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Are business cycles in the US and emerging economies synchronized?

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Abstract

In this study, we use the tools of cross-spectral analysis and structural vector autoregression (SVAR) modelling to investigate whether there exists a significant link between the movement of the cyclical component of real GDP in developed and emerging economies. Specifically, we look at the United States and six emerging countries: Brazil, Chile, Korea, Malaysia, Mexico and Singapore. The simple answer to the question posed in the title of our article is no. Our results indicate that there exists no significant relationship between cyclical fluctuations in the US and emerging countries at business cycle frequencies. Although a statistically and economically significant link is detected in the past decade (the 2000s), it seems that it reflects mostly the severity of the 2008-2009 recession and its effects reverberating throughout the globe rather than a structural convergence between the developed and emerging world which could be expected to persist into the future. In general, both spectral methods and SVAR models suggest that over a long horizon, GDP cycles in the US and the emerging countries are not related.

Keywords: business cycles synchronization, time series filtering, cross-spectral analysis, SVAR models.

JEL codes: C22, C32, E32.

1. Introduction

The synchronization of business cycles between major developed economies, like the US and the Euro Area, and within Europe, is a well-documented fact (see Azevedo (2002), Bergman (2004) and others). This knowledge is of great policy significance as it allows those creating economic policy to adjust their output forecasts for, say, Europe, based on what is already known to be happening in the US. However, where emerging markets are concerned, the major conjecture recently has been one of a 'decoupling' of their business cycles from those in the developed world.

The economic literature relating to the issue of business cycle synchronization among advanced economies is vast (see for example Wynne & Koo (2000), De Haan et al. (2002), Kose et al. (2003), Bergman (2004), Eickmeier & Breitung (2006), Rose & Engel (2002)). The general picture that emerges from this strand of research is that various advanced economies exhibit similar patterns of economic activity fluctuations. Specifically economies of the euro zone show strong linkages between business cycles. Strong linkages of various economies and the US in terms of economic activity fluctuations are also reported. At the same time there exists a growing number of economic research relating to the case of economic activity fluctuations fit between developed economies and emerging markets. Just to give a brief overview of the subject we focus on following examples. Fidrmuc and Korhonen (2010) have demonstrated that business cycles in emerging Asia generally show little synchronization with cycles in the OECD, although the financial crisis of 2008-2009 has had a profound impact on the emerging economies' output. We also find an extremely close synchronization between cycles in the US and Malaysia in the past decade, and this synchronization disappears in other countries, for which considerably more data was available. This suggests a lack of convergence over a long run in conditions of moderate cycle fluctuations. Kose et al. (2008), using dynamic factor models, also present evidence in favour of the decoupling hypothesis, arguing that business cycle convergence exists within groups of emerging markets but not between developed and emerging economies. The dominance of country-specific factors in emerging countries' business cycles is also well-documented in a study by Artis et al. (2011), which uses FSVAR models and is based on 125 years' worth of GDP data. Similarly, Sanchez (2007) looks at fifteen emerging market economies and finds that no more than 10% of their output fluctuation can be explained by external factors. Conrad (2008) investigates business cycle convergence between countries belonging to the same trade agreement (like NAFTA and the EU) and concludes that while

developed countries undergo synchronization, emerging markets belonging to such agreements continue to be affected mainly by local shocks. Although Kose et al. (2003) find some evidence that integration of trade and financial markets increases international macroeconomic spillovers, they also do not show at a significant level that such integration leads to a greater business cycle synchronization. All these studies give support to the hypothesis of decoupling between developed and emerging markets, which our study confirms.

To our knowledge, this is the first study applying the tools of cross-spectral analysis and SVAR models to investigate the synchronization of GDP cycles between the US and emerging countries. However, our results are in line with conclusions reached by researchers who have approached the same question using different methods or a somewhat different question using similar methods.

The structure of the paper is as follows. Section 2 describes the data and econometric methods used in our empirical investigation. In section 3 we discuss the results. Section 4 concludes.

2. Data and econometric framework

In our study we focus on GDP data. The emerging countries taken into consideration were selected according to their location (we were looking for geographical variety) and the availability of data.

We have used both annual and quarterly real GDP series to perform our analysis. Annual series have been obtained from the IMF World Economic Outlook database and go back to 1980 for all countries. Quarterly data come from Ecowin database and their coverage varies from country to country; for the US, the series starts in 1947, while at the other extreme, the series for Malaysia only starts in 2000. Firstly, all series were converted into logarithmic form and seasonally adjusted using X-12 ARIMA. They were then broken up into trend and cycle components using two filters: Christiano-Fitzgerald (1999) and Hodrick-Prescott (1997).

Our empirical investigation is divided into two parts. Firstly, we focus on cross-spectral analysis of time series representing business cycles in the US and analyzed emerging markets. This allows us to shed light on economic activity fluctuations linkages in terms of both amplitudes and turning points at all business cycle frequencies. Secondly, we turn to SVAR modelling in order to quantify the importance of external and domestic shocks in explaining business cycle behaviour in considered countries.

Data used in cross-spectral analysis were detrended using the full sample asymmetric CF filter under the assumption that the series were I(1), which was supported by ADF and KPSS tests results. The filter was adjusted for drift and set up to pick up cycles with periods between six and forty quarters, which corresponds to the stylized length of a typical business cycle. In case of annual data this period span ranged from two to ten years. The cyclical components of the US and emerging markets GDP were then subjected to cross-spectral analysis[1]. Namely, we analyze four cross-spectral measures: coherence, dynamic correlation, gain and phase shift. These statistics allow us to fully describe the cyclical relations. In our study we use the non-parametric estimation of these measures, namely we

[1] To perform cross-spectral analysis we used our own MATLAB codes. These are available upon request.

implement the Parzen kernel to obtain the estimates.[2] For reference on spectral and cross-spectral analysis see Hamilton (1994) or Chatfield (1996).

The VAR models were estimated using data detrended by the HP filter, with the smoothing parameter λ=1600 for quarterly data and λ=100 for annual data. The reason why a different filtering method was used for VAR models is that cycles produced by the CF filter required an extremely large number of lags in the models, while HP cycles never required more than three lags. The number of lags in the final model was chosen according to the Schwarz Criterion, which places a greater penalty on the number of explanatory variables than the Akaike Information Criterion. Structural identification of the models was obtained by Cholesky factorization of the variance-covariance matrix of the underlying VAR models[3]. This in turn allowed us to perform the forecast error variance decompositions to fundamental shocks.

[2] The weights for the Parzen kernel were calculated for $K=2\sqrt{T}$, where T is the number of observations in the series, as per Chatfield (1996), p. 115.

[3] The Cholesky factorization allows us to assume that domestic shocks from a given emerging economy do not hit the US economy instantaneously which seems to be a plausible assumption. In turn in all our models the US time series appears as the first one in the modelled vector.

3. The results

3.1. Cross-spectral analysis results

Our results suggest there is no stable relationship between the cyclical fluctuations in GDP in the US and the emerging countries we considered.

On the whole, results based on quarterly data were found to be more significant than those based on annual data, but even there, the relationships were limited. Coherence is a measure of goodness of fit which in cross-spectral analysis plays a role roughly corresponding to R^2 in multivariate regression. Therefore, it is suitable as a first test to check if there is any relationship between two cyclical series. In our case, the cycle for the US was compared against the cycle for the particular emerging country (Figure 3). In the case of Brazil, there is no cycle period for which coherence is significantly different from zero, which suggests that cycles in both countries are unrelated. Other countries display a range of patterns which vary considerably from case to case. Chile for instance has a significant coherence for cycles longer than 3.5 years; Mexico for those longer than two years; South Korea for those shorter than two years. In turn, only cycles lasting about two years seem to be significantly related between Singapore and the US. In all cases, the relationship is pro-cyclical, which can be determined by looking at the correlation diagrams (Figure 4). The correlation measure presented in these diagrams can be interpreted in the same way as the correlation coefficient in bivariate regression. Note that cycles in Malaysia seem to be almost perfectly related to cycles in the US, which is reflected in very high coherence at all cycle lengths, but this is merely a result of the limited sample coverage (the series for Malaysia only goes back to 2000).

Phase shift diagrams, which show whether the cycle in one country is leading or lagging the cycle in the other country, paint a similarly varied picture (Figure 6). Cycles in Brazil and Mexico seem to lag behind those in the US at all cycle lengths (as expected, the shift is particularly well-pronounced for Mexico). Those in Chile and Singapore lead or lag, depending on the specific cycle length we are interested in. South Korea leads the US, but only for cycles which last over 3.5 years (and the coherence is insignificant at those lengths).

Gain can be interpreted as the ratio of cycle amplitudes in two countries. Gain diagrams show that cycles are more volatile in emerging countries than in the US at all cycle lengths (Figure 5).

Therefore, results based on quarterly data yield a completely different result for each country. In some cases, one may be tempted to think that there is a coherent underlying relationship, but results from annual data refute this view. Based on annual data going back to 1980, coherence is insignificant for virtually all cycle lengths for Brazil, South Korea, Malaysia, Mexico and Singapore (Figure 7). The only exception is Chile, for which there seems to be a significant result for cycles between two and four years in length. However, note that even this result is in contradiction with the result based on quarterly data, which found a significant coherence only for cycles above 3.5 years in length.

In terms of phase shift (Figure 10), the US leads Chile and Mexico at all cycle lengths, while Malaysia leads the US, though only for cycles lasting around ten years. There is no coherent pattern for other countries. Therefore, the only country for which phase shift diagrams tell the same qualitative story using quarterly and annual data is Mexico. Its cycle lags behind the US in both cases as expected, though quarterly data suggest a longer lag.

We include the results of spectral analysis for the US-Europe pair for comparison (Figure 13). The coherence is strongly significant at all cycle lengths, and the phase shift diagram clearly shows that US cycles lead European cycles. None of the emerging countries produces similarly consistent results.

3.2. SVAR results

We have also undertaken SVAR modelling to establish whether there was anything particular about our spectral analysis approach that prevented us from obtaining significant results. However, the results of SVAR models were just as unpromising.

As mentioned before, we switched to the Hodrick-Prescott filter in separating our series into trend and cycle for SVAR models. This is because when the CF filter was used instead, the Schwarz Criterion would invariably select as many lags as it was allowed (we have tried up

to fifteen). The HP filter, on the other hand, always selected two or three, which makes far more intuitive sense.

After conducting the standard tests for AR roots and serial correlation in the errors, we produced model estimates and variance decomposition diagrams for quarterly data (Figure 11). With the exception of Malaysia, the contribution of the US to the variance of the local cycle was between 10 and 20 percent. In Malaysia's case the figure was 70%, but again, this result stemmed from the fact that Malaysian data were only available back to 2000, and the cycle in both countries in the past decade has been synchronized to an exceptionally high degree (a long expansion from 2002 until 2008, then a major downturn, then recovery).

Impulse response diagrams tell a broadly similar story. Shocks in emerging countries have no impact on the US, while only shocks in the opposite direction affect only Malaysia and Mexico. The result for Malaysia comes from a short sample, but the one for Mexico confirms our previous conclusion that the US cycle strongly affects Mexico.

However, these already dubious relationships become even weaker when annual data is used. Impulse response is virtually zero for all countries. The proportion of cycle variance due to the US generally oscillates between 0 and 20 percent (Figure 12). The exception here is Singapore, for which the contribution of the long US cycle is around 40 percent. However, note that this result is not confirmed in quarterly data.

4. Conclusions

Business cycle synchronization among developed economies is well documented. Over the past years the phenomenon of business cycles in emerging markets gained attention of researchers because knowledge of this subject is of great interest and importance to all economic agents as it enables better understanding of the features of these economies. In our study we focused on business cycle synchronization between the US and emerging markets. We used cross-spectral analysis methods and SVAR modelling techniques in order to investigate the linkages between economic activity fluctuations in the US and various Asian and Latin Amercian emerging countries. We find that there is no evidence to support the hypothesis that there exists a significant synchronization between their business cycles. With the exception of Mexico, whose proximity to the US makes it vulnerable to large spillovers, business cycles in emerging countries seem to be largely independent from the US cycle. This result provides support for the decoupling hypothesis.

Our analysis could be extended by considering a greater number of emerging countries, obtaining longer data series, or by looking at cyclical fluctuations in other economic series of interest like industrial production. The example of Malaysia, for which only data from 2000 onwards was available and which has shown a remarkable cycle synchronization with the US in the past decade, illustrates the importance of using extended time series in researching business cycles. Finally, it seems also interesting to analyze the discussed issues by means of other econometric tools as for example wavelets or dynamic factor models. We believe that this is an interesting field for future research.

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Appendix

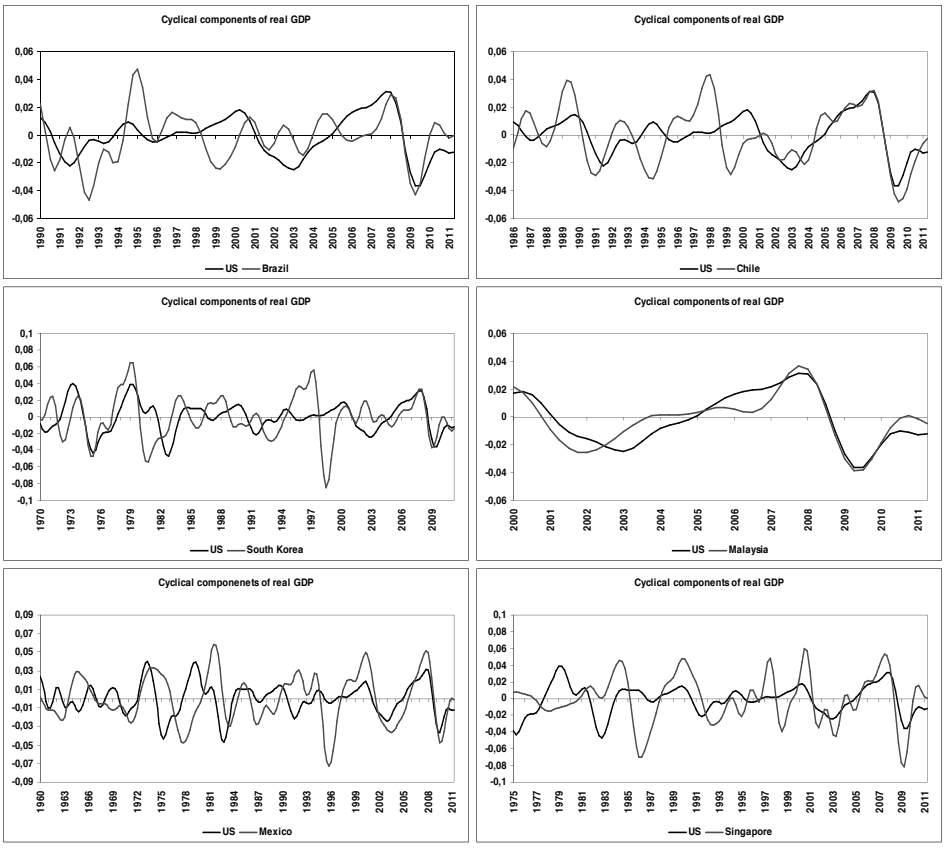

Figure 1. Cyclical components of real GDP (quarterly data)

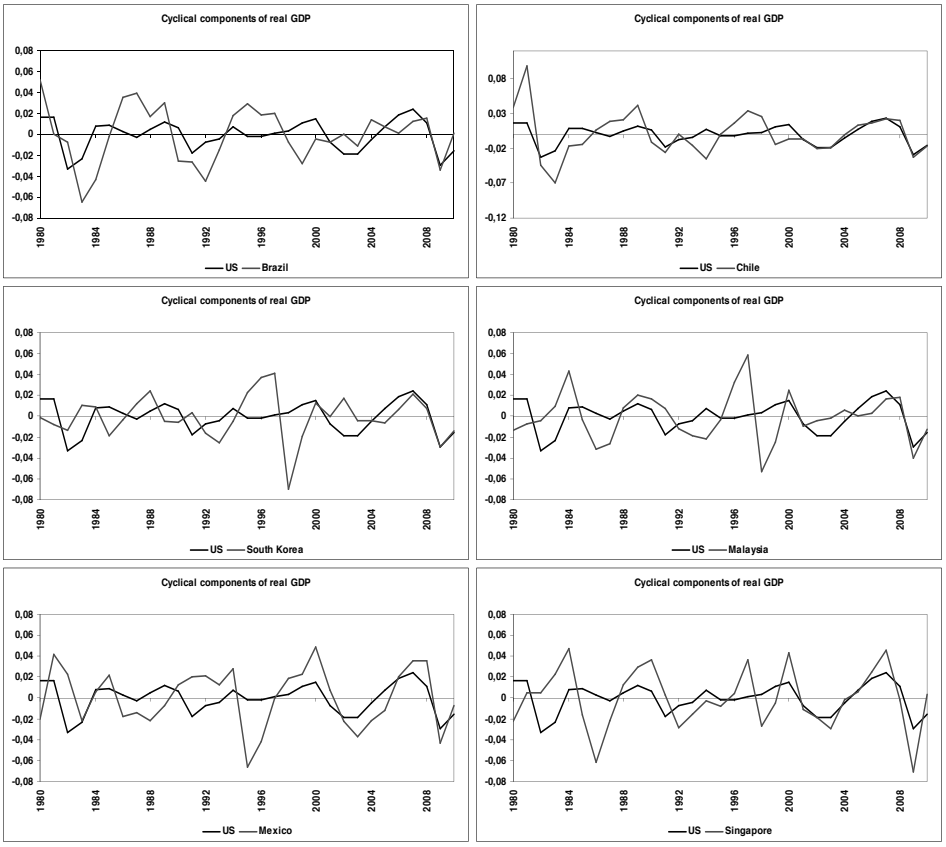

Figure 2. Cyclical components of real GDP (annual data)

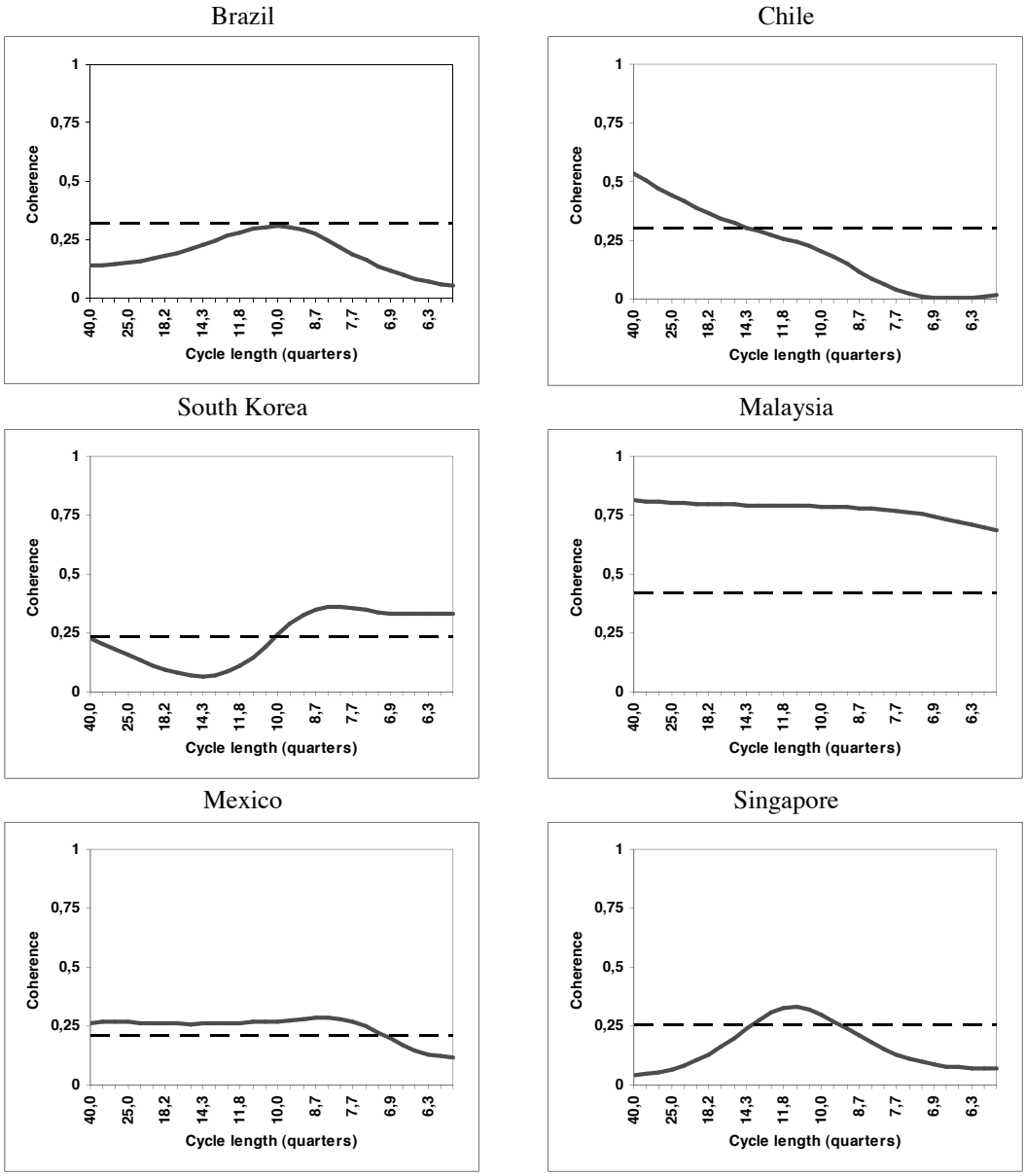

Figure 3. Coherence diagrams (quarterly data, 5% one-sided critical values)

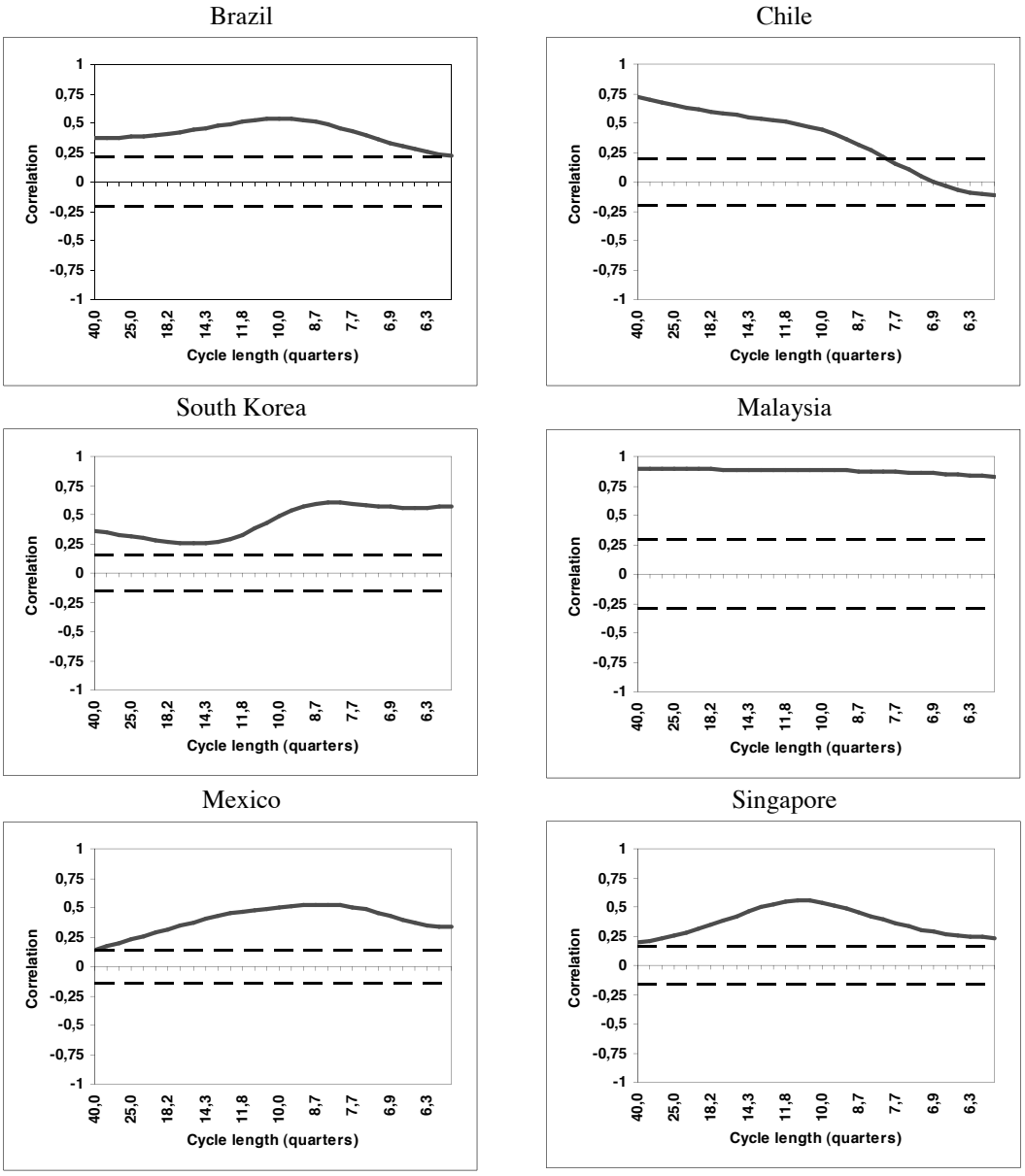

Figure 4. Dynamic correlation diagrams (quarterly data, 5% two-sided critical values)

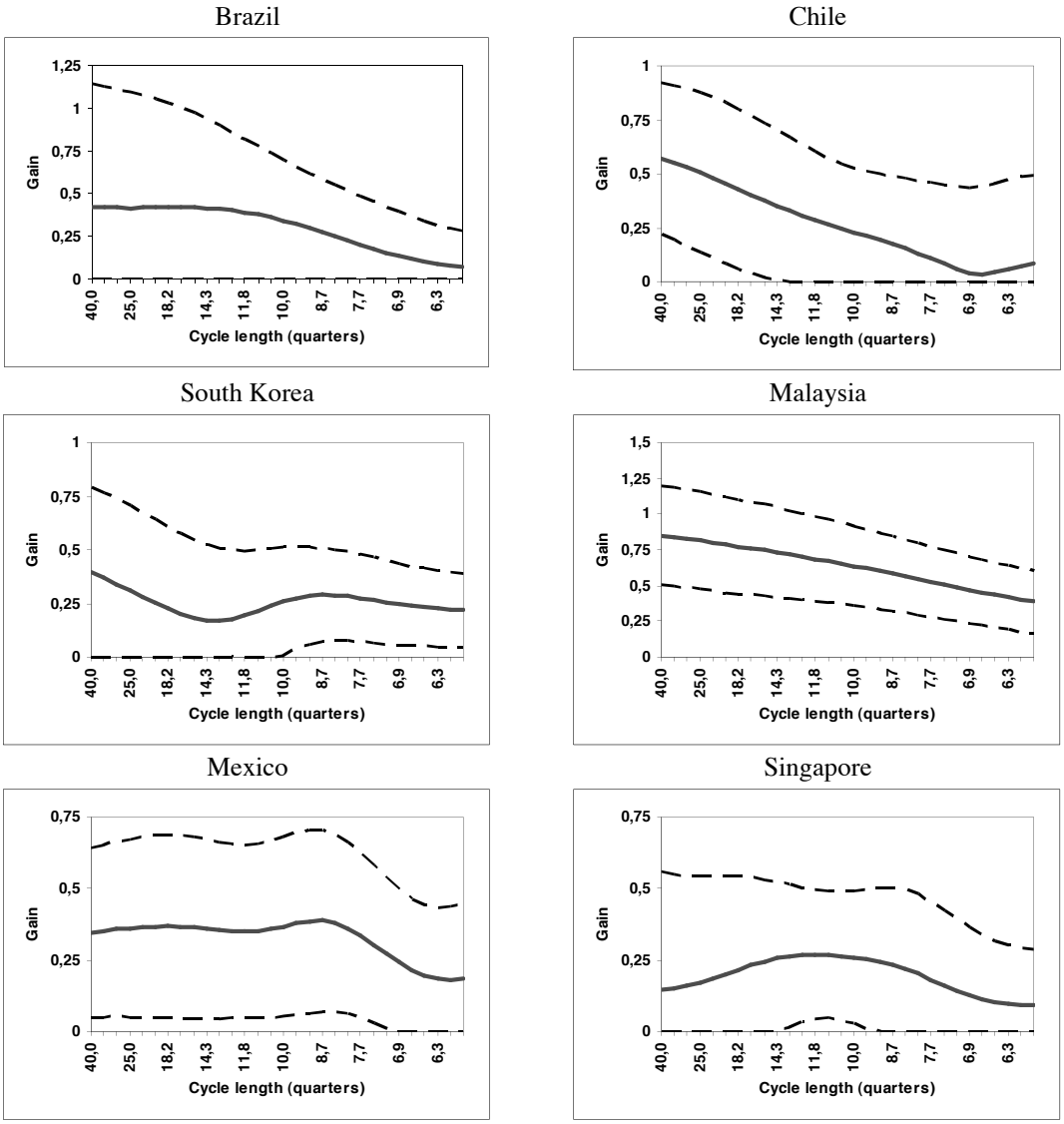

Figure 5. Gain diagrams (quarterly data, 95% confidence bounds)

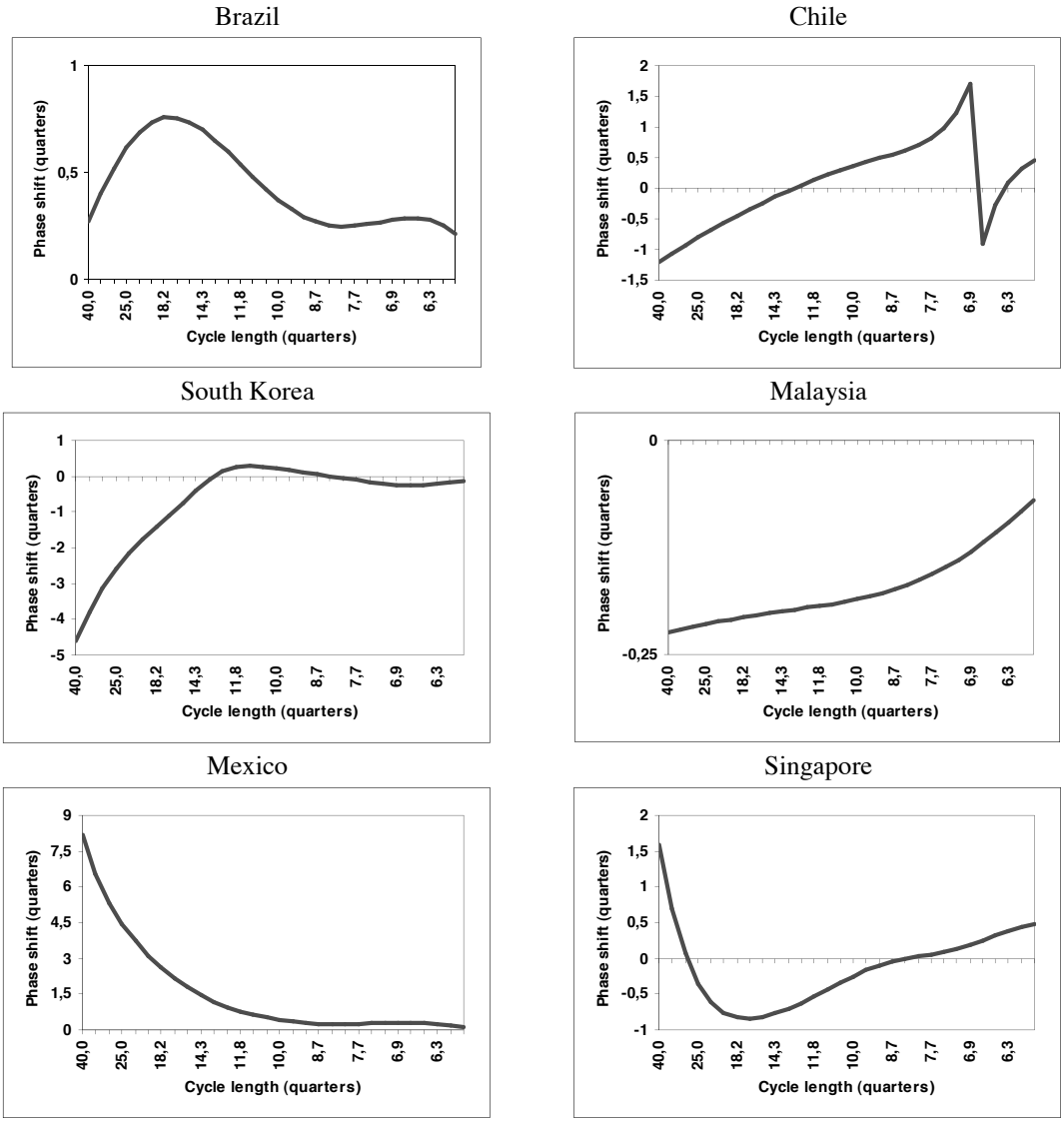

Figure 6. Phase shift diagrams (quarterly data)

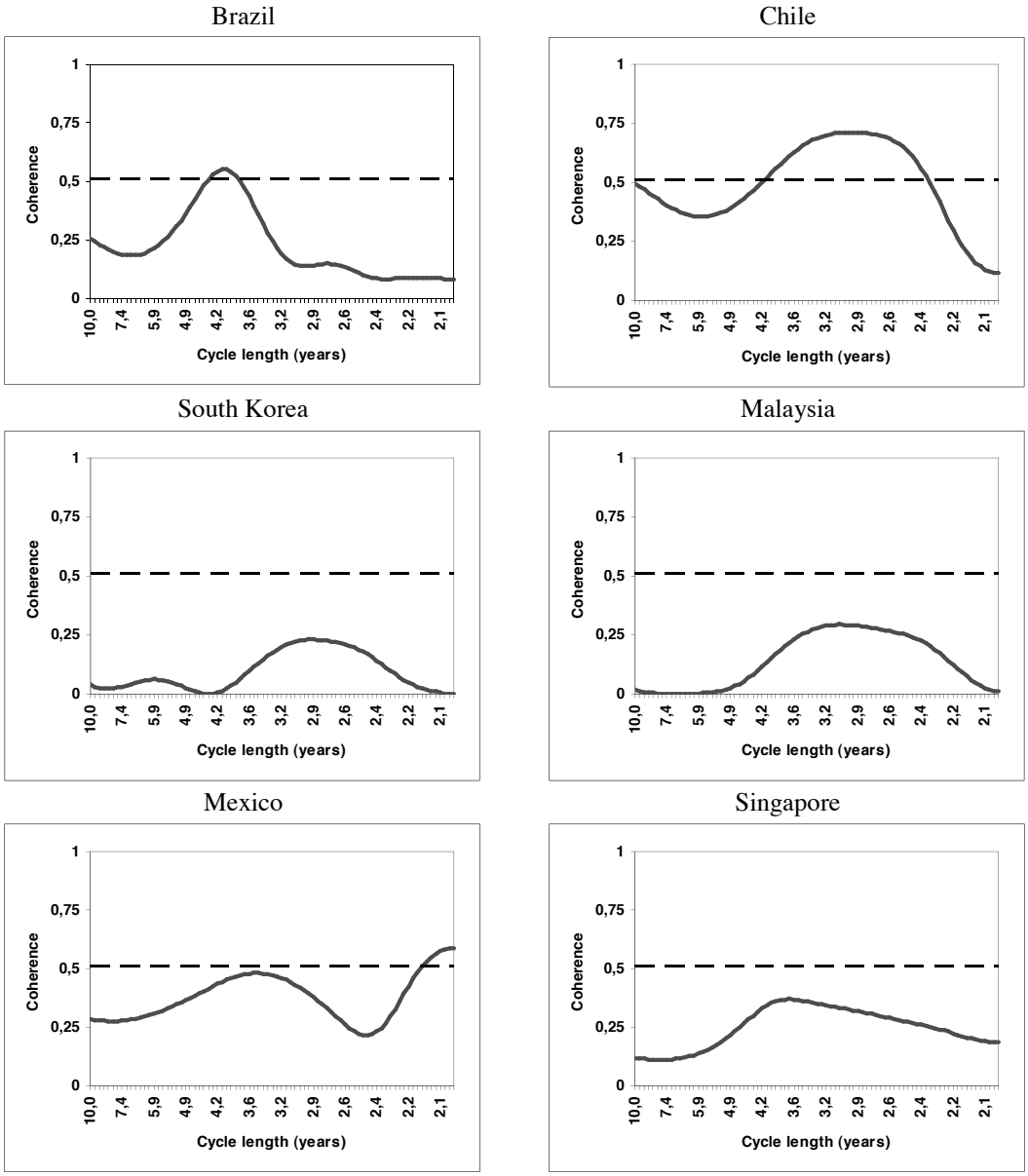

Figure 7. Coherence diagrams (annual data, 5% one-sided critical values)

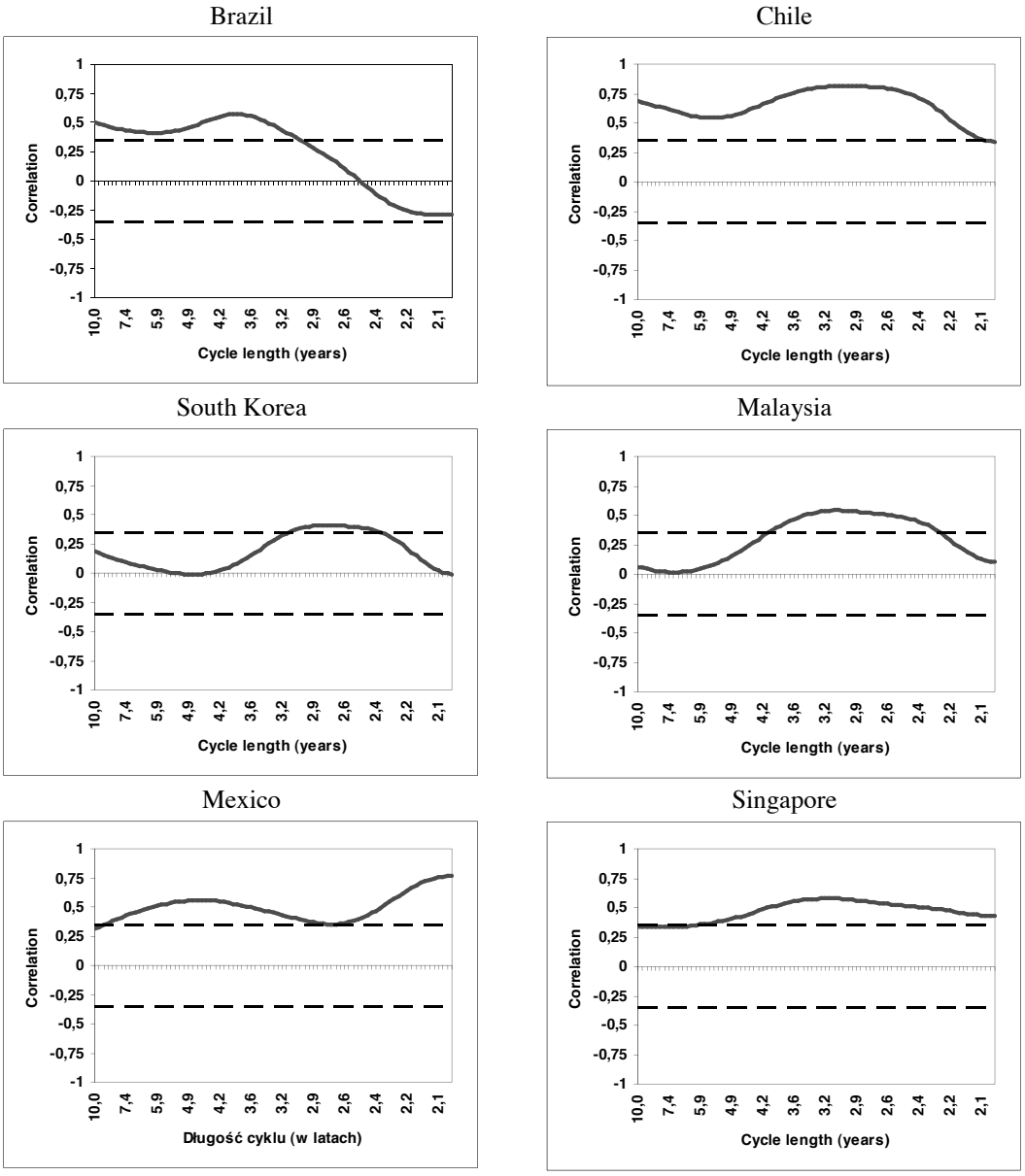

Figure 8. Dynamic correlation diagrams (annual data, 5% two-sided critical values)

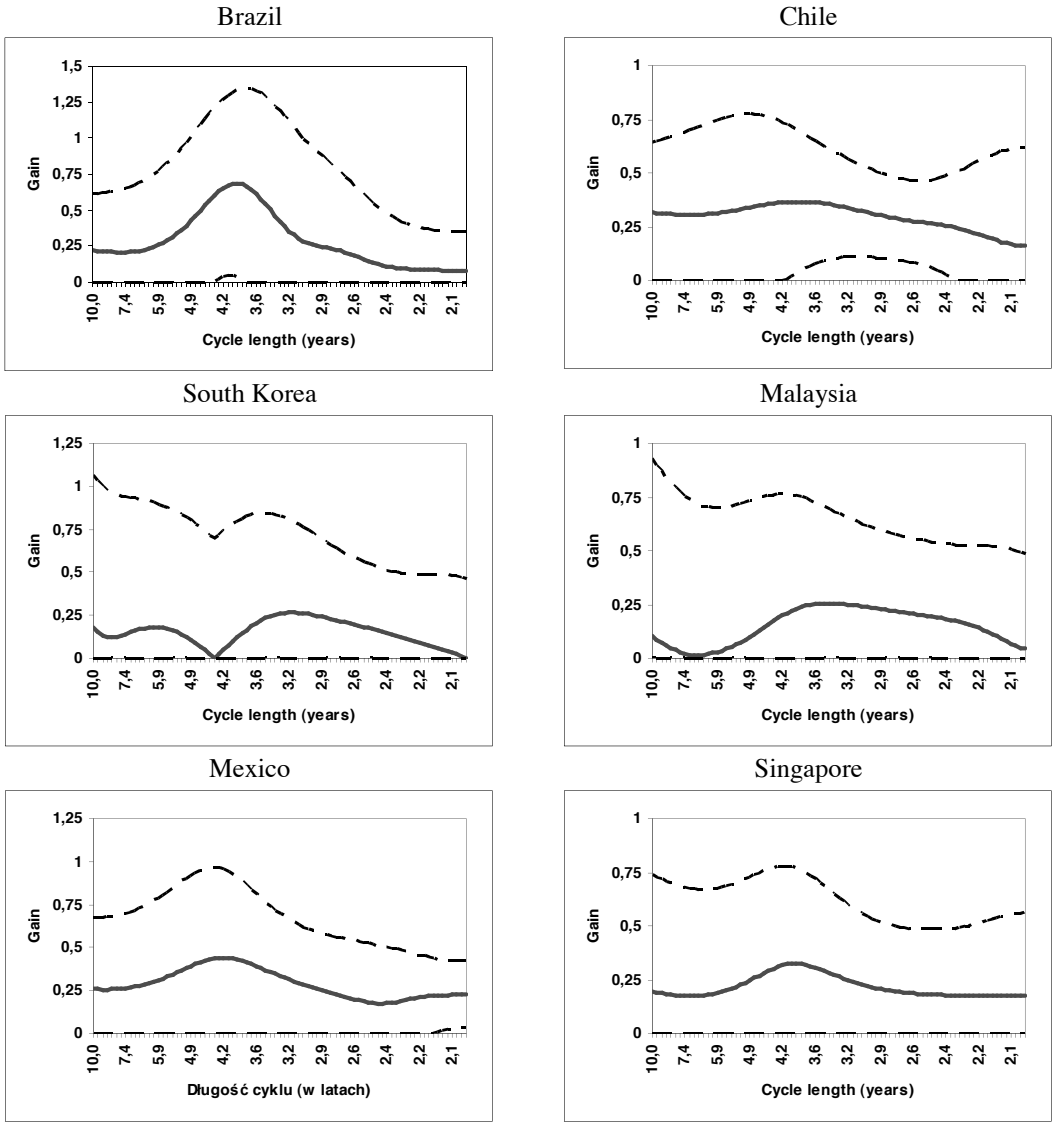

Figure 9. Gain diagrams (annual data, 95% confidence bounds)

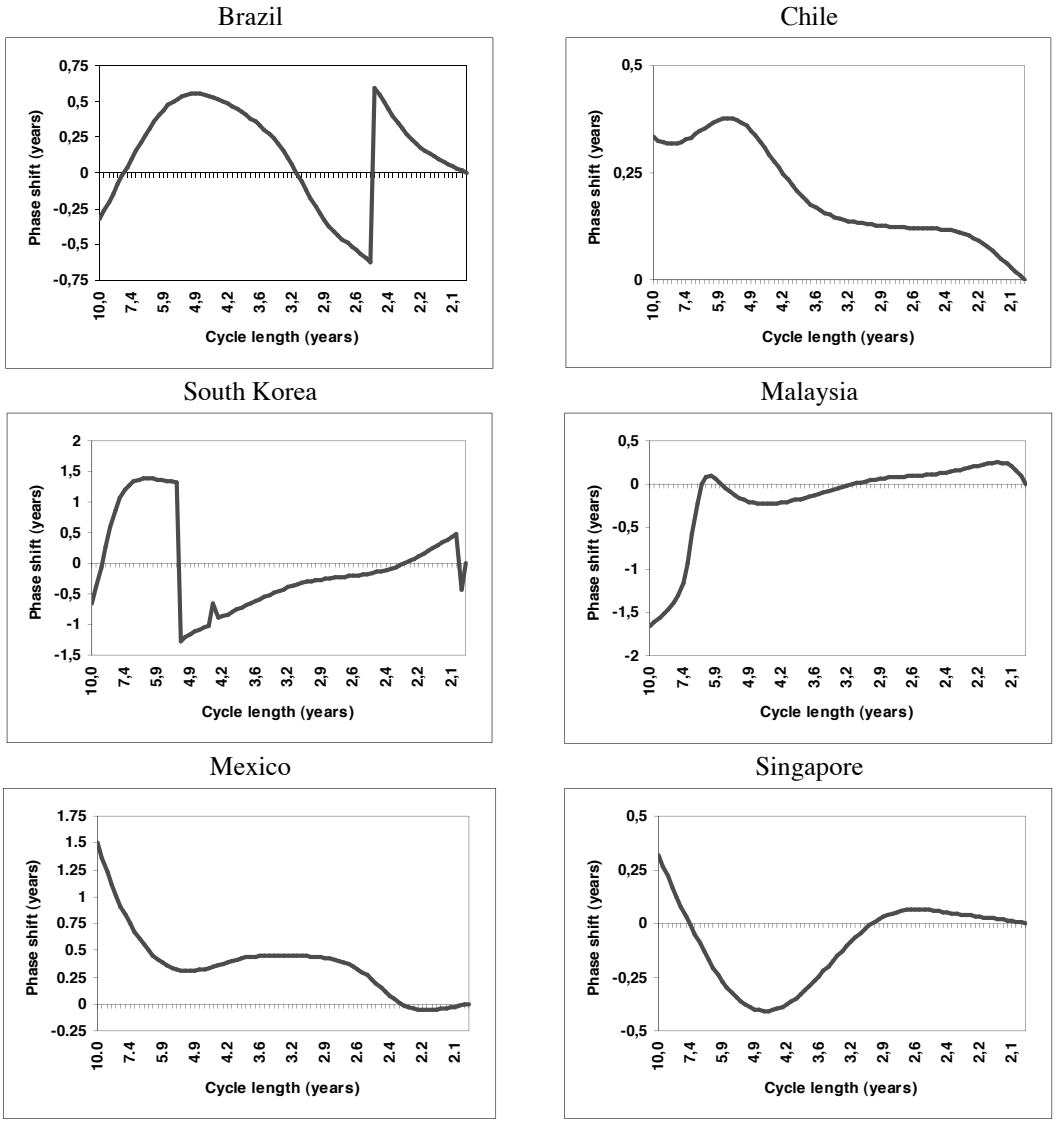

Figure 10. Phase shift diagrams (annual data)

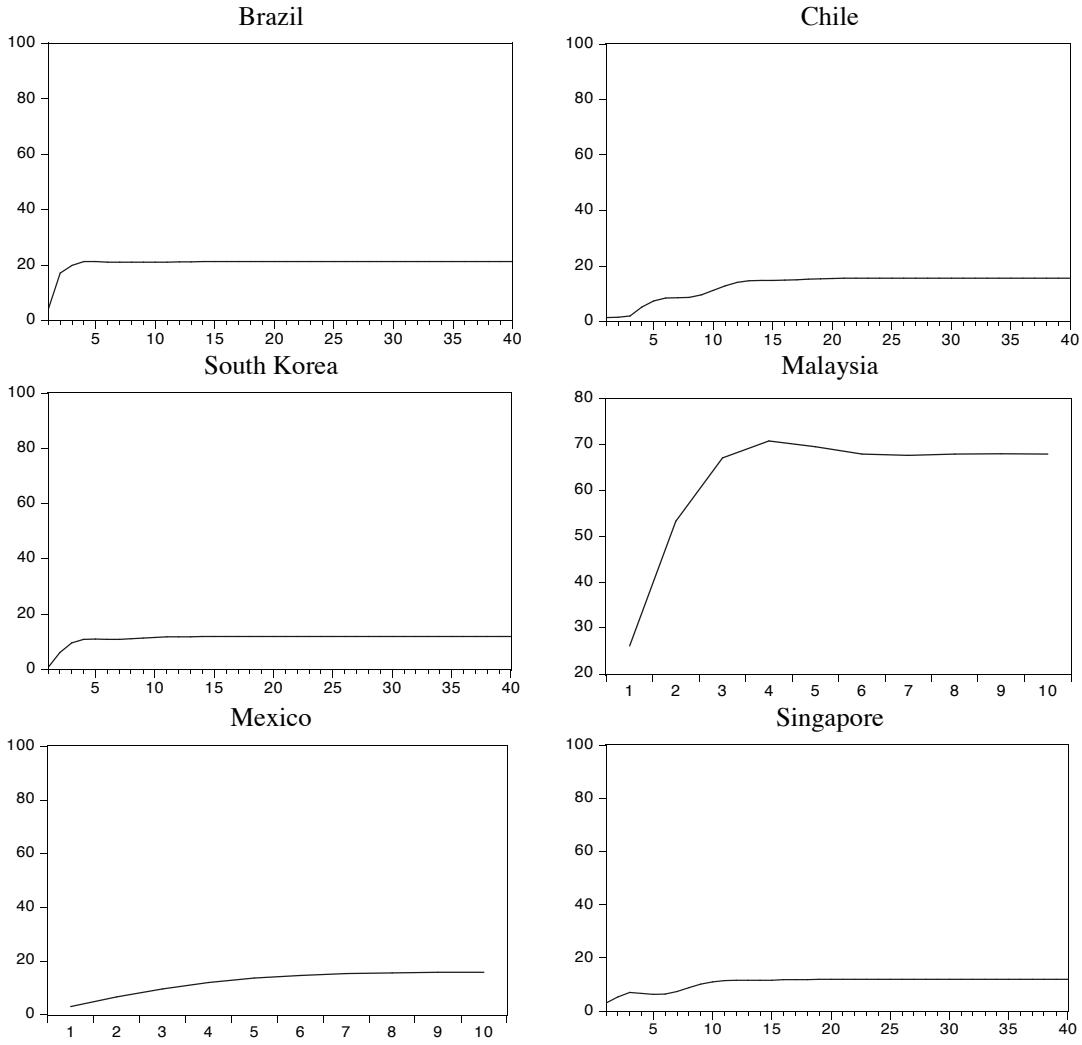

Figure 11. US contribution to the variance of the local business cycle (quarterly data)

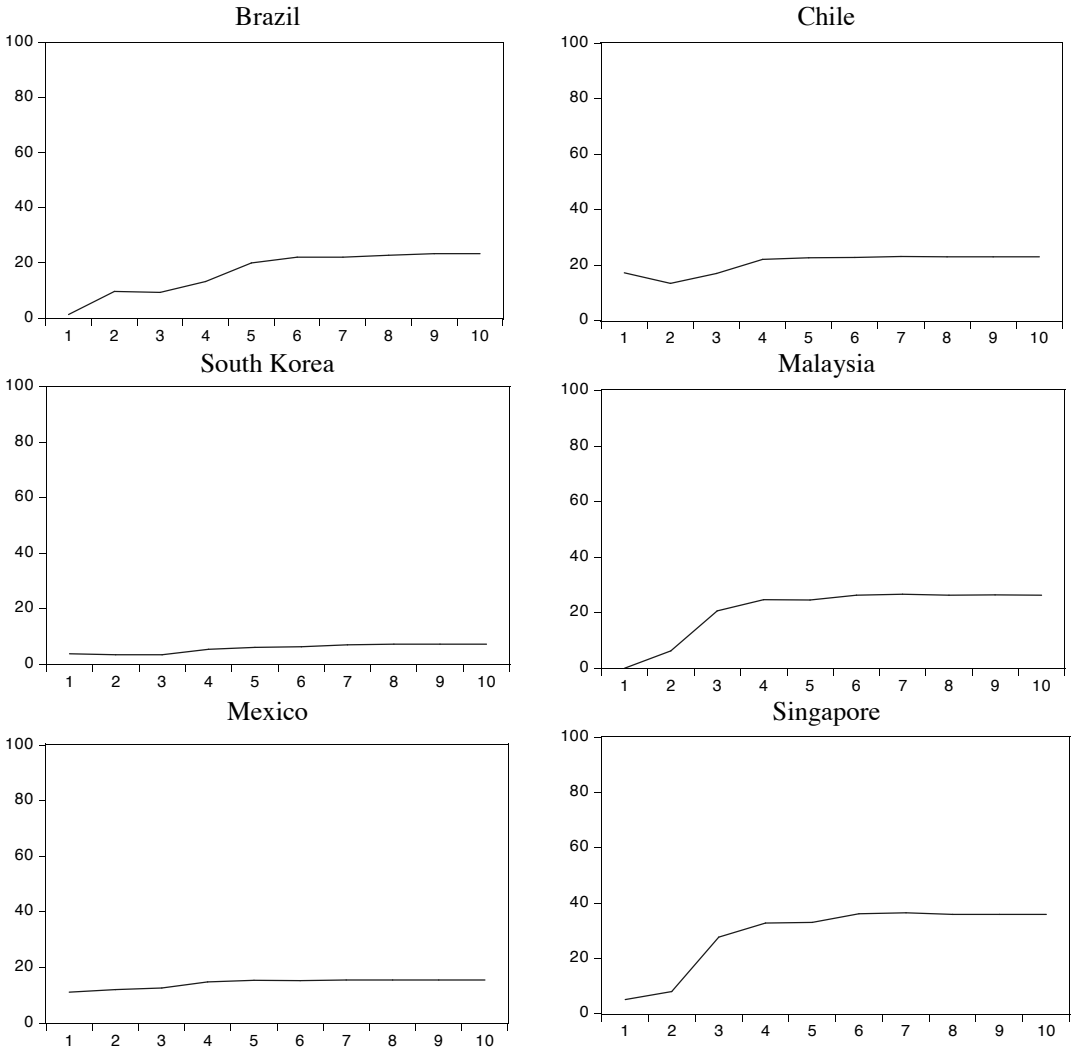

Figure 12. US contribution to the variance of the local business cycle (annual data)

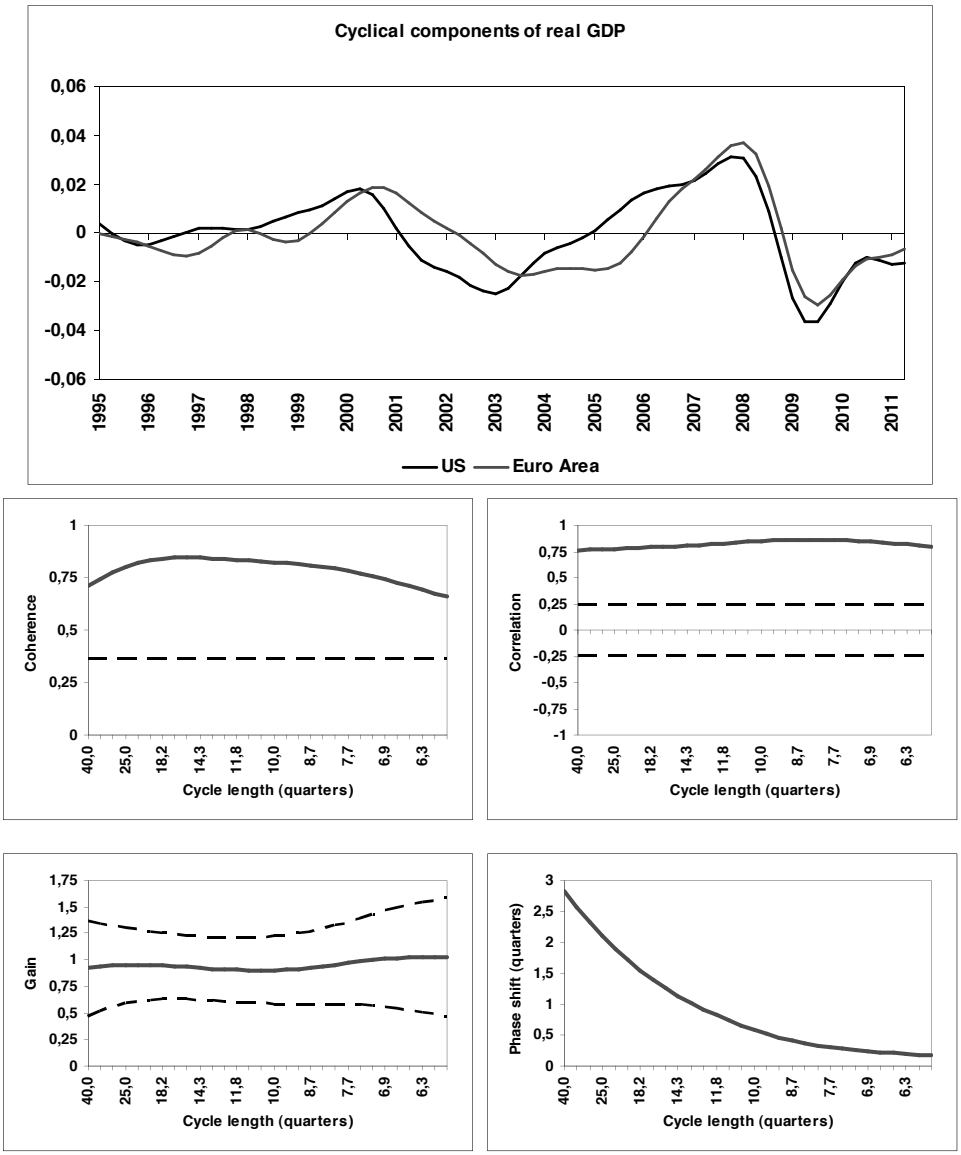

Figure 13. Cycle synchronization between the US and the Euro Area since 1995 (quarterly data, 5% critical values and 95% confidence bounds)