INTERDEPENDENCE AND BUSINESS CYCLE TRANSMISSION BETWEEN SOUTH AFRICA AND THE USA, UK, JAPAN AND GERMANY

Terrence Tafadzwa Mugova

Student number: 603m2595

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Department of Economics and Economic History

Rhodes University, Grahamstown

Supervisor: Dr. Meshach Aziakpono

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ABSTRACT

The process of globalisation has had a large impact on the world economy over the past three decades. Economic globalisation has manifested itself in the increasing integration of goods and services through international trade and the integration of financial markets. As a consequence the existence of co-movements in economic variables of different countries has become more evident. The extent to which globalisation causes a country's economy to move together with the rest of the world concerns policy-makers. When such co-movement is significant, the influence of policy-makers on their respective domestic economies is significantly reduced. South Africa re-entered the international economy in the early 1990s when the forces of globalisation, especially for developing countries, seemed to gain momentum. Empirical research such as Kabundi and Loots (2005) found strong evidence of international co-movement between the world business cycle and the South African business cycle, particularly following South Africa's integration into the global economy.

This study examines the relationship and interdependence between South Africa and four of its major developed trading partners. More particularly, the study examines the question of whether business cycles are transmitted from Germany, Japan, US and UK to South Africa, and/or from South Africa to Germany, Japan, the US and UK. The study employs structural vector autoregressive (SVARs) models to analyse monthly data from 1980:01–2008:04 on industrial production, producer prices, short-term interest rates and real effective exchange rates. The results show that South Africa benefits from economic growth in both the UK and US. They also indicate significant price transmission from Germany and Japan to South Africa, with transmission in the opposite direction being statistically insignificant. The impulse response graphs show that a positive one standard deviation shock to both German and Japanese producer prices has a negative impact on South African output (industrial production) growth. Furthermore, South African monetary policy is relatively unresponsive to international monetary policy stances. The findings of this study indicate that South African policymakers need to take into consideration economic performance of the country's major trading partners, with particular emphasis on the UK and US economies.

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ACRONYMS

ADF	Augmented Dickey Fuller
CPI	Consumer Price Index
EMU	European Monetary Union
EU	European Union
FDI	Foreign direct investment
GDP	Gross Domestic Product
IMF	International Monetary Fund
NMS	New EU Member States
PC	Principal Component
PCA	Principal Components Analysis
PPI	Producer Price Index
PPP	Purchasing Power Parity
SA	South Africa
SADC	Southern Africa Development Community
SARB	South African Reserve Bank
SVAR	Structural Vector Autoregressive
UK	United Kingdom
US	United States of America
VAR	Vector Autoregressive

CHAPTER ONE:
INTRODUCTION

1.1 CONTEXT OF THE RESEARCH

The phenomenon of international business cycle co-movements and the possible transmission of fluctuations between countries have taken the interest of economists dating back to as early as 1927 (Mitchell, 1927). The issue of international business cycle transmission and interdependence is particularly important for countries considering tying their currencies to another currency. The insight common throughout the optimal currency area literature is that the more fully harmonised two countries' business cycles are, the more appropriate it is for them to share a monetary policy and therefore a currency (Gruben, Koo and Millis, 2000:4). The associated benefits for countries that exhibit such characteristics are reduction in transaction costs associated with trade and investment flows and thus the countries may benefit from economic specialisation (Rose, 2000). The symmetry of the business cycle thus plays a key role in determining the cost of sacrificing an independent monetary policy. Calderón, Chong and Stein (2003) argue that countries with close international trade links are more likely to be members of an optimal currency area, whereas countries with asymmetric business cycles are less likely to be members of an optimal currency area.

The start of the European Monetary Union (EMU) represents a major development that has affected the transmission of cyclical fluctuations within Europe and between Europe and the rest of the world. Having EMU has had the effect of reducing the instruments available to individual EU countries to react to unfavourable phases in their business cycle. The loss of the exchange rate as an instrument has made large cyclical divergences increasingly difficult to accommodate by a common monetary policy (Cacciotti *et al*., 2002:4). Also, a number of technological advances and structural reforms have affected different countries in different ways, with implications on the domestic business cycles and on their interaction (Cacciotti *et al*., 2002:5).

Global events such as the Asian financial crisis, creation of the European monetary union, the world economic slowdown in 2001 and globalisation have had the effect of increasing interest in international business cycle synchronisation and the possible transmission of fluctuations between countries (cf. Selover, 1999, 2004; Sayek and Selover, 2002; Shing and Wang, 2002; Eickmeier and Breitung, 2006; Paczyński and Woźniak, 2007; Eickmeier, 2007). For instance, economic disturbances in the United States have often been labelled by some researchers as the cause of the world economic downturn in 2001 (cf. Artis *et al*., 2005 and Monfort *et al*., 2003). The US economy experienced a prolonged phase of extraordinarily large productivity gains in the second half of the 1990s due to technological advances. The productivity gains had the effect of boosting global demand, triggering a rapid and exaggerated boom in international stock markets. This was followed by the subsequent bursting of the stock market bubble which contributed notably to the global economic downturn in 2001. Its remarkable strength, speed and synchronicity across industrial countries were apparently unexplainable in terms of trade linkages alone. This led researchers to examine international business cycle linkages more closely, with a particular focus on the international propagation of US shocks and the relevance of the various international transmission channels.

With regards to globalisation, the forces of economic globalisation are particularly evident in the breaking down of national economic boundaries, the liberalisation of international trade, finance and production activities and the growing power of transnational corporations and international financial institutions (Khor, 2000:3). As such the transmission of shocks across national borders is now faster, which could possibly cause national economies to commove on a permanent basis. For developing countries the forces of globalisation became more pronounced from the late 1980s and early 1990s (Loots, 2002). The extent to which globalisation causes domestic economies to move with economies in the rest of the world or in their particular region, concerns policy-makers. When such business cycle co-movement is comprehensive, the influence of policy-makers on their respective domestic economies is significantly reduced (Kabundi and Loots, 2005:1). This implies that for a national economy if the forces of globalisation

lead to increased business cycle co-movement with other countries, this could have the effect of reducing the country's ability to manage itself out of a crisis.

Since 1994, South Africa has entered into various trade agreements with other countries and regional groupings to reduce trade barriers and implemented sound monetary and fiscal policies (Rusike, 2007:3). The liberalisation of South African markets coincided with the period when the forces of globalisation, especially for developing countries, seemed to gain momentum. One of the implications of South Africa becoming an open economy is that the country became more vulnerable to changes in the world economy. For instance, South Africa seems to have been affected by information flows following the Asian financial crisis in which information, attitudes, and fear motivated investors and speculators to examine economic conditions in emerging markets and developing countries. This led to relatively remarkable capital outflows from emerging markets, including South Africa, as investors' confidence in these markets declined. Examples of other world events that might have affected the South African economy are the Russian crisis in 1998, the September 11 terrorist attacks in the US, and more recently the global financial crisis which emanated from the credit crunch in the US beginning in the second half of 2007.

What is evident from the discussion of some of the international events and phenomenon such as globalisation is that the South African economy might have become more vulnerable to volatility in international economies. This could be possibly through "contagion effects" (Khalid and Rajaguru, 2005:8). The response of world economies to events such as the Asian financial crisis and the economic slowdown in 2001 is an indication that national economies tend to react to international events. As previously alluded to the extent and magnitude of international business cycle transmission and interdependence, is particularly important to policy makers. Thus, the current study assesses the possibility of international business cycle transmission and interdependence between South Africa and four of its major developed trading partners. Studies that have been carried out in South Africa thus far have focused on the impact of the world business cycle, as measured by the G7 factor, on the South African business cycle (cf.

Botha, 2004; Kabundi and Loots, 2005) or the impact of increasing trade on the co-movement of the business cycle between South Africa and the Southern African Development Community (SADC) countries (cf. Kabundi and loots, 2005, 2007).

1.2 OBJECTIVES OF THE STUDY

The study has two main objectives:

- To determine the extent and magnitude of business cycle transmission and interdependence of the South African business cycle with those of the US, UK, Germany and Japan.
- To establish the dominant country amongst the four, in terms of business cycle transmission to South Africa.
- To propose policy recommendations and implications based on the findings.

1.3 ORGANISATION OF THE STUDY

The thesis is organised as follows. Chapter Two provides a review of the literature highlighting theoretical and empirical literature relating to international business cycle co-movement and transmission across countries. Chapter Three presents the econometric methods used for analysis in the study. The data, variable selection and *a priori* expectations are also described and explained in this chapter. Chapter Four presents and analyses the results. Summary of findings, policy recommendations and conclusions derived are presented in Chapter Five.

CHAPTER 2:
LITERATURE REVIEW

2.1 INTRODUCTION

This chapter reviews both theoretical and empirical literature on issues regarding international business cycle transmission and synchronisation. The chapter is organised as follows. Section 2.2 briefly explores business cycle theory and the mechanism of business cycle synchronisation. Section 2.3 reviews the empirical literature on business cycle synchronisation and transmission across countries. The empirical literature is divided into three sub-parts. Finally, Section 2.4 concludes the chapter.

2.2 THEORATICAL LITERATURE REVIEW

2.2.1 Business Cycle Theory

Business cycles are defined as the upward and downward movement of aggregate output in an economy (Mishkin, 2004:9). No two business cycles are quite the same, yet they have much in common. The business cycle is broken up into four phases, namely expansion, contraction, peak and trough (Mitchell, 1927; Burns and Mitchell, 1946; and Kuznets, 1958).

The expansion phase comes to an end and goes into the contraction phase at the upper turning point, the peak. Similarly, the contraction phase gives way to that of expansion at the lower turning point, the trough. The emphasis was on the dynamic aspects of rising and falling business activity and not so much on high or low business activity. Business cycle theory can be grouped into the classical approach, the trend cycle approach (growth cycles), monetarist approach and real business cycle approach (Cacciotti *et al.*, 2002; Mishkin, 2004). A brief discussion of these approaches follows.

Early work on business cycle theory formed what is referred to as the classical approach of business cycle theory (cf. Mitchell, 1927; Burns and Mitchell, 1946). The classical

approach of business cycles holds that each cyclical phase of the economy carries within it the seed that generates the next cyclical phase. Thus, the classical approach viewed business cycles as consisting of four phases that inevitably evolve from one into another: prosperity, crisis, depression, and revival (Kydland and Prescott, 1980:3). This implies that the economy is caught forever in a self-sustaining cycle. New classical economists extended the discussion on business cycles by regarding unanticipated changes in aggregate demand, resulting, for instance, from "monetary surprises," as the main source of fluctuations in output and employment (Froyen, 2005:282). Chatterjee (2000:1) argues that a major implication of classical approach is that the economy cannot deliver stable and sustainable economic performance and therefore calls for aggressive countercyclical policies that are aimed at smoothing out the cycle.

Laubscher (2004:22) defines a growth cycle (trend-cycle) as the fluctuation of the general economic growth rate around the long-term potential rate of growth, with such fluctuations being recurrent but not periodic. The trend-cycle approach focuses on deviations in economic activity from a long-term trend, so that growth expansions are described as periods when the economic activity is above the long-term trend of growth and conversely, contractions as periods when it is below the long-run trend (Cacciotti *et al.*, 2002:5).

Monetary theorists put a great deal of emphasis on the observed relationship between changes in money supply and changes in national income, and given this, they believe that monetary policy is at the heart of the business cycle (Hardwick *et al.*, 1990:404). According to the monetarist view, upswings in economic activity result from unexpectedly rapid increases in the supply of money, while downswings result from slow growth or a fall in the money supply (Chatterjee, 1999:18). The belief that the growth rate of money leads business cycles, because it declines before every recession is subject to a lot of criticism. For instance proponents (cf. King and Plosser, 1984; Plosser, 1989) of a new theory of aggregate fluctuations called real business cycle theory are more critical of the monetarist view that money is important to business cycle fluctuations. Real business cycle theorists believe there is reverse causation from the business cycle to

money. This implies that monetary surprises are not the main source of fluctuations in output and employment (Froyen, 2005, 282).

One group of economists, led by Edward Prescott[1] of the University of Minnesota, developed a theory of aggregate economic fluctuations called real business cycle theory, in which aggregate supply shocks affect the natural rate level of output (Mishkin, 2004:597). The real business cycle theorists argue that supply side variables (such as shocks to technology, variations in environmental conditions, and changes in the real prices of imported raw materials and changes in tax rates) are the source of short-run fluctuations in output and employment. These are the same factors that determined output in the classical model but classical economists believed that for the most part these factors moved slowly over time and in the short run were taken as given (Froyen, 2005:282). The importance placed by real business cycle theory on supply side variables distinguishes it from the new classical economists, who regarded unanticipated changes in aggregate demand as the main source of fluctuations in output and employment.

Despite the age of the debate and growing competing theories of business cycles, there is little consensus on the causes of cyclical fluctuations in the economy. Although business cycle theories differ on the causes of the cyclical fluctuations, what is noteworthy from the debate is that several consistent observations have been made by the various studies which have been labelled stylised facts about business cycles. Pradhan (2001:1-2) provides a list of these stylised facts about business cycles. Some of these are listed below:

- The upswings and downswings caused by the business cycle are NOT restricted to a few industries or variables but manifest themselves over the entire economy at the same time.

[1]Some of the forerunners of this view on the real business cycle theory include Finn Kydland (1982), John Long (1983), Robert King and Charles Plosser (1983) and Charles Plosser (1989)

- Business cycles follow a familiar pattern: a boom followed by a slowdown followed by a boom and so on. However, the length of time for which a boom or a slowdown persists is not known and cannot be predicted with certainty.
- Once either a boom or a slowdown shows up in the economy, it tends to stick around for a while. Thus, the business cycle shows a considerable amount of persistence.
- A decrease in the growth rate of money supply is usually followed by a slowdown in GDP. Note that the role of money supply is extremely controversial and one should be careful not to conclude that the decrease in the growth rate of money supply *causes* the slowdown in GDP.
- Nominal interest rates increase after the economy begins a boom and they start falling once the economy experiences a slowdown. The behaviour of the nominal interest rate has a lot to do with the expected value of inflation. When the economy enters a boom period, people expect prices and inflation to start rising.
- Large fluctuations in the GDP of large countries affect the GDP of their trading partners.

The general consensus on the stylised facts about business cycles provides motivation for use of the stylised facts to study the business cycle. This paper therefore examines the observed relationship between the business cycles of different countries, implied by the last stylised fact. But why, theoretically would the business cycles of different countries be related or move together? The next section reviews literature that explains the possible reasons why different countries business cycles are expected to be synchronised.

2.2.2 Mechanism of International Business Cycle Transmission and Synchronisation

The synchronisation of economic fluctuations across countries is one of the stylised facts in the literature on international business cycles, especially among industrialised countries (cf. Sherman, 1991; Zarnowitz, 1992; Backus and Kehoe, 1992; Dore, 1993; Artis and Zhang, 1995). Such a stylised fact raises the question as to the mechanism of business cycle synchronisation. There are three major competing theories or hypothesis that attempt to explain the tendency of international business cycles to synchronise- *the*

locomotive hypothesis, common shocks hypothesis and the mode-locking theory. These are discussed in turn.

i. The locomotive hypothesis

The idea behind the locomotive hypothesis is that, fluctuations in large countries or blocs of countries like the United States, Japan, and the European Union are presumed to act as locomotives, driving the fluctuations in smaller nations such as South Africa (Ibrahim, 2003:12). A simple way of explaining the locomotive hypothesis is one country acting as a locomotive, driving the other national economies with it, thus generating a world business cycle. Canova and Dellas (1993:23) suggested that a development in any one country may, depending on the relative size and the degree of openness, be transmitted rapidly to other countries with the transmission mechanisms being through trade in goods, services, and capital flows. Other sources of business cycle synchronisation that have been identified as falling under the locomotive hypothesis are globalisation through increased trade and financial integration, investment flows, labour migration, financial and informational flows (cf. Sherman 1991; Kose, Prasad and Terrones, 2003).

However, of the above channels, trade is the most recognised and acknowledged channel through which shocks are transmitted across countries (cf. Canova and Dellas, 1993; Frankel and Rose, 1998; Otto *et al*., 2001; Imbs, 2004). One argument used to explain the transmission of output and price shocks across borders from an importing country to an exporting country is based on the Dornbusch trade repercussion model. The basic idea being that an importing country in response to a domestic economic boom will increase imports thus stimulating the economy of the exporting country (Bezmen and Selover, 2005:220). The question then is does increasing trade make trading countries business cycles more synchronised?

There is no consensus about whether increased trade leads to more or less synchronised business cycles across countries (cf. Frankel and Rose, 1998; Kose, Prasad and Terrones, 2003; Calderón, Chong and Stein, 2003; Shin and Wang, 2004). One view on the issue is that, if stronger trade linkages are associated with increased inter-industry specialisation

across countries, and industry-specific shocks are important in driving business cycles, then international business cycle co-movements might be expected to decrease (Kose, Prasad and Terrones, 2003:57). The theoretical justification is that if trade occurs mainly of the Ricardian type[2], greater specialisation could induce the industrial structures of the trading countries to diverge, resulting in less synchronised movements of their business cycles (Shin and Wang, 2004:2). Thus, in this case trade integration leads to specialisation in different industries, which in turn leads to asymmetric effects of industry-specific shocks, which implies less synchronised business cycles across countries.

Frankel and Rose (1998:1011) propose a counterargument suggesting that if intra-industry trade becomes more pronounced than inter-industry trade, then business cycles will become more positively correlated as trade becomes more integrated. If intra-industry trade prevails as observed in industrial countries, specialisation does not necessarily lead to asymmetric effects of industry-specific shocks, since the pattern of specialisation occurs mainly within industries (Calderón, Chong and Stein, 2003:6). Thus, this view implies positive correlation or increased co-movement of business cycles across countries.

There are at least two more important linkages that could lead to a positive relationship between business cycle co-movements and increased trade. The first being, if demand shocks drive a boom in one country, the effects can spill-over to its trading partners, because the rapidly growing country will require an increased volume of imports. Thus, through increased imports especially from the large countries the economy of the growing country exposes itself to fluctuations in the larger countries with which it trades which makes it possible for these larger countries to act as locomotives. Second, increased trade might create a greater need for more coordinated fiscal and monetary policies, and if such policies are pursued, then policy shocks will be synchronised among the trading partners making economies of different countries more correlated (Shin and

[2] This type of trade comes from the theory of comparative advantage developed by David Ricardo. This theory states that each country exports goods in which it has a comparative advantage and imports those in which it is the lowest.

Wang, 2004:3). The literature on trade and business cycle co-movements highlights the ambiguous nature of the impact of trade on business cycle co-movements in developing and industrialised countries. According to Calderón *et al.* (2003:6) the important differences in the pattern of trade and specialisation among country pairs suggest that the impact of trade integration on cycle correlation in developing countries may differ substantially from that among industrial countries.

The locomotive hypothesis also puts forward the capital flows channel. Foreign capital allows countries to borrow necessary funds to either smooth domestic consumption during recession, or spur domestic investment without forcing an increase in domestic saving (Tomljanovich and Ying, 2005:4). If this occurs business cycles across countries will be positively correlated. On the other hand, if investors have imperfect information and tend to withdraw their funds suddenly, the tremendous capital reversal may result in decreasing business cycles correlations or co-movement across countries (Tomljanovich and Ying, 2005:4). Many developing countries rely heavily on external financing for their domestic investment and current account deficits. The magnitude and volatility of capital flows from industrialised countries can therefore have a significant influence on investment and output performance of developing countries and regional spill-overs (Akin, 2006:8).

Another channel of the locomotive hypothesis is through globalisation, which refers to the rising trade and financial integration of the world economy, which has gathered momentum in recent decades. As previously mentioned, the forces of economic globalisation are particularly evident in the breaking down of national economic boundaries, the liberalisation of international trade, finance and production activities and the growing power of trans-national corporations and international financial institutions (Khor, 2000:3). As a result the transmission of shocks across national borders is now faster, which could possibly cause national economies to co-move on a permanent basis. The relationship between business cycle co-movements and increased trade has already been touched on. How financial linkages could result in increased business cycle synchronisation is now discussed. According to Kose *et al.* (2003:57-58) international

financial integration could stimulate specialisation of production through the reallocation of capital in a manner consistent with countries' comparative advantage in the production of different goods. Such specialisation of production, which could result in more exposure to industry- or country-specific shocks, would be expected to be accompanied by the use of international financial markets to diversify consumption risk. This implies that financial integration, in particular, should result in stronger co-movement of consumption across countries, also meaning positive correlation of business cycles across countries.

In addition to the channels suggested by the locomotive hypothesis other authors have suggested other hypotheses or theories about international business cycle synchronisation, namely the common shocks hypothesis and the mode locking theory. Attention is now turned to these.

ii. Common shocks hypothesis

The idea behind the common shocks hypothesis is that common shocks, such as exogenous oil shocks and technology shocks, are the driving force behind the world business cycle. Common 'exogenous' disturbances such as oil shocks affect simultaneously all oil-dependent economies, resulting in similar economic policies and common technological advances (Canova and Dellas, 1983:24). For instance, rises in oil prices are usually associated with recessions and it is known that cycles are globally more synchronised during such periods (Akin, 2006:9). Thus, the common shocks hypothesis gives importance to worldwide or country specific shocks in explaining international business cycles.

Support for the common shocks hypothesis is provided by events such as the 2001 bursting of the stock market bubble in the United States of America (US). The dispersion of economic growth rates across the industrialised economies fell to its lowest level in over 30 years, as the global economy experienced a downturn that was unusually widespread across countries (Jansen and Stokman, 2004:7). The widespread economic downturn across countries following this event suggests that output developments will be

more positively correlated if common shocks are predominant, while they will be more asymmetric if idiosyncratic shocks are more dominant. According to Andrews and Kohler (2005:193) in the open economy context, business cycles can move together if country specific shocks are transmitted across borders, thus acting like a common shock, with one key vehicle for this international transmission being trade.

Certainly common exogenous shocks are responsible for part of the synchronisation as witnessed by the 1973 and 1979 oil shocks, the Asian Crisis and the world economic downturn of 2001, but it is difficult to believe that common shocks alone could account for all of the synchronisation of national business cycles. As Selover (1999:233) argues, if the common shocks create a world business cycle, then the common shocks must occur reasonably frequently, they must happen with certain periodicity, and they must diffuse around the world fairly quickly. Moreover, the shocks must originate somewhere. It is not clear how all these conditions can be met by common exogenous shocks alone. This forms one of the reasons why the common shocks hypothesis compared to the locomotive theory has received considerably less acceptance in economic theory. What is observed from the literature is that the locomotive and common shocks hypotheses of business cycle synchronisation are not independent, and thus both play a role in explaining business cycle synchronisation between countries.

iii. ***Mode-locking theory***

Selover and Jensen (1999) found the common world shock explanation implausible and developed a new nonlinear mode-locking explanation of business cycle synchronisation. The idea leading to the theory came from a mechanism for explaining international business synchronisation, suggested by Krugman (1996) and was then developed by Selover and Jensen (1999), Sussmuth (2000), and Selover, Jensen, and Kroll (2003). This theory of world business cycle formation is based upon a nonlinear process known as mode-locking. The crux of the story is that although linkages may not be strong enough for one economy to drive another; they may be strong enough to cause a slight timing shift in the fluctuations of other economies, leading to business cycle synchronisation of these economies.

The mode locking hypothesis views national economies as separate, noisy oscillators, with fluctuations of roughly similar frequencies. In mode-locking, the strength of the linkage must reach a certain threshold in order to attain ‘‘mode-lock’’ and bring about a synchronisation. For a linkage weaker than the threshold value, synchronisation is not attained. For a linkage stronger than the threshold value, there is a qualitative switch, mode-locking takes place, and the fluctuations of the oscillating systems are synchronised, perhaps with a modest lag or phase difference. This means that the business cycles of the economies become synchronised, thus creating a common world business cycle (Selover and Jensen, 1999:592). This linkage threshold may be quite low.

Selover and Jensen (1999:597) suggest that trade in goods and capital flows provide just the sort of weak linkage that could induce a synchronising mode-locking relationship between two or more economies. Imports and exports of goods and capital are assumed to provide the coupling between the economies, making the assumption that trade is a function of output in the two economies. This leads to a situation where, if the home economy enters a boom, it imports more from, and provides a slight boost to the foreign economy, thus stimulating the foreign economy and simultaneously slightly shifting the frequency and phase of the foreign business cycle. The qualitative change in the dynamics of the business cycle of each economy is induced by the coupling strength going beyond some threshold, causing the two cycles to be transformed into a “world business cycle” at zero or fixed phase shift (Selover and Jensen, 1999: 592).

In summary, the three competing theories provide explanations of why different countries business cycles may move together. According Selover and Jensen (1999:595) it is plausible for both the common shocks hypothesis and the locomotive hypothesis to operate through the mode-locking mechanism in creating a world business cycle. This implies that the three theories are not independent, and thus all play a role in explaining business cycle synchronisation between countries. However, not all countries share the same degree and speed of co-movements. Put differently, the extent to which the locomotive, common shocks and mode-locking theories bring about business cycle

synchronisation across countries is not the same in magnitude. Countries may experience different shocks or may respond differently to shocks depending on the domestic policies, differences in the composition of output and differences in the monetary transmission due to diverging financial structures (Chan and Lau, 2004:3). Business cycle co-movement is important especially if it is significant, as the influence of policy-makers on their respective domestic economies can be significantly reduced (Kabundi and Loots, 2005:1). Thus, the extent to which business cycles across countries are synchronised is important and an empirical issue. The next section discusses the empirical literature on cyclical interdependence between countries.

2.3 EMPIRICAL LITERATURE REVIEW

A survey of the literature shows evidence of synchronisation between different national business cycles. A study of the literature highlights three issues in the study of international business cycle transmission and synchronisation namely differences in variables used, country coverage and econometric methods employed. A review of some of these studies is now provided to demonstrate the aforementioned observations so as to draw some lessons for further empirical studies.

2.3. 1 Variables used in the study of International Business Cycle Transmission and Synchronisation

In the study of international business cycles synchronisation and transmission, ideally what is required is a precise and accurate measure of a nation's business cycle. This means having a series which accurately and without requiring further revisions, measures total economic activity. Since no such series is available, researchers have made use of a number of variables to provide a proxy for the business cycles of different countries. Several studies on international business cycle synchronisation and transmission have used single data series such as GDP or industrial production as a proxy for the business cycles of different countries (cf. Dellas, 1986; Selover, 1999; Shin and Wang, 2002; Bezmen and Selover, 2005; Kabundi and Loots, 2007; Packzynski and Wozniak, 2007, Takeuchi, 2007). An important reason for using GDP as a measure of business cycles is

because it is the most comprehensive of the official statistical series that approximates aggregate economic activity (Boehm and Summers, 1999:14).

With the possibility of co-movements in economic variables different from GDP or industrial production, a number of studies have adopted different measures in the analysis of international business cycle linkages (cf. Burbidge and Harrison, 1985; Selover and Round, 1995; Sayek and Selover, 2002; Botha, 2004; Desroches, 2004; Eickmeier and Breitung, 2006; Moneta and Ruffer, 2006). These studies have made use of a selection of variables such as, price indices (CPI, PPI)[3], long term interest rates, short-term interest rates, money supply (M1, M2 or M3), exchange rates, industrial production, international oil price, consumption and investment data. The US Department of Commerce (1984:65) provides support for the use of multiple variables to represent countries business cycles by arguing that "no single time series measures aggregate economic activity adequately; however, a variety of statistical series measure some of its major aspects." Therefore, in the examination of the existence of business cycle transmission and co-movements across countries, five variables are considered in the current study, namely industrial production, short-term interest rates, international oil prices, producer prices[4]and South Africa's real effective exchange rate .

2.3. 2 Econometric Techniques used in the study of International Business Cycle Transmission and Synchronisation

A number of econometric techniques have been employed to investigate international business cycle transmission and synchronisation across countries. With regards to transmission of business cycles across countries several studies have employed some forms of vector autoregressive models and impulse response/variance decomposition analysis and have found a modest amount of linkage between the countries (cf. Burbidge and Harrison; 1985; Hutchison and Walsh; 1992; Selover and Round, 1995; Canova and Marrinan, 1998; Selover, 1999, 2004; Sayek and Selover, 2002; Artis *et al.*, 2004; Bezmen and Selover, 2005; Artis *et al.*, 2005; Stockman and Watson, 2005; Takeuchi,

[3] CPI refers to the Consumer Price Index and PPI is the Producer Price Index.
[4] PPI series is not reported for Japan, CPI is used in this case.

2007). Vector autoregression (VAR) models have the advantages of being simple to apply and being able to provide robust results when a long sample period or large sample size is available (Bezmen and Selover, 2005:224).

A survey of the literature also reveals an increasing usage of dynamic factor models to the analysis of international business cycle transmission (cf. Bayoumi and Helbing, 2003; Eickmeier, 2005, 2007; Eickmeier and Breitung, 2006; Moneta and Ruffer, 2006; Kabundi and Loots, 2007). Dynamic factor models and structural VAR models have the advantages of being able to assess the impact of shocks on business cycles of countries and on individual countries' macroeconomic variables. Dynamic factor models also allow for the identification of the different transmission channels. Although dynamic factor models have the advantage of being more informative than VAR models, dynamic factor models involve the defining of a single unobserved factor common to some macroeconomic variables to measure business cycles, which is referred to as the composite index (Watabane, 2003:35). However, it is difficult to give economic meaning to the composite index derived. Thus, dynamic factor models offer a more complex means both in terms of application and data requirements relative to VAR models of investigating international business cycle transmission and synchronisation.

As highlighted earlier given that a relatively large sample size is available, VAR models are able to yield robust results. This study thus employs the simpler model relative to dynamic factor models that is the structural VAR models (SVAR). This is also particularly favourable in the context of this study as employing a structural VAR allows for the examination of whether the South African economy and the economies of its major trading partners move together and the extent of business cycle transmission. A discussion of the Structural VAR technique is pursued in the methodology chapter.

2.3. 3 Country coverage

As highlighted earlier, the co-movement of economic fluctuations across countries is one of the stylised facts of the dynamics of international business cycles. A survey of the literature also shows that the majority of empirical studies on interdependence and

international business cycle transmission have focused on developed industrialised nations with relatively less attention on developing countries. A discussion of some of this work now follows.

A significant amount of literature has documented the cyclical interdependence between the United States of America (US) and various developed countries. For instance, Burbidge and Harrison (1985) were among the early researchers to employ a full scale VAR model to investigate the interdependence between the US and Canada. The results of Burbidge and Harrison (1985:796) showed the importance of shocks in the US monetary variables to events in the Canadian monetary sector and in particular a strong and quick response of the Canadian interest rate to a shock in the US rate. Business cycle linkages have also been examined between the US and Europe (cf. IMF, 2001; GCEE, 2001; Artis *et al.*, 2004, Monfort *et al.*, 2003; Artis *et al.*, 2005). Most of these studies find a rather strong correlation between EU countries and the US. Such a finding led to the interpretation by Fidrmuc and Korhonen (2006:6) that there is no independent European cycle and that the increased degree of business cycle synchronisation within the EU is consistent with globalisation rather than with Europeanization. This finding contradicts results of previous studies on the existence or absence of a European business cycle (cf. Artis and Zhang, 1997 and 1999; Artis. 2003; Altavilla, 2004; Reichlin, 2005; Camacho *et al.*, 2006; Böwer and Guillemineau, 2006).

With Germany being the largest European economy in terms of GDP and population, this generated interest in investigating the transmission of US shocks to Germany (cf. Canova and Marrinan, 1998; Artis *et al.*, 2004; Artis *et al.*, 2005; the German Council of Economic Experts (GCEE), 2001; Eickmeier, 2007). All these studies found that shocks to the US business cycle are transmitted significantly and positively to Germany. Eickmeier (2007) employing a large scale dynamic factor model found that US shocks affect both the US and Germany largely symmetrically.

A number of studies have also examined the relationship between Japan and various countries (cf. Hutchison and Walsh, 1992; Selover and Round, 1996; Selover, 1997; Kim

and Bordo, 1998). For instance, Hutchison and Walsh (1992) investigated the relationship between Japan and the United States, and found that the flexible exchange rate system provides better insulation between countries. Selover and Round (1996) found that shocks in Japanese real output have significant and persistent effects on Australian GDP. In the case of Japan and the United States, however, Selover (1997) found only moderate effects of US fluctuations on the Japanese economy. Moreover, the effects of the US shocks on Japan seemed to be stronger in the short-run. Also investigating the historical interdependence between the USA and Japan, Kim and Bordo (1998) found that the floating exchange rate regime helped insulate Japan from short-run shocks, but not long-run effects.

Interest in the formation of regional blocks in the world economy, usually identical to trading blocks also spurred research interest in the synchronicity of cycles between countries. Among these, the European Union has become the focus of a particularly large body of literature, especially after it started preparations for adopting a common currency. The optimal currency area theory enjoyed a revival of sorts in the run up to the euro, with the result of increasing interest in the study of co-movement of business cycles in Europe and the existence or absence of a European business cycle (cf. Bayoumi and Eichengreen, 1993; Artis and Zhang, 1995, 1997, 1999; Sayek and Selover, 2002). Most of the empirical studies of this period assessed correlations between the German business cycle and those of other potential member countries. For example, Artis and Zhang (1995) present strong evidence of positive output correlations for most Western European countries with both the German and the US cycle.

Following the formation of the European Monetary Union, it became clear that new EU members would participate in the monetary union, this stimulated work on the characteristics of business cycles in new EU Member States (NMS) and synchronicity of business cycles between NMS and countries of the euro area (cf. Artis et al., 2004; Darvas and Szapary, 2004; Benczúr and Rátfai, 2005; Eickmeier and Breitung, 2006). While studies on the topic apply various methods in their analysis, most find that the business cycles in several new member states are about as synchronised with the euro

area as several of the older or already established members of the euro area (cf. Darvas and Szapary, 2004; Benczúr and Rátfai, 2005; Eickmeier and Breitung, 2006; Paczyński and Woźniak, 2007).

Given in particular, the rising prominence of emerging markets in the global economy and particularly in the context of international business cycle spill-overs, studies have emerged investigating business cycle co-movements in emerging market economies. With regards to emerging market countries the majority of studies on international business cycle transmission and synchronisation seem to focus on countries in the Asian region (cf. Selover, 1999; Shin and Wang, 2002; Selover, 2004; Desroches, 2004; Moneta and Ruffer, 2006; Takeuchi, 2007). For instance, Selover (1999) found evidence of a world business cycle and a unique regional ASEAN[5] business cycle. Shin and Wang (2002) found that intra-industry trades is the main channel, by which the Korean business cycle becomes synchronised with those of the other Asian countries and the costs of joining a currency union will diminish significantly only when intra-industry trade becomes dominant. Selover (2004) investigating economic links between Japan and Korea found that the Japanese business cycle has a moderate effect upon business cycle fluctuations in Korea and that the transmission effects from Japan to Korea seem to be increasing over time. This result received further support by Takeuchi (2007) findings of strengthening cyclical synchronisation between Japan and the Asian region countries.

The body of literature looking into the existence of business cycle co-movements focusing on African countries is still limited. What follows is an analysis of a few of the studies that investigate business cycle transmission and synchronisation between African countries and developed countries, with emphasis on previous studies in South Africa (e.g Botha, 2004; Kabundi and Loots, 2005, 2007). Nyembwe and Kholodilin (2004) investigate the asymmetric relationship between the European Monetary Union and sub-Saharan African countries by testing whether evidence on business cycle convergence exists. Applying a linear dynamic factor model, Nyembwe and Kholodilin (2004) found no evidence on the transmission of European economic fluctuations to sub-Saharan

[5] The ASEAN nations refer to Indonesia, Malaysia, Philippines, Singapore and Thailand.

Africa despite the fact that the EU is the main trading partner of the majority of African countries.

Botha (2004) focuses on South Africa, and amongst other issues, investigates the impact of the global factor on the South African business cycle. Botha (2004) employing correlation analysis, principal components analysis and variance decompositions investigated the impact of the world factor on the South African business cycle. The evolution of the South African business cycle was explored by dividing the time period into three distinct sub-periods, namely the Bretton woods period (1961:Q1 to 1972:Q4), the common shocks period (1973:Q1 to 1986:Q2) and the globalisation period (1986:Q3 to 2003:Q3). Output, consumption and investment data was used in the analysis of co-movement across countries. The time period was divided into three periods in order, to differentiate the impact of common shocks from those of globalisation on the degree of co-movement of the business cycles. Where the first period represents the period associated with the fixed exchange rate regime and the second period representing the period associated with sharp fluctuations in the price of oil and contractionary monetary policy in industrialised countries, whilst the third period encompasses the period when the forces of globalisation, especially for developing countries, seemed to gain momentum.

The results of the principal components analysis showed correlation between the SA factor and the world factor was negative in both the Bretton woods period and the common shocks period, implying that fluctuations in the South African business cycle during these periods were largely due to country-specific shocks. The correlation only became positive at 38% in the globalisation period, implying some co-movement between South Africa and the world cycle, with some fluctuations due to country-specific fluctuations. However, from the end of 1997 the positive correlation experienced between the South African and world cycle changed again to a negative relationship. Botha (2004:67) singles out the Asian crisis and the crisis in Argentina in 2001 as the reasons behind this change.

The most important results from the variance decompositions were that the world factor differs quite a lot across countries. In SA and Korea the country-specific factor was found to be more important in explaining variations in the business cycle (Botha, 2004:86). The world factor played a greater role in explaining variations in the common shock period. The country-specific factor was found to be very prominent in explaining the business cycle in all three sub-periods. However, this factor increased in the globalisation period in all the countries except in South Africa, where it declined from 70% to about 60%.

Applying a dynamic factor model, Kabundi and Loots (2007) investigate the extent of co-movement of the South African business cycle with those of eleven Southern African Development Community (SADC) countries, covering the period 1980–2002. Real GDP growth rates were used to analyse the co-movement between the South African business cycle and the 11 SADC countries. Kabundi and Loots (2007:747) found positive and statistically significant evidence of co-movement between the South African business cycle and those of the SADC countries. However, this co-movement is not driven by regional common components, but largely by global common and/or country specific components. Kabundi and Loots[6] (2005) using an aggregate G7 cycle as a proxy for the world business cycle, found a strong relationship to exist between the South African and G7 components. The co-movement improved from the early 1990s, corresponding to South Africa's integration into the global economy after a long period of isolation. The G7 common component explained approximately 66 per cent of the variation in the South African economic growth rate (Kabundi and Loots, 2005:1).

Examining the studies on international business cycle transmission and synchronisation focussing on South Africa, the work of Botha (2004) and Kabundi and Loots (2005, 2007) has paved the way for such analysis. The rationale of this study is to add to the literature investigating international business cycle co-movements and transmission between South Africa and other countries, and in the process attempt to fill the gaps that have been left by previous studies on South Africa. Thus, it attempts to provide a deeper

[6] The study is similar study to Kabundi and Loots (2007), but differs in that Kabundi and Loots (2005) investigate co-movement of South Africa with G7 countries and nine emerging market countries.

analysis on the existence of co-movements by incorporating relatively more macroeconomic variables as compared to Kabundi and loots (2007) study which restricts analysis to a single variable. The current study also provides a different country coverage to that examined by Botha (2004) and Kabundi and Loots (2007) by examining the relationship between the South African business cycle and those of the US, the UK, Japan and Germany. The UK, US, Japan and Germany are four of South Africa's major export markets and are amongst the top ten import sources (Kalaba, 2007).

With regards to the transmission of business cycle across countries this study employs a different econometric technique to the ones used by previous studies on South Africa. This study employs a structural VAR model which has the advantage, amongst others, of allowing the author to utilise underlying shocks with properties derived from economic theory. Instead of differentiating the impact of common shocks from those of globalisation on the degree of co-movement of the business cycles as in the study by Botha (2004), this study focuses on the individual country's business cycle transmission and synchronisation relationships between South Africa and its major trading partners.

2.4 CONCLUSION

This chapter explores some of the diverse issues regarding the transmission and synchronisation of business cycles across countries. A review of the theoretical literature reveals three competing theories- *the locomotive hypothesis, the common shocks hypothesis and the mode locking theory* through which countries business cycles can move together or move further apart. The evidence from the literature suggests that the three theories are not independent; instead they could all play a role in explaining business cycle synchronisation between countries. Nevertheless, all countries do not share the same degree and speed of co-movement due to differences in the domestic policies, in the composition of output and monetary transmission due to diverging financial structures. Thus, the extent to which the business cycle of a country is synchronised with other countries as suggested by the three theories could be different and as such becomes an empirical issue.

The empirical literature was grouped into three sections focusing on the relevant literature on the variables used, country coverage and econometric methods employed in exploring international business cycle transmission and synchronisation across countries. Generally the bulk of empirical literature on international business cycle linkages focus on developed countries, with emerging markets increasingly getting attention after the Asian financial crisis and the ensuing discussions regarding creation of optimal currency areas or blocks, and with very little studies on African countries. This study adds to the international business cycle literature on both African countries and emerging markets, by examining international business cycle transmission and synchronisation between South Africa and its major trading partners.

The next chapter sets out the analytical framework that will be utilised in addressing the questions regarding the transmission and synchronisation of business cycles between South Africa and its major trading partners.

CHAPTER THREE:
METHODOLOGY AND DATA DESCRIPTION

3.1 INTRODUCTION

This chapter sets out the analytical framework that is used to provide answers to the objectives set out in Chapter 1. The chapter also discusses the proxies and data used in this study. As noted earlier, the study examines the following issues: the interdependence and transmission of the South African business cycle with those of the US, UK, Japan and Germany. Following other empirical studies principal components analysis and Structural Vector Autoregression (SVAR)-impulse response and variance decompositions functions are used to examine the business cycle transmission and overall interdependence issue (cf. Selover and Round, 1995; Selover, 1997; Selover, 1999; Sayek and Selover, 2002; Selover, 2004; Desroches, 2004; Bezman and Selover, 2005; Takeuchi, 2007).

The chapter is organised as follows: Section 3.1 describes the data used in the study. Section 3.2 discusses the methods proposed to analyse the international business cycle transmission and interdependence issues. Section 3.3 discusses the need to include event dummies in SVAR models and details some principal historic events. Section 3.4 concludes the chapter.

3.2 DATA

The data for empirical estimations consists of monthly observations over the period January 1980 to April 2008 from the Thomson DataStream with the exception of the world oil prices and real effective exchange rate series which are obtained from the IMF International Financial Statistics (IFS) website. The sample period is determined by data availability. When studying the issue of common movements, most research has considered output that is either industrial production or GDP. From the theoretical and empirical literature in the previous chapters, a number of other variables have been suggested in exploring international business cycle transmission across countries. The

literature appears to provide support for a multivariable approach (cf. Sayek and Selover, 2002; Selover, 2004; Fry, 2001; Botha, 2004; Desroches, 2004; Breitung and Eickmeier, 2006; Eickmeier, 2006; Moneta and Ruffer, 2006).

With regards to studies focusing on South Africa use has been made of national GDPs, consumption and investment data, which are available on a quarterly basis, in the examination of international business cycle transmission and synchronicity. These variables have performed well when used in empirical studies on international business cycle transmission; however according to Kabundi and Loots (2007:743) it is more informative to study macroeconomic variables with high frequency data. This study therefore employs a multivariable approach with data which is available on a monthly basis. The SVAR models include those variables that are most essential to the interdependence and transmission relationship - for South Africa this includes the industrial production index, PPI, the repurchase rate and the real effective exchange rate. For the US, UK, Germany and Japan the industrial production indices, PPI prices and short-term interest rates are included. The short term interest rates employed are the federal rate for the US, the German discount rate, the bank rate for the UK and the Japanese discount rate. A PPI series is not reported for Japan; therefore this study employs the CPI for Japan. World crude oil prices enter the SVAR models as exogenous variables. Industrial production indexes are used instead of GDP because industrial production is available monthly, and thus offers more observations, and industrial production is more sensitive to the business cycle[7] (cf. Selover, 1997 and 2004; Selover and Jensen, 1999).

The level of each macroeconomic variable used is expressed in natural logarithms with the exception of the interest rates for each country, which are expressed in percentage terms. All the macroeconomic variables are seasonally adjusted. Where first differences of the log forms of the macroeconomic variables are used this is to achieve stationarity

[7] Industrial production is more sensitive to business cycle fluctuation than is GDP and is more likely to show significant business cycle transmission. This is because industrial production fluctuations are not confounded by the weather fluctuations inherent in agriculture nor smoothed by the stability of the service sector, both of which are included in GDP. Therefore, for GDP growth, the degree of correlations between countries will be smaller than for industrial production indexes.

and the differenced series can be interpreted as growth rates. The variables to be utilised in the international SVAR models, along with the abbreviations adopted in this study and source codes are summarised in Table 1.

Table 1: Variable descriptions and source codes of key variables

Variable	Variable description	Source code
IPUS	industrial production index for the US	USIPMAN.G
PUS	producer price index for the US	USPROPRCE
RUS	Federal funds rate	USPRATE
IPG	German industrial production index	BDIPTOT.G
PG	German producer price index	BDPROPRCF
RG	German discount rate	BDPRATE.
IPUK	industrial production index for the UK	UKIPTOT.G
PUK	producer price index for the UK	UKPROPRCF
RUK	UK bank rate	UKPRATE.
IPJ	Japanese industrial production index	JPIPTOT.G
PJ	Japanese consumer price index	JPCONPRCE
RJ	Japanese discount rate	JPDISCRT
IPSA	industrial production index for the SA	SAIPMAN.G
PSA	South African producer price index	SAPROPRCF
RSA	Repo rate (South African monetary policy rate)	SAPRATE
REERS	South Africa's real effective exchange rate	199..RECZF...
Oil	Petroleum: Average crude oil price	00176AAZZF...

Note: the source codes for the average crude oil price and the real effective exchange rate were obtained from the IMF IFS website and the source codes for the rest of the variables were obtained from the Thomson DataStream.
Source: Compiled by author

3.3 ESTIMATION TECHNIQUES

3.3. 1 Principal Components Analysis (PCA)

Principal Components Analysis (PCA) is a standard data reduction technique which extracts data, removes redundant information, highlights hidden features and visualises the main relationships that exist between observations (Dunteman, 1989 and 1999). This is achieved by transforming the original variables to a new set of variables, the principal components (PCs), which are uncorrelated, and which are ordered so that the first few retain most of variation present in all of the original variables (Jolliffe, 2002:1).

In an attempt to circumvent the over parameterisation problem often associated with multiple variable based approaches[8], this study uses principal components analysis to extract latent factors for the US, UK, German and Japanese economies. The principal components approach is used to extract the commonality in the movements of the key macroeconomic series for the US, the UK, Germany and Japan into national latent factors for the four countries. The latent factors represent the state of each economy which is equivalent to Burns and Mitchell (1946) reference cycle. The approach of extracting business cycle latent factors has received significant empirical support over the last few years (cf. Stock and Watson, 1991; Gregory, Head and Raynauld, 1997; Kose, Ortrok and Whiteman, 1999; Pesaran, Schermann and Weiner, 2001; Fry, 2002). These previous studies in extracting the business cycle latent factor employed a Kalman filter. However, the current study does not employ a Kalman filter to extract business cycle latent factor instead it uses principal components analysis. This study follows Botha (2004) who used factor models for US, SA, Japan, Korea, and UK using principle component analysis on output, consumption and investment data for the countries. The use of the principal components approach is also motivated by the simplicity of the method relative to utilising the Kalman filter method.

The reference cycles for the US, UK, Germany and Japan are derived from a selection of key macroeconomic variables for each country. The key macroeconomic variables are output (industrial production), producer prices, short term interest rates and real effective exchange rates. Following, Fry (2002) all the variables are detrended by regressing each variable against a constant and a linear time trend and using the residuals as the detrended series. The use of detrended data implies that the reference cycles extracted by the principal components approach are in growth cycle terms. The use of detrended data is consistent with Lucas (1977) definition of the business cycles as deviations of aggregate real output from trend.

[8] This study also estimates the international SVAR model using variable based approaches.

One of the issues regarding the calculation of principal components is whether to transform the original data using a correlation matrix or a covariance matrix on the data matrix. That is, the calculation of principal components can be carried out by transforming the original data matrix to either a covariance matrix or a correlation matrix. Eviews has the option of using the covariance or the correlation matrix. According to Borgognone *et al* (2001:324) the use of the covariance matrix implies that only the difference due to different means is removed from the original variables but the variances are not considered equal. Those variables with larger variances will have a greater impact on the weights of the PCs. This study makes use of the variables given by the correlation matrix and hence, in this form, the PCs combinations are unique and independent of the units of measure. The use of correlation matrix of variables is also inline with the literature on international business cycle co-movements (cf. Selover, 1999; Sayek and Selover, 2002; Bezmen and Selover, 2005).

3.3. 2 Structured Vector Autoregressions (SVAR)

Vector autoregressive models were popularised by Sims (1980) as a natural generalisation of univariate autoregressive models. One of the important and also attractive features of the vector autoregressive model is its flexibility and the ease of generalisation (Brooks, 2002:331). However, vector autoregressive models have been criticised as being mere vehicles to summarise the dynamic properties of data. That is, without reference to a specific economic structure, such VAR models are difficult to understand (Cooley and LeRoy, 1995). In light of the a-theoretical nature of standard VAR models, Sims (1981, 1986), Bernanke (1986), and Shapiro and Watson (1988) developed a new class of econometric models that is now known as structural vector autoregression (SVAR). Instead of identifying the autoregressive coefficients, identification using SVAR models focuses on the errors of the system, which are interpreted as (linear combinations of) exogenous shocks. These exogenous shocks are often associated with an economy meaning such as oil price shock, exchange rate shock, aggregate demand shocks or aggregate supply shocks.

The standard VAR model (Sims, 1980) also suffered from an arbitrary assumption of recursive error structure, which often gave different results, depending on the order that the variables were entered into the model (Selover, 2004:64). Bernanke (1986) and Sims (1986) development of SVAR models provided a reasonable remedy. The SVAR model adds economic restrictions to an otherwise statistical model to identify the sources of macroeconomic fluctuations. SVARs therefore also provide an appropriate framework in which to examine the transmission of shocks**.** The use of SVAR models in the current study is motivated by the above mentioned facts. In international SVAR modelling, before estimation of the actual models a number of issues related to the SVAR specification need to be taken into account. A discussion of some of these important issues thus follows.

i. Data transformation issues

In carrying out the SVAR, an issue is how to proceed correctly in order to identify the dynamic adjustment after a structural shock given the specification of the variables of interest in the VAR model. One attempt might be to proceed with the SVAR in level (cf. Sayek and Selover, 2002; Selover, 2004; Guay and Pelgrin, 2006). The estimated coefficients of the VAR with possibly non-stationary variables are consistent and the asymptotic distribution of individual estimated parameters is standard (Hamilton, 1994:557). According to Guay and Pelgrin (2006:6) the estimated impulse response functions are also consistent estimators of the true impulse-response functions except in the long run. In the long run, the responses do not converge to the true values with a probability of one. This therefore means that SVAR models can be estimated with non-stationary variables and the resulting impulse response functions in the short- and medium-run are reliable estimators of the true impulse response functions. This also holds with cointegrated variables.

Another approach is to estimate the SVAR in first difference. According to Guay and Pelgrin (2006:7) this approach may be preferred when variables include integrated processes. As previously mentioned differencing achieves stationarity of the variables and thus, the estimated impulse response functions are reliable estimators of the true

impulse responses, even in the long run. However, if the restrictions that lead to these systems are incorrect, differencing the data will result in the system being misspecified and the estimators might be biased (Guay and Pelgrin, 2006:7). According to Sims *et al.* (1990) transforming the data into stationary representations by first differencing is often unnecessary even if the data appears or is likely to be integrated.

A third approach is proceeding with the SVAR using detrended[9] data. In this case the variables can be interpreted as growth cycles. This study employs all three data transformations in estimating SVAR models. This study thus allows the author to assess the impact on the potential business cycle transmission relationships, resulting from using different data transformations.

ii. Lag length selection

An important step in the estimation of a VAR model is the lag length selection. In selecting the appropriate VAR lag length the information criteria (IC) approach is used**.** The information criteria ensure that residuals are Gaussian. Various IC are available such as Akaike Information criterion (AIC), Schwarz criterion (SC), Hannan Quinn (HQ) and the Final Prediction Error (FPE). Empirical experimentation with information criteria has nevertheless shown that information criteria normally select conflicting VAR orders (Takaendesa, 2005:98). Where the information criteria provide conflicting results, the selected lag length which produces residuals that are not autocorrelated and the most economically interpretable results is chosen.

iii. Identification scheme (or identification restrictions)

SVAR models treat all the variables as endogenous. That is the sampling information in the data is modelled with the help of VAR models, which model each variable as a function of all other variables. Regarding the restrictions, SVAR models first decompose all variables into their expected and unexpected parts. According to Gottschalk (2001:24)

[9] All variables are detrended by regressing each variable against a constant and a linear time trend and using the residuals as the detrended series.

the identifying restrictions are then imposed only on the unexpected part (that is the residuals), where plausible identifying restrictions are easier to find. As previously noted, structural shocks are the central variables in an SVAR model. These shocks are unpredictable with respect to the past of the process (Breitung et al., 2004:161).

To identify the structural form parameters restrictions must be placed on the parameter matrices. These restrictions can be obtained from a 'timing scheme" for the shocks. Three such timing restrictions which have enjoyed extensive usage in SVAR modelling are short run restrictions, long run restrictions and the block exogeneity assumption (cf. Bernanke, 1986; Blanchard and Watson, 1986; Sims, 1986; Blanchard and Quay, 1989; King, Plosser, Stock and Watson, 1991; Cushman and Zha, 1997; Gali, 1999; Dungey and Pagan, 2000; Desroches, 2004; Guay and Pelgrin, 2006). Short run restrictions impose some contemporaneous feedback effects among the variables while long run restrictions assume that the effects of some shocks are zero in the long run that is the shocks have transitory effects with respect to particular variables (cf. Breitung *et al.*, 2004 and Guay and Pelgrin, 2006). The block exogeneity assumption on the other hand rests on the small open economy specification implying that the domestic (South African) variables have no impact- neither contemporaneously nor with lags- on the foreign macroeconomic variables in the SVAR specification (Guay and Pelgrin,2006:8). This means in the specification of the SVAR both short-run and long-run restrictions are imposed.

In what follows this study does not impose a block exogeneity representation, despite the fact that South Africa can possibly be characterised as a small open economy. The reasons for taking this stance are two-fold; firstly with the Eviews software package one cannot impose both short-run and long-run restrictions simultaneously (Eviews 6 guide, 2008:360). Secondly, Guay and Pelgrin (2006:9) argue that the unconstrained representation resulting by not imposing block-exogeneity provides consistent estimators whether the block exogeneity is true or not. However, imposing block exogeneity when this hypothesis is false yields inconsistent estimators.

In the analysis of international business cycle transmission between South Africa and its four major trading partner countries, a benchmark model able to properly explain the macroeconomic short- and long-term dynamics of the country relationships under consideration is needed. The choice in this study is based on the specification proposed by Sayek and Selover (2002)[10] and later followed by Selover (2004) [11], which is imposing short-run restrictions. This study proposes a set of restrictions that is relatively close (as shown in equation 3.2) to those set by Sayek and Selover (2002) and Selover (2004).

This study keeps the monthly frequency of the data as in Selover (2004). The current study differs from the abovementioned studies in terms of the country selection and most notably in terms of the number of SVAR models to be estimated. This study is similar to both Sayek and Selover (2002) and Selover (2004) in that it investigates the transmission relationships between two countries at a time. The current study estimates four SVAR models under each data transformation. As previously mentioned the data transformations used in the estimation of the SVAR models are variables in levels, first differenced variables, detrended variables and latent factors extracted using PCA.

Thus, the vector of endogenous variables is as follows:

$$Y_t = \left[IPf_t, Pf_t, Rf_t, IPSA_t, PSA_t, RSA_t, REERS_t\right] \quad \text{.....(3.1)}$$

where IPf_t is the foreign industrial production index, Pf_t is the foreign producer price index, Rf_t is the foreign short term interest rate, $IPSA_t$ is the South African industrial production index, PSA_t is the producer price index for South Africa, RSA_t is the South African short term interest rate, whereas $REERS_t$ is the South African real effective exchange rate.

The identification scheme used is characterised by the following model for the innovations $u_t = B\varepsilon_t$ [12]:

[10] The study investigated the relationship between Turkish and German economies

[11] The study investigated the relationship between the Korean and Japanese economies

[12] Where u_t is the observed (or reduced form residuals), while ε_t is the unobserved structural innovations. The matrix A which specifies the instantaneous relations between the variables, is set to an identity matrix

$$\begin{bmatrix} u^{IPf_t} \\ u^{Pf_t} \\ u^{Rf_t} \\ u^{IPSA_t} \\ u^{PSA_t} \\ u^{RSA_t} \\ u^{REERS_t} \end{bmatrix} = \begin{bmatrix} 1 & 0 & 0 & 0 & 0 & 0 & 0 \\ b_{21} & 1 & 0 & 0 & 0 & 0 & 0 \\ b_{31} & b_{32} & 1 & 0 & 0 & 0 & 0 \\ 0 & 0 & 0 & 1 & 0 & 0 & 0 \\ 0 & 0 & 0 & b_{54} & 1 & 0 & b_{57} \\ 0 & 0 & 0 & b_{64} & b_{65} & 1 & 0 \\ b_{71} & b_{72} & b_{73} & b_{74} & b_{75} & b_{76} & 1 \end{bmatrix} \begin{bmatrix} \varepsilon^{IPf_t} \\ \varepsilon^{Pf_t} \\ \varepsilon^{Rf_t} \\ \varepsilon^{IPSA_t} \\ \varepsilon^{PSA_t} \\ \varepsilon^{RSA_t} \\ \varepsilon^{REERS_t} \end{bmatrix} \quad \ldots\ldots\ldots\ldots\ldots\ldots (3.2)$$

The first two rows are the non-policy variables of the foreign country's industrial production and producer prices responding to innovations in the short term interest rate and real effective exchange rate only with a lag. As in Selover (2004:81), the third row deals with the foreign country's interest rate policy, which is used to decide the monetary policy according to output growth and domestic[13] prices and the lagged real exchange rate. The South African interest rate policy is also decided upon according to output growth and domestic prices and the lags of real effective exchange rate (Row six). In the fourth row South African industrial production responds with a lag to developments in domestic interest rates, foreign output and the real effective exchange rate.

Row five is the modified South African Phillips curve equation in which prices are assumed to be a function of output, the real effective exchange rate and the lags of the domestic interest rate and foreign prices. In the seventh row the real effective exchange rate reacts to contemporaneous changes in all the variables. Thus, the theoretical model underlying the econometric analysis is an IS–LM style model, combining two economies. The IS–LM form of the system is adapted from Sayek and Selover (2002) and Selover (2004) who found a fair amount of empirical support for such a model. The IS–LM style model adopted is a simplified version of the theoretical model of Kim and Bordo (1998) without their long-run restrictions. With the conditions for estimation of structural models having been outlined the effects of the structural shocks ε_t, can be investigated through

(A= I_k where k = 7). The structural innovations ε_t, are assumed to be orthonormal innovations that is covariance matrix is an identity matrix $E[\varepsilon_t \varepsilon_t'] = I$ (Eviews6 guide, 2008: 357)

[13] In row five domestic prices refers to prices in the foreign country

an impulse response analysis. The results of the impulse response are often more informative than the structural estimates themselves (Breitung *et al.*, 2004:184).

The fourth row is the most relevant to the South Africa international economy interdependence question (also see Sayek and Selover, 2002 and Selover, 2004). In row four, foreign industrial production is expected to have a positive effect on South African industrial production through net exports. It is not expected that the South African industrial production will have much effect on foreign industrial production. Likewise, the real effective exchange rate and foreign producer prices should have a positive effect on South African output growth through net exports (cf. Sayek and Selover, 2002; Selover, 2004). However, it is possible for foreign producer prices to have a negative impact on South African industrial production growth if inter-industry trade is dominant. It is also expected that South Africa's real effective exchange rate and foreign prices will put inflationary pressure on South African prices. A positive shock to South African producer prices and South African interest rates should have a negative effect on output growth through their effects on net exports and increasing borrowing costs respectively. According to the Economic Intelligence Unit (2008) the real exchange rate (the index) rises[14] if domestic costs or prices increase faster than foreign costs or prices. Thus, positive shocks to South African prices are expected to have a positive effect on the real effective exchange rate while positive shocks to foreign prices should have a negative effect on the real effective exchange rate.

3.3. 3 SVAR- Impulse Response and Variance Decomposition analysis

Matrix 3.2 shows the short-run restrictions used in the computation of the SVAR impulse response functions. Note that these restrictions bind only in the first period of the impulse responses, and that the impulse responses are free to vary after the first period. It is also worth noting that the period is short, and that most factors take longer than a month to

[14] A larger index number (stronger real exchange rate) indicates that the home country is less competitive. The broad implication is that to restore competitiveness, the domestic currency must weaken or domestic prices/costs will have to increase less than foreign prices/costs

have an effect on real (non-financial) variables, these short-run restrictions should not be very serious constraints (cf. Sayek and Selover, 2002; and Selover, 2004).

Impulse response functions show the response of a system to a one-standard-deviation shock to one of the variables (Morling, 2002:11). Put differently, impulse response functions track the impact of any variable on others in the system (Lin, 2006:1). Impulse response analysis is an essential tool in empirical causal analysis and policy effectiveness analysis (Lin, 2006:1). In the context of this study, the graphs of the impulse response functions illustrate the dynamic responses of the selected country's (in this study South Africa) macroeconomic variables to a positive one standard deviation shock in each of the macroeconomic variables of the other countries (that is the US, UK, Germany and Japan). The impulse response functions are estimated in order to view the overall interdependence relationship as a system and to examine for possible business cycle transmission between South Africa and the economies of its major trading partners.

Variance decompositions offer a slightly different method for examining SVAR system dynamics. Variance decomposition functions show how much of the unanticipated changes of variables are explained by different shocks. Put differently, variance decompositions indicate the percentage of the forecast error variance in one variable that is due to errors in forecasting itself and each of the other variables (Alami, 2001). From the variance decompositions it is possible to learn if the corresponding effects of one country upon another are important in a relative sense. Of particular concern in this study are the percentage variations in the relevant South African macroeconomic variables explained by innovations in the macroeconomic variables of the developed countries under study. The variance decompositions will also be used to assess which of the four developed countries explain the largest portion of variations in the South African economy. In conclusion, the basic patterns of international business cycle interdependence and transmission can be illustrated by estimating the impulse response and variance decomposition functions of the SVAR models.

3.4 Accounting for Global and Local Events in SVAR modelling

South Africa's emerging market status coupled with the relative size of imports and exports to GDP (about 35% in 2008) makes the country very vulnerable to changes in the world economy. For instance, recent events in the global economy have certainly confirmed the vulnerability of the South African economy to world events. More explicitly, the global economy is currently in its worst state for decades, with central banks everywhere responding to rising consumer prices by raising interest rates (particularly in the first half of 2008), at just the time when relaxation would be the more appropriate (Stern, 2008:60). These policies would have been appropriate had the source of inflation been excess demand but, the increased inflation can be traced to soaring oil and food prices. Rises in oil prices are usually associated with recessions and it is known that cycles are globally more synchronised during such periods (Akin, 2006:9). In response to rising inflation, South Africa has also followed the very same policies implemented everywhere else. That is, with the South African Reserve Bank (SARB) increasing interest rates in an attempt to choke off inflationary expectations. However, despite the raising of interest rates, inflation remains at relatively high levels.

Thus, in modelling an economy one has to be aware of specific exogenous domestic or global shocks which might have significant effects upon the economy. Failure to control for these shocks may give false negative or positive indications of business cycle transmission and synchronisation, due to omitted variable bias (Selover, 2004: 59). Some of the major events in Japan, Germany, US, the UK, South Africa and global events with potentially significant effects upon the economies of the abovementioned countries are listed in the historical chronology shown in Table 2. This study thus, creates a number of dummy variables to account for certain (some of these) important events and structural changes[15] in the SVAR models. 0, 1 dummy variables are used where a value of 1 is given for the period in which the event occurred and a value of 0 is assigned otherwise.

[15] See Appendix A under table A3 for a list of the dummy variables used in the study

Table 2:Principal historical events in the Japanese, US, German, UK and South African economies

Years	Event
Worldwide Events	
1980-89	Iraq and Iran War (September 1980 - July 1988)
1990-91	Persian Gulf war (Aug 1990 – Feb 1991) Temporary oil price rise
2001	World economic slowdown
Events in Japan	
1986-89	The Japanese "bubble economy". Peak of Japanese stock markets Dec 1989
1989	Japanese economy enters a recession, with stock markets and real estate collapsing
1995	Kobe Earthquake
1997	Asian Financial Crisis (Oct./Nov. 1997)
1998-99	Economic and financial reforms in response to financial crisis
2003	An earthquake of magnitude 8 rocks the Northern Island of Hokkaido
Events in Europe	
1989	End of the USSR Cold War: Fall of the Berlin Wall (Nov)
1990	Reunification of Germany (Aug)
1991-92	UK in recession following the economic chaos of "Black Wednesday" (Sept 1992)
1992	The Maastricht treaty signed
1993	Maastricht treaty adopted by 12 nations. The European Community becomes the EU
1999	Formation of the European Monetary Union (Jan): European common currency, the euro
Events in America	
1979-82	US federal reserve pursues monetary targeting (Oct 1979 - Oct 1982)
1987	US stock markets crashes slowing mid 80s economic boom
1993	World trade centre bombed (Feb)
2001	September 11 terrorist attacks on the World Trade Centre and the Pentagon
	Invasion of Afghanistan by the US
2003	Invasion of Iraq (May 2003) and occupation of Iraq by US and British armed forces
2005	Period of the US housing market bubble (June)
2007	Subprime mortgage crisis (Aug 2007 to date)
	World stock markets collapse triggered by the subprime crisis in the USA
Events in S.A	
1985	Increasing civil unrest and township violence leads to a state of emergency being declared in parts of South Africa
1987	US places sanctions on South Africa to limit trade
1990	Nelson Mandela released from prison
1994	The ANC Adopts the Reconstruction and Development Programme (RDP) as a policy framework
1996	The ANC Adopts the Growth, Employment and Redistribution macroeconomic strategy
2006	The launch of the Accelerated and Shared Growth Initiative for South Africa (6 February)
2007	Hundreds of thousands of public-sector workers in South Africa take part in the biggest strike since the end of apartheid (June)

Note: Information on events in South Africa is from southafrica.info and Government communications (GCIS). Information on events in Europe is from Europa Publications (1998). The rest of the event information was obtained from the chronology of World events (Skomal, 2005).
Source: Compiled by author

3.5 CONCLUSION

This chapter has set out the analytical framework which will be used in addressing the main question regarding business cycle transmission between South Africa and its four major trading partner countries. Firstly, the chapter began with a discussion of the data used in the study and the justification for the choice of macroeconomic variables used in this study. Secondly, the analytical approach for estimating reference cycles for the foreign countries was discussed, as it formed one of the data transformations to be estimated, that is a factor-based SVAR model. The next step was to discuss some of the important issues related to the SVAR specification. Lastly, identification of SVAR model together with the impulse response and variance decomposition functions for the actual macroeconomic variables were discussed. Also included in the discussion was how these approaches will be utilised to analyse international business cycle transmission across countries. Having set out the analytical framework, the next chapter deals with the actual estimation of the SVAR models with a view to achieve the objectives of this study as set out in Chapter One.

CHAPTER FOUR:
ESTIMATION AND ANALYSIS OF RESULTS

4.1 INTRODUCTION

In Chapter One, the following objectives were set: (i) To determine the extent and magnitude of business cycle transmission and interdependence of the South African business cycle with those of the US, UK, Germany and Japan. (ii) To establish the dominant country amongst the four, in terms of business cycle transmission to South Africa. Having reviewed the existing empirical literature, analysed the possible mechanisms of business cycle linkages across national economies and set out the analytical framework, the next step is to apply the analytical framework to address these objectives.

This chapter presents and discusses the results of the study. This chapter is divided into four sections including the introduction. Section 4.2 provides a preliminary analysis. Section 4.3 focuses on the results of the SVAR-impulse response and variance decomposition analysis and Section 4.4 concludes the chapter.

4.2 PRELIMINARY ANALYSIS

Table 3 presents some basic statistics regarding the United Kingdom, Japan, the United States, Germany and South Africa. Note that although South Africa has a little over 79% of the population of the United Kingdom and about 33% of the population of Japan, its (SA) economy is about 25% the size of the UK economy and about 13% the size of the Japanese economy. As far as Germany and South Africa are concerned, South Africa has a population a little over half the population of Germany, but its economy is about 22% the size of the German economy. From Table 3, the US economy is at least three times the size of the developed countries (that is, Germany, Japan and the UK) economies in PPP terms, and more than 20 times the size of the South African economy. Consequently, it is not expected that the South African economy will have much impact upon the abovementioned developed countries economies.

Table 3: Size of economies

Country	Population Year 2000 Millions	GDP (2005) US$Bill ($ PPP)	GDP Per capita ($ PPP)	GDP Growth (%)	
				1990-2000	2000-2006
Germany	82.7	2,429.60	29,461	1.8	2.6
Japan	127.9	3,995.10	31,267	1.1	1.5
US	299.8	12,416.50	41,890	3.5	2.6
UK	60.2	2,001.80	33,238	2.7	2.5
SA	47.9	520.9	11,110	2.1	4.1

Note. Population, GDP and GDP per capita are taken from the Human Development report (2008). The annual GDP growth rates data is obtained from the World Development indicators (World Bank, 2008).

In addition, Granger causality tests were ran in order to identify whether any causality exists between the macroeconomic variables of the foreign countries and those of South Africa. The Granger causality tests employed are simple *F*-tests performed on five variable VARs with twelve lags over the sample period. Since all the macroeconomic variables in the study are non-stationary at levels[16], the Granger causality tests[17] are performed on first differences of the logs of the variables (except for interest rates, which are not logged). By and large, the results of the Granger causality tests provide some indication that the South African economy is affected by movements in the macroeconomic variables of the foreign countries under study. Causality from South Africa to its major trading partners is only evident between South African and UK producer price inflation.

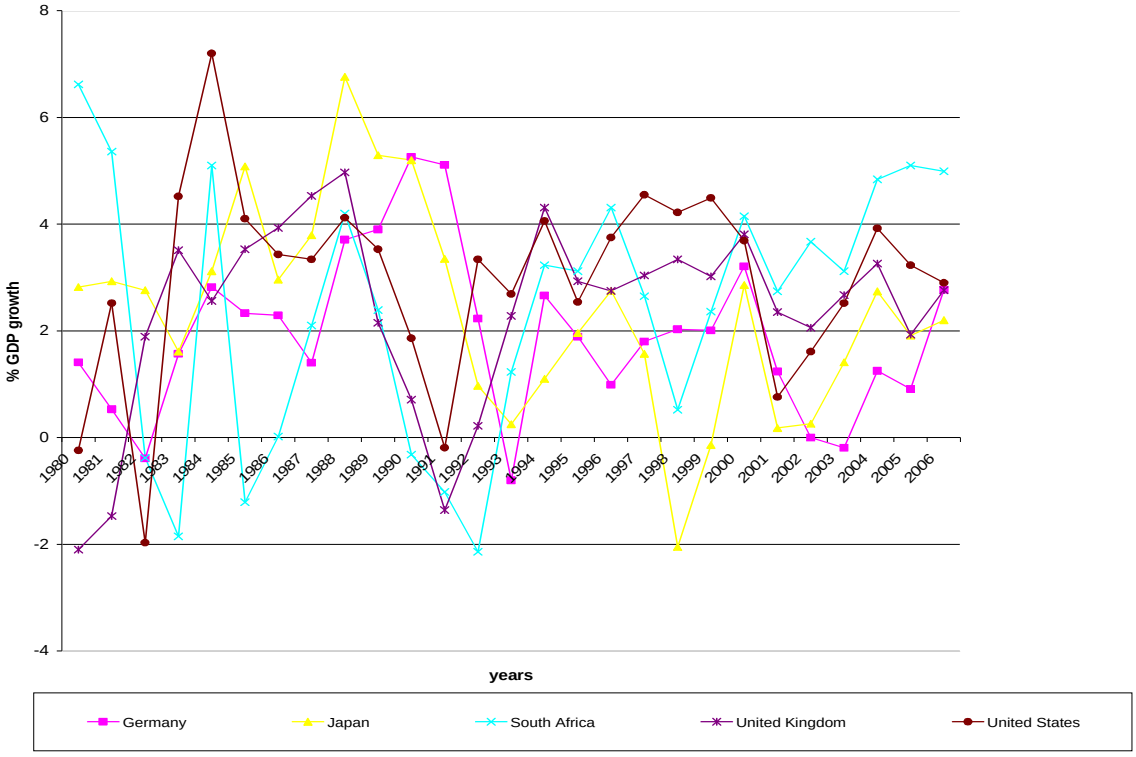
Figure 1 shows the South African, US, UK, German and Japanese growth rates of GDP. The figure reveals a significant amount of correspondence between the timing of the South African business cycle with those of its developed trading partner countries. This result is consistent with the findings of Kabundi and Loots (2005:26) who find significant correlation between the South African business cycle with the G-7 countries. The common shocks hypothesis operating through world oil price fluctuations and more recently rising food prices globally could provide a partial explanation for the timing of the fluctuations in GDP growth across these countries. The co-movement appears to be

[16] With the exception of UK producer prices which are I(0). See Appendix A (A1) for detailed unit root/stationarity test results

[17] See Appendix A (A2) for detailed Granger causality results

relatively reasonable between South Africa business cycle and those of the US, UK and Japan. South African and German growth rates also co-move but not as closely. In the case of the US and UK business cycles the main deviation from South African business cycle appears to have been in 1997-1999, this is most probably because of the negative economic impacts of the Asian financial crisis particularly on emerging markets including South Africa. The other notable deviation of the South African business cycle from those of its major trading partners appears to have been in 2004-2006, with increasing growth being experienced in South Africa whilst the business cycles of the other countries appear to enter into a downturn. The increased growth in the South African economy corresponds to part of the period when South African economy experienced an upward phase of the business cycle noted as the longest period of economic expansion in the country's recorded history (Sandrey *et al.*, 2007:28).

Fig 1. South African, UK, US, German and Japanese GDP growth rates



Note: The line graphs plot the growth rates of GDP from 1980 to 2006.The data was obtained from the 2008 World development Indicators CD Rom.
Data Source: World Bank (2008).

4.2. 1 Direction of trade and financial linkages

Trade is very important to the South African economy. Imports and exports of goods and services each account for about 35% of its GDP (SARB, 2008:146). South Africa imports predominantly manufactured goods from the rest of the world and primary goods from SADC. This reflects South Africa's relative comparative advantage in producing manufactured goods, when compared with SADC and its comparative advantage in producing primary goods (resources) with respect to the world (Sandrey *et al.,* 2007:9). South Africa's exports to the world are predominantly commodity based. More particularly, South Africa's major exports to the world are concentrated in minerals and related products (Sandrey *et al.,* 2007:197).

According to Table 4, from individual country point of view, South Africa's largest trading partners in terms of total exports (and imports) are the United States (11. 9% of South African exports) and Japan (11.1%), followed by Germany and the UK. In terms of imports sources Germany is South Africa's largest import source followed by the US then Japan and lastly the UK. As a consequence, one might expect the US, Japan, Germany and the UK to transmit business cycles to South Africa. The ranking shown in Table 4 are also consistent with Kalaba (2007) who provides a list of South Africa's major trading partners in terms of imports and exports.

Table 4: Direction of Trade (2007)

South African exports				South African imports			
Rank	**Country**	**Amount**	**%**	**Rank**	**Country**	**Amount**	**%**
1	USA	7537.8	11.9	1	Germany	9305.9	10.9
2	Japan	7025	11.1	2	US	6155.1	7.2
3	Germany	5104.5	8	3	Japan	5254	6.1
4	UK	4900.8	7.7	4	UK	3846.2	4.5
	World	63484	100		World	85574	100

Note: the amounts are in millions of US dollars. The percentages were calculated by dividing the individual country amount by the world amount and then multiplying the result by 100.
Source: IMF Direction of Trade Statistics.

Another source of economic linkages is through capital flows such as foreign direct investment (FDI). Jansen and Stokman (2004:6) argue that FDI constitutes a separate channel through which economies may affect each other in an economically significant

fashion. According to Rusike (2007:56) the United Kingdom is the largest source of inward FDI to South Africa, this is mainly concentrated in the services and natural resource sectors. More particularly, Barclay's acquisition of ABSA in the financial services sector and the activities of mining companies such as Anglo American and BHP Billiton show evidence of the dominance of the UK as the major FDI source. The United Kingdom is followed by the US, Germany, Netherlands, Switzerland and Malaysia in that order, in terms of inward FDI flows to South Africa. This finding also raises the expectation of business cycle transmission to South Africa from the set of developed countries under study.

4.3 SVAR-IMPULSE RESPONSE AND VARIANCE DECOMPOSITIONS

As previously mentioned four different approaches based on the data transformations described in Chapter Three are used in estimating the SVAR models. Namely, the first approach was to estimate the SVAR with variables in levels. The second and third approaches were to estimate the SVAR models in first difference and using detrended data respectively. These three approaches can be referred to as variable based approaches to estimating SVAR models. The fourth approach followed was to estimate a factor-based SVAR using the reference cycles computed for Japan, Germany, the US and UK. Table 5 reports the summary of the variance decomposition analysis for all the approaches used. For the variable based approaches the variance decomposition coefficients reported are a summation of the coefficients for industrial production, producer prices and interest rates of South Africa's trading partners. In the case of the factor based approach the variance decomposition coefficients reported are a summation of the reference cycle coefficients. Thus, Table 5 reports how much of the variation in South African macroeconomic variables are explained by shocks to the economies of South Africa's trading partners.

The results of the factor based approach did not perform well in that the South African business cycle, as measured by the macroeconomic variables, was found to be relatively unresponsive to changes in the reference business cycles of its trading partners. The factor based model results strongly suggest that the South African economy is almost

entirely influenced by the domestic economic environment only. This result seems to be at variance with evidence displayed in the real world. More focus is thus placed on the results of the variable based approaches reported in Table 5. It is evident from both the detrended data (*detrend*) and first difference (*growth*) approaches that economic fluctuations in the UK are the most dominant in terms of explaining economic fluctuations in South African industrial production, however, the levels *(level)* approach suggests that economic fluctuations from Japan are most dominant.

All the variable based approaches found that economic fluctuations in the UK were the most influential in explaining economic fluctuation in South African producer prices. With regards to explaining movements in South African interest rates the levels and first difference approaches found economic fluctuations in Germany as being most influential whilst the detrended data approach found economic fluctuations in the US to be dominant. Lastly, the levels and detrended data approaches found economic fluctuations in the US as the most influential in explaining economic fluctuations in the South African real effective exchange rate, however, the first difference approach found Germany to be most influential in terms of explaining movements in the external competitiveness of the rand. With regards to business cycle transmission between South Africa and the developed countries used, by and large, the results of the variable based approaches exhibit a similar pattern and direction of transmission differing mainly with regards to the magnitude of the impulse response and variance decomposition coefficients.

A common finding across all approaches is that the South African economy appears to be unresponsive to changes in international monetary policy. That is, changes in RUS, RUK, RG and RJ do not have a significant impact on IPSA, PSA, RSA or REERS (see Fig 2 to Fig 5). This finding is consistent with Fry (2002) who found that Australian monetary policy did not respond directly to an international monetary policy shock. The result implied that Australian monetary policy responds to domestic economic conditions, rather than the monetary policy decisions of major trading partners (Fry, 2002:2). In South Africa's case this was recently evidenced by the decision of the South African Reserve Bank (September 2008) not to lower interest rates despite the trend by most

central banks around the world of lowering interest rates. The unresponsiveness of South African monetary policy to changes in international monetary policy stances could be an indication of the autonomy of the South African Reserve Bank (SARB) with respect to making monetary policy decisions. However, what is evident in the results of the variable based approaches is that output and price developments in South Africa's trading partners' economies have an impact on South African monetary policy.

The variable based approaches produced plausible results and therefore, these results are discussed in more detail. To avoid unnecessary duplication in the reporting of results, the results of SVAR models estimated with variables in levels are reported. The choice of reporting the results of SVARs estimated in level is also motivated by the possibility of the existence of cointegration among the variables within each economy (see Sayek and Selover, 2002; Selover, 2004). The summary of the variance decomposition analysis results of the other three approaches are reported in the appendix[18]and not discussed in detail. There appears to be a consensus among the variable based approaches with regards to international business cycle transmission to the South African economy. More explicitly, the impulse responses and variance decompositions indicate significant transmission of industrial production (output) shocks from the US and UK, and on the other hand; price shocks from Japan and Germany to South Africa.

The general picture portrayed by the estimated SVAR models, is that in terms of economic impact and the transmission of business cycles to South Africa, on average, the UK, as measured by the three key macroeconomic variables, is the dominant economy followed by the US and Germany and lastly Japan in that order. The finding of significant transmission of international business cycles to South Africa and the relatively weak transmission in the opposite direction, that is, from South Africa to its trading partner's economies could indicate that these larger countries are acting as locomotives, driving the South African economy with them as discussed in Chapter One.

[18] See table C1, table C2 and table C3 in appendix C for the summarised variance decomposition results of the other three approaches. The complete impulse response graphs and variance decomposition functions for all the approaches are available from the author on request.

Table 5, Summarised Variance Decomposition analysis results of the data transformations

	US				Germany				UK				Japan			
Period	**Level**	**Growth**	**Detrend**	**Factor**	**Level**	**growth**	**detrend**	**factor**	**Level**	**growth**	**detrend**	**factor**	**Level**	**growth**	**detrend**	**factor**
SA industrial production (IPSA)																
1	1.98	4.3	2.49	0.18	2.97	6.53	1.77	0.1	48.62	25.41	46.76	0.29	2.56	5.5	2.53	0.01
12	48.44	26.49	47.95	0.13	15.1	21.33	14.59	0.11	63.31	33.45	58.82	0.21	52.76	24.88	48.13	0.02
24	63.4	26.53	60.39	0.13	41.7	21.49	44.6	0.09	70.32	33.45	63.41	0.15	71.41	24.95	59.3	0.02
36	66.87	26.53	61.91	0.12	51	21.49	57.35	0.07	70.04	33.45	63.45	0.11	75.91	24.95	52.49	0.04
SA producer prices (PSA)																
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	2.84	1.52	2.54	0	6.24	5.34	13.56	0.01	63.09	5.37	60.38	0	0.87	4.46	4.12	0
24	10.94	1.53	7.35	0	26.7	5.35	35.82	0.02	88.94	5.37	84.89	0.01	3.15	4.47	8.62	0.01
36	15.99	1.53	9.34	0	43.2	5.35	48.01	0.02	94.6	5.37	91.37	0.01	7.75	4.47	13.11	0.02
SA interest rate (RSA)																
1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
12	55.44	73.12	68.07	0.02	78	84.09	73.07	0	21.67	78.9	22.55	0.05	48.93	68.72	18.19	0.02
24	50.45	73.15	58.29	0.04	71.5	84.28	45.64	0.01	16.44	78.9	17.28	0.05	60.48	68.75	16.23	0.03
36	48.04	73.15	49.54	0.04	71.2	84.28	33.03	0.01	29.71	78.9	16.25	0.04	67.47	68.75	18.16	0.04
SA real effective exchange rate (REER)																
1	0.7	0.83	0.62	0	0.4	0.56	0.46	0.01	0.85	0.87	0.87	0	0.79	0.4	0.66	0
12	47.06	28.49	27.81	0.04	30.4	39.06	20.85	0.2	16.07	24.28	6.11	0.06	18.76	13.85	5.15	0.08
24	67.45	28.49	38.09	0.05	50.9	39.07	35.14	0.19	39.04	24.28	10.35	0.07	34.17	13.86	8.27	0.16
36	72.26	28.49	43.76	0.04	59.7	39.07	36.16	0.14	50.37	24.28	12.93	0.06	42.19	13.86	9.67	0.12

*Note: **level** is the approach that estimates the SVAR models with variables in levels. **Growth** is the approach that estimates the SVAR models with first differenced variables. **Detrend** is the approach that estimates the SVAR models with detrended data. **Factor** is the approach that estimates factor-based SVAR using the reference cycles computed for Japan, Germany, the US and UK. The variance decomposition coefficients are a summation of the coefficients of fluctuations in industrial production, producer prices and interest rates of South Africa's trading partners, in the case of the factor based approach are a summation of the reference cycle coefficients.*
Source: Estimated by author.

Table 6: Summarised Variance Decomposition results for the SVAR models estimated with variables in levels

Time	Panel 1: US to SA				Panel 2: Germany to SA				Panel 3: UK to SA				Panel 4: Japan to SA			
Period	**IPUS**	**PUS**	**RUS**	**SUM**	**IPG**	**PG**	**RG**	**SUM**	**IPUK**	**PUK**	**RUK**	**SUM**	**IPJ**	**PJ**	**RJ**	**SUM**
SA industrial production (IPSA)																
1	1.98	0.00	0.00	1.98	2.97	0.00	0.00	2.97	23.66	0.00	0.00	23.66	2.56	0.00	0.00	2.56
12	45.60	2.84	0.00	48.44	9.15	5.94	0.03	15.12	45.27	4.25	0.00	49.52	1.49	51.25	0.02	52.76
24	59.63	3.77	0.00	63.40	9.30	32.27	0.12	41.70	60.35	2.66	0.00	63.02	1.01	70.39	0.01	71.41
36	58.93	7.94	0.00	66.87	7.04	43.83	0.16	51.03	63.71	3.60	0.00	67.32	2.21	73.69	0.01	75.91
SA producer prices (PSA)																
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.44	2.40	0.00	2.84	2.44	3.79	0.00	6.24	0.72	51.71	0.00	52.43	0.39	0.47	0.00	0.87
24	0.78	10.16	0.00	10.94	7.51	19.16	0.01	26.67	3.87	78.62	0.00	82.49	2.85	0.29	0.01	3.15
36	2.50	13.49	0.00	15.99	8.90	34.27	0.01	43.18	6.29	85.27	0.00	91.56	7.46	0.28	0.01	7.75
SA interest rate (RSA)																
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	43.29	12.15	0.00	55.44	1.81	76.12	0.03	77.96	3.49	24.93	0.00	28.43	37.86	10.99	0.09	48.93
24	36.81	13.63	0.00	50.45	3.07	68.36	0.02	71.45	3.06	16.87	0.00	19.94	54.70	5.73	0.06	60.48
36	35.20	12.83	0.00	48.04	6.22	64.94	0.02	71.18	8.20	27.73	0.00	35.93	54.84	12.59	0.04	67.47
SA real exchange rate (REERS)																
1	0.46	0.25	0.00	0.70	0.06	0.33	0.00	0.40	0.41	0.44	0.00	0.85	0.44	0.35	0.00	0.79
12	23.03	24.02	0.00	47.06	7.86	22.49	0.00	30.35	8.38	14.33	0.00	22.70	4.66	14.09	0.01	18.76
24	49.91	17.54	0.00	67.45	14.69	36.20	0.01	50.89	22.13	26.54	0.00	48.68	5.12	29.05	0.01	34.17
36	57.76	14.49	0.00	72.26	13.38	46.28	0.02	59.69	26.36	33.92	0.00	60.28	4.47	37.72	0.00	42.19

Note: the variables are as defined in Table 1 of Chapter Three. The period column details selected months following a shock to the macroeconomic variables of South Africa's trading partners in which variance decomposition coefficients are reported.
Source: Estimated by author.

As a starting point of estimating the SVAR models, the lag length needs to be selected. As previously mentioned in Chapter Three, in cases were information criteria suggest conflicting lag lengths, the lag length that produces serially uncorrelated residuals is chosen. Based on the abovementioned criterion a lag length of three months is set for almost all the SVAR models except for the SVAR model with Japan and South Africa, where a lag length of four months is chosen. Table B1 in appendix B reports the lag length selection results. The results reported and analysed here focus on the impulse response graphs and the variance decomposition functions because they are the most relevant to the main question of this study- the potential business cycle transmission between South Africa and its major trading partners that is the US, the UK, Germany and Japan. The results of a selected set of impulse response functions, each estimated over a three year (36 months) horizon, are reported in Appendix B. Table 6 provides a summary of the variance decomposition analysis results of the four SVAR models estimated with variables in levels. The rest of the chapter provides a detailed discussion of the results of the SVAR models estimated in levels.

4.3. 1 Business Cycle Linkages between South Africa and the US

The SVAR model presented here is a seven variable structured Bernanke–Sims SVAR using the short-run restriction matrix outlined in Chapter Three for identification[19]. The specification of VAR model is as follows:

$$Y_t = \alpha_0 + \sum_{i=1}^{3}\alpha_i ipus_{t-1} + \sum_{i=1}^{3}\beta_i pus_{t-i} + \sum_{i=i}^{3}\gamma_i rus_{t-i} + \sum_{i=1}^{3}\delta_i ipsa_{t-i} + \sum_{i=i}^{3}\phi_i psa_{t-i} + \sum_{i=1}^{3}\vartheta_i rsa_{t-i} + \sum_{i=1}^{3}\varphi_i reers_{t-i} + \sum_{i=1}^{3}\mu_i oil_{t-i} + \sum_{1}^{7}\sigma_i D_{it} + \varepsilon_t \quad \ldots\ldots (4.1)$$

where Y_t stands for each endogenous variable in sequence. Following Selover (1995, 2004) and Sayek and Selover (2002) world oil prices (oil) are included in the SVAR model as controls because failure to include them in the model could lead to a false or spurious finding of business cycle transmission. The D_{it} are the seven event dummy variables, D2, D3, D6, D7, D9, D10 and D11 used as controls. The dummy variables are

[19] The over-identifying restrictions are not rejected by the data.

defined as follows: D2 (Iran-Iraq war, 1980.09 - 1988.07), D3 (Persian Gulf War, 1990.08 - 1991.02), D6 (South African economic and political reform, 1994.02-2008.04), D7 (Asian financial crisis, 1997.12 - 1998.12), D9 (US housing market boom, 2005.01 - 2006.12), D10 (Subprime mortgage crisis, 2007.08 - 2008.04) and D11 (Invasion and occupation of Iraq by the US and UK, 2003.05 - 2004.12).

Fig 2 in appendix B reports the impulse response graphs detailing the impact of changes in US macroeconomic variables on the South African economy. The impulse response graph in Fig.2a shows that changes in US industrial production (IPUS) have a positive and significant impact on South Africa's industrial production (IPSA). This finding constitutes evidence of reasonable transmission of output shocks from the US to South Africa. The associated variance decomposition, in the first column of panel 1, slightly falls from about 60% after two years to about 59% after three years (36 months). This means that US industrial production growth explains about 60% of the variance in South African industrial production growth after two years and about 59% after three years. These findings imply that South Africa stands to benefits from economic growth in the US. The finding of a positive impact of a shock to foreign output on domestic output is consistent with the study by Selover (2004) who finds that Korea benefits from Japan's economic growth. More specifically, Selover (2004:76) using a SVAR model found that a one standard deviation shock to Japanese industrial production had a positive and significant impact on Korean industrial production. Selover (2004:81) suggests trade as the possible cause of the positive effect of Japanese industrial production on Korean industrial production.

Cacciotti *et al. (2003*) using SVAR models also found shocks to foreign output to have a positive impact on domestic output. More explicitly, Cacciotti *et al.* (2003:22) found that the Italian output gap reacted positively to innovations in the US output gap. Cacciotti *et al.* (2003) suggested that US innovations could have affected the Italian cycle directly through trade between the countries and indirectly through the impact on trade and financial markets in other economies that are linked to the Italian markets. Following the same arguments put forward by Selover (2004) and Cacciotti *et al.* (2003), in the case of

South Africa, given that the US is one of its major trading patterns, it is possible that the positive impact of US industrial production on South African industrial production could be the result of trade between the countries. South African industrial production (IPSA) in graph Fig.2b responds insignificantly to US producer price (PUS) shocks, thus showing a relatively weak response of South African industrial production to US producer prices.

Fluctuations in US producer prices appear to have a slightly significant impact on South African producer prices after about one year (Fig.2e). The associated variance decompositions (the second column in Panel 1) rise from about 10% after two years to just over 13% after three years. Fig.2m indicates that shocks to South African price (PSA) exhibit a positive and slightly significant impact on US producer prices with the associated variance decompositions (not displayed) increasing from about 11% after two years to about 14% after three years. This finding is consistent with Selover (1997:406) who found that US prices had little effect upon Japanese prices, but Japanese prices had a greater effect upon US prices. Sayek and Selover (2002) covering a different set of countries also found a positive and significant impact of fluctuations in foreign prices on domestic prices. Sayek and Selover (2002:233) found that price fluctuations were transmitted from Germany to Turkey but transmission in the opposite direction was not significant.

Selover (2004:69) suggests that a purchasing power parity type mechanism might enforce long run co-movement among price levels and the exchange rate of two countries. Selover (2004:69) tested the purchasing power parity type specification by incorporating the logged prices for Japan and Korea, and the exchange rate between the two countries and found evidence of cointegration. Though the current study does not suggest a cointegration relationship between the countries prices, it instead uses the argument put forward by Selover (2004) as a possible reason for the co-movement between US and South African producer prices. That is, America being, on average, South Africa's major trading partner the positive and significant impact of shocks to US prices on South African prices, could be the result of imported inflation. Shocks to US industrial

production (IPUS) appear not to have a significant impact on South African producer prices (PSA), as shown in Fig.2d. The associated variance decompositions reached a maximum of 2.5% after three years.

South African interest rates (RSA) in Fig.2g appear to respond positively and significantly to shocks in US industrial production (IPUS) with the maximum impact being observed about ten months after the shock, after which the impact of output shocks decrease steadily. The associated variance decompositions (panel 1 column 1) fall from about 43% after one year to just over 35% after three years. This is evidence that changes in US industrial production have a statistically significant influence on monetary policy changes in South Africa. This finding could be the result of economic growth in the US creating an increased demand for South African imports. This increased demand for imports is followed by an increase the price of South African products. Prices inflate and interest rates are raised in a bid to curb inflation. Shocks to US prices (PUS) seem to exhibit the same pattern of influence as shocks to US output (IPUS) on South African interest rates except that the maximum impact is experienced about a year after the shock, as shown in Fig.2h. The explanatory power of US producer price shocks appears to diminish over time, with the associated variance decompositions (Panel 1 column 2) being about 13% after three years from a level of 19% after two months. This finding is consistent with Selover (1997:405) who found US prices significantly influenced movements in Japanese short-term interest rates. However, Selover (1997:405) argues that due to the presence of significant serial correlations, any inferences made from his result would be doubtful. The positive impact of a shock to US prices on South African interest rates could be the result of imported inflation. The importation of goods from the US provides a transmission channels for the US producer price inflation to be transmitted to South Africa.

The South African real exchange rate (REERS) in Fig.2j initially responded positively for about six months and then negatively (decreases) to US output shocks. The associated variance decompositions (Panel 1 column 1) rise from about 23% after one year to over 57% after three years. This means that a statistically significant portion of the movements

in the real exchange rate (REERS) are caused by shocks to US industrial production (output), and the transmission appears to be increasing over time. A positive shock to US industrial production can be interpreted as an increase in economic activity in the US. Increases in economic activity can result in lower US prices due to increase in the amounts of goods available. However, an output shock can also result in higher US prices due to over-demand as economic activity increases. Thus, when US prices are decreasing (lower) the real effective exchange rate increases and when US prices increase the real effective exchange rate decreases. South Africa's real exchange rate (REERS) also responds significantly to US producer price (PUS) shocks with a similar pattern of transmission with that of a shock US industrial production. The maximum impact of the shock to US producer prices is felt after about four months, as shown in Fig.2k. The associated variance decompositions (Panel 1 column 2) being about 31% after four months and falling to about 14% after three years, implying a decrease in transmission over time.

According to the EIU (2008) the real effective exchange rate index falls if foreign prices increase faster than domestic prices. Thus, the initial positive response of South Africa's real effective exchange rate to a shock in US prices is not consistent with theory. The initial positive response could be the result of the unrest in South Africa caused by apartheid leading to multilateral sanctions being imposed on South Africa which were preceded by President P.W. Botha declaration a state of emergency in 1985. Shortly thereafter, Chase Manhattan Bank declared it would not renew its short-term loans, touching off a liquidity crisis as other lenders followed suit (Levy, 1999:5). As the crisis intensified, the South African Rand fell further and in late August the government temporarily closed the stock exchange and foreign-exchange markets and suspended interest payments on its debt (Levy, 1999:6). The above chain of events could be responsible for the a-theoretical the initial response of the real effective exchange rate to a shock in US prices.

4.3. 2 Business Cycle Linkages between South Africa and Germany

The SVAR model presented here has the following specification:

$$Y_t = \alpha_0 + \sum_{i=1}^{3} \alpha_i ipg_{t-1} + \sum_{i=1}^{3} \beta_i pg_{t-i} + \sum_{i=i}^{3} \gamma_i rg_{t-i} + \sum_{i=1}^{3} \delta_i ipsa_{t-i} + \sum_{i=i}^{3} \phi_i psa_{t-i} + \sum_{i=1}^{3} \vartheta_i rsa_{t-i} + \sum_{i=1}^{3} \varphi_i reers_{t-i} + \sum_{i=1}^{3} \mu_i oil_{t-i} + \sum_{1}^{6} \sigma_i D_{it} + \varepsilon_t \quad \text{..... (4.2)}$$

where Y_t stands for each endogenous variable in sequence. The D_{it} are the six event dummy variables. D2, D3, D6, D7, D10 are as defined in 4.3.1 and D4 (Collapse of the Berlin wall and German reunification, 1990.02 - 1999.12).

Fig 3 in appendix B reports the impulse response graphs detailing the impact of changes in German macroeconomic variables on the South African economy. In graph Fig.3a South Africa's industrial production (IPSA) appears to respond negatively but insignificantly to a shock in German industrial production (IPG). The associated variance decompositions (Panel 2 column 1) decrease from about 9% after one year to about 7% after three years. German price (PG) shocks only have a significant negative impact on South African industrial production (IPSA) after about 18 months, as shown in Fig.3b. With the associated variance decompositions (Panel 2 column 2) being about 19% after 18 months, which in turn rises to about 43% after three years. According to the Department of Foreign Affairs (2004) the major South African exports to Germany include based metals such as ferro-alloys, primary commodities notably coal, iron ores/metal ash, food products and motor vehicles/parts. Major South African imports from Germany included machinery (25%), motor vehicles/parts (13.3%), electrical engineering products and chemicals. Germany is also South Africa's most important supplier, particularly in capital goods and technology transfer.

What can be concluded is that the trade between these two countries is to a large extent of a Ricardian type. That is, each country appears to export goods in which it has a comparative advantage and imports those goods in which it does not. According to Shin and Wang (2004:2), if trade occurs mainly of the Ricardian type, greater specialisation could induce the industrial structures of the trading countries to diverge, resulting in less synchronised movements of their business cycles. Thus, the negative impact of German price shocks on South African industrial production growth could be the result of

specialisation caused by the Ricardian type trade inducing the industrial structures of Germany and South Africa to diverge, resulting in less synchronised movements of their business cycles.

Fluctuations in German producer prices (PG) in Fig.3e appear to significantly impact South African prices (PSA) after about six months, with South African prices responding positively to such shocks. The associated variance decompositions (Panel 2 column 2) notably rise from about 4% after one year to about 34% after three years. These findings constitute evidence of statistically significant transmission of producer price fluctuations from Germany to South Africa, with the transmission increasing over time. A similar argument is proposed for the positive impact of a shock to German producer prices as in the case of a shock to US producer prices. Shocks to German industrial production (IPG) appear to have an almost significant and positive impact on South African prices (PSA) after about 16 months, as shown in Fig.3d. The associated variance decompositions (Panel 2 column 1) increase from about 4% after 16 months to about 9% after three years. The transmission effects are relatively weak but increasing over time. South African producer price shocks appear to have a slightly significant positive impact on German interest rates (RG), as shown in Fig.3m, with an associated variance decomposition (not displayed) of about 12% after three years.

South African interest rates (RSA) in Fig.3h appear to respond positively and significantly to fluctuations in German producer prices (PG), with the maximum impact of the shock occurring after about eight months. The variance decompositions (Panel 2 column 2) appear to show that German price shocks explain a very significant portion of movements in South African interest rates, with the explanatory power reaching a maximum after eight months of about 78%. This could be the result of imported inflation, pushing up producer prices in South Africa and thus interest rates rise in an attempt to curb the resultant inflation. Shocks to German industrial production (IPG) appear to have an insignificant impact on movements in South African interest rates (RSA) (Fig.3g), with a maximum variance decomposition (Panel 2 column 1) of about 6 % after three years.

In Fig.3k German price shocks have a positive impact on the real exchange rate (REERS) for about seven months and thereafter shocks to German prices have a negative impact on the real exchange rate. The pattern of transmission is similar to that for a shock in US prices and thus a similar explanation as in the US case is suggested. The associated variance decompositions (Panel 2 column 2) rise from just above 23% after one year to about 46% after three years. Thus, shocks to German prices over time explain a greater portion of movements in the real effective exchange rate. German industrial production (IPG) shocks appear to have a moderate impact on the real exchange rate (REERS), as shown in Fig.3j. The variance decompositions also seem to echo this sentiment, with the maximum variance decomposition (Panel 2 column 1) being about 15% after two years.

4.3. 3 Business cycle linkages between South Africa and the UK

The SVAR model detailing the proposed linkage between South Africa and the UK is specified as follows:

$$Y_t = \alpha_0 + \sum_{i=1}^{3} \alpha_i ipuk_{t-1} + \sum_{i=1}^{3} \beta_i puk_{t-i} + \sum_{i=i}^{3} \gamma_i ruk_{t-i} + \sum_{i=1}^{3} \delta_i ipsa_{t-i} + \sum_{i=i}^{3} \phi_i psa_{t-i} + \sum_{i=1}^{3} \vartheta_i rsa_{t-i} + \sum_{i=1}^{3} \varphi_i reers_{t-i} + \sum_{i=1}^{3} \mu_i oil_{t-i} + \sum_{1}^{7} \sigma_i D_{it} + \varepsilon_t \quad \text{..... (4.3)}$$

where Y_t stands for each endogenous variable in sequence. The D_{it} are the seven event dummy variables. D2, D3, D6, D7, D10 are as defined in 4.3.1, D11 (Invasion and occupation of Iraq by the US and UK, 2003.05 - 2004.12) and D13 (Black Wednesday in the UK, 1992.09 - 1993.12).

Fig 4 in appendix B presents a selected set of impulse response functions each simulated over 3 years (36 months). The impulse response graph in Fig.4a shows that UK industrial production (IPUK) has a positive and significant impact on industrial production in South Africa (IPSA). This constitutes evidence of transmission of output shocks from the UK to South Africa. UK industrial production growth explains about 45% of the variance in South African industrial production growth after one year and 63% after 36 months (Panel 3 column 1). This is evidence of statistically significant transmission of fluctuations from the UK to South Africa. As in the case with the US, South Africa stands

to benefit from economic growth in the UK, with the possible transmission channels being trade and capital flows. UK producer price (PUK) shocks appear to have an insignificant impact on South African industrial production (IPSA) as shown in Fig4.b, with variance decomposition (Panel 3 column 2) of about 4% after three years.

Producer price fluctuations appear to be transmitted from the UK to South Africa, as evidenced in graph Fig.4e by the positive and very significant impact of a UK price shock on South African prices. The associated variance decompositions (Panel 3 column 2) increase from about 52% after one year to about 85% after three years. This is evidence of very strong and statistically significant transmission of producer price fluctuations from the UK to South Africa. These results indicate that UK price fluctuations play a pivotal role as far as explaining changes in inflation in South Africa. The impact of a shock to UK producer prices on South African producer prices could be the result of imported inflation. With the possible transmission channels being trade and capital flows. Taking into account that the UK is the largest foreign investor in South Africa and one of South Africa's most significant trading partners, the finding of a positive impact of a shock to UK prices on South African producer prices seems reasonable. South African producer prices (PSA) in Fig.4d appear not to respond significantly to changes in UK industrial production (IPUK). The associated variance decompositions (Panel 3 column 1) reach a high of about 6% after three years.

Shocks to UK industrial production (IPUK) appear to have an insignificant impact on South African interest rates (RSA), as shown in Fig.4g, with variance decomposition (Panel 3 column 1) of around 8% after three years. South African interest rates (RSA) in Fig.4h appear to respond significantly to UK price (PUK) shocks, with the response being positive for about 17 months before becoming negative. The variance decompositions (Panel 3 column 2) show that UK price shocks explain a relatively significant portion of movements in South African interest rates, with a variance decomposition of about 28% after three years. A similar argument is proposed for the positive impact of a shock to UK producer prices on South African interest rates as in the case of a US price shock. Stern (2008:60) provides a possible explanation for the

negative response of short-term interest rates to a positive shock in UK prices. As previously mentioned a rise in UK producer prices is transmitted to South African producer prices therefore having an inflationary effect on South African prices. According to Stern (2008:60-61) if the source of the inflation is a supply shortage then the appropriate policy stance would be to relax or decrease interest rates.

In Fig.4j UK producer price (PUK) shocks appear to have a negative and significant impact on the real exchange rate (REERS) after about five months. The associated variance decompositions (Panel 3 column 2) increase over time from just above 14% after one year to about 34% after three years. According to the EIU (2008) the real effective exchange index falls if foreign prices increase faster than domestic prices. Thus, the negative impact of a shock to UK producer prices on the real effective exchange rate is consistent with theory. Shocks to UK industrial production (IPUK) appear to have a significant negative impact on the real exchange rate (REERS), as shown in Fig.4k), with the pattern of transmission being similar to that for US industrial production shocks. The associated variance decompositions (Panel 3 column 1) increase over time from about 8% after one year to about 26% after three years. One of the implications of the growth in output (industrial production) could be an increase in the costs of production. According to the EIU (2008) the real effective exchange index falls if foreign costs increase faster than domestic costs. Thus, the negative response of the real effective exchange to a shock to UK industrial production (increase in the costs of production) is consistent with theory.

4.3. 4 Business cycle linkages between South Africa and Japan

The SVAR model detailing the proposed linkage between South Africa and Japan is specified as follows:

$$Y_t = \alpha_0 + \sum_{i=1}^{3} \alpha_i ipj_{t-1} + \sum_{i=1}^{3} \beta_i pj_{t-i} + \sum_{i=i}^{3} \gamma_i rj_{t-i} + \sum_{i=1}^{3} \delta_i ipsa_{t-i} + \sum_{i=i}^{3} \phi_i psa_{t-i} + \sum_{i=1}^{3} \vartheta_i rsa_{t-i} + \sum_{i=1}^{3} \varphi_i reers_{t-i} + \sum_{i=1}^{3} \mu_i oil_{t-i} + \sum_{1}^{8} \sigma_i D_{it} + \varepsilon_t \quad \text{..... (4.4)}$$

where Y_t stands for each endogenous variable in sequence. The D_{it} are the eight event dummy variables. D2, D3, D5, D6, D7, D10 are as defined in 4.3.1, D14 (Japan

earthquakes, Kobe (1994.10 - 1995.10) and northern islands of Hokkaido, 2003:07 - 2004.06) and D15 (Japan recession, 1989.12 - 2001.12).

Fig 5 in appendix B presents a selected set of impulse response functions each simulated over 3 years. Shocks to Japanese industrial production (IPJ) appear to have a negative and insignificant impact on South African industrial production (IPSA) growth, as shown in Fig.5a. The associated variance decomposition (Panel 4 column 1) after three years is about 2%. Japanese producer price (PJ) shocks in Fig.5b appear to have a significant negative impact on South African output (IPSA) after about 5 months. The variance decompositions increase over time from about 51% after one year to about 74% after three years. According to Sandrey and Jensen (2007:266) South Africa's exports to Japan during 2005 were concentrated in precious stones and metals and motor vehicles. Imports from Japan are concentrated in motor vehicles and there has been a substantial increase in the importation of motor vehicles in particular from Japan. Thus, it can be argued that to a greater extent trade between Japan and South Africa is of the Ricardian type. The impact of a shock to Japanese producer prices is similar to that of a shock in German producer prices and thus a similar explanation as in the German case is suggested. In Fig.5m South African prices appear to have a moderately and positive impact on Japanese industrial production, with the associated variance decompositions (not displayed) rising from about 16% after one year to about 22% after three years. Japan is the main single country destination for South African exports and the fourth main source of imports (Sandrey and Jensen, 2007:266). Thus, the trade channel provides a possible explanation of the positive impact of a shock to South African producer prices on Japanese industrial production.

In Fig.5d fluctuations in Japanese producer prices (PJ) do not appear to have a statistically significant impact on South African producer prices (PSA) showing a relatively weak response of South African producer prices to Japanese producer prices. This is supported by the associated variance decomposition (Panel 4 column 2) of about 0.28% after three years. Shocks to Japanese industrial production (IPJ) also have an

insignificant impact on South African prices (PSA) (Fig.5d), with maximum variance decomposition (Panel 4 column 1) of around 7% after three years.

In Fig.5g shocks to Japanese industrial production (IPJ) appear to have a positive and significant impact on South African interest rates (RSA). The associated variance decompositions increase from about 38% after one year to about 55% after three years. The impact of a shock to Japanese industrial production on South African interest rates is similar to that of a shock to US industrial production and thus, a similar explanation as in the US case is suggested. South African interest rates (RSA) also appear to respond positively and significantly to Japanese price (PJ) shocks, with the strongest impact being experienced after about 4 months, as shown in Fig.5h. The positive response of South African interests to a shock in Japanese producer prices is consistent with *a-priori* expectations. The variance decomposition results (Panel 4 column 2) show that Japanese price shocks explain a significant portion of movements in South African interest rates, in the period between 4-8 months after the shock, with a maximum variance decomposition of about 38% and decreasing thereafter.

Japanese price shocks appear to have a significant and positive impact on the real exchange rate (REERS), as shown in Fig.5k. The associated variance decompositions increase from about 14% after one year to about 38% after three years. This finding is at odds with *a priori* expectations. However, this anomaly could be a consequence of the fact that a large part of the sample period corresponds to the period in which the Japanese economy was in a recession. This particular point calls for further research, but would require a more detailed model, beyond the scope of this study. In Fig.5j shocks to Japanese industrial production (IPJ) do not appear to have a statistically significant impact on the real exchange rate (REERS). The associated variance decompositions (Panel 4 column 1) reach a maximum of about 5% after two years.

4.3. 5 The Domestic economy

The results of the variable based approaches showed similar results in terms of the relationships between domestic macroeconomic variables. Across all models, South

African industrial production does not appear to respond significantly to either South African prices or interest rates. South African prices also appear not to respond significantly to either South African output shocks or South African interest rates. The South African interest rate reacts positively to both a shock in South African industrial production and producer prices. This result appears to correspond to the inflationary effects of both output and producer prices shocks, which have the consequence of inducing a rise in interest rates in a bid to reduce or control inflation.

South African output does not appear to respond significantly to changes in the real effective exchange rate. However, South African producer prices and interest rates appear to be sensitive to changes in the real effective exchange rate. South African prices respond immediately and positively to real effective exchange rate shocks. This finding is consistent with Abbey (2001) who found that for developing countries the net contribution of shocks to real effective exchange rates is to increase price inflation. The inflationary effect of a positive shock to the real effective exchange rate can be attributed, to some extent, to the "pass through" from the exchange rate to domestic prices resulting in inflationary pressures coming from abroad. This dominant inflationary effect of real effective exchange rate shocks could also provide motivation for monetary policy officials to raise the repo rate, in an attempt to reduce inflation. A positive South African price (PSA) shock has a positive impact on the real effective exchange rate (REERS). This finding is consistent with the *a priori* expectations set in Chapter Three. This finding is also consistent with Sayek and Selover (2002:233) who found that Turkish prices (domestic prices) had a positive effect on the TL/DM[20] exchange rate.

4.4 CONCLUSION

This chapter presented and discussed the estimations and results with regard to the manner in which the South African business cycle is linked to world business cycles. The first part of the chapter presented and discussed some statistics regarding the size of the economy and simple granger causality tests. This was followed by a graphical analysis carried out by superimposing South Africa's GDP growth rates over the GDP growth

[20] TL is the abbreviation for Turkish Lira and DM stands for German Mark.

rates of the US, UK, Germany and Japan. Direction of trade statistics and sources of financial linkages between South Africa and different world economies were also discussed. The tests, statistics and graphs discussed support the possibility of business cycle transmission from the US, UK, Germany and Japan to South Africa but not in the opposite direction.

International business cycle transmission and overall interdependence was then investigated using SVARs impulse response and variance decomposition functions, and significant business cycle linkages were established. The UK, followed by the US and Germany appeared to have the most influence on the South African economy. In most of the cases impulse response analysis results had the correct signs conforming to the *a priori* expectations stated in Chapter Three.

Overall, regarding business cycle transmission and synchronisation, the results of the impulse responses and variance decompositions of the variable based approaches indicate significant transmission of industrial production (output) shocks from the US and UK, and on the other hand price shocks from Japan and Germany to the South African business cycle. The results of the variable based approaches lend some support to the finding of Kabundi and Loots (2005) who found evidence of high correlation between the South African business cycle with the G-7 countries and most emerging market countries. A consistent finding across the variable and factor based approaches is that the South African economy appears to be unresponsive to changes in international monetary policy.

CHAPTER FIVE:
CONCLUSIONS AND POLICY RECOMMENDATIONS

5.1 INTRODUCTION

Global events such as the Asian financial crisis, creation of the European monetary union, the world economic slowdown in 2001 and globalisation have had the effect of increasing interest in international business cycle synchronisation and the possible transmission of fluctuations between countries (cf. Selover, 1999, 2004; Sayek and Selover, 2002; Shing and Wang, 2002; Eickmeier and Breitung, 2006; Paczyński and Woźniak, 2007; Eickmeier, 2007). For instance, the extent to which globalisation causes domestic economies to move with economies in the rest of the world or in their particular region, concerns policy-makers. When such business cycle co-movement is comprehensive, the influence of policy-makers on their respective domestic economies is significantly reduced (Kabundi and Loots, 2005:1). This implies that for a national economy if the forces of globalisation lead to increased business cycle co-movement with other countries, this could have the effect of reducing the country's ability to manage itself out of a crisis.

A survey of the literature showed that the majority of empirical studies on interdependence and international business cycle transmission have focused on industrialised nations with relatively less attention on developing countries. Studies that have been carried out in South Africa, thus far, have focused on the impact of the world business cycle, as measured by the G7 factor, on the South African business cycle (cf. Botha, 2004; Kabundi and Loots, 2005) or the impact of increasing trade on the co-movement of the business cycle between South Africa and the Southern African Development Community (SADC) countries (Kabundi and loots, 2005, 2007).

Against this backdrop, this study assesses the possibility of international business cycle transmission and interdependence between South Africa and four of its major developed trading partners. Specifically, it attempts to determine the extent and magnitude of

business cycle transmission and interdependence of the South African business cycle with those of the US, UK, Germany and Japan, and to establish the dominant country amongst the four, in terms of business cycle transmission to South Africa.

The empirical analysis in this study use basic statistics such as population figures, national GDPs and the growth rates, trade statistics, as well as graphs and econometric models to explore the extent and magnitude of business cycle transmission and synchronisation. The empirical analysis commences with an examination of statistics regarding the size of the economy and simple granger causality tests. This is followed by a graphical analysis carried out by superimposing South Africa's GDP growth rates over the GDP growth rates of the US, UK, Germany and Japan. A discussion of the direction of trade statistics and sources of financial linkages between South Africa and its trading partner's economies then follows. To explore the business cycle transmission and synchronisation issue, the study uses SVAR impulse response and variance decomposition functions.

The purpose of this chapter is two fold. First to provide a general summary of the key findings of this study focusing on the evidence presented in Chapter Four. Secondly to highlight policy implications and offer some recommendations based on the findings.

5.2 SUMMARY OF KEY FINDINGS

There is a clear tendency for business cycle synchronisation between South Africa and its major trading partner's economies, as seen in the graphs of GDP growth rates. The co-movement appears to be relatively considerable between South Africa business cycle and those of the US, UK and Japan. South African and German growth rates also co-move but not as closely, both in terms of timing and of magnitude. The results of simple Granger causality tests show evidence of Granger causality running from the international economies to South Africa. However, in terms of Granger causality from South Africa to its trading partner's only South African producer price inflation Granger causes UK producer price inflation.

South Africa and its major trading partners' industrial production indexes, producer prices, interest rates and the real exchange rate were then modelled in a SVAR system. The results of impulse responses and variance decompositions indicate significant transmission of industrial production (output) shocks from the US and UK, and on the other hand; price shocks from Japan and Germany to the South African business cycle. Economic growth in the US and UK appears to benefit South Africa. It can be inferred that if the US and/or the UK enter into a recession some of the recession effects will be transmitted to South Africa. The evidence of business cycle co-movement of the South African business cycle with its major developed country trading partners is consistent with the of Kabundi and Loots (2005) who found evidence of co-movement between the South African business cycle with the business cycles of the G-7 countries and most emerging market countries.

The finding of significant transmission of business cycles from the UK and US to South Africa appears to reflect the strong trade ties between South Africa and the two countries as well as the importance of UK foreign direct investment (FDI) in South Africa. Thus, according to the locomotive hypothesis the US and the UK can be presumed to be acting as locomotives, driving a significant portion of the fluctuations in the South African economy. The trade and capital flows channels of the locomotive hypothesis may provide a mechanism through which economic fluctuations in the US and UK are transmitted to South Africa. The current economic conditions in the US and UK economies appear to reflect strong signs of economies on the brink of a recession. Based on the findings of this study, it can be argued that a recession in the US and UK will certainly leave the South African economy a little more fragile and possibly raise fears of South Africa also entering a recession. Fears of a recession in South Africa might also be exacerbated by domestic issues such as the Eskom debacle, political uncertainty and plummeting business and consumer confidence.

In the case of German and Japanese economies impact on South Africa, the impulse response graphs indicate that a positive shock to both German and Japanese producer prices has a negative impact on South African industrial production growth. This finding

is possibly the result of the Ricardian type trade between South Africa and these two countries. According to Shin and Wang (2004:2) if trade occurs mainly of the Ricardian type, greater specialisation could induce the industrial structures of the trading countries to diverge, resulting in less synchronised movements of their business cycles.

The impulse response and variance decomposition functions also made it possible to identify the dominant foreign economy with regards to business cycle transmission to the South African economy. The UK appears to have emerged as the country that has the strongest influence on the South African economy, with the transmission of business cycles running from the UK to South Africa and not vice versa. Thus, the UK transmits shocks which partially synchronise the two economies. The dominance of the UK in terms of business cycle transmission to South Africa could, in part, be the result of the dominance of the UK as the major FDI source. However, with the global economy seeming to be on the brink of a recession, this might pose serious implications with regards to trade and capital flows. According to Trevor Manuel in his speech at the World Economic Forum (2008), "Declining commodity prices and lower growth in major trading partners will lower demand for South African exports and reduce the income we (South Africa) derive from them." Taking into account the positive effect of both the trade and capital flows channels on the South African economy a sizeable reduction in these channels could bear the seeds of a downturn in the South African business cycle. Thus, it can be argued that decreases in trade and capital flow to South Africa, depending on the extent, could realise fears of South Africa entering a recession.

The current political uncertainty being experienced in South Africa which seems to be becoming less tolerant and increasingly violent could heighten the fears of a recession. That is information flows might cause negative sentiment towards investing in South Africa possibly causing reasonable capital reversals and this coupled with the possibility of reduced trade volumes and foreign capital flows to South Africa. Thus, the political uncertainty could add to plummeting business and consumer confidence in South Africa. It can be argued that it is of paramount importance to monitor developments in the global economy with particular attention to the economic conditions in the UK and US when

drafting economic policies for South Africa. Also of importance is a quick and peaceful resolution to the current political uncertainty in the country as this situation can have negative economic repercussions.

5.3 POLICY IMPLICATIONS, RECOMMENDATIONS AND AREAS FOR FURTHER RESEARCH

The results of this study act as evidence of the increasing importance and spread of the forces of globalisation, resulting from the increasing integration of goods and services through international trade and the integration of financial markets. One of the implications of South Africa becoming an open economy is that the influence of policy-makers on their respective domestic economies could be significantly reduced. Thus, South African policymakers need to take into consideration the economic performance of South Africa's major trading partners with particular emphasis on the UK and US economies when drafting macroeconomic policy.

The unresponsiveness of the South African economy to changes in international monetary policy stance was attributed to South Africa pursuing other monetary policy goals over much of the sample period and could be an indication of the autonomy of the South African Reserve Bank. The lack of a direct impact of changes in international monetary policy stances on the South African repo rate suggests that little attention needs to given to such changes when making monetary policy decisions in South Africa. However, the study does find that changes in the industrial productions and producer prices of South Africa's major trading partners have a significant impact on South Africa's monetary policy stance. Thus, South African monetary policy is closely linked to developments in South Africa's major trading partners' economies. This finding leads to the suggestion that, in drafting and deciding on monetary policy the Reserve Bank will do well to continually monitor developments in the economies of South Africa's major trading partners. Failure to take into account these developments might affect the ability of the South African Reserve bank to meet its monetary policy goals.

Future research in this area could possibly involve the investigation of the interdependence and business transmission between South Africa, and its major trading partners using dynamic factor models. The results of the dynamic factor models could be used to check the robustness of the results obtained in this study. The current study did not employ dynamic factor models because the dynamic factor models offer a more complex means both in terms of application and data requirements relative to SVAR models of investigating international business cycle transmission and synchronisation. The use of SVAR models was particularly favoured in this study since it allowed for the examination of whether the South African economy and the economies of its major trading partners moved together and the extent of business cycle transmission. A survey of empirical literature by the author revealed that the use of SVAR models for investigating business cycle transmission in developing countries and particularly in South Africa seems almost non-existent. This study is therefore an attempt to promote the use of the SVAR technique in studies looking into the existence of business cycle co-movements focusing on African countries. Future research on South Africa's linkage with other national economies can also be extended to incorporate larger or different set of countries. The motivation being to increase the literature investigating international business cycle transmission and to provide more insights to South African policymakers.

This study found evidence of the locomotive and common shocks hypotheses at work; however the mode locking hypothesis could be another means of explaining the tendency of business cycles to co-move. That is the mode locking theory operating through trade in goods and capital flows could be responsible for providing just the sort of weak linkage that induced a synchronising relationship between South Africa and the economies of its major trading partners. However, there is no decisive statistical test to identify the mode-locking phenomenon (Selover and Jensen, 1999:596). As previously mentioned in Chapter Two the three theories are not independent, and can be argued to all play a role in explaining business cycle synchronisation between South Africa and its trading partners.

APPENDIX

Appendix A

Table A1: Unit root /stationarity test results

Country	ADF		KPSS	
Variables	Level	First diff	Level	First diff
IPUS	-2.34	-7.23 [a]	2.19 [a]	0.13
PUS	-2.57	-15.03 [a]	2.18 [a]	0.24
RUS	-3.35 [a]	4.13 [a]	0.19 [b]	0.05
IPG	1.03	-18.07 [a]	2.01 [a]	0.2
PG	0.36	-5.49 [a]	0.17 [b]	0.25
RG	-2.65	-6.11 [a]	0.81 [a]	0.07
IPUK	-1.13	-15.55 [a]	1.92 [a]	0.15
PUK	-4.37 [a]	-13.7 [a]	0.52 [a]	0.32 [a]
RUK	-2.85	-16.3 [a]	0.1 [a]	0.12
IPJ	-1.8	-6.11 [a]	1.59 [a]	0.15
PJ	-2.1	-3.84 [a]	0.53 [a]	0.12
RJ	-3.22	-4.48 [a]	0.16 [b]	0.05
IPSA	-1.29	-11.81 [a]	0.41 [a]	0.04
PSA	-1.46	-9.99 [a]	0.54 [a]	0.14
RSA	-0.43	-9.2 [a]	0.22 [a]	0.06

Note: The ADF test has a null hypothesis that the series is non-stationary (that is has a unit root), while the KPSS test has a null hypothesis that the series is stationary. Thus, while in the former case rejection of the null hypothesis would mean that the series is stationary, in the latter rejection of the null hypothesis implies that the series is not stationary. a and b denote the rejection of the null hypothesis of a unit root/ stationarity for both tests at 1% and 5% level of significance respectively. The Lag order for the series for the ADF was determined by the Schwarz information criterion and the spectral estimation method used for KPSS is Bartlett Kernel.

Table A2: Granger Causality tests: F tests

	US:SA	SA:US	UK:SA	SA:UK	Ger:SA	SA:Ger	JPN:SA	SA:JPN
Industrial production growth rates								
Prob	0.02**	0.14	0.2	0.27	0.02**	0.54	0.44	0.1
Producer price index inflation rates								
Prob	0.11	0.78	0.08	0.01**	0.4	0.22	0.1	0.33
Interest rates								
Prob	0.01*	0.07	0.01**	0.36	0.32	0.1	0.94	0.06

*Note: Sample period: 1980.02 -2008.04, Lags = 12, n= 339. The Granger causality test has a null hypothesis that a causal relationship does not exist between series or variables. * and ** represent rejection of the null hypothesis at the 1% and 5% level of significance.*

Table A3: Dummy variables created

Name	Description
D2	Iran-Iraq war (1980.09 - 1988.07)
D3	Persian Gulf war (1990.08 - 1991.02)
D4	Collapse of the Berlin wall and German reunification (1990.02 - 1999.12)
D5	Japan bubble economy (1986.03 - 1989.12)
D6	South African economic and political reform (1994.02-2008.04)
D7	Asian financial crisis (1997.12 - 1998.12)
D9	US housing market boom (2005.01 - 2006.12)
D10	Subprime mortgage crisis (2007.08 - 2008.04)
D11	Invasion and occupation of Iraq by the US and UK (2003.05 - 2004.12)
D13	Black Wednesday in the UK (1992.09 - 1993.12)
D14	Japan earthquakes, Kobe (1994.10 - 1995.10) and northern islands of Hokkaido (2003:07 - 2004.06)
D15	Japan recession (1989.12 - 2001.12)
D16*	September 11 terrorist attacks in the US (2001.08 – 2002.06)

Note: 0, 1 dummy variables were used. The dummy variables were created by setting a value of 1 for the period in which the event occurred and a value of 0 otherwise. D16 was created but was later dropped from the empirical estimations because Eviews repeatedly gave error reports each time the SVAR models were ran, with D16 included.
Source: Compiled by author.

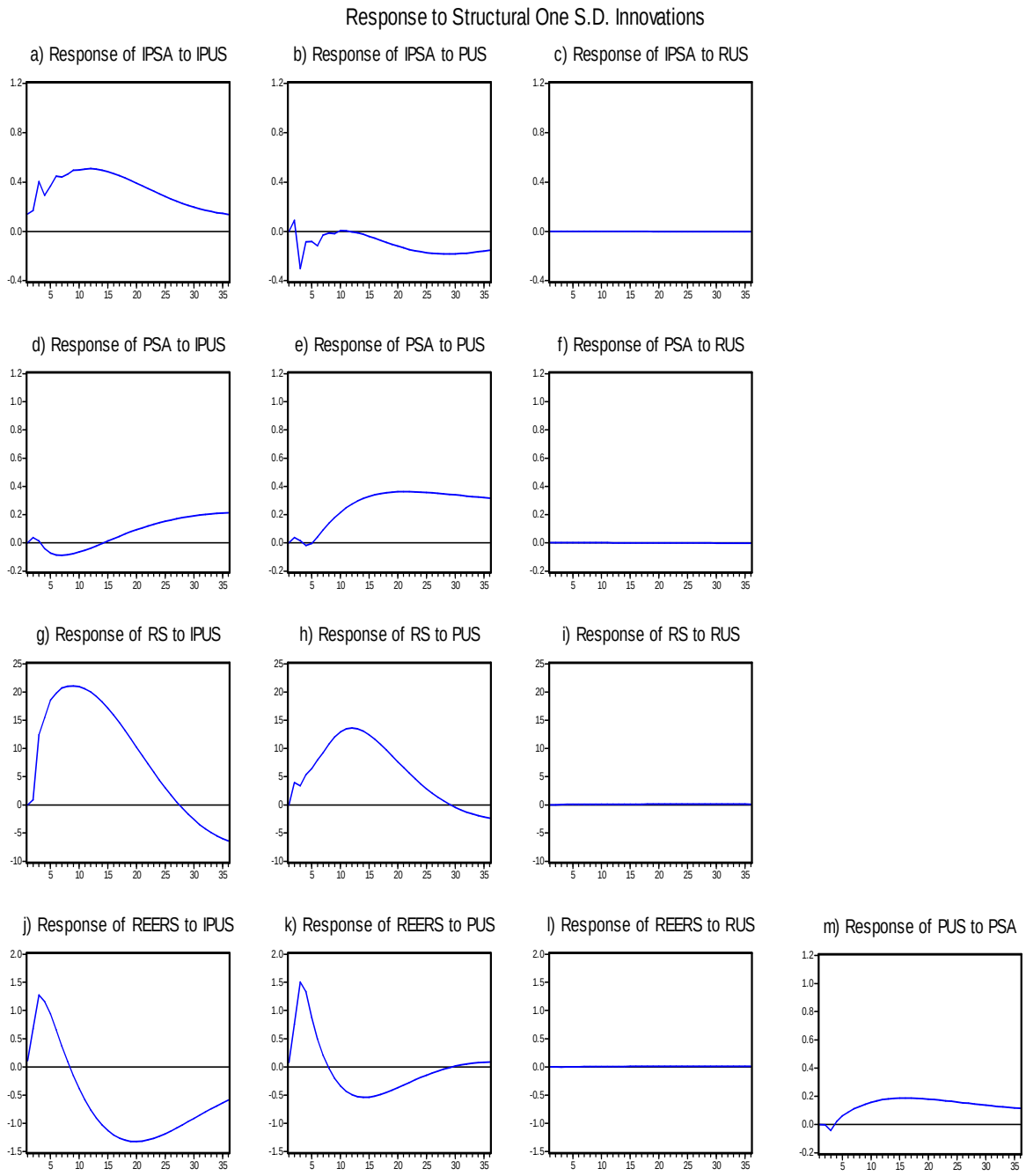
Appendix B

Table B1. Lag Length Selection for SVAR

Lag criteria	SA:US	SA:GER	SA:UK	SA:JPN	Selected lag length	
LR	9	8	9	11	SA:US	3
FPE	3	3	3	3	SA:GER	3
AIC	3	3	3	3	SA:UK	3
SIC	1	1	1	1	SA:JPN	4
HQ	1	2	2	2		

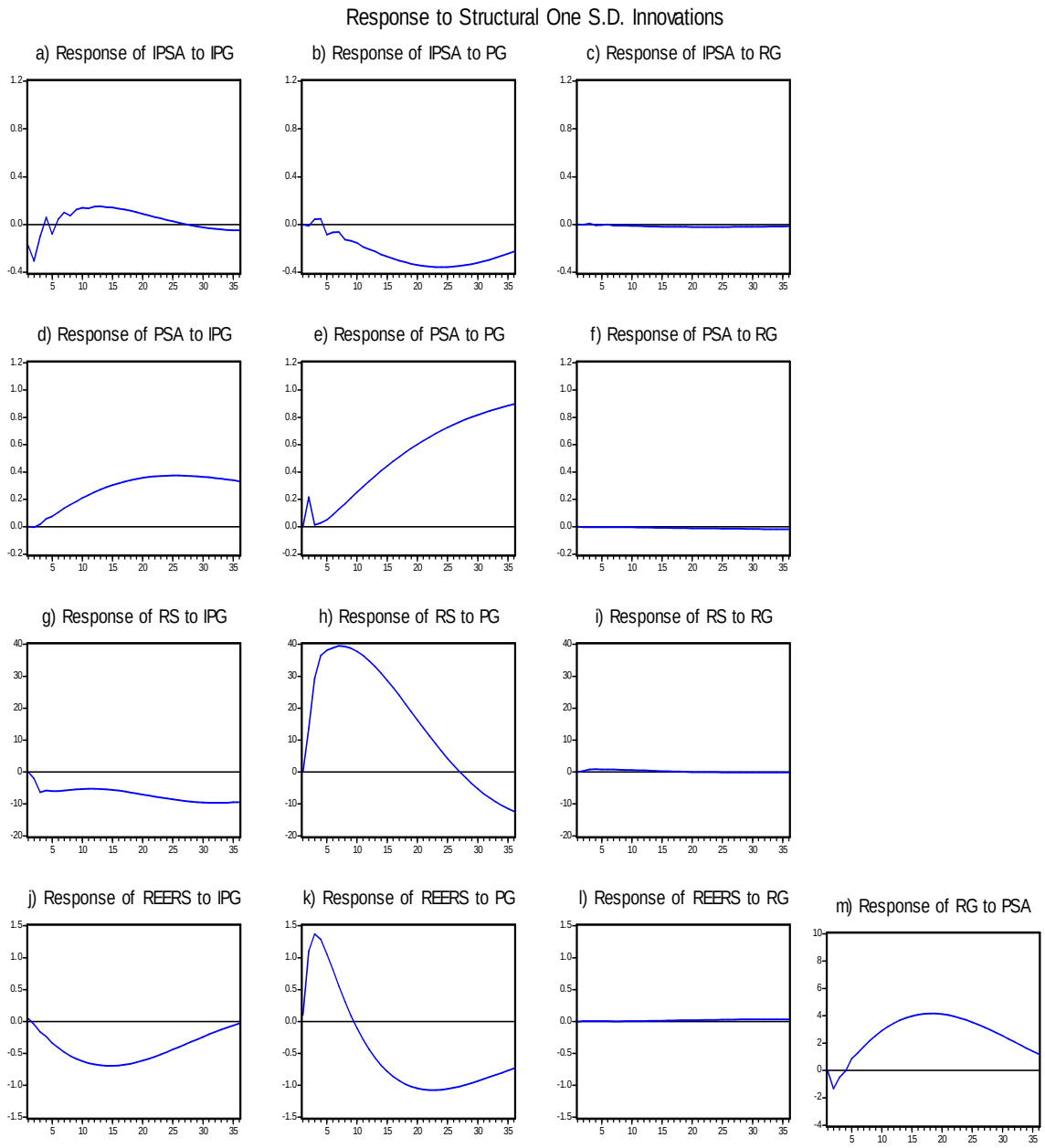
Note LR: sequential modified LR test statistic (each test at 5% level)
FPE: Final prediction error
AIC: Akaike information criterion
SC: Schwarz information criterion
HQ: Hannan-Quinn information criterion
Note: The selected lag length represents the lag length that produces white noise residuals.

Fig 2. Selected impulse response functions: US and SA



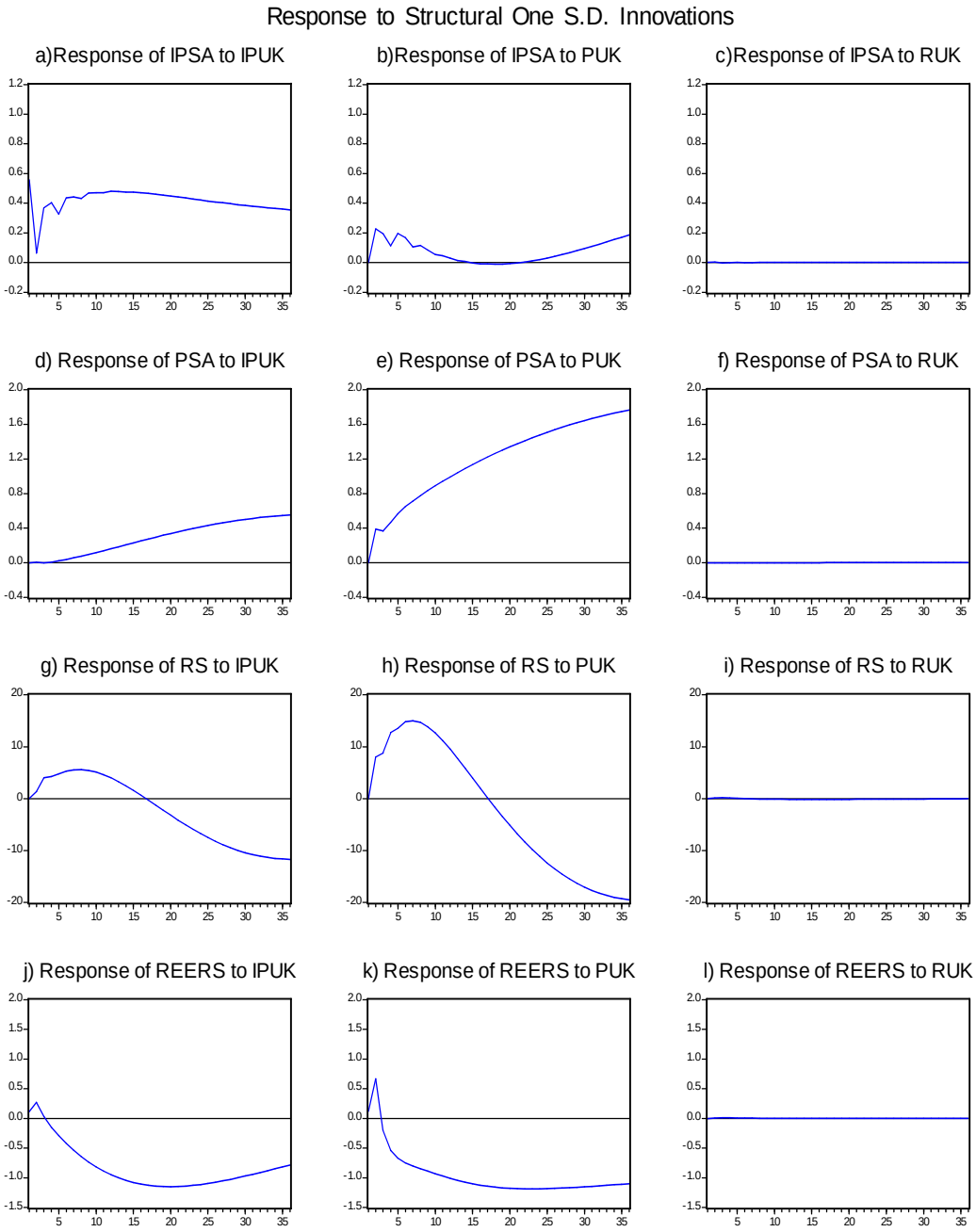
Note: the variables and abbreviations are as defined in Table 1 of Chapter Three.
Source: Estimated by author

Fig 3. Selected impulse response functions: Germany and SA



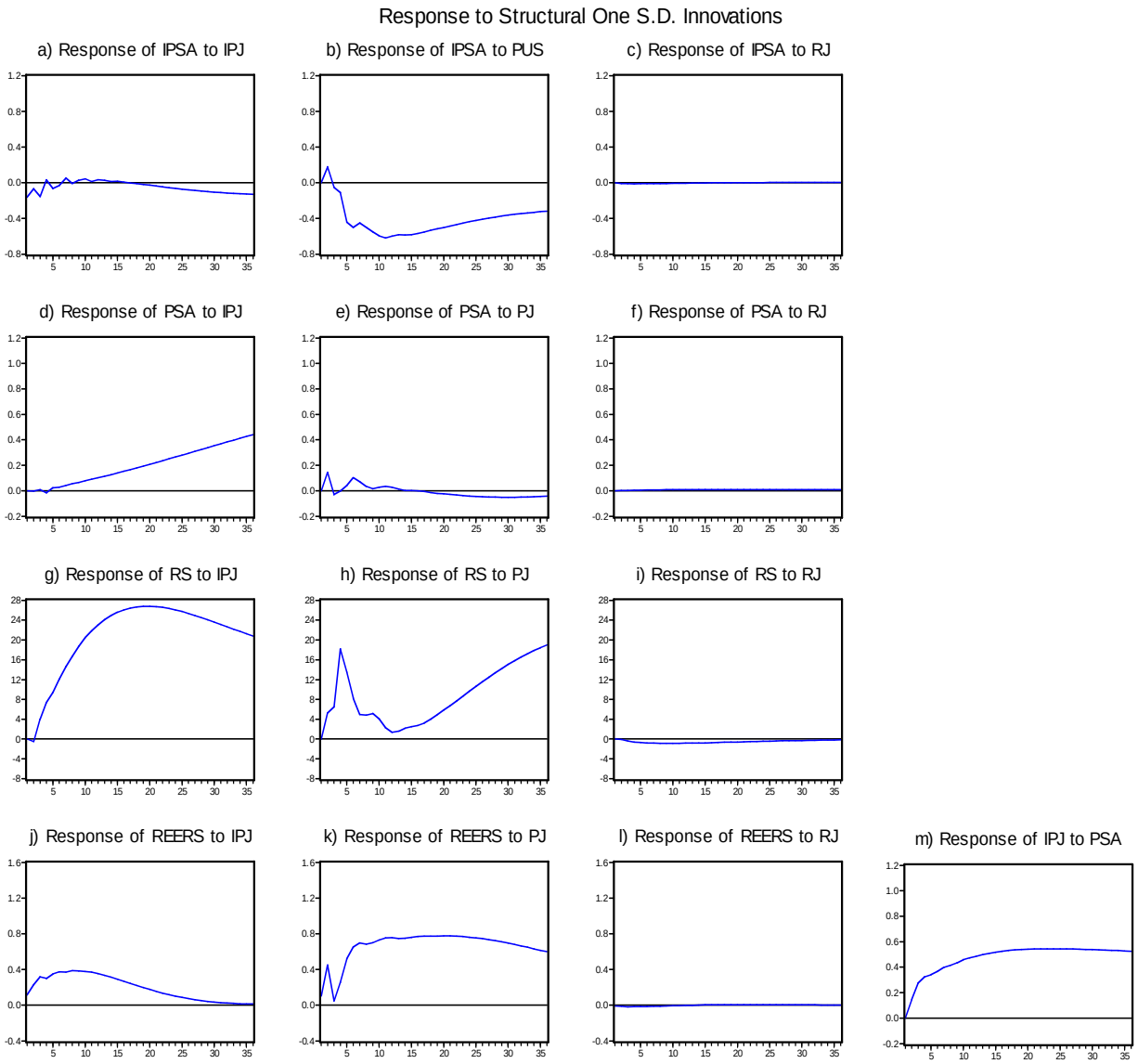
Note: the variables and abbreviations are as defined in Table 1 of Chapter Three.
Source: Estimated by author

Fig 4. Selected impulse response functions: UK and SA



Note: the variables and abbreviations are as defined in Table 1 of Chapter Three.
Source: Estimated by author

Fig 5. Selected impulse response functions: Japan and SA



Note: the variables and abbreviations are as defined in Table 1 of Chapter Three.
Source: Estimated by author

Appendix C

Table C1: Variance Decomposition analysis using growth rates data

	US				Germany				UK				Japan			
Period	**GIPUS**	**GPUS**	**GRUS**	**SUM**	**GIPG**	**GPG**	**GRG**	**SUM**	**GIPUK**	**GPUK**	**GRUK**	**SUM**	**GIPJ**	**GPJ**	**GRJ**	**SUM**
South African industrial production growth rate (GIPSA)																
1	4.30	0.00	0.00	4.30	6.53	0.00	0.00	6.53	25.41	0.00	0.00	25.41	5.50	0.00	0.00	5.50
12	4.28	22.22	0.00	26.49	11.26	10.05	0.01	21.33	30.78	2.67	0.00	33.45	8.72	16.16	0.01	24.88
24	4.28	22.25	0.00	26.53	11.27	10.20	0.01	21.49	30.78	2.67	0.00	33.45	8.78	16.16	0.01	24.95
36	4.28	22.25	0.00	26.53	11.27	10.20	0.01	21.49	30.78	2.67	0.00	33.45	8.78	16.16	0.01	24.95
South African producer prices growth rate (GPSA)																
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	1.39	0.13	0.00	1.52	0.04	5.31	0.00	5.34	0.06	5.31	0.00	5.37	0.35	4.11	0.00	4.46
24	1.39	0.13	0.00	1.53	0.04	5.31	0.00	5.35	0.06	5.31	0.00	5.37	0.35	4.12	0.00	4.47
36	1.39	0.13	0.00	1.53	0.04	5.31	0.00	5.35	0.06	5.31	0.00	5.37	0.35	4.12	0.00	4.47
South African interest rates growth rate (GRSA)																
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	29.92	43.20	0.00	73.12	2.70	81.37	0.01	84.09	0.76	78.14	0.01	78.90	12.10	56.60	0.03	68.72
24	29.99	43.16	0.00	73.15	2.67	81.59	0.01	84.28	0.76	78.14	0.01	78.90	12.10	56.61	0.03	68.75
36	29.99	43.16	0.00	73.15	2.67	81.60	0.01	84.28	0.76	78.14	0.01	78.90	12.10	56.61	0.03	68.75
South Africa's real effective exchange rate growth rate (GREERS)																
1	0.51	0.32	0.00	0.83	0.12	0.44	0.01	0.56	0.37	0.50	0.00	0.87	0.18	0.21	0.01	0.40
12	11.38	17.11	0.00	28.49	0.26	38.80	0.01	39.06	1.56	22.71	0.00	24.28	0.80	13.04	0.01	13.85
24	11.38	17.11	0.00	28.49	0.26	38.81	0.01	39.07	1.56	22.71	0.00	24.28	0.80	13.05	0.01	13.86
36	11.38	17.11	0.00	28.49	0.26	38.81	0.01	39.07	1.56	22.71	0.00	24.28	0.80	13.05	0.01	13.86

Note: SUM is the summation of the growth rates of industrial production, producer prices and interest rates for each of the trading partners. GIPUS, GPUS and GRUS are the growth rate of US industrial production, producer prices and the federal funds rate respectively. GIPG, GPG and GRG are the growth rates of German industrial production, producer prices and the discount rate respectively. GIPUK, GPUK and GRUK are the growth rates of UK industrial production, producer prices and the bank rate respectively. GIPJ, GPJ and GRJ are the growth rates of Japanese industrial production, producer prices and the discount rate respectively.
Source: Estimated by author.

Table C2: Variance Decomposition analysis using detrended data

	US				Germany				UK				Japan			
Period	**GIPUS**	**GPUS**	**GRUS**	**SUM**	**GIPG**	**GPG**	**GRG**	**SUM**	**GIPUK**	**GPUK**	**GRUK**	**SUM**	**GIPJ**	**GPJ**	**GRJ**	**SUM**
South African industrial production growth cycle (GIPSA)																
1	2.49	0.00	0.00	2.49	1.77	0.00	0.00	1.77	46.76	0.00	0.00	46.76	2.53	0.00	0.00	2.53
12	43.62	4.33	0.00	47.95	8.00	6.57	0.02	14.59	56.68	2.13	0.00	58.82	2.50	45.61	0.03	48.13
24	49.63	10.75	0.00	60.39	5.83	38.71	0.06	44.60	56.30	7.11	0.00	63.41	1.92	57.37	0.02	59.30
36	40.02	21.89	0.00	61.91	6.29	51.02	0.04	57.35	47.24	16.22	0.00	63.45	1.72	50.76	0.01	52.49
South African producer prices growth cycle (GPSA)																
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.25	2.28	0.00	2.54	2.68	10.88	0.01	13.56	2.18	58.20	0.00	60.38	1.07	3.05	0.00	4.12
24	0.46	6.89	0.00	7.35	7.01	28.80	0.01	35.82	7.02	77.86	0.00	84.89	5.53	3.08	0.00	8.62
36	1.03	8.31	0.00	9.34	7.82	40.18	0.01	48.01	9.06	82.31	0.00	91.37	10.38	2.73	0.00	13.11
South African interest rates growth cycle (GRSA)																
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	40.11	27.96	0.00	68.07	0.25	72.80	0.02	73.07	8.54	14.01	0.00	22.55	9.78	8.38	0.03	18.19
24	34.47	23.82	0.00	58.29	0.09	45.53	0.01	45.64	7.90	9.38	0.00	17.28	13.46	2.75	0.02	16.23
36	29.74	19.81	0.00	49.54	0.12	32.89	0.02	33.03	7.25	9.00	0.00	16.25	15.41	2.74	0.01	18.16
South Africa's real effective exchange rate growth cycle (GREERS)																
1	0.43	0.19	0.00	0.62	0.08	0.38	0.00	0.46	0.43	0.44	0.00	0.87	0.35	0.31	0.00	0.66
12	12.25	15.56	0.00	27.81	6.48	14.37	0.00	20.85	2.51	3.60	0.00	6.11	0.23	4.92	0.00	5.15
24	25.67	12.43	0.00	38.09	7.77	27.37	0.00	35.14	6.51	3.83	0.00	10.35	0.29	7.97	0.01	8.27
36	32.47	11.29	0.00	43.76	7.56	28.60	0.00	36.16	6.87	6.06	0.00	12.93	0.32	9.35	0.01	9.67

Note: SUM is the summation of the growth cycles of industrial production, producer prices and interest rates for each of the trading partners. GIPUS, GPUS and GRUS are the growth cycles of US industrial production, producer prices and the federal funds rate respectively. GIPG, GPG and GRG are the growth cycles of German industrial production, producer prices and the discount rate respectively. GIPUK, GPUK and GRUK are the growth cycles of UK industrial production, producer prices and the bank rate respectively. GIPJ, GPJ and GRJ are the growth cycles of Japanese industrial production, producer prices and the discount rate respectively.
Source: Estimated by author.

Table C3: Variance Decomposition analysis using reference cycles

	US			Germany			UK			Japan		
Period	**RCU1**	**RCU2**	**SUM**	**RCG1**	**RCG2**	**SUM**	**RCK1**	**RCK2**	**SUM**	**RCJ1**	**RCJ2**	**SUM**
South African industrial production (GIPSA)												
1	0.13	0.05	0.18	0.08	0.02	0.10	0.29	0.00	0.29	0.01	0.00	0.01
12	0.09	0.04	0.13	0.09	0.02	0.11	0.20	0.01	0.21	0.01	0.01	0.02
24	0.09	0.04	0.13	0.07	0.02	0.09	0.14	0.01	0.15	0.01	0.01	0.02
36	0.08	0.04	0.12	0.05	0.02	0.07	0.11	0.01	0.11	0.03	0.01	0.04
South African producer prices (GPSA)												
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
24	0.00	0.00	0.00	0.00	0.01	0.02	0.00	0.00	0.01	0.01	0.00	0.01
36	0.00	0.00	0.00	0.01	0.02	0.02	0.00	0.01	0.01	0.02	0.00	0.02
South African interest rate (GRSA)												
1	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00	0.00
12	0.00	0.02	0.02	0.00	0.00	0.00	0.00	0.05	0.05	0.01	0.01	0.02
24	0.00	0.04	0.04	0.00	0.01	0.01	0.00	0.05	0.05	0.01	0.02	0.03
36	0.01	0.03	0.04	0.00	0.00	0.01	0.00	0.04	0.04	0.02	0.02	0.04
South Africa's real effective exchange rate (GREERS)												
1	0.00	0.00	0.00	0.00	0.01	0.01	0.00	0.00	0.00	0.00	0.00	0.00
12	0.02	0.02	0.04	0.01	0.19	0.20	0.05	0.01	0.06	0.05	0.02	0.08
24	0.03	0.02	0.05	0.01	0.18	0.19	0.06	0.01	0.07	0.12	0.04	0.16
36	0.02	0.02	0.04	0.01	0.14	0.14	0.05	0.01	0.06	0.09	0.03	0.12

Note: SUM is the summation of the reference cycles for each of the trading partners. RCU1 and RCU2 are the US reference cycles. RCG1 and RCG2 are the German reference cycles. RCK1 and RCH2 are the UK reference cycles. Lastly, RCJ1 and RCJ2 are the Japanese reference cycles. The reference cycles were computed using principal components analysis. RCI and RC2 are the factors having Eigen values greater than 1 and thus according to the Kaiser rule describe more of the data than any single variable and should be examined most closely.
Source: Estimated by author.

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