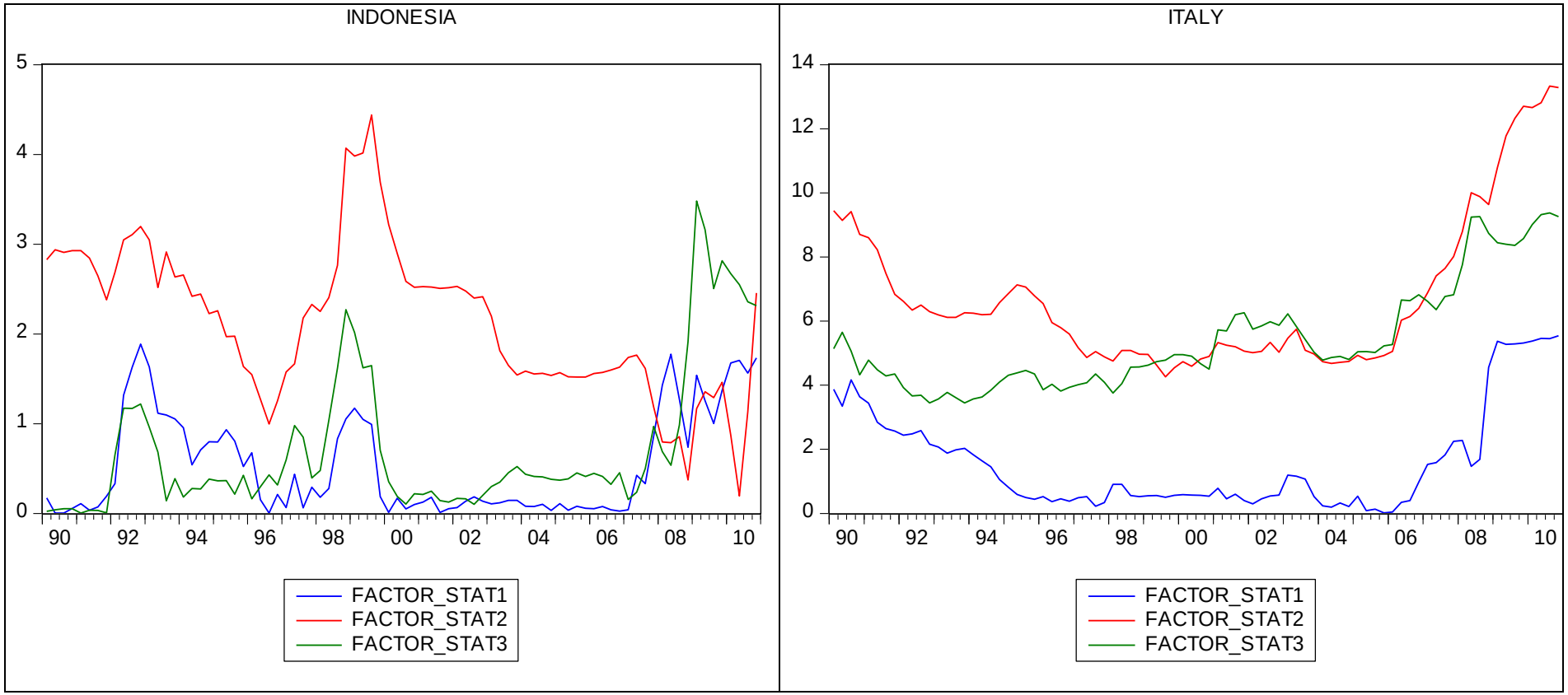
FACTOR_STAT3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FACTOR_STAT2
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ITALY
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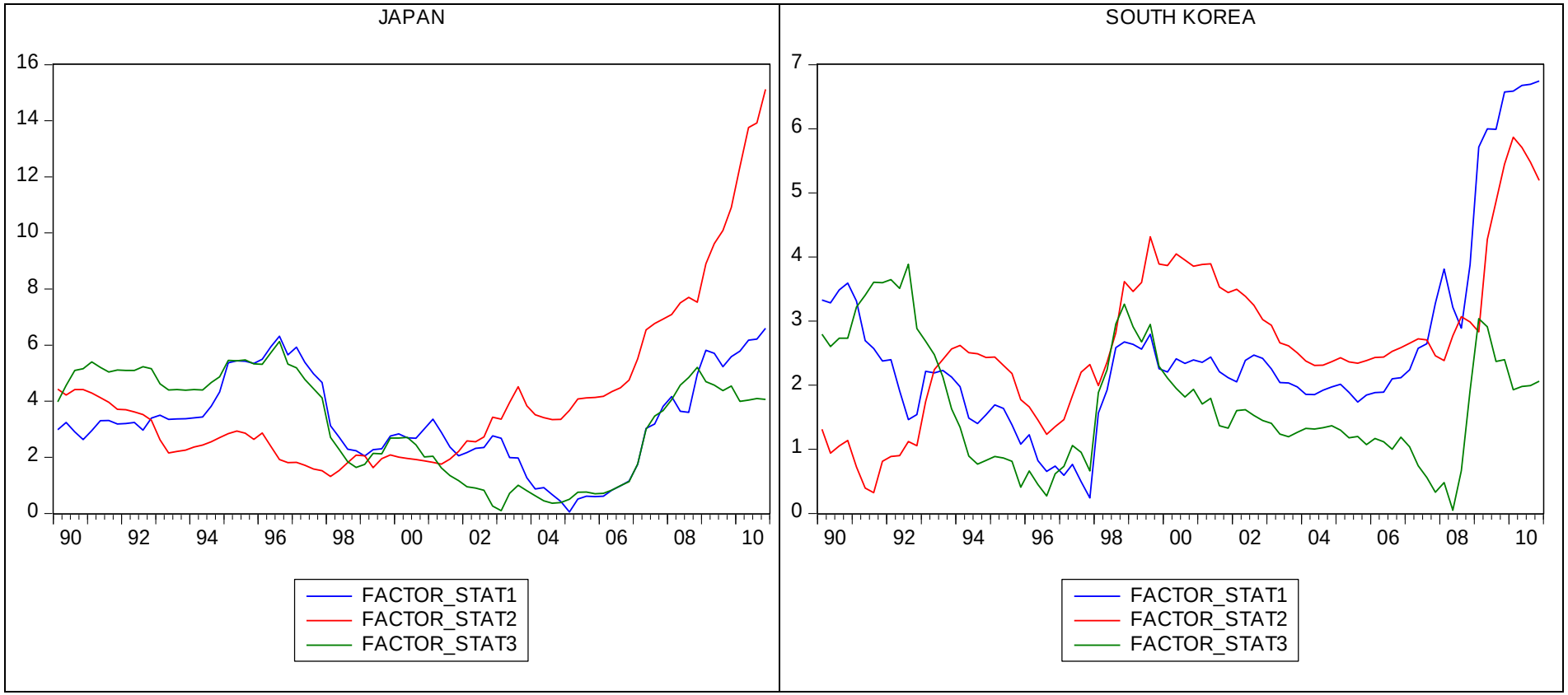
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FACTOR_STAT1
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FACTOR_STAT3
SOUTH KOREA
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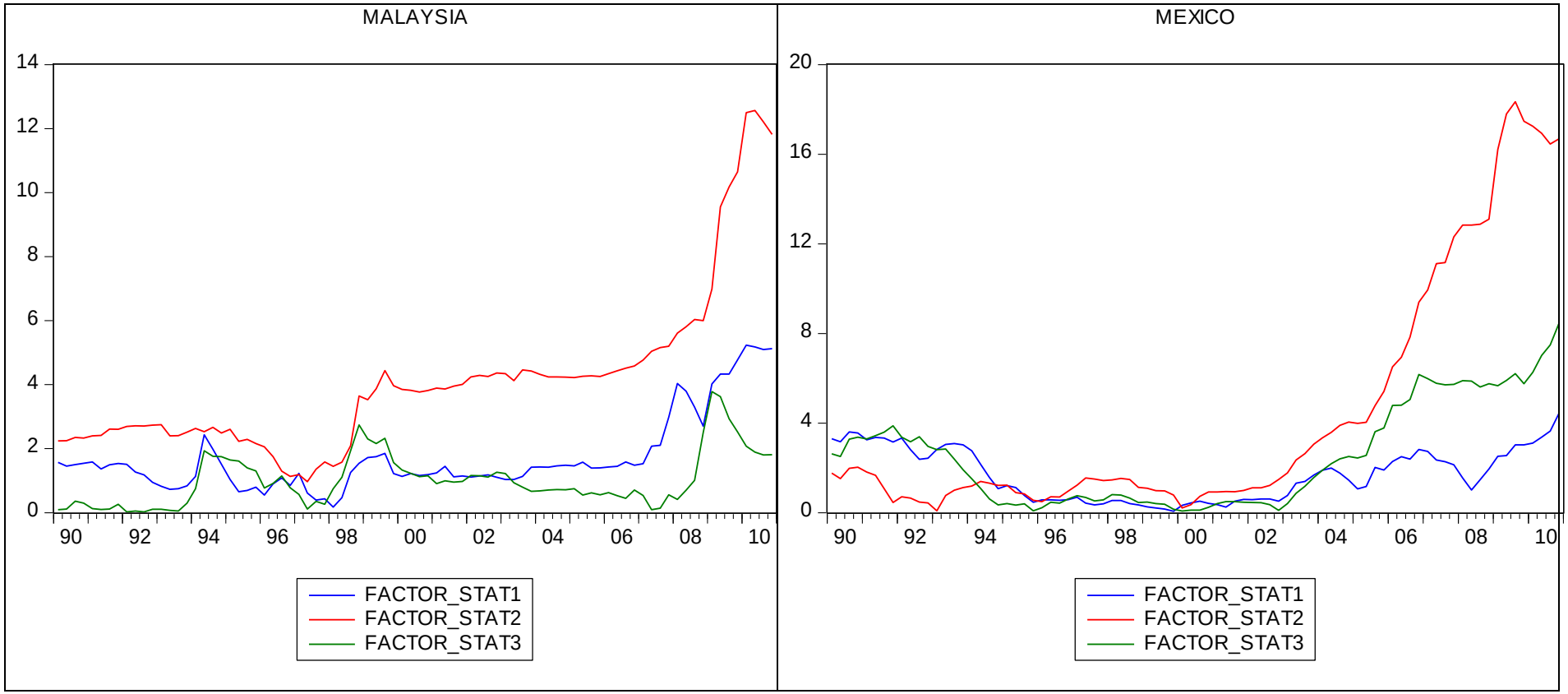
FACTOR_STAT3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FACTOR_STAT1
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FACTOR_STAT3
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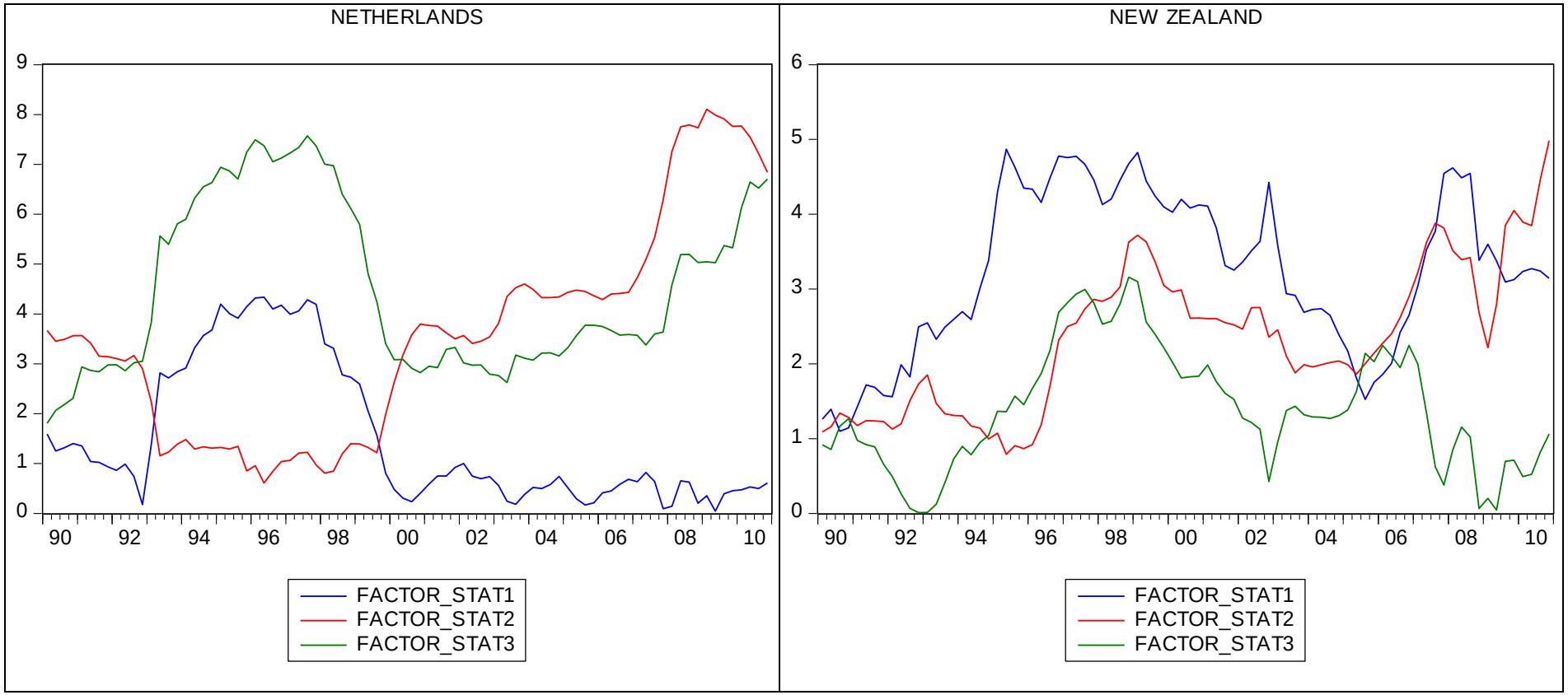
FACTOR_STAT3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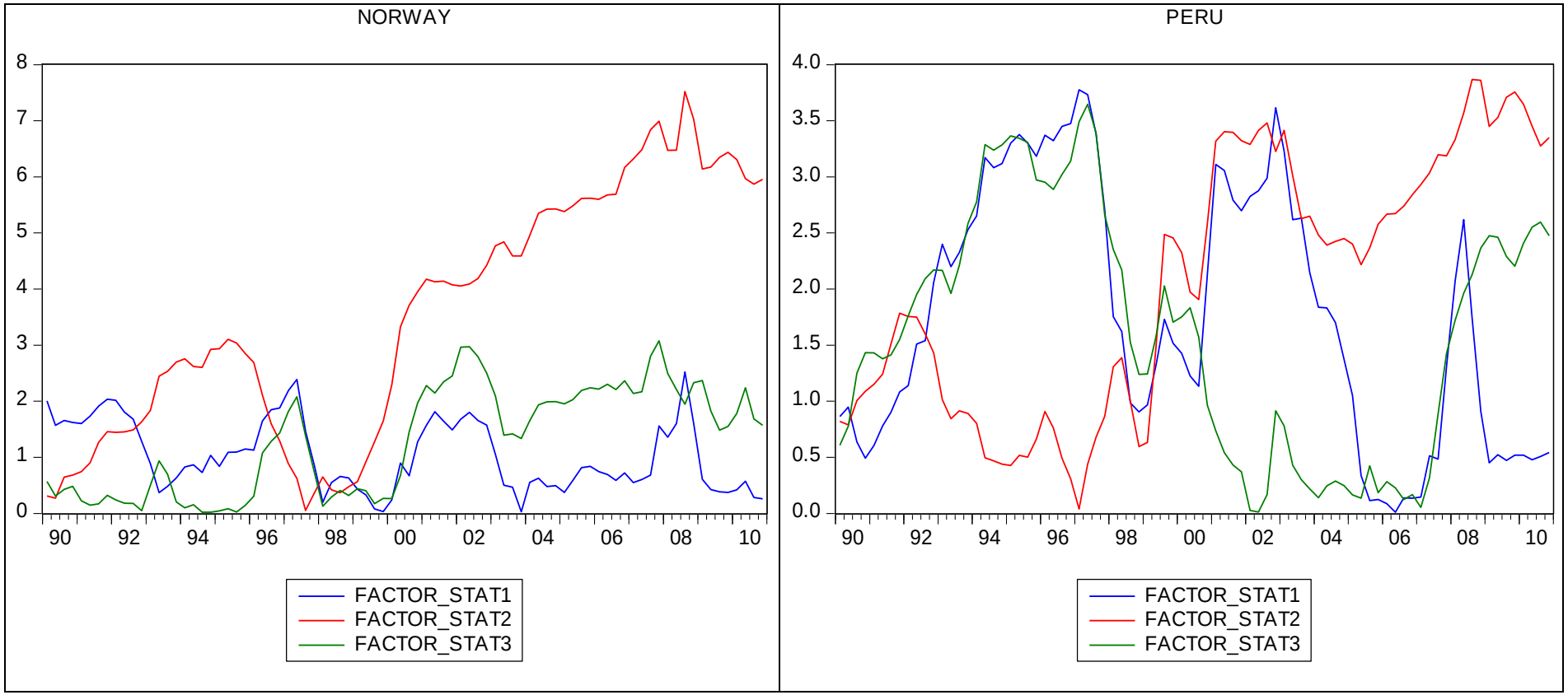
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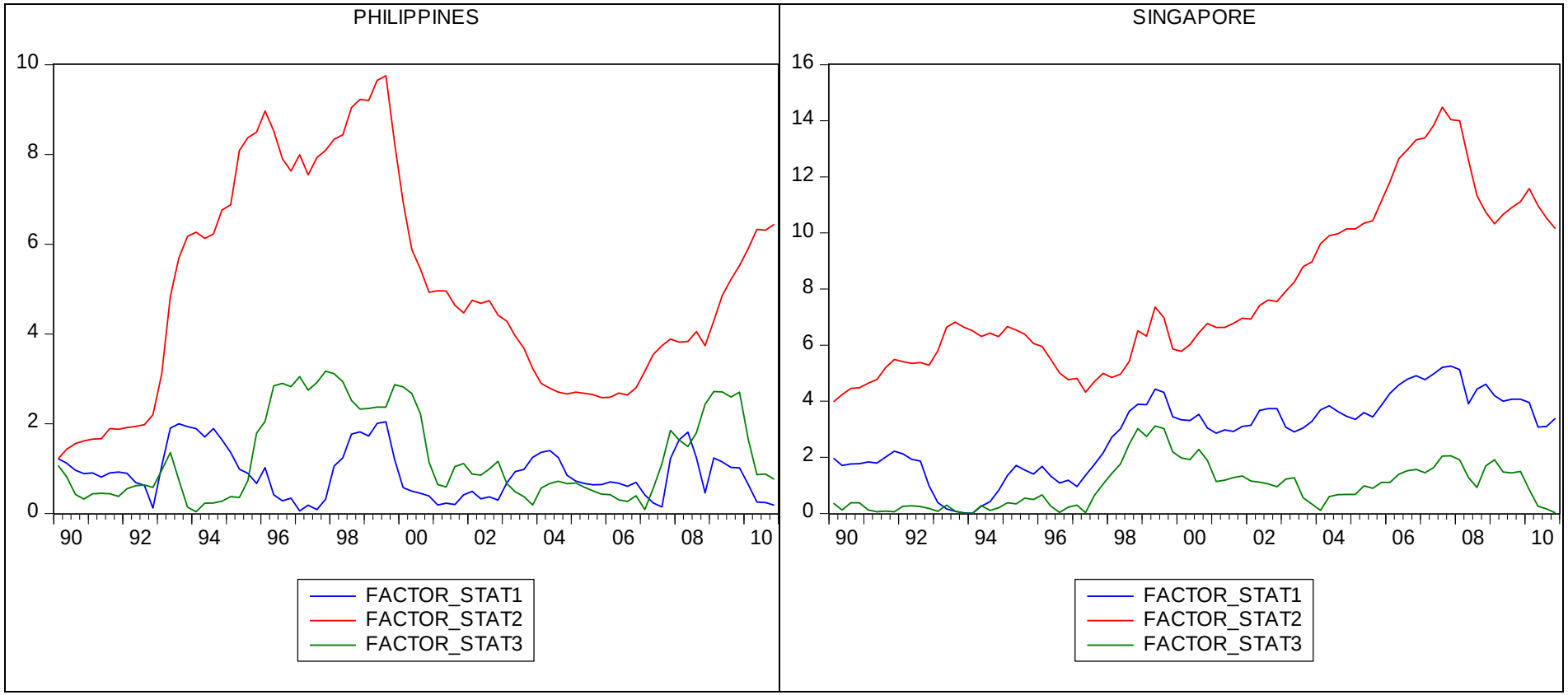
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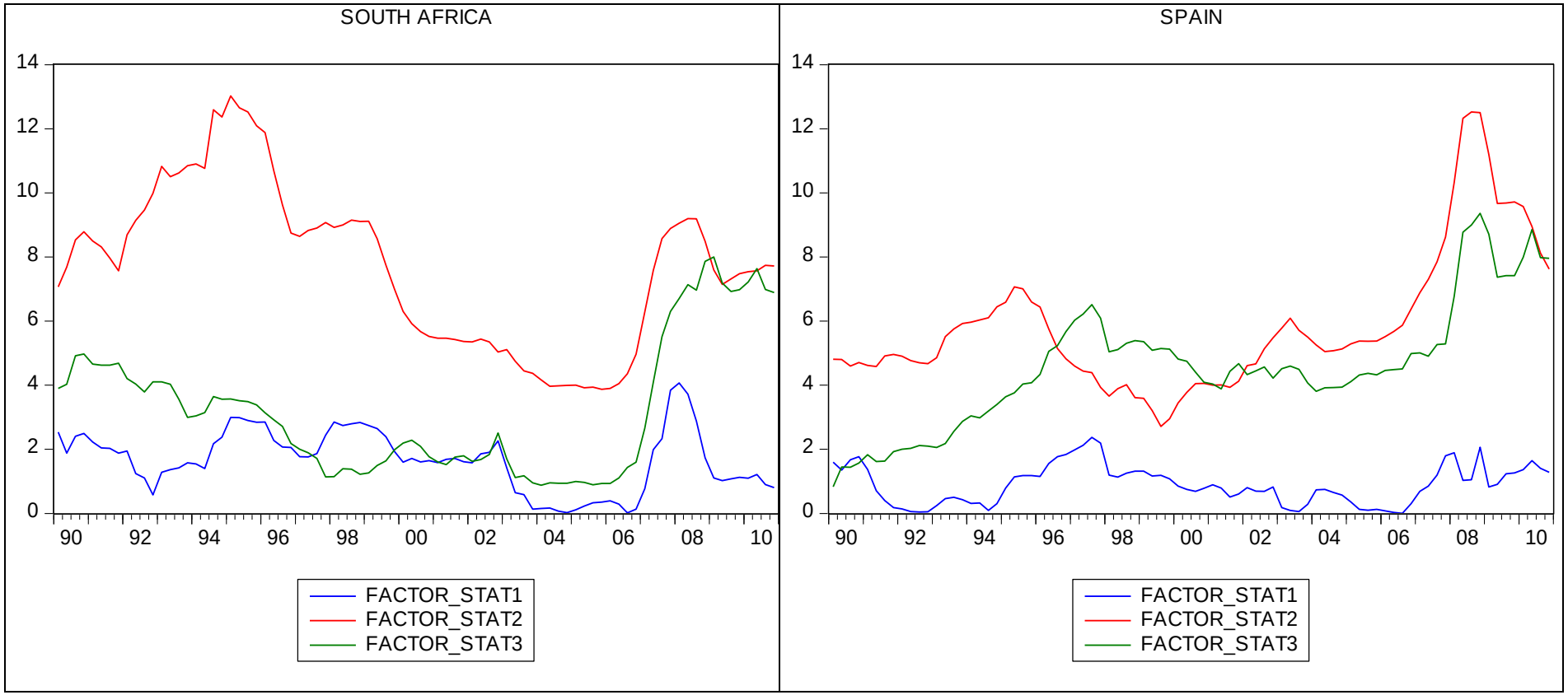
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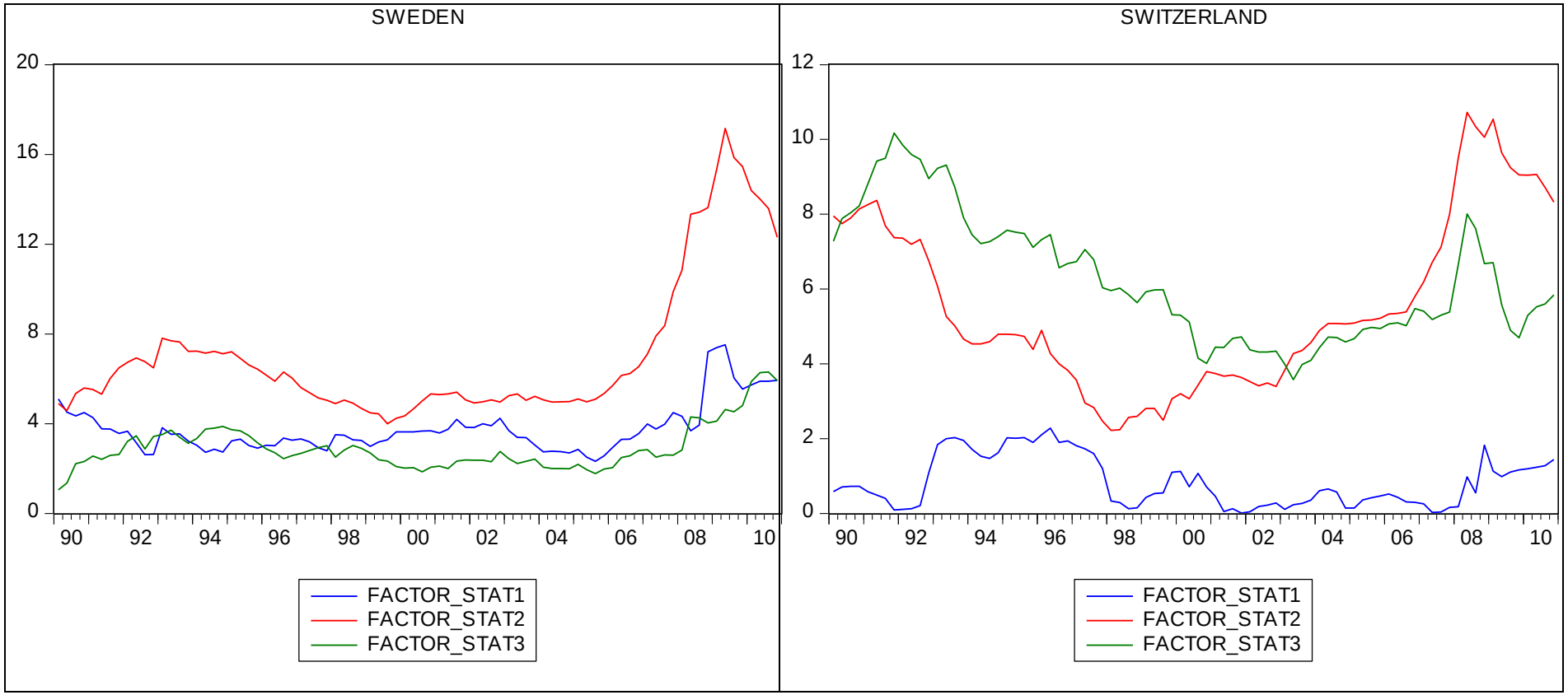
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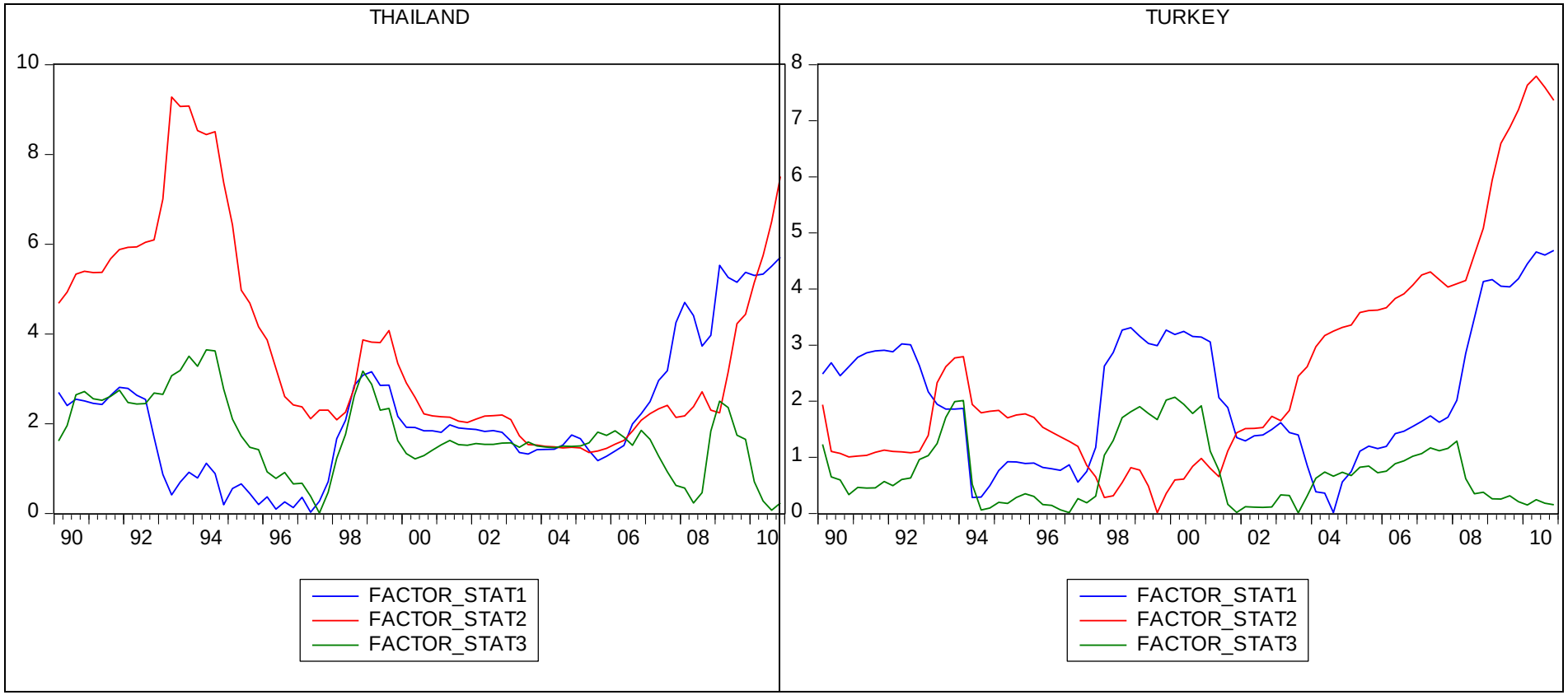
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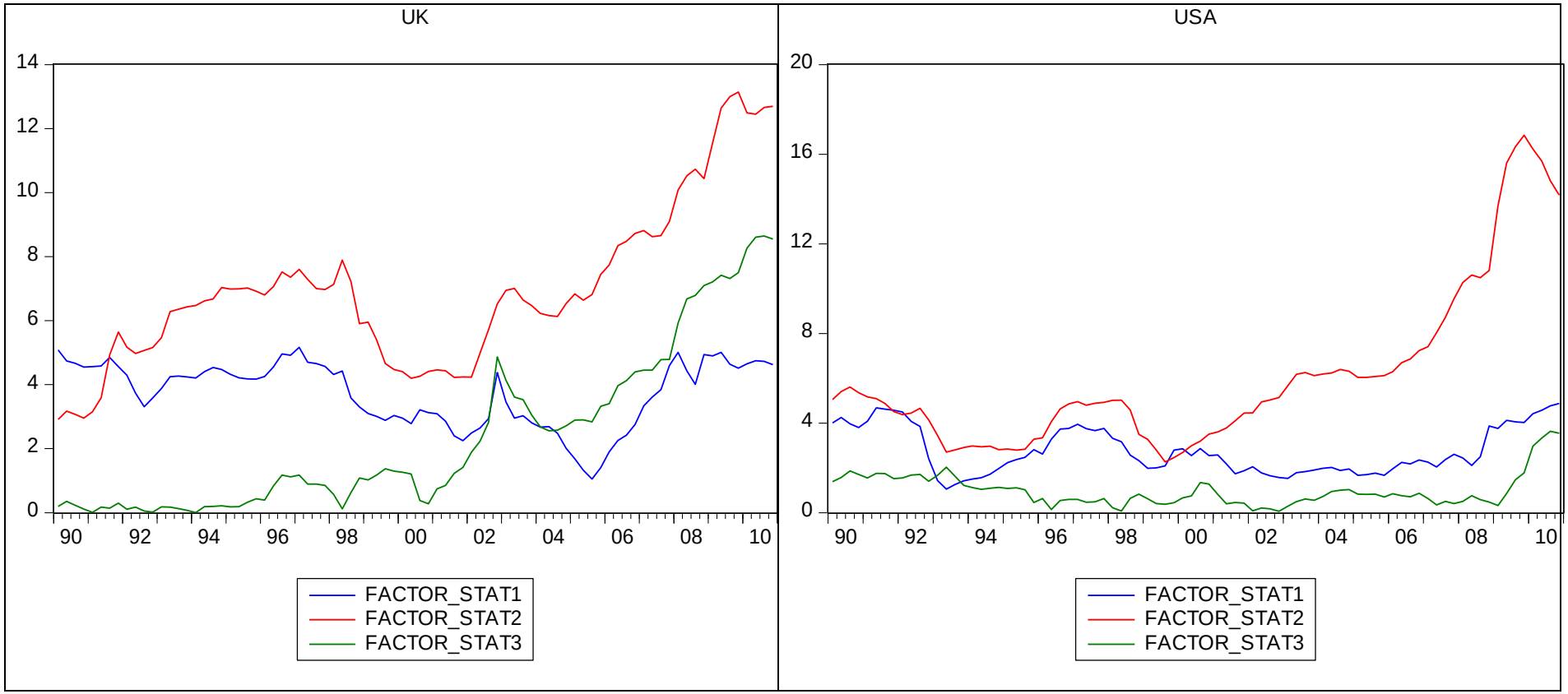
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FACTOR_STAT1
FACTOR_STAT2
FACTOR_STAT3

# Appendix B: Co-movement between China and advanced economies (Chapter 5)

## Table B.1: Variance shares, 1979Q3-2011Q2

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| China_TotalReserves | 0.033248 | Imports_Austria | 0.740242 | Rshort_finland | 0.237026 | Iproduction_germany | 0.61197 | Imports_netherlands | 0.799009 |
| China_Ind.Production | 0.031582 | Cycle_Austria | 0.45062 | Exports_finland | 0.515765 | RGDP_italy | 0.570828 | Cycle_netherlands | 0.545786 |
| China_SharePrice | 0.064286 | Exch.rate_Austria | 0.892664 | Imports_finland | 0.397387 | CPI_italy | 0.18065 | Exch.rate_netherlands | 0.904864 |
| ChinaDepositRate | 0.105705 | PPI_Austria | 0.555082 | Cycle_finland | 0.571834 | Rshort_italy | 0.315795 | PPI_netherlands | 0.530457 |
| ChinaLendingRate | 0.103701 | Iproduction_Austria | 0.441792 | Exch.rate_finland | 0.805211 | Exports_italy | 0.679085 | SPI_netherlands | 0.506473 |
| ChinaShortTermRate | 0.106982 | RGDP_Belgium | 0.467724 | PPI_finland | 0.594157 | Imports_italy | 0.695922 | Iproduction_netherlands | 0.215056 |
| Exch_rateChina | 0.025281 | CPI_Belgium | 0.38801 | SPI_finland | 0.394167 | Cycle_italy | 0.779286 | RGDP_newzealand | 0.151044 |
| RGDP_china | 0.069403 | Rshort_Belgium | 0.248232 | Iproduction_finland | 0.359513 | Exch.rate_italy | 0.814146 | CPI_newzealand | 0.046485 |
| CPI_china | 0.080893 | Cycle_Belgium | 0.775075 | RGDP_france | 0.457202 | PPI_italy | 0.365472 | Rshort_newzealand | 0.025429 |
| Exports_china | 0.22496 | Exch.rate_belgium | 0.898592 | CPI_france | 0.282998 | SPI_italy | 0.241334 | Exports_newzealand | 0.328701 |
| Imports_china | 0.215033 | PPI_belgium | 0.544575 | Rshort_france | 0.259889 | Iproduction_italy | 0.58389 | Imports_newzealand | 0.387106 |
| Cycle_china | 0.089628 | Belgium_SPI | 0.422095 | Exports_france | 0.852831 | RGDP_japan | 0.243425 | Cycle_newzealand | 0.199217 |
| RGDP_Austral | 0.161045 | Iproduction_Belgium | 0.191953 | Imports_france | 0.861498 | CPI_japan | 0.114153 | Exch.rate_newzealand | 0.495184 |
| CPI_Austral | 0.055069 | RGDP_Canada | 0.460929 | Cycle_france | 0.574853 | Rshort_japan | 0.157589 | PPI_newzealand | 0.255591 |
| Rshort_Austral | 0.122895 | CPI_Canada | 0.252884 | Exch.rate_france | 0.884122 | Exports_japan | 0.492962 | SPI_newzealand | 0.1092 |
| Exports_Austral | 0.25914 | Rshort_canada | 0.228482 | PPI_france | 0.552363 | Imports_japan | 0.45384 | RGDP_norway | 0.117684 |
| Imports_Austral | 0.421874 | Exports_canada | 0.481224 | Iproduction_France | 0.325142 | Cycle_japan | 0.4189 | CPI_norway | 0.080728 |
| Cycle_Austral | 0.201942 | Imports_canada | 0.186323 | RGDP_germany | 0.416311 | Exch.rate_japan | 0.243383 | Rshort_norway | 0.137189 |
| Exch.rate_Austral | 0.43562 | Cycle_canada | 0.530449 | CPI_germany | 0.392882 | PPI_japan | 0.506831 | Exports_norway | 0.561972 |
| PPI_Austral | 0.151841 | Exch.rate_canada | 0.472758 | Rshort_germany | 0.533618 | SPI_japan | 0.384185 | Imports_norway | 0.547246 |
| Iproduction_Australia | 0.144034 | PPI_canada | 0.229334 | Exports_germany | 0.827069 | Iproduction_japan | 0.527828 | Cycle_norway | 0.19837 |
| RGDP_Austria | 0.198467 | SPI_canada | 0.462673 | Imports_germany | 0.777358 | RGDP_netherlands | 0.404895 | Exch.rate_norway | 0.802182 |
| CPI_Austria | 0.191142 | Iproduction_Canada | 0.301936 | Cycle_germany | 0.490882 | CPI_netherlands | 0.13438 | PPI_norway | 0.48677 |
| Rshort_Austria | 0.459147 | RGDP_finland | 0.346123 | Exch.rate_germany | 0.890523 | Rshort_netherlands | 0.381859 | SPI_norway | 0.480244 |
| Exports_Austria | 0.831129 | CPI_finland | 0.202363 | PPI_germany | 0.323222 | Exports_netherlands | 0.813849 | Iproduction_norway | 0.031665 |

| | | | |
|---|---|---|---|
| RGDP_spain | 0.447033 | Exports_uk | 0.632307 |
| CPI_spain | 0.115082 | Imports_uk | 0.660132 |
| Rshort_spain | 0.037772 | Cycle_uk | 0.53667 |
| Exports_spain | 0.34191 | Exch.rate_uk | 0.610715 |
| Imports_spain | 0.621657 | PPI_uk | 0.333129 |
| Cycle_spain | 0.629554 | SPI_uk | 0.438479 |
| Exch.rate_spain | 0.819601 | Iproduction_uk | 0.377976 |
| PPI_spain | 0.455122 | RGDP_usa | 0.548545 |
| Iproduction_Spain | 0.505685 | CPI_usa | 0.348198 |
| RGDP_sweden | 0.416784 | Rshort_usa | 0.220624 |
| CPI_sweden | 0.195432 | Exports_usa | 0.517635 |
| Rshort_sweden | 0.158378 | Imports_usa | 0.624535 |
| Exports_sweden | 0.736994 | Cycle_usa | 0.585971 |
| Imports_sweden | 0.750709 | Iprod_usa | 0.605632 |
| Cycle_sweden | 0.656806 | SPI_usa | 0.31862 |
| Exch.rate_sweden | 0.734065 | Ppi_usa | 0.674718 |
| PPI_sweden | 0.359908 | Rer_usa | 0.749559 |
| RGDP_switzerland | 0.465475 | Oil price | 0.605456 |
| CPI_switzerland | 0.265041 | | |
| Rshort_switzerland | 0.123835 | | |
| Exports_switzerland | 0.759041 | | |
| Imports_switzerland | 0.676161 | | |
| Cycle_switzerland | 0.623547 | | |
| Exch.rate_switzerland | 0.847492 | | |
| PPI_switzerland | 0.212294 | | |
| Iproduction_switzerland | 0.338614 | | |
| RGDP_uk | 0.452678 | | |
| CPI_uk | 0.096389 | | |
| Rshort_uk | 0.299088 | | |

## Table B.2: Variance shares, 1979Q3-1990Q4

| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| China_TotalReserves | 0.155045 | Iproduction_Austria | 0.329357 | SPI_finland | 0.33788 | Iproduction_italy | 0.338602 | Rer_usa | 0.839216 |
| ChinaDepositRate | 0.588326 | RGDP_Belgium | 0.552253 | Iproduction_finland | 0.050092 | RGDP_japan | 0.168006 | Oil price | 0.152554 |
| ChinaLendingRate | 0.401505 | CPI_Belgium | 0.130033 | RGDP_france | 0.50985 | CPI_japan | 0.066917 | | |
| ChinaShortTermRate | 0.584725 | Rshort_Belgium | 0.306745 | CPI_france | 0.081587 | Rshort_japan | 0.337381 | | |
| Exch_rateChina | 0.025869 | Cycle_Belgium | 0.726115 | Rshort_france | 0.346036 | Cycle_switzerland | 0.578823 | | |
| RGDP_china | 0.489349 | Exch.rate_belgium | 0.897792 | Exports_france | 0.782879 | Exch.rate_switzerland | 0.853968 | | |
| CPI_china | 0.166283 | PPI_belgium | 0.314546 | Imports_france | 0.833341 | PPI_switzerland | 0.587503 | | |
| Exports_china | 0.076573 | Belgium_SPI | 0.314546 | Cycle_france | 0.36238 | Iproduction_switzerland | 0.3 | | |
| Imports_china | 0.150562 | Iproduction_Belgium | 0.136598 | Exch.rate_france | 0.862204 | RGDP_uk | 0.536485 | | |
| Cycle_china | 0.236609 | RGDP_Canada | 0.566406 | Iproduction_France | 0.243064 | CPI_uk | 0.663068 | | |
| RGDP_Austral | 0.386179 | CPI_Canada | 0.072911 | RGDP_germany | 0.29161 | Rshort_uk | 0.238507 | | |
| CPI_Austral | 0.247308 | Rshort_canada | 0.436922 | CPI_germany | 0.078487 | Exports_uk | 0.453159 | | |
| Rshort_Austral | 0.07483 | Exports_canada | 0.444117 | Rshort_germany | 0.481675 | Imports_uk | 0.452503 | | |
| Exports_Austral | 0.176512 | Imports_canada | 0.430707 | Exports_germany | 0.718233 | Cycle_uk | 0.58822 | | |
| Imports_Austral | 0.252504 | Cycle_canada | 0.467125 | Imports_germany | 0.775722 | Exch.rate_uk | 0.642921 | | |
| Cycle_Austral | 0.504977 | Exch.rate_canada | 0.101951 | Cycle_germany | 0.319807 | PPI_uk | 0.720971 | | |
| Exch.rate_Austral | 0.073619 | PPI_canada | 0.19187 | Exch.rate_germany | 0.897608 | SPI_uk | 0.267401 | | |
| PPI_Austral | 0.004274 | SPI_canada | 0.14158 | Iproduction_germany | 0.303356 | Iproduction_uk | 0.372808 | | |
| Iproduction_Australia | 0.235323 | Iproduction_Canada | 0.443688 | RGDP_italy | 0.52742 | RGDP_usa | 0.53385 | | |
| RGDP_Austria | 0.179859 | RGDP_finland | 0.07369 | CPI_italy | 0.103699 | CPI_usa | 0.204332 | | |
| CPI_Austria | 0.565631 | CPI_finland | 0.618874 | Rshort_italy | 0.330798 | Rshort_usa | 0.426616 | | |
| Rshort_Austria | 0.470311 | Rshort_finland | 0.077717 | Exports_italy | 0.451683 | Exports_usa | 0.300678 | | |
| Exports_Austria | 0.790284 | Exports_finland | 0.323127 | Imports_italy | 0.437822 | Imports_usa | 0.495598 | | |
| Imports_Austria | 0.663792 | Imports_finland | 0.204478 | Cycle_italy | 0.454785 | Cycle_usa | 0.495848 | | |
| Cycle_Austria | 0.145629 | Cycle_finland | 0.647584 | Exch.rate_italy | 0.815718 | Iprod_usa | 0.648567 | | |
| Exch.rate_Austria | 0.89461 | Exch.rate_finland | 0.807352 | PPI_italy | 0.015357 | SPI_usa | 0.239346 | | |
| PPI_Austria | 0.684857 | PPI_finland | 0.744587 | SPI_italy | 0.043259 | Ppi_usa | 0.65262 | | |

## Table B.3: Variance shares, 1991Q1-2000Q4

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| China_TotalReserves | 0.205075 | Exch.rate_Austria | 0.883892 | Exch.rate_finland | 0.808546 | Exch.rate_italy | 0.755564 |
| China_Ind.Production | 0.052931 | PPI_Austria | 0.393518 | PPI_finland | 0.675808 | PPI_italy | 0.590057 |
| China_SharePrice | 0.201256 | Iproduction_Austria | 0.302563 | SPI_finland | 0.398766 | SPI_italy | 0.572213 |
| ChinaDepositRate | 0.436445 | RGDP_Belgium | 0.29735 | Iproduction_finland | 0.423044 | Iproduction_italy | 0.362078 |
| ChinaLendingRate | 0.354237 | CPI_Belgium | 0.103952 | RGDP_france | 0.501795 | RGDP_japan | 0.252787 |
| ChinaShortTermRate | 0.436515 | Rshort_Belgium | 0.401411 | CPI_france | 0.435222 | CPI_japan | 0.08093 |
| Exch_rateChina | 0.040497 | Cycle_Belgium | 0.817708 | Rshort_france | 0.312597 | Rshort_japan | 0.441927 |
| RGDP_china | 0.213517 | Exch.rate_belgium | 0.88656 | Exports_france | 0.85274 | Exports_japan | 0.44407 |
| CPI_china | 0.569945 | PPI_belgium | 0.765963 | Imports_france | 0.834739 | Imports_japan | 0.620413 |
| Exports_china | 0.199067 | Belgium_SPI | 0.45445 | Cycle_france | 0.824675 | Cycle_japan | 0.525649 |
| Imports_china | 0.236703 | Iproduction_Belgium | 0.051963 | Exch.rate_france | 0.889064 | Exch.rate_japan | 0.293818 |
| Cycle_china | 0.655228 | RGDP_Canada | 0.52611 | Iproduction_France | 0.138561 | PPI_japan | 0.120045 |
| RGDP_Austral | 0.334314 | CPI_Canada | 0.366644 | RGDP_germany | 0.206114 | SPI_japan | 0.09002 |
| CPI_Austral | 0.14405 | Rshort_canada | 0.516373 | CPI_germany | 0.199436 | Iproduction_japan | 0.243272 |
| Rshort_Austral | 0.480542 | Exports_canada | 0.30465 | Rshort_germany | 0.809758 | RGDP_netherlands | 0.388391 |
| Exports_Austral | 0.137865 | Imports_canada | 0.259625 | Exports_germany | 0.84133 | CPI_netherlands | 0.181822 |
| Imports_Austral | 0.421213 | Cycle_canada | 0.744963 | Imports_germany | 0.707261 | Rshort_netherlands | 0.796503 |
| Cycle_Austral | 0.538306 | Exch.rate_canada | 0.040294 | Cycle_germany | 0.749051 | Exports_netherlands | 0.798302 |
| Exch.rate_Austral | 0.186813 | PPI_canada | 0.454548 | Exch.rate_germany | 0.874061 | Imports_netherlands | 0.783058 |
| PPI_Austral | 0.453109 | SPI_canada | 0.144831 | PPI_germany | 0.577494 | Cycle_netherlands | 0.285724 |
| Iproduction_Australia | 0.224616 | Iproduction_Canada | 0.592108 | Iproduction_germany | 0.583573 | Exch.rate_netherlands | 0.883152 |
| RGDP_Austria | 0.094573 | RGDP_finland | 0.460245 | RGDP_italy | 0.369696 | PPI_netherlands | 0.534721 |
| CPI_Austria | 0.074532 | CPI_finland | 0.484328 | CPI_italy | 0.148406 | SPI_netherlands | 0.449639 |
| Rshort_Austria | 0.754647 | Rshort_finland | 0.619263 | Rshort_italy | 0.65939 | Iproduction_netherlands | 0.224718 |
| Exports_Austria | 0.797585 | Exports_finland | 0.482379 | Exports_italy | 0.777432 | RGDP_newzealand | 0.62954 |
| Imports_Austria | 0.732425 | Imports_finland | 0.513671 | Imports_italy | 0.814344 | CPI_newzealand | 0.32969 |
| Cycle_Austria | 0.62878 | Cycle_finland | 0.684504 | Cycle_italy | 0.733361 | Rshort_newzealand | 0.219563 |

| | | | | | |
|---|---|---|---|---|---|
| Exports_newzealand | 0.30922 | Imports_sweden | 0.776563 | Iprod_usa | 0.302147 |
| Imports_newzealand | 0.270457 | Cycle_sweden | 0.611357 | SPI_usa | 0.155703 |
| Cycle_newzealand | 0.582673 | Exch.rate_sweden | 0.709205 | Ppi_usa | 0.578512 |
| Exch.rate_newzealand | 0.496816 | PPI_sweden | 0.618166 | Rer_usa | 0.579198 |
| PPI_newzealand | 0.536832 | RGDP_switzerland | 0.273169 | Oil price | 0.620847 |
| SPI_newzealand | 0.04989 | CPI_switzerland | 0.147643 | | |
| RGDP_norway | 0.142788 | Rshort_switzerland | 0.451852 | | |
| CPI_norway | 0.215236 | Exports_switzerland | 0.758551 | | |
| Rshort_norway | 0.184921 | Imports_switzerland | 0.770869 | | |
| Exports_norway | 0.50409 | Cycle_switzerland | 0.564979 | | |
| Imports_norway | 0.534857 | Exch.rate_switzerland | 0.859019 | | |
| Cycle_norway | 0.579446 | PPI_switzerland | 0.612085 | | |
| Exch.rate_norway | 0.777676 | Iproduction_switzerland | 0.211308 | | |
| PPI_norway | 0.354668 | RGDP_uk | 0.643742 | | |
| SPI_norway | 0.458525 | CPI_uk | 0.154293 | | |
| Iproduction_norway | 0.101458 | Rshort_uk | 0.70316 | | |
| RGDP_spain | 0.630612 | Exports_uk | 0.61611 | | |
| CPI_spain | 0.098132 | Imports_uk | 0.611573 | | |
| Rshort_spain | 0.306431 | Cycle_uk | 0.660846 | | |
| Exports_spain | 0.594633 | Exch.rate_uk | 0.61294 | | |
| Imports_spain | 0.750704 | PPI_uk | 0.516606 | | |
| Cycle_spain | 0.893645 | SPI_uk | 0.5261 | | |
| Exch.rate_spain | 0.76092 | Iproduction_uk | 0.377646 | | |
| PPI_spain | 0.720126 | RGDP_usa | 0.19921 | | |
| Iproduction_Spain | 0.459076 | CPI_usa | 0.509872 | | |
| RGDP_sweden | 0.34821 | Rshort_usa | 0.640171 | | |
| CPI_sweden | 0.503287 | Exports_usa | 0.220086 | | |
| Rshort_sweden | 0.599619 | Imports_usa | 0.687241 | | |
| Exports_sweden | 0.768122 | Cycle_usa | 0.05739 | | |

## Table B.4: Variance shares, 2001Q1-2011Q2

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| China_TotalReserves | 0.339945 | Exch.rate_Austria | 0.965375 | Exch.rate_finland | 0.965855 | Cycle_italy | 0.943688 |
| China_Ind.Production | 0.2584 | PPI_Austria | 0.737692 | PPI_finland | 0.889725 | Exch.rate_italy | 0.964464 |
| China_SharePrice | 0.327759 | Iproduction_Austria | 0.690403 | SPI_finland | 0.767151 | PPI_italy | 0.510677 |
| ChinaDepositRate | 0.760593 | RGDP_Belgium | 0.810394 | Iproduction_finland | 0.712557 | SPI_italy | 0.67437 |
| ChinaLendingRate | 0.850337 | CPI_Belgium | 0.75632 | RGDP_france | 0.778677 | Iproduction_italy | 0.804692 |
| ChinaShortTermRate | 0.760592 | Rshort_Belgium | 0.860452 | CPI_france | 0.321679 | RGDP_japan | 0.658789 |
| Exch_rateChina | 0.613541 | Cycle_Belgium | 0.944912 | Rshort_france | 0.860452 | CPI_japan | 0.509454 |
| RGDP_china | 0.381511 | Exch.rate_belgium | 0.965605 | Exports_france | 0.919054 | Rshort_japan | 0.549515 |
| CPI_china | 0.467834 | PPI_belgium | 0.796269 | Imports_france | 0.94005 | Exports_japan | 0.715539 |
| Exports_china | 0.717409 | Belgium_SPI | 0.73984 | Cycle_france | 0.939763 | Imports_japan | 0.719777 |
| Imports_china | 0.691916 | Iproduction_Belgium | 0.419492 | Exch.rate_france | 0.962751 | Cycle_japan | 0.895559 |
| Cycle_china | 0.593886 | RGDP_Canada | 0.703771 | PPI_france | 0.90804 | Exch.rate_japan | 0.12561 |
| RGDP_Austral | 0.133526 | CPI_Canada | 0.581248 | Iproduction_France | 0.855637 | PPI_japan | 0.837858 |
| CPI_Austral | 0.580362 | Rshort_canada | 0.375603 | RGDP_germany | 0.788366 | SPI_japan | 0.497111 |
| Rshort_Austral | 0.845302 | Exports_canada | 0.668106 | CPI_germany | 0.729426 | Iproduction_japan | 0.714442 |
| Exports_Austral | 0.643173 | Imports_canada | 0.34824 | Rshort_germany | 0.860452 | RGDP_netherlands | 0.77737 |
| Imports_Austral | 0.848501 | Cycle_canada | 0.851868 | Exports_germany | 0.902503 | CPI_netherlands | 0.180272 |
| Cycle_Austral | 0.39996 | Exch.rate_canada | 0.633801 | Imports_germany | 0.828455 | Rshort_netherlands | 0.860452 |
| Exch.rate_Austral | 0.808792 | PPI_canada | 0.502222 | Cycle_germany | 0.869225 | Exports_netherlands | 0.917127 |
| PPI_Austral | 0.61457 | SPI_canada | 0.607273 | Exch.rate_germany | 0.962956 | Imports_netherlands | 0.932143 |
| Iproduction_Australia | 0.141656 | Iproduction_Canada | 0.792368 | PPI_germany | 0.674575 | Cycle_netherlands | 0.896095 |
| RGDP_Austria | 0.287705 | RGDP_finland | 0.68405 | Iproduction_germany | 0.827176 | Exch.rate_netherlands | 0.962059 |
| CPI_Austria | 0.685677 | CPI_finland | 0.709747 | RGDP_italy | 0.850825 | PPI_netherlands | 0.648598 |
| Rshort_Austria | 0.860452 | Rshort_finland | 0.879958 | CPI_italy | 0.64767 | SPI_netherlands | 0.6636 |
| Exports_Austria | 0.88562 | Exports_finland | 0.727788 | Rshort_italy | 0.817481 | Iproduction_netherlands | 0.344141 |
| Imports_Austria | 0.800583 | Imports_finland | 0.912059 | Exports_italy | 0.890113 | RGDP_newzealand | 0.293985 |
| Cycle_Austria | 0.78595 | Cycle_finland | 0.915735 | Imports_italy | 0.923652 | CPI_newzealand | 0.467402 |

| | | | | | |
|---|---|---|---|---|---|
| Rshort_newzealand | 0.820544 | Exports_sweden | 0.874973 | Cycle_usa | 0.872261 |
| Exports_newzealand | 0.627977 | Imports_sweden | 0.901227 | Iprod_usa | 0.761266 |
| Imports_newzealand | 0.780093 | Cycle_sweden | 0.851801 | SPI_usa | 0.811601 |
| Cycle_newzealand | 0.534965 | Exch.rate_sweden | 0.908046 | Ppi_usa | 0.812939 |
| Exch.rate_newzealand | 0.738267 | PPI_sweden | 0.514629 | Rer_usa | 0.84991 |
| PPI_newzealand | 0.419895 | RGDP_switzerland | 0.65778 | Oil price | 0.77187 |
| SPI_newzealand | 0.500478 | CPI_switzerland | 0.66968 | | |
| RGDP_norway | 0.14744 | Rshort_switzerland | 0.285801 | | |
| CPI_norway | 0.318089 | Exports_switzerland | 0.807707 | | |
| Rshort_norway | 0.741716 | Imports_switzerland | 0.761262 | | |
| Exports_norway | 0.778602 | Cycle_switzerland | 0.860786 | | |
| Imports_norway | 0.610707 | Exch.rate_switzerland | 0.797374 | | |
| Cycle_norway | 0.65049 | PPI_switzerland | 0.651556 | | |
| Exch.rate_norway | 0.793197 | Iproduction_switzerland | 0.523351 | | |
| PPI_norway | 0.724645 | RGDP_uk | 0.757454 | | |
| SPI_norway | 0.53591 | CPI_uk | 0.536876 | | |
| Iproduction_norway | 0.00882 | Rshort_uk | 0.80388 | | |
| RGDP_spain | 0.679592 | Exports_uk | 0.666512 | | |
| CPI_spain | 0.629433 | Imports_uk | 0.776416 | | |
| Rshort_spain | 0.861696 | Cycle_uk | 0.91847 | | |
| Exports_spain | 0.872309 | Exch.rate_uk | 0.789361 | | |
| Imports_spain | 0.875962 | PPI_uk | 0.778329 | | |
| Cycle_spain | 0.890131 | SPI_uk | 0.613579 | | |
| Exch.rate_spain | 0.956262 | Iproduction_uk | 0.676781 | | |
| PPI_spain | 0.898096 | RGDP_usa | 0.763124 | | |
| Iproduction_Spain | 0.757994 | CPI_usa | 0.792546 | | |
| RGDP_sweden | 0.610631 | Rshort_usa | 0.423588 | | |
| CPI_sweden | 0.683969 | Exports_usa | 0.850766 | | |
| Rshort_sweden | 0.802977 | Imports_usa | 0.850025 | | |

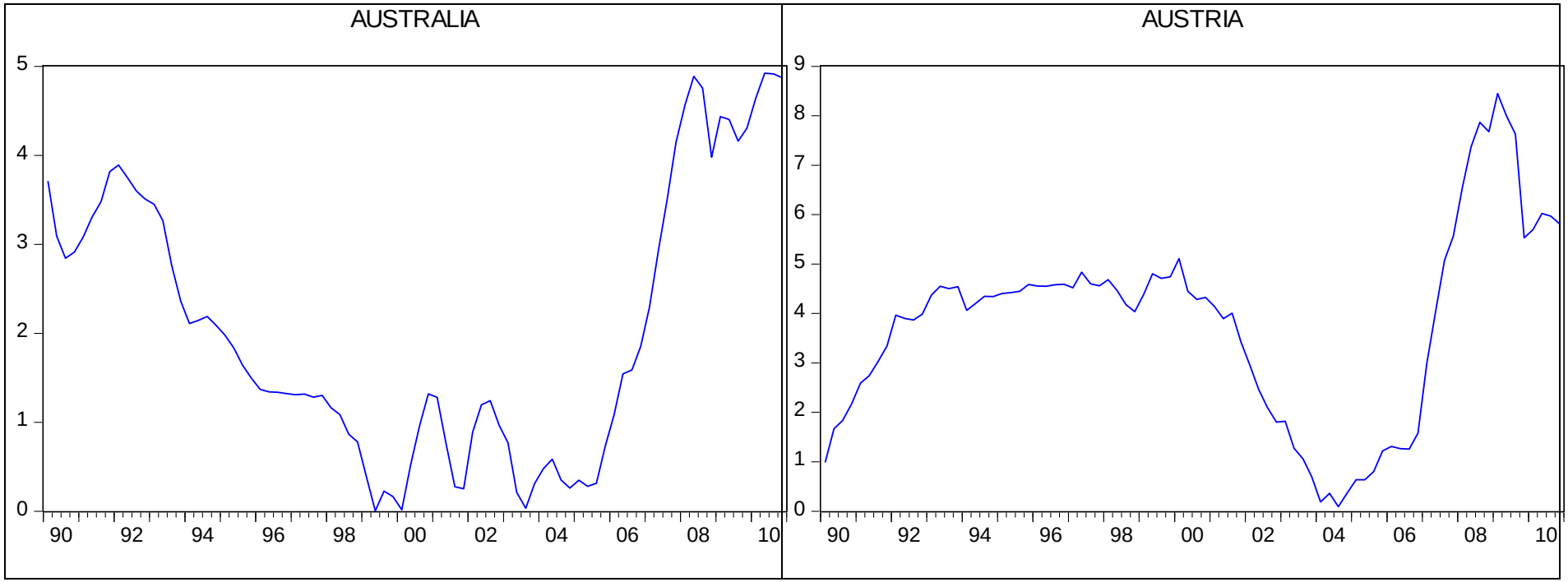
## Table B.5: Bai-Ng criteria

The ideal number of factors is indicated with an asterisk.

| | Criteria | | | | | | |
|---|---|---|---|---|---|---|---|
| *r* | *PCp1* | *PCp2* | *PCp3* | *ICp1* | *ICp2* | *ICp3* | *Cumulated Variance* |
| 1 | 0.811404 | 0.8147 | 0.802434 | -0.18232 | -0.17474 | -0.20295 | 0.21 |
| 2 | 0.74758 | 0.754172 | 0.72964 | -0.24436 | -0.2292 | -0.28562 | 0.09 |
| 3 | 0.693511 | 0.703399 | 0.666602 | -0.30703 | -0.28429 | -0.36892 | 0.08 |
| 4 | 0.677939 | 0.691123 | 0.64206 | -0.31728* | -0.28696* | -0.39979 | 0.04 |
| 5 | 0.673582 | 0.690062* | 0.628733 | -0.31187 | -0.27397 | -0.41501 | 0.03 |
| 6 | 0.671218* | 0.690994 | 0.617399 | -0.30559 | -0.26011 | -0.42936 | 0.03 |
| 7 | 0.672604 | 0.695676 | 0.609816 | -0.29458 | -0.24152 | -0.43898 | 0.02 |
| 8 | 0.674777 | 0.701145 | 0.603019 | -0.28427 | -0.22363 | -0.4493 | 0.02 |
| 9 | 0.681752 | 0.711416 | 0.601023 | -0.26574 | -0.19752 | -0.4514 | 0.02 |
| 10 | 0.689331 | 0.72229 | 0.599633 | -0.24749 | -0.17168 | -0.45378 | 0.02 |

## B.6: T-statistics of rolling regressions

T-statistics for the rolling regressions of individual advanced country business cycles against the Chinese business are reported here graphically. The critical t-value is 1.66, 2.37 and 3.19 at 5%, 10% and 1% significance, respectively.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98
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02
04
06
08
10
AUSTRIA
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8
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6
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96
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04
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08
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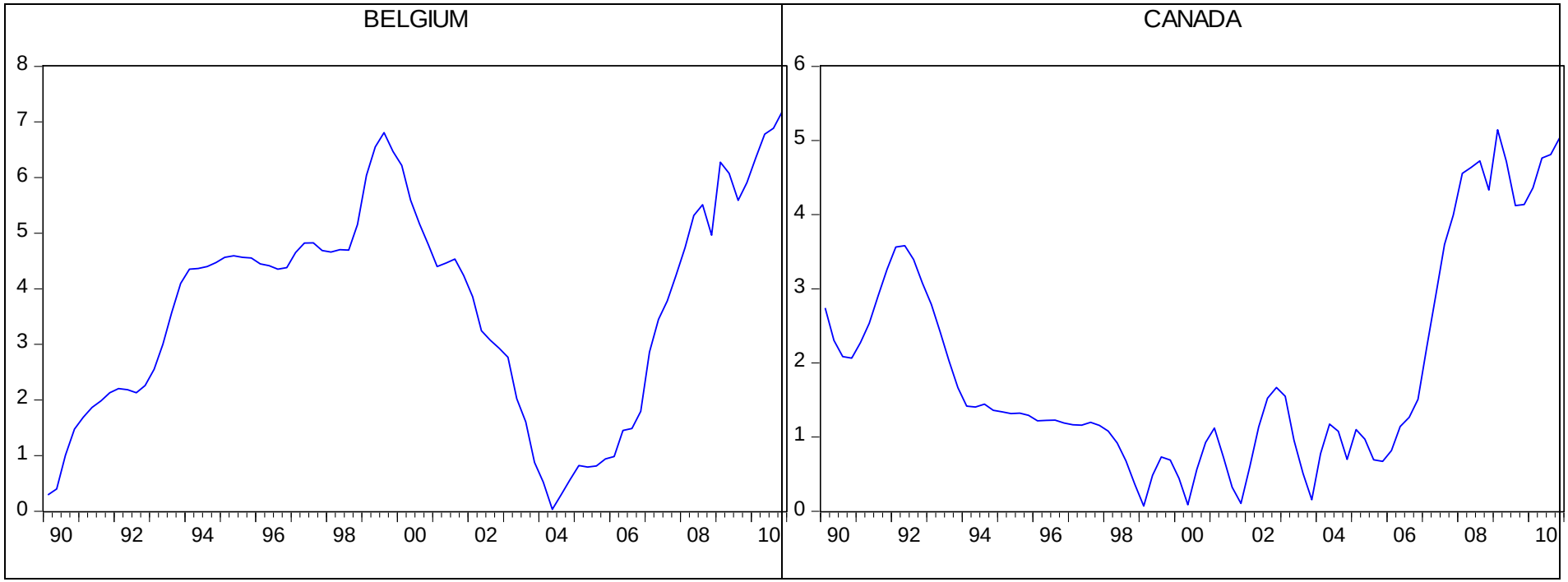
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90
92
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98
00
02
04
06
08
10
CANADA
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3
2
1
0
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92
94
96
98
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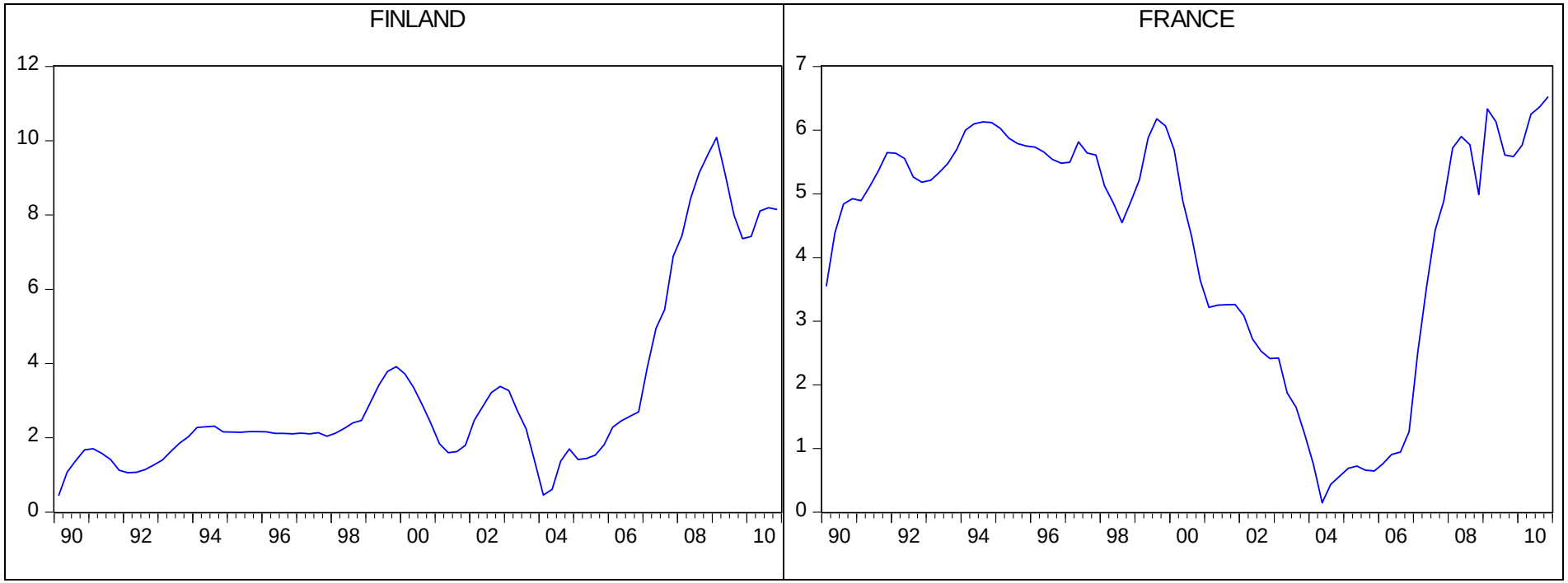
04
06
08
10


FINLAND
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8
6
4
2
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90
92
94
96
98
00
02
04
06
08
10
FRANCE
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6
5
4
3
2
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0
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92
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96
98
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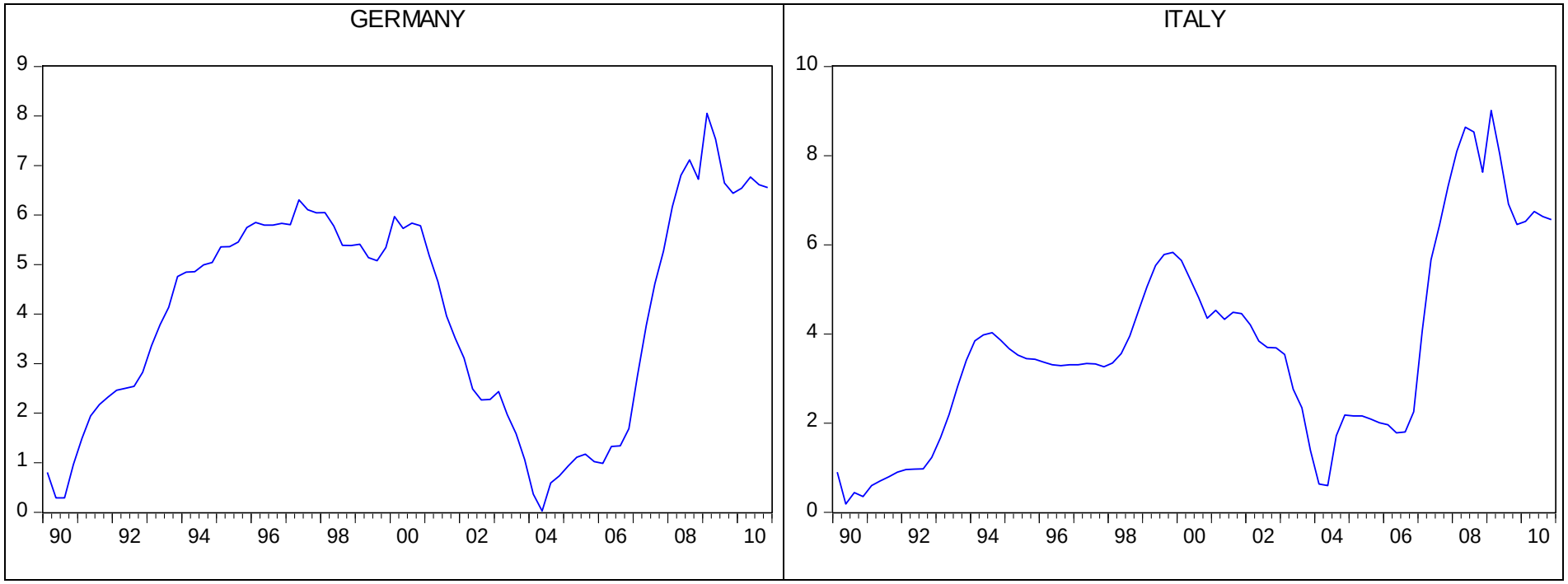
04
06
08
10


GERMANY
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6
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4
3
2
1
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90
92
94
96
98
00
02
04
06
08
10
ITALY
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8
6
4
2
0
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92
94
96
98
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02
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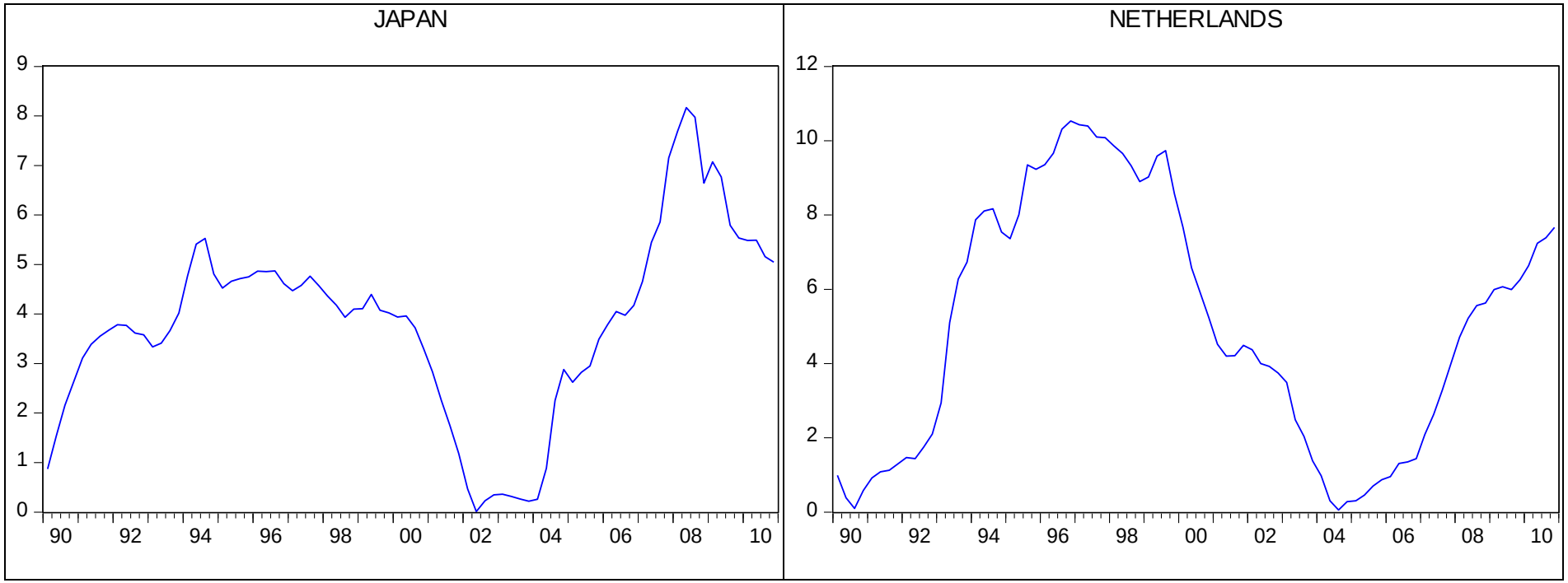
10


JAPAN
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8
7
6
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4
3
2
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90
92
94
96
98
00
02
04
06
08
10
NETHERLANDS
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10
8
6
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2
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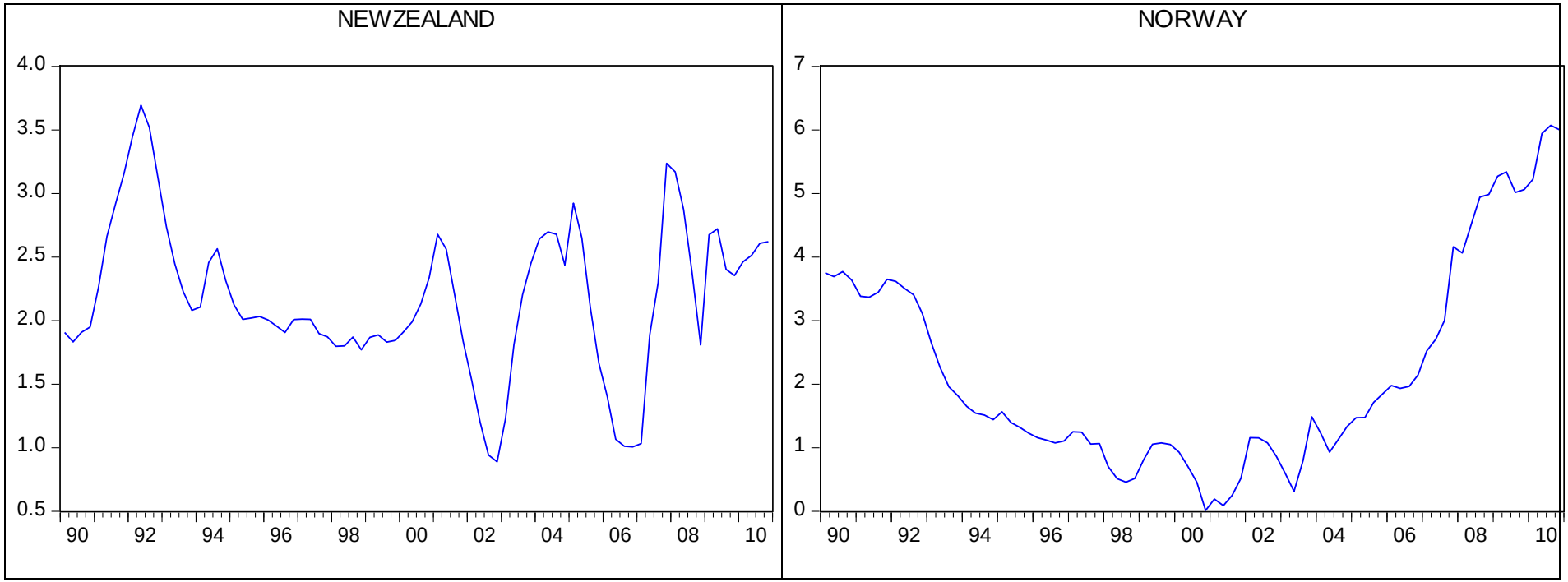
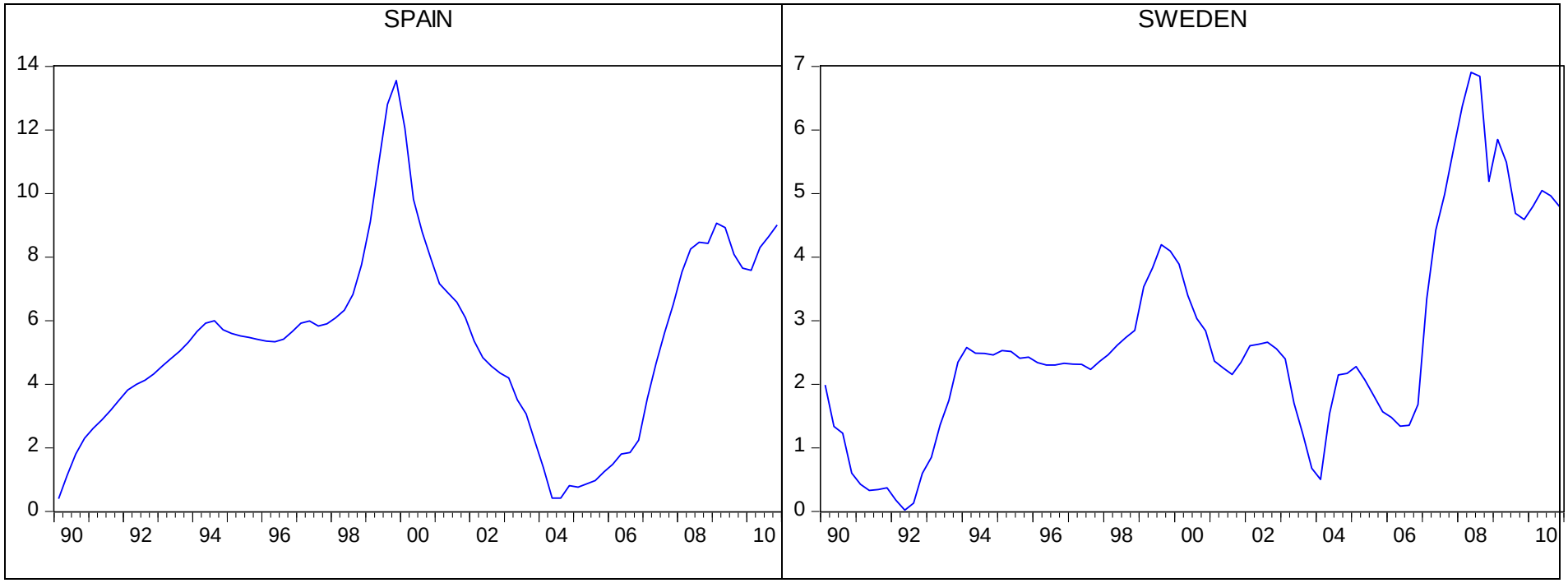
94
96
98
00
02
04
06
08
10


NEWZEALAND
4.0
3.5
3.0
2.5
2.0
1.5
1.0
0.5
90
92
94
96
98
00
02
04
06
08
10
NORWAY
7
6
5
4
3
2
1
0
90
92
94
96
98
00
02
04
06
08
10


SPAIN
14
12
10
8
6
4
2
0
90
92
94
96
98
00
02
04
06
08
10
SWEDEN
7
6
5
4
3
2
1
0
90
92
94
96
98
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04
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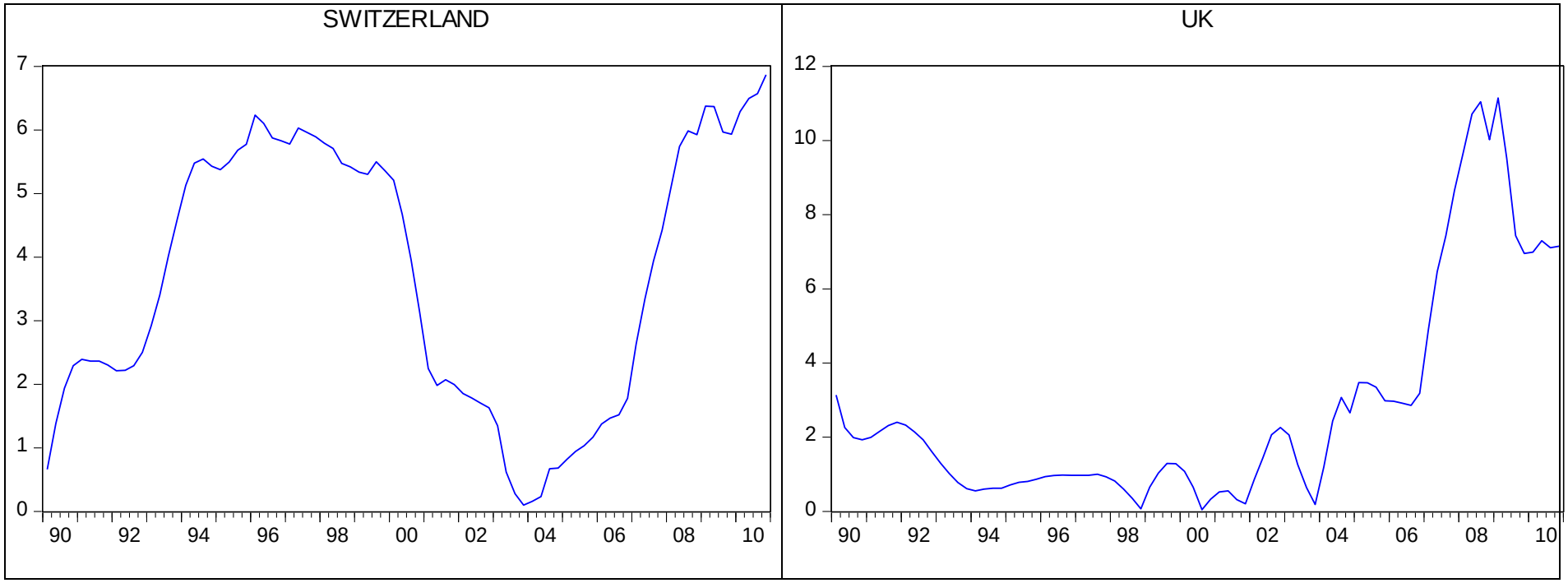
10


SWITZERLAND
7
6
5
4
3
2
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90
92
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UK
12
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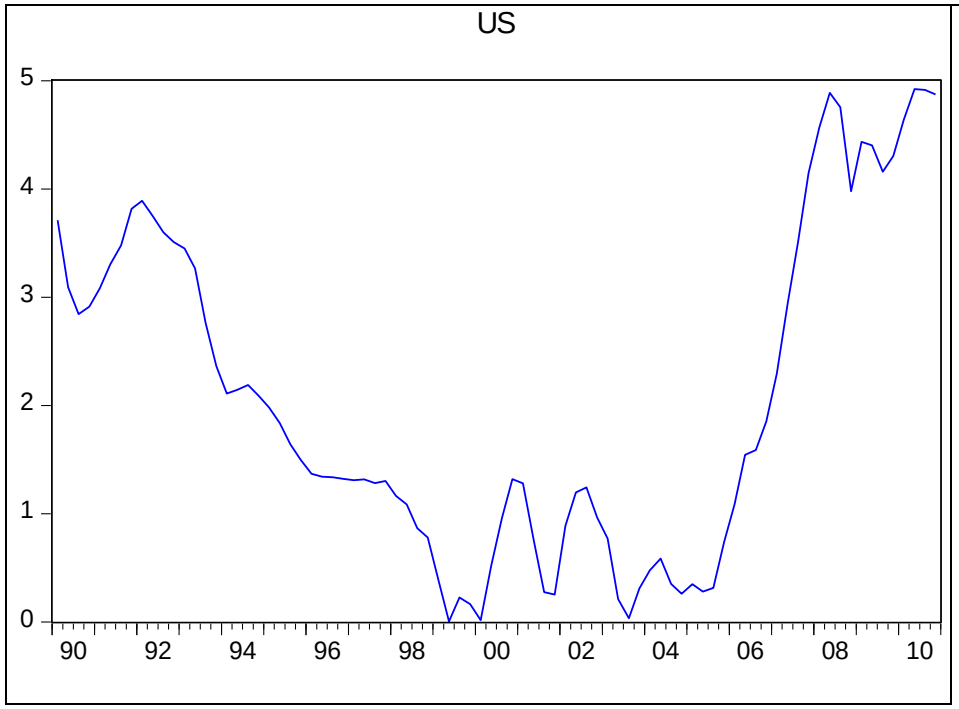
US
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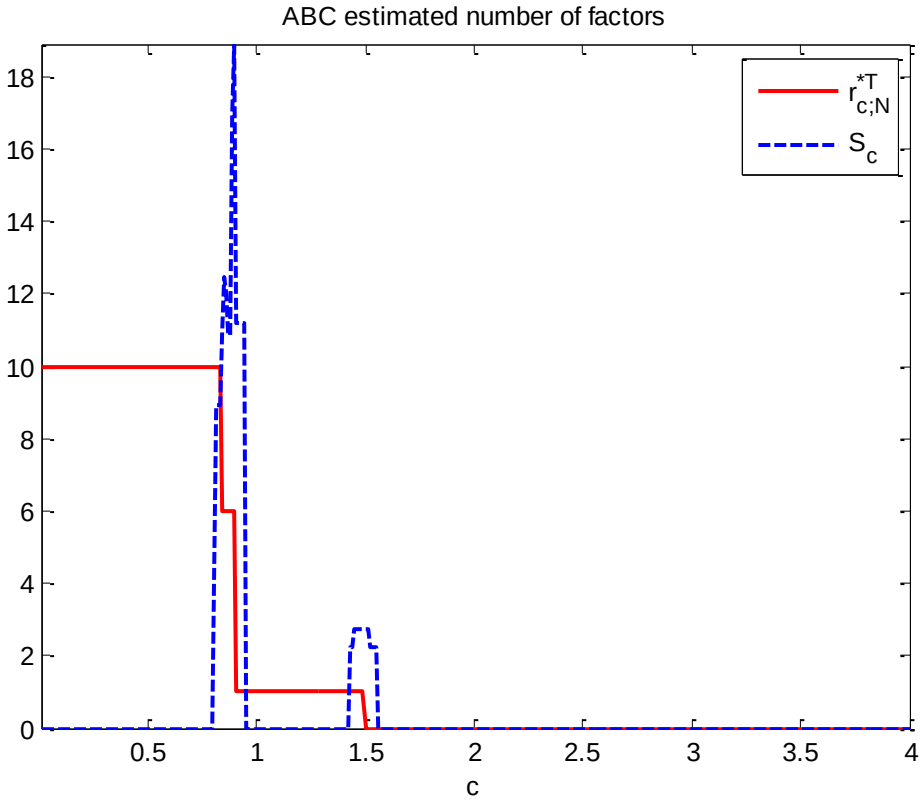
# Appendix C: Comovement between Africa and advanced economies (Chapter 6)

## C.1: ABC criteria



## C.2: GDP weights used for aggregation of African economies

| Oil exporter countries | | | | | | | |
|---|---|---|---|---|---|---|---|
| | **Angola** | **Cameroon** | **Chad** | **Congo** | **Equatorial Guinea** | **Gabon** | **Nigeria** |
| **1980** | *** | 0.113 | 0.018 | 0.033 | *** | 0.071 | 0.765 |
| **1981** | *** | 0.142 | 0.020 | 0.041 | *** | 0.081 | 0.716 |
| **1982** | *** | 0.150 | 0.021 | 0.050 | *** | 0.077 | 0.702 |
| **1983** | *** | 0.163 | 0.024 | 0.054 | *** | 0.083 | 0.676 |
| **1984** | *** | 0.177 | 0.025 | 0.058 | *** | 0.090 | 0.650 |
| **1985** | 0.144 | 0.151 | 0.024 | 0.046 | 0.004 | 0.069 | 0.563 |
| **1986** | 0.145 | 0.157 | 0.022 | 0.041 | 0.004 | 0.067 | 0.563 |
| **1987** | 0.157 | 0.155 | 0.022 | 0.042 | 0.004 | 0.056 | 0.564 |
| **1988** | 0.156 | 0.134 | 0.024 | 0.040 | 0.004 | 0.059 | 0.582 |
| **1989** | 0.150 | 0.126 | 0.024 | 0.039 | 0.003 | 0.062 | 0.596 |
| **1990** | 0.143 | 0.113 | 0.022 | 0.038 | 0.003 | 0.062 | 0.618 |
| **1991** | 0.137 | 0.106 | 0.023 | 0.038 | 0.003 | 0.064 | 0.629 |
| **1992** | 0.127 | 0.102 | 0.025 | 0.039 | 0.004 | 0.062 | 0.643 |
| **1993** | 0.098 | 0.101 | 0.021 | 0.039 | 0.004 | 0.065 | 0.672 |
| **1994** | 0.101 | 0.098 | 0.024 | 0.037 | 0.004 | 0.068 | 0.670 |
| **1995** | 0.107 | 0.098 | 0.023 | 0.037 | 0.004 | 0.068 | 0.662 |
| **1996** | 0.113 | 0.098 | 0.022 | 0.037 | 0.005 | 0.068 | 0.657 |
| **1997** | 0.118 | 0.099 | 0.023 | 0.035 | 0.009 | 0.069 | 0.649 |
| **1998** | 0.122 | 0.100 | 0.024 | 0.035 | 0.011 | 0.069 | 0.640 |
| **1999** | 0.124 | 0.103 | 0.023 | 0.034 | 0.015 | 0.062 | 0.639 |
| **2000** | 0.122 | 0.103 | 0.022 | 0.035 | 0.016 | 0.058 | 0.644 |
| **2001** | 0.121 | 0.103 | 0.023 | 0.035 | 0.025 | 0.057 | 0.636 |
| **2002** | 0.133 | 0.103 | 0.024 | 0.035 | 0.029 | 0.054 | 0.622 |
| **2003** | 0.127 | 0.099 | 0.026 | 0.032 | 0.030 | 0.052 | 0.634 |
| **2004** | 0.128 | 0.093 | 0.031 | 0.030 | 0.037 | 0.047 | 0.633 |
| **2005** | 0.141 | 0.089 | 0.034 | 0.030 | 0.038 | 0.045 | 0.622 |
| **2006** | 0.158 | 0.085 | 0.032 | 0.030 | 0.036 | 0.043 | 0.616 |
| **2007** | 0.178 | 0.081 | 0.029 | 0.027 | 0.040 | 0.041 | 0.602 |

| | Angola | Cameroon | Chad | Congo | Equatorial Guinea | Gabon | Nigeria |
|---|---|---|---|---|---|---|---|
| **2008** | 0.190 | 0.078 | 0.027 | 0.027 | 0.042 | 0.040 | 0.597 |
| **2009** | 0.185 | 0.075 | 0.026 | 0.027 | 0.042 | 0.037 | 0.608 |
| **2010** | 0.180 | 0.073 | 0.027 | 0.028 | 0.039 | 0.037 | 0.616 |
| **2011** | 0.176 | 0.072 | 0.026 | 0.027 | 0.039 | 0.037 | 0.623 |

| Middle-income countries | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Botswana** | **Cape Verde** | **Ghana** | **Lesotho** | **Mauritius** | **Namibia** | **Senegal** | **Seychelles** | **South Africa** | **Swaziland** | **Zambia** |
| **1980** | 0.012 | 0.001 | 0.038 | 0.004 | 0.013 | 0.018 | 0.029 | 0.002 | 0.848 | 0.005 | 0.031 |
| **1981** | 0.012 | 0.001 | 0.035 | 0.003 | 0.013 | 0.017 | 0.029 | 0.002 | 0.850 | 0.005 | 0.031 |
| **1982** | 0.014 | 0.001 | 0.033 | 0.004 | 0.013 | 0.017 | 0.031 | 0.002 | 0.849 | 0.005 | 0.031 |
| **1983** | 0.016 | 0.001 | 0.032 | 0.004 | 0.014 | 0.017 | 0.030 | 0.002 | 0.848 | 0.006 | 0.030 |
| **1984** | 0.017 | 0.001 | 0.033 | 0.004 | 0.014 | 0.016 | 0.030 | 0.002 | 0.849 | 0.006 | 0.029 |
| **1985** | 0.018 | 0.001 | 0.035 | 0.004 | 0.015 | 0.016 | 0.031 | 0.002 | 0.843 | 0.006 | 0.030 |
| **1986** | 0.019 | 0.001 | 0.036 | 0.004 | 0.016 | 0.017 | 0.032 | 0.002 | 0.836 | 0.007 | 0.030 |
| **1987** | 0.021 | 0.001 | 0.037 | 0.004 | 0.017 | 0.017 | 0.033 | 0.002 | 0.831 | 0.007 | 0.030 |
| **1988** | 0.024 | 0.001 | 0.037 | 0.004 | 0.017 | 0.016 | 0.031 | 0.002 | 0.829 | 0.007 | 0.030 |
| **1989** | 0.026 | 0.001 | 0.038 | 0.004 | 0.018 | 0.016 | 0.032 | 0.003 | 0.825 | 0.008 | 0.029 |
| **1990** | 0.028 | 0.001 | 0.039 | 0.004 | 0.019 | 0.016 | 0.031 | 0.003 | 0.819 | 0.010 | 0.029 |
| **1991** | 0.030 | 0.001 | 0.041 | 0.005 | 0.020 | 0.018 | 0.032 | 0.003 | 0.811 | 0.010 | 0.029 |
| **1992** | 0.031 | 0.002 | 0.043 | 0.005 | 0.021 | 0.019 | 0.033 | 0.003 | 0.803 | 0.010 | 0.028 |
| **1993** | 0.031 | 0.002 | 0.045 | 0.005 | 0.022 | 0.019 | 0.033 | 0.003 | 0.800 | 0.011 | 0.030 |
| **1994** | 0.032 | 0.002 | 0.045 | 0.005 | 0.022 | 0.019 | 0.032 | 0.003 | 0.803 | 0.011 | 0.027 |
| **1995** | 0.032 | 0.002 | 0.045 | 0.005 | 0.022 | 0.020 | 0.033 | 0.003 | 0.802 | 0.011 | 0.025 |
| **1996** | 0.032 | 0.002 | 0.045 | 0.005 | 0.023 | 0.019 | 0.032 | 0.003 | 0.802 | 0.011 | 0.026 |
| **1997** | 0.035 | 0.002 | 0.046 | 0.005 | 0.023 | 0.020 | 0.032 | 0.003 | 0.798 | 0.011 | 0.026 |
| **1998** | 0.038 | 0.002 | 0.047 | 0.005 | 0.024 | 0.020 | 0.033 | 0.004 | 0.791 | 0.011 | 0.025 |
| **1999** | 0.039 | 0.002 | 0.048 | 0.005 | 0.024 | 0.020 | 0.034 | 0.004 | 0.788 | 0.011 | 0.025 |
| **2000** | 0.039 | 0.002 | 0.048 | 0.005 | 0.025 | 0.020 | 0.034 | 0.004 | 0.788 | 0.011 | 0.025 |
| **2001** | 0.039 | 0.002 | 0.048 | 0.005 | 0.025 | 0.020 | 0.035 | 0.003 | 0.786 | 0.010 | 0.025 |
| **2002** | 0.041 | 0.002 | 0.049 | 0.005 | 0.025 | 0.020 | 0.034 | 0.003 | 0.786 | 0.010 | 0.025 |

| | Botswana | Cape Verde | Ghana | Lesotho | Mauritius | Namibia | Senegal | Seychelles | South Africa | Swaziland | Zambia |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **2003** | 0.043 | 0.002 | 0.050 | 0.005 | 0.025 | 0.020 | 0.035 | 0.003 | 0.782 | 0.010 | 0.025 |
| **2004** | 0.043 | 0.002 | 0.050 | 0.005 | 0.025 | 0.021 | 0.035 | 0.003 | 0.780 | 0.010 | 0.025 |
| **2005** | 0.042 | 0.002 | 0.050 | 0.005 | 0.024 | 0.021 | 0.035 | 0.003 | 0.782 | 0.010 | 0.026 |
| **2006** | 0.042 | 0.003 | 0.051 | 0.005 | 0.024 | 0.021 | 0.034 | 0.003 | 0.783 | 0.009 | 0.026 |
| **2007** | 0.041 | 0.003 | 0.051 | 0.005 | 0.024 | 0.021 | 0.034 | 0.003 | 0.783 | 0.009 | 0.026 |
| **2008** | 0.041 | 0.003 | 0.053 | 0.005 | 0.024 | 0.021 | 0.034 | 0.003 | 0.781 | 0.009 | 0.026 |
| **2009** | 0.039 | 0.003 | 0.056 | 0.005 | 0.025 | 0.021 | 0.035 | 0.003 | 0.775 | 0.009 | 0.028 |
| **2010** | 0.041 | 0.003 | 0.058 | 0.005 | 0.026 | 0.022 | 0.035 | 0.003 | 0.770 | 0.009 | 0.029 |
| **2011** | 0.041 | 0.003 | 0.064 | 0.005 | 0.026 | 0.022 | 0.035 | 0.003 | 0.763 | 0.009 | 0.030 |

| **Low-income countries** | | | | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Benin** | **Burkina Faso** | **Ethiopia** | **Gambia** | **Kenya** | **Madagascar** | **Malawi** | **Mali** | **Mozambique** | **Niger** | **Rwanda** | **Sierra Leone** | **Tanzania** | **Uganda** |
| **1980** | 0.056 | 0.062 | *** | 0.014 | 0.314 | 0.156 | 0.060 | 0.076 | 0.074 | 0.077 | 0.059 | 0.051 | *** | *** |
| **1981** | 0.047 | 0.049 | 0.232 | 0.011 | 0.248 | 0.107 | 0.044 | 0.056 | 0.059 | 0.059 | 0.047 | 0.040 | *** | *** |
| **1982** | 0.044 | 0.050 | 0.215 | 0.010 | 0.231 | 0.096 | 0.041 | 0.049 | 0.051 | 0.055 | 0.044 | 0.039 | *** | 0.075 |
| **1983** | 0.041 | 0.049 | 0.228 | 0.011 | 0.229 | 0.095 | 0.042 | 0.050 | 0.042 | 0.052 | 0.046 | 0.037 | *** | 0.078 |
| **1984** | 0.045 | 0.048 | 0.223 | 0.012 | 0.235 | 0.098 | 0.044 | 0.052 | 0.039 | 0.043 | 0.044 | 0.039 | *** | 0.078 |
| **1985** | 0.049 | 0.053 | 0.200 | 0.012 | 0.247 | 0.100 | 0.047 | 0.047 | 0.040 | 0.047 | 0.046 | 0.037 | *** | 0.076 |
| **1986** | 0.047 | 0.054 | 0.208 | 0.012 | 0.251 | 0.096 | 0.044 | 0.048 | 0.037 | 0.047 | 0.046 | 0.036 | *** | 0.072 |
| **1987** | 0.044 | 0.051 | 0.225 | 0.011 | 0.252 | 0.092 | 0.043 | 0.045 | 0.040 | 0.045 | 0.044 | 0.036 | *** | 0.071 |
| **1988** | 0.038 | 0.045 | 0.187 | 0.010 | 0.222 | 0.079 | 0.036 | 0.038 | 0.036 | 0.040 | 0.038 | 0.028 | 0.139 | 0.064 |
| **1989** | 0.036 | 0.044 | 0.181 | 0.010 | 0.225 | 0.080 | 0.036 | 0.041 | 0.037 | 0.039 | 0.037 | 0.027 | 0.140 | 0.066 |
| **1990** | 0.037 | 0.043 | 0.179 | 0.010 | 0.227 | 0.080 | 0.037 | 0.039 | 0.036 | 0.037 | 0.035 | 0.027 | 0.145 | 0.068 |
| **1991** | 0.039 | 0.046 | 0.166 | 0.010 | 0.229 | 0.074 | 0.040 | 0.040 | 0.038 | 0.038 | 0.034 | 0.028 | 0.147 | 0.071 |
| **1992** | 0.041 | 0.047 | 0.154 | 0.011 | 0.231 | 0.077 | 0.037 | 0.044 | 0.037 | 0.036 | 0.036 | 0.023 | 0.151 | 0.075 |
| **1993** | 0.042 | 0.047 | 0.168 | 0.011 | 0.224 | 0.075 | 0.039 | 0.041 | 0.039 | 0.035 | 0.032 | 0.022 | 0.147 | 0.078 |
| **1994** | 0.042 | 0.047 | 0.173 | 0.011 | 0.229 | 0.075 | 0.035 | 0.042 | 0.041 | 0.037 | 0.016 | 0.022 | 0.149 | 0.083 |
| **1995** | 0.042 | 0.047 | 0.174 | 0.010 | 0.226 | 0.072 | 0.039 | 0.042 | 0.040 | 0.036 | 0.020 | 0.019 | 0.146 | 0.088 |
| **1996** | 0.041 | 0.049 | 0.183 | 0.010 | 0.221 | 0.069 | 0.039 | 0.040 | 0.040 | 0.034 | 0.022 | 0.018 | 0.143 | 0.090 |

| | Benin | Burkina Faso | Ethiopia | Gambia | Kenya | Madagascar | Malawi | Mali | Mozambique | Niger | Rwanda | Sierra Leone | Tanzania | Uganda |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| **1997** | 0.042 | 0.051 | 0.182 | 0.010 | 0.214 | 0.069 | 0.039 | 0.042 | 0.043 | 0.034 | 0.024 | 0.016 | 0.143 | 0.091 |
| **1998** | 0.043 | 0.053 | 0.170 | 0.010 | 0.214 | 0.070 | 0.039 | 0.043 | 0.046 | 0.037 | 0.025 | 0.016 | 0.143 | 0.092 |
| **1999** | 0.043 | 0.054 | 0.171 | 0.010 | 0.209 | 0.069 | 0.039 | 0.044 | 0.047 | 0.035 | 0.026 | 0.015 | 0.143 | 0.095 |
| **2000** | 0.043 | 0.053 | 0.175 | 0.010 | 0.203 | 0.070 | 0.038 | 0.043 | 0.046 | 0.033 | 0.027 | 0.016 | 0.146 | 0.095 |
| **2001** | 0.044 | 0.054 | 0.179 | 0.010 | 0.199 | 0.070 | 0.034 | 0.046 | 0.049 | 0.033 | 0.028 | 0.014 | 0.146 | 0.094 |
| **2002** | 0.044 | 0.054 | 0.176 | 0.010 | 0.194 | 0.060 | 0.034 | 0.046 | 0.051 | 0.033 | 0.030 | 0.017 | 0.151 | 0.099 |
| **2003** | 0.044 | 0.056 | 0.165 | 0.010 | 0.191 | 0.063 | 0.034 | 0.048 | 0.052 | 0.034 | 0.029 | 0.018 | 0.155 | 0.101 |
| **2004** | 0.042 | 0.055 | 0.175 | 0.010 | 0.188 | 0.062 | 0.033 | 0.046 | 0.053 | 0.031 | 0.029 | 0.017 | 0.156 | 0.101 |
| **2005** | 0.041 | 0.056 | 0.183 | 0.009 | 0.186 | 0.060 | 0.032 | 0.045 | 0.054 | 0.031 | 0.030 | 0.017 | 0.156 | 0.100 |
| **2006** | 0.039 | 0.055 | 0.189 | 0.009 | 0.184 | 0.059 | 0.030 | 0.044 | 0.053 | 0.030 | 0.030 | 0.016 | 0.156 | 0.104 |
| **2007** | 0.038 | 0.053 | 0.196 | 0.008 | 0.183 | 0.058 | 0.031 | 0.043 | 0.053 | 0.029 | 0.030 | 0.017 | 0.155 | 0.104 |
| **2008** | 0.037 | 0.053 | 0.203 | 0.008 | 0.174 | 0.058 | 0.031 | 0.042 | 0.053 | 0.030 | 0.032 | 0.016 | 0.156 | 0.106 |
| **2009** | 0.037 | 0.052 | 0.210 | 0.008 | 0.170 | 0.053 | 0.033 | 0.042 | 0.054 | 0.028 | 0.032 | 0.016 | 0.157 | 0.108 |
| **2010** | 0.035 | 0.052 | 0.216 | 0.008 | 0.168 | 0.050 | 0.033 | 0.042 | 0.054 | 0.028 | 0.032 | 0.016 | 0.157 | 0.107 |
| **2011** | 0.035 | 0.052 | 0.220 | 0.008 | 0.167 | 0.048 | 0.032 | 0.040 | 0.055 | 0.027 | 0.033 | 0.016 | 0.159 | 0.109 |

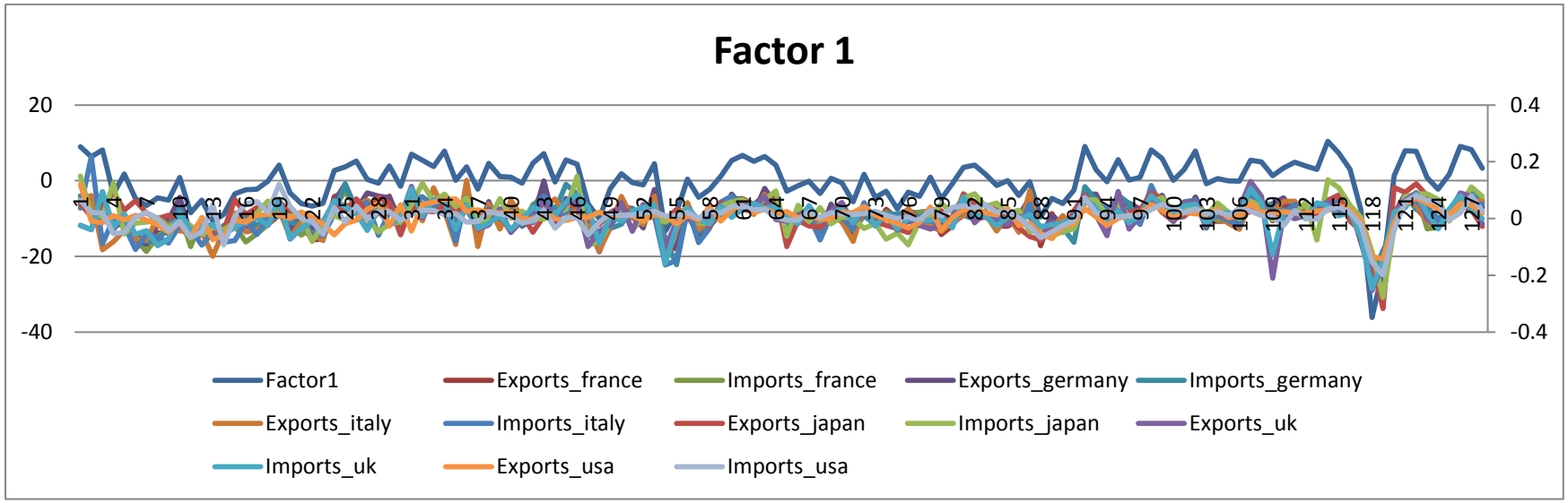
| **Fragile countries** | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| | **Burundi** | **Central African Republic** | **Comoros** | **Congo, Dem. Rep.** | **Cote d'Ivoire** | **Eritrea** | **Guinea** | **Guinea-Bissau** | **Liberia** | **Sao Tome and Principe** | **Togo** |
| **1980** | 0.046 | 0.041 | 0.007 | 0.384 | 0.406 | *** | *** | 0.014 | 0.044 | *** | 0.058 |
| **1981** | 0.050 | 0.039 | 0.007 | 0.382 | 0.409 | *** | *** | 0.016 | 0.042 | *** | 0.055 |
| **1982** | 0.049 | 0.043 | 0.008 | 0.380 | 0.410 | *** | *** | 0.017 | 0.041 | *** | 0.053 |
| **1983** | 0.052 | 0.040 | 0.008 | 0.392 | 0.400 | *** | *** | 0.016 | 0.041 | *** | 0.051 |
| **1984** | 0.051 | 0.043 | 0.008 | 0.406 | 0.382 | *** | *** | 0.017 | 0.039 | *** | 0.052 |
| **1985** | 0.055 | 0.043 | 0.008 | 0.396 | 0.388 | *** | *** | 0.018 | 0.038 | *** | 0.054 |
| **1986** | 0.051 | 0.040 | 0.008 | 0.374 | 0.361 | *** | 0.067 | 0.016 | 0.034 | *** | 0.049 |
| **1987** | 0.054 | 0.038 | 0.008 | 0.379 | 0.355 | *** | 0.068 | 0.016 | 0.033 | *** | 0.049 |
| **1988** | 0.055 | 0.038 | 0.008 | 0.375 | 0.354 | *** | 0.071 | 0.016 | 0.032 | *** | 0.051 |
| **1989** | 0.056 | 0.038 | 0.008 | 0.368 | 0.362 | *** | 0.074 | 0.017 | 0.023 | *** | 0.053 |

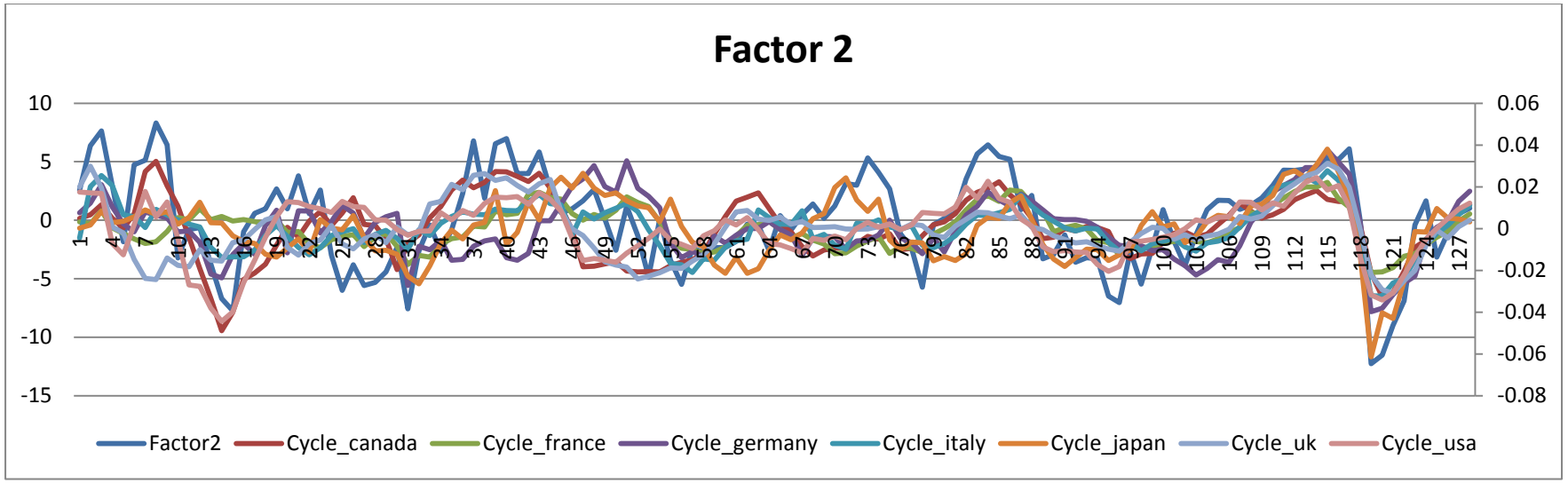
| | Burundi | Central African Republic | Comoros | Congo, Dem. Rep. | Cote d'Ivoire | Eritrea | Guinea | Guinea Bissau | Liberia | Sao Tome and Principe | Togo |
|---|---|---|---|---|---|---|---|---|---|---|---|
| **1990** | 0.060 | 0.039 | 0.008 | 0.356 | 0.371 | *** | 0.080 | 0.019 | 0.012 | *** | 0.055 |
| **1991** | 0.065 | 0.040 | 0.008 | 0.335 | 0.381 | *** | 0.084 | 0.021 | 0.010 | *** | 0.056 |
| **1992** | 0.066 | 0.038 | 0.009 | 0.305 | 0.387 | 0.023 | 0.088 | 0.021 | 0.007 | *** | 0.055 |
| **1993** | 0.065 | 0.040 | 0.010 | 0.278 | 0.406 | 0.028 | 0.098 | 0.023 | 0.005 | *** | 0.049 |
| **1994** | 0.062 | 0.041 | 0.009 | 0.265 | 0.406 | 0.033 | 0.101 | 0.023 | 0.004 | *** | 0.056 |
| **1995** | 0.055 | 0.043 | 0.009 | 0.256 | 0.418 | 0.033 | 0.101 | 0.023 | 0.003 | *** | 0.058 |
| **1996** | 0.049 | 0.039 | 0.008 | 0.244 | 0.433 | 0.035 | 0.102 | 0.025 | 0.004 | *** | 0.060 |
| **1997** | 0.047 | 0.040 | 0.009 | 0.223 | 0.443 | 0.036 | 0.103 | 0.026 | 0.007 | *** | 0.067 |
| **1998** | 0.048 | 0.041 | 0.008 | 0.215 | 0.455 | 0.036 | 0.105 | 0.018 | 0.009 | *** | 0.064 |
| **1999** | 0.047 | 0.042 | 0.009 | 0.204 | 0.459 | 0.036 | 0.108 | 0.018 | 0.011 | *** | 0.065 |
| **2000** | 0.048 | 0.043 | 0.009 | 0.196 | 0.456 | 0.032 | 0.115 | 0.020 | 0.015 | *** | 0.067 |
| **2001** | 0.048 | 0.042 | 0.009 | 0.189 | 0.449 | 0.038 | 0.117 | 0.021 | 0.018 | 0.003 | 0.065 |
| **2002** | 0.050 | 0.041 | 0.009 | 0.193 | 0.436 | 0.039 | 0.121 | 0.021 | 0.023 | 0.003 | 0.063 |
| **2003** | 0.049 | 0.039 | 0.010 | 0.205 | 0.431 | 0.038 | 0.123 | 0.020 | 0.016 | 0.003 | 0.067 |
| **2004** | 0.050 | 0.038 | 0.009 | 0.212 | 0.427 | 0.038 | 0.123 | 0.019 | 0.014 | 0.003 | 0.066 |
| **2005** | 0.049 | 0.038 | 0.009 | 0.222 | 0.419 | 0.037 | 0.123 | 0.019 | 0.015 | 0.003 | 0.065 |
| **2006** | 0.051 | 0.038 | 0.009 | 0.228 | 0.411 | 0.036 | 0.122 | 0.019 | 0.016 | 0.003 | 0.066 |
| **2007** | 0.051 | 0.038 | 0.009 | 0.235 | 0.405 | 0.035 | 0.121 | 0.019 | 0.018 | 0.003 | 0.065 |
| **2008** | 0.052 | 0.038 | 0.009 | 0.241 | 0.400 | 0.031 | 0.122 | 0.020 | 0.020 | 0.003 | 0.064 |
| **2009** | 0.052 | 0.037 | 0.009 | 0.240 | 0.403 | 0.031 | 0.118 | 0.020 | 0.022 | 0.003 | 0.064 |
| **2010** | 0.052 | 0.037 | 0.009 | 0.248 | 0.397 | 0.031 | 0.116 | 0.020 | 0.023 | 0.003 | 0.065 |
| **2011** | 0.053 | 0.038 | 0.009 | 0.261 | 0.372 | 0.033 | 0.119 | 0.020 | 0.025 | 0.004 | 0.067 |

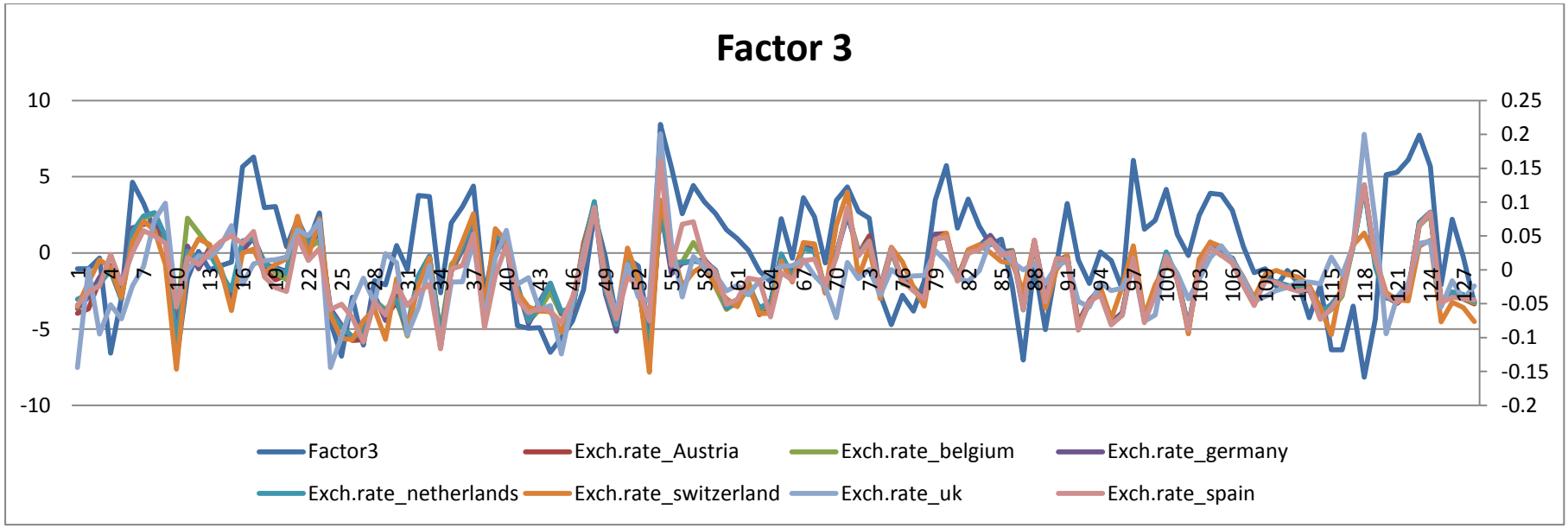
## Appendix D: Factors

### Chapter 4: Decoupling between EM and advanced economies

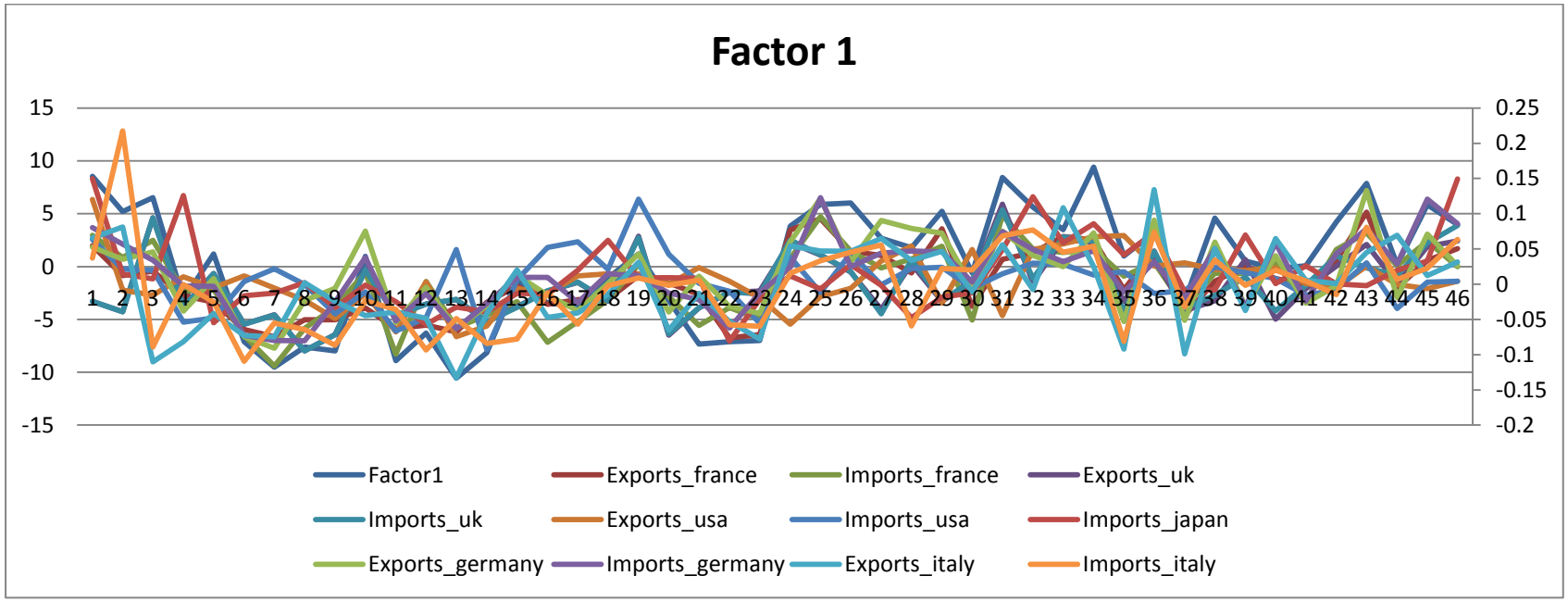
**1979Q3-2011Q2**

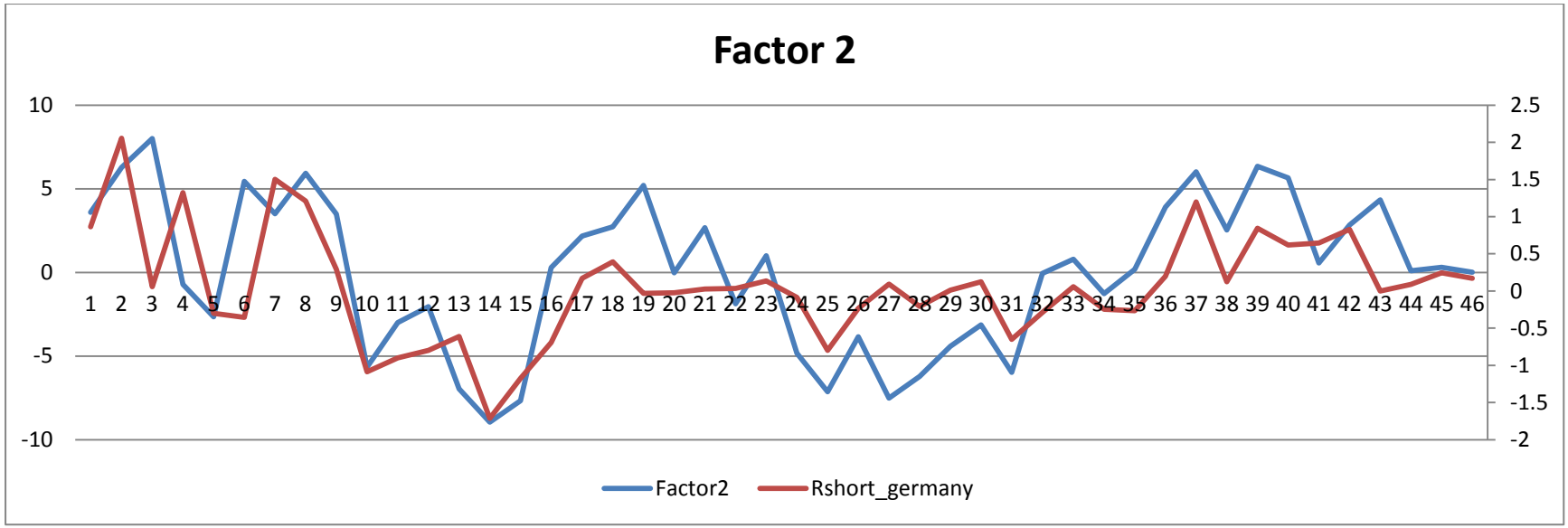


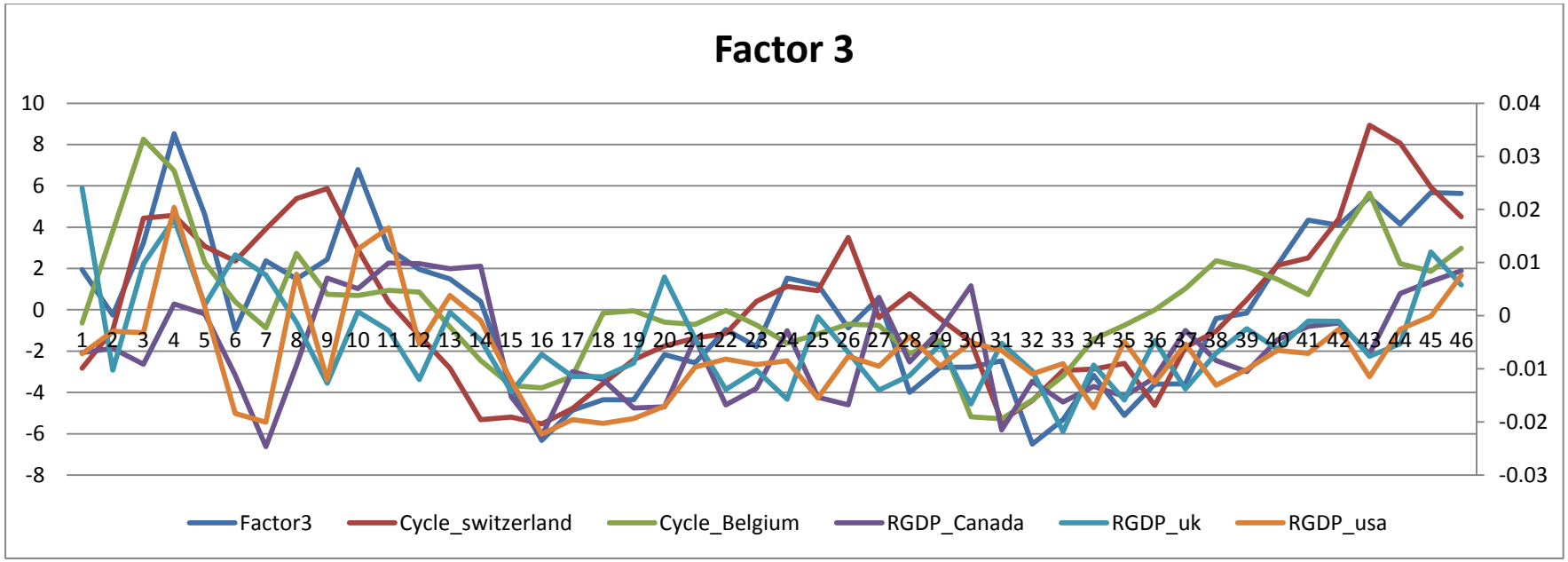

Factor 2
10
5
0
-5
-10
-15
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
61
64
67
70
73
76
79
82
85
88
91
94
97
100
103
106
109
112
115
118
121
124
127
Factor2
Cycle_canada
Cycle_france
Cycle_germany
Cycle_italy
Cycle_japan
Cycle_uk
Cycle_usa


Factor 3
10
5
0
-5
-10
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
-0.2
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
61
64
67
70
73
76
79
82
85
88
91
94
97
100
103
106
109
112
115
118
121
124
127
Factor3
Exch.rate_Austria
Exch.rate_belgium
Exch.rate_germany
Exch.rate_netherlands
Exch.rate_switzerland
Exch.rate_uk
Exch.rate_spain

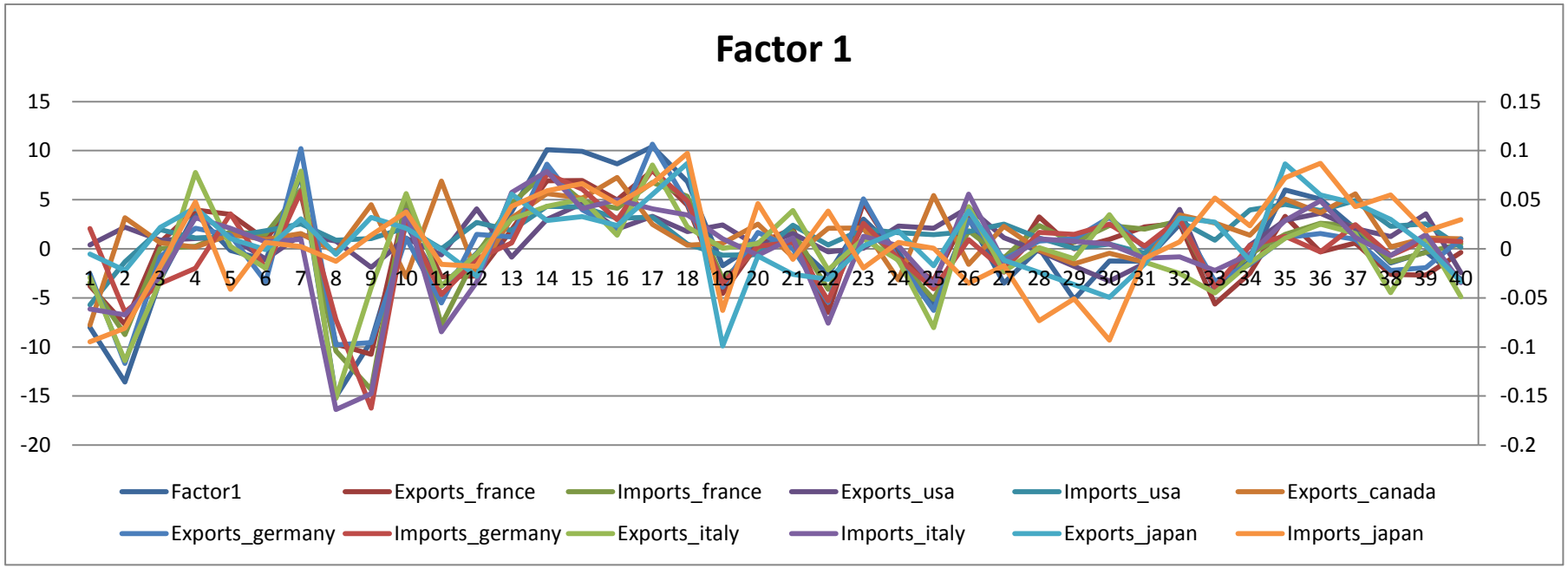
**1979Q3-1990Q4**

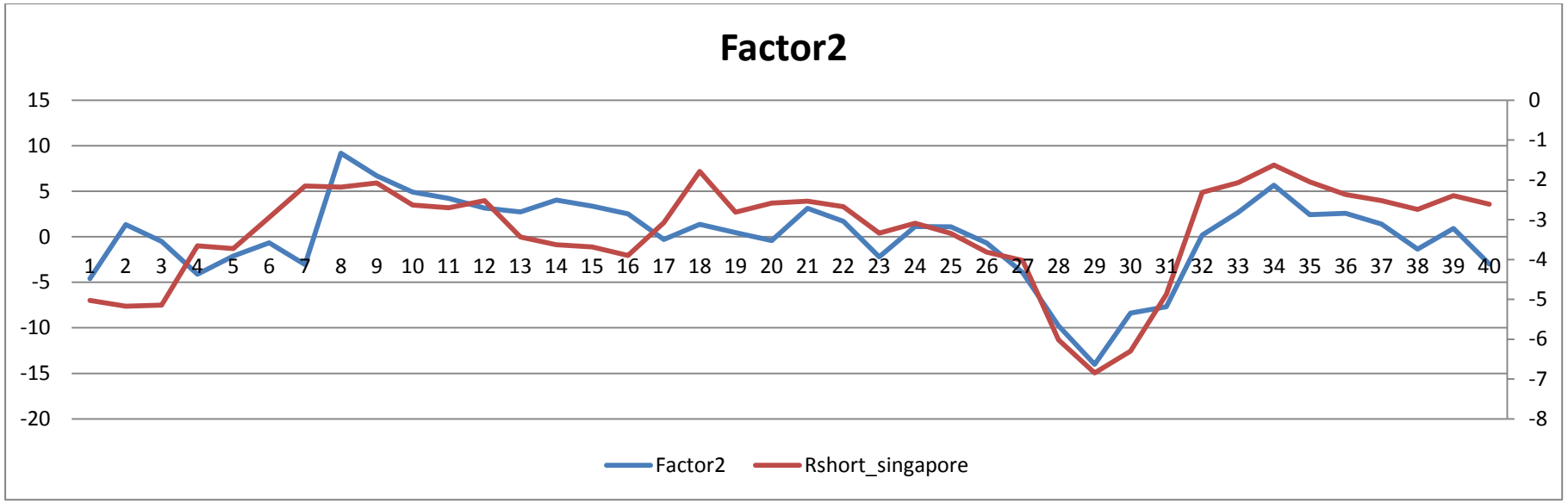



Factor 2
10
5
0
-5
-10
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
-2
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46
Factor2
Rshort_germany


Factor 3
10
8
6
4
2
0
-2
-4
-6
-8
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46
Factor3
Cycle_switzerland
Cycle_Belgium
RGDP_Canada
RGDP_uk
RGDP_usa

**1991Q1-2000Q4**




Factor2
15
10
5
0
-5
-10
-15
-20
0
-1
-2
-3
-4
-5
-6
-7
-8
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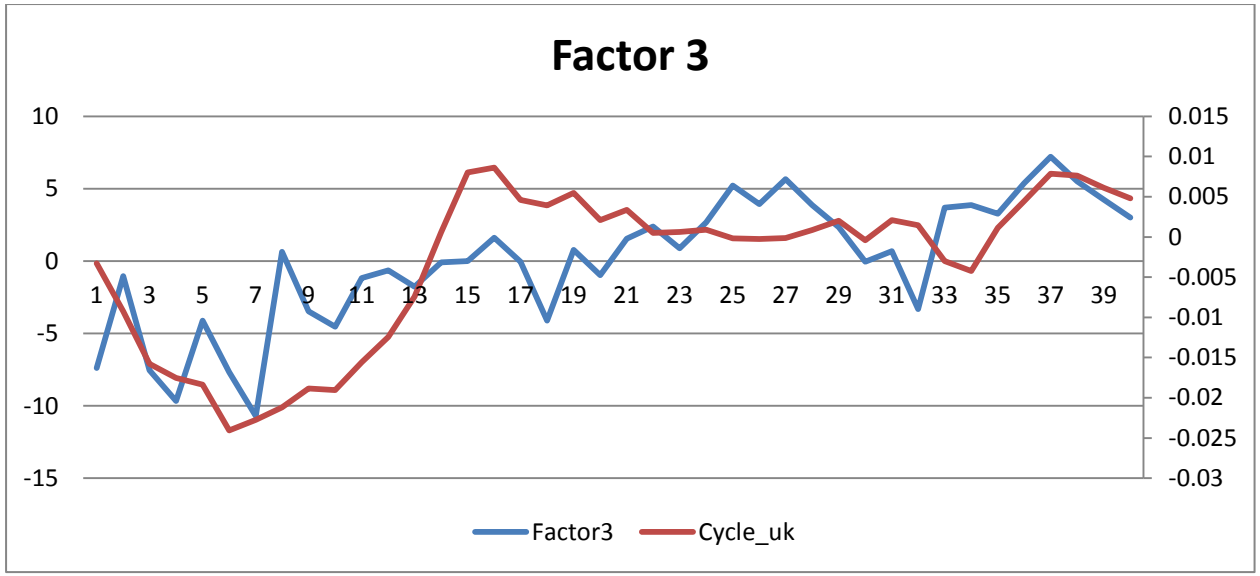
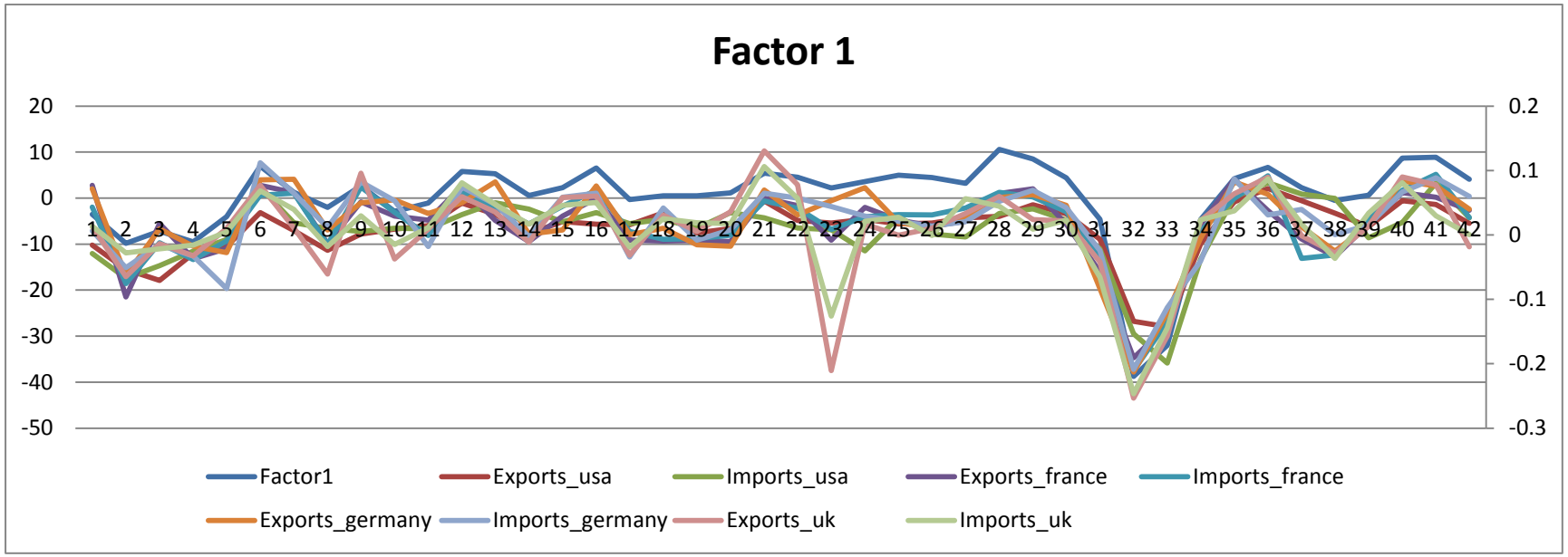
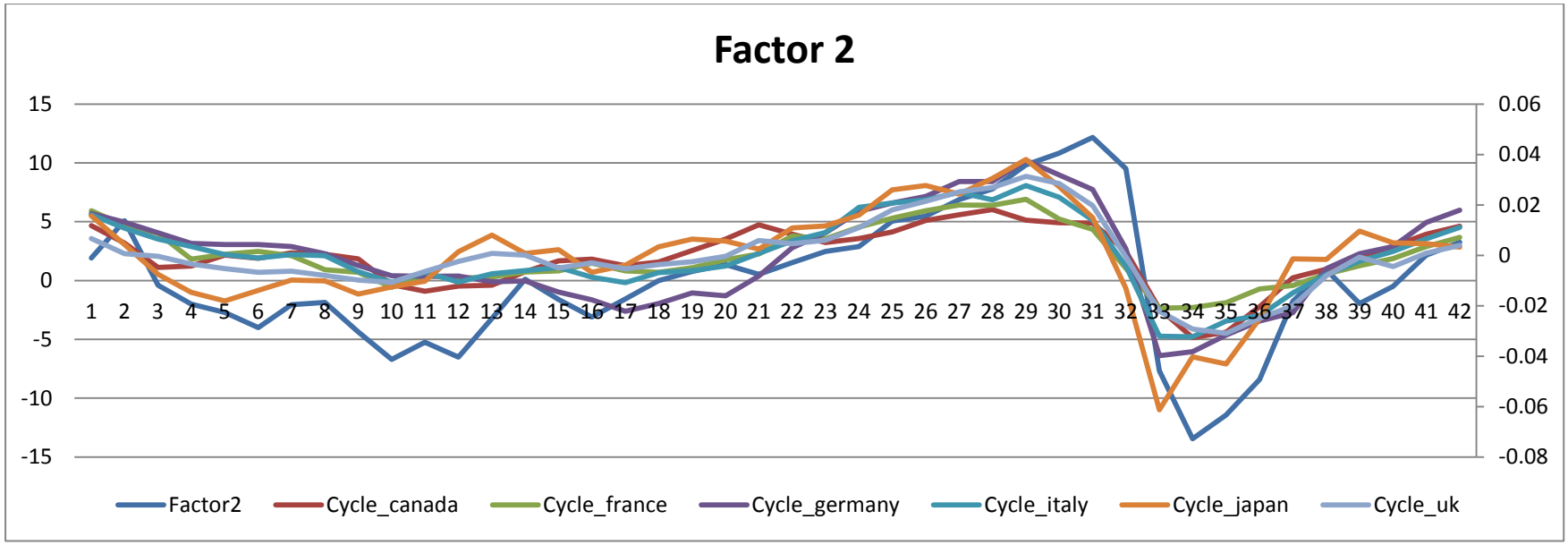
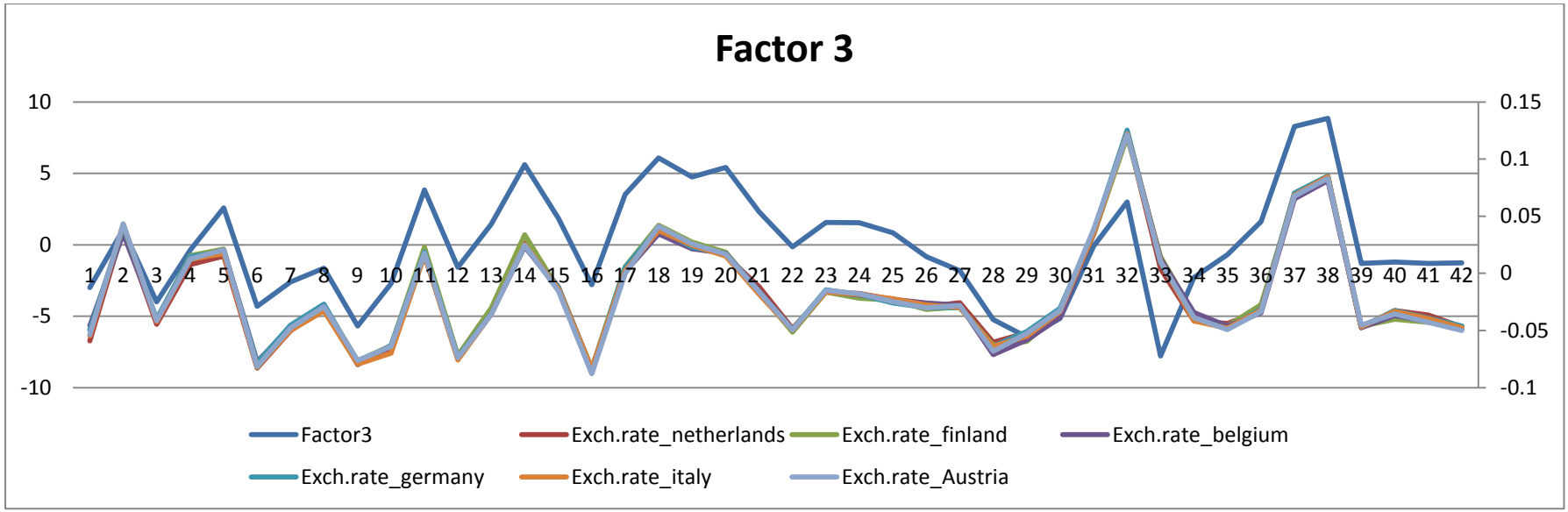
Factor2
Rshort_singapore


Factor 3
10
5
0
-5
-10
-15
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
-0.025
-0.03
1 3 5 7 9 11 13 15 17 19 21 23 25 27 29 31 33 35 37 39
Factor3
Cycle_uk

**2001Q1-2011Q2**

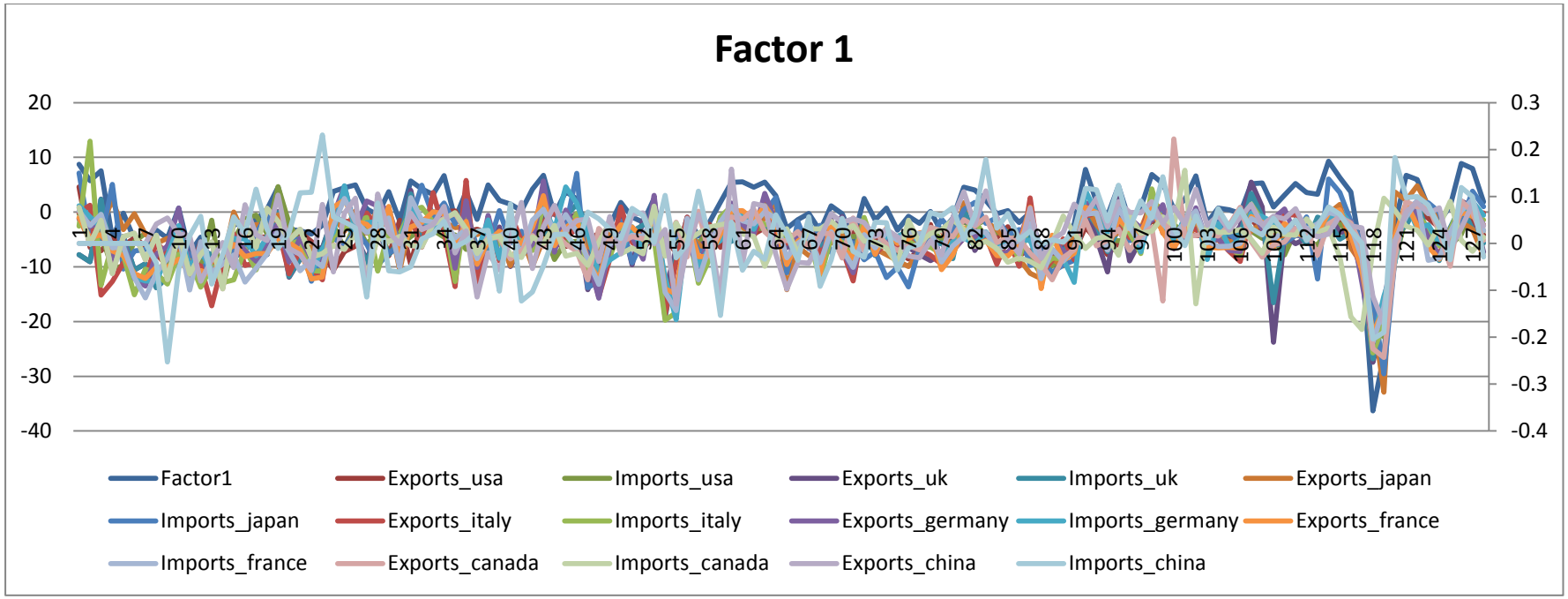


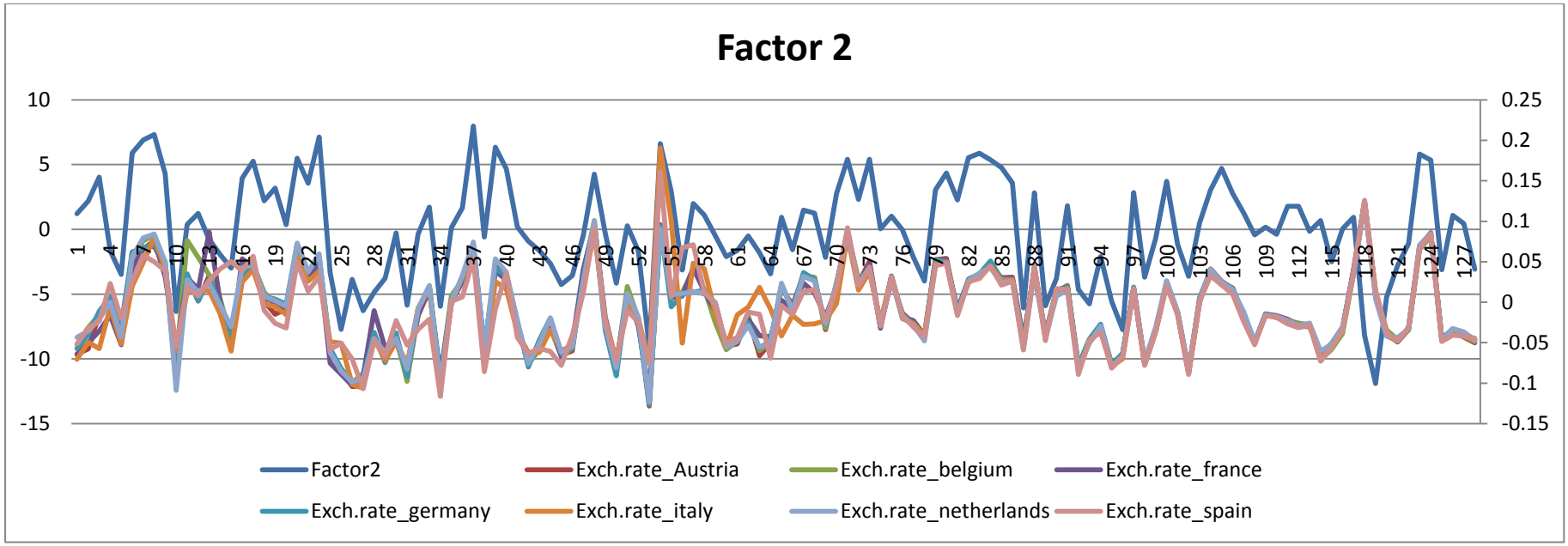

Factor 2
15
10
5
0
-5
-10
-15
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
Factor2
Cycle_canada
Cycle_france
Cycle_germany
Cycle_italy
Cycle_japan
Cycle_uk

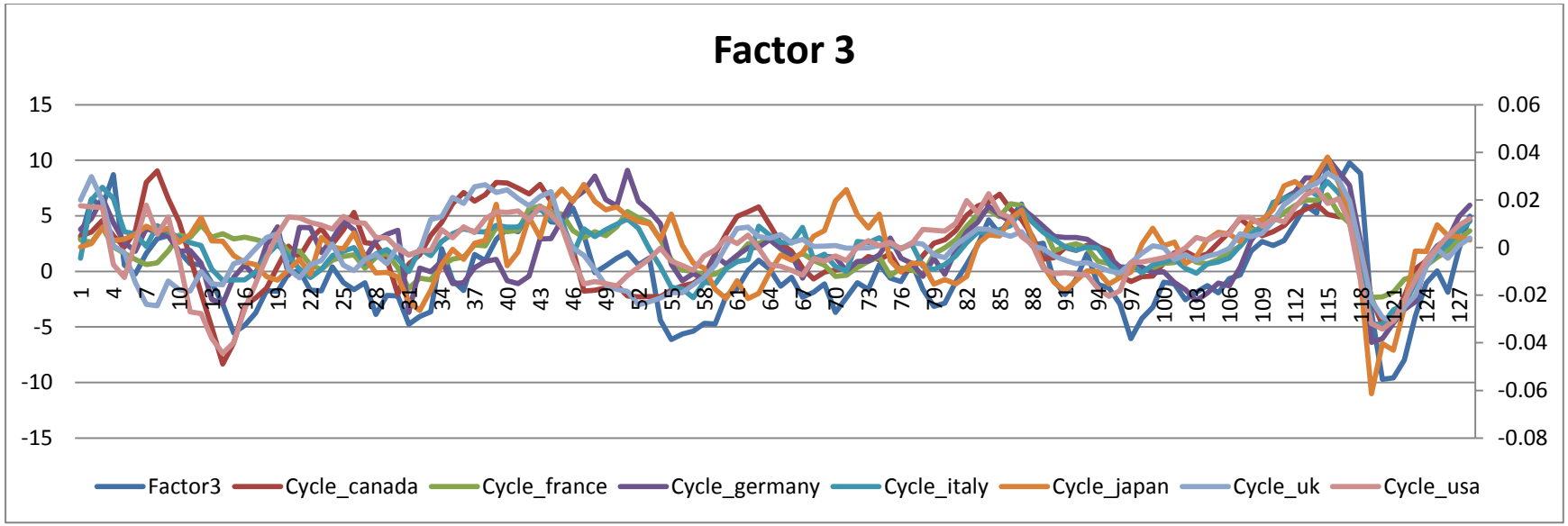

Factor 3
10
5
0
-5
-10
0.15
0.1
0.05
0
-0.05
-0.1
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
Factor3
Exch.rate_netherlands
Exch.rate_finland
Exch.rate_belgium
Exch.rate_germany
Exch.rate_italy
Exch.rate_Austria

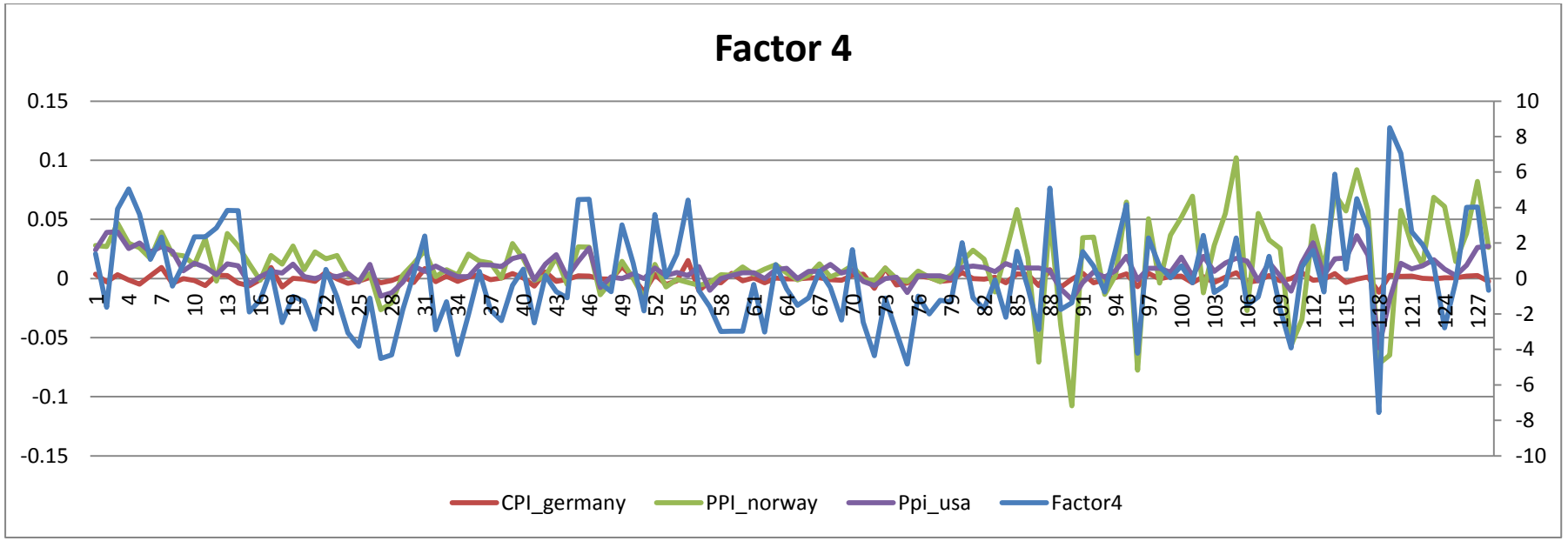
## Chapter 5: Decoupling between China and advanced economies

**1979Q3-2011Q2**




Factor 2
10
5
0
-5
-10
-15
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
61
64
67
70
73
76
79
82
85
88
91
94
97
100
103
106
109
112
115
118
121
124
127
Factor2
Exch.rate_Austria
Exch.rate_belgium
Exch.rate_france
Exch.rate_germany
Exch.rate_italy
Exch.rate_netherlands
Exch.rate_spain


Factor 3
15
10
5
0
-5
-10
-15
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
1 4 7 10 13 16 19 22 25 28 31 34 37 40 43 46 49 52 55 58 61 64 67 70 73 76 79 82 85 88 91 94 97 100 103 106 109 112 115 118 121 124 127
Factor3
Cycle_canada
Cycle_france
Cycle_germany
Cycle_italy
Cycle_japan
Cycle_uk
Cycle_usa


Factor 4
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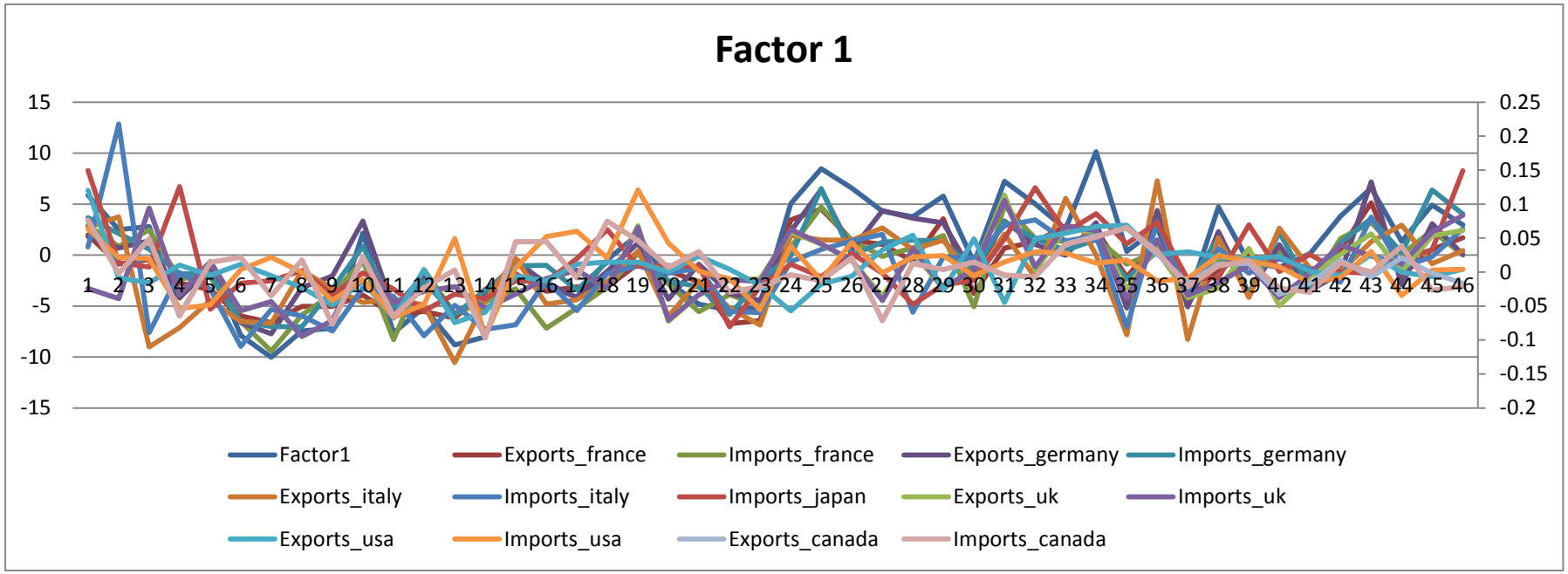
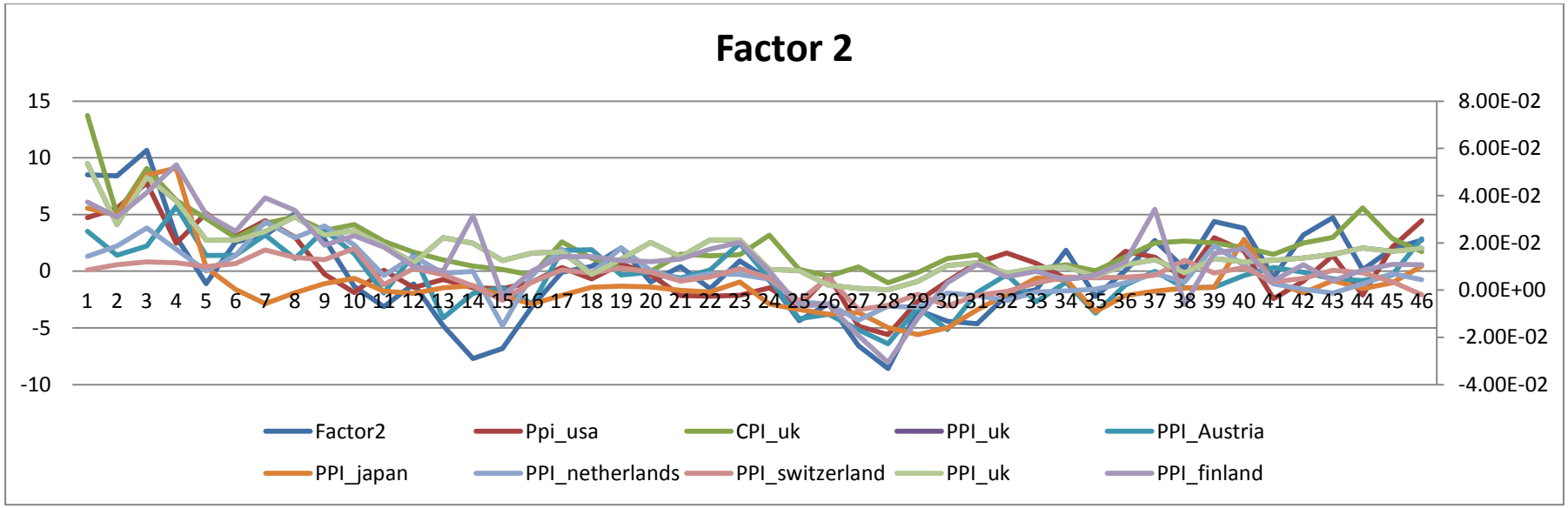
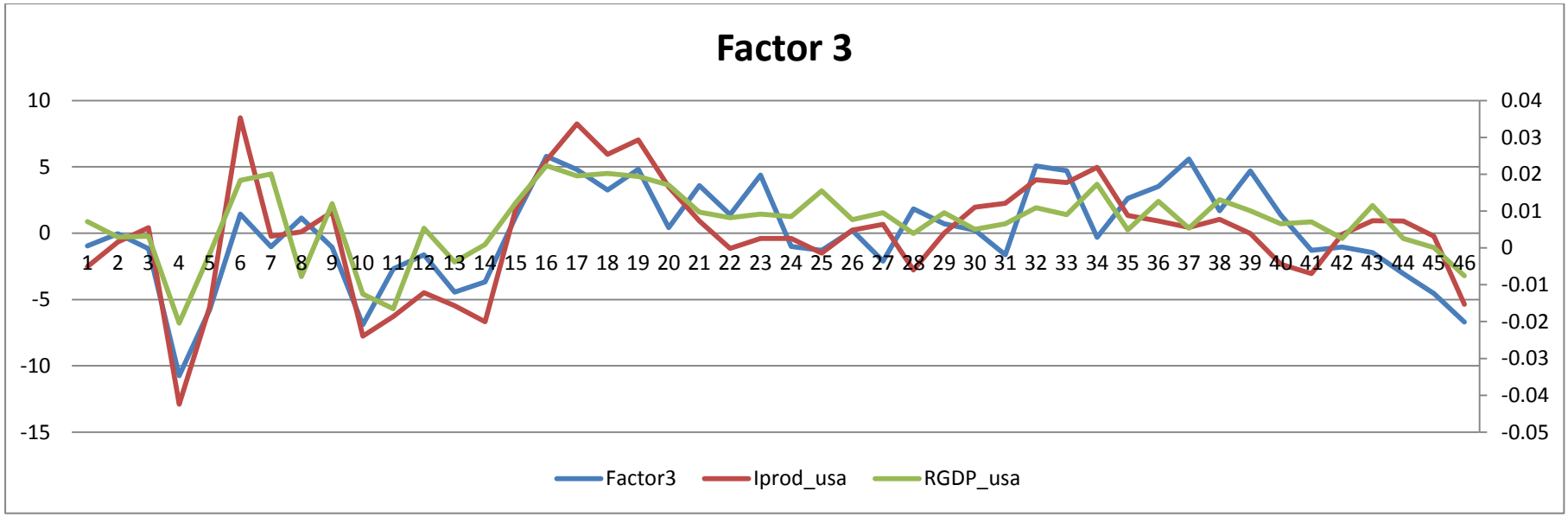
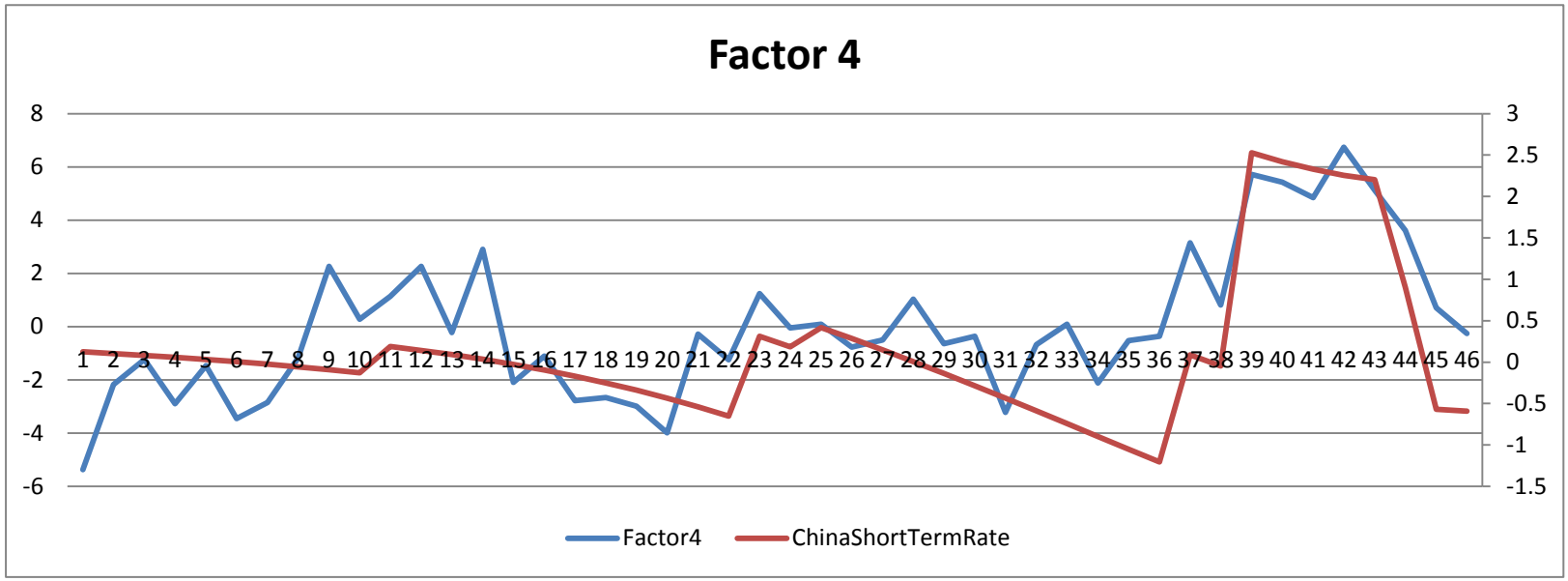
0.1
0.05
0
-0.05
-0.1
-0.15
10
8
6
4
2
0
-2
-4
-6
-8
-10
1
4
7
10
13
16
19
22
25
28
31
34
37
40
43
46
49
52
55
58
61
64
67
70
73
76
79
82
85
88
91
94
97
100
103
106
109
112
115
118
121
124
127
CPI_germany
PPI_norway
Ppi_usa
Factor4

**1979Q3-1990Q4**

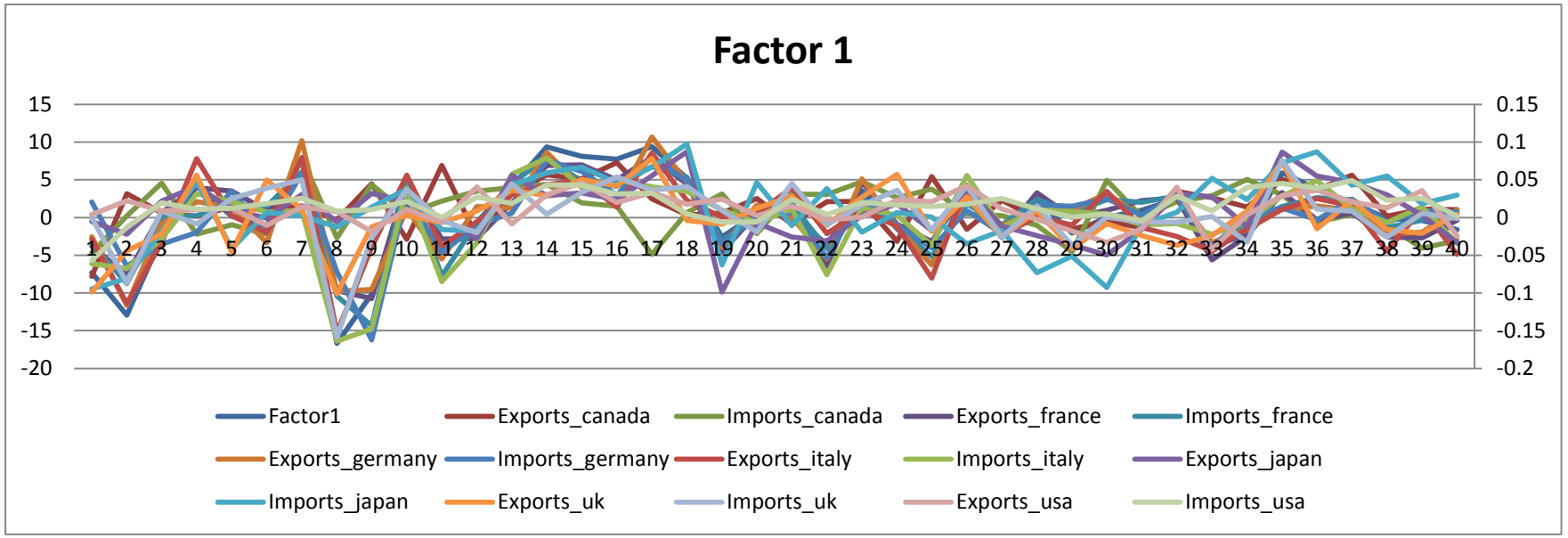


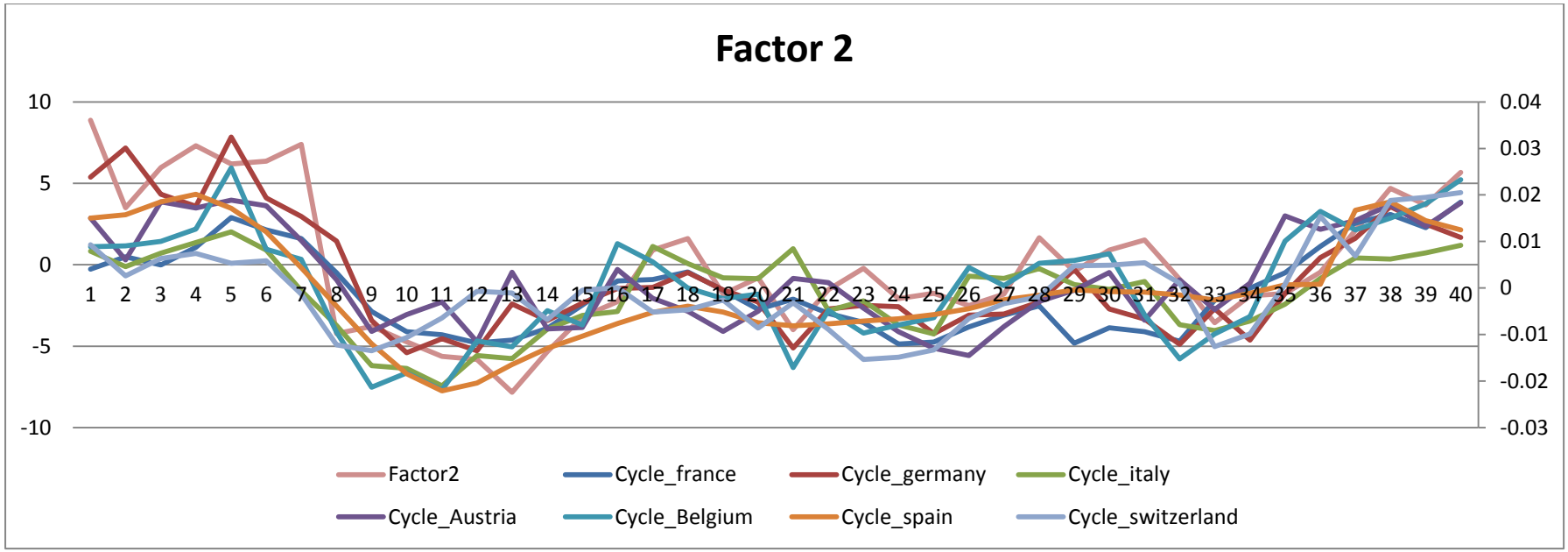

Factor 2
15
10
5
0
-5
-10
8.00E-02
6.00E-02
4.00E-02
2.00E-02
0.00E+00
-2.00E-02
-4.00E-02
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46
Factor2
Ppi_usa
CPI_uk
PPI_uk
PPI_Austria
PPI_japan
PPI_netherlands
PPI_switzerland
PPI_uk
PPI_finland

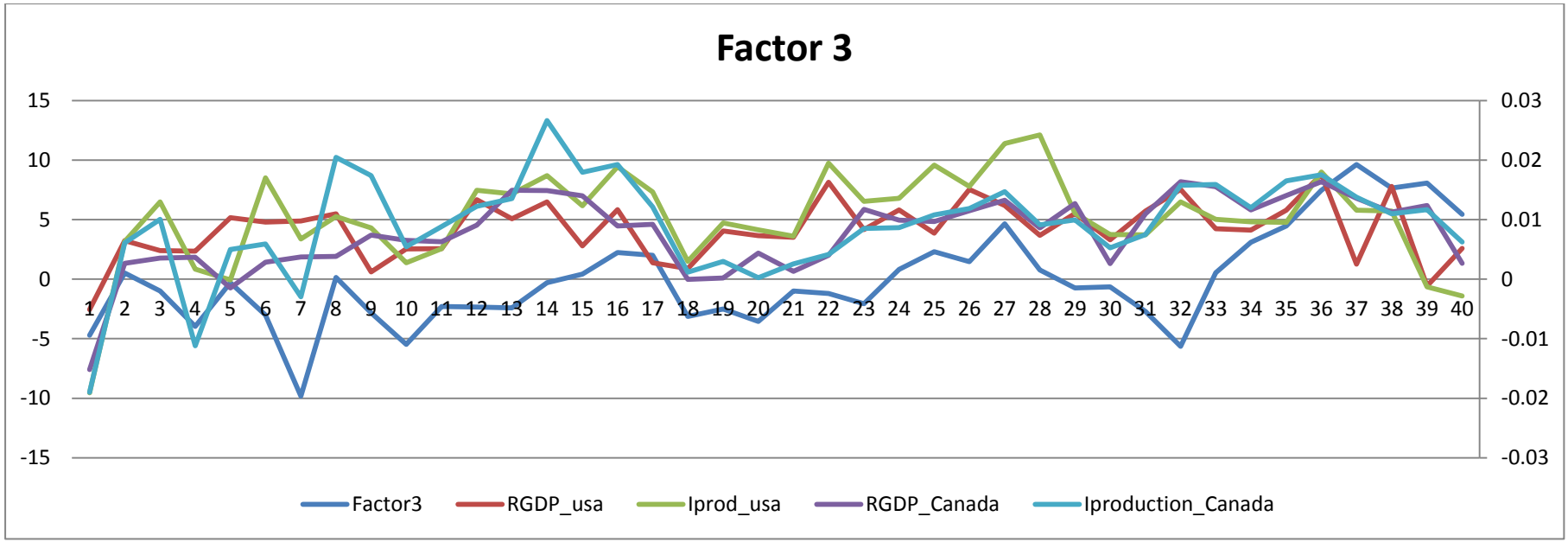

Factor 3
10
5
0
-5
-10
-15
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
-0.04
-0.05
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46
Factor3
Iprod_usa
RGDP_usa

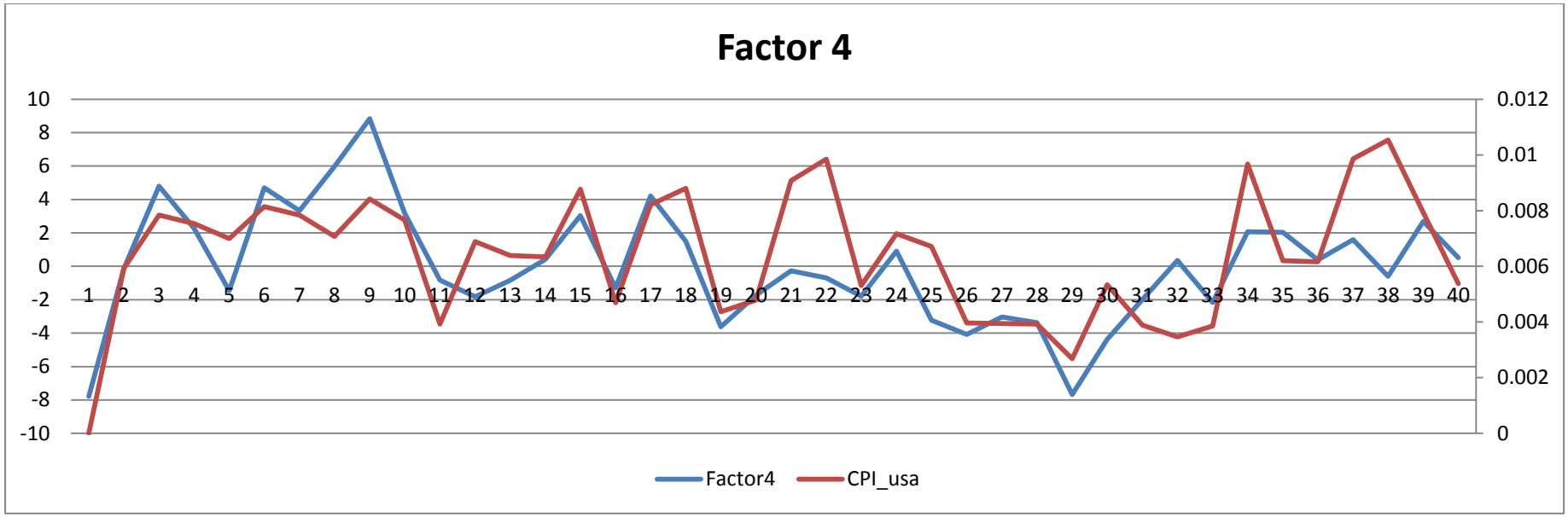

Factor 4
8
6
4
2
0
-2
-4
-6
3
2.5
2
1.5
1
0.5
0
-0.5
-1
-1.5
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42 43 44 45 46
Factor4
ChinaShortTermRate

**1991Q1-2000Q4**

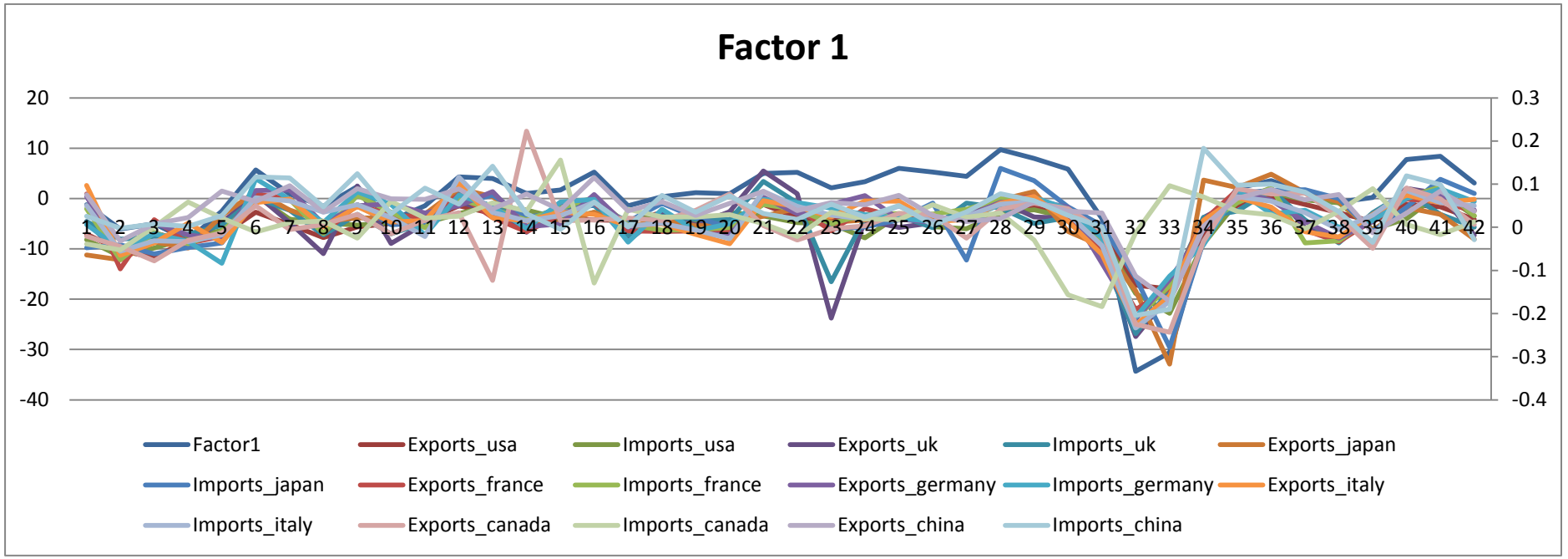


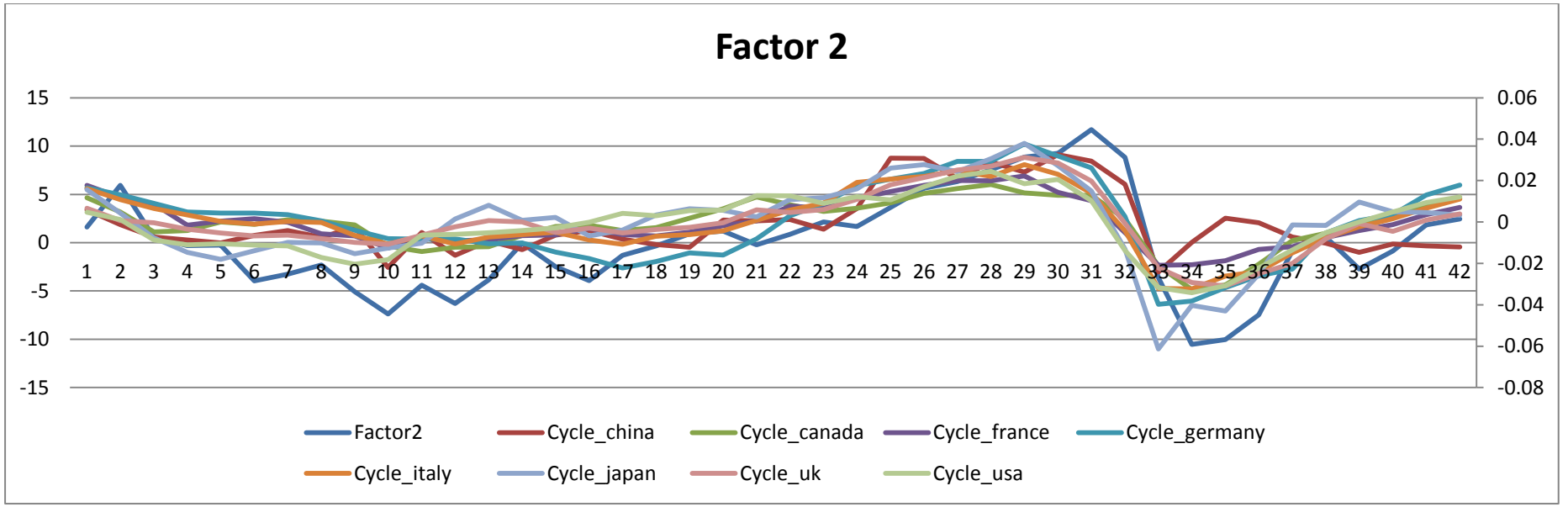

Factor 2
10
5
0
-5
-10
0.04
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Factor2
Cycle_france
Cycle_germany
Cycle_italy
Cycle_Austria
Cycle_Belgium
Cycle_spain
Cycle_switzerland

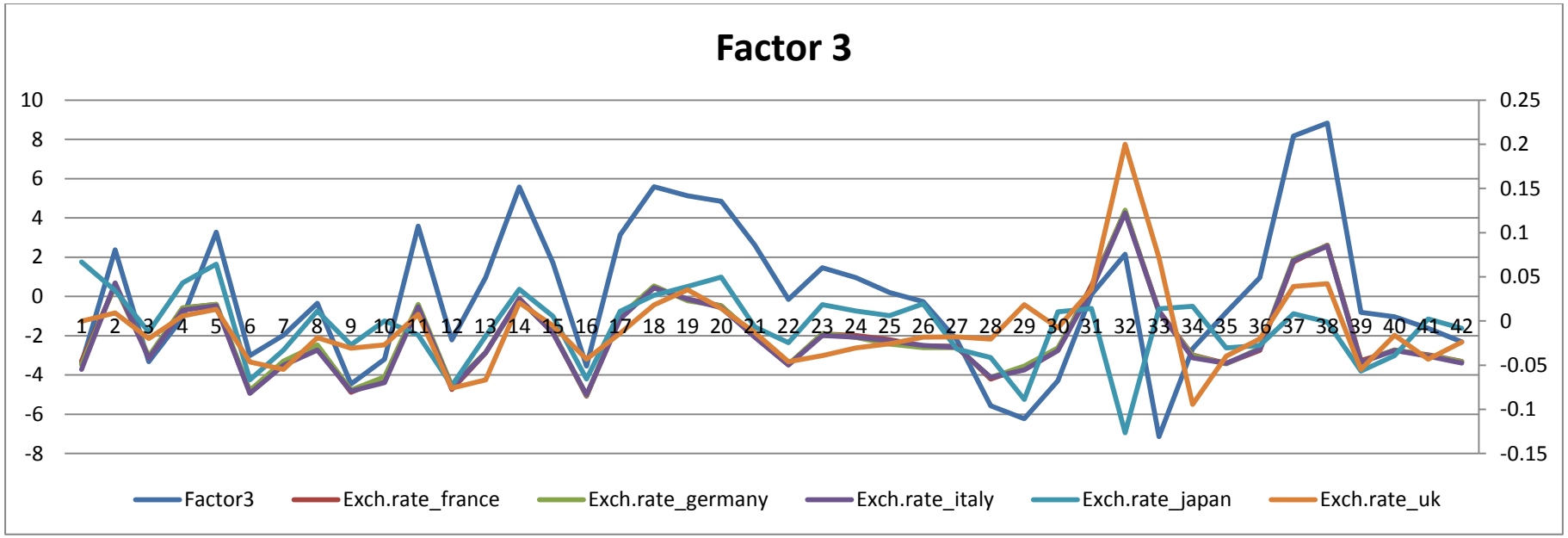

Factor 3
15
10
5
0
-5
-10
-15
0.03
0.02
0.01
0
-0.01
-0.02
-0.03
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Factor3
RGDP_usa
Iprod_usa
RGDP_Canada
Iproduction_Canada

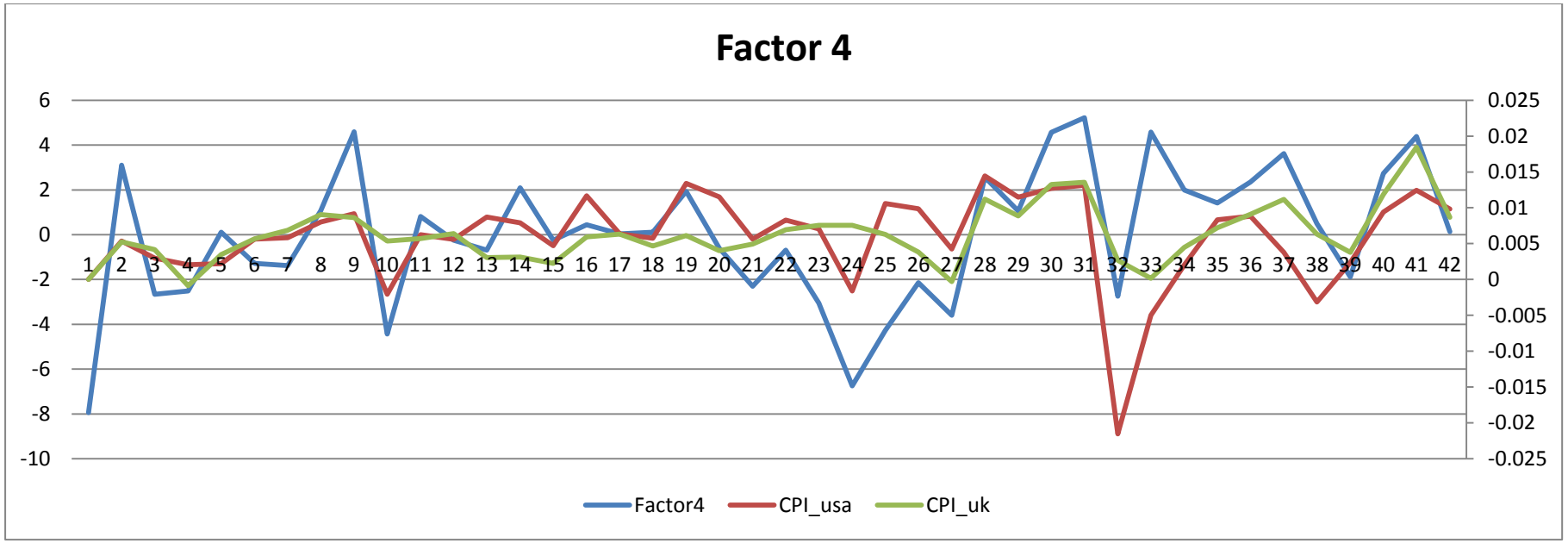

Factor 4
10
8
6
4
2
0
-2
-4
-6
-8
-10
0.012
0.01
0.008
0.006
0.004
0.002
0
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40
Factor4
CPI_usa

**2001Q1-2011Q4**




Factor 2
15
10
5
0
-5
-10
-15
0.06
0.04
0.02
0
-0.02
-0.04
-0.06
-0.08
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
Factor2
Cycle_china
Cycle_canada
Cycle_france
Cycle_germany
Cycle_italy
Cycle_japan
Cycle_uk
Cycle_usa


Factor 3
10
8
6
4
2
0
-2
-4
-6
-8
0.25
0.2
0.15
0.1
0.05
0
-0.05
-0.1
-0.15
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
Factor3
Exch.rate_france
Exch.rate_germany
Exch.rate_italy
Exch.rate_japan
Exch.rate_uk


Factor 4
6
4
2
0
-2
-4
-6
-8
-10
0.025
0.02
0.015
0.01
0.005
0
-0.005
-0.01
-0.015
-0.02
-0.025
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22 23 24 25 26 27 28 29 30 31 32 33 34 35 36 37 38 39 40 41 42
Factor4
CPI_usa
CPI_uk

# Appendix E: Macroeconomic series

## Table E.1: Chapter 4

| Country | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| Argentina | Real GDP | GVAR Toolbox | l | 5 |
| Argentina | Consumer Price Index | GVAR Toolbox | l | 5 |
| Argentina | Short term interest rate | GVAR Toolbox | nl | 2 |
| Argentina | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Argentina | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 3 |
| Argentina | Business cycle | GVAR Toolbox | l | 1 |
| Argentina | Exchange rate | GVAR Toolbox | l | 5 |
| Australia | Real GDP | GVAR Toolbox | l | 5 |
| Australia | Consumer Price Index | GVAR Toolbox | l | 3 |
| Australia | Short term interest rate | GVAR Toolbox | nl | 2 |
| Australia | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 3 |
| Australia | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Australia | Business cycle | GVAR Toolbox | l | 1 |
| Australia | Exchange rate | GVAR Toolbox | l | 5 |
| Austria | Real GDP | GVAR Toolbox | l | 5 |
| Austria | Consumer Price Index | GVAR Toolbox | l | 5 |
| Austria | Short term interest rate | GVAR Toolbox | nl | 2 |
| Austria | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Austria | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Austria | Business cycle | GVAR Toolbox | l | 1 |
| Austria | Exchange rate | GVAR Toolbox | l | 5 |
| Belgium | Real GDP | GVAR Toolbox | l | 5 |
| Belgium | Consumer Price Index | GVAR Toolbox | l | 5 |
| Belgium | Short term interest rate | GVAR Toolbox | nl | 2 |
| Belgium | Business cycle | GVAR Toolbox | l | 1 |
| Belgium | Exchange rate | GVAR Toolbox | l | 5 |
| Brazil | Real GDP | GVAR Toolbox | l | 5 |
| Brazil | Consumer Price Index | GVAR Toolbox | l | 5 |
| Brazil | Short term interest rate | GVAR Toolbox | nl | 2 |

| Country | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| Brazil | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 3 |
| Brazil | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 3 |
| Brazil | Business cycle | GVAR Toolbox | l | 1 |
| Brazil | Exchange rate | GVAR Toolbox | l | 5 |
| Canada | Real GDP | GVAR Toolbox | l | 5 |
| Canada | Consumer Price Index | GVAR Toolbox | l | 3 |
| Canada | Short term interest rate | GVAR Toolbox | nl | 2 |
| Canada | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Canada | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Canada | Business cycle | GVAR Toolbox | l | 1 |
| Canada | Exchange rate | GVAR Toolbox | l | 5 |
| Chile | Real GDP | GVAR Toolbox | l | 5 |
| Chile | Consumer Price Index | GVAR Toolbox | l | 5 |
| Chile | Short term interest rate | GVAR Toolbox | nl | 2 |
| Chile | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Chile | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 3 |
| Chile | Business cycle | GVAR Toolbox | l | 1 |
| Chile | Exchange rate | GVAR Toolbox | l | 5 |
| China | Real GDP | GVAR Toolbox | l | 5 |
| China | Consumer Price Index | GVAR Toolbox | l | 5 |
| China | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| China | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| China | Business cycle | GVAR Toolbox | l | 1 |
| China | Exchange rate | GVAR Toolbox | l | 5 |
| Finland | Real GDP | GVAR Toolbox | l | 5 |
| Finland | Consumer Price Index | GVAR Toolbox | l | 5 |
| Finland | Short term interest rate | GVAR Toolbox | nl | 2 |
| Finland | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Finland | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Finland | Business cycle | GVAR Toolbox | l | 1 |
| Finland | Exchange rate | GVAR Toolbox | l | 5 |
| France | Real GDP | GVAR Toolbox | l | 5 |
| France | Consumer Price Index sa | GVAR Toolbox | l | 3 |
| France | Short term interest rate | GVAR Toolbox | nl | 2 |

| Country | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| France | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| France | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| France | Business cycle | GVAR Toolbox | l | 1 |
| France | Exchange rate | GVAR Toolbox | l | 5 |
| Germany | Real GDP | GVAR Toolbox | l | 5 |
| Germany | Consumer Price Index | GVAR Toolbox | l | 3 |
| Germany | Short term interest rate | GVAR Toolbox | nl | 2 |
| Germany | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Germany | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Germany | Business cycle | GVAR Toolbox | l | 1 |
| Germany | Exchange rate | GVAR Toolbox | l | 5 |
| India | Real GDP | GVAR Toolbox | l | 5 |
| India | Consumer Price Index | GVAR Toolbox | l | 5 |
| India | Short term interest rate | GVAR Toolbox | nl | 2 |
| India | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 3 |
| India | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| India | Business cycle | GVAR Toolbox | l | 1 |
| India | Exchange rate | GVAR Toolbox | l | 5 |
| Indonesia | Real GDP | GVAR Toolbox | l | 5 |
| Indonesia | Consumer Price Index | GVAR Toolbox | l | 5 |
| Indonesia | Short term interest rate | GVAR Toolbox | nl | 2 |
| Indonesia | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Indonesia | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Indonesia | Business cycle | GVAR Toolbox | l | 1 |
| Indonesia | Exchange rate | GVAR Toolbox | l | 5 |
| Italy | Real GDP | GVAR Toolbox | l | 5 |
| Italy | Consumer Price Index sa | GVAR Toolbox | l | 3 |
| Italy | Short term interest rate | GVAR Toolbox | nl | 2 |
| Italy | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Italy | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Italy | Business cycle | GVAR Toolbox | l | 1 |
| Italy | Exchange rate | GVAR Toolbox | l | 5 |
| Japan | Real GDP | GVAR Toolbox | l | 3 |
| Japan | Consumer Price Index | GVAR Toolbox | l | 3 |

| Country | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| Japan | Short term interest rate | GVAR Toolbox | nl | 2 |
| Japan | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Japan | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Japan | Business cycle | GVAR Toolbox | l | 1 |
| Japan | Exchange rate | GVAR Toolbox | l | 5 |
| Korea (South) | Real GDP | GVAR Toolbox | l | 5 |
| Korea (South) | Consumer Price Index | GVAR Toolbox | l | 5 |
| Korea (South) | Short term interest rate | GVAR Toolbox | nl | 2 |
| Korea (South) | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Korea (South) | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Korea (South) | Business cycle | GVAR Toolbox | l | 1 |
| Korea (South) | Exchange rate | GVAR Toolbox | l | 5 |
| Malaysia | Real GDP | GVAR Toolbox | l | 5 |
| Malaysia | Consumer Price Index | GVAR Toolbox | l | 5 |
| Malaysia | Short term interest rate | GVAR Toolbox | nl | 2 |
| Malaysia | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Malaysia | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Malaysia | Business cycle | GVAR Toolbox | l | 1 |
| Malaysia | Exchange rate | GVAR Toolbox | l | 5 |
| Mexico | Real GDP | GVAR Toolbox | l | 5 |
| Mexico | Consumer Price Index sa | GVAR Toolbox | l | 5 |
| Mexico | Short term interest rate | GVAR Toolbox | nl | 2 |
| Mexico | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 3 |
| Mexico | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Mexico | Business cycle | GVAR Toolbox | l | 1 |
| Mexico | Exchange rate | GVAR Toolbox | l | 5 |
| Netherlands | Real GDP | GVAR Toolbox | l | 5 |
| Netherlands | Consumer Price Index | GVAR Toolbox | l | 5 |
| Netherlands | Short term interest rate | GVAR Toolbox | nl | 2 |
| Netherlands | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Netherlands | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Netherlands | Business cycle | GVAR Toolbox | l | 1 |
| Netherlands | Exchange rate | GVAR Toolbox | l | 5 |

| Country | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| New Zealand | Real GDP | GVAR Toolbox | l | 5 |
| New Zealand | Consumer Price Index | GVAR Toolbox | l | 3 |
| New Zealand | Short term interest rate | GVAR Toolbox | nl | 2 |
| New Zealand | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| New Zealand | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| New Zealand | Business cycle | GVAR Toolbox | l | 1 |
| New Zealand | Exchange rate | GVAR Toolbox | l | 5 |
| Norway | Real GDP | GVAR Toolbox | l | 3 |
| Norway | Consumer Price Index | GVAR Toolbox | l | 3 |
| Norway | Short term interest rate | GVAR Toolbox | nl | 2 |
| Norway | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Norway | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Norway | Business cycle | GVAR Toolbox | l | 1 |
| Norway | Exchange rate | GVAR Toolbox | l | 5 |
| Peru | Real GDP | GVAR Toolbox | l | 5 |
| Peru | Consumer Price Index | GVAR Toolbox | l | 5 |
| Peru | Short term interest rate | GVAR Toolbox | nl | 2 |
| Peru | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 3 |
| Peru | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Peru | Business cycle | GVAR Toolbox | l | 1 |
| Peru | Exchange rate | GVAR Toolbox | l | 5 |
| Philippines | Real GDP | GVAR Toolbox | l | 5 |
| Philippines | Consumer Price Index sa | GVAR Toolbox | l | 5 |
| Philippines | Short term interest rate | GVAR Toolbox | nl | 2 |
| Philippines | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Philippines | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Philippines | Business cycle | GVAR Toolbox | l | 1 |
| Philippines | Exchange rate | GVAR Toolbox | l | 5 |
| Singapore | Real GDP | GVAR Toolbox | l | 5 |
| Singapore | Consumer Price Index sa | GVAR Toolbox | l | 5 |
| Singapore | Short term interest rate | GVAR Toolbox | nl | 2 |
| Singapore | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Singapore | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Singapore | Business cycle | GVAR Toolbox | l | 1 |

| Country | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| Singapore | Exchange rate | GVAR Toolbox | l | 5 |
| South Africa | Real GDP | GVAR Toolbox | l | 5 |
| South Africa | Consumer Price Index | GVAR Toolbox | l | 3 |
| South Africa | Short term interest rate | GVAR Toolbox | nl | 2 |
| South Africa | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 3 |
| South Africa | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| South Africa | Business cycle | GVAR Toolbox | l | 1 |
| South Africa | Exchange rate | GVAR Toolbox | l | 5 |
| Spain | Real GDP | GVAR Toolbox | l | 5 |
| Spain | Consumer Price Index | GVAR Toolbox | l | 3 |
| Spain | Short term interest rate | GVAR Toolbox | nl | 2 |
| Spain | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Spain | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Spain | Business cycle | GVAR Toolbox | l | 1 |
| Spain | Exchange rate | GVAR Toolbox | l | 5 |
| Sweden | Real GDP | GVAR Toolbox | l | 5 |
| Sweden | Consumer Price Index | GVAR Toolbox | l | 3 |
| Sweden | Short term interest rate | GVAR Toolbox | nl | 2 |
| Sweden | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Sweden | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Sweden | Business cycle | GVAR Toolbox | l | 1 |
| Sweden | Exchange rate | GVAR Toolbox | l | 5 |
| Switzerland | Real GDP | GVAR Toolbox | l | 5 |
| Switzerland | Consumer Price Index | GVAR Toolbox | l | 3 |
| Switzerland | Short term interest rate | GVAR Toolbox | nl | 2 |
| Switzerland | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Switzerland | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Switzerland | Business cycle | GVAR Toolbox | l | 1 |
| Switzerland | Exchange rate sa | GVAR Toolbox | l | 5 |
| Thailand | Real GDP | GVAR Toolbox | l | 5 |
| Thailand | Consumer Price Index | GVAR Toolbox | l | 5 |
| Thailand | Short term interest rate | GVAR Toolbox | nl | 2 |
| Thailand | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Thailand | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |

| Country | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| Thailand | Business cycle | GVAR Toolbox | l | 1 |
| Thailand | Exchange rate | GVAR Toolbox | l | 5 |
| Turkey | Real GDP | GVAR Toolbox | l | 5 |
| Turkey | Consumer Price Index | GVAR Toolbox | l | 3 |
| Turkey | Short term interest rate | GVAR Toolbox | nl | 2 |
| Turkey | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 3 |
| Turkey | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Turkey | Business cycle | GVAR Toolbox | l | 1 |
| Turkey | Exchange rate | GVAR Toolbox | l | 5 |
| United Kingdom | Real GDP | GVAR Toolbox | l | 5 |
| United Kingdom | Consumer Price Index | GVAR Toolbox | l | 5 |
| United Kingdom | Short term interest rate | GVAR Toolbox | nl | 2 |
| United Kingdom | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| United Kingdom | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| United Kingdom | Business cycle | GVAR Toolbox | l | 1 |
| United Kingdom | Exchange rate | GVAR Toolbox | l | 5 |
| United States of America | Real GDP | IMF IFS | l | 5 |
| United States of America | Consumer Price Index | GVAR Toolbox | l | 5 |
| United States of America | Short term interest rate | GVAR Toolbox | nl | 2 |
| United States of America | Long term interest rate | GVAR Toolbox | nl | 5 |
| United States of America | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| United States of America | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| United States of America | Business cycle | GVAR Toolbox | l | 1 |
| United States of America | Industrial production | IMF IFS | l | 5 |
| United States of America | S&P500 | S&P 500 | l | 5 |
| United States of America | Unemployment rate | IMF IFS | nl | 1 |
| United States of America | Producer Price Index | IMF IFS | l | 5 |
| United States of America | Exchange rate | IMF IFS | l | 5 |

Note: The following treatment codes are applicable to this table: 1 - no transformation (level); 2 – first difference; 3 – second difference of logarithm; 4 - logarithm (log-level); 5 - first difference of logarithm. sa denotes seasonally adjusted series; l stands for logarithm; nl indicates no logarithm was taken.

## Table E.2: Chapter 5

| Country | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| Australia | Real GDP | GVAR Toolbox | l | 5 |
| Australia | Consumer Price Index | GVAR Toolbox | l | 3 |
| Australia | Short term interest rate | GVAR Toolbox | nl | 2 |
| Australia | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 3 |
| Australia | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Australia | Business cycle | GVAR Toolbox | l | 1 |
| Australia | Exchange rate | GVAR Toolbox | l | 5 |
| Australia | Producer Price Index | IMF IFS | l | 5 |
| Australia | Industrial production | IMF IFS | l | 5 |
| Austria | Real GDP | GVAR Toolbox | l | 5 |
| Austria | Consumer Price Index | GVAR Toolbox | l | 5 |
| Austria | Short term interest rate | GVAR Toolbox | nl | 2 |
| Austria | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Austria | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Austria | Business cycle | GVAR Toolbox | l | 1 |
| Austria | Exchange rate | GVAR Toolbox | l | 5 |
| Austria | Producer Price Index | IMF IFS | l | 5 |
| Austria | Industrial production | IMF IFS | l | 5 |
| Belgium | Real GDP | GVAR Toolbox | l | 5 |
| Belgium | Consumer Price Index | GVAR Toolbox | l | 5 |
| Belgium | Short term interest rate | GVAR Toolbox | nl | 2 |
| Belgium | Business cycle | GVAR Toolbox | l | 1 |
| Belgium | Exchange rate | GVAR Toolbox | l | 5 |
| Belgium | Producer Price Index | IMF IFS | l | 5 |
| Belgium | Industrial production | IMF IFS | l | 5 |
| Canada | Real GDP | GVAR Toolbox | l | 5 |
| Canada | Consumer Price Index | GVAR Toolbox | l | 3 |
| Canada | Short term interest rate | GVAR Toolbox | nl | 2 |
| Canada | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Canada | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Canada | Business cycle | GVAR Toolbox | l | 1 |
| Canada | Exchange rate | GVAR Toolbox | l | 5 |

| Country | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| Canada | Producer Price Index | IMF IFS | l | 5 |
| Canada | Industrial production | IMF IFS | l | 5 |
| China | Real GDP | GVAR Toolbox | l | 5 |
| China | Consumer Price Index | GVAR Toolbox | l | 5 |
| China | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| China | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| China | Business cycle | GVAR Toolbox | l | 1 |
| China | Exchange rate | GVAR Toolbox | l | 5 |
| China | Total reserves | IMF IFS | l | 5 |
| China | Industrial production | IMF IFS | l | 5 |
| China | Share price index | IMF IFS | l | 5 |
| China | Deposit rate | IMF IFS | nl | 1 |
| China | Lending rate | IMF IFS | nl | 1 |
| China | Short term interest rate | IMF IFS | nl | 1 |
| Finland | Real GDP | GVAR Toolbox | l | 5 |
| Finland | Consumer Price Index | GVAR Toolbox | l | 5 |
| Finland | Short term interest rate | GVAR Toolbox | nl | 2 |
| Finland | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Finland | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Finland | Business cycle | GVAR Toolbox | l | 1 |
| Finland | Exchange rate | GVAR Toolbox | l | 5 |
| Finland | Producer Price Index | IMF IFS | l | 5 |
| Finland | Industrial production | IMF IFS | l | 5 |
| France | Real GDP | GVAR Toolbox | l | 5 |
| France | Consumer Price Index sa | GVAR Toolbox | l | 3 |
| France | Short term interest rate | GVAR Toolbox | nl | 2 |
| France | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| France | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| France | Business cycle | GVAR Toolbox | l | 1 |
| France | Exchange rate | GVAR Toolbox | l | 5 |
| France | Producer Price Index | IMF IFS | l | 5 |
| France | Industrial production | IMF IFS | l | 5 |
| Germany | Real GDP | GVAR Toolbox | l | 5 |
| Germany | Consumer Price Index | GVAR Toolbox | l | 3 |

| Country | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| Germany | Short term interest rate | GVAR Toolbox | nl | 2 |
| Germany | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Germany | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Germany | Business cycle | GVAR Toolbox | l | 1 |
| Germany | Exchange rate | GVAR Toolbox | l | 5 |
| Germany | Producer Price Index | IMF IFS | l | 5 |
| Germany | Industrial production | IMF IFS | l | 5 |
| Italy | Real GDP | GVAR Toolbox | l | 5 |
| Italy | Consumer Price Index sa | GVAR Toolbox | l | 3 |
| Italy | Short term interest rate | GVAR Toolbox | nl | 2 |
| Italy | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Italy | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Italy | Business cycle | GVAR Toolbox | l | 1 |
| Italy | Exchange rate | GVAR Toolbox | l | 5 |
| Italy | Producer Price Index | IMF IFS | l | 5 |
| Italy | Industrial production | IMF IFS | l | 5 |
| Japan | Real GDP | GVAR Toolbox | l | 3 |
| Japan | Consumer Price Index | GVAR Toolbox | l | 3 |
| Japan | Short term interest rate | GVAR Toolbox | nl | 2 |
| Japan | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Japan | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Japan | Business cycle | GVAR Toolbox | l | 1 |
| Japan | Exchange rate | GVAR Toolbox | l | 5 |
| Japan | Producer Price Index | IMF IFS | l | 5 |
| Japan | Industrial production | IMF IFS | l | 5 |
| Netherlands | Real GDP | GVAR Toolbox | l | 5 |
| Netherlands | Consumer Price Index | GVAR Toolbox | l | 5 |
| Netherlands | Short term interest rate | GVAR Toolbox | nl | 2 |
| Netherlands | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Netherlands | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Netherlands | Business cycle | GVAR Toolbox | l | 1 |
| Netherlands | Exchange rate | GVAR Toolbox | l | 5 |
| Netherlands | Producer Price Index | IMF IFS | l | 5 |

| Country | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| Netherlands | Industrial production | IMF IFS | l | 5 |
| New Zealand | Real GDP | GVAR Toolbox | l | 5 |
| New Zealand | Consumer Price Index | GVAR Toolbox | l | 3 |
| New Zealand | Short term interest rate | GVAR Toolbox | nl | 2 |
| New Zealand | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| New Zealand | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| New Zealand | Business cycle | GVAR Toolbox | l | 1 |
| New Zealand | Exchange rate | GVAR Toolbox | l | 5 |
| New Zealand | Producer Price Index | IMF IFS | l | 5 |
| New Zealand | Industrial production | IMF IFS | l | 5 |
| Norway | Real GDP | GVAR Toolbox | l | 3 |
| Norway | Consumer Price Index | GVAR Toolbox | l | 3 |
| Norway | Short term interest rate | GVAR Toolbox | nl | 2 |
| Norway | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Norway | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Norway | Business cycle | GVAR Toolbox | l | 1 |
| Norway | Exchange rate | GVAR Toolbox | l | 5 |
| Norway | Producer Price Index | IMF IFS | l | 5 |
| Norway | Industrial production | IMF IFS | l | 5 |
| Spain | Real GDP | GVAR Toolbox | l | 5 |
| Spain | Consumer Price Index | GVAR Toolbox | l | 3 |
| Spain | Short term interest rate | GVAR Toolbox | nl | 2 |
| Spain | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Spain | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Spain | Business cycle | GVAR Toolbox | l | 1 |
| Spain | Exchange rate | GVAR Toolbox | l | 5 |
| Spain | Producer Price Index | IMF IFS | l | 5 |
| Spain | Industrial production | IMF IFS | l | 5 |
| Sweden | Real GDP | GVAR Toolbox | l | 5 |
| Sweden | Consumer Price Index | GVAR Toolbox | l | 3 |
| Sweden | Short term interest rate | GVAR Toolbox | nl | 2 |
| Sweden | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Sweden | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Sweden | Business cycle | GVAR Toolbox | l | 1 |

| Country | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| Sweden | Exchange rate | GVAR Toolbox | l | 5 |
| Sweden | Producer Price Index | IMF IFS | l | 5 |
| Sweden | Industrial production | IMF IFS | l | 5 |
| Switzerland | Real GDP | GVAR Toolbox | l | 5 |
| Switzerland | Consumer Price Index | GVAR Toolbox | l | 3 |
| Switzerland | Short term interest rate | GVAR Toolbox | nl | 2 |
| Switzerland | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| Switzerland | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| Switzerland | Business cycle | GVAR Toolbox | l | 1 |
| Switzerland | Exchange rate sa | GVAR Toolbox | l | 5 |
| Switzerland | Producer Price Index | IMF IFS | l | 5 |
| Switzerland | Industrial production | IMF IFS | l | 5 |
| United Kingdom | Real GDP | GVAR Toolbox | l | 5 |
| United Kingdom | Consumer Price Index | GVAR Toolbox | l | 5 |
| United Kingdom | Short term interest rate | GVAR Toolbox | nl | 2 |
| United Kingdom | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| United Kingdom | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| United Kingdom | Business cycle | GVAR Toolbox | l | 1 |
| United Kingdom | Exchange rate | GVAR Toolbox | l | 5 |
| United Kingdom | Producer Price Index | IMF IFS | l | 5 |
| United Kingdom | Industrial production | IMF IFS | l | 5 |
| United States of America | Real GDP | IMF IFS | l | 5 |
| United States of America | Consumer Price Index | GVAR Toolbox | l | 5 |
| United States of America | Short term interest rate | GVAR Toolbox | nl | 2 |
| United States of America | Real exports *[log(exports)-log(cpi)]* | IMF IFS | l | 5 |
| United States of America | Real imports *log(imports)-log(cpi)]* | IMF IFS | l | 5 |
| United States of America | Business cycle | GVAR Toolbox | l | 1 |
| United States of America | Industrial production | IMF IFS | l | 5 |
| United States of America | Producer Price Index | IMF IFS | l | 5 |
| United States of America | Exchange rate | IMF IFS | l | 5 |

Note: The following treatment codes are applicable to this table: 1 - no transformation (level); 2 – first difference; 3 – second difference of logarithm; 4 - logarithm (log-level); 5 - first difference of logarithm. sa denotes seasonally adjusted series; l stands for logarithm; nl indicates no logarithm was taken.

## Table E.3: Chapter 6

| Group | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| Low-income | Consumer Price Index | World Bank | l | 5 |
| Low-income | Real exports | World Bank | l | 5 |
| Low-income | FDI inflows | UNCTAD FDIstat | l | 5 |
| Low-income | Real GDP | World Bank | l | 5 |
| Low-income | Real imports | World Bank | l | 5 |
| Low-income | Official Development Assistance inflows | UNCTAD FDIstat | l | 5 |
| Low-income | Business cycle | World Bank | l | 1 |
| Middle-income | Consumer Price Index | World Bank | l | 5 |
| Middle-income | Real exports | World Bank | l | 3 |
| Middle-income | Real imports | World Bank | l | 3 |
| Middle-income | FDI inflows | UNCTAD FDIstat | l | 5 |
| Middle-income | Real GDP | World Bank | l | 5 |
| Middle-income | Official Development Assistance inflows | UNCTAD FDIstat | l | 5 |
| Middle-income | Business cycle | World Bank | l | 1 |
| Oil exporters | Consumer Price Index | World Bank | l | 5 |
| Oil exporters | Real exports | World Bank | l | 5 |
| Oil exporters | FDI inflows | UNCTAD FDIstat | l | 5 |
| Oil exporters | Real GDP | World Bank | l | 5 |
| Oil exporters | Real imports | World Bank | l | 5 |
| Oil exporters | Official Development Assistance inflows | UNCTAD FDIstat | l | 5 |
| Oil exporters | Business cycle | World Bank | l | 1 |
| Fragile states | Real exports | World Bank | l | 5 |
| Fragile states | FDI inflows | UNCTAD FDIstat | l | 5 |
| Fragile states | Real GDP | World Bank | l | 5 |
| Fragile states | Real imports | World Bank | l | 5 |
| Fragile states | Official Development Assistance inflows | UNCTAD FDIstat | l | 5 |
| Fragile states | Business cycle | World Bank | l | 1 |
| G7 | Consumer Price Index | FRED database | l | 5 |
| G7 | Real exports | FRED database | l | 5 |
| G7 | Real GDP | FRED database | l | 5 |
| G7 | Real imports | FRED database | l | 5 |
| G7 | Producer Price Index | FRED database | l | 5 |

| Group | Variable | Source | Log | Treatment |
|---|---|---|---|---|
| G7 | Unemployment rate | FRED database | nl | 1 |
| G7 | Business cycle | FRED database | l | 1 |

Note: The following treatment codes are applicable to this table: 1 - no transformation (level); 2 – first difference; 3 – second difference of logarithm; 4 - logarithm (log-level); 5 - first difference of logarithm. sa denotes seasonally adjusted series; l stands for logarithm; nl indicates no logarithm was taken. African country groups were aggregated using share of GDP (PPP).