Macroeconomic Integration in Asia Pacific: Common Stochastic Trends and Business Cycle Coherence

Abstract

This paper addresses the question of macroeconomic integration in the Asian Pacific region. Economically, the analysis is based on the notions of stochastic long-run convergence and business cycle coherence. The econometric procedure consists of tests for cointegration, the examination of vector error correction models, different variants of common cycle tests and forecast error variance decompositions. Results in favour of cyclical synchrony can be partly established, and are even exceeded by the broad evidence for equilibrium relations. In these domains, several leading countries are identified.

Keywords: Real Convergence, Cointegration, Common Cycles, Asia Pacific
JEL classification: E32, F15, C32

Contents

1 Introduction

The last decades of economic development in Asia Pacific are marked by vibrant dynamics as well as the region has witnessed extraordinary growth just as striking inequality and severe crises. A recent example has been the Asian financial crisis in 1997/98, which occurred in a period of a booming economy and a deepening interaction between the region's countries. While some nations could make considerable progress, others did far less participate in the dynamic development process. As matter of fact, the members of the main regional organisations, ASEAN and APEC, range from highly industrialised to developing countries, the integration concepts from "open regionalism" to discriminatory trade policies. Until now, progress in convergence is driven more by market mechanisms than by institutionalised cooperation.

From the scientific point of view, it stays an open task to examine the ambiguous character of the Asian Pacific economy, even after some work, mainly done on shock identification and income convergence (e.g. Bayoumi and Eichengreen 1994, Lee et al. 2004), has shed some light on this topic. Surely, the special regional scenery with its varying economic conditions and polit-historical backgrounds raises several questions:

Does Asia Pacific justify using the notion of *one economic region*? In detail, do the different national economies share common structural properties, and do the mutual interlinkages further transmission effects between them? Given incomparable stages of industrialisation, is there any evidence for the presence of several highly integrated regional subgroups? And furthermore, is it possible to extract a leading role of one nation, or at least to determine a certain direction in the overall adjustment pattern?

Answering these questions would not only give a more profound insight into the functioning and structure of the world's most dynamic and forward-looking region. It would above provide important information for understanding the difficulties in enhancing sustained progress and ensuring macro-stability despite the high vulnerability, which has been a permanent threat in the past. In this context, enhanced cooperation based on a deepening integration could bear high potential for stabilisation policies.

This paper approaches the outlined problems in the context of an empirical time series analysis, which will proceed on an aggregated macro-level. This allows processing the whole information manifested in the development of the relevant indicators, in the present case mainly the gross domestic products. The examination makes use of recent econometric advantages in the field of common features. Namely, the analysis of common stochastic trends and common cyclical dynamics provides adequate means for the given target of finding evidence about stance and course of a macroeconomic convergence: Cointegration is a natural prerequisite for similar growth paths in the long run, and synchronous business cycles indicate common grounds mainly in the medium-frequency macroeconomic processes.

The proceeding differs from the main approaches in the existing literature, which focus for example the identification and comparison of national supply and demand shocks (Bayoumi and Eichengreen 1994), or cross-section panel convergence (e.g. Engelbrecht and Kelsen 1999). Furthermore, I explicitly consider the recent structural breaks in the Asian economies, utilise a very flexible concept behind the notion of business cycle synchrony, and inquire the conditions of economic leadership and dependence. The last point aims at uncovering, in how far common economic features are due to propagation of cycles and growth shocks through the region, and which countries are the main origins of these developments.

Preceding the empirical part, section 2 supplies the foundation of the economic concept consisting of theories on convergence, business cycle transmission, growth and optimal currency areas. In the section thereafter, the econometric methods, cointegration and common cycles analysis, are to be introduced. Section 4 presents the empirical results in bivariate and multivariate model settings. Finally, the last section evaluates and summarises the outcome of the econometric investigation.

2 Economic Foundation

Before discussing and applying the econometric methods in the next sections, it is worthwhile to take a closer look at the economic notion that underlies the following analysis.

As has been mentioned in the introduction, the examination aims at grasping the actual stance of regional economic integration in Asia Pacific. My concept behind the term *integration* is built on the stochastic trending behaviour of the national GDPs in the long run as well as the cyclical fluctuations in the short and medium run. The word *cycle* has not necessarily to be taken literally, but rather in the sense of describing transitory movements in contrast to permanent trending (e.g. Vahid and Engle 1993). Of course, this definition still comprises the original meaning of regular periodical up- and downswings in a macro economy.

The motivation for this concept may be best illustrated by the theory of optimal currency areas (Mundell 1961): It recommends the introduction of a common currency as a very high stage of integration, if different exchange rates and separated monetary policies have lost their necessity. Above all, this is the case when synchronous cycles facilitate an adequate reaction by one common central bank, and when a long-run growth equilibrium between the economies provides the preconditions for a development in a unified economic system.

Focusing the latter point, the neoclassical growth theory has the important and well-known implication, that the steady-state of per capita output does not depend on initial conditions. In detail, diminishing marginal returns are the base for higher growth prospects in countries with lower current income levels, at least theoretically. As a consequence, a common convergence target between different economies is determined in the long run. Only in case of structural microeconomic parameters differing across countries, stable gaps between outputs would persist due to distinct production functions.

In a stochastic framework, Bernard and Durlauf (1996) require for convergence, that increasing the time horizon makes the forecast of the gap in outputs between country 1 and 2 tend to zero:

$$\lim_{k \to \infty} E_t(y_{1,t+k} - y_{2,t+k}) = 0 \, . \tag{1}$$

Since this definition rules out persistent shocks to the output gap, it implies, that the per capita outputs are in pairs cointegrated with the vector (1,-1) (Bernard and Durlauf 1995). In other words, outputs are driven by a single common trend and do therefore exhibit an equilibrium co-movement aligning the steady state level means in the long run. Obviously, this criterion is met by countries, which have already reached this state of integration. Nonetheless, unfinished convergence can be modelled by allowing for a constant and a linear trend in the cointegrating relation. Depending on the direction, deterministic trending could stand for catching-up (Bernard and Durlauf 1996) as well as divergence. A constant is to be interpreted as an initial output gap, which could be reduced in case of catching-up, but would otherwise represent a persistent difference. Such a situation might be explained by the above-mentioned concept of conditional convergence. At last, under a cointegrating vector other than (1,-1), trend shocks would still be related, even if with different strength.

A similar concept, now for the short-run fluctuations, defines common cycles (Engle and Kozicki 1993) as transitory movements, which are well synchronised among the series and logically cancelled out in a linear combination. A bivariate cofeature vector of (1,-1) would indicate equal per capita business cycle strength. This definition can be weakened for example by allowing for limited periods of asynchrony in order to incorporate adjustment delays. By the same token, distinguishing between cycle frequencies leads to more flexible theoretical requirements.

Two economies can share the same innovations, for example caused by transnational production networks or exposure to world market shocks. But even in absence of such *initial* commonalities, co-movement can be fostered by a transmission mechanism. The most important transmission channels discussed in a comprehensive literature shall be shortly presented:

Most directly, impulses are propagated, when the demand for foreign goods (in the broadest sense) depends on the domestic economic situation, as it is usually stated in import functions. This export channel (e.g. Canova and Dellas 1993) is of distinct importance in the industrialisation process specifically apparent in South-East Asia. In the financial markets, the in- and outflow of capital due to real and nominal triggers creates a link between countries. In the focused region the foreign direct investment channel (e.g. Jansen and Stokman 2004) plays an extraordinarily important role. By the same token, diffusion of technological knowledge, possibly in combination with the aforementioned point, leads to similar shifts in the production functions. At last, labour mobility across borders can cause effects on wages, production and consumption.

3 Methodological Proceeding

3.1 Model

The basic data generating process in the econometric procedure is the VAR with lag length $q+1$

$$y_t = c_0^* + c_1^* t + c_2^* b_t + c_3 d_t + \sum_{i=1}^{q+1} A_i^* y_{t-i} + u_t \ , \tag{2}$$

where y_t contains the n endogenous variables, A_i^* are $n \times n$ coefficient matrices and u_t is an n-dimensional vector of white noise errors. The deterministic terms are a constant, a linear trend (t) and level breaks (b_t), as well as impulse and centred seasonal dummies (d_t).

Before proceeding, assume that a unit root process is an acceptable description of the per capita GDP series behaviour. Following Johansen (1995), the commonness of $n-r$ stochastic trends is reflected by a reduced rank of $A^*(1)$, with $A^*(L) = I_n - \sum_{i=1}^{q+1} A_i^* L^i$. Consequently, one can write $A^*(1) = -\alpha\beta'$, where β spans the space of the r cointegrating vectors, and α contains the corresponding adjustment coefficients. Granger's representation theorem leads to the VECM

$$\Delta y_t = \alpha(\beta' y_{t-1} + c_0 + c_1(t-1) + c_2 b_{t-1}) + c_3 d_t + \sum_{i=1}^{q} A_i \Delta y_{t-i} + u_t \ , \tag{3}$$

with $A_i = -\sum_{j=i+1}^{q+1} A_i^*$, $i = 1, \ldots, q$. This representation assumes that constant, trend and breaks are absorbed in the cointegrating relation. Note that in (3) lagged intervention dummies, which condition the likelihood function in each subsample (defined by the break dates), as in Johansen et al. (2000), are not displayed for simplicity.

3.2 Trend Analysis

3.2.1 Unit Root Tests

The unit root behaviour of the non-breaking series is checked by the standard ADF test (see e.g. Dickey and Fuller 1979), with constant, trend and centred seasonal dummies included. The lag length is set following the usual information criteria and autocorrelation tests. Simulated critical values for the null hypothesis of non-stationarity are taken from Davidson and MacKinnon (1993).

Various authors found, that the presence of structural breaks distorts the unit root test results, see i.e. Perron (1989). Certainly, there is no doubt, that such shifts have recently occurred in Asia Pacific. Here, I follow Saikkonen and Lütkepohl (2002), who propose first estimating the deterministic nuisance parameters and afterwards testing the residuals for non-stationarity. Accordingly, in the first step a GLS regression of the time series on constant, trend, dummies and a shift is run. As in the case of Asia Pacific, the dates, where shifts have occurred, are quite obvious, I assume the break points to be known a priori. In the second step, an ADF type test on the estimated residuals is performed. For critical values of the t-statistic and additional correction terms in the regression see Lanne et al. (2002).

3.2.2 Cointegration Analysis

Johansen (1994, 1995) provides a test for cointegration in the VECM in (3), Johansen et al. (2000) incorporate structural breaks. Their likelihood ratio (LR) trace test statistic for the null hypothesis of at most r cointegrating relations is given by

$$\Lambda(r) = -T \sum_{i=r+1}^{n} log(1 - \hat{\lambda}_i) \ , \qquad (4)$$

where n is the number of endogenous variables and T the number of observations. $\hat{\lambda}_i$ denotes the i-th largest squared sample canonical correlation between Δy_t and the respective cointegrating relation, both corrected for the influence of the remaining regressors. Critical values are obtained by computing the response surfaces in Doornik (1998), or Trenkler (2004) in case of breaks. Given the cointegration results, further LR tests are applied to check the null hypothesis of various parameter restrictions against the unrestricted model.

3.3 Cycle Analysis

Besides cointegration as rank reduction in the long-run multiplier matrix, I am also interested in short- and medium-term business cycle synchrony implying reduced rank in the short-run dynamics. More precisely, I am looking for a linear combination of the differenced time series, which is not predictable from the relevant past, thus eliminates all systematic autocorrelation structure. In the following, I present the variants of the common cycles feature, which are employed in the empirical part.

3.3.1 Common Cycles

Engle and Kozicki (1993) introduced the common cycles feature, which was taken up by Vahid and Engle (1993). They define a cycle as common, if some linear combination of the autocorrelated series is not serially correlated itself. In model (3) this implies, that there exists an $n \times s$ matrix γ, such that $\gamma' A_i = 0$ for $i = 1, \ldots, q$ and $\gamma' \alpha = 0$. That is, if γ' lies in the intersection of the left nullspaces of the long- and short-run adjustment coefficients, one gets the innovation process $\gamma' \Delta y_t = \gamma' u_t$. Integration of both sides clarifies, that γ' removes as well the cyclical component in the *levels* y_t, leaving only a random walk with naturally uncorrelated innovations. It is obviously not worth considering VECMs with $q = 0$, because γ would simply be the orthogonal complement of α.

The test of the null hypothesis of at most s common cycle vectors is done by canonical correlation analysis between Δy_t on one side and the regressors from (3), Δy_{t-i} ($i = 1, \ldots, q$) and $\hat{\beta}' y_{t-1}$, on the other side. Note that s cannot exceed $n-r$ (Vahid and Engle 1993), because the cofeature matrix must lie in the space of the $n \times (n-r)$ orthogonal complement of α. The canonical correlations are conditioned on a constant, seasonal dummies[1] and outlier neutralisation dummies. With the eigenvalues η_i (in ascending order), the LR test statistic for the null hypothesis of at least s common cycle vectors

$$CC(s) = -(T - n(q-1) - r) \sum_{i=1}^{s} log(1 - \hat{\eta}_i) \quad (5)$$

is calculated. The relevant χ^2-distribution has $s(r + nq) - s(n-s)$ degrees of freedom. This can be seen, when using the common cycle restrictions in the VECM from (3):

$$\begin{pmatrix} I_s & \tilde{\gamma}' \\ 0_{(n-s)\times s} & I_{n-s} \end{pmatrix} \Delta y_t = \begin{pmatrix} 0_{s\times r} \\ \tilde{\alpha} \end{pmatrix} (\beta' y_{t-1} + c_0 + c_1(t-1) + c_2 b_{t-1}) + c_3 d_t + \sum_{i=1}^{q} \begin{pmatrix} 0_{s\times n} \\ \tilde{A}_i \end{pmatrix} \Delta y_{t-i} + v_t \quad (6)$$

The cofeature matrix has been normalised such that $\gamma' = (I_s : \tilde{\gamma}')$. $\tilde{\alpha}$ and the $\tilde{A}_i$ contain the lower $n-s$ rows of α and the A_i; the upper rows are filled with $s \cdot r$ restrictions on α and $s \cdot n$ on each of the q A_i. The efficient estimation of the cofeature matrix requires $s \cdot (n-s)$ additional parameters.

3.3.2 High-Frequency Common Cycles

While the common cycles concept demands a linear combination not predictable at all, one could reduce this requirement to the short-run, meaning high frequencies. This leads to allowing for different factors generating the long- and short-term dynamics as in Hecq et al. (2006). In detail, the low-frequency fluctuations from the adjustment processes are considered as idiosyncratic. Therefore, in the search for unpredictable linear combinations, one corrects for the cointegration equilibrium effects: $\gamma'(\Delta y_t - \alpha\beta' y_{t-1}) = \gamma' u_t$.

The appropriate model differs from (6) only in that α is left unrestricted. Accordingly, the test statistic

[1]Common seasonality is not of special interest in the present business cycle analysis.

$$CC^{hf}(s) = -(T - n(q-1)) \sum_{i=1}^{s} log(1 - \hat{\mu}_i) \quad (7)$$

is χ^2-distributed with $snq-s(n-s)$ degrees of freedom. The eigenvalues μ_i are estimated in the canonical correlation program from section 3.3.1, though now additionally conditioned on the error correction terms.

3.3.3 Non-Contemporaneous Common Cycles

As the cyclical fluctuations of different time series might not be perfectly synchronised in the very immediate reaction to an impulse, Vahid and Engle (1997) introduced the concept of codependent cycles. The incorporation of adjustment delays means, that the cycles are treated as common only after a certain time. It follows, that the cofeature linear combination is predictable up to a certain number of periods a (with $a < q$) into the past, but not beyond. Formally, this is $\gamma'(\Delta y_t - \sum_{i=1}^{a} A_i \Delta y_{t-i}) = \gamma' u_t$.

Differing from (6), the A_i, $i = 1, \ldots, a$, are now unrestricted. Consequently, the χ^2-distribution of the test statistic CC^{nc}, formally the same as in (5), has $s(r + n(q-a)) - s(n-s)$ degrees of freedom. The canonical correlations are to be conditioned on the first a lags of Δy_t. Of course, one could additionally correct for the cointegrating relations (test statistic CC^{nc}_{hf}), as in section 3.3.2.

4 Empirical Evidence

4.1 Data

This study makes use of all Asian Pacific nations' quarterly GDP series, which were available in sufficient quality and length; in detail those of Australia, China, Hong Kong (Special Administrative Region of China), India, Indonesia, Japan, South Korea (”Korea” in the following), Malaysia, New Zealand, Philippines, Singapore, Taiwan and Thailand. The list clarifies, that in this paper, *Asia Pacific* comprises East, South-East and South Asia as well as Oceania. In a macro-analysis, the GDP is surely the best broadly available indicator for the aggregated economic development of whole countries. The sample ends in autumn 2005, the starting point varies between the countries (see Figures 2 and 3). I decided to accept this variation, because otherwise all series would have had to be cut to the shortest series' length.

Because of inflation, different currencies and price levels as well as different population sizes, the raw GDP series are not adequate data. Accordingly, the series have been transformed as follows: Per capita GDP has been calculated by dividing GDP by total population, which was linearly interpolated to gain quarterly data. The nominal data have been deflated to the 2000 level using the GDP price deflator or, where not available, the consumer price index. All the data have been taken out of the EcoWin and IMF IFS databases. At last, the 2000 purchasing power parity conversion factors from the international comparison program of the World Bank have been employed to transform all series into US dollar.[2] The calculated variables can be interpreted as the per quarter amount of dollars one would have needed in the USA in 2000, to reach the same living standard as the foreigner in the respective country and period.

The real quarterly per capita GDPs in purchasing power dollars are displayed in Figures 1, 2 and 3. At a glance, one can identify two groups with very different income levels: on the one hand the (newly) industrialised economies of Australia, Hong Kong, Japan, Korea, New Zealand, Singapore and Taiwan, and on the other the more or less fast developing countries China, India, Indonesia, Malaysia, Philippines and Thailand. As the GDP series are calculated per capita, one should always keep in mind the heterogeneity, which is hidden behind the pure numbers.

A first graphical inspection brings the following stylised facts to the fore: The high-income countries exhibit very similar growth patterns, where Hong Kong has taken the most dynamic development quadrupling its income level within three decades. Among the low-income countries, growth accelerates in China, while it has partly even stagnated in the Philippines. The 1998 financial crises can clearly be seen in the series of Hong Kong, Indonesia, Korea, Malaysia, Singapore and Thailand, countries known for having struggled the most by the time. In Singapore and Taiwan further disruptions took place between 2001 and 2003. The economic crisis in the early 1980s shows impacts mostly on Australia, Korea, the Philippines and Singapore.[3] In the Oceanic countries Australia and New Zealand there appears a growth weakness around 1992, which coincides with a world economic downturn. In Japan the economic boom in the late 1980s is visible just as the long period of deflationary recession.

Before digging into the formal model analysis, the unit root properties of the time series are explored. Table 1 shows the results of the ADF tests for the series, which do not

[2]For Taiwan, the factor has been calculated by a PPP update based on the 1990 relative price from Penn World Table.

[3]Of course, various series had not even begun in the early 80s.

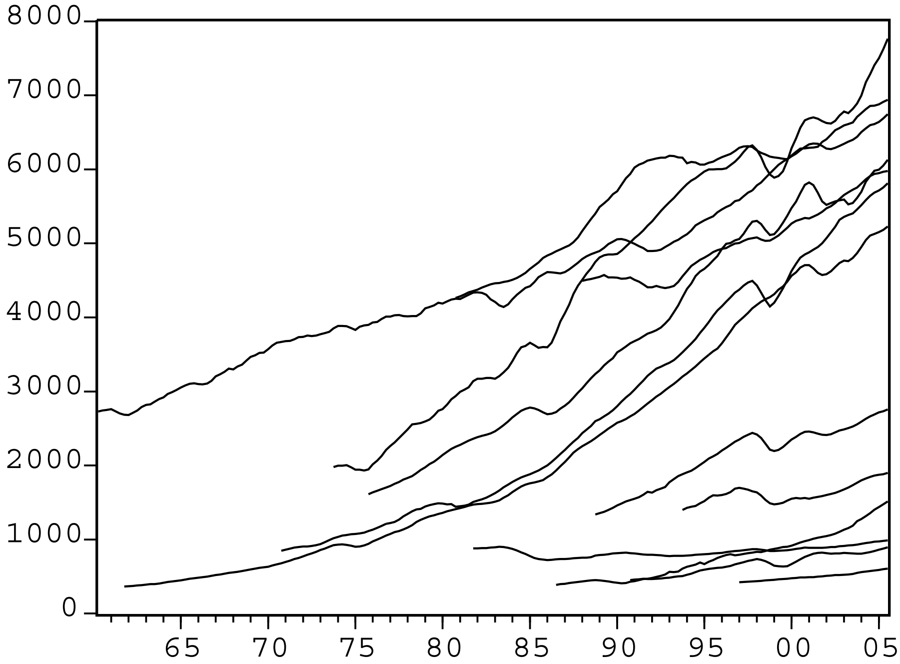

Figure 1: Asia Pacific GDPs (2000 per capita purchasing power US $) - seasonally adjusted

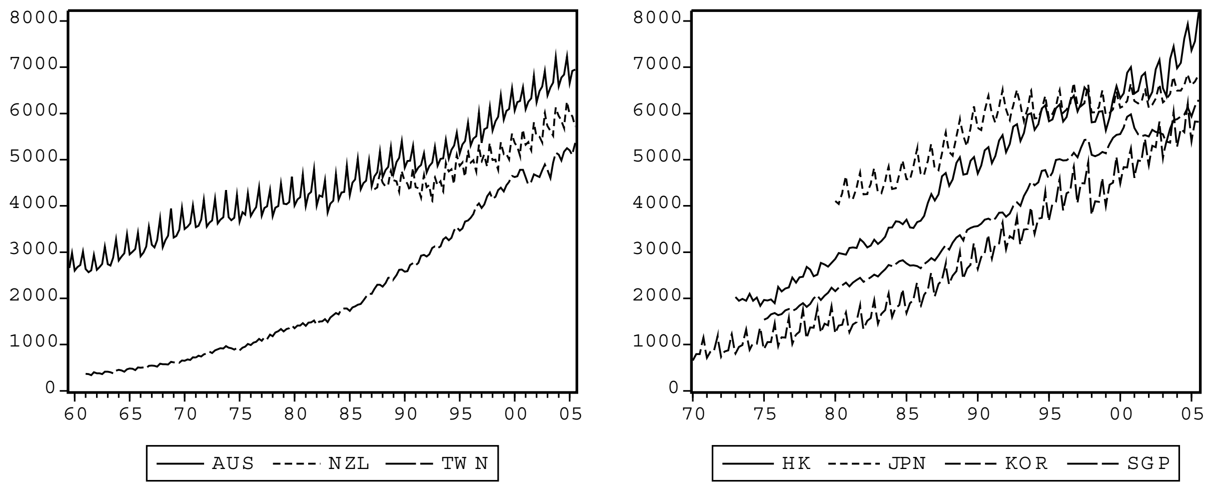

Figure 2: High-income GDPs (2000 per capita purchasing power US $)

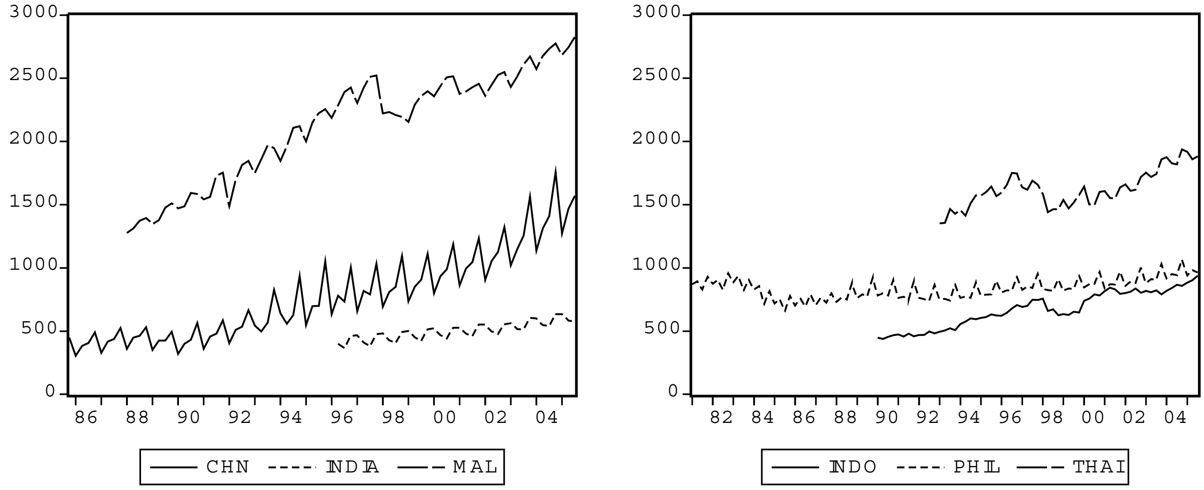

Figure 3: Low-income GDPs (2000 per capita purchasing power US $)

require the specification of a structural break. In no case, instationarity can be rejected even at the 10% level.

	AUS	CHN	INDIA	JPN	NZL	PLP
t-value	-0.79	0.03	0.19	-1.59	-2.24	-2.87
lag length	4	5	3	7	4	4
* H_0 can be rejected at 10% significance level constant, trend and seasonal dummies included						

Table 1: ADF tests for the GDPs without breaks

In Table 2 the results of the Saikkonen and Lütkepohl (2002) test for the breaking series are presented. Again, no evidence against the null hypotheses can be found. Only in the case of Indonesia the test indicates significance at the 10% level; since even here non-stationarity cannot be rejected at the 5% level, but can in no case be maintained for the first differences, I assume all examined GDPs integrated of order one.

	HK	IDN	KOR	MAL	SGP	TWN	THL
t-value	-2.31	-2.93*	-0.38	-2.22	-2.02	-2.07	-1.62
break date	1998:1	1998:2	1998:1	1998:1	1998:1	2001:1	1998:2
lag length	8	5	6	0	1	8	4
* H_0 can be rejected at 10% significance level constant, trend, shift and seasonal dummies included							

Table 2: Unit root tests for the GDPs with breaks

4.2 Cointegration and Convergence

To provide an overview of the convergence structures in the region, at first I discuss bivariate models, analysing each pair of countries. It is well known that two series, both cointegrated with a third one, cointegrate with each other, too. Interesting enough, the actual results will not uniformly follow this rule. Of course, in statistical inference this fact does not surprise, and apart from that, it is due to different sample lengths and different model specifications being necessary for different pairs. I take the results not as contradicting the pure theory, but as sparking an impression about the strength of regional linkages.

Table 3 shows the values of the trace test statistics for $H_0 : r = 0$. Here, and in all succeeding tables, the country in the respective column is always ordered first in the endogenous vector. The ordering in the tables is arbitrary and of no importance. The bold lines divide the industrialised and developing countries. The model specifications can be found in the Appendix Table 11. The break dates, naturally most frequently in 1998:1, are set following the arguments in section 4.1. Impulse dummies have been included to attain normality, and the model properties have been checked to pass the Jarque-Bera test and a Lagrange multiplier test for serial correlation.[4]

	KOR	AUS	HK	NZL	SGP	TWN	JPN	MAL	IDN	THL	INDIA	CHN
AUS	49.7**											
HK	33.6*	33.7*										
NZL	51.3**	33.5*	30.4*									
SGP	51.2**	38.0*	45.3**	42.7*								
TWN	55.8**	41.0**	54.9**	54.4**	77.4**							
JPN	29.8*	44.1**	30.3*	31.0*	43.3**	36.4**						
MAL	34.3**	15.9	18.5	37.7*	44.5**	62.5**	56.9**					
IDN	46.2**	41.8**	33.3*	43.4**	42.7*	49.0**	30.5*	33.1*				
THL	33.9**	49.4**	25.9	33.5*	40.6*	34.4**	63.7**	33.5**	51.9**			
INDIA	72.6**	16.4	34.1**	10.9	37.4**	39.5**	20.8	51.9**	38.7**	29.3*		
CHN	43.0**	42.2**	51.6**	36.3**	72.5**	62.7**	37.4**	41.0**	68.8**	31.9*	34.1**	
PLP	54.1**	40.0**	33.7*	46.2**	37.6*	41.3**	32.6*	30.9*	62.0**	40.0**	55.9**	47.4**

** , * : H_0 can be rejected at 1% respectively 5% significance level

Table 3: Bivariate trace test statistics

At first glance, the results mirror a very convincing impression of the cointegration prop-

[4] Due to the high number of models, I do without presenting the details.

erties. Unfortunately, the pure trace test significances conceal several problems in the model specification, which are closely linked to the data qualities, for example instability in the economies. Taking this into account, I provide an evaluation of the common trend results in Table 4. To avoid confusion by too many details, I chose a very simple codification: ”+” means cointegration and ”−” no cointegration; ”0” (problematic) stands for results, which do not rule out cointegration, but are tainted with problems of insisting autocorrelation, very high sensibility to minor changes in the model specification, signs of series stationarity in the trace tests or borderline values. As in the remaining paper, decisions are made at the 5% level, if not explicitly set otherwise.

	KOR	AUS	HK	NZL	SGP	TWN	JPN	MAL	IDN	THL	INDIA	CHN
AUS	+											
HK	+	+										
NZL	+	+	+									
SGP	+	+	+	+								
TWN	+	+	0	+	0							
JPN	+	+	+	+	+	0						
MAL	+	−	−	+	+	+	+					
IDN	+	+	+	+	+	+	+	0				
THL	+	+	−	+	0	+	+	0	0			
INDIA	+	−	0	−	+	+	−	+	+	+		
CHN	0	+	0	+	0	0	+	0	+	+	0	
PLP	+	+	+	0	0	+	0	+	+	0	+	+
+ cointegration, − no cointegration, 0 problematic												

Table 4: Evaluation of cointegration results

At first, the most convincing cointegration relations can be found in the group of high-income countries, where only Taiwan reveals certain weaknesses. Results involving China are partly unstable, which is not surprising in view of its special character as a huge nation with enormous transition dynamics. Among the low-income countries, besides China, Malaysia does not show convincing results, probably because as a very fast developing country it does not fit perfectly well in this group. The equilibrium relations of the low-income countries towards Hong Kong seem rather problematic. This might be due to the outstanding development Hong Kong has taken in the sample period. In contrast, these relations for example towards Korea and Taiwan are very well developed. Above all, Indonesia comes off very well in the tests. Reasons for the lack of significance in some tests involving India might be found in its very short time series. In general, most negative results appear between the two groups of industrialised and developing countries, but even here the overall impression is not against common trend linkages.

Bearing in mind, that the implications of the Bernard and Durlauf (1995) definition are not limited to cointegration, but comprise equal weights in the long-run relation, some attention should be paid to the cointegrating vectors. The numbers displayed in Table 5 are the β-elements for the countries in rows, those for the column series are normalised to unity. The bulk of the elements is negative, a considerable number is even restrictable to -1, and only relatively few are positive. Remarkably, Japan shows deviations from the otherwise relatively harmonic results. Though, the positive values can probably be explained by the presence of deterministic trends in the cointegrating relations: In estimations with necessarily limited sample sizes, these trends can partly capture stochastic effects between the GDPs. Leaving out the deterministics, although no sensible choice in case of catching-up or divergence, would move the vectors towards (1,-1). The strongest stochastic trends, indicated by relatively low weights in β, appear in Thailand, China, Singapore and New Zealand, the weakest in the Philippines, India and Australia.

	KOR	AUS	HK	NZL	SGP	TWN	JPN	MAL	IDN	THL	INDIA	CHN
AUS	-1.04											
HK	-2.46[1]	-0.61										
NZL	-0.12	-0.51	-0.05									
SGP	-0.54[1]	-0.33	0.27	-1.08								
TWN	-1.23[1]	-0.39	-0.45	-1.51[1]	-1.09[1]							
JPN	0.21	0.51	-0.43	0.25	0.48	0.39						
MAL	0.18	*	*	2.17	-2.85	-1.95	-0.14[1]					
IDN	-0.97[1]	-0.03[1]	4.49	1.09	-11.3	-7.16	0.72	0.29				
THL	0.34	-0.03	*	-0.72	-0.10	2.42	-0.96[1]	-0.99[1]	0.33			
INDIA	2.69	*	-22.8	*	-8.00[1]	-1.62[1]	*	-3.84	-1.95	-4.17		
CHN	-0.2	-2.19	-1.04[1]	-1.85[1]	-0.08	-0.64	0.65	0.36	0.04	-0.62[1]	-0.15	
PLP	-0.92[1]	-1.45[1]	0.34	-3.60	-3.03	-1.77	3.83	2.40	1.11	-5.51	-1.75	-1.59[1]

* no significant cointegration

[1] restriction to -1 accepted

Table 5: Bivariate cointegrating coefficients

Besides the cointegrating linear combination, the equilibrium relations contain a constant and a linear trend, giving an impression of a continuous convergence or divergence process, which is modelled deterministically. I do not present the complete results, because qualitatively they can already be seen from Figure 1: Undoubtedly, the gap between the high- and low-income countries is still widening, significant trends are estimated in nearly all cases. These deterministic trends can be given an interpretation as an autonomous component shared only within the high-income group: Here, catching-up is taking place or already finished, only the enormous development of Hong Kong leads to differing estimations. For the low-income countries, the results confirm the relatively good performance of Malaysia, Thailand and China, while especially the Philippines lag behind in GDP growth. Of course, in terms of growth *rates* rather than *levels*, the low-income countries come off far better. Unfortunately, these higher rates are not to close the level gap in the foreseeable future. Nonetheless, divergence in the deterministics could be mitigated by considering arguments from the conditional convergence concept, which allows for several key growth determinants differing across economies. Furthermore, forecasts based on deterministic variables generally have to be treated with caution.

4.3 Business Cycle Coherence

Until now, the stochastic trend analysis has been the subject of interest. This section introduces the second conceptual element by presenting the results on common cycles.[5] For each pair of countries, at first it is checked, whether a linear combination can be found, which cancels out the effects of all VECM regressors except the dummies (section 3.3.1). Only, when this does not hold, I test for high-frequency common cycles by taking out the error correction term (section 3.3.2), and for non-contemporaneous common cycles by gradually taking out lagged differences (section 3.3.3).

To save space, only the p-values of the most convenient and acceptable alternatives are displayed, see Table 6. In few cases though, an overall inspection of the different results favoured to give relatively low p-values, which should consequently be taken with reservations. When all hypotheses were clearly rejected at the 5% level, the respective table field has been crossed out. In case of no cointegration, the tests have been performed in a VAR model in first differences, thus excluding any error correction term and allowing only for the high-frequency variant. To be able to carry out the tests, in the models initially without lags, one lagged difference was included, if significant and reasonable. Otherwise, the respective field has been kept blank.

Before the evaluation, recall that some series, above all those of India, Thailand and Indonesia, are rather short and therefore make it difficult to reject the common cycle hy-

[5]These calculations have been done in a program written by the author using the R language.

	KOR	AUS	HK	NZL	SGP	TWN	JPN	MAL	IDN	THL	INDIA	CHN
AUS	hf 13.8											
HK	nc4 46.3	nc1 7.8										
NZL	cc 9.8	cc 10.4	cc 20.7									
SGP	cc 30.8	cc 9.6	cc 33.4	cc 9.5								
TWN	nc4 22.5	nc4 10.4	nc4 hf 12.7	hf 66.2	hf 16.5							
JPN	nc4 18.1	nc4 35.1	nc4 14.5	nc3 hf 5.6	nc4 10.4	nc1 3.0						
MAL	cc 58.4	hf 52.7	hf 5.1	nc2 51.2	cc 24.9	cc 83.2	cc 89.2					
IDN	cc 49.2	cc 57.2	cc 13.0	cc 22.6	cc 27.5	cc 9.9	cc 21.9	cc 26.8				
THL	cc 16.2	*	hf 14.0	cc 24.8	cc 99.6	cc 21.5	cc 21.3	cc 43.7	cc 39.0			
INDIA	cc 75.4	*	cc 4.2	hf 5.7	cc 18.9	cc 11.3	*	cc 81.1	cc 73.7	*		
CHN	X	cc 5.9	nc1 hf 9.7	nc2 12.0	hf 39.9	hf 3.7	nc1 43.7	cc 7.8	cc 43.6	hf 6.5	cc 7.6	
PLP	X	nc2 8.0	X	cc 30.1	hf 23.4	hf 7.0	X	cc 21.9	cc 10.4	cc 15.0	cc 91.6	X

cc: common cycles, hf: high-frequency, nc: non-contemporaneous of given order
* no lags

Table 6: Bivariate common cycles: hypotheses and p-values in %

potheses. Accordingly, these countries happened to reach very strong support for common features. This problem of data availability can only be faced by speaking of "no evidence against common cycles", which is of course far from any positive confirmation.

Among the high-income countries, New Zealand and Singapore yield the results most in favour of common cycles. In contrast, especially Taiwan and Japan seem to be synchronised in most cases only several quarters in delay; considering Japan, its idiosyncratic inflationary course is likely to explain this effect. For the group of low-income countries, excellent common cycle results are provided. Between the groups, p-values are surprisingly high, above all for Indonesia. China and the Philippines yield the weakest evidence. The latter have attained no considerable development dynamics in the last decades, presumably due to structural and political problems.

	KOR	AUS	HK	NZL	SGP	TWN	JPN	MAL	IDN	THL	INDIA	CHN
AUS	-1.40 (-17.2)											
HK	0.17 (1.0)	-0.15 (-1.2)										
NZL	-0.90 (-25.2)	-0.73 (-21.1)	-0.21 (-4.7)									
SGP	-1.98 (-5.8)	-2.34 (-5.5)	-2.62 (-4.6)	-7.61 (-2.6)								
TWN	-0.55 (-3.5)	-0.54 (-2.3)	-1.03 (-3.4)	-2.38 (-2.0)	-0.22 (-1.8)							
JPN	-0.39 (-1.6)	0.64 (1.9)	0.75 (1.3)	-0.75 (-3.7)	-0.62 (-2.0)	-0.07 (-1.2)						
MAL	-4.60 (-3.8)	2.94 (1.2)	-4.08 (-3.3)	-9.59 (-3.6)	0.12 (0.2)	0.35 (0.8)	-3.05 (-2.4)					
IDN	18.76 (3.9)	26.09 (3.7)	7.21 (3.5)	22.07 (5.0)	0.13 (0.1)	2.34 (2.9)	23.28 (3.5)	0.23 (0.8)				
THL	-4.37 (-5.3)	*	0.13 (0.2)	-3.47 (-3.6)	-3.49 (-2.2)	-0.67 (-2.7)	-6.23 (-3.2)	-0.59 (-4.3)	-0.09 (-1.2)			
INDIA	-5.88 (-12.1)	*	-1.75 (-3.3)	0.30 (0.1)	-0.82 (-1.8)	-1.16 (-3.8)	*	-0.25 (-1.9)	0.23 (2.12)	*		
CHN	X	-1.40 (-11.5)	-0.53 (-3.5)	-1.31 (-7.2)	-0.26 (-1.7)	-0.17 (-3.3)	-1.04 (-5.7)	-0.11 (-3.0)	0.04 (1.9)	-0.06 (-0.2)	-0.35 (-17.7)	
PLP	X	-2.63 (-8.1)	X	-4.44 (-21.3)	-0.48 (-3.3)	-1.00 (-6.6)	X	-0.14 (-1.7)	0.12 (2.6)	-0.43 (-2.9)	-0.78 (-20.7)	X

* no lags; t-values in parentheses

Table 7: Common cycle coefficients

The restrictions accepted by the tests in Table 6 can now be applied to the VECM from (3), as has been shown in section 3.3. Table 7 lists the estimated elements of the cofeature vectors and their t-values. A "right-directed" synchrony expects the estimations to be negative, -1 stands for coherent cycles of equal per capita strength. As can be seen, for the most part these expectations are met, whilst the few positive values are not significant. Only Indonesia exhibits nearly exclusively positive and significant cofeature vectors. These values are likely to be explained by lags in the business cycle transmission, but might as well be due to the exceptionally low seasonality in the Indonesian GDP. Again indicated by low weights in the respective cofeature vectors, the business cycle dynamics have the highest intensity in Japan, New Zealand and China, in Malaysia and Singapore they are rather weak.

4.4 Economic Leadership

The preceding sections have dealt with examining the strength of economic integration. Given the present insights, I now turn to searching for a system of impacts and dependences within the regional area. In short, it shall be identified, which countries for their part find themselves in a leading role, and which are rather influenced by foreign impulses.

As the first technique, I employ forecast error variance decompositions (FEVD) based on the VAR model representations, which still include the cointegration restrictions. Frankly speaking, FEVDs determine the proportion of variation in one series accounted for by the other series. Obviously, no economic theory can provide general restrictions for the identification of the contemporaneous effects between the GDPs of different countries. I therefore neglect these effects by diagonalising the instantaneous impact matrix. For the most part of the pairs in any way no significance for residual cross-correlation exists. As shorter-term influences might nonetheless suffer from the lack of simultaneity, Table 8 uses the long-run contributions succeeding the initial dynamics.

	KOR	AUS	HK	NZL	SGP	TWN	JPN	MAL	IDN	THL	INDIA	CHN	PLP
KOR		0	98	72	26	98	82	54	97	77	99	10	79
AUS	99		91	49	69	93	92	4	7	57	74	38	87
HK	0	2		4	66	25	67	0	95	6	16	84	39
NZL	8	46	11		90	97	91	97	95	91	31	63	13
SGP	75	4	4	1		59	65	1	1	12	7	4	97
TWN	1	1	62	2	41		29	3	0	1	9	19	6
JPN	2	6	25	6	28	70		1	56	99	69	93	26
MAL	23	0	99	2	97	96	90		32	32	23	2	36
IDN	0	1	5	1	98	97	6	41		64	24	75	5
THL	17	1	77	3	83	96	1	76	35		1	2	1
INDIA	1	18	84	55	93	91	30	74	75	97		69	21
CHN	12	63	18	37	94	80	7	96	31	97	31		26
PLP	9	1	23	87	1	89	55	62	92	98	6	74	
contribution of column series to row series variance in %													

Table 8: FEVD long-run contributions

The strongest effects obviously originate from Taiwan, Singapore and Japan, though for the latter restricted to the high-income countries. In contrast, the Oceanic countries Australia and New Zealand, India (mainly on low-income), Korea and Malaysia (only on high-income) have the weakest influence on their neighbours. Changing the task to looking for the degree of dependence, the ordering is mainly reversed: The last mentioned countries are subject to the strongest foreign impacts (Malaysia only from high-income except Oceania), Taiwan, Singapore and Japan (only from high-income) to the weakest impacts. For the others, the distribution is more or less mixed.

In a second step, Granger causality LR tests are applied to zero restrictions separately put on the adjustment parameters and the cross-country short-run coefficients. This raises two currently unaddressed issues, namely the significance of influences and the difference between equilibrium error correction and short-run effects. In the following tables, again the influences go from the column to the row series: Table 9 gives the p-values for the zero restrictions on the α-element of the respective row series; in Table 10 the restrictions lie on the A_i-elements, which represent the short-run impacts from column to row.[6]

	KOR	AUS	HK	NZL	SGP	TWN	JPN	MAL	IDN	THL	INDIA	CHN	PLP
KOR		84	0	0	0	0	0	0	0	0	0	0	0
AUS	0		0	0	0	0	0	*	0	0	*	0	0
HK	91	19		0	0	0	0	*	0	*	0	1	0
NZL	1	0	5		0	0	0	0	0	0	*	0	0
SGP	0	20	18	1		0	0	50	56	2	2	1	0
TWN	35	45	0	0	0		1	19	59	69	1	0	14
JPN	27	7	1	13	0	0		44	0	0	0	0	0
MAL	0	*	*	31	0	0	0		0	6	1	15	0
IDN	93	0	16	51	0	0	0	0		0	2	0	0
THL	0	1	*	37	0	0	4	0	0		0	3	8
INDIA	3	*	0	*	0	0	0	0	0	0		0	10
CHN	0	0	0	0	0	0	5	0	0	0	0		0
PLP	2	59	0	0	51	0	0	0	0	0	0	0	
p-values in % for H_0: "no error correction influence from column to row" * no significant cointegration													

Table 9: LR tests on equilibrium adjustment restrictions, p-values

At a glance, apparently there is higher significance for the adjustment process than for the short-run effects, a result, which might as well be found in the cointegration and common cycles analysis.[7] The long-run equilibrium (see Table 9) seems to be mostly influenced by Taiwan, Singapore and Japan, which are as well the countries subject to

[6] In case of no lags, one lagged difference was included as in section 4.3.

[7] Note though, that the common cycles concept involved the error correction term, and the two concepts are therefore not totally equivalent.

	KOR	AUS	HK	NZL	SGP	TWN	JPN	MAL	IDN	THL	INDIA	CHN	PLP
KOR		0	1	11	0	0	2	21	0	10	0	1	20
AUS	9		3	8	30	8	0	5	46	*	*	0	0
HK	1	69		66	0	0	6	6	0	2	1	0	0
NZL	0	6	0		48	15	2	2	17	31	2	0	0
SGP	0	43	7	49		4	3	0	42	83	1	72	3
TWN	21	35	0	40	0		7	0	9	5	1	60	35
JPN	33	24	16	0	3	0		1	21	1	0	0	39
MAL	0	18	5	12	53	0	1		8	0	1	11	3
IDN	46	61	1	38	18	0	45	96		0	1	0	0
THL	0	*	1	4	52	0	14	0	2		*	49	4
INDIA	24	*	5	2	2	0	3	2	1	*		0	46
CHN	46	0	2	1	9	2	4	85	0	1	0		8
PLP	5	1	12	6	11	90	3	0	0	0	0	0	

p-values in % for H_0: "no short-run influences from column to row"
* no lags

Table 10: LR tests on cross-country short-run restrictions, p-values

the fewest important foreign impacts. But in general there is broad evidence for wide spread equilibrium dynamics. The relatively weakest attraction forces stem from Oceania and unexpectedly Korea. All these results are well in line with the forestanding FEVD analysis. In the short-run domain (see Table 10), the strongest business cycle impulses originate from Japan, Hong Kong, Taiwan and India. Weak effects radiate again from Oceania and Korea, as well as Singapore.

4.5 Multivariate Examination

The bivariate analysis uncovers the structure of economic linkages, but therein it is difficult to gain information about the degree of total regional integration. In a multivariate context, the number of common Asian Pacific trends and cycles shall now be established. For this purpose, I construct several multivariate models, all including the usual deterministics. These submodels follow the tendency of the forestanding results to imply a grouping along the lines of the national states of industrialisation. For reasons of brevity, only the results for the highest reasonable numbers of cointegration and common cycle vectors are discussed. Not mentioned lower numbers are clearly accepted, higher numbers clearly rejected.

The first setting contains the GDPs of six high-income countries, among which very strong bivariate cointegration results had been achieved. New Zealand is not included for gaining seven sample years. The trace test with six lags and two breaks (1998:1 and 2001:1) produces a p-value of 2.4% for $H_0 : r \leq 4$. The presence of one common stochastic trend can thus be confirmed. The maximum number of common cycle vectors is therefore $n - r = 1$, and cannot be rejected by the LR test ($CC(1) = 42.20$, $p = 22.1\%$). To test for higher dimensions of the cofeature space, I make use of the high-frequency form, which is not subject to restrictions from the cointegration space. At first, two cofeature vectors can be found ($CC^{hf}(2) = 76.79$, $p = 13.12\%$). Allowing for adjustment delays, this rises to three ($a = 1$, $CC^{nc}_{hf}(3) = 94.38$, $p = 14.7\%$) and four ($a = 2$, $CC^{nc}_{hf}(4) = 98.23$, $p = 21.4\%$). All in all, the common cycle results reflect a high, but not perfect, business cycle coherence amongst the regions' industrialised nations.

In the second model, I include four low-income countries. India and Thailand are not considered, because their series do not yield enough observations for a higher-dimensional model. $H_0 : r \leq 2$ can be rejected with a p-value of 0.8%, setting $q = 4$ and one break in 1998:1. Again, one single common trend allows only one common cycles vector, which can easily be established ($CC(1) = 17.73$, $p = 34.0\%$). Using the high-frequency test, there is evidence for one more vector ($CC^{hf}(2) = 31.16$, $p = 31.0\%$), but the non-contemporaneous variant cannot yield the maximum number of three vectors. Thus, the coherence properties are somewhat weaker than in the bivariate analysis.

At last, I construct a model with all GDP series (except India and Thailand), three lags and one break in 1998:1. While - given the sample length - this dimension seems too high, the cross-grouping is surely interesting. The trace test is able to establish all possible cointegrating vectors ($\Lambda(9) = 28.87$, $p = 4.6\%$), but only by a borderline decision. Although it is not impossible, that the stochastic trending behaviour between the groups is not totally identical, I proceed assuming a single common trend. After having confirmed the one possible common cycles vector ($CC(1) = 12.23$, $p = 95.3\%$), I find five vectors in the high-frequency test ($CC^{hf}(5) = 91.86$, $p = 17.2\%$), and six in its non-contemporaneous version ($a = 2$, $CC^{nc}_{hf}(6) = 39.93$, $p = 30.0\%$). As one more vector is not totally ruled out, this evidence for coherence is not unsatisfying, but neither ameliorating the situation from the two subgroups.

5 Concluding Summary

In this paper, I have focused stance and properties of the macroeconomic integration in the Asian Pacific region. Stochastic convergence, business cycle coherence and impulse transmission were the main points of interest. In summarising the empirical results, I will conclude by evaluating the answers to the questions set out in the beginning.

The cointegration analysis has been motivated by the convergence definition of Bernard and Durlauf (1995), which requires a cointegrating long-run equilibrium with equal weights on different GDPs. In fact, the evidence is in favour of the presence of common stochastic trends in the Asian Pacific national per capita GDPs, even if results between high- and low-income countries cannot hold the general level. Regarding the cointegration structures, the convergence definition is partly met, but trends of different strength are not exceptional; trends of reversed direction though appear rather seldom. Nonetheless, catching-up does indeed succeed within the group of industrialised countries, but not between industrialised and developing economies due to divergence in the deterministics.

As the second element in the integration concept, I examined the synchrony of business cycle fluctuations. In this, a cycle is defined as common, if it is possible to cancel out all autocorrelation dynamics in a linear combination between the GDPs. In order to accommodate weaker but more flexible forms of coherence, non-contemporaneous and high-frequency variants have been included. In part, I found convincing signs of co-movement in the transitory components, especially within the low-income group. Though in general, results are not totally straightforward, for example thinking of the delays in adjustment of Japan and Taiwan.

So, while not behaving totally in line with the role of an integrating regional centre, Japan still represents beyond doubt the major economic power in Asia Pacific. Thus turning to the questions of the direction of impact transmission and economic leadership, I established the following facts: The most significant and effective impulses originate from Japan, Taiwan and Singapore. Contrasting, Australia, New Zealand and surprisingly Korea are not senders, but far more receivers of economic influences. Although Asia Pacific lacks any fixed point of natural dominance, a certain structure in the regional relations can be defined. As a general trend it becomes evident, that the equilibrium adjustment is more developed than the links in the short-run dynamics. This reflects the existence of similar structural driving forces in a regional setting, which is at the same time made up by economies of very particular characters.

Despite this heterogeneity between the Asian Pacific nations, I found considerable evidence for regional interlinkages in the macroeconomic processes. For the discussions of growth development, trade arrangements, monetary cooperation, regional institutionalisation, as well as structural vulnerability this analysis surely provides interesting results. Further research could for example address the determinants for the strength of different interlinkages or the identification and interpretation of structural shocks driving the common and idiosyncratic developments. The present paper can be seen as a broad base for more specialised work to come.

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Appendix

	KOR	AUS	HK	NZL	SGP	TWN	JPN	MAL	IDN	THL	INDIA	CHN
AUS	4 91:1 98:1											
HK	5 98:1	4 98:1										
NZL	92:1 98:1	91:1	98:1									
SGP	10 98:1 01:2	8 98:1 01:2	4 98:1 01:1	0 98:1 01:1								
TWN	8 98:1 01:2	8 01:2	8 98:1 01:2	0 91:2 01:1	4 98:1 01:1							
JPN	5 98:1	7 -	5 98:1	4 92:1	7 98:1 01:1	8 01:2						
MAL	4 98:1	1 98:1	2 98:1	4 92:1 98:1	0 98:1 01:4	0 98:1 01:2	9 98:1					
IDN	4 98:1	0 98:1	2 98:1	4 92:1 98:1	4 98:1 01:4	5 98:1	0 98:1	0 98:1				
THL	4 98:1	0 98:1	1 98:1	5 98:1	0 98:1 01:3	5 98:1	0 98:1	7* 98:1	5 98:1			
INDIA	6 -	4 -	3 -	3 -	4 01:4	4 01:2	6 -	3 98:1	6* -	0 98:1		
CHN	2 98:1	3 -	3 98:1	3 92:1	2 98:1 01:1	2 01:2	3 -	3 98:1	6 98:1	1 98:1	3 -	
PLP	4 84:3 98:1	4 91:1	4 98:1	3 92:1	4 98:1 01:1	5 01:2	2 92:1	3 98:1	3 98:1	7 98:2	7 -	3 -
trend, constant, seasonal and impulse dummies included; * : no trend												

Table 11: Lag length and break dates in the bivariate models

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