

A COMPARATIVE ANALYSIS OF THE SYNCHRONISATION  
OF BUSINESS CYCLES FOR DEVELOPED AND DEVELOPING  
ECONOMIES WITH THE WORLD BUSINESS CYCLE

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*Abstract*

Globalisation brought about worldwide changes, including economic and financial integration between countries. The objective of this paper is to establish if there is synchronisation between developed and developing countries with the world cycle. Research results show that business cycles have become less volatile after globalisation, but there is not much consensus on whether business cycles have become less or more synchronised since globalisation. Little research has been done on co-movement between emerging markets, such as South Africa, and the world business cycle. This paper derives common factors for developed and developing countries by applying principal component analysis (PCA) to output, consumption and investment data, which represents the countries' business cycles. The empirical analysis shows co-movement between some countries and the world business cycle (G7 countries as proxy). The results suggest that there are idiosyncratic and globally common shocks, which play different roles over time in different countries. The paper goes on to suggest that there are clear differences in how developed and emerging markets co-move with the world business cycle. A key finding is that the co-movement between developing economies and the world business cycle has increased since globalisation. This research also confirms previous research that most economies follow the world business cycle when large shocks – such as the recent economic downturn – occur. This has implications for forecasting the business cycle, especially in times of economic turmoil.

*JEL Classification: E32, C32*

*Keywords: Business cycle, synchronisation, co-movement, principle component analysis, developed market, emerging market*

## 1. INTRODUCTION

Business cycles have become less volatile, a phenomenon known as business cycle moderation, while trade and financial liberalisation have increased (Kose *et al.*, 2003; Stock and Watson, 2003). The latter, which has been brought about by globalisation, has led to an interdependent worldwide economy. According to Stiglitz (2003), cycles have become less volatile and more similar and can be characterised by the emergence of a common cycle. A lot of debate has taken place around the existence of a common cycle and the question of synchronisation between countries' business cycles has yet to receive a definitive answer because of the conflicting results reported in the literature.

This paper will investigate the synchronisation or co-movement of developed and developing countries with the world cycle. Correlation analysis and PCA will be

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employed. The paper is structured as follows: section 2 is the literature review, section 3 describes the method of research and sections 4, 5 and 6 are the results of the correlation analysis – full sample, sub-periods and principal component analysis, respectively. Section 7 concludes with a presentation of the findings.

## 2. LITERATURE REVIEW

Synchronisation as a recognised notion has only recently been formally introduced into the business cycle literature, where co-movements among cyclical time series have been the dominant objective of analysis for many years (Bordo and Helbling, 2003). In the literature, the overall impression is that business cycles have become less volatile since globalisation. However, conflicting results exist on whether or not business cycles have become more synchronised after globalisation.

Romer (1999) found that volatility in real macroeconomic indicators decreased and the severity of recessions declined pre-World War I and post-World War II. Recessions have become less frequent and more uniform. She argues that the new economy is not necessarily the foreseeable result of structural changes, globalisation or the information revolution, but that it has emerged as a consequence of sound macroeconomic policy, and if it is not maintained, the old economy will re-emerge. Chakraborty (2001) also argued that as economic policy reform becomes established around the globe, economies are becoming more efficient and competitive. Globalisation coupled with liberalisation is expected to reduce cyclical instability. Reduced trade distortions, globalisation and international trade liberalisation lessen the sensitivity of economic activity to conditions in any single country. The global integration of capital markets is expected to reduce uncertainties in investment decisions and therefore result in a less volatile business cycle. Adding to these findings, Bordo and Helbling (2003) provided evidence of business cycle synchronisation among 16 countries. The main reason for this increased synchronisation is the dominant influence of global common shocks. They found that, in the twentieth century, a trend towards stronger synchronisation over different exchange rate regimes emerged. This, they found, occurred alongside a less volatile, less frequent business cycle due to a change in the composition of output, automatic stabilisers and improvements in fiscal and monetary policy. This is similar to the views of Romer (1999) and Chakraborty (2001). However, Stock and Watson (2003) found that because of the lower volatility in international shocks there is less synchronisation. They argue that business cycles in the G7 would have been more volatile and more synchronised if the common international shocks of the 1980s and 1990s were as large as those of the 1960s and 1970s. All these authors agree that the business cycle is less volatile, but whether or not greater synchronisation exists is debatable.

The factors that cause stronger linkages between economies are financial market and trade integration. Economic theory is not clear on the impact of globalisation on the degree of business cycle synchronisation (Kose *et al.*, 2003). Kose *et al.* (2003) found that financial linkages can generate large-demand side effects, causing increased business cycle synchronisation. Global financial linkages could cause specialisation of production through the reallocation of capital and therefore expose a country to industry- or country-specific shocks. Global financial markets are then used to diversify consumption risk, causing stronger co-movement of consumption across countries. This should be stronger for developing countries, because of less diversification, with more volatile output,

implying greater gains from international risk-sharing. They also found that stronger trade linkages cause demand and supply spill-overs, resulting in stronger international trade relations with more correlated business cycles. If these stronger trade relations increase inter-industry specialisation across countries, co-movement between countries might decrease since industry-specific shocks are important in driving business cycles. Kose *et al.* (2003) also found that globalisation leads to stronger business cycle synchronisation. They found that trade and financial market integration enhance global spill-overs of macroeconomic fluctuations. Phylaktis and Ravazzolo (2002) also found a relationship between economic and financial integration. They argue that if economic integration transmits to countries' co-movement of output growth and economic activity is positively related to stock prices, stock prices also move together. Therefore, economic integration provides a channel for financial integration. Similarly, Kalemlı-Ozcan *et al.*, (2009) found a positive association between integration and output co-movement in a cross-section of developed markets, but when country pair-fixed effects and time-fixed effects are controlled for, a negative association emerges. A higher degree of cross-border financial integration leads to less synchronised, more divergent output cycles, which were evident in the within specifications. Heathcote and Perri (2002) found that financial globalisation is coupled with real regionalisation. They also found that correlations between the USA and its foreign counterparts dropped and country-specific risk increased. International financial integration increases endogenously in response to increased country-specific risk. Therefore, less correlated shocks and endogenous financial development account for the changes in the international business cycle, showing less international co-movement.

Kose *et al.* (2005) studied the changes in the nature of G7 business cycles in main macroeconomic aggregates (output, consumption and investment). They found that the degree of co-movement between the G7 countries has increased during the globalisation period. By contrast, however, Doyle and Faust (2002) report that there is no consensus on how large the effect of these factors is on the co-movement between the USA and the other G7 countries. They could not find a marked change in correlations between the USA and G7 countries. They argue that any effect of these factors on the correlation between countries would be gradual and if it is combined with increased economic integration, it remains to be seen how it will affect co-movement between business cycles.

It is evident from the literature that business cycles have become less volatile since globalisation and that a link between economic and financial integration exists. There are, however, conflicting results on whether these developments cause more synchronised cycles.

### 3. METHOD OF RESEARCH

The notion of business cycles becoming more synchronised across countries is in accordance with the view that the timing and magnitude of major changes in economic activity appear increasingly similar (Bordo and Helbling, 2003). Harding and Pagan (2002) proposed a definition of cross-country synchronisation that is a derivative of the concept developed by the National Bureau of Economic Research (NBER) since researchers believe the NBER approach is too atheoretical. They argue that if cycles are synchronised, their turning points will occur more or less at the same time. They derived the statistical measure-concordance correlation, which determines whether national

cycles are significantly synchronised. This means that business cycles are in the same phase at about the same time. Standard correlations and factor-based measures are used to test synchronisation. Factor models are widely used to date business cycles or extract a common business cycle (factor) (Diebold and Rudebusch, 1996; Chauvet, 1998; Kim and Nelson, 1998; Forni and Reichlin, 1998; Stock and Watson, 2002, 2003; Favero *et al.*, 2004; Kose *et al.*, 2005). Simple correlation analysis and PCA are used in this paper to determine whether or not synchronisation with the world business cycle occurs.

In this research, real output, consumption and investment data are used to extract a common factor for each country (representing the business cycle). The behaviour of developed economies is compared with that of developing economies in this regard since little research have been done on the synchronisation of developing economies with the world cycle. According to Stock and Watson (2003), real GDP as a measure of the business cycle is used rather than the reference cycle series used by the NBER. This is the reason for using the G7 countries' GDP growth as a proxy for the world business cycle. The G7 countries are the USA, the UK, Japan, Canada, France, Germany and Italy. The phrases G7 factor, G7 cycle and the world cycle will be used interchangeably here, as will the country factor and the idiosyncratic component.

#### (a) PCA

Factor models identify patterns in data and highlight similarities and differences (Smith, 2002). They are used primarily as dimensionality reduction techniques in situations where a large number of closely related variables are used and where the purpose is to allow for the most important influences from all these variables at the same time (Brooks, 2008).

Factor models decompose the structure of a set of series into factors that are common to all series and a proportion that are specific to each series (idiosyncratic variable). These models fall into two broad types: macroeconomic and mathematical factor models. The factors are observable for the former but unobservable for the latter (Brooks, 2008).

The most ordinary mathematical factor model is principal components analysis (PCA). This is a useful technique where explanatory variables are closely related, such as when multicollinearity is present. If there are  $k$  explanatory variables in the regression model, PCA will transform them into  $k$  uncorrelated new variables.

The original explanatory variables can be denoted as  $x_1, x_2, \dots, x_k$  and the principal components as  $p_1, p_2, \dots, p_k$ . These principal components are independent linear combinations of the original data:

$$p_1 = \alpha_{11}x_1 + \alpha_{12}x_2 + \dots + \alpha_{1k}x_k$$

$$p_2 = \alpha_{21}x_1 + \alpha_{22}x_2 + \dots + \alpha_{2k}x_k$$

$$p_k = \alpha_{k1}x_1 + \alpha_{k2}x_2 + \dots + \alpha_{kk}x_k$$

where  $\alpha_{ij}$  are the coefficients to be calculated, representing the coefficient of the  $j^{\text{th}}$  explanatory variable in the  $i^{\text{th}}$  principal component. These coefficients are known as factor loadings. The sum of the squares of the coefficients for each component is required to be one (Brooks, 2008). No assumption is made about the structure, distribution or other properties of the variable since the components are constructed by

a mathematical process of constrained optimisations. The principal components are derived in descending order of importance. If there is multicollinearity between the original explanatory variables, it is likely that the last few principal components will account for little of the variation and can therefore be discarded. However, if the explanatory variables are uncorrelated, all the components will be required, and then using PCA will not be useful.

The principal components can also be understood as the eigenvalues of  $(X'X)$ , where  $X$  is the matrix of observations on the original variables. If the ordered eigenvalues are denoted  $\lambda_i$  ( $i = 1, \dots, k$ ), the ratio:

$$\phi_i = \lambda_i / \sum \lambda_i$$

gives the proportion of the total variation in the original data explained by the principal component  $i$ . If only the first  $r$  ( $0 < r < k$ ) principal component is sufficient to explain the variation, then  $k-r$  components are discarded (Brooks, 2008). Factors with eigenvalues greater than one are retained; therefore if a factor does not extract at least as much as the equivalent of one variable, it is dropped (Statsoft, 2008). This criterion was proposed by Kaiser in 1960 (Armstrong, 1968).

The final regression after the principal components have been formed would be  $y$  on the  $r$  principal components:

$$y_t = \gamma_0 + \gamma_1 p_1 + \dots + \gamma_r p_r + u_t$$

In this way, the principal components keep most of the important variation in the original explanatory variable, but are orthogonal. This is useful for independent variables that are very closely related. The principal component estimates will be biased estimates, but will simultaneously reduce large variances of regression estimates caused by multicollinearity. This method estimates are therefore more efficient than OLS estimators since redundant information has been removed (Brooks, 2008).

If, depending on the explanatory variables ( $x$ ), the original regression of  $y$  is denoted as the estimated  $\beta$  and it can be shown that:

$$\gamma_r = P_r' \beta$$

where  $\gamma_r$  are the coefficient estimates for the principal components, and  $P_r$  is a matrix of the first  $r$  principal components (significant principal component), the principal component coefficients are simply linear combinations of the original OLS estimates (Brooks, 2008).

#### *(b) The Data*

The objective of this paper is to establish if there is synchronisation between developed and emerging markets with the world cycle. The following countries were chosen: the G7 (as a benchmark for the world cycle), the USA, the UK, Japan, the EU, Australia, Mexico, Turkey and South Africa (SA). The developed countries are the USA, the UK, Japan, the EU and Australia. Australia was chosen since it is a developed market which is not part of the G7 and is a small open, commodity-based economy, similar to SA. The EU consists of a few emerging markets, but overall it would be considered a

developed market. The UK also forms part of the EU. The choice of emerging markets was limited to the availability of data. Mexico and SA form part of the more advanced emerging markets.

The macro time series data is from the I-net Bridge database. Quarterly output, consumption and investment data of the countries for the period 1961 (quarter 1) to 2008 (quarter 3) was used (except for EU data, which was available only from first quarter of 1995, and data for Turkey and Mexico, which was available only from fourth quarter of 1991). The specification of the model was as follows:  $k = 3$  per country for nine countries, with  $T = 191$  time series observations for each being used, with the exception of the countries mentioned above.

A limitation of this technique is that a change in the units of measurement of a variable will change the principal components (Brooks, 2008). Data used in PCA must be stationary (Alexander, 2001). Data should be transformed to have a zero mean and unit variance before PCA is applied (Smith, 2002). The sizes of the economies in this analysis differ and therefore growth rates were used in order to enable a comparison between developed and developing economies. All the data sets were stationary at least on a 90% level except for EU investment and consumption data which were stationary on an 85% level.

In the research reported by this paper, the changes in the business cycle during the period 1961-2008 were studied. The principal component method was employed to estimate common components in main macroeconomic variables (output, consumption and investment), to form a common component for each country representing the countries' business cycle. These factors were used to quantify the relative importance of the common and country (idiosyncratic) components in explaining co-movement with the world cycle in each observable aggregate over three distinct periods: the Bretton Woods period (1960 to 1972 quarter 2); the period of common shocks (1972 quarter 3 to 1986 quarter 2); and the globalisation period (1986 quarter 3 to 2008 quarter 3) (Kose *et al.*, 2005). This demarcation is important to set common shocks apart from globalisation on the extent of co-movement of business cycles. Firstly simple correlation analysis will be employed to see how the correlations of the country common components compared to the world factor change over the three periods; thereafter PCA will be applied to the common components to establish how synchronisation changed over the three periods. Throughout, a distinction will be made between developed and emerging markets to establish if there is a difference in co-movement with the world cycle.

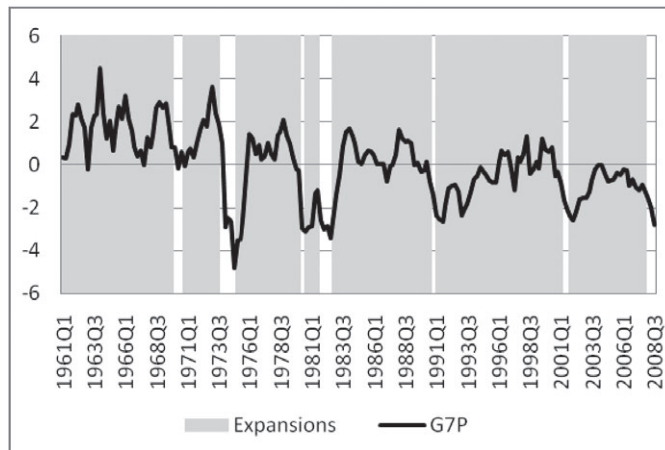
#### 4. RESULTS OF THE CORRELATION ANALYSIS FOR THE FULL SAMPLE

The common G7 factor from the PCA on the output, consumption and investment data of the G7 countries is used as the proxy for the world cycle; this factor captures most of the major economic events. It is consistent with the expansionary phase of the 1960s, the boom in the early 1970s, the recession in the mid-1970s (first oil price shock), the recession in the early 1980s (tight monetary policies of industrialised nations), the expansionary phase of the late 1980s, the recession of the early 1990s and the highly synchronised downturn of the early 2000s. The recovery in 2003 and the latest downturn in 2007 are also evident. This factor coincides with the NBER reference cycle (indicated by the squares in Fig. 1).



*Table 1. Correlations of the developed markets with the world cycle*

	G7P	AUSP	EURP	JAPP	UKP	USP
G7P	1.00					
AUSP	0.33	1.00				
EURP	0.60	0.21	1.00			
JAPP	0.68	0.13	-0.08	1.00		
UKP	0.54	0.28	0.52	0.26	1.00	
USP	0.82	0.31	0.53	0.26	0.48	1.00



*Figure 1. G7 factor and the National Bureau of Economic Research (NBER) reference dates*  
 Source: NBER (2009).

#### *(a) The Developed Markets*

The correlations for the developed markets over the whole sample period are shown in Table 1.

The G7 factor and the US country factor exhibit some common movements. Even though the USA is part of the G7 and has the largest economy, and therefore has a larger weight, there are some differences between the two factors. In the early 1970s, the G7 was expansionary and the US factor was contracting. In the mid-1990s, the USA experienced an expansionary phase, while the G7 factor was contracting. Towards the end of the 1990s, the G7 factor was in a downturn, while the US factor was booming. The correlation between these factors is 82%, suggesting strong co-movement with the world cycle.

There are some periods of co-movement between the rest of the world and Japan. The major difference between Japan and the world factor is the boom in the late 1960s in Japan, when the G7 factor was contracting. In the early 1980s, the situation was similar. The correlation between the Japan factor and the G7 factor is 68%, suggesting that there is some co-movement with the world cycle, although fluctuations in Japan have an important component not related to the world cycle.

There is some co-movement between the UK and the world cycle. However, there are periods when changes are country-specific, such as during the late 1960s, 1980s, 1990s and towards the end of the sample. The correlation between the UK and the world cycle is 54%, implying that fluctuations in the UK business cycle could follow those in the rest of the world, but that there are idiosyncratic factors influencing the cycle.

There is some co-movement between the EU and the world cycle. However, there are periods when changes are country-specific, such as during the late 1990s and towards the end of the sample period where the EU cycle moves counter-cyclically compared with the G7 factor. The correlation between the EU and the world cycle is 60%, implying that fluctuations in the EU business cycle could follow those in the rest of the world, but also suggesting that there are idiosyncratic factors influencing the cycle.

There is little co-movement between Australia and the world cycle. Country-specific changes play a role. This occurred during the 1960s, early 1970s, 1980s and 1990s and towards the end of the sample period where the Australian cycle moved counter-cyclically in relation to the G7 factor. The correlation between the Australian and the world cycle is 33%, implying that there are idiosyncratic factors influencing the cycle.

### *(b) Emerging Markets*

Table 2 shows the correlations of the emerging markets with the world cycle.

The South African factor coincides with some of the downward phases of the G7 factor (Fig. 2). There was a downward phase in 1982 and 1985 in SA, but an expansion in the world cycle. This indicates that the downturn in the South African business cycle was country-specific. During the downward phase in 1991, the G7 factor and the South African factor coincided, but the G7 factor expanded towards the end of the phase. The same goes for the downward phase in 1997, where the G7 countries recovered more quickly than SA. The correlation between the world factor and SA is 14% for the full sample, signifying that most of the changes in the business cycle in SA are idiosyncratic.

The Mexican cycle has shown co-movement with the world cycle since 1997. During the downturn of the world cycle in 1995, the Mexican cycle also contracted, but much more deeply. The Mexican cycle boomed during the world downturn in 1996. The correlation with the world cycle is 43%, indicating some co-movement with the world cycle, but suggesting that changes are also due to country-specific factors.

Turkey, which is also an emerging market, has a correlation of 13% with the world factor over the whole sample period. Troughs and peaks are deeper and higher, such as during the Asian crisis in 1997 and the crisis in 2001. This suggests, as in the case of SA, that fluctuations are more country-specific.

The results from the correlation analysis suggest that there are country-specific or idiosyncratic and global sources of economic shocks. These shocks play different roles in different countries. During certain periods, the country factor is more strongly reflective of domestic economic activity, while in others it is reflected by the G7 factor. It is important, however, to divide the full sample into sub-samples to take all the different financial systems, exchange rate regimes and globalisation into account in order to establish how business cycles changed over time.

*Table 2. Correlations between the emerging markets and the world cycle*

	G7P	MEXP	SAP	TURP
G7P	1.00			
MEXP	0.43	1.00		
SAP	0.14	0.03	1.00	
TURP	0.13	0.06	0.33	1.00



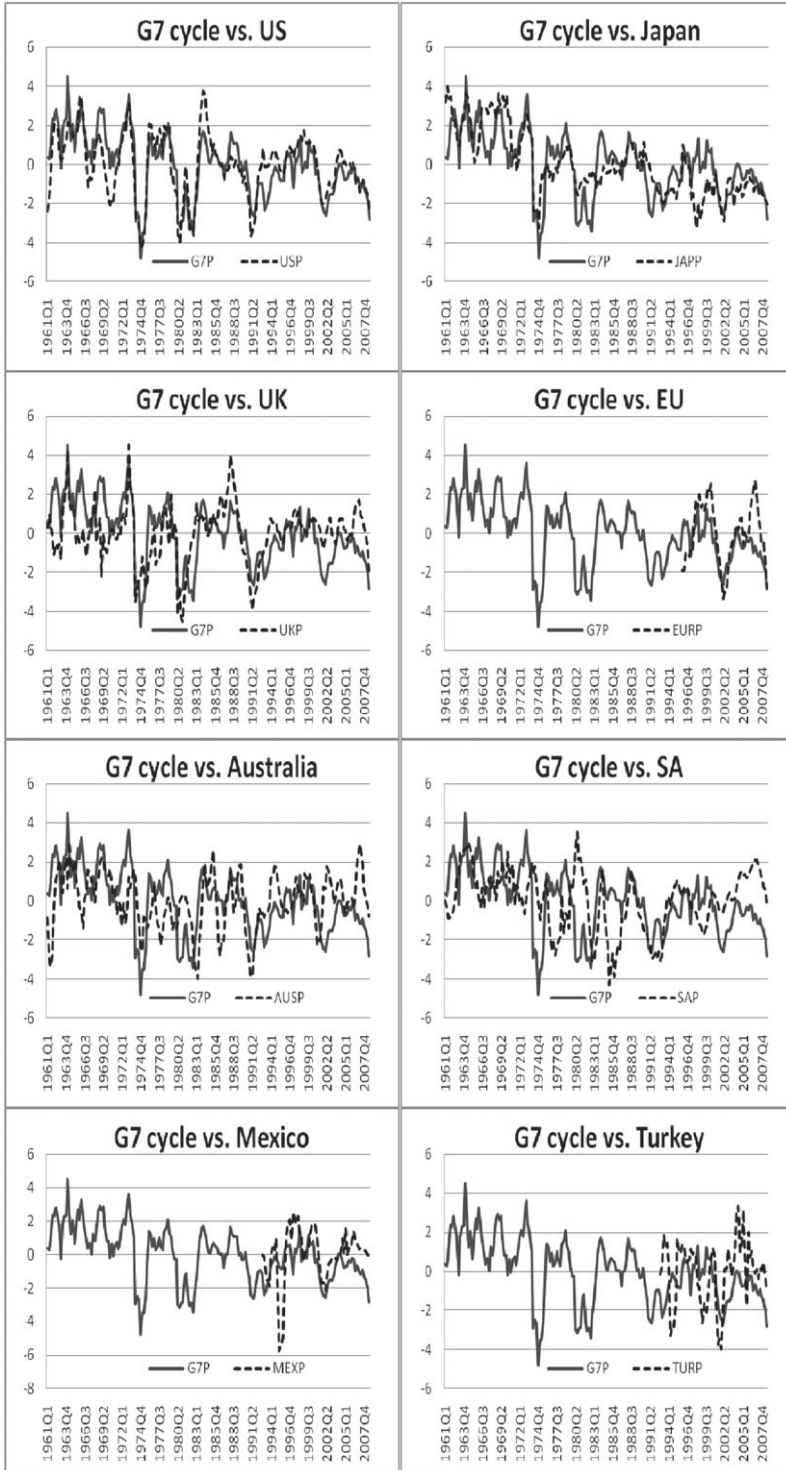


Figure 2. Co-movement between the G7 factor and the country factors

## 5. CORRELATION ANALYSIS FOR THE SUB-PERIODS

This part of the analysis uses the sub-periods mentioned earlier. These sub-periods are the Bretton Woods period, the common shock period and the globalisation period as proposed by Kose *et al.* (2005).

### (a) *Bretton Woods Period (First Quarter of 1961–Fourth Quarter of 1972)*

The correlation between the world factor and the US factor (74%) is high for this period. However, all the other correlations in this period are rather weak. Therefore it can be said that fluctuations during this period are the result of country-specific shocks.

### (b) *Common Shock Period (First Quarter of 1973–Second Quarter of 1986)*

The correlation between the world factor and the US factor is 94%. The USA follows the world cycle closely during this period. The correlation between the SA factor and the world factor is negative at 24%, implying that when the world is in recession SA is in a boom. The negative correlation is a result of the closed economy during this period in SA, specifically the political sanctions during the 1980s.

In this period, the relationship between the world factor and the Japan factor was higher than in the previous period (76%), implying that the world factor played a role during this period. The change in the correlation could be the result of the OPEC recession hitting harder and faster in Japan than in the rest of the world, reflecting Japan's heavy dependence on imported oil.

During this period, the correlation of the UK factor with the world cycle rose to 72%, indicating more dependence on the world cycle.

The correlation of the Australian cycle increased to 34%, which shows that country-specific factors were still playing a role in the changes in the business cycle.

### (c) *Globalisation Period (Third Quarter of 1986–Third Quarter of 2008)*

In this period, the correlation is 74% between the world factor and the US factor. This is lower than in the common shock period, implying that during this globalisation period some of the fluctuations in the US business cycle were country-specific. These country-specific fluctuations can be seen in the third quarter of 1993 and between the third quarter 1998 and the third quarter of 1999.

The correlation between Japan and the world factor dropped to 42% in this period and most of the variations in the Japanese factor were country-specific. This is in accordance with economic history because the Japanese economy was in recession for most of the late 1990s, while the rest of the world was booming. The recovery was slower than that of the world after the global downturn in 1998 because of the recession in Japan.

The correlation between the world factor and the UK factor was 64%, lower than in the common shock period. This implies that country-specific factors become more important and can be seen in the counter-cyclical behaviour in the late 1980s, 1990s and the recent downturn compared to the world cycle.

The correlation between the world factor and the South African factor is positive in this period at 22%. This implies some co-movement between SA and the world cycle, with most fluctuations being a result of country-specific fluctuations. There was co-movement from 1986 to 1997 in the sense that the SA factor was booming when the world economy was booming. From the end of 1997, this changed again to a negative

*Table 3. Correlations with the world cycle per sub-period*

	<b>Bretton Woods</b>	<b>Common shock</b>	<b>Globalisation</b>
Australia	0.12	0.34	0.30
Japan	0.16	0.76	0.42
UK	0.25	0.72	0.64
US	0.74	0.94	0.74
EU	n/a	n/a	0.60
SA	0.03	-0.24	0.22
Mexico	n/a	n/a	0.43
Turkey	n/a	n/a	0.13

relationship, which can be attributed to the Asian crisis and the crisis in Argentina in 2001, which spilled over to emerging markets.

The correlation of the Turkey business cycle with the world factor in this period was 13% and most of the fluctuations during this period were country-specific. This lower co-movement was due to the Asian crisis in 1997/1998. This reinforces the point that, as with SA, Turkey is an emerging market, and was seen as a risk, and was still paying the price of liberalising later than other countries. Mexico liberalised earlier, and this is reflected in the higher correlation of 43%.

From the correlations in the discussion above and in Table 3, it is evident that the correlations between the world factor and the country factors changed over time. From a developed market perspective, correlations dropped and synchronisation with the world cycle slowed down (although correlations were still high). This supports the views of Stock and Watson (2003), Heathcote and Perri (2002) and Chakraborty (2001). Their views imply broadly that volatility is decreasing and this makes the world cycle moderate, which implies little tendency towards international synchronisation of business cycles.

From an emerging market perspective, the correlations picked up in this period support the views of Stiglitz (2003), Bordo and Helbling (2003) and Kose *et al.* (2005), which indicates that, after globalisation, a common cycle emerges and business cycles are then more interdependent than before globalisation.

The difference between the behaviour of the developed markets and the emerging markets in the globalisation period may be attributed to the time when financial liberalisation was implemented in the various countries.

During the first period, co-movement was present in the developed markets, and this declined towards the third period. This could imply that, as time goes by and financial liberalisation gets established in the country, volatility and the severity of shocks dampen. This relates to the work by Stock and Watson (2003), who found that the declining volatility of common G7 shocks is the source of much of the observed moderation in the business cycles of individual countries.

## 6. RESULTS FROM THE PCA

Applying PCA to all the common components per sub-period is another way of testing for co-movement with the world factor. In this section, the eigenvalues of each sub-period for the first three principal components (PCs) are shown in order to see which PCs are significant. Where applicable the factor loadings for each significant PC are reported to evaluate the signs and the weights of these coefficients.

The eigenvalues of the first three PCs are plotted in Fig. 3. The eigenvalue for the three PCs are statistically significant except that PC3 in the common shock period is not

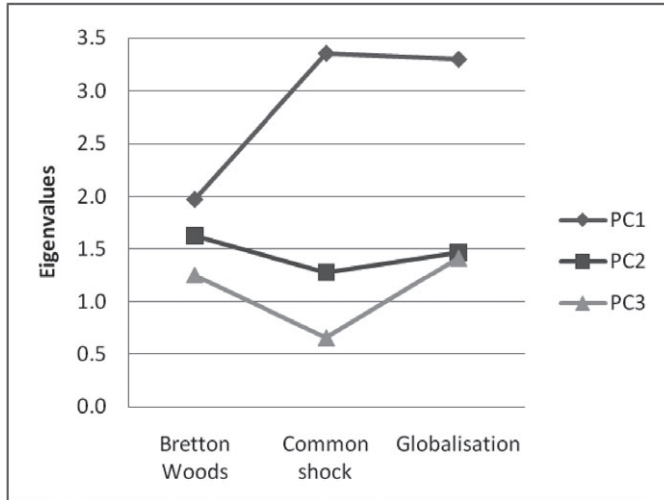


Figure 3. Eigenvalues from the PCA – all countries

significant (eigenvalue  $> 1$  shows significance). The increasing value of PC1 shows the adequacy of PC1 in accounting for the variability, although PC2 and PC3 increased during the globalisation period. Hence, the declining ability of PC1 shows that not all countries had similar patterns.

In all three periods, at least more than one significant PC appears. This suggests that idiosyncratic components do play a part in signalling the changes in business cycles.

Since the correlation analysis showed that developed and emerging markets co-move differently with the world cycle, the next part of the analysis will divide the countries into developed and emerging markets.

*(a) PCA for Developed Markets (Fig. 4)*

Only PC1 and PC2 are significant for the developed markets. In the common shock period only PC1 is significant. In the globalisation period PC2 increased and PC1 decreased; most of the variability is still explained by PC1.

The factor loadings for the Bretton Woods period show that although the signs are the same for PC1, some loadings (weights) are higher in PC2 (Japan and UK). This shows that, during this period, idiosyncratic components played a role in changes in business cycles.

In the common shock period, only PC1 was significant and the sign and magnitude of the loadings for most countries were the same, except for Australia. This shows the emergence of a common cycle during this period.

In the globalisation period, PC1 has the same sign and magnitude for most countries – except Japan, which is better explained by PC2 (higher loading). The same applies for Australia. This is a confirmation of the correlation analysis, in which Japan and Australia had lower correlations with the world cycle than the other countries.

*(b) PCA of the Emerging Markets*

Due to the unavailability of data, only SA and the G7 component were used for the Bretton Woods and common shock period. All three emerging markets were used for the globalisation period.

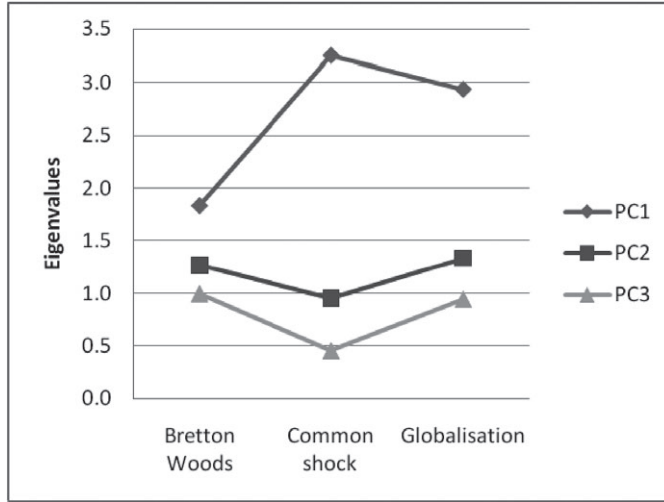


Figure 4. Eigenvalues from the PCA – developed markets

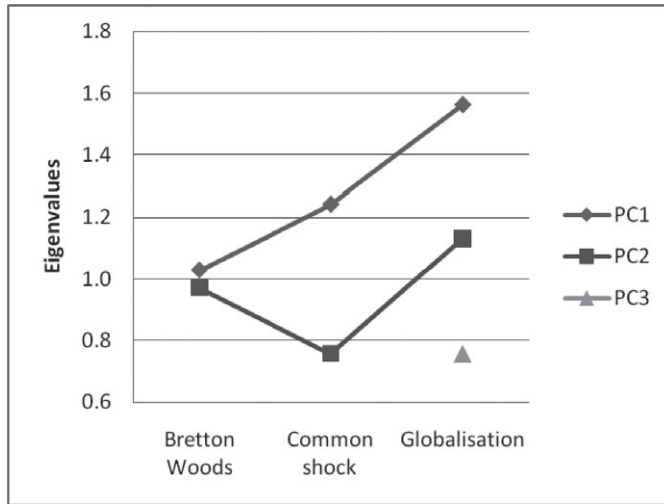


Figure 5. Eigenvalues from the PCA – emerging markets

PC1 became more significant over the three periods. PC2 was significant only in the globalisation period. In the globalisation period the sign and magnitude of the factor loadings were the same for PC1, showing the emergence of the common cycle. In PC2, the loadings of SA and Turkey are higher and the G7 and Mexico are negative. There is stronger synchronisation in this period for the emerging markets, which is a confirmation of the correlation analysis done earlier.

The PCs of the emerging markets became more significant towards the globalisation period (Fig. 5). Since the other emerging markets were added only in the globalisation period due to the lack of data, a 5-year rolling window approach was implemented in

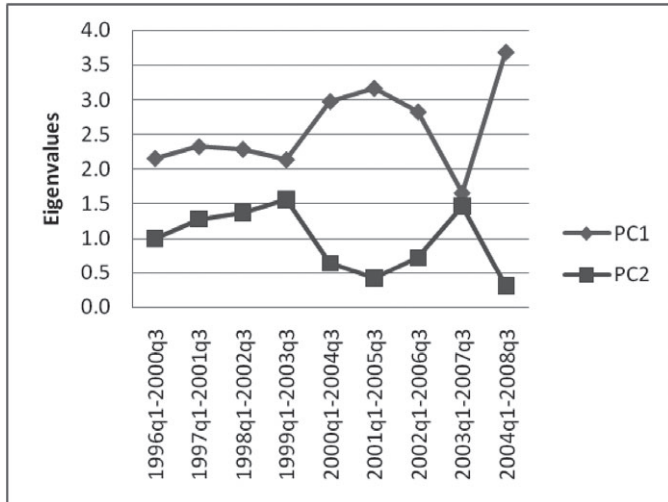


Figure 6. Eigenvalues of the significant PCs for the 5-year rolling period

order to capture the time-varying nature of the emerging markets from 1996 to 2008 as a confirmation of the behaviour in Fig. 5.

PC1 is significant throughout the rolling period. PC2 is significant at the start of the window and spikes again towards the end, but PC1 remain more significant than PC2. This shows the emergence of a common cycle, and the correlations with the world cycle over this rolling period also gained momentum with very high correlations from 2000 (see Fig. 6).

### 7. CONCLUSION

Globalisation has led to an increase in economic and financial integration between countries. Business cycles have become less volatile since globalisation and research has shown conflicting results on whether or not business cycles are more synchronised. The objective in this paper was to determine whether or not synchronisation between developed and developing countries with the world cycle differs. Previous research focused mainly on developed economies and their interactions with the world business cycle. This paper, in contrast, focuses on the interactions of developing economies with the world business cycle as well.

Business cycles in the USA, the UK, the EU, Japan, Australia, Mexico, Turkey and SA were examined. Factor models for each country were constructed using PCA with output, consumption and investment data. These factors were compared to the G7 factor – the benchmark for the world business cycle. It was found that there is some co-movement between most of the countries and the world factor. The results suggest that there are idiosyncratic or country-specific and global sources of economic shocks. These shocks play different roles over time in different countries. In some countries, the country factor is more reflective of domestic economic activity, while in other countries domestic growth reflects the common global pattern shown by the G7 factor.

To establish the changes in business cycles over time, the sample was divided into sub-samples to take all the different financial systems, exchange rate regimes and



globalisation into account. Correlation and PCA were employed to establish the changes in the different periods. The analysis showed that the correlations between the world and the country factors changed over time. There are clearly differences in how developed and emerging markets co-move with the world cycle. The behaviour of developed markets (although still high, lower correlations) supports the views of Stock and Watson (2003), Heathcote and Perri (2002) and Chakraborty (2001). Their views imply broadly that volatility is decreasing and this makes the world cycle moderate, which implies less international synchronisation of business cycles. The emerging markets confirm the views of Stiglitz (2003), Bordo and Helbling (2003) and Kose *et al.* (2003, 2005), who argue that, after globalisation, a common cycle emerges and business cycles are then more synchronised than before globalisation. In a sense, this applies to the developed markets because although correlations have dropped since globalisation, they are still high, showing some co-movement with the world cycle.

In general, it can be concluded that larger shocks increase synchronisation; this was evident in the common shock period in the analysis. This can also be seen in the current recession, where all countries have followed the recent global downturn. Therefore it can be said that a common cycle does exist, but due to globalisation it is less volatile. Thus only large shocks increase the synchronisation of business cycles with the world cycle. The timing and magnitude of major changes in economic activity appear to be similar, as Bordo and Helbling (2003) found, and therefore it can be said that business cycles will be in the same phase at more or less the same time, as Harding and Pagan (2003) have suggested.

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