



ADB Working Paper Series

Trans-Pacific Economic Relations and US-China Business Cycles: Convergence within Asia versus US Economic Leadership

Andrew Hughes Hallett and
Christian Richter

No. 292
June 2011

Asian Development Bank Institute

Andrew Hughes Hallett is professor of economics at the School of Public Policy in George Mason University, Arlington, VA and in the Department of Economics at the University of St Andrews, Scotland. Christian Richter is director of graduate studies at the Business School of the University of East London, London.

The authors would like to thank Choy Keen Meng for his valuable comments.

The views expressed in this paper are the views of the authors and do not necessarily reflect the views or policies of ADBI, the Asian Development Bank (ADB), its Board of Directors, or the governments they represent. ADBI does not guarantee the accuracy of the data included in this paper and accepts no responsibility for any consequences of their use. Terminology used may not necessarily be consistent with ADB official terms.

The Working Paper series is a continuation of the formerly named Discussion Paper series; the numbering of the papers continued without interruption or change. ADBI's working papers reflect initial ideas on a topic and are posted online for discussion. ADBI encourages readers to post their comments on the main page for each working paper (given in the citation below). Some working papers may develop into other forms of publication.

Suggested citation:

Hughes Hallett, A., and C. Richter. 2011. Trans-Pacific Economic Relations and US-China Business Cycles: Convergence within Asia versus US Economic Leadership. ADBI Working Paper 292. Tokyo: Asian Development Bank Institute. Available: <http://www.adbi.org/working-paper/2011/06/28/4622.transpacific.economic.relations.us.prc/>

Please contact the author(s) for information about this paper.

Email: ahughesh@gmu.edu; c.richter@uel.ac.uk

Asian Development Bank Institute
Kasumigaseki Building 8F
3-2-5 Kasumigaseki, Chiyoda-ku
Tokyo 100-6008, Japan

Tel: +81-3-3593-5500
Fax: +81-3-3593-5571
URL: www.adbi.org
E-mail: info@adbi.org

© 2011 Asian Development Bank Institute

Abstract

This paper tests the hypothesis that the links and leadership/dependency relationships between the People's Republic of China (PRC), the United States (US), and the other large Asian economies have changed over the past 20 years with the industrialization of the PRC economy. We use time-varying spectral methods to decompose the links between seven advanced Asian economies and the US. We find: (a) the links with the US have been weakening, while those within a bloc based on the PRC have strengthened; (b) that this is not new—it has been happening since the 1980s, but has been partly reversed by the recent surge in trade; (c) that there are two blocs within the Asian economic area: one based on Japan and the Republic of Korea and the other on the PRC and her satellites; (d) that product composition is responsible for this division (and for some movement between the blocs); and (e) that the links between the PRC and the US are rather complex, with the US able to shape the cycles elsewhere through her control of monetary conditions, but the PRC able to control the size of the cycles at home and (to some extent) abroad.

JEL Classification: C22, C29, C49, F43, O49

Contents

1.	Introduction.....	1
2.	Empirical Results: Single Country Spectra.....	3
3.	Changing Trans-Pacific Economic Relationships?.....	9
4.	Increased Coherence among the Asian Economies?.....	17
5.	One Bloc or Two?	20
6.	Conclusions	27
	References	28

1. INTRODUCTION

That the balance of economic power between the United States (US), G8 economies, the People's Republic of China (PRC) and the emerging economies of Asia has changed dramatically in the past two decades is a popular hypothesis for which there is a great deal of casual evidence. But there have been no formal studies or assessments of the strength and form of those trans-Pacific linkages, how they have changed, whether the PRC and the Asian economies now form a coherent economic bloc to rival the US, or whether US dominance has passed to the PRC and her partners.¹

This hypothesis is based on the economic reality of the PRC as one of the world's largest trading economies; on the increasing sophistication of Japan the Republic of Korea (hereafter Korea), and Taipei, China as investors and manufacturing centers for network trade; and on Singapore or Hong Kong, China as suppliers of finance and investment, all of which have changed the dependency relationships between many economies in the Asia-Pacific area.² It used to be that the US was the dominant economy, and hence the locomotive (or economy of first resort) through her consumption of final and intermediate products, trade in sophisticated manufactures, and her supply of investment capital and financial stability when exchange rates were fixed. But the rise of the PRC and her Asian partners may have changed all that. In addition, their rapidly expanding stocks of foreign assets, acquired through the large and continuing trade imbalances in the region, give them a certain influence over monetary conditions and financial stability.

These are the ideas we try to evaluate here. Enhanced trade and integration effects come in three parts: increased economic convergence (coherence, correlation), increased impact (or spillovers) from developments in one economy onto another, and stronger lead/lag relationships between economies (a lead for those supplying materials or intermediate inputs, a lag for those consuming manufactures or services or supplying investment goods or finance).³ We examine all three; focusing on measures of coherence, gain, and phase shifts respectively. We then ask: to what extent are growth cycles more correlated among the Asian economies, signaling perhaps a Chinese economic block to rival US hegemony? Is there evidence of US-PRC convergence at business cycle or other frequencies? Does that imply a common business cycle and scope for coordinated, if not common, policies?

We are not aware that this has been attempted before, although some papers have examined the relationships between the PRC and her Organisation for Economic Co-operation and Development (OECD) neighbors.⁴ A selective reading of the convergence literature would allow us to reach almost any conclusion. Hence, finding a way to measure the strength of the linkages/dependencies between economies that is better than computing the usual correlations of national output over a particular time period would be an important advance. In this paper we show how to use time-varying spectral analysis to determine the degree of convergence at different frequencies and cycles, even where data samples are small and structural breaks and changing structures are a part of the story. The inconclusive results obtained in the past, particularly for the Euro area, may have been the result of using correlations which average the degree of contemporaneous convergence across all frequencies. That is problematic: two economies could share a trend or short-term shocks

¹There are studies for Europe, for the PRC, and her satellite economies (Hughes Hallett and Richter 2008, 2009), and for the financial markets (Hughes Hallett and Richter 2004, Pinho and Madaleno 2010).

²This paper uses the names of ADB members as listed in the ADB Handbook of Style and Usage: People's Republic of China (PRC); Hong Kong, China refers to the Hong Kong economy; and Taipei, China to the economy whose largest city is Taipei. China is used to mean the collective of those economies.

³As shown in Chaplygin, Hughes Hallett, and Richter (2006), for example.

⁴See Sato and Zhang (2006), Shin and Sohn (2006), Shin and Wang (2004), and Kocenda and Hanousek (1998).

but show no coherence between their business cycles.⁵ Or they might share similar cycles but one as a supplier of inputs or capital to the other, so they are out of phase. That would imply low and possibly negative contemporaneous correlations, but give no picture of the true linkage or dependence between them at other frequencies or other lead/lags.

Theoretical growth models show that every economy approaches a steady-state income level determined by the discount rate, the elasticity of factor substitution, the depreciation rate, capital share, and population growth. Once at steady state, the economy grows at a constant rate. So, to the extent that the determinants of the steady state are similar across economies, convergence is to be expected. But if those determinants are different, they will not converge. Thus, Mankiw, Romer, and Weil (1992); Dowrick and Nguyen (1989); and Barro and Sala-i-Martin (1991, 1992) find evidence of convergence for a sample of OECD countries at similar levels of development over the years 1960–1985. But they reject that hypothesis in a wider sample of 75 economies whose structures and levels of uncertainty vary a good deal more. Similarly, Chauvet and Potter (2001) report that the US business cycle was in line with the G7 from the mid 1970s, but diverged thereafter. Likewise, Stock and Watson (2002, 2005) and Hughes Hallett and Richter (2006) find divergence caused by structural breaks, and argue that cyclical convergence is a global rather than regional phenomenon. In that vein, Artis and Zhang (1997) and Frankel and Rose (1998), have argued that if exchange rates are pegged and trade and financial links intensify, business cycles are likely to converge. But in practice, Inklaar and de Haan (2000) do not find any evidence for a common business cycle in the Eurozone. Likewise, Gerlach (1989) and Baxter and Kouparitsas (2005) find no evidence of convergence among the OECD economies as exchange rates stabilized or trade increased⁶.

A common feature of all these studies is that the results are sensitive to: a) the choice of coherence measure (correlation, concordance index), b) the choice of cyclical measure (classical, deviation or growth cycles), and c) the “detrending” measure used (linear, Hodrick-Prescott filter, band pass, etc.). This sensitivity to the detrending technique is a difficulty highlighted in particular by Canova (1998). The advantages of a time-frequency approach are therefore:

It does not depend on any particular detrending technique, so we are free of the lack of robustness found in so many recent studies.⁷

Our methods also do not have an “end-point problem”—no future information is used, implied or required as in band-pass or trend projection methods.

There is no arbitrary smoothing parameter, such as in the HP algorithm, equivalent to an arbitrary band-pass selection (Artis, Marcellino, and Prioretti 2004).

Any spectral approach, however, is based on a weighted sum of sine and cosine functions. That is not restrictive. Any periodic function can be approximated arbitrarily well over its entire range, and not just around a particular point, by its Fourier expansion (a suitably weighted sum of sine and cosine terms). Hence, once we have time-varying weights, we can obtain almost any cyclical shape we want. For example, to get long expansions but short

⁵ As shown by Fidrmuc and Batorova (2008).

⁶ In practice it seems that cyclical correlations typically fall with the degree of industrial specialization, and the latter increases as trade and financial integration intensify (Kalemli-Ozcan, Sorenson, and Yosha 2001, 2003). But market reforms, liberalisation measures, and the extent to which policies are coordinated or made common to a group of economies, may have the opposite effect: Kalemli-Ozcan, Sorenson, and Yosha (2003); and Peersman and Smets (2005).

⁷ Using first differences of Gross Domestic Product (GDP) to generate growth rates is a form of filter which could alter the data-generating process. However, for policy purposes, we are interested in the relationships between growth rates. We do not need to filter the growth rate (as opposed to GDP) any further. Put differently, this point highlights the usual dichotomy between growth cycles vs. classical cycles: do you want to analyze cyclical convergence or level convergence? Obviously, since the issue is the scope for a common approach to policy, we want the former here.

recessions, the typical shape of economic cycles, we need only a regular business cycle plus a longer cycle whose weight increases above trend but decreases below trend (i.e., varies with the level of activity). This is important because many observers have focused on how the shape of economic cycles has changed over time in terms of amplitude, duration, and slope (Harding and Pagan 2001; Peersman and Smets 2005; Stock and Watson 2002). It implies that a time-varying spectral approach, capable of separating out changes at different cyclical frequencies in the economy, will be needed to provide the flexibility to capture these features.

Similarly, a time-varying approach will be necessary if we are to accommodate the structural breaks that must be expected with the PRC emerging as one of the largest trading economies; Japan as major investor and consumer of components; the increasing sophistication of Taipei, China or Korea in terms of trade in manufactures, components, and investment; changes to the supply chain of components or inputs to/from PRC; Taipei, China; or Korea through network trade; and changes to the size and composition of trade imbalances with the US. All these changes argue for a time-varying approach to measuring the coherence between national economies. They also argue for a decomposition of the different cycles that make up an economy's performance. One cannot expect increased linkages through traded components or manufactures to affect those economies at the same cyclical frequencies as those due to long-term investment or short-term financing. Hence we have chosen to use a time-frequency approach.

The paper is structured as follows. This section introduced the idea of a time-frequency approach. The estimation technique is exactly that used in Hughes Hallett and Richter (2004, 2008, 2009) and the details may be found there. Section 2 then presents the single country spectral results. Section 3 presents the cyclical relationships between the core economies in the Asia-Pacific region: the PRC, Japan, and the US. Section 4 does the same for the smaller economies involved in network trade. Section 5 examines whether a common economic bloc has emerged in Asia and concludes that there are two. Section 6 concludes.

2. EMPIRICAL RESULTS: SINGLE COUNTRY SPECTRA

For countries in the Asia-Pacific region, and for the US itself, GDP will be expressed in US dollars over the entire sample. We use the International Monetary Fund's (IMF) *International Financial Statistics* database to ensure that price deflations, seasonal adjustment and exchange rate conversions are applied consistently to each country. Growth rates are then defined, using real GDP data, as:

$$y_t = \Delta(\log(Y_t)) = \log\left(\frac{Y_t}{Y_{t-1}}\right) \quad (2.1)$$

Next we employ a two-step procedure. As Evans and Karras (1996) have shown, if business cycles are to converge, they need to follow the same AR(p) process. We therefore estimate an AR(p) process for each variable individually. That is, we estimate the data-generating process of each of the growth rates separately. Then we estimate the bilateral links between the cycles in those growth rates and calculate the spectral and co-spectral results we need from those estimated time series relationships. Our earlier work, already cited, shows the technical details of how we do that and how the diagnostic tests of the significance of our results are applied.

In this section and the next, we study the spectra and cross-spectra of output growth in selected Asian economies compared to the US, or compared to the PRC and Japan, over the past 20 years. We take the US, PRC, and Japan to be the leading economies ("economies of first resort") in the Asia-Pacific area and analyze the changing relations between them. Then we analyze the changing relations between them and other major

manufacturing/investing economies in the region (Korea; Taipei,China; Hong Kong, China; and Malaysia), since the Asian crisis of 1996–1997. Similar results for the changing relations between the US and the United Kingdom, and the US versus the Eurozone, will be found in Hughes Hallett and Richter (2006) and provide a benchmark for these comparisons.

We use the IMF *International Financial Statistics* database for all economies, except Taipei,China. All GDP observations are quarterly data, deflated by the IMF statistical service and expressed in US dollars. They are also seasonally adjusted by the IMF. Finally, we log difference the GDP data which results in the (quarterly) growth rate. We use seasonally adjusted quarterly data from the fourth quarter of 1987 to the third quarter of 2006. The sample starts earlier for Hong Kong, China (1977); Taipei,China (1984); and the US (1982), but later for Malaysia (1990). The analysis will be restricted, however, to the period following the stock market and financial crash of 1987. The Taipei,China data is taken from the economy's national statistical service, and the PRC data is augmented with quarterly figures supplied by the PRC national statistical office.

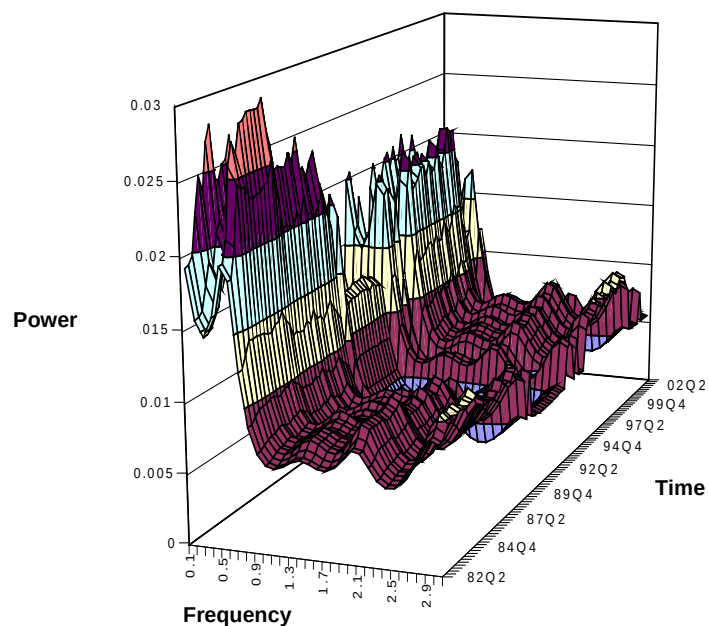
The resulting data are then fitted to a time-varying AR(p) or ADL(p,q) model, estimated using a Kalman filter, then tested for “stationarity”, statistical significance, and subjected to various diagnostic, specification, and parameter stability tests, before being converted into spectra and cross-spectra by direct calculation. The required coherence, gain, and phase shifts are then extracted in each case using standard techniques.

a) The Core Economies: the US, the PRC, and Japan. One striking feature of the individual country spectra is that, in all three core economies, the trend growth rate has come to play a diminishing role in terms of spectral mass. Indeed, taking into account the vertical scale in each diagram, there is very little volatility in output growth of any kind in the PRC after 1987 (Figure 2), except at the business cycle frequency, defined as between 2 to 6 years in length, and only then until the period of especially rapid trade growth and trade surpluses from 2004 onwards. This is in contrast to the US spectrum (Figure 1), which shows the declining power of trend growth after 1987 and mildly increasing volatilities at short-to-medium cycle lengths over the same period. There is a clear persistence in her trend growth rates nonetheless.

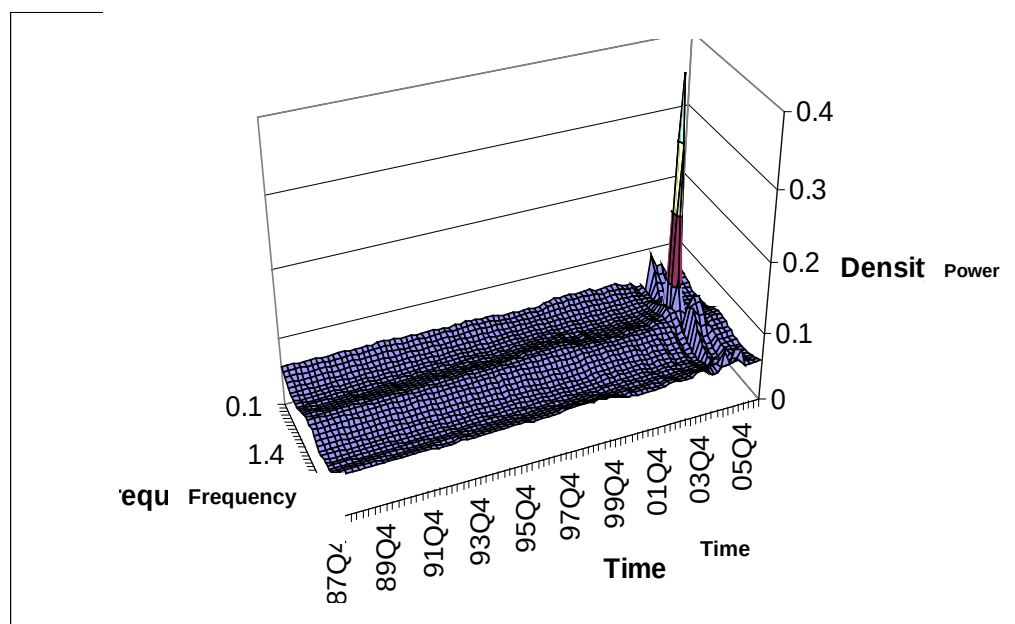
Figure 1 shows that the US spectrum used to be dominated by long cycles at frequencies of between 0.1 and 0.5, equivalent to cycles of between 60 and 12 quarters in length. However, the dominance of that band has diminished over time. Clearly visible also are the financial problems in the early 1990s, which led to increased uncertainty reflected here in the breakdown of the long cycle. At the end of the sample the old dominance is restored although at a lower level of power. Lastly, the US cycle is characterized by some noise. Given that the long cycles have lost importance, this feature indicates that the US has become more flexible over time since the relative weight of the shorter cycle has increased.

The business cycle is therefore weak (but not entirely absent) in the PRC before 2004, but more important thereafter. This is the result of the rising importance of trade in the GDP of each economy; and hence the rising share of trade, but falling *share* of investment in the PRC-US linkages, especially after 2004.

In making these points we draw a distinction between persistent trends, that is events whose effects on performance last a long time before they die away or are overtaken by subsequent events, and constant growth trends whose effects are persistent and always the same in terms of economic performance. Obviously the former implies some variance in the outcomes, if only slowly changing, and hence some long cycle power in the associated spectrum. But the latter implies no effective variance in the outcomes, and hence no power in the corresponding spectrum at low frequencies (or anywhere else).

Figure 1: Spectrum of the US Growth Rate

Source: Author's calculations.

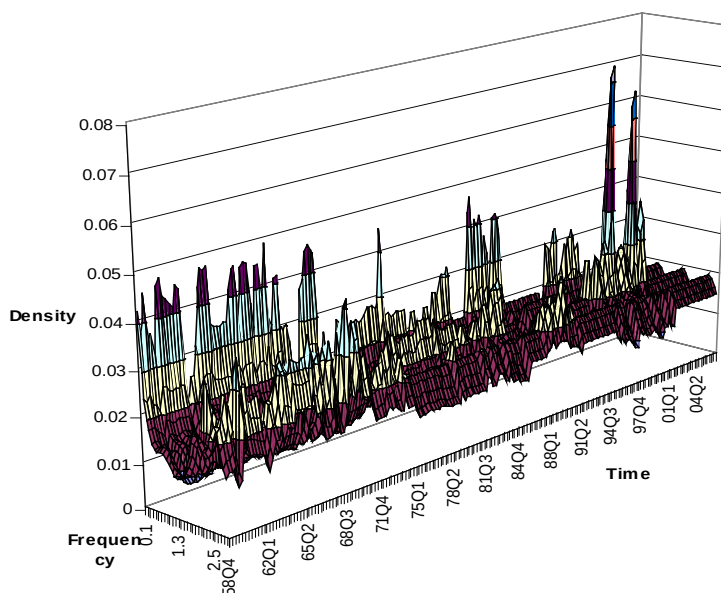
Figure 2: Spectrum of the PRC Growth Rate

Source: Author's calculations.

Figure 3 shows the Japanese spectrum. The Japanese spectrum is based on an AR(7) model. Like in the US, the dominant cycle is the long cycle; but the spectrum is more volatile than the US. And like the US, the dominance of the long cycle is decreasing. Toward the end of the sample two new cycles emerge: at a frequency of 1.3 or 4.8 quarters and at a

frequency of 2.5 or 2.5 quarters. The financial crisis in Japan has clearly contributed to the decline of the long cycle and the appearance of shorter cycles. After 1990 the long cycle effectively disappeared altogether. At the same time, noise is not as important as in the US. So there are similarities between the US spectrum and the Japanese spectrum and their changes, although the Japanese one shows more volatility. Thus, despite the similarity between the two countries in trend and cyclical behavior, there is diversity in terms of volatility. So similarity and diversity can go together. Finally, the similarity of the two spectra suggests there may be a close link between the two countries, which will be confirmed when we look at the coherence between the two national cycles.

Figure 3: Spectrum of the Japanese Growth Rate



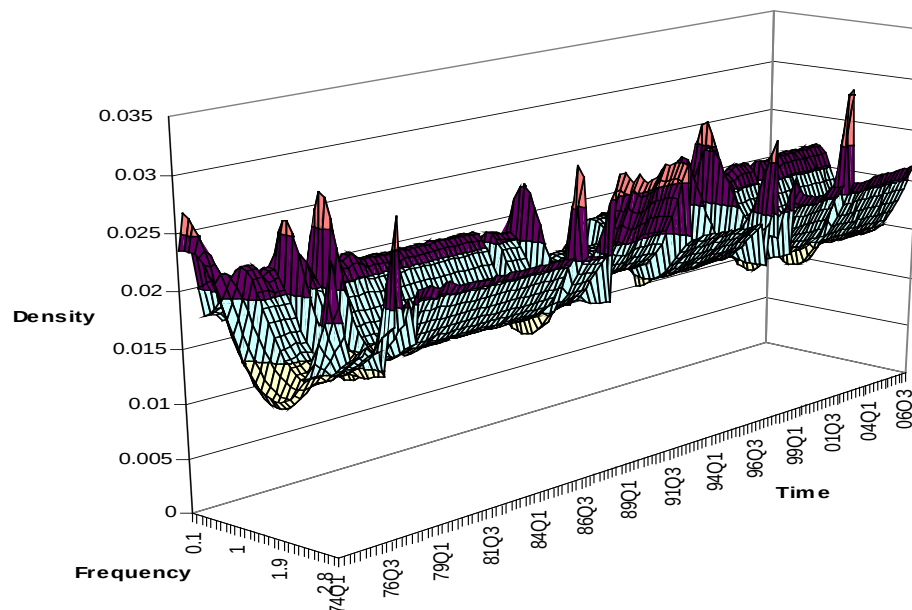
Source: Author's calculations.

The US-PRC linkage: There may have been changes in these two economies; but not changes that have altered the growth pattern in the US in any significant way, or the growth patterns in the PRC for that matter (except in the period after 2003). That is not to say that the economic relationship between the two has not changed. But if it has, it must have been a change involving outsiders; or more likely, a change that involved a reallocation of roles between the economies of the Asia-Pacific area. The latter appears more likely because the pattern of structural (regime) breaks shows little in common taking each economy separately. Had they been settling into a new regime, there would have been something in common in the structural breaks as each economy entered that regime. As it is, the US is only showing structural breaks in 1996 and 2001 (the Clinton-Greenspan boom), while the PRC shows small breaks in 1993 and 1995 (the start and finish of the high inflation period), 2000 and 2002 (the onset and end of deflation), and then a very large one in 2004–2005 (expansion of trade, curtailing of PRC imports). With a pattern like that, these breaks are far more likely to reflect changes in the domestic economies than in the trade or financial links between them.

b) Other manufacturers: Korea; Taipei,China; and Malaysia. We now turn to the economies principally involved with components and the network manufacturing. Figure 4 shows the Korean spectrum. This spectrum is rather different from those of the core economies. It is based on an AR(3) model and has power at both the long and short cycles, but rather less at business cycle frequencies. It also appears to be stable, apart from an interruption in the early 1990s. The Korean spectrum is characterized by a short business cycle at a frequency of 0.8 or 8 quarters. However, that cycle collapsed during the early 1990s when a temporary cycle of a shorter frequency of 1.9 or 3.5 quarters appeared. That

cycle disappeared again at the end of the 1990s, only to reappear at the end of the sample. Korea also contains a long cycle, but is generally less volatile than Japan. And like Japan, there is a new business cycle at the end of the sample. So there seems to be a common development between Japan and Korea at the end of the sample, and similar behavior during the rest of the sample.

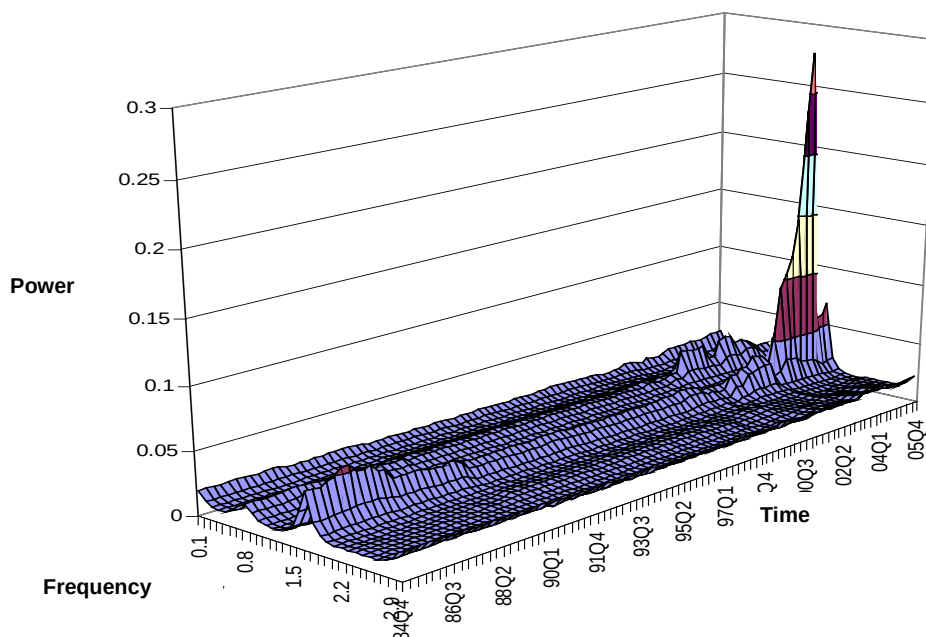
Figure 4: Spectrum of the Korean Growth Rate



Source: Author's calculations.

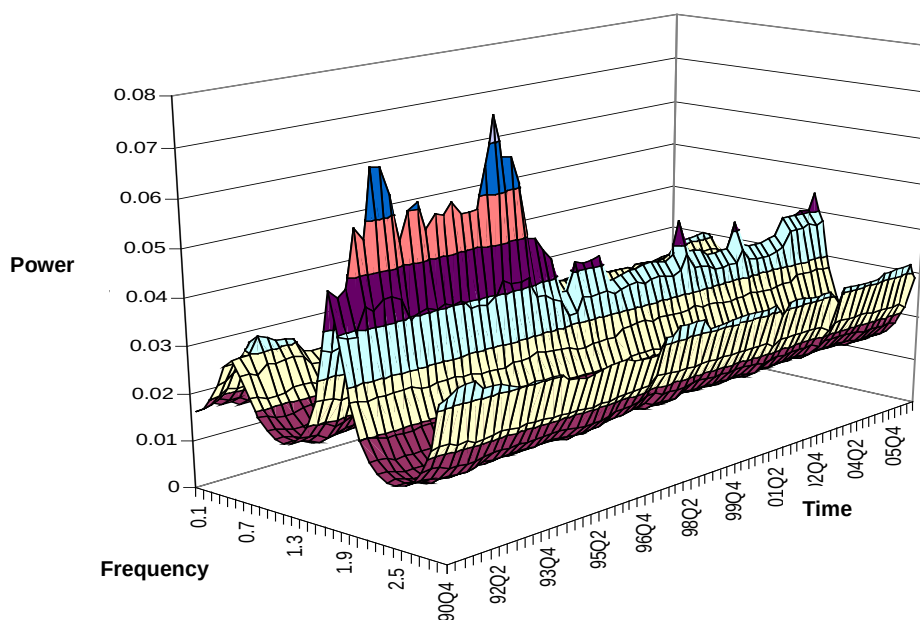
Taipei,China (Figure 5), by contrast, appears to be similar to the PRC. The Taipei,China spectrum has no power at long cycles or trend growth and very limited power at business cycle frequencies (with the exception of a ridge at those frequencies and a spike in 2003–2005). In that respect the Taipei,China economy is the most similar to the PRC economy, but with less power at the business and trend growth cycles.

Malaysia (Figure 6) meanwhile is different again in that it has power and significant volatility at the business cycle and short cycle frequencies. But this has not changed since 1996 when the economy's growth appears to have stabilized and there is rather little power at long cycles or trend growth.

Figure 5: Spectrum of the Taipei,China Growth Rate

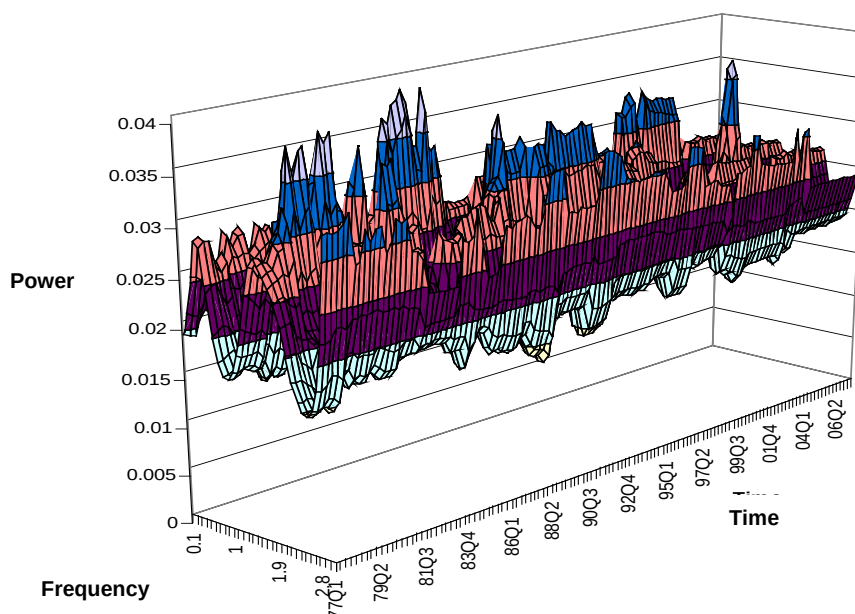
Source: Author's calculations.

Service economies and financial markets: The spectrum for Hong Kong, China is quite different from those we have seen so far, reflecting their greater diversification through the Asia-Pacific area as suppliers of investment and financial services. Hong Kong, China has, on the face of it, little in common with the PRC or Taipei,China other than the fact that it has rather low power over all frequencies. Instead, power is concentrated at business cycles and the short end of the spectrum and has been so since the 1980s, strengthening in good times, but weakening at others (in the early 1990s, at the hand over in 1997, and since 2004).

Figure 6: Spectrum of the Malaysian Growth Rate

Source: Author's calculations.

Figure 7: The Spectrum of Hong Kong, China



Source: Author's calculations.

c) Commentary: An interim conclusion at this stage is that there has been no great change in the growth patterns of these economies in the past two decades, with the exception of some increases in volatility in business cycles at the time of the Asian crisis, and also since 2004 in the PRC; Japan; Taipei, China; and (possibly) Hong Kong, China. This makes it hard to see if there is an emerging group of economies in the Chinese sphere with common cyclical and economic behavior. We suspect not. But to establish that, we need to see if the within-group coherences and gains have increased and if those out-of-group, with the US in particular, have decreased at the same time. Even so, the low spectral power in PRC area economies shows they are all influenced by similarly stable growth rates. That much they do have in common, in contrast to the US. But it is certainly not a new phenomenon; such similarities have existed since the 1980s.

3. CHANGING TRANS-PACIFIC ECONOMIC RELATIONSHIPS?

We now turn to the coherence, or correlations, between the economic cycles of our core economies at different frequencies, and whether those coherences have increased or decreased over time. These results will supply, first, a test of the hypothesis that the Chinese economies form a coherent group, more similar in their performance than with those outside their area, and could therefore be regarded as an emerging regional bloc. Second, it will show if their dependence on the US has decreased as the strength of the linkages between those in the PRC group has increased. Third, we can test the argument that, if exchange rates are pegged, then business cycles will converge as trade and financial links intensify. The advantage of our approach is that we have a ready-made control group: the PRC; Hong Kong, China; and the US have maintained (mostly) fixed exchange rates over the sample period; but the Korean won, the NT dollar and the Malaysian ringgit have all followed flexible rates. If the convergence shows up in the Taipei, China or Korean cycles, but not in the PRC-US cycles, then fixed exchange rates/financial integration are not sufficient.

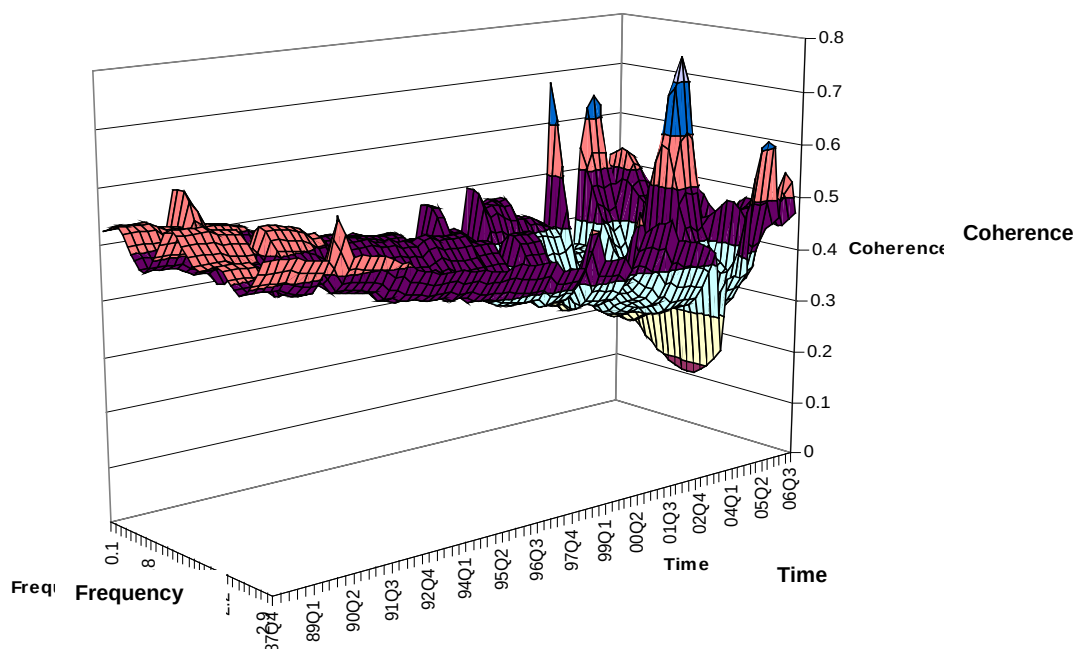
a) Coherence between the leaders: the US and the PRC.

We first examine the coherence and gains: that is, the cyclical association and spillover effects between the two largest economies in the Asia-Pacific region. From the PRC-US relationship (“US affects PRC”, Figure 8), we can see that the coherence has been declining from 1987 to 2001, but that it remained at a reasonably high level of 0.4 to 0.5 throughout⁸.

However, it increased again rather abruptly in 2001, to imply a stronger if somewhat uncertain influence (there are several interruptions in this increased coherence) of US growth on the PRC economy at long, short, and (most of all) business cycle frequencies from 2004 to 2006. From the underlying regression, we can see that these fluctuations are largely caused by the PRC lag and not by the US lag, whose value remained constant and stable over the entire sample.

The gains (Figure 9), however, show the impact of US growth on the PRC economy to be small with multipliers of below 0.08 per unit change in US output, and declining until 2002. But there is a sudden increase in the US influence at short, long, and business cycle frequencies from 2003–2004. So much so that, by 2005, the spillovers onto the PRC had settled back to the levels previously reached in 1990–1991. This is partial support for our first hypothesis, but not quite as expected. US dominance and the economy of first resort effects have declined with respect to the PRC as hypothesized, but slowly and only up until 2002. The recent surge in trade with the US, based as it is expanding exports and import substitution in the PRC, has now reversed that decline although the influence of the US on the PRC remains small.

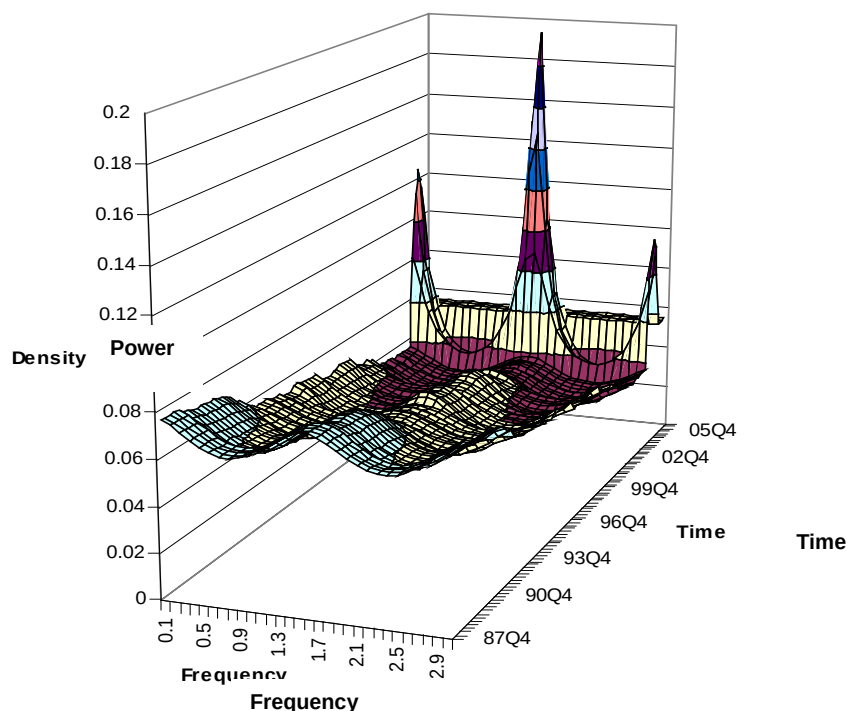
Figure 8: Coherence between the PRC and the US: “PRC-US”



⁸ Note that each coherence/gains relationship implies a direction of causality, and hence different degrees of association or spillover effects, depending on whether we are looking at how much US growth affects growth in the PRC or how much PRC growth affects the US performance. We therefore get different results, and different implications, depending on whether the underlying regressions specify PRC growth to be a function of US growth rates, or US growth as a function of PRC growth. Coherences can therefore imply that one growth pattern is more closely associated or dependent on another, than holds in reverse (the dependence/association of the second on the first). Coherence therefore measures the generalized closeness of fit between two variables x and y , rather than a simple correlation coefficient which is symmetric. Gains likewise measure the impact effects of growth in one economy on another, and therefore vary with the direction in which the linkage is said to run.

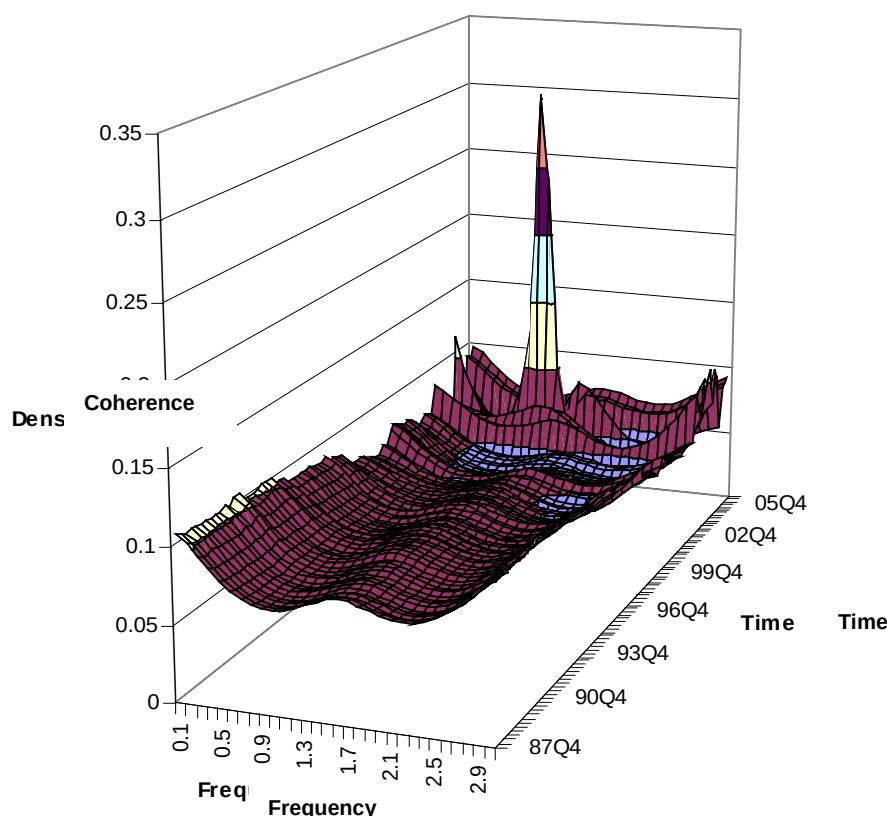
Source: Author's calculations.

Figure 9: Gain between the PRC and the US: “PRC-US”



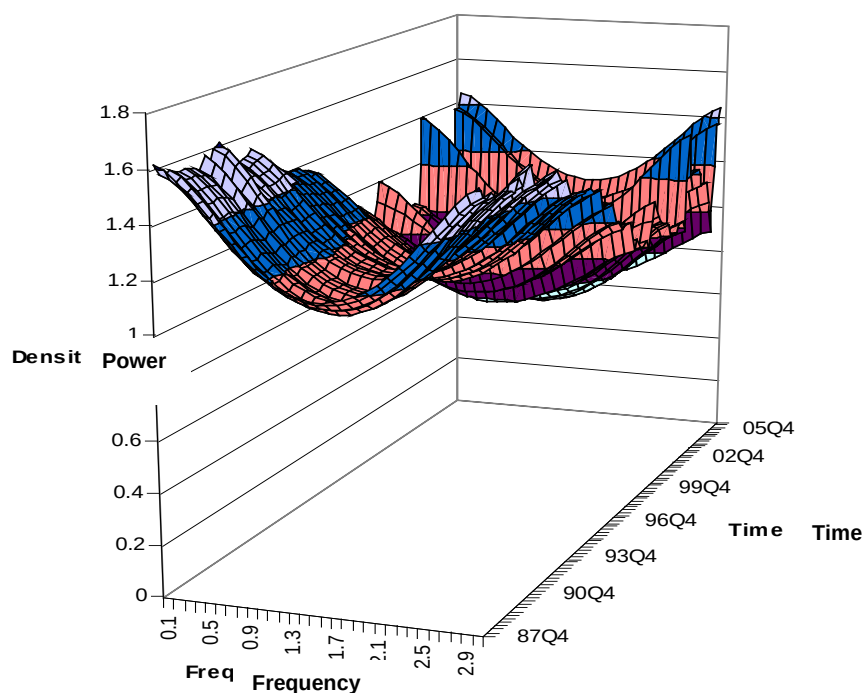
Source: Author's calculations.

In the light of these results, it is important to see if the counterpart is true: if the PRC's impact on the US economy has also been increasing. We might expect to see the PRC to US gains (Figure 11) and coherence (Figure 10) to be increasing with the expansion of trade and financial flows between the two, in the same way as the US to PRC coherence and gains increased. And to some extent we do. The US-PRC coherence is fairly low and falls steadily (from 0.1 to 0.05) up until 2001, just as the PRC-US coherence did. It then jumps back up to 0.1 (and temporarily up to 0.3 at business cycle frequencies) and remains at that level. In the same way, the US-PRC gain (the impact of PRC growth on the US) is high but falls steadily until 2001, then recovers sharply to values similar to those of the early 1990s—again similarly to the PRC-US case, although this has happened more at long and short cycles than at business cycles. That suggests a change in the phase relationship. If there were such a change, then the strength of the coherence or gain must increase at some frequency, and decrease at another, while the change itself takes place.

Figure 10: Coherence between the US and PRC: “US-PRC”

Source: Author's calculations.

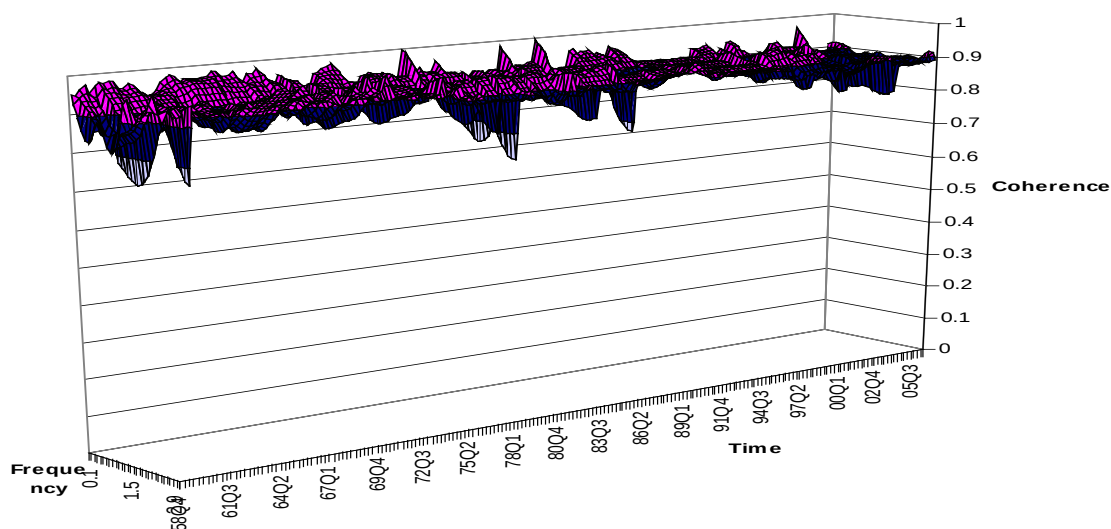
These results suggest a continuing linkage between the PRC and the US, based on the assumed leadership of the US economy in the 1980s and 1990s. However, that inference would be wrong because of the asymmetry in the linkage: the US to PRC linkage has a high coherence but a low gain, while the PRC to US linkage has low coherence but a high gain. Such asymmetries give us the pattern of dependency or leadership. In this case, it appears the US has the power to shape the cycle in the PRC through her dominance of monetary (interest rates, supply of capital, exchange rates) and financial conditions, while the PRC has the power to influence spillover effects onto the US (and hence the *size* of the cycle) through the “outsourcing” of manufactures and intermediate inputs for the US economy. This gives a much more nuanced view of the relationship between the US and PRC economies than is generally assumed. It is consistent with the idea that the PRC has gained greater influence through trade, at the cost of a dependence on foreign monetary conditions (risking inflation, excess liquidity, asset bubbles). However, this relationship is not new. It has been in this form since the 1980s, although it has clearly become stronger, if more uncertain, since 2000.

Figure 11: Gain between the US and PRC: “US-PRC”

Source: Author's calculations.

b) Japan and the Core Economies

The Japan-US relationship presents a rather simpler picture. The coherence shows a steady but surprisingly strong linkage between Japanese growth and US performance. This association may be stronger at long cycles, and may have weakened in the past few years, but those changes are very small. Hence as far as Japan is concerned, the US is still the dominating influence on Japan's business (and other) cycles.

Figure 12: Coherence between Japan and US: Japan-US

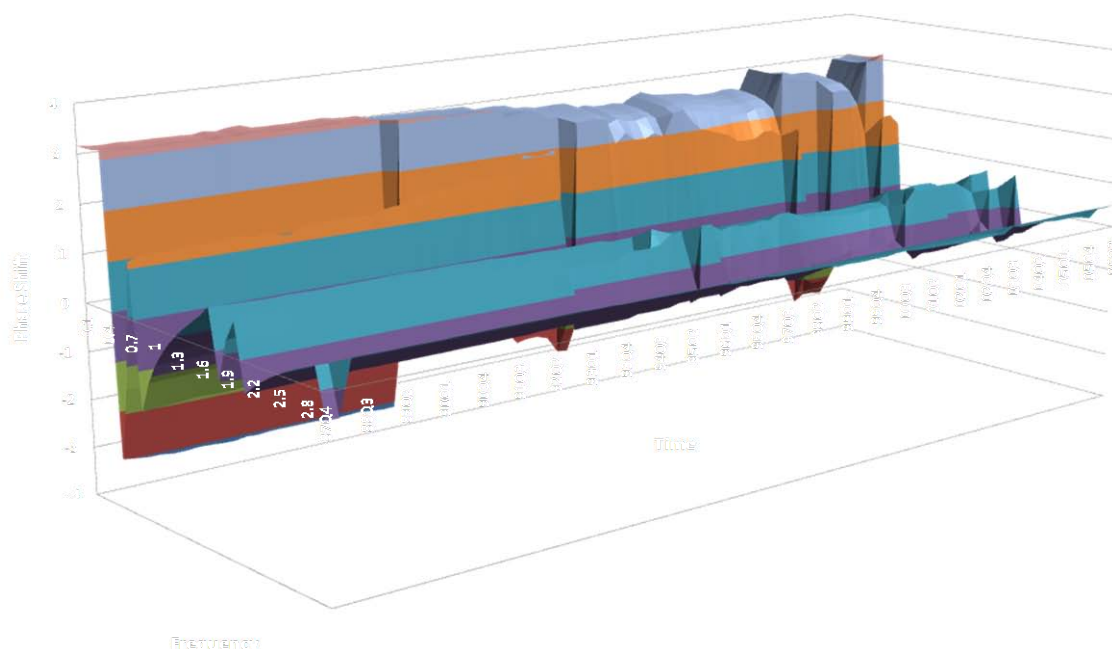
Source: Author's calculations.

c) The Changes in Phase between the PRC, US, and Japan

Figures 13, 14, 15, and 16 display the phase shifts diagrams between the US and the PRC, and between the PRC and Japan, in both directions in each case. These diagrams confirm the interpretation we already had for the PRC-US economic linkage and business cycle relationships; and also the separation of the Japan-US bloc from the China block since 2000. The phase diagrams between Japan and the US are not reproduced since the coherence in that case was close to one at all cycles, implying there are no phase shifts. The US and Japanese cycles are therefore mostly in line with each other.

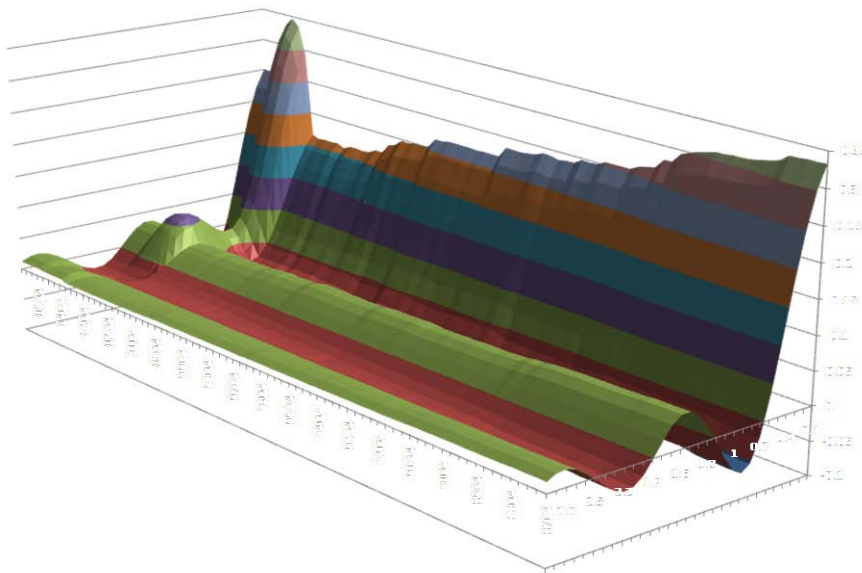
Figure 13 shows the US, as dependent variable, has had a steady lag of three quarters (or nine months) behind the PRC economy at trend/long cycles (up to frequencies of 0.4, below business cycle frequencies). That lag shortened a little in the 1990s, but returned to 3 quarters after 2000. Then the US took a lead of 3 quarters at business cycle frequencies (0.4 to 0.7), but then had a lag of one quarter at 0.7 to 0.9, a lead of two quarters at 0.9 to 1.1, and so on, fairly consistently through the sample. These lags and leads describe the pattern of trade and financial links between the two economies. Lags in the impact of changes in demand or production in the PRC on the US reflect the PRC demand for investment or the supply of PRC funds for re-investment in US securities (long cycles), or the PRC demand for services (at business or shorter cycles). Leads reflect the PRC demand for intermediate goods or materials. But in either case, the results are consistent with our earlier interpretation that PRC economic conditions have a distinct effect on the US economy—only it is now in terms of leads/lags rather than size of spillovers.

Figure 13: Phase Shifts US-PRC



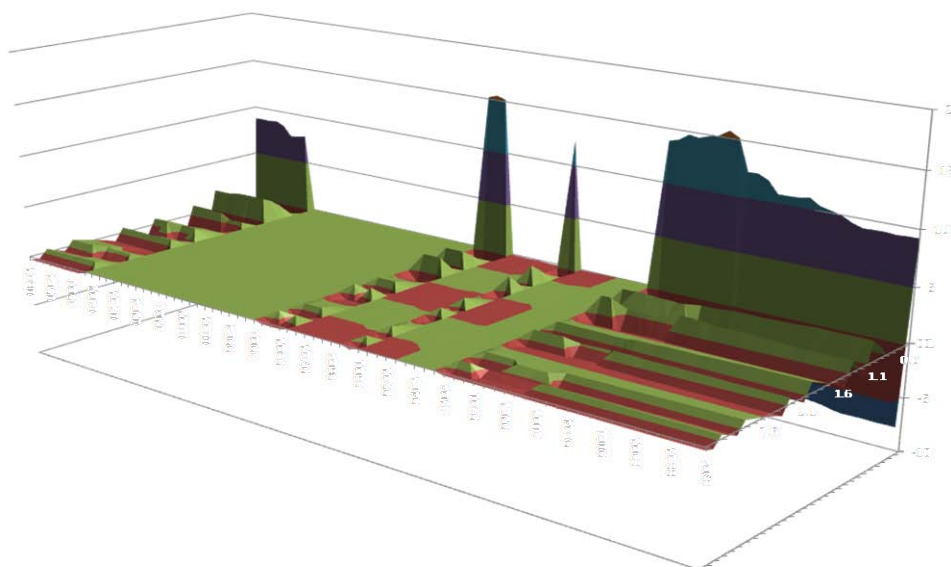
Source: Author's calculations.

The reverse linkage, Figure 14, where the PRC becomes the dependent variable, shows the US does have an effect on the PRC with a small delay of one month or less at long cycles; but virtually no delay or lead at other cycles. This is evidence for the fact that the chief impact of the US on the PRC has been through monetary policy and monetary conditions, where financial markets can process changes in information very rapidly. Interestingly, one can also see the shortening of that delay in the aftermath of the Tiananmen Square incident, but that is not an important part of our story.

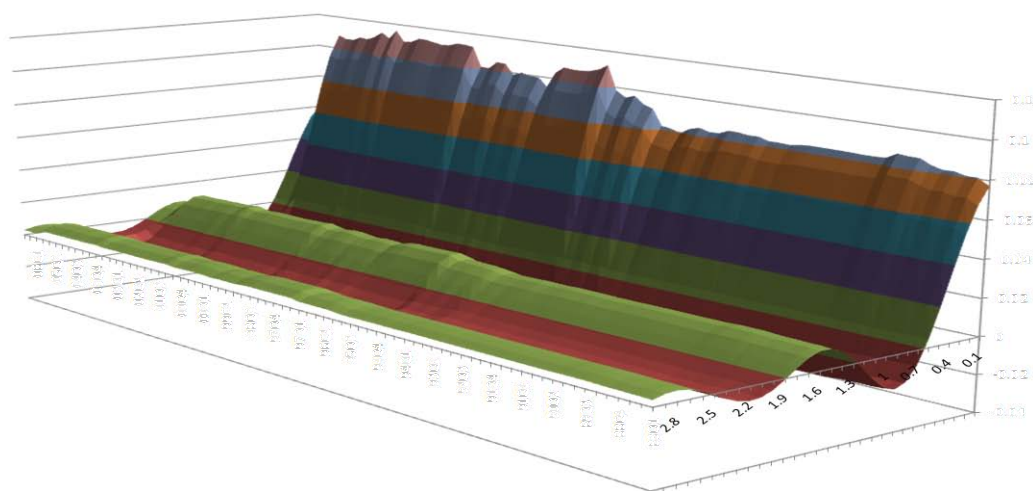
Figure 14: Phase Shifts PRC-US

Source: Author's calculations.

Turning now to the PRC-Japan linkage, Figure 15, the PRC has started to lag Japan at long cycles. The lag is 10–15 quarters (2½–4 years). That is from 2000 onwards. Before then there were no systematic lags or leads. This probably reflects the Japanese demand for sophisticated electronic components from the PRC in network trade and Japanese investment in Chinese plants for the same purpose. The reverse linkage, Figure 16, produces no material leads or lags on Japan. As in the PRC-US case, the Chinese cyclical effects on Japan (if any) are coincident. Similarly, the Japan-US shifts are zero (not reproduced here) because the Japan-US coherence is near unity at each cycle (recall Figure 12).

Figure 15: Phase Shift PRC-Japan

Source: Author's calculations.

Figure 16: Phase Shifts Japan-PRC

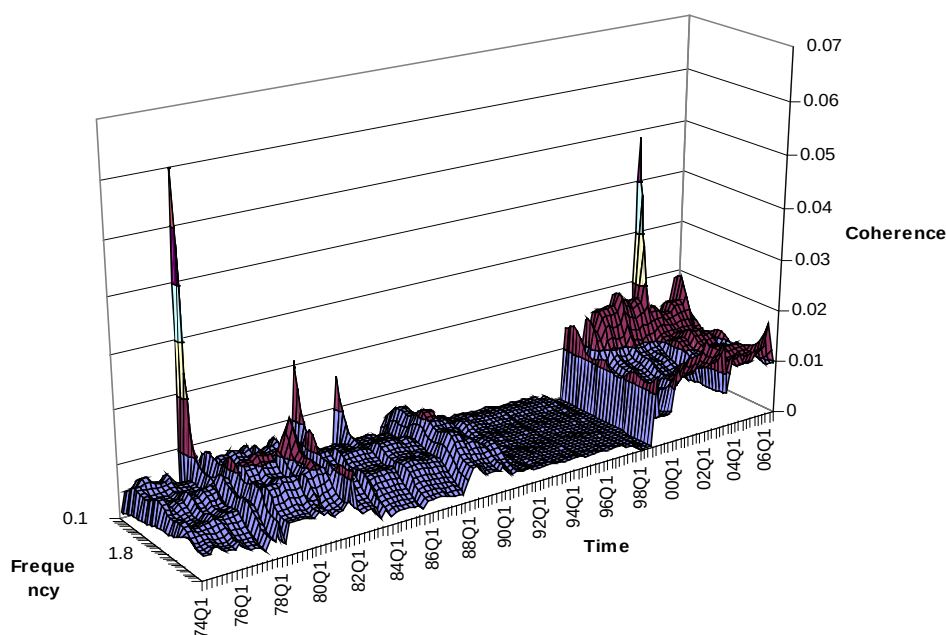
Source: Authors' calculations

4. INCREASED COHERENCE AMONG THE ASIAN ECONOMIES?

To show that the Asian region as whole does not converge toward a common business cycle, as represented by either the US or the PRC, we examine the coherences of the other (smaller) economies with the US and the PRC and the spillovers of the US and PRC on those economies. We focus on the coherence, gain, and phase shifts most germane to the story.

Coherence with the US: In contrast to the PRC-US and Japan-US coherences above, that between Korea and the US is weak: 2% at the end of the sample, instead of 50% to 90% in the PRC-US and Japan-US cases (Figure 17). The profile appears to be similar to the PRC-US case, but the timing is different. The coherence gradually diminishes, almost to zero, until 1998, and then jumps to its highest sustained level in the sample period, with more coherence at long cycles and the trend part of the spectrum. But even then, the coherence remains low compared with the Japan-US case. So if there is an emerging Japan-Korea-US bloc, as the single spectra and Japan-US results suggest, and the Korea-Japan results that follow also suggest, then the Korea component is only just now starting to emerge in the wake of the Asian crisis.

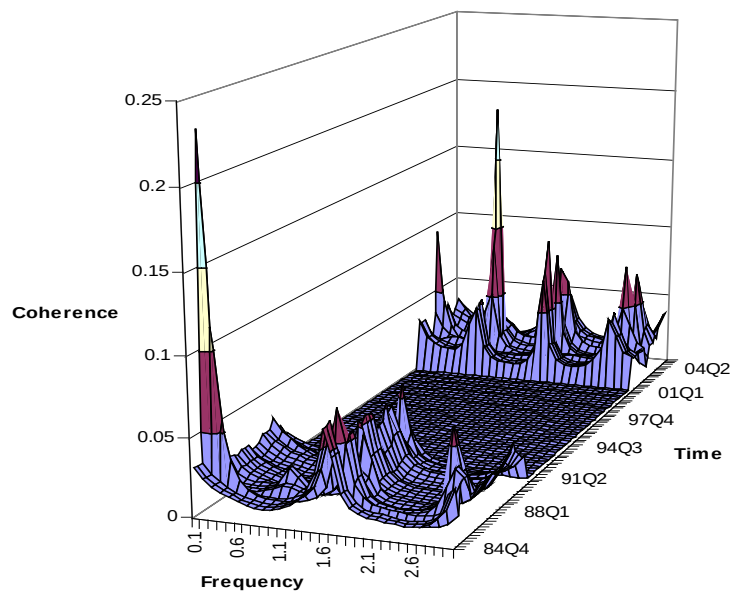
Figure 17: Coherence Korea-US



Source: Author's calculations.

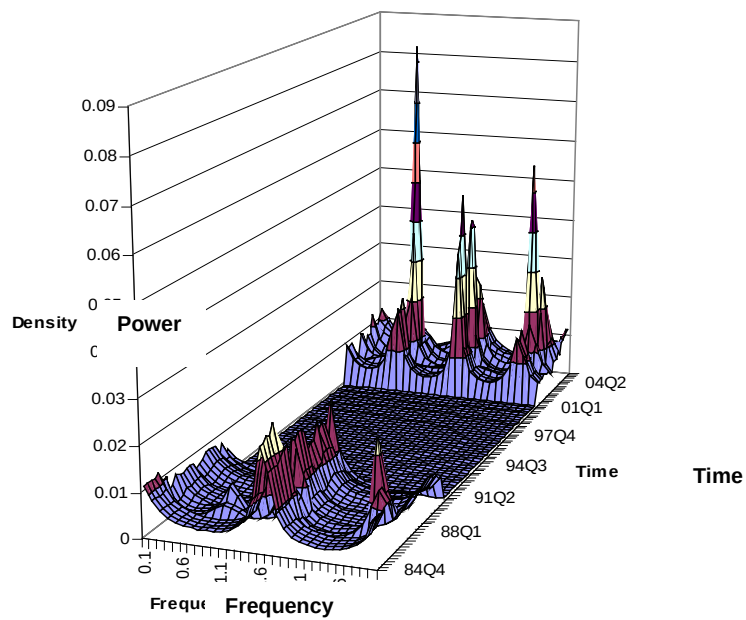
Like the PRC, the other smaller economies experienced a weakening of their linkage to the US since the 1980s. They also show low coherences and falling gains from US activity, but coherences and gains that pick up in the period 2000–2001. Specifically, the Taipei, China coherence with the US in Figure 18 is low (less than 0.05), falls to zero after 1991, and only revives after 2000 to give modest correlations at the 3-year, 1-year, and shorter cycles. The associated gains (Figure 19) are even smaller, in decline until 1999, and then only increase to values between 0.01 and 0.02. These changes appear at all frequencies, but mostly at the short and business cycles.

Figure 18: Coherence Taipei,China-US

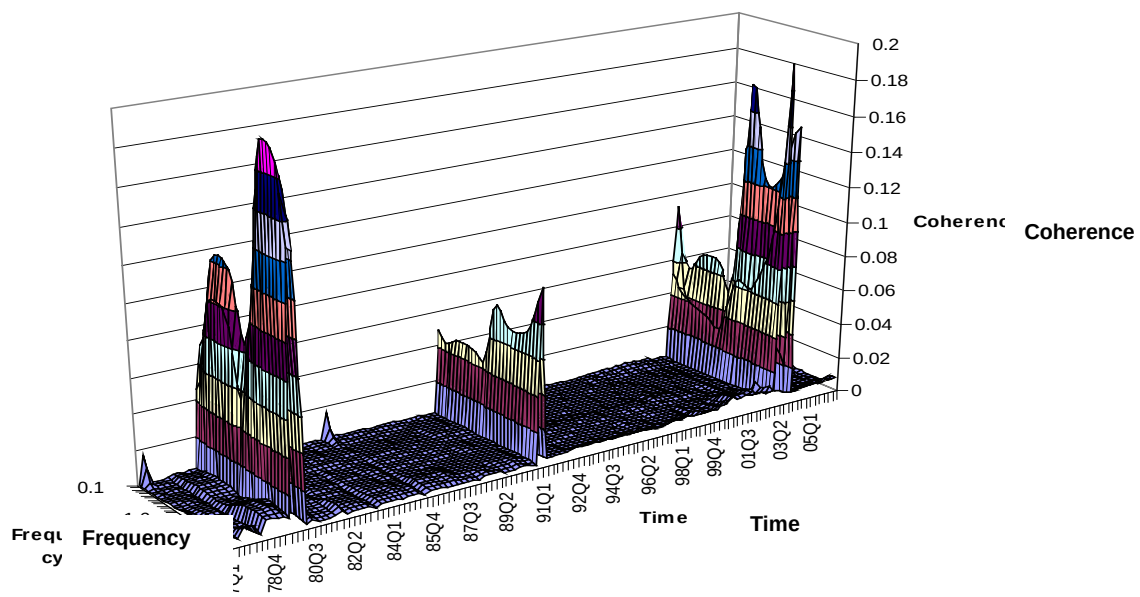


Source: Author's calculations.

Figure 19: Gain Taipei,China-US



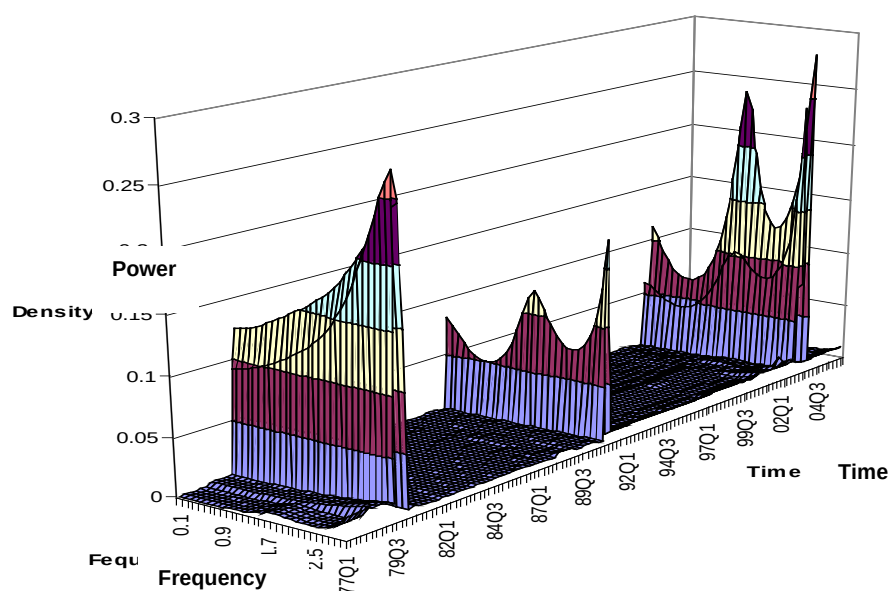
Source: Authors Calculations

Figure 20: Coherence Hong Kong, China-US

Source: Authors Calculations

The Hong Kong, China coherence (Figure 20) and gains (Figure 21) with the US tell a different story. The coherences are also low, often zero, but reach 0.06–0.16 in the recessions of 1978–1980, 1991–1992, and 2002–2004. In those periods the coherence is clearly stronger at short cycles than at business or long cycle frequencies. This suggests an economy which is still linked to and dependent upon the US at least in bad times—presumably a reflection of her financial and investment links. These are not features that appear in the Taipei, China results.⁹

⁹Both Hong Kong, China and Taipei, China have periods of zero gains and zero coherence between 1991 and 2001. The gains go to zero if the time series coefficients in the underlying ADL relationship go to zero. Our general to specific testing procedures automatically set those coefficients to zero if they are not statistically significant in a particular period. So a zero gain means that Hong Kong, China and Taipei, China became dissociated from the US economy in those periods. Or, to be more accurate, that the US economy had no significant impact on their growth or cycles. Once the gain goes to zero, then so does the corresponding coherence.

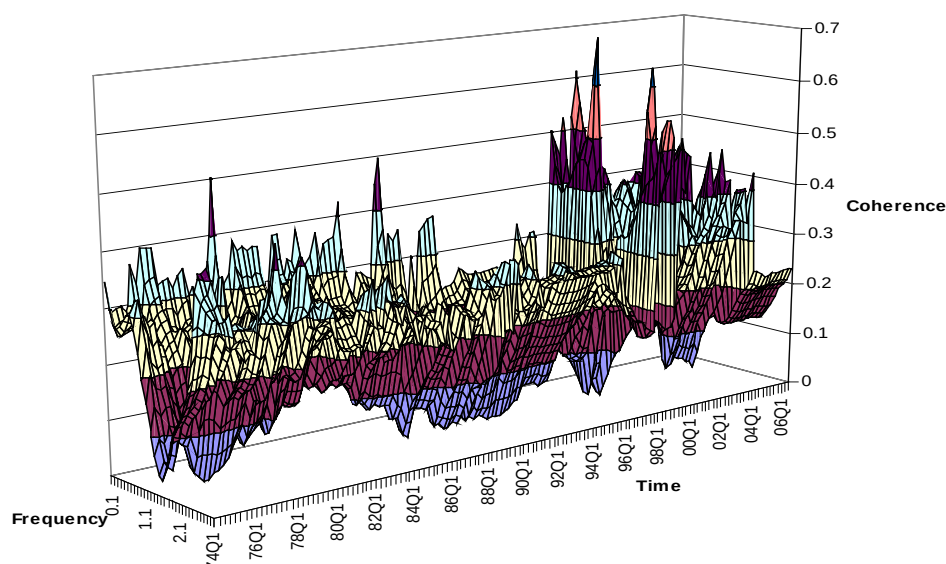
Figure 21: Gains Hong Kong, China-US

Source: Author's calculations.

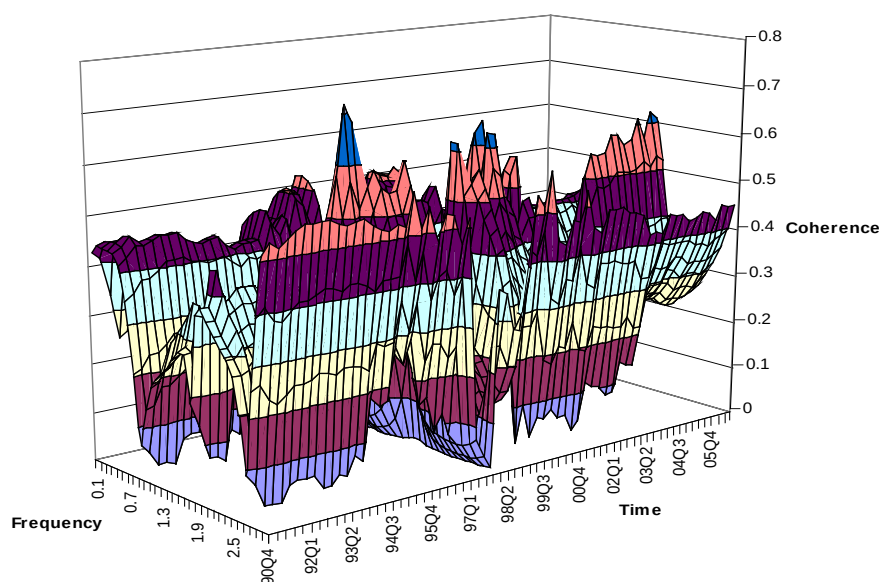
5. ONE BLOC OR TWO?

Inside the Japan bloc: The coherence between Korea and Japan is reasonably strong—at 25% in the 1990s, rising to 40% after 1999—but very volatile (Figure 22). It has a similar profile to the PRC-US coherence, with a gradually diminishing coherence in the 1990s, and a sharp increase in the long cycles and the business cycle frequencies with the increase in Asian trade after 1999. Thus, if there is an emerging Japan-Korea-US bloc, it is only just now evolving with the link to the US through Japan. That it is detaching itself from the rest of East and South East Asia can be seen from the very low levels of coherence and gains for Japan-PRC (Figure 24) and Korea-PRC; and from the fact that, unlike what happens within the China bloc, the associated gains fall significantly after 2003.

Turning to Malaysia, the coherence with Japan is steady, if fluctuating, at all cycle lengths. At an average of 40%, it is quite strong but shows additional uncertainty around the Asian crisis period (1995–2001). It appears that the strength of that coherence has been building up at the business cycle frequency, but possibly weakening at the long cycles since 1999—consistent with Malaysia's position of a supplier of components and materials to Japan. But these changes are small, and not yet comparable to the strengthening coherence in the PRC-US or Korea-Japan relationships. This is consistent with a continuing but weakening linkage with Japan—as would happen if Malaysia was acquiring new trading partners, and/or had shifted from being a supplier of raw materials to being a partner in Japan's network trade. But it is not sufficient on its own to conclude that the Japanese bloc has started to separate itself from the rest. But to demonstrate that, we need to check that the counterpart changes have also occurred in the coherences with the PRC.

Figure 22: Coherence between Korea and Japan

Source: Author's calculations.

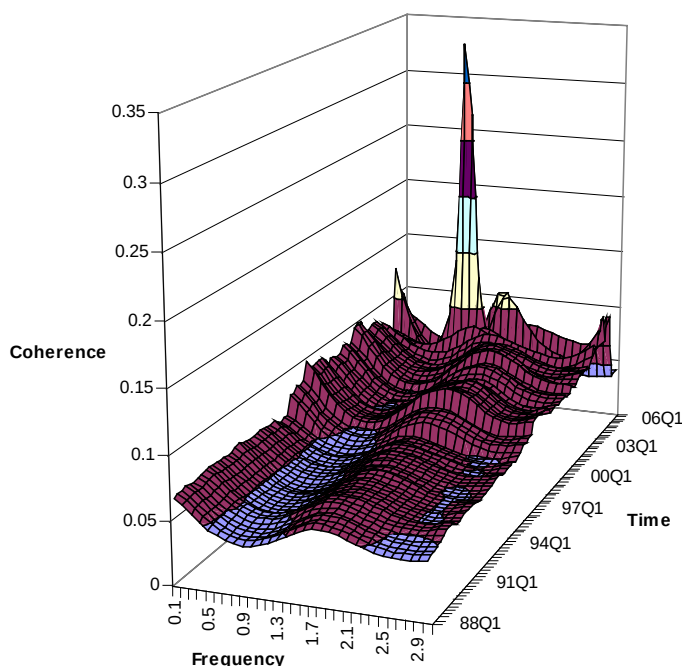
Figure 23: Coherence between Malaysia and Japan

Source: Author's calculations.

Between the blocs: The Japan-PRC (the PRC influences Japan) coherence is very low throughout our sample, at 10% or less, but shows distinct increases in 1997 and in 2003 where the relationship starts to show a significant increase in volatility. At that point the transmissions from the PRC are to the short, long, but mainly business cycle frequencies in Japan. However, the coherence remains small: no more than for the PRC influencing the US, and far smaller (by factors of 5 to 6) than the US's coherence with the PRC or Japan. This is consistent with a Japan bloc developing separately from a Chinese bloc, even though one might have expected some linkage between the two as PRC-made components are increasingly used, and manufactures consumed, in Japan and as more Japanese equipment or investment goes into the PRC. The fact that the same thing is also happening between

the PRC and the US means that Japan and the US continue to behave in the same way with respect to the PRC despite their, and the PRC's, changing roles in the Asian economy.

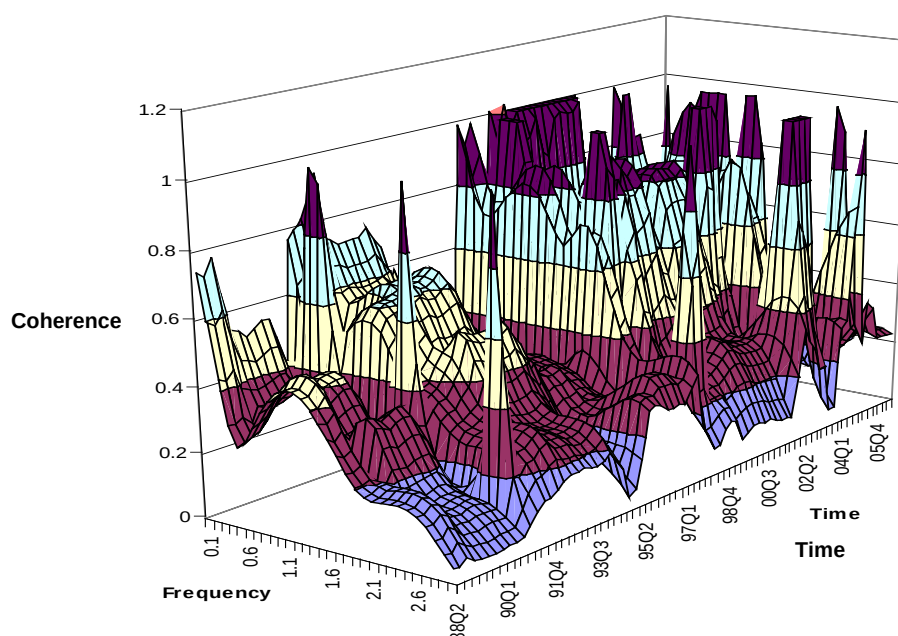
Figure 24: Coherence Japan-PRC



Source: Author's calculations.

Inside the Chinese bloc: We now review the coherences between the PRC and her two special regions. We consider only the possibility that the PRC influences Hong Kong, China or Taipei, China; not Hong Kong, China or Taipei, China influencing the PRC, for which we could find no significant evidence.

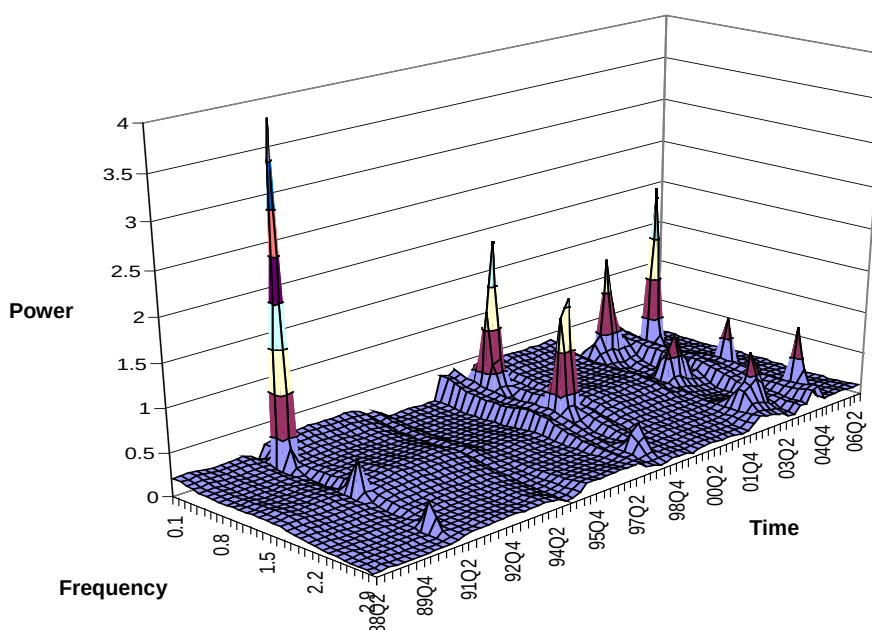
Figure 25 shows the coherence between Hong Kong, China and the PRC. At the beginning of the sample there is only coherence between the two for the trend cycle and at cycle lengths of 1.1 (6 quarters). But over time, and most obviously after the handover of Hong Kong, China in 1997, the coherence shows increases at all but the short cycle frequencies (those less than one year in length). Nevertheless those changes are concentrated at the trend or long cycles, and to a limited extent at business cycle frequencies. Short cycle coherence is absent except at specific dates (1991, 1999, 2004, 2006). This is a good example of convergence, in terms of the coincidence of movement due to longer-term investment, trade and the trade in services. But short-term income fluctuations and short-run financing show little coherence with the PRC except in bad times. Coherence results cannot show which way the fluctuations and short-term financing help goes, but the consistently low gains at short and middle cycle frequencies in figure 25 show that the income fluctuations are in fact in the PRC. So the short-term financing goes to the PRC. The gains are generally lower than the Hong Kong-PRC coherences across all frequencies; except at the handover period, they are one third to one half of the associated coherence values and have melted away since 2003. Nonetheless some frequencies still play a special role (0.8, 1.5, and 2.9), reflecting the occasional shocks transmitted in 1991, 1998, 2003, and 2005 which explain the peaks in short-term coherence noted above. But even these low level gains are declining, and have been lost since 2005.

Figure 25: Coherence Hong Kong, China-PRC

Source: Author's calculations.

These results have therefore left Hong Kong, China in the same position, in her relationship with the PRC, which the PRC occupied in the PRC-US linkage: a large coherence, but small spillover effects. Hong Kong, China is therefore subject to the existence and shape of a cycle generated in the PRC; but it is able to influence, if not control the size of that cycle herself. This shows Hong Kong, China has developed as an independent economy, integrated with the PRC but specialised and trading according to comparative advantage as a supplier of services, entrepot trade, investment and short-term finance. It is not an integral part of the Chinese economic bloc as such.

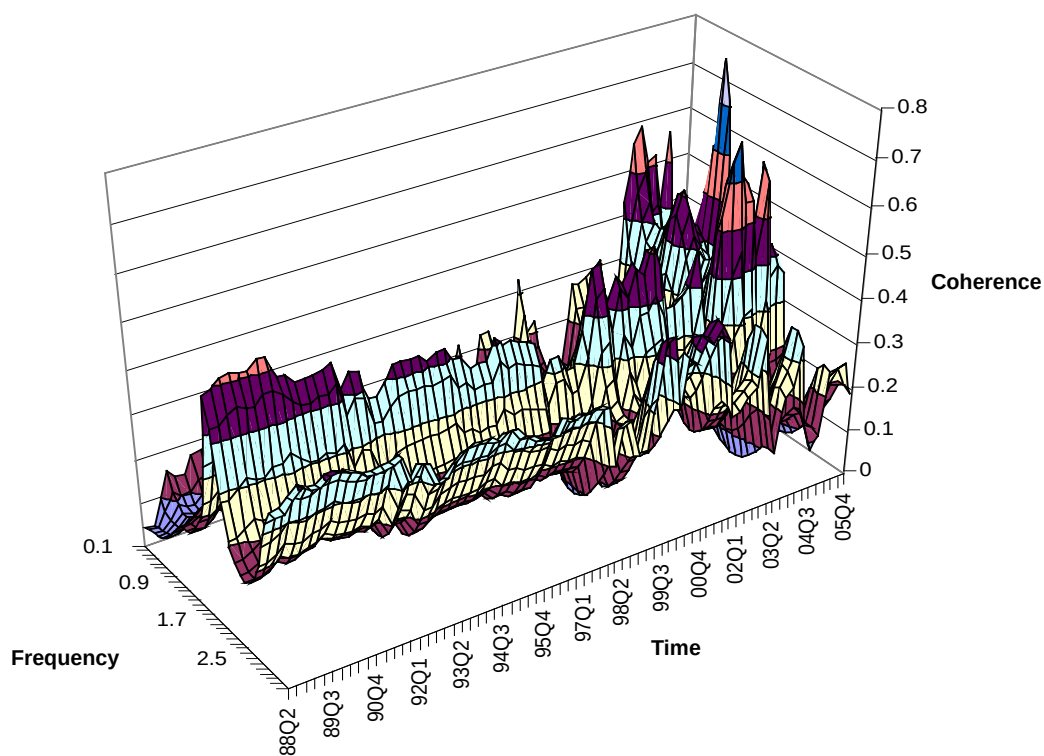
None of these results are available in the Taipei,China case where the coherences with, and gains from, the PRC are approaching equal size at the long and business cycle frequencies. In fact Taipei,China shows the closest relationship to, and most influence from, the PRC. Our Taipei,China-PRC coherence, Figure 27, is substantially higher at 0.4 to 0.5 in 2004 than our other PRC coherences (including that with the US) or the Korea-Japan coherence. Moreover, there has been a precipitous rise since 2002 (possibly since 1999), with power concentrating at the long and business cycle frequencies and away from the short to intermediate frequencies. That suggests that a shift in phase and in product structure has taken place: with an increase in consumer goods traded both ways and increased intermediate inputs from the PRC to Taipei,China affecting business cycle frequencies; and increased financing from Taipei,China to provide the long cycle connection. The gains, Figure 28, show the same thing for the influence of the PRC on Taipei,China. Those gains are not especially large at 0.2–0.3, although they are larger than for other members of the China bloc even after the shifts of 2002.

Figure 26: Gains Hong Kong, China-PRC

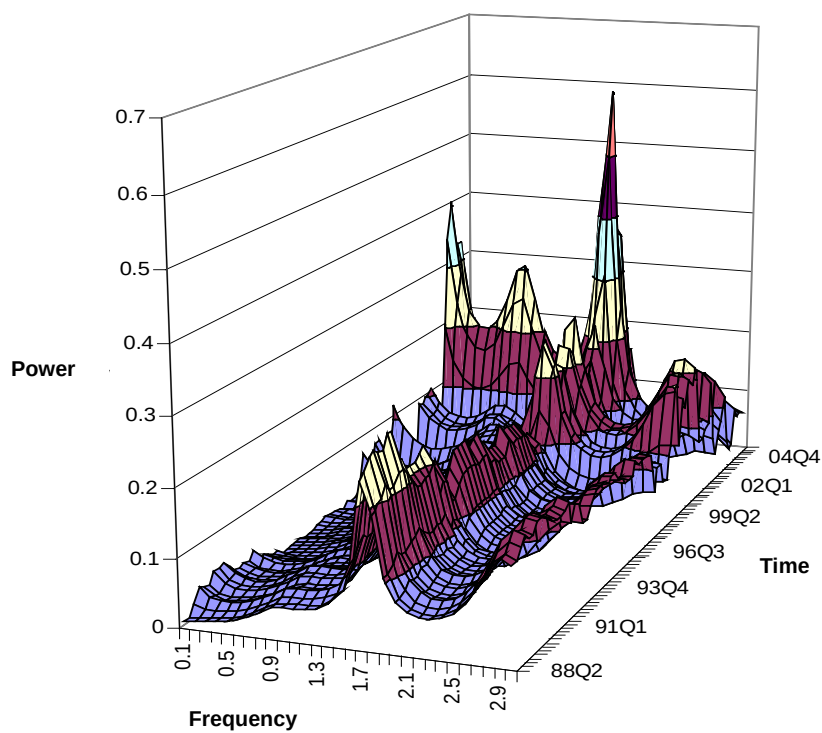
Source: Author's calculations.

Nevertheless, the Taipei,China-PRC coherences remain moderate: more than for the PRC influencing the US, but smaller than the US influence on the PRC. The gains (the PRC affects Taipei,China) are smaller at 0.2-0.3, although they too show a clear increase in 1997 at the short and long frequencies, before tailing off again after 2003. This is consistent with Taipei,China being partly separate from the PRC, although one might have expected more linkage between the two as PRC components are increasingly used, and PRC manufactures increasingly consumed in Taipei,China and as more investment from Taipei,China goes into the PRC. Those developments would imply increased phase shifts between these two economies, as can be seen from 2001 with the strengthening coherences, and especially gains, in the long and business cycle frequencies, at the expense of the short cycles.

So there are some similarities with Hong Kong, China: increased power at those two frequencies would reflect an increased dependence on two-way network trade in components and manufactures, and an increased dependence of Taipei,China on the PRC for investment opportunities. Yet there are important differences. The fact that this is true in an economy that is otherwise closely integrated with the PRC suggests that Taipei,China is in transit. It once held a position similar to Hong Kong, China, but is now increasingly part of a single Chinese economic zone.

Figure 27: Coherence Taipei,China-PRC

Source: Author's calculations.

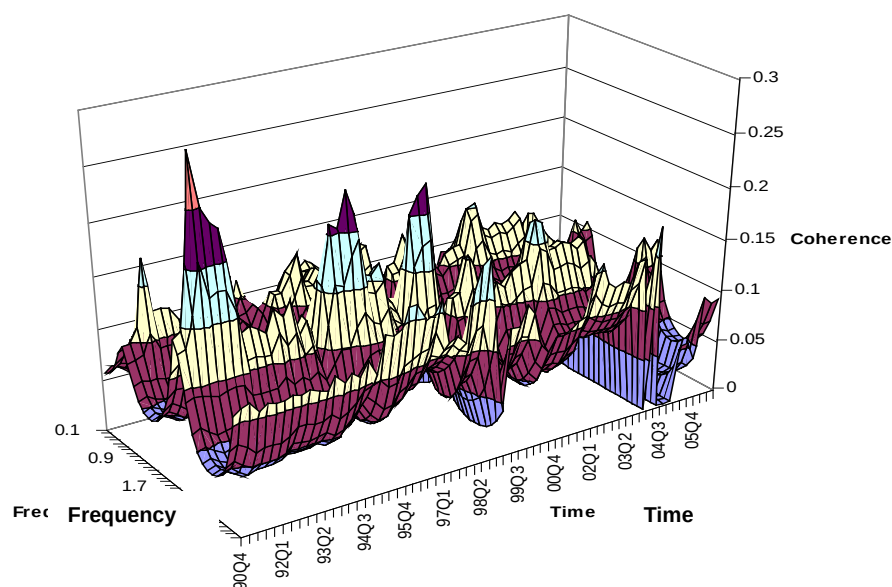
Figure 28: Gains Taipei,China-PRC

Source: Author's calculations.

Part-time Members of the China Bloc: At this point, we reintroduce Malaysia, which appears, from the earlier results, to be the next most closely linked to the PRC. We do this to provide a contrast; to show that, although Chinese economic hegemony is expanding; it has not (yet) reached the point where Malaysia can be considered part of the Chinese economic area in the same way that Taipei, China or Hong Kong, China might be.

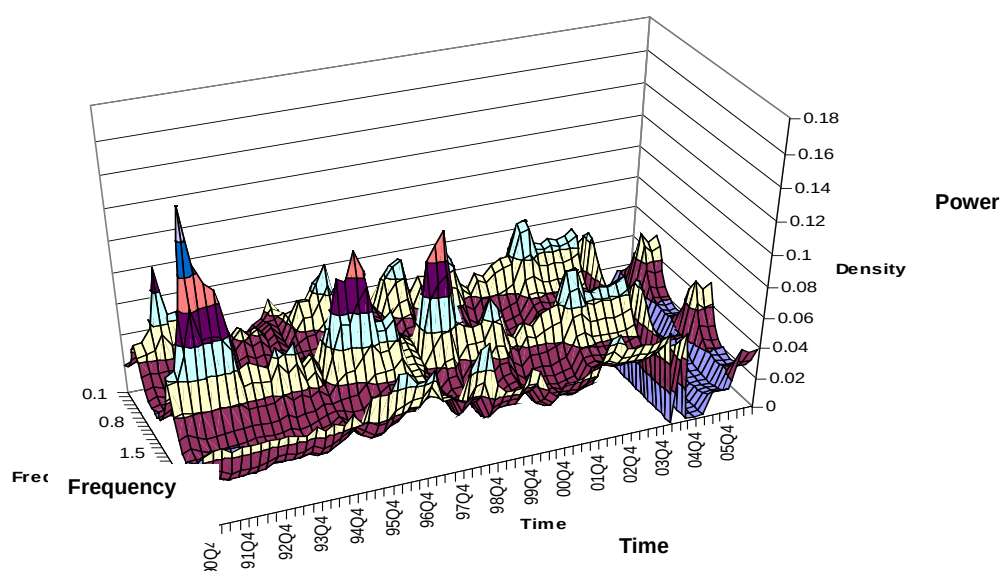
The Malaysia-PRC coherence (Figure 29) is relatively low; and has been falling across the board from 2002 onwards, to reach a level of less than 0.1 by 2005. It shows a significant amount of volatility in the 1990s and during the Asian crisis. This coherence is therefore four or five times smaller than Malaysia's coherence with Japan, even if larger than her coherence with the US. And it is volatile and declining, unlike the coherence with Japan.

Figure 29: Coherence Malaysia-PRC



Source: Author's calculations.

Figure 30: Gains Malaysia-PRC



Source: Author's calculations.

Thus, while earlier results may have suggested the opposite, it is hard to argue that Malaysia really is part of an emerging bloc based on the PRC. Given the falling coherence, the most that can be said is that Malaysia is a marginal, part-time member who flirted with that bloc but is now drifting away. The gains (Figure 30), showing the impact of the PRC on growth patterns in Malaysia, support that interpretation. These gains are very low and again falling, many times smaller than the effect of Japanese growth and no stronger than the impact of the US. Malaysia's role as supplier of components and materials to Japan therefore dominates.

6. CONCLUSIONS

The contribution of this paper has been to examine how the economic links and leadership-dependency relationships in the Asia-Pacific area have changed over the last 20 years. We have used spectral methods to decompose the growth rates, and linkages between them, of the major economies: the PRC, the US, and Japan; and then the regional manufacturers: Korea; Taipei,China; and Malaysia. We studied convergence in terms of coherence, spillover effects, and changes in leads, lags, and product composition. We found:

- a) That the links with the US have indeed weakened, and those within a bloc centered on the PRC have strengthened. But this is not new. It has been happening steadily since the mid-1980s. Since then it has been partly, if incompletely, reversed by the unbalanced expansion of trade.
- b) At the same time there is evidence of convergence among the Asian economies, albeit not on a single bloc based on Chinese leadership. Instead there appears to be a Japan-Korea bloc based on advanced manufacturing and investment, with conventional links to the US; and a China bloc, with Taipei,China and possibly Hong Kong, China, based on the network trade and investment links. Finally, there are the part-time members, like Malaysia, which used to be part of the China bloc, but who have become closer to the Japan bloc as their economies have focused on more expensive and sophisticated products/components and on financial services. Product compositions seem to be the chief determinant of this convergence pattern.
- c) Convergence between the PRC and her partners is incomplete. It is stronger between the PRC and Taipei,China than between the PRC and Hong Kong, China. The coherence between the PRC and Hong Kong, China is strong only at long cycles, with some at business cycles, except in bad times. The gains too are small. This is an economy making its own way through comparative advantage in finance, investment, and services. Taipei,China's performance by contrast is a good deal closer to the PRC.
- d) The relationship with the US is more complex. It appears that the US still influences the shape and existence of cycles elsewhere through her control of monetary conditions where exchange rates are pegged, but the PRC has some control of the size of her own cycles through her expanding trade in consumption and intermediate goods.
- e) There is no evidence that fixed exchange rates have encouraged convergence despite increasing trade and financial links.¹⁰ This suggests that the failure of fixed exchange rates to create deeper convergence is due to the capacity of misaligned or undervalued exchange rates to generate adverse monetary conditions—excess liquidity, easy credit, and asset bubbles.

¹⁰ Four of our larger economies (Japan; Korea; Taipei,China; and Malaysia) maintain flexible exchange rates. These economies show convergence rather than divergence. This conclusion is in line with Cavoli and Rajan (2007).

REFERENCES

- Artis, M., and W. Zhang. 1997. International Business Cycles and the ERM: Is there a European Business Cycle? *International Journal of Finance and Economics* 2: 1–16.
- Artis, M., M. Marcellino, and T. Priorietti. 2004. Dating the Euro Area Business Cycle. In *The Euro Area Business Cycle: Stylised Facts and Measurement Issues*, edited by L. Reichlin. London: Centre for Economic Policy Research.
- Barro, R. J., and X. Sala-i-Martin. 1991. Convergence across States and Regions. *Brookings Papers on Economic Activity* 1.
- . 1992. Convergence. *Journal of Political Economy* 100: 223–251.
- Baxter, M., and M. A. Kouparitsas. 2005. Determinants of Business Cycle Comovement: a Robust Analysis. *Journal of Monetary Economics* 52: 113–158.
- Canova, F. 1998. Detrending and Business Cycle Facts. *Journal of Monetary Economics* 41: 475–512.
- Cavoli, T., and R. S. Rajan. 2007. Exploring the Case for Monetary Integration between the Chinese Mainland and Hong Kong. *China & the World Economy* 15: 17–34.
- Chaplygin, V., A. Hughes Hallett, and C. R. Richter. 2006. Monetary Re-integration in the ex-Soviet Union: A Union of Four? *Economics of Transition* 14: 47–68.
- Chauvet, M., and S. Potter. 2001. Recent Changes in the US Business Cycle. *Manchester School* 69: 481–508.
- Dowrick, S., and D.T. Nguyen. 1989. OECD Comparative Economic Growth 1950–85. *American Economic Review* 79: 1010–1030.
- Evans, P., and G. Karras. 1996. Convergence Revisited. *Journal of Monetary Economics* 37: 249–265.
- Fidrmuc, J., and I. Batorova. 2008. China and the World Economy: A Dynamic Correlation Analysis of Business Cycles. United Nations University World Institute for Development Economics Research Discussion Paper 2008/02. Helsinki: United Nations.
- Frankel, J., and A. Rose. 1998. The Endogeneity of the Optimal Currency Area Criteria. *Economic Journal* 108: 1009–1025.
- . 2002. An Estimate of the Effect of a Common Currency on Trade and Income. *Quarterly Journal of Economics* 117: 437–466.
- Gerlach, S. 1989. Information, Persistence, and Real Business Cycles. *Journal of Economic Dynamics and Control* 13: 187–199.
- Harding, D., and A. Pagan. 2001. Extracting, Analysing and Using Cyclical Information. Canberra: Australian National University.
- Hughes Hallett, A., and L. Piscitelli. 2002. Does Trade Cause Convergence?. *Economics Letters* 75: 165–170.
- Hughes Hallett, A., and C. Richter. 2004. Spectral Analysis as a Tool for Financial Policy: An Analysis of the Short End of the British Term Structure. *Computational Economics* 23: 271–288.
- . 2006. Is the Convergence of Business Cycles a Global or Regional Issue? The US, UK, and Euroland. *International Journal of Finance and Economics* 11: 177–194.

- . 2008. Have the Euro-zone Economies Converged on a Common European Cycle? *International Economics and Economic Policy* 5: 71–101.
- . 2009. Economics in the Backyard: How much Convergence is there between China and her Special Regions?. *World Economy* 32: 819–861.
- Inklaar, R., and J. de Haan. 2000. Is there really a European Business Cycle?. CESifo Working Paper 268. Munich: CESifo.
- Kalemli-Ozcan, S., B. Sorenson, and O. Yosha. 2001. Economic Integration, Industrial Specialisation, and the Asymmetry of Macroeconomic Fluctuations. *Journal of International Economics* 55: 107–137.
- . 2003. Risk Sharing and Industrial Specialisation: Regional and International Evidence. *American Economic Review* 93: 903–918.
- Kocenda, E., and J. Hanousek. 1998. Integration of Emerging Equity Markets: Major Asian Players. *Korean Economic Review* 14: 99–114.
- Mankiw, N. G., D. Romer, and D. Weil. 1992. A Contribution to the Empirics of Economic Growth. *Quarterly Journal of Economics* 107: 407–437.
- Peersman, G., and F. Smets. 2005. Industry Effects of Monetary Policy in the Euro Area. *Economic Journal* 115: 319–342.
- Pinho, C., and M. Madaleno. 2010. Time-frequency effects on market indices: world co-movements. *China-USA Business Review* 9: 1–24.
- Sato, K., and Z. Zhang. 2006. Real Output Co-movements in East Asia: Any Evidence for a Monetary Union?. *World Economy* 29: 1671–1689.
- Shin, K., and C. H. Sohn. 2006. Trade and Financial Integration in East Asia: Effects on Co-movements. *World Economy* 29: 1649–1669.
- Shin, K., and Y. Wang. 2004. Trade Integration and Business Cycle Co-movements: the Case of Korea with other Asian countries. *Japan and the World Economy* 16: 213–230.
- Stock, J. H., and M. W. Watson. 2002. Has the Business Cycle Changed and Why?. National Bureau of Economic Research Working paper 9127. Cambridge, MA: National Bureau of Economic Research.
- . 2005. Understanding Changes in the International Business Cycles. *Journal of the European Economic Association* 3: 966–1006.