No decoupling, more interdependence: business cycle comovements between advanced and emerging economies

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Abstract

The decoupling hypothesis is the idea that business cycles in emerging market economies have become more independent from business cycles in advanced economies in recent years. Decoupling essentially amounts to a structural break in the degree of business cycle interdependence between the two groups of economies, and it can be tested as such. We develop an innovative measure of business cycle interdependence based on the Euclidean distance, available at the annual frequency, which allows for a proper test for a structural break in a graphical setup. We also make use of a standard econometric test. Both approaches point to the same conclusion: there has been no decoupling in recent years. In fact, the degree of business cycle interdependence has become stronger.

JEL Classification: E32, F15, F36, F41, O47.

Keywords: Business cycle; synchronisation; globalization; decoupling; emerging markets.

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1 Introduction

The decoupling hypothesis is the idea that business cycles in emerging market economies have become more independent from business cycles in advanced economies during the last decade. Proponents of the decoupling hypothesis argue that over the last decade, emerging markets have achieved stronger growth in domestic demand, thereby lowering the relative contribution of net exports to economic growth. Moreover, emerging markets have allegedly also managed to strengthen domestic policy frameworks and to reduce external vulnerabilities, thereby increasing the scope for counter-cyclical policies to mitigate the impact of external shocks. Consequently, it is argued, these developments imply that emerging markets have decoupled from advanced economies.

The decoupling hypothesis runs against the idea that globalisation, namely stronger trade and financial linkages across countries, facilitates the international transmission of country-specific shocks, thus leading to greater business cycle synchronisation. Since emerging markets have become more integrated into the world economy, one would expect greater business cycle interdependence with advanced economies. Indeed, the decoupling hypothesis is difficult to reconcile with the extensive empirical evidence supporting the idea that trade and financial integration lead to greater business cycle synchronisation.

Testing the decoupling hypothesis amounts to testing for the presence of a structural break in the degree of business cycle interdependence between advanced and emerging market economies. We follow two approaches. First, we provide graphical evidence on the degree of business cycle interdependence between regional groups of emerging markets and four aggregates of advanced economies. The bulk of the literature on business cycle synchronisation makes use of correlation coefficients to measure interdependence. In the context of the decoupling hypothesis, such a measure is problematic since decoupling is expected to have occurred in recent years. Since correlation coefficients must be estimated over relatively large sub-samples of the data, they do not display enough variation over recent years. Therefore, pinning down a structural break with any decent degree of precision remains largely illusory. In contrast with the existing literature, we construct annual measures of interdependence by exploiting the fact that the Euclidean distance between two standardized random variables provides the same qualitative information as the correlation coefficient. This approach allows us to test for the presence of a structural break in a meaningful manner. The Euclidean distance between business cycles of emerging markets and advanced economies is calculated for each year in the sample and graphed against time. Testing the decoupling hypothesis simply amounts to check visually whether the Euclidean distance between standardized business cycles of emerging markets and advanced economies has increased in recent years.

Our second approach follows Levy-Yeyati (2009) and is based on pooled regression analysis. We regress pooled business cycles of emerging markets on the business cycle of advanced economies, as well as an interaction term between the business cycle of advanced economies and a dummy variable taking a value of one from a recent, arbitrarily chosen year (between 1999 and 2007) until the last year in the sample. The coefficient estimate on the interaction term provides information on a possible structural break in the degree of interdependence. Should this coefficient estimate be negative and statistically different from zero, the degree of business cycle interdependence between emerging markets and advanced economies would have decreased significantly in recent years, thereby confirming the decoupling hypothesis.

Our sample comprises thirty individual emerging market economies and four aggregate groups of advanced economies, namely all advanced economies, the G7 group, the United States alone, and Europe. The sample period runs from 1980 to 2008. Data on annual gross domestic product at constant prices are retrieved from the IMF's World Economic Outlook database. The business cycle is extracted using two different filters, the Hodrick-Prescott filter and the Baxter-King filter. Both the graphical and econometric approaches point to the same conclusion. If there has been any structural break in the degree of business cycle interdependence between emerging markets and advanced economies over the last decade, it is toward greater interdependence, not decoupling.

The remainder of this paper is organised as follows. Section 2 focuses on the graphical approach. The first part outlines our innovative empirical strategy to measure business cycle interdependence, including the data. The second part discusses whether there is graphical evidence supporting the decoupling hypothesis. Section 3 describes the pooled regression analysis and presents results from our estimations. Section 4 provides concluding remarks.

2 A graphical test of the decoupling hypothesis

The decoupling hypothesis states that the degree of business cycle interdependence between emerging markets and advanced economies has decreased in recent years. This definition points out two requirements for a test of the hypothesis: a suitable measure of business cycle interdependence, and a way to identify a structural break in the pattern of interdependence. This section outlines a graphical approach to testing the decoupling hypothesis.

2.1 Empirical strategy

Business cycle synchronisation is usually measured as the correlation coefficient between the business cycles of two countries, or groups of countries (see, for example, Baxter and Kouparitsas, 2005; Fidrmuc and Korhonen, 2006; Frankel and Rose, 1998; Imbs, 2004, 2006; Kose et al., 2003; Rose and Engel, 2002). Flood and Rose (2009) have computed correlation coefficients over five-year rolling sub-samples of quarterly data and find no evidence of decoupling. But this procedure remains problematic to identify a structural break in the degree of business cycle synchronisation.[1] The last correlation coefficient is calculated using the previous five years of data. If a structural break occurs within this time period, the correlation coefficient may not pick it up. Ideally, we would like to have a measure of business cycle interdependence which varies from year to year from the beginning until the end of the sample. Such time variation would allow to identify a structural break with much greater precision than by using correlation coefficients.

[1] Another problem is that the choice of sub-samples remains largely arbitrary and different sub-samples of the same data can yield different conclusions. For example, Artis and Zhang (1997, 1999) have concluded that participation in the Exchange Rate Mechanism of mutually fixed exchange rates raised business cycle synchronisation, while Inklaar and de Haan (2001) reached the opposite conclusion using the same dataset but splitting the sample in different sub-periods of time.

Wälti (2009) defines business cycle synchronicity as the coincidence of output gaps (Mink et al., 2007) and finds no evidence of decoupling. When the business cycles of two countries are in the same phase, that is when both output gaps are positive or when both are negative, they are synchronous and the indicator is equal to 1. Otherwise, it is equal to -1. The major advantage of this approach is that a measure of business cycle interdependence can be computed for each year. As discussed in the previous paragraph, this is a very desirable characteristic to test for the presence of a structural break in recent years. The major drawback, however, is its binary nature. Consider two countries A and B, both having positive but very distant output gaps. Their business cycles are not very synchronised and yet, the binary measure is equal to 1. In contrast, suppose that country A has a very small, positive output gap, while country B has a very small, negative output gap. Their business cycles will be relatively close to each other and yet, the binary measure is equal to -1. Unlike correlation coefficients, therefore, the binary measure captures synchronicity, as defined by the coincidence of positive or negative output gaps, but takes no account of differences in the amplitude of business cycles.

In this paper, we propose an innovative measure of business cycle interdependence which conveys the same qualitative information as correlation coefficients, but which can be calculated for each year to allow for a proper identification of a structural break. We exploit the fact that the Euclidean distance between two standardized random variables provides the same information as a correlation coefficient (see Appendix A for a simple algebraic computation). The Euclidean distance between two business cycles can be computed for each year in the sample and like correlation coefficients, it takes differences in amplitude into account. In the one-dimensional case, the Euclidean distance is simply the absolute value of the numerical difference between two business cycles. Thus, our measure of business cycle interdependence between the business cycle of country i, denoted as g_i, and any of four groups of advanced economies a, denoted as g_a, in year t is given by

$$\phi_{i,a}(t) = |g_i(t) - g_a(t)| \tag{1}$$

When $\phi_{i,a} = 0$, the business cycles of emerging market i and the group of advanced economies a are perfectly in tune. Any positive value means less than perfect synchronisation; the larger is the distance between business cycles, the less interdependent they are. We will only present graphical evidence on the degree of business cycle interdependence between groups of emerging markets on the one hand (all emerging markets, Asia, Latin America, Eastern Europe), and four different aggregate groups of advanced economies, namely all advanced economies, the G7 group, the United States alone, and Europe.[2] The measure of interdependence for each group of emerging markets is simply the unweighted average of the Euclidean distance across group members. We have chosen the unweighted average to prevent very large countries from dominating the group measure of interdependence.

There are many different ways to define the business cycle. For example, Kose et al. (2008) focus on the rate of growth of real GDP as a measure of the business cycle. This procedure is flawed when comparing emerging market economies and advanced economies. Emerging markets are those countries which have experienced very high economic growth over the last twenty years or so, while advanced economies have typically had lower growth rates. Does this mean that they have decoupled in the sense that their rates of growth have become more distant? Clearly, no. The *trend* growth rate of emerging markets has increased significantly over the last twenty years but there is no indication that deviations from trend have diverged between emerging markets and advanced economies (see Wälti, 2009, for a discussion).[3] The correct measure of the business cycle is to extract the trend

[2]Results for specific emerging market economies can be obtained from the author upon request.

[3]Kose et al. (2008) decompose the real GDP growth rate in over 100 countries into three factors: a global factor, which picks up fluctuations that are common to all countries; an economy-type factor, which captures fluctuations that are common to countries within each of the three types of economies advanced, emerging, and developing; and a country-specific factor. These factors are estimated over two time periods, 1960-1984 and 1985-2005. During the second period, the share of the variation in growth rates explained by the global factor decreased. At the same time, the share explained by the economy-type factor increased for both advanced and emerging market economies. Kose et al. (2008) interpret this finding as decoupling between advanced economies and emerging markets, but stronger convergence of growth rates within both groups. But since trend growth rates diverged massively during the second time period, it must be the case that the share of the variation in actual growth rates explained by the global factor has decreased, and that the share explained by the economy-type factor has increased. This result obtains regardless of the evolution of business cycle synchronisation.

from a time-series of output and to compute the output gap of each country in the sample.

Data on gross domestic product at constant prices are retrieved from the October 2009 World Economic Outlook database provided by the IMF on its website. These data series are available at the annual frequency from 1980 onwards, including forecasts for the years 2009 to 2014. We use both the Hodrick-Prescott filter[4] and the Baxter-King filter to extract the time-varying trend from the original data. The business cycle is defined as the output gap, that is the difference between actual GDP and trend GDP, divided by trend GDP. The standardized business cycle is obtained by subtracting the mean of the output gap and dividing by its standard deviation. Accordingly, the standardized business cycle has zero mean and unit variance.

The Hodrick-Prescott filter features an end-point bias problem, whereby the last observation of the series has a disproportionate impact on the identified trend at the end of the series. One solution would be to drop the last observation but this is not desirable when testing the decoupling hypothesis. Since decoupling is supposed to have occurred in recent years, we really need all available observations at the end of the sample. Alternatively, we extend the sample period to include three years of forecasts (2009-2011) to extract the trend from the original data and then drop these years in the analysis of business cycle interdependence. As such, we exploit all available information on actual real output data, while avoiding the end-point bias problem. Similarly, to the extent that the Baxter-King filter loses three years of data at the end of the sample, we also extract the trend using this filter by extending the sample period by three years of forecasts. Figure A1 in the Appendix depicts the business cycles identified using the two filters. Both series are very correlated for all countries; only two countries have correlation coefficients below 0.95.

The sample period ranges from 1980 to 2008 when the Hodrick-Prescott filter is used, and 1983 to 2008 when the Baxter-King filter is used. We consider a large sample of thirty emerging market countries from different regions of the world: eight Asian economies (China, India, Indonesia, Malaysia, Pakistan, Philippines, Thailand and Vietnam), nine Latin American countries (Argentina, Brazil, Chile, Colombia, Ecuador, Mexico, Peru,

[4]We make use of a penalty parameter of 4 as suggested by Ravn and Uhlig (2002).

Uruguay and Venezuela), and thirteen Eastern European economies (Bulgaria, Croatia, Czech Republic, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Russia, Slovakia, Turkey and Ukraine). The four aggregate groups of advanced economies consist of either twenty-six advanced economies (Australia, Austria, Belgium, Canada, Cyprus, Denmark, Finland, France, Germany, Greece, Hong Kong, Iceland, Ireland, Israel, Italy, Japan, Korea, Netherlands, New Zealand, Norway, Portugal, Spain, Sweden, Switzerland, the United Kingdom and the United States), or the G7 group (Canada, France, Germany, Italy, Japan, the United Kingdom and the United States), or the United States alone, or a European group (Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, Switzerland and the United Kingdom).[5]

2.2 Results

Figures 1 to 4 depict the average degree of business cycle interdependence over time for, respectively, all emerging markets, eight Asian countries, nine Latin American countries and six Eastern European countries.[6] The upper part of each figure displays evidence based on the Hodrick-Prescott filter, while the lower part presents results obtained with the Baxter-King filter. Each graph shows the actual measure of business cycle interdependence (blue line) as well as a time-varying trend (red line).[7]

INSERT FIGURES 1 TO 4 HERE

Testing the decoupling hypothesis amounts to check visually whether the average distance between the business cycles of emerging markets and the business cycle of advanced economies has increased during the last decade. A visual inspection of the graphs in Figures 1 to 4 reveals that the average distance has *not* increased during the last decade. If anything, the degree of business cycle interdependence between emerging markets and

[5]We have calculated the output gap of aggregate groups of advanced economies using PPP GDP shares as weights.

[6]We only include the six Eastern European countries for which data are available throughout the whole sample period.

[7]This time-varying trend is computed using the Hodrick-Prescott filter for the time period 1980-2011 to avoid the end-point bias problem.

advanced economies seems to have become stronger in recent years, with the exception of Europe which does not display significant change over the sample period. Thus, our graphical approach provides no support for the decoupling hypothesis.

Doyle and Faust (2005) have emphasised the need for a proper statistical test to judge whether the degree of business cycle interdependence has changed over time in a statistical sense. In our context, however, such a test is not necessary. The null hypothesis (that decoupling has taken place) is that the average distance between the business cycle of emerging markets and advanced economies has increased. So long as it has decreased, no statistical test is required to reject the null hypothesis.

3 Econometric evidence on the decoupling hypothesis

The standard approach to test for a change in the slope of the regression line within a specific sub-sample of the data is to regress the dependent variable on an independent variable as well as an interaction term. The interaction term is the product of the independent variable and a dummy variable taking a value of unity for observations within the specific sub-sample for which the slope coefficient is expected to have changed, and zero otherwise.

3.1 Empirical strategy

We build on the approach of Levy-Yeyati (2009) and make use of pooled regression analysis to test for the decoupling hypothesis. The business cycles of emerging markets are pooled and regressed on each of the four aggregate business cycles of advanced economies separately, as well as an interaction term with a dummy variable taking a value of one for observations within a sub-sample of the data corresponding to recent years. Since we do not have any a priori information about the year in which the structural break could have happened, we allow the starting year of the sub-sample of recent years to vary between 1999 and 2007.[8] The econometric specification is given as

[8]Levy-Yeyati (2009) assumes that a structural break may have happened in 2001 but does not provide a sensitivity analysis for this assumption.

$$\text{GAP-EME}_{i,t} = \alpha + \beta\text{GAP-ADV}_t + \gamma\text{GAP-ADV}_t * \text{D}_t + \varepsilon_{i,t} \tag{2}$$

where GAP-EME_i is the business cycle of emerging market i, GAP-ADV is one of the four aggregate business cycles of advanced economies, and D is the dummy variable introduced to test for a structural break. The statistical significance of the coefficient γ provides a direct test of the decoupling hypothesis. A significantly lower degree of business cycle interdependence obtains when the coefficient γ is negative and statistically significant. This is easily seen by differentiating equation (2) with respect to GAP-ADV.

$$\frac{\partial \text{GAP-EME}_{i,t}}{\partial \text{GAP-ADV}_t} = \begin{cases} \beta & \text{when D} = 0, \\ \beta + \gamma & \text{when D} = 1. \end{cases}$$

Our sample includes thirty individual emerging markets over the time period 1980 to 2008. Coefficient estimates are obtained by pooled ordinary least squares.

3.2 Results

Table 1 presents estimates of the coefficients β and γ for different years in which the structural break may have occurred, and for each of the aggregate business cycle of advanced economies (advanced economies, the G7 group, the United States, and Europe). These baseline results focus on business cycles identified with the Hodrick-Prescott filter. Table A1 in the Appendix provides the corresponding results when business cycles are identified using the Baxter-King filter.

We find no evidence in support of the decoupling hypothesis. The coefficient on the interaction term is *positive* and statistically significant in all regressions, irrespective in which year the structural break is assumed to occur and irrespective of the specific aggregate business cycle of advanced economies. If there has been any structural break, it is towards greater business cycle interdependence between emerging markets and advanced economies in recent years. Moreover, the coefficient on the standardized output gap of advanced economies is generally also positive and statistically significant, with the excep-

Table 1: Baseline results[a,b]

	Structural break occurs in								
	1999	2000	2001	2002	2003	2004	2005	2006	2007
GAP-ADV	0.07*	0.09***	0.09***	0.10***	0.09***	0.11***	0.11***	0.11***	0.12***
	(0.04)	(0.03)	(0.03)	(0.03)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Structural break	0.56***	0.94***	0.93***	0.95***	0.94***	0.90***	0.90***	0.90***	0.89***
	(0.08)	(0.10)	(0.10)	(0.10)	(0.10)	(0.11)	(0.11)	(0.11)	(0.11)
GAP-G7	0.05	0.07**	0.07**	0.08**	0.09**	0.11***	0.11***	0.11***	0.12***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Structural break	0.59***	0.75***	0.75***	0.75***	0.75***	0.73***	0.72***	0.74***	0.73***
	(0.07)	(0.08)	(0.08)	(0.08)	(0.09)	(0.10)	(0.10)	(0.10)	(0.10)
GAP-US	0.16***	0.13***	0.13***	0.14***	0.16***	0.18***	0.19***	0.19***	0.19***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Structural break	0.41***	0.52***	0.70***	0.70***	0.71***	0.79***	0.80***	0.81***	0.89***
	(0.08)	(0.08)	(0.08)	(0.08)	(0.09)	(0.11)	(0.11)	(0.11)	(0.12)
GAP-EUROPE	−0.05	−0.04	−0.01	−0.02	−0.01	0.06	0.07	0.07	0.08*
	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)
Structural break	0.51***	0.49***	0.49***	0.53***	0.51***	0.44***	0.44***	0.50***	0.48***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Observations	784	784	784	784	784	784	784	784	784
Countries	30	30	30	30	30	30	30	30	30

[a] Standard errors in parentheses. * Significant at 10% level; ** significant at 5% level; *** significant at 1% level.
[b] All output gaps in this table have been computed using the Hodrick-Prescott filter.

tion of Europe. The evidence is strongest for the United States. Overall, our results are consistent with the empirical evidence showing that globalisation fosters business cycle interdependence. The results in Table A1 show that our results are robust to using the Baxter-King filter instead of the Hodrick-Prescott filter to extract the business cycle.

Tables A2 to A4 replicate the above analysis for three sub-samples of countries: Asia, Latin America and Eastern Europe.[9] Splitting the sample in such a way allows us to test whether the pattern of business cycle interdependence differs geographical regions. It may be the case that decoupling has occurred in one region only, and that pooling all individual emerging markets together hides this region-specific structural break. The results in Tables A2 to A4 are very clear. The rejection of the decoupling hypothesis extends to the three sub-samples of countries; none of Asia, Latin America and Eastern Europe have decoupled. Again, if anything, the degree of business cycle interdependence has increased in recent years.

4 Concluding remarks

This paper casts light on the decoupling hypothesis. Testing this hypothesis amounts to testing for a structural break in the degree of business cycle interdependence between emerging markets and advanced economies in recent years. Our graphical approach relies on an innovative measure of business cycle interdependence. This measure is based on the fact that the Euclidean distance between two business cycles conveys the same qualitative information as the correlation coefficient. However, a distance measure has the major advantage that it can be computed on an annual basis, thereby allowing for a proper test of a structural break. Our econometric approach follows the suggestion of Levy-Yeyati (2009) to use pooled regression analysis.

Both the graphical and the econometric approaches point to the same conclusion. There has been no decoupling between emerging markets and advanced economies in recent years. If anything, the degree of business cycle interdependence has become stronger. Since our

[9]See section 2.2 for the list of individual countries.

sample period ends in 2008, which marks the beginning of a major global crisis, it will be interesting to examine the influence of this crisis on business cycle interdependence once further data become available.

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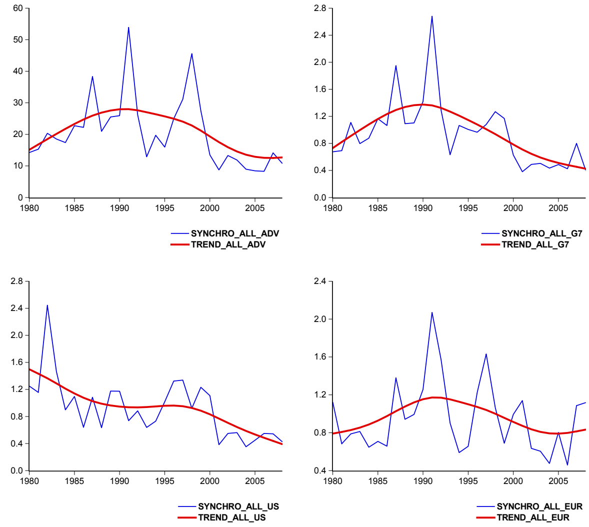
Figure 1: Euclidean distance: all emerging markets and four advanced groups

(a) Hodrick-Prescott filter



(b) Baxter-King bandpass filter

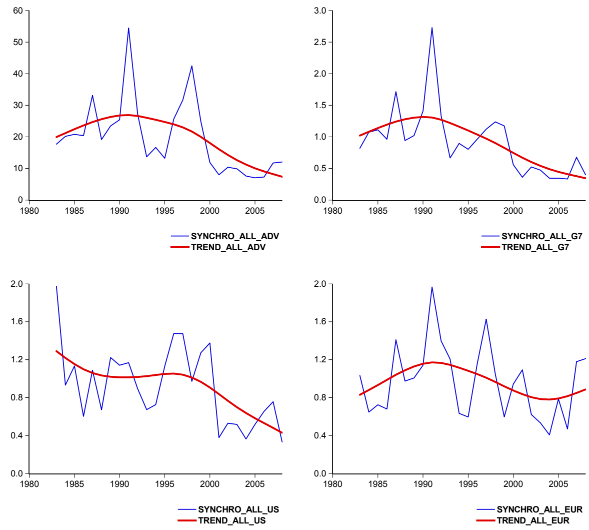
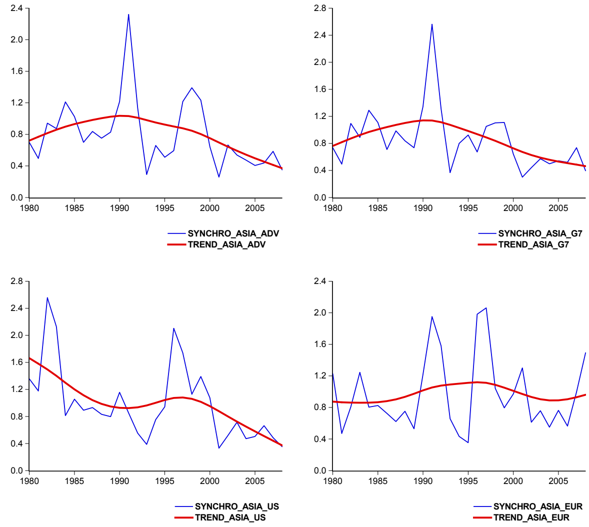


Figure 2: Euclidean distance: Asia and four advanced groups

(a) Hodrick-Prescott filter



(b) Baxter-King bandpass filter

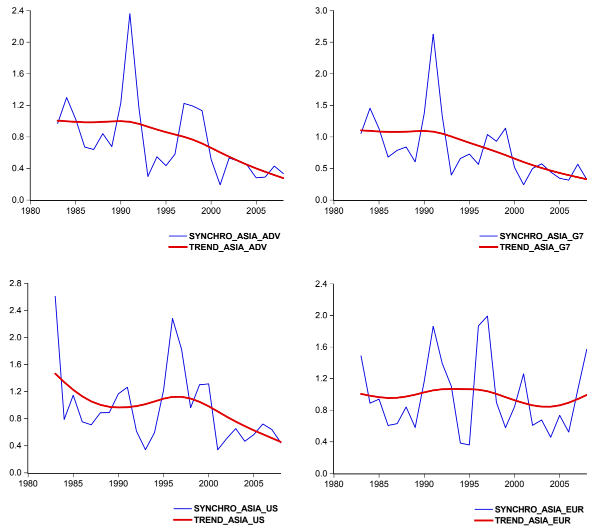
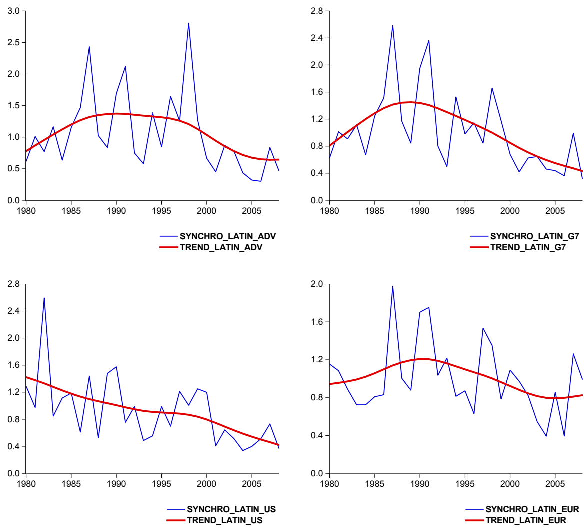


Figure 3: Euclidean distance: Latin America and four advanced groups

(a) Hodrick-Prescott filter



(b) Baxter-King bandpass filter

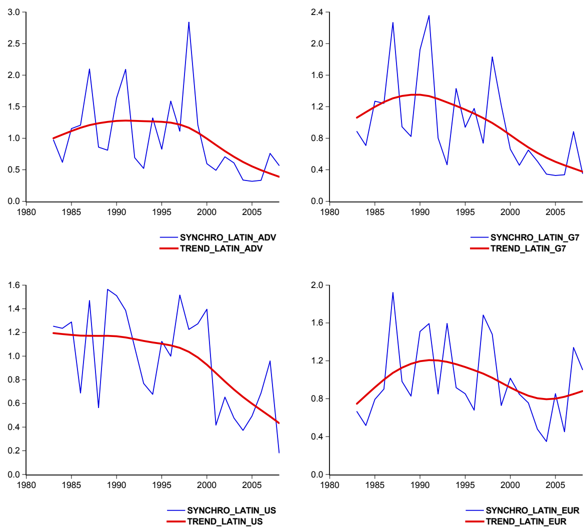
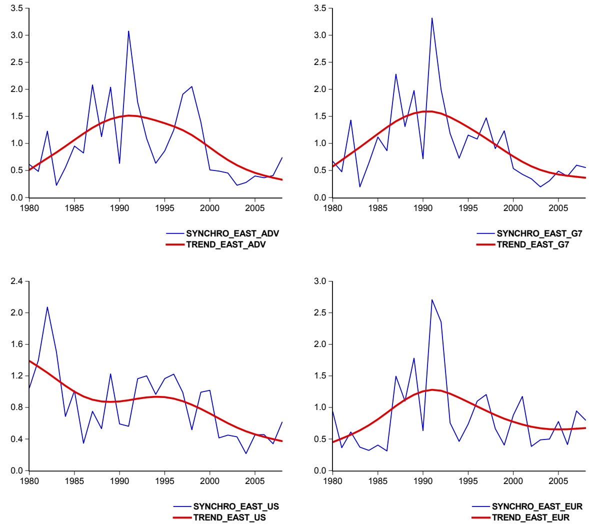
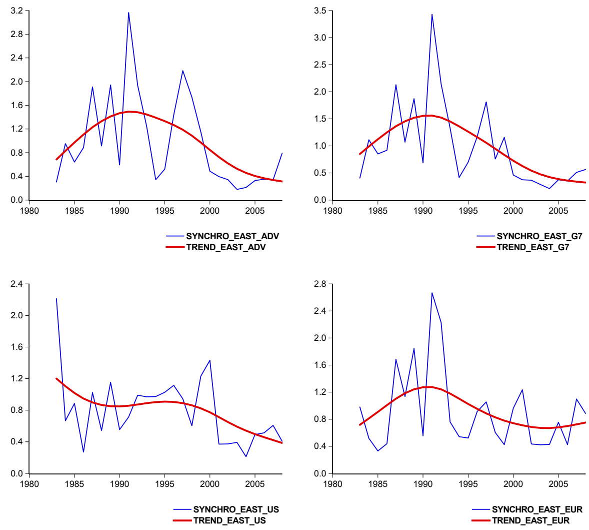


Figure 4: Euclidean distance: Eastern Europe and four advanced groups

(a) Hodrick-Prescott filter



(b) Baxter-King bandpass filter



A The correlation coefficient and the Euclidean distance

The correlation coefficient and the Euclidean distance convey the same qualitative information about interdependence for standardized random variables. The correlation coefficient between two random variables x and y, denoted as $\rho(x, y)$, is given as

$$\begin{aligned} \rho(x, y) &= \frac{cov(x, y)}{\sigma_x \sigma_y} \\ &= \frac{\frac{1}{n}\sum_{i=1}^{n} x_i y_i - E(x)E(y)}{\sigma_x \sigma_y} \end{aligned} \tag{3}$$

Suppose that x and y are standardized variables, so that they have zero mean and unit variance. Then, $E(x) = E(y) = 0$ and $\sigma_x = \sigma_y = 1$, and equation (3) reduces to

$$\rho(x, y) = \frac{1}{n}\sum_{i=1}^{n} x_i y_i \tag{4}$$

The Euclidean distance between two random variables x and y, written as $d(x, y)$, is given by

$$\begin{aligned} d(x, y) &= \sqrt{\sum_{i=1}^{n} (x_i - y_i)^2} \\ &= \sqrt{\sum_{i=1}^{n} x_i^2 + \sum_{i=1}^{n} y_i^2 - 2\sum_{i=1}^{n} x_i y_i} \end{aligned} \tag{5}$$

If x and y are standardized variables, then $\sum x^2 = \sum y^2 = n$. Thus,

$$d(x, y) = \sqrt{2n - 2\sum_{i=1}^{n} x_i y_i}$$

and using equation (4), we get

$$\rho(x,y) = 1 - \frac{d^2(x,y)}{2n} \tag{6}$$

The correlation coefficient is equal to one when the Euclidean distance is zero. For any strictly positive value of the Euclidean distance, the correlation coefficient will be strictly smaller than unity.

In the one-dimensional case, the distance between two points on the real line is simply the absolute value of their numerical difference. Therefore,

$$\sqrt{(x-y)^2} = |x-y| \tag{7}$$

Table A1: Sensitivity analysis: Baxter-King filter[a,b]

	Structural break occurs in								
	1999	2000	2001	2002	2003	2004	2005	2006	2007
GAP-ADV	0.05	0.09**	0.09**	0.09**	0.09**	0.10***	0.11***	0.11***	0.11***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Structural break	0.71***	1.07***	1.07***	1.08***	1.06***	1.08***	1.09***	1.09***	1.07***
	(0.08)	(0.10)	(0.10)	(0.11)	(0.11)	(0.11)	(0.12)	(0.12)	(0.12)
GAP-G7	0.02	0.07*	0.07*	0.07*	0.09**	0.11***	0.11***	0.11***	0.11***
	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Structural break	0.70***	0.85***	0.85***	0.85***	0.88***	0.92***	0.92***	0.92***	0.90***
	(0.07)	(0.08)	(0.08)	(0.08)	(0.09)	(0.10)	(0.10)	(0.10)	(0.10)
GAP-US	0.14***	0.11**	0.10**	0.11**	0.13***	0.14***	0.14***	0.14***	0.16***
	(0.05)	(0.05)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)	(0.04)
Structural break	0.36***	0.47***	0.67***	0.66***	0.67***	0.70***	0.70***	0.72***	0.77***
	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.09)	(0.09)	(0.09)	(0.09)
GAP-EUROPE	−0.15**	−0.12**	−0.07	0.07	−0.07	−0.02	−0.02	−0.02	0.00
	(0.06)	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Structural break	0.65***	0.62***	0.60***	0.63***	0.63***	0.58***	0.59***	0.65***	0.61***
	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.08)	(0.07)
Observations	694	694	694	694	694	694	694	694	694
Countries	30	30	30	30	30	30	30	30	30

[a] Standard errors in parentheses. * Significant at 10% level; ** significant at 5% level; *** significant at 1% level.
[b] All output gaps in this table have been computed using the Baxter-King filter. Some observations are lost because of missing data for some Eastern European countries.

Table A2: Sensitivity analysis: Asia[a,b]

	Structural break occurs in								
	1999	2000	2001	2002	2003	2004	2005	2006	2007
GAP-ADV	0.36***	0.35***	0.35***	0.35***	0.35***	0.36***	0.36***	0.36***	0.37***
	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Structural break	0.21	0.50***	0.49**	0.48**	0.46**	0.41*	0.39*	0.40*	0.40*
	(0.15)	(0.19)	(0.19)	(0.20)	(0.20)	(0.21)	(0.21)	(0.21)	(0.21)
GAP-G7	0.26***	0.26***	0.26***	0.27***	0.28***	0.29***	0.30***	0.29***	0.30***
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Structural break	0.30**	0.42***	0.42***	0.41**	0.37**	0.33*	0.33*	0.34*	0.35*
	(0.14)	(0.16)	(0.16)	(0.16)	(0.17)	(0.18)	(0.19)	(0.18)	(0.19)
GAP-US	0.03	0.02	0.04	0.04	0.06	0.09	0.09	0.09	0.09
	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Structural break	0.47***	0.57***	0.67***	0.66***	0.63***	0.67***	0.66***	0.67***	0.73***
	(0.15)	(0.15)	(0.16)	(0.16)	(0.18)	(0.22)	(0.22)	(0.22)	(0.24)
GAP-EUROPE	−0.03	−0.02	0.02	−0.00	0.01	0.06	0.07	0.07	0.08
	(0.10)	(0.10)	(0.09)	(0.09)	(0.09)	(0.09)	(0.08)	(0.08)	(0.08)
Structural break	0.38***	0.36***	0.33**	0.40***	0.38***	0.31**	0.29**	0.33**	0.32**
	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.13)	(0.14)	(0.14)	(0.14)
Observations	232	232	232	232	232	232	232	232	232
Countries	8	8	8	8	8	8	8	8	8

[a] Standard errors in parentheses. * Significant at 10% level; ** significant at 5% level; *** significant at 1% level.

[b] All output gaps in this table have been computed using the Hodrick-Prescott filter.

Table A3: Sensitivity analysis: Latin America[a,b]

	Structural break occurs in								
	1999	2000	2001	2002	2003	2004	2005	2006	2007
GAP-ADV	−0.12*	−0.07	−0.07	−0.07	−0.07	−0.05	−0.05	−0.05	−0.04
	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Structural break	0.71***	0.99***	0.98***	1.03***	1.01***	0.88***	0.88***	0.87***	0.87***
	(0.14)	(0.19)	(0.19)	(0.19)	(0.20)	(0.21)	(0.21)	(0.21)	(0.21)
GAP-G7	−0.12*	−0.08	−0.08	−0.08	−0.05	−0.02	−0.02	−0.02	−0.01
	(0.07)	(0.06)	(0.06)	(0.06)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Structural break	0.75***	0.87***	0.87***	0.89***	0.84***	0.72***	0.72***	0.72***	0.72***
	(0.13)	(0.15)	(0.15)	(0.15)	(0.16)	(0.18)	(0.18)	(0.18)	(0.18)
GAP-US	0.15**	0.14**	0.14**	0.14**	0.17***	0.20***	0.21***	0.21***	0.21***
	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Structural break	0.43***	0.54***	0.72***	0.73***	0.69***	0.60***	0.60***	0.61***	0.68***
	(0.14)	(0.14)	(0.15)	(0.15)	(0.16)	(0.20)	(0.21)	(0.21)	(0.22)
GAP-EUROPE	−0.18*	−0.16*	−0.12	−0.11	−0.09	0.01	0.02	0.02	0.03
	(0.09)	(0.09)	(0.09)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)	(0.08)
Structural break	0.63***	0.61***	0.58***	0.59***	0.56***	0.41***	0.40***	0.47***	0.45***
	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.12)	(0.13)	(0.13)	(0.13)
Observations	261	261	261	261	261	261	261	261	261
Countries	9	9	9	9	9	9	9	9	9

[a] Standard errors in parentheses. * Significant at 10% level; ** significant at 5% level; *** significant at 1% level.
[b] All output gaps in this table have been computed using the Hodrick-Prescott filter.

Table A4: Sensitivity analysis: Eastern Europe[a,b]

	Structural break occurs in								
	1999	2000	2001	2002	2003	2004	2005	2006	2007
GAP-ADV	0.02	0.04	0.05	0.05	0.05	0.06	0.06	0.06	0.07
	(0.06)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)	(0.05)
Structural break	0.69***	1.18***	1.18***	1.21***	1.20***	1.24***	1.24***	1.24***	1.22***
	(0.12)	(0.15)	(0.15)	(0.15)	(0.15)	(0.16)	(0.17)	(0.17)	(0.17)
GAP-G7	0.03	0.06	0.06	0.06	0.07	0.08	0.09	0.08	0.10*
	(0.07)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)	(0.06)
Structural break	0.66***	0.88***	0.88***	0.88***	0.94***	0.99***	0.99***	1.02***	0.99***
	(0.11)	(0.12)	(0.12)	(0.12)	(0.13)	(0.14)	(0.15)	(0.14)	(0.15)
GAP-US	0.31***	0.27***	0.24***	0.24***	0.26***	0.27***	0.27***	0.26***	0.28***
	(0.08)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)	(0.06)	(0.06)	(0.06)
Structural break	0.28**	0.40***	0.67***	0.66***	0.73***	0.96***	0.99***	1.02***	1.11***
	(0.12)	(0.12)	(0.13)	(0.13)	(0.14)	(0.16)	(0.17)	(0.16)	(0.17)
GAP-EUROPE	0.05	0.06	0.07	0.04	0.05	0.10	0.11	0.10	0.13*
	(0.09)	(0.09)	(0.08)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)	(0.07)
Structural break	0.47***	0.46***	0.50***	0.57***	0.55***	0.53***	0.55***	0.63***	0.59***
	(0.11)	(0.11)	(0.10)	(0.10)	(0.10)	(0.10)	(0.10)	(0.11)	(0.11)
Observations	291	291	291	291	291	291	291	291	291
Countries	13	13	13	13	13	13	13	13	13

[a] Standard errors in parentheses. * Significant at 10% level; ** significant at 5% level; *** significant at 1% level.
[b] All output gaps in this table have been computed using the Hodrick-Prescott filter.

Figure A1: HP and BK filtered output gaps, 1980-2008