Common and Uncommon Sources of Growth in Asia Pacific

Abstract

This paper embarks to analyse the role of exports and investment supposed to be major sources of economic growth in Asia Pacific. Therefore at first, the cointegration properties of exports, capital formation and GDP are examined in vector error correction models (VECMs). The results confirm the crucial role of exports and investment in the Asian growth dynamics. In a second stage, the structural shocks are identified by short- and long-run restrictions. These shocks, as well as the corresponding dynamic responses, are then correlated across all sample countries to provide insight into the depth of regional coherence. At last, the identified trends are explained by various macroeconomic variables.

Keywords: Economic Growth, Structural VECM, Export, Investment, Asia Pacific
JEL classification: O11, F15, C32

Contents

1 Introduction

Since the 1970s, the Asian Pacific region has witnessed an incomparable economic upswing, which has later on been called the "Asian miracle". Countries, which had traditionally relied on policies such as import substitution and national subsistence switched to an enduring export-orientated strategy. This change coincided with the take-off of foreign direct investments mostly conducted by multinational firms intending to tap new markets and striving for profitability increases. In addition, high domestic savings enabling continuous investment were backing the sustained development. Therefore, the Asian success story might be characterised as based on both outward orientation and steady domestic progress. Nevertheless, these vibrant dynamics are not common to all the region's nations, thus leaving several economies in a pre-take-off state of relative stagnation. The appearance of severe crises, most recently in 1997/98, additionally harmed the image of self-enduring growth.

The exceptional development dynamics of the last decades are inconceivable without the sustained influence of exports and investment. The close connection of those two growth drivers with technological progress, acquisition of knowledge, market enlargement and economic liberalisation set up two major steering forces behind the remarkable economic success, drawing attention of several strands of literature: The role of exports in the Asian economies has been analysed for example by Krueger (1985). Nelson and Pack (1999) provide a critical review on the approaches favouring a key function of capital accumulation in the Asian growth processes. Section 2 provides an overview of the basic lines of argumentation.

The literature about identifying structural shocks as driving forces was initially influenced by Bayoumi and Eichengreen (1994). These authors specified output and inflation vector autoregressive models in order to isolate one persistent supply and one transitory demand shock, but did not deduce their restrictions from the presence of common stochastic trends. This literature mainly focuses the symmetry of structural disturbances, which is interpreted in the sense of the theory of optimal currency areas. Unlike the present paper though, it does not try to find origins of the growth innovations.

Given the above considerations, I believe it is worthwhile to pursue the following key questions in the present analysis: Is it possible to detect export and investment trends driving the GDP growth dynamics? Which roles can be assigned to each of these trends? Is there any evidence for regional coherence in the sense of similarity between the structural innovations, and what are special characteristics for example of the "Asian tigers"?

Finally, which are determinants of the identified trends?

This paper approaches the outlined issues in the context of an empirical time series analysis, which will be proceeded on an aggregated macro-level. The examination works with cointegration restrictions, which are imposed on reduced form VECMs. In this, I explicitly consider the recent structural breaks in the Asian economies. On this level, I can already deduce a causal growth connection basically running from exports and investment to GDP. In the second step, long- and short-run restrictions are inferred from the model properties and economic considerations. In the identified model structure, the growth effects are examined using impulse responses and variance decompositions. Additionally, the structural shocks are compared among the nations and explained by relevant macroeconomic variables.

In order to knit my research to a theoretical line, I start out to present the basic economic concepts of export and investment dynamics, which underlie my empirical modelling. Section 3 introduces the econometric techniques with emphasis on cointegration and identification. Afterwards, the results of the reduced form and structural models are presented and analysed in section 4. In the end, the summary gives a concluding overview.

2 Economic Foundation

Since the seminal work of Solow (1956), literature on growth has mostly concentrated on the determination of steady state paths. Therein, the neoclassical approach stresses, that due to diminishing marginal returns in the aggregate production function deviations from the equilibrium growth rate can only be transitory. Especially, the development of capital accumulation has no long-run effect on growth rates, which are determined by exogenous variables such as technological progress.

While the theory initially predicts convergence of growth rates *within* one country, implications for the relations between different countries are straightforward: Convergence of per capita income levels between nations follows from the fact, that less developed countries should achieve higher growth rates. Bearing in mind the assumption of equal production functions, in case of structural economic parameters differing across countries, convergence would have to be conditioned on these determinants.

As a reaction, the endogenous growth theory, with its origins in Romer (1986) and Lucas (1988), has been developed. Essentially, model-inherent mechanisms prevent the growth

rates from falling quasi automatically caused by diminishing marginal returns. The most prominent examples in the theoretical discussion are endogenous technological change and human capital augmentation. Both are considered to take the role of endogenous investment-linked drivers of permanent changes in the growth rate. As a consequence, the hypothesis of necessary convergence to an exogenously determined steady state path cannot be maintained.

The outstanding development the newly industrialised countries in Asia Pacific have taken in the last decades casts doubt on the implications of the neoclassical approach. However, in the empirical time series context a long-run link between stationary growth rates and non-stationary real investment, as predicted by endogenous growth models, seems rather problematic (see Jones 1995). Disregarding this theoretical discussion, the relevant measure of economic strength is far more given by output *levels* rather than growth *rates*. Therefore, in this paper, I do not explicitly test the validity of the mentioned theories, but focus on the sources of the partly rapid expansion of income levels in the Asian Pacific region, notwithstanding the debate on theoretical steady state properties.

In several strands of literature, above all exports and investment have been assumed to be main sources of the extraordinary Asian Pacific development. The corresponding empirical tests for the most part are based on the concept of Granger causality between measures of output and exports respectively investment (see e.g. Krishna, Ozyildirim and Swanson (1998), or Feasel, Kim and Smith (2001) for a combined analysis). Nevertheless, the mainstream literature does not deal with long-run cointegrating relations or identification of structural growth shocks. Intending to find out the structural economic forces behind the "Asian miracle" and their regional coherence, apart from GDP I include both real capital formation and exports in structural cointegration models. In the following, major theoretical justifications for the important roles of the chosen variables in growth processes are given.

First of all, both exports and investment are components of the aggregated demand and therefore have a direct influence on the GDP level. Notwithstanding possible permanent effects, originating for example from market enlargement or output stabilisation, demand impulses normally remain transitory. Consequently, in an economic growth context it is supply side arguments, which are of decisive importance:

The role of *investment* is closely linked to the main arguments in standard growth theory: For the neoclassical part, factor endowment accumulation is the key variable for catching-up, even though representing only transitory processes. However, the endoge-

nous approach assigns persistent effects to real investment, which generally stem from external effects (see Romer 1986 and Lucas 1988): For example, a higher capital accumulation could trigger further technological progress, resulting in higher productivity. Likewise, the idea of dynamic interaction between physical capital and human resources, comprising abilities, knowledge, experience and social institutions, directs to structural growth effects of investment. All these arguments direct at justifying, that additional capital causes more than pure moving along the production function. In the same line, the notion of embodied growth (Solow 1960), meaning that new capital goods are bearers of inherent technological progress, is of straightforward importance. For a debate on factor accumulation and technology as sources especially of Asian growth see Krugman (1994) and Rodrigo (2000), as well as the references therein.

Most approaches on *export* impacts origin in the theories of growth or development, as elaborated in Lewis (1980), Feder (1982), Helpman and Krugman (1985) and Krueger (1985). First of all, openness to trade is likely to increase the intensity of competition and set economic incentives, thus enhancing efficiency in production and causing sector reallocation. Contact to the world markets may trigger learning processes and generate knowledge about manufacturing processes, organisation, sales strategies and so on, even though this absorption might require some minimum level of development (e.g. Grossman and Helpman 1991). These points are geared to the situation of developing economies, which still operate below world market standard, but bear the potential of catching-up. Therefore, the applicability to South-East Asia should be striking. Furthermore, export strengthening could be a solution to the problem of growth constraints in case of foreign exchange restricting important imports or policy flexibility. At last, scale and specialisation effects are likely to occur as markets expand, so that for example problems of large minimum plant sizes are mitigated.

Besides the causality running from exports and investment to GDP growth, reverse-directed interactions should not be ignored a priori. Beginning with a classical simultaneity argument, enhanced growth and competitiveness, possibly combined with domestic demand lagging behind, could lead as well to higher exports. In the same line, exports can rise in consequence of production augmented by real investment. The other way round, capital formation might be encouraged in presence both of a reliable foreign demand source and creditworthiness based on sound foreign accounts as well as favourable domestic growth prospects. For times of a take-off in economic dynamics though the considerations on different growth drivers seem to be more adequate.

In the empirical analysis this question of causality, amongst others, will be subject to

verification. In the light of the forestanding arguments then, I will try to identify the common trends in exports (EXP), gross fixed capital formation (GCF) and gross domestic product (GDP) as generated by export and investment shocks. In this context, innovations with only transitory effects are likely to take the role of demand shocks.

3 Methodological Proceeding

3.1 Reduced Form Models

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

$$y_t = c_0^* + c_1^* t + c_2^* b_t + c_3^* s_t t + c_4 d_t + \sum_{i=1}^{q+1} A_i^* y_{t-i} + u_t \ , \tag{1}$$

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 constant, linear trend (t), level breaks (b_t) and trend shift (s_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 behaviour. According to 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

$$\Delta y_t = \alpha[\beta' y_{t-1} + c_0 + c_1(t-1) + c_2 b_{t-1} + c_3 s_{t-1}(t-1)] + c_4 d_t + \sum_{i=1}^{q} A_i \Delta y_{t-i} + u_t \ , \tag{2}$$

with $A_i = -\sum_{j=i+1}^{q+1} A_i^*$, $i = 1, \ldots, q$. This representation assumes that constant, trend and shifts are absorbed in the cointegrating relation. If breaks exist in the individual series, but are nevertheless empirically insignificant in the VECM estimation, they are obviously cancelled out by the cointegrating vector. A so-called co-breaking thus allows leaving out the shifts. Note that in (2) 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. Here, as well as in all subsequent models, the lag length is set following the usual information criteria (maximum lag 10) 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 shifts 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 (2), Johansen et al. (2000) incorporate structural breaks. Their likelihood ratio trace test statistic for the null hypothesis of at most r cointegrating relations is given by

$$\Lambda(r) = -T \sum_{i=r+1}^{n} log(1 - \hat{\lambda}_i) \ , \tag{3}$$

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.

3.3 Identification

From equation (2) it can be seen, that due to the lack of simultaneous structure, the residuals in u_t do not represent the economically interpretable innovations. The absence of explicit contemporaneous effects between the endogenous variables makes the error terms linear combinations of the underlying structural shocks. Formally, this is

$$u_t = Be_t \ , \tag{4}$$

where B contains the n^2 instantaneous impact coefficients, and e_t represents the vector of structural disturbances. Since the simultaneous effects are thus modelled in the systematic part, the residuals can be assumed free of cross-correlations. Together with an appropriate normalisation this assumption yields $n(n+1)/2$ different equations, still leaving $n^2 - n(n+1)/2 = n(n-1)/2$ restrictions to impose for full identification of the B matrix. This is exactly the number of different instantaneous covariances.

From the VECM moving average representation (Johansen 1995) one gets the matrix of the long-run effects of the reduced form residuals u_t:

$$\Xi = \beta_\perp(\alpha'_\perp(I_n - \sum_{i=1}^{q} A_i)\beta_\perp)^{-1}\alpha'_\perp \ , \tag{5}$$

with $\perp$ denoting the orthogonal complement (thus $\alpha'\alpha_\perp = 0$). Accordingly, the long-run matrix of e_t results as ΞB. From the cointegration properties it is known, that at most r shocks have only transitory effects. This fact can be exploited by placing zero restrictions on ΞB, which can afterwards be transformed into conditions the elements of B have to satisfy. Note however, that setting r columns of ΞB to zero produces not more than $r(n-r)$ *independent* constraints, since ΞB has only the reduced rank of $n-r$. Therefore, identification is completed by $n(n-1)/2 - r(n-r)$ additional restrictions, of which $r(r-1)/2$ must disentangle the transitory shocks (Gonzalo and Ng 2001). Once the structural innovations are identified, they provide the base for impulse responses and forecast error variance decompositions (FEVD). These are estimated by the usual recursive calculations in the VAR model representation, which still preserves all cointegrating rank restrictions.

4 Empirical Evidence

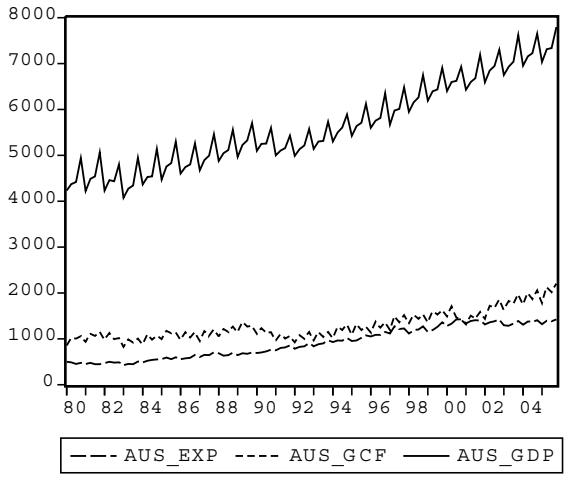
4.1 Data

Country by country, this paper aims at identifying the growth impacts on GDP, which stem from exports and gross fixed capital formation. Including other variables, like human capital or FDI, might be desirable, but is prohibited by the lack of data. All the quarterly data have been taken from the EcoWin, IMF IFS and OECD databases. The series have been transformed as follows: Per capita levels have been calculated by dividing by total population, which was linearly interpolated to gain quarterly data. The nominal data have been deflated to the 2002 level using the implicit price deflators for exports, capital formation and GDP, or, where not available, only the GDP deflator respectively the consumer price index. At last, the 2002 purchasing power parity conversion factors from the international comparison program of the World Bank have been employed to transform all series into US dollar.[1] The calculated variables can be interpreted as the per quarter amount of dollars one would have needed in the USA in 2002, to reach the same level as in the respective country and period. A detailed data description can be found in the Appendix.

Figure 1 gives an overview of the time series from the respective starting points, which are mainly determined by data availability, till the end of 2005. While it is beyond the scope of this paper to provide a detailed descriptive historical analysis of the various courses of economic development, several characteristics shall be emphasised: The sample can be split into the industrialised countries Australia, Hong Kong (Special Administrative Region of China), Japan, South Korea ("Korea" in the following), New Zealand, Singapore and Taiwan, and the more or less fast developing countries Indonesia, Malaysia, the Philippines and Thailand. In most cases, exports exceed investment in terms of magnitude. While Hong Kong, Malaysia and Singapore exhibit the largest export shares, the economies of Australia, Japan and Korea seem to rely more on domestic capital formation. Severe effects of the 1997/98 Asian crisis can be detected in the series of Hong Kong, Indonesia, Korea, Malaysia, Singapore and Thailand, countries known for having struggled the most by the time; in general, exports are less affected than GDP and GCF.

The economic crisis in the early 1980s shows impacts mostly on Australia, Hong Kong,

[1] For Taiwan, which is not included in the official program, the factor has been calculated by a PPP update based on the 1990 relative price from Penn World Table.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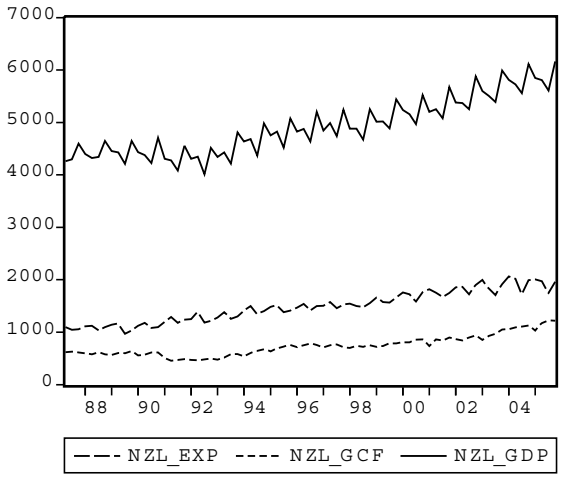
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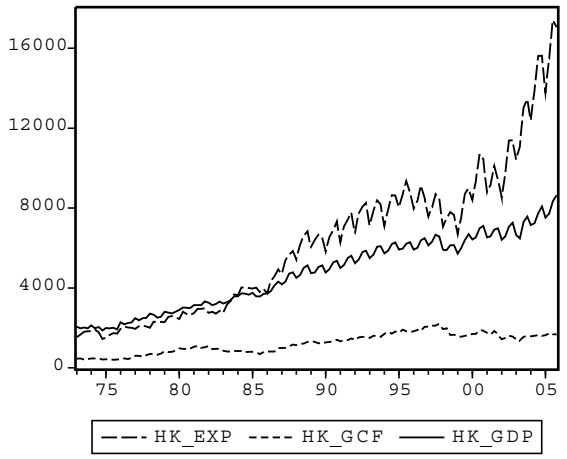
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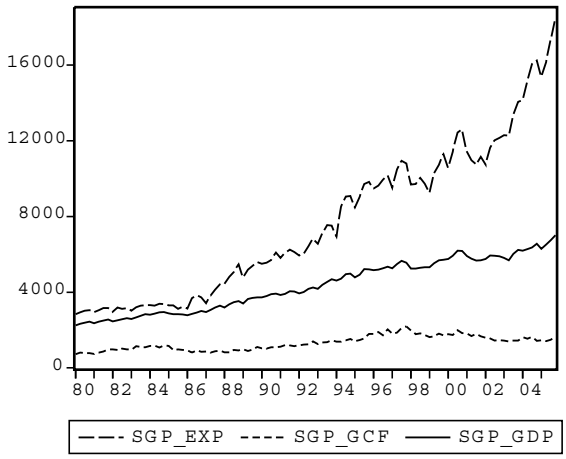
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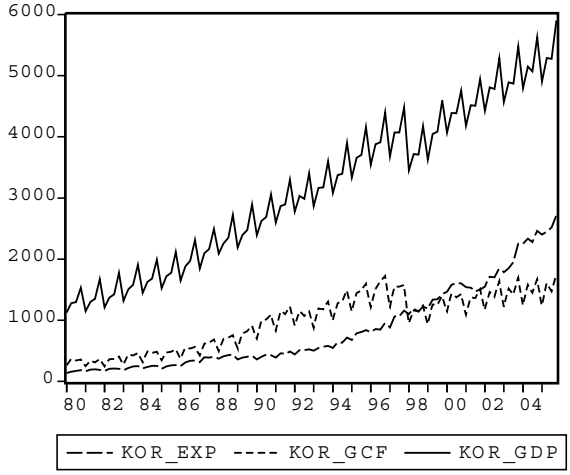
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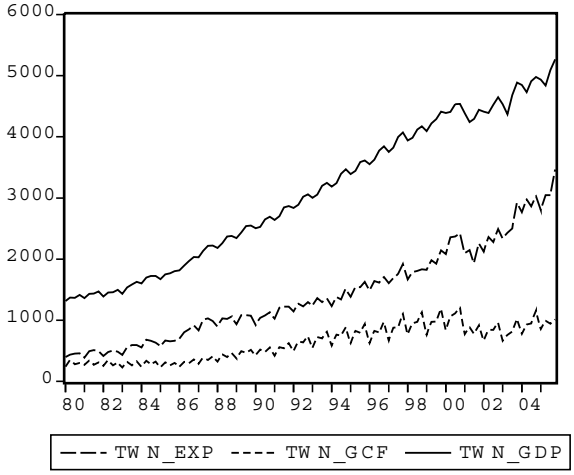
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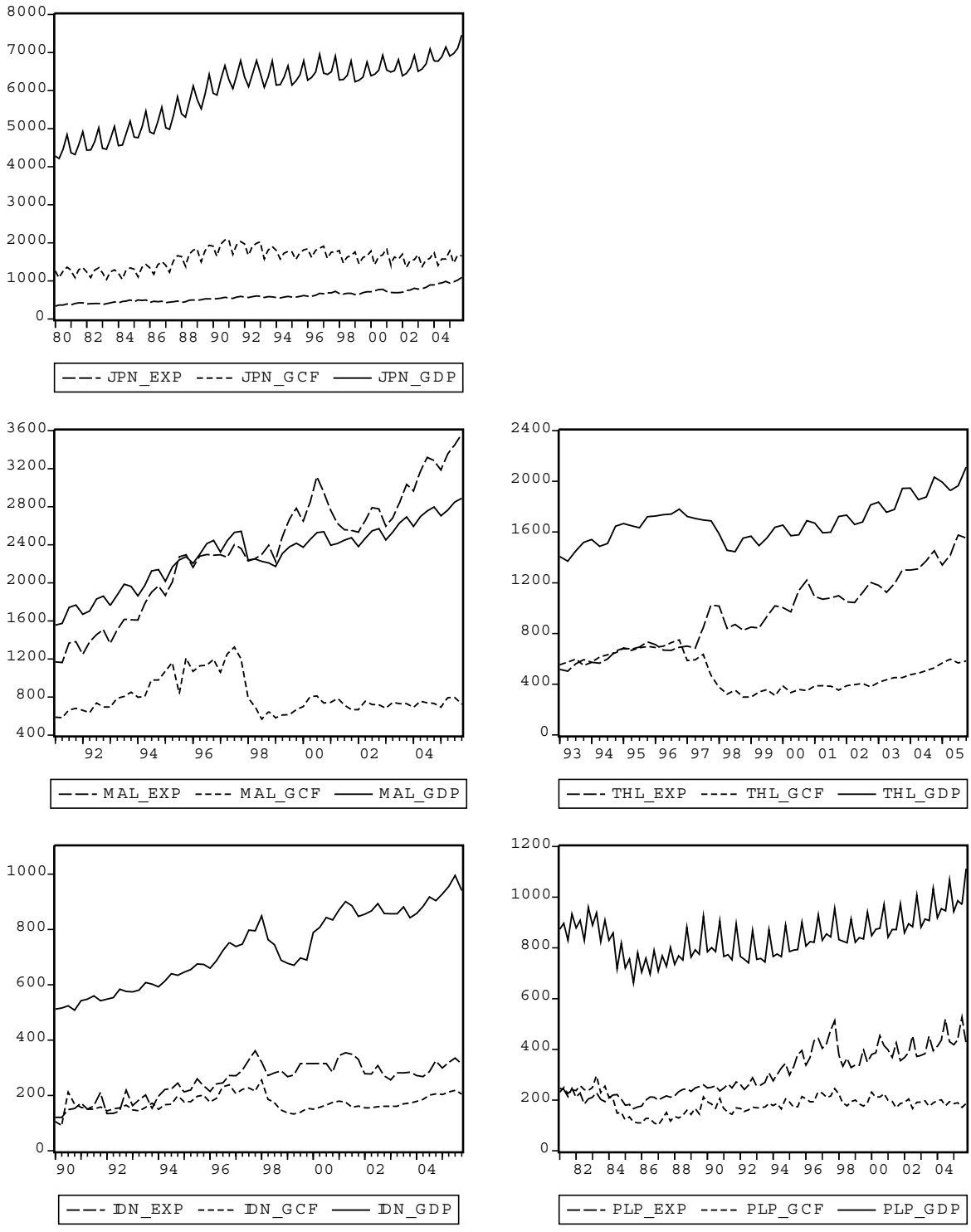

Figure 1: Exports, Gross Fixed Capital Formation and GDP (2002 p.c. PPP US $)

the Philippines and Singapore.[2] Regarding the Oceanic countries Australia and New Zealand, there appears a growth weakness around 1992, which coincides with a general world economic downturn. In Japan the boom of the bubble economy in the late 1980s is visible just as the ensuing long period of deflationary recession, which might not have come to an end but in the most recent time.

Finally, I provide formal tests for the presence of unit roots in the series: Appendix Table 13 displays the ADF statistics, or, where breaks have been considered, the Saikkonen and Lütkepohl (2002) statistics. In none of the cases, the null hypothesis of non-stationarity can be rejected at the 10% level. As additionally, the first differences are clearly stationary, I assume the series integrated of order one. All calculations in this paper have been carried out in JMulti 4.06, EViews 5.0 and Gauss 8.0.0.

4.2 Cointegration in National Models

As I have established non-stationarity of exports, investment and GDP in all countries under consideration, I proceed with determining the number of common trends in each national system. For this reason, Table 1 displays the trace test statistics for the hypotheses of $r = 0$ and $r = 1$. The former can be rejected in all cases at least at the 5% level, however more than one cointegrating vector is not within reach.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
$H_0 : r = 0$	46.2*	77.2**	33.7*	65.5*	52.3**	48.6*	49.4*	53.0**	46.5*	49.0**	64.8**
$H_0 : r = 1$	22.1	28.0	15.0	33.8	21.9	11.8	27.1	25.4	17.8	17.9	18.3
** , * : H_0 can be rejected at 1% respectively 5% significance level											

Table 1: Trace test statistics

Consequently, all VECMs are estimated allowing for one error correction term. Even for the countries of which the individual time series exhibit clear shifts, for the most part these are insignificant due to co-breaking. In the few remaining cases, the break dates are set following the arguments in section 4.1. Impulse dummies have been included to attain normality, and the models were checked to pass a Lagrange multiplier (LM) test for serial correlation (see Doornik 1996) and the Jarque-Bera test. Table 2 presents the results, which underline satisfying model properties. The full specifications can be found in Appendix Table 14.

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

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
LM(1)	0.05	0.29	0.41	0.77	0.40	0.22	0.25	0.34	0.40	0.55	0.34
LM(4)	0.12	0.52	0.30	0.55	0.80	0.33	0.11	0.63	0.10	0.59	0.23
JB	0.20	0.04	0.00	0.99	0.51	0.97	0.99	0.12	0.85	0.95	0.80

Table 2: p-values of LM-tests for no residual autocorrelation and Jarque-Bera tests

Table 3 lists the cointegrating vectors for further interpretation: The relatively low standard errors indicate, that all variables are necessary elements in the respective equilibrium relations. Using different normalisations, this holds as well for the EXP parameters, and applying Wald tests to zero restrictions on the cointegrating vectors does not change the results. The export normalisation is just to avoid small numbers and allows for estimating standard errors of the GDP parameters.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
EXP	1	1	1	1	1	1	1	1	1	1	1
GCF	0.80	0.56	1.53	0.96	1.76	2.41	1.08	-1.88	2.99	0.63	4.15
	(0.24)	(0.29)	(0.52)	(0.23)	(0.11)	(0.36)	(0.22)	(0.36)	(1.09)	(0.06)	(0.76)
GDP	-0.80	-3.64	-0.45	-0.88	-2.11	-4.90	-1.03	0.49	-9.04	-0.94	-3.44
	(0.13)	(0.26)	(0.10)	(0.16)	(0.17)	(0.63)	(0.13)	(0.14)	(1.19)	(0.05)	(0.67)
standard errors in parentheses											

Table 3: Cointegrating vectors

Except for the Philippines, the GDP coefficient is the only one to carry a negative sign. The equilibrium equations therefore result with GDP on the left hand side and EXP as well as GCF on the right hand side. This suggests the straightforward interpretation, that both EXP and GCF contain an idiosyncratic stochastic trend, and that these trends both drive the GDP growth. The high estimates for coefficients of Hong Kong, Malaysia, Singapore and Taiwan are probably attributable to their strong export performance.

Having defined the long-run relations, I now turn to the question of equilibrium adjustment, which is for obvious reasons a crucial one in the given growth context. As can be seen in Table 4, the reaction of GDP is always positive and clearly significant, lending support to the interpretation of export and investment trends driving economic growth. Exports do not adjust significantly (and correctly) but in Hong Kong, Japan and Thailand. For the two former, this might reflect the economic strength of their export-orientated sectors. The same countries surprisingly are those with significant and wrong-directed adjustment of GCF, which is nonetheless outweighed by the behaviour of the other series.

A reverse pattern is found for Singapore, where GCF instead of EXP adjusts in line with the expectations. Of course, the theory of two stochastic trends belonging to the export and investment dynamics fits best to the cases, where these two variables are weakly exogenous. Otherwise, the interpretation has to be completed with spill-back effects, but in presence of significant and dominant GDP adjustment it is still appealing.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
EXP	0.01	-0.22	-0.03	-0.12	0.04	-0.07	-0.10	-0.01	0.12	-0.35	0.06
	[0.74]	[-2.55]	[-1.03]	[-3.82]	[1.84]	[-1.15]	[-0.61]	[-0.46]	[4.93]	[-2.87]	[0.75]
GCF	0.01	0.07	-0.04	0.24	0.04	-0.07	0.09	-0.01	-0.02	0.45	0.05
	[0.48]	[3.12]	[-1.60]	[2.84]	[1.32]	[-1.57]	[0.77]	[-0.28]	[-3.48]	[4.08]	[1.22]
GDP	0.35	0.13	0.12	0.53	0.23	0.09	0.82	0.12	0.03	0.31	0.12
	[7.76]	[3.58]	[5.29]	[4.46]	[8.52]	[3.35]	[4.37]	[5.40]	[3.81]	[2.94]	[2.28]
t-values in brackets											

Table 4: Adjustment parameters

As the only country, the Philippines deviate substantially from the established systematic functioning: While GDP enters the error correction term with a positive sign, it also reacts positively to equilibrium deviations. Qualitatively, this finding is not sensitive to different model specifications, estimation procedures and sample periods. The main reason is probably the very low GCF performance (see Figure 1), which makes it impossible to extract a positive impact on GDP.

4.3 Structural VECMs

In section 4.2, I have established two common trends each in all three-dimensional national models. To identify the underlying shocks, I first exploit the reduced rank properties by restricting the long-run impact of one shock to zero, thus interpreting it as transitory demand innovation. As this provides $r(n-r) = 1(3-1) = 2$ linearly independent restrictions, following the criterion from section 3.3, one more is needed for full identification. In the growth-orientated analytical frame it would surely be inconsistent to impose further long-run constraints. Therefore, I adopt the most sensible assumption about contemporaneous impacts:

Clearly, as components of GDP, quasi by definition both exports and investment must have simultaneous effects on income, which are to be freely estimated. By the same token, it seems unreliable to restrict the contemporaneous reaction of GCF, because investment

is normally seen as reacting quite quickly to news giving ground to profit expectations. In a word, a sensible model should not prevent the forerunner of the business cycle to be affected by the latest innovations. Provided linear independence, it remains to constrain the contemporaneous impact of investment on exports to zero. This does not seem unfounded, because first, exports depend at least in the short-run mainly on influences from foreign demand, and second, the settling process of new capital is typically characterised by delays. Furthermore, my models do generally exhibit the lowest residual cross-correlations between GCF and EXP, averaging to 0.18.

Before proceeding, all insignificant parameters have been sequentially eliminated in order to enhance efficiency and to avoid disturbing the residuals, which shall form the series of structural shocks. The corresponding plots and the GDP impulse responses can be found in the Appendix Figures 2 and 3.

Table 5 includes key information about the structural long-run effects of export and investment unit shocks on GDP (measured as usually in 2002 per capita PPP US $): The first two rows contain the respective elements of the matrix ΞB with standard errors computed in a bootstrap procedure with 3.000 replications. The last row shows the relations of FEVD contributions to GDP in the long-run.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
EXP	1.16	0.20	0.69	0.80	0.41	0.23	0.27	1.10	0.18	1.15	0.59
	(0.15)	(0.04)	(0.16)	(0.43)	(0.21)	(0.05)	(0.09)	(0.49)	(0.03)	(0.27)	(0.18)
GCF	0.99	-0.83	1.33	2.27	0.85	0.32	0.92	-1.65	-0.13	0.94	1.24
	(0.12)	(0.22)	(0.25)	(0.61)	(0.19)	(0.04)	(0.12)	(0.69)	(0.11)	(0.29)	(0.32)
FEVD	39/61	71/29	28/72	8/92	11/89	33/67	15/85	39/61	83/17	76/24	38/62
standard errors in parentheses FEVD: long-run contributions (%) of EXP and GCF on GDP variance											

Table 5: GDP long-run effects of structural export resp. investment unit shocks

Basically all long-run coefficients are clearly significant and, with three exceptions, positive. In most countries, the investment shocks bring about higher growth effects than the export shocks. This is especially true for industrialised economies of Japan, Korea, New Zealand and Taiwan and can as well be seen in the FEVD relations. Exceptions are Australia, which - as a small country - exports high amounts of raw materials, and Thailand, which is known to depend heavily on exports. The negative GCF parameters for Hong Kong and Singapore are probably caused by the weak investment, above all in the phase of corporate and financial restructuring after the Asian crisis, contrasting with

the enormous export performance (see as well Figure 1). The still low export parameters can be rationalised by taking into account, that the nearly explosive export figures in the two city states go hand in hand with a similar import development and can impossibly affect GDP one by one.

As a general result, exports of developing countries tend to have higher growth impacts than in matured economies. An appealing interpretation is, that nations with non-settled enclave-like technology sectors depend more on foreign impulses than countries with broad and deep industrial structures. Put it the other way round, outward orientation obviously is highly effective in catching-up processes. Recalling the explanations from section 4.2, again the Philippine coefficients are at odds with the overall results, but are actually reflecting the economy's stagnating course of the last decades.

Addressing the transitory demand shock, the long-run GDP effect is of course unavailable as a relevant measure. Therefore, Table 6 provides the *accumulated* long-run impulse responses (in 2002 per capita PPP US $), which are reached at the very latest after about ten years. In addition, the number of quarters with significant impulse responses is provided. Thereby, significance is assessed by bootstrapping 95% Hall confidence intervals (see Hall 1992) with 3.000 replications. All measures keep within the bounds, which are implied by the interpretation of the identified shock as demand innovation. In Australia, Indonesia, the Philippines and Thailand these disturbances are most important and persistent.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
Duration (quarters)	26	5	19	2	5	2	5	23	9	12	6
Accumul.Responses	4.28	0.02	4.26	2.41	3.51	1.04	1.41	22.76	1.68	6.59	2.47

Table 6: GDP effects of structural demand unit shocks

4.4 Regional Coherence

The last sections set out growth models with variables stemming exclusively from the countries' own national accounts. The following analysis shall now deal with a comparison between the different economies. Table 7, 8 and 9 contain the cross-country correlations among the structural shocks in the lower left and among the impulse responses in the upper right triangles. The former give an impression of the coherence of structural innovations the countries are subject to. The latter then provide information, on which degree the shocks are processed symmetrically within the different economies. The impulse responses have been calculated for the first 30 quarters, capturing all relevant developments. Varying

the end point has only negligible effects.

Evidently, the strongest correlations exist between the export innovations: Even though the total mean does not exceed 0.11, with a mean of 0.25 the main cluster consists of Hong Kong, Japan, Malaysia, Korea, Taiwan and Thailand, among which the bulk of correlations is significantly positive. This definition roughly corresponds to the group of newly industrialised "Asian tigers", even though Singapore does not significantly correlate but with Taiwan. Most directly, these connections could naturally be explained by common dependences on foreign demand. Going beyond this point, the high amounts of FDI have led to the establishment of multinational firms over country borders. These transnational production and trade networks (see e.g. Kimura 2006) propagate impulses virtually along integrated production chains. Another cluster could possibly comprise Australia, Indonesia and the Philippines. However, the impulse responses (mean=0.14) are most in line within the group of Australia, Indonesia, Malaysia, the Philippines, Singapore and Thailand (mean=0.86), Korea might be added. While this unites all less developed countries, the negative correlations including Hong Kong and Japan are a product of high impact multipliers going down in the following periods.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
AUS	×	-0.29	0.99**	-0.91**	0.41**	0.73**	-0.34*	0.93**	0.93**	0.99**	0.06
HK	0.17*	×	-0.26	0.45**	-0.33*	-0.15	-0.12	-0.34*	-0.08	-0.26	-0.13
IDN	0.27**	-0.15	×	-0.88**	0.38**	0.75**	-0.30	0.91**	0.97**	1.00**	0.04
JPN	0.08	0.25**	-0.06	×	-0.38**	-0.68**	0.46**	-0.79**	−0.89**	-0.88**	-0.08
KOR	0.01	0.19*	-0.12	0.24**	×	-0.07	-0.06	0.55**	0.37	0.38**	0.03
MAL	0.29**	0.41**	0.00	0.36**	0.19*	×	-0.35*	0.47**	0.83**	0.74**	0.31*
NZL	0.11	0.13	0.01	-0.11	0.12	-0.02	×	-0.14	-0.31*	-0.29	-0.20
PLP	0.16	0.17*	0.24*	0.13	-0.00	0.10	0.13	×	0.81**	0.91**	-0.09
SGP	0.12	0.08	-0.10	0.15	-0.09	0.08	-0.22*	0.08	×	0.97**	0.00
THL	0.07	0.45**	0.13	0.19	0.05	0.32**	0.16	0.20	0.05	×	0.03
TWN	-0.07	0.28**	-0.21	0.22**	0.10	0.24**	-0.05	0.11	0.20**	0.23*	×
** , * : significant at 5% respectively 10% level											

Table 7: Correlations among export shocks (lower left) and responses (upper right)

Among the investment shocks, evidence for coherence is weakest (mean=0.04). Apart from several correlations often involving Malaysia, no significance can be detected. Nevertheless, the reactions to GCF shocks follow a fairly symmetric course: Only Hong Kong, Singapore and the Philippines, the three countries, which are subject to negative long-

run effects, deviate substantially from the normal adjustment pattern, reducing the mean correlation to 0.04; with a mean of 0.71 though, correlations are highest among Australia, Indonesia, Japan, Malaysia, Thailand and Taiwan. In spite of being subject to quite distinct innovations, the economic processing is thus very similar among these countries.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
AUS	×	-0.55**	0.62**	0.50**	0.17	0.51**	0.11	-0.47**	-0.70**	0.69**	0.44**
HK	-0.07	×	-0.75**	-0.80**	-0.24	-0.39**	-0.31*	0.69**	0.90**	-0.85**	-0.89**
IDN	-0.08	-0.09	×	0.86**	0.24	0.84**	0.29	-0.80**	-0.91**	0.96**	0.81**
JPN	-0.03	0.04	-0.00	×	0.17	0.59**	0.47**	-0.73**	-0.88**	0.89**	0.91**
KOR	-0.06	-0.10	0.06	-0.04	×	0.46**	0.14	0.17	-0.11	0.13	0.20
MAL	0.03	-0.25*	0.23*	-0.07	0.24*	×	0.15	-0.42**	-0.58**	0.68**	0.49**
NZL	0.16	-0.19	0.16	0.03	0.13	0.30**	×	-0.18	-0.35*	0.32*	0.21
PLP	−0.21*	-0.06	0.04	0.10	0.10	0.26**	0.12	×	0.83**	-0.86**	-0.77**
SGP	-0.01	0.08	-0.07	-0.08	-0.01	0.22*	0.16	0.19*	×	-0.99**	-0.85**
THL	0.11	0.06	-0.11	0.13	0.11	0.06	-0.11	0.15	0.19	×	0.86**
TWN	0.04	-0.01	0.11	-0.26**	-0.15	0.07	-0.04	0.06	0.30**	0.22	×
** , * : significant at 5% respectively 10% level											

Table 8: Correlations among investment shocks (lower left) and responses (upper right)

The demand shock correlations average only to 0.04, but evidently, many negative values belong to developing countries. Indeed, one cluster might be found containing the industrialised nations (mean=0.16, without Singapore). In this, it should be considered, that my models include no nominal variables, which are normally seen as predestined for identifying structural demand innovations (e.g. Bayoumi and Eichengreen 1994). The responses to the transitory shocks are highly coherent, resulting in a mean correlation of 0.60; significantly lower values could at most be detected for Hong Kong and the Philippines. Though, the interpretation should take into account, that the zero long-run restrictions naturally contribute to high impulse response correlations by setting a common convergence target.

4.5 Explaining Shocks

In continuation, I aim at finding evidence for connections between important model-exogenous macro variables and the identified structural shocks. This is done by accumulating the shocks, thus producing random walk or stochastic trend series, and then testing

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
AUS	×	0.44**	0.91**	0.92**	0.78**	0.91**	0.71**	0.50**	0.73**	0.90**	0.63**
HK	0.10	×	0.40**	0.32*	0.51**	0.53**	0.81**	-0.23	0.32*	0.40**	0.65**
IDN	-0.06	-0.11	×	0.72**	0.88**	0.77**	0.59**	0.51**	0.94**	1.00**	0.66**
JPN	-0.05	0.15	-0.03	×	0.58**	0.85**	0.69**	0.45**	0.49**	0.69**	0.53**
KOR	0.09	0.10	0.22*	0.12	×	0.78**	0.64**	0.18	0.82**	0.88**	0.54**
MAL	-0.02	0.17	-0.13	-0.22*	-0.10	×	0.73**	0.17	0.53**	0.76**	0.48**
NZL	0.17	0.22*	0.01	0.20*	0.18	0.04	×	0.05	0.43**	0.58**	0.74**
PLP	-0.02	-0.02	-0.23*	0.12	0.23**	-0.14*	0.20*	×	0.48**	0.50**	0.19
SGP	0.08	-0.06	-0.12	-0.10	-0.11	0.09	-0.05	0.11	×	0.95**	0.68**
THL	-0.05	0.03	-0.19	-0.24*	0.04	0.05	0.19	0.20	0.04	×	0.66**
TWN	0.07	0.34**	-0.10	0.11	0.15	0.11	0.35**	0.17*	-0.08	-0.02	×
** , * : significant at 5% respectively 10% level											

Table 9: Correlations among demand shocks (lower left) and responses (upper right)

for cointegration. As these trends do not contain level and trend shifts, which have been explicitly considered in the underlying model deterministics, corresponding breaks in the additional series are taken into account in the trace tests. The exact specifications including the lag lengths are available from the Appendix Table 15. In most cases, the additional series prove to be weakly exogenous, thus "explaining" variables. Nonetheless, in view of the interdependences in a (growing) economic system, the finding of several feedback relations comes not as a surprise.

For explaining export shocks, intuitive candidates from standard export functions are foreign incomes and exchange rates. Table 10 shows the p-values of the trace tests between the respective export trends and the real per capita GDPs of Japan, Euroland (Eurostat, seasonally adjusted, starting 1980) and the USA (Dept. of Commerce), as well as the real effective exchange rates (J.P. Morgan). When non-stationarity of these series was rejected, "I(0)" is reported instead of a p-value. Summarising the figures, export trends are determined first of all by the US GDP, followed by Euroland and Japan. Bearing in mind the estimation sample, a dominant role of the US is not surprising, but in presence of growing intra-regional trade and a thriving China it might nonetheless be weakened in the future. Indonesia, Malaysia and Thailand yield the weakest evidence. Furthermore, the exchange rates exhibit the closest connections to the exports of the smaller or currently not matured economies.

Capital formation is likely to depend on expectations of future profits on the one hand

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
JPN	0.23	0.02	0.16	–	0.03	0.16	0.04	0.41	0.23	0.57	0.61
Euro	0.23	0.09	0.82	0.07	0.06	0.31	0.14	0.06	0.19	0.78	0.15
USA	0.07	0.12	0.28	0.00	0.00	0.57	0.01	0.02	0.06	0.56	0.02
REER	0.89	0.03	I(0)	0.86	0.20	0.00	0.09	I(0)	0.16	I(0)	0.02

Table 10: Trace test p-values: export trends vs. foreign incomes resp. exchange rates

as well as opportunity costs on the other. Logically, I chose the indexed share prices from the main national stock exchanges, which can be seen as discounted expected future cash-flows, and representative interest rates (long-term government bond yields or similar rates if not available). Interpreting Table 11 reveals the strong connection of investment with share prices in most industrialised countries. The contrary result for Hong Kong is not curious, because its extreme openness and its role as an international stock market could disconnect the Hang Seng from domestic investment; see as well the wrong-directed adjustment in Table 4. The linkage between capital formation and bond yields is relatively well developed. In Japan, it has probably weakened during the long deflationary period marked by ineffective interest rate lowering, and Singapore is known not relying on bond financing. Since national stock markets are likely to follow strong idiosyncratic determinants, and the interest rate linkages in the Asian Pacific region are not very close (e.g. Eichengreen and Park 2004), the weak relations between the investment shocks (Table 8) do not come as a surprise.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
share	0.06	0.63	0.01	0.00	0.06	0.01	0.00	0.47	0.04	0.34	0.77
interest	0.06	0.06	0.00	0.46	0.03	0.34	0.11	0.10	0.93	0.02	0.83

Table 11: Trace test p-values: investment trends vs. share prices resp. interest rates

Addressing the aggregate demand shocks, compelling explanatory power can be expected in the main macroeconomic policy variables, public expenditure (per capita real government consumption) and money (per capita real M3; M2 where not available). Indeed, for most countries at least one of the tests in Table 12 is in favour of cointegration. Recalling the demand correlation cluster from Table 9, the interpretation seems to be appealing, that macroeconomic policy among the industrialised countries is not totally inconsistent. The remaining variation is left to be explained by other sources, probably private aggregate demand.

	AUS	HK	IDN	JPN	KOR	MAL	NZL	PLP	SGP	THL	TWN
G	0.03	0.18	0.01	0.08	0.10	0.28	0.08	0.04	0.42	0.09	0.83
M3	0.62	0.03	0.01	0.61	I(0)	0.36	0.03	0.01	0.08	0.25	0.43

Table 12: Trace test p-values: demand trends vs. government consumption resp. M3

5 Concluding Summary

Guided by the task to shed light on the Asian Pacific economic growth process, this paper focused on the role of exports and investment. Integrating these variables together with GDP in cointegrating systems led to estimations of dynamic impacts, which underlie the impressive economic development. Furthermore, the explicit identification of the structural shocks allowed to compare and explain the major driving forces of the different economies in an aspiring region.

In all considered countries, the three-dimensional systems of GDP, exports and gross fixed capital formation have been found out to contain two common stochastic trends. The cointegrating vectors and the highly significant GDP adjustment parameters supported the hypothesis, that one export and one investment trend drive the income growth dynamics. On the one hand, this is consistent with the export-led growth hypothesis, which has especially gained relevance in the South-East Asian industrialisation, while on the other hand, it underpins the crucial importance of capital accumulation for economic progress.

Imposing short- and long-run restrictions allowed the identification of two persistent growth shocks as well as one transitory demand shock. In almost all cases, the former have a positive and significant effect on the long-run GDP level. In general, the investment-related impacts proved to dominate those radiating from the export innovations, but especially for the developing countries this proportion was found to be relatively more in favour of export influences. Apart from that, the demand shocks initiate positive GDP effects with sensible durations.

Subsequently, economic coherence in the Asian Pacific region has been analysed. Addressing the similarity of structural innovations, I correlated the respective shock time series. While the investment shocks exhibit strong idiosyncratic components, I was able to identify clusters of countries subject to resembling export and demand disturbances. With this investigation directing at the pure *presence* of related shocks, the question of symmetric *reactions* can be incorporated by correlating the dynamic responses of GDP to

the respective structural innovations. These calculations yielded a high degree of symmetry, but also a few interesting exceptions concerning above all Hong Kong, the Philippines and Japan.

In order to uncover systematic connections of the structural trends, in the last step, I tested for cointegration with several observable macroeconomic variables. In particular, export trends seem to be largely determined by exchange rates and foreign income. In this, the USA proved to be slightly more important than Euroland and Japan. For investment and demand shocks, significant cointegration could be frequently established with share price and interest rates, respectively government consumption and broad money.

In an attempt to grasp the "Asian miracle" of powerful economic growth, two major sources come to the fore within a mixture of impulses from the outside industrialised world as well as domestic dynamics, in fashion of exports and investments. Furthermore, several features of economic growth are shared in the Asian Pacific region. This implies, that amongst others, policies aiming at free trade, capital market deepening, transnational investment and monetary cooperation, as well as sustainable development, should be constructed along these lines. For example, one should take into account investment effects of interest rates as instruments of foreign exchange management, the importance of exports in regional and world trade liberalisation, and the role of capital stocks and flows in the building of sound domestic and international financial systems. Besides these second-step policy implications, one should be aware, that past growth trends are not to be simply extrapolated, making it necessary to continue in exhausting new potentials of progress.

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Appendix

Data Description

Exports

Exports of Goods and Services

Investment

Gross Fixed Domestic Capital Formation

Income

Gross Domestic Product

Euro: Gross Domestic Product, seasonally adjusted (Eurostat)

Exchange Rates

J.P. Morgan, Real Broad Effective Exchange Rate Index, Average

Share Prices

IMF IFS Share Prices

HK: Hang Seng Index

IDN: Jakarta SE Composite Index

KOR: IMF IFS Share Prices, Industrial

PLP: IMF IFS Share Prices, Commercial

THL: SET Index

TWN: TAIEX Weighted Index

Interest Rates

AUS: Treasury Bonds 15 year

HK: HIBOR 6 month

IDN: Working Capital Loans

JPN: Government Bonds

KOR: National Housing Bonds

MAL: Treasury Bills 3 month

NZL: Government Bonds

PLP: Average Common Lending Rate

SGP: Government Bonds 5 year

THL: Government Bonds 10 year

TWN: Corporate Papers 31-90 day secondary market

Government Expenditure

General Government Final Consumption Expenditure

Money

Monetary Aggregate M3

HK, PLP, THL, TWN: Money Supply M2

PLP: Money plus Quasi-Money (M4)

Deflators

Implicit Price Deflator: Total (GDP), respectively EXP, GCF, G

HK, THL: Implicit Price Deflator, Total

IDN: Consumer Price Index

Population

Total Midyear Population (interpolated), Bureau of the Census, International Data Base

	EXP	lags	shifts	GCF	lags	breaks	GDP	lags	breaks
AUS	-1.61	4		-0.30	5		-0.80	4	
HK	-1.87	6	00:3 T	-1.87	7	98:1	-2.34	8	98:1
IDN	-2.98	0		-0.74	0	98:2	-2.58	5	98:2
JPN	0.99	5		-1.91	8		-1.63	4	
KOR	1.33	9		-0.93	3	98:1	-0.84	4	98:1
MAL	-2.24	1	01:2 L	-1.95	1	98:1	-2.00	1	98:1
NZL	-3.08	6		-2.19	0	91:1	-2.17	4	91:1
PLP	-1.20	4	98:1 L, 86:1 T	-2.50	5	84:3	-2.73	4	84:3
SGP	-0.67	1		-2.10	1	85:2 L, 98:1 T	-2.86	1	
THL	-2.51	0		-1.37	0	98:1	-1.93	4	98:1
TWN	0.85	5		-1.31	6	01:1	-1.28	8	01:1
* H_0 can be rejected at 10% significance level constant, trend and seasonal dummies included; L: level shift, T: trend shift									

Table 13: Unit root test statistics

	lags	shifts	impulse dummies	remarks
AUS	3		00:3,00:4,97:2	
HK	6	98:1 L, 00:3 T	85:2,98:3	
IDN	1		98:2,00:1	no trend
JPN	5	91:4 T	93:2,94:1,98:1	
KOR	6		97:2,98:1,03:3,03:4,05:3	
MAL	0		95:3,95:4,98:1	
NZL	4	91:1 L	91:1,98:2	
PLP	4		88:4,98:1,98:2,98:4	no constant
SGP	1		94:2,98:1,02:3,03:2,03:3,05:1	
THL	2		97:1,97:4,01:1	no trend
TWN	5		00:2,00:4,03:3,05:4	2-step estimation
L: level shift, T: trend shift				

Table 14: VECM specifications

	JPN	Euro	USA	REER	share	interest	G	M3
AUS	5	5	5	1	1	1	3	1,84:1T
HK	7,91:4T	5	7	3	5	1,97:3-98:2i	5	6
IDN	2	1	1	I(0)	1	4,97:3i,99:4i	3	3,98:3LT
JPN	–	5	5	2	2,90:1T	1,98:1-98:3i	5	5
KOR	8	5	5	4,97:4L	2	2,97:4-98:3i	6	I(0)
MAL	4	2	3	3,97:3L	2	1	5	1
NZL	5	5	3	4	1,98:1i	2	3,97:2i	2
PLP	5,91:4T	5	5	I(0)	1	2,84:2-85:3i,97:4-98:2i	6	5,84:1L
SGP	5	1	6	1	3	1	4	1
THL	1	2	3	I(0)	1	2	1	3
TWN	5,91:4T	6	6	2,98:2L	1	1	4	6
L: level shift, T: trend shift, i: impulse dummies								

Table 15: Lag lengths and shift dates in cointegration models


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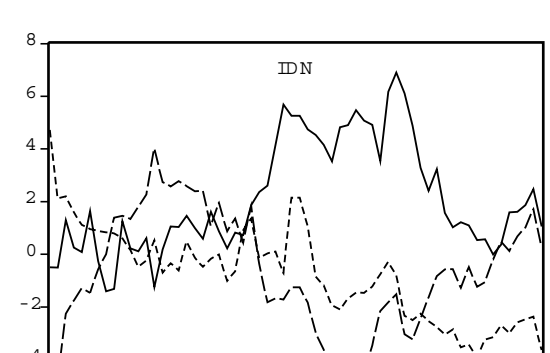
12
8
4
0
-4
-8
-12
-16
-20
-24
70 75 80 85 90 95 00 05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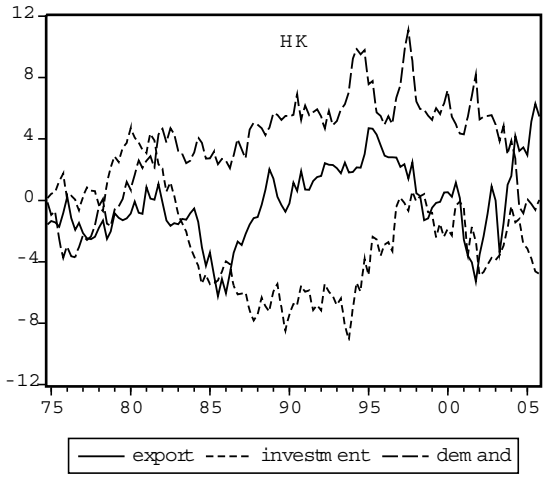
demand


HK
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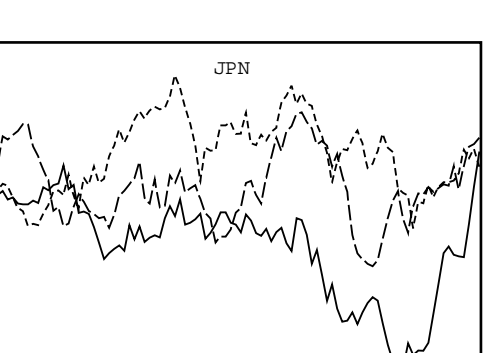
8
4
0
-4
-8
-12
75 80 85 90 95 00 05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demand

IDN
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4
2
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-2
-4
-6
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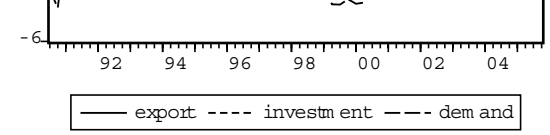
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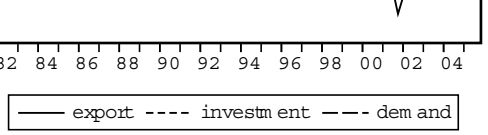
investment
demand

JPN
8
4
0
-4
-8
-12
-16
82 84 86 88 90 92 94 96 98 00 02 04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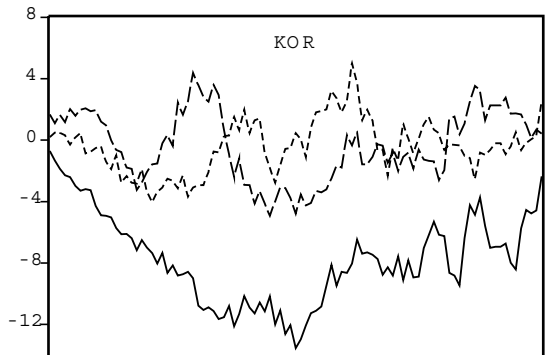
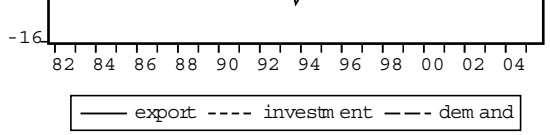

KOR
8
4
0
-4
-8
-12
-16
82 84 86 88 90 92 94 96 98 00 02 04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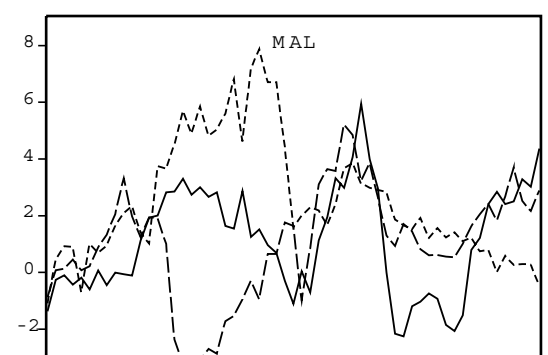
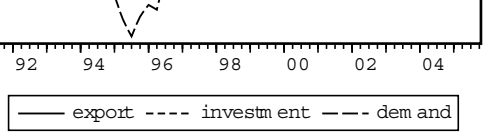

MAL
8
6
4
2
0
-2
-4
92 94 96 98 00 02 04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investment
demand

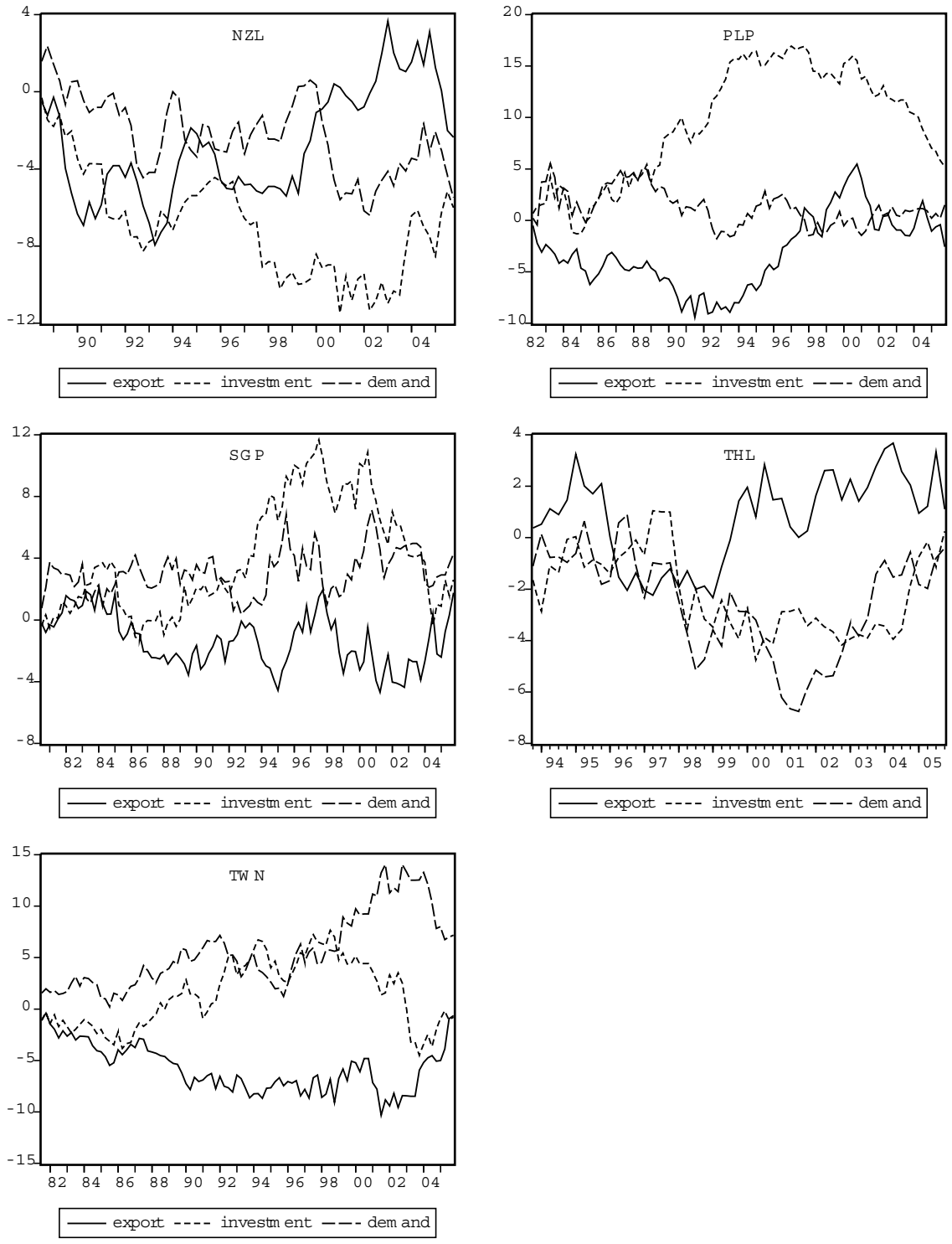
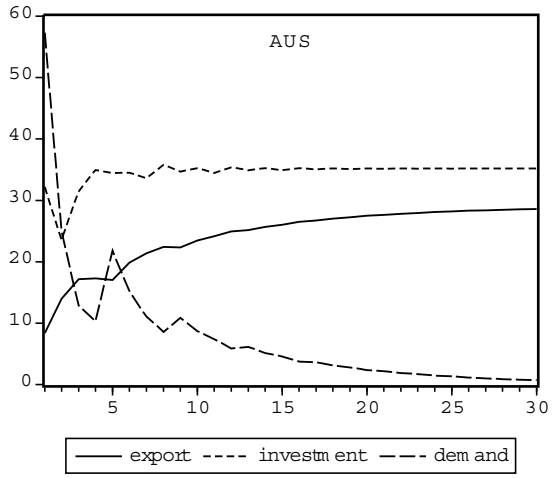


Figure 2: Accumulated structural shocks (in 2002 p.c. PPP US $)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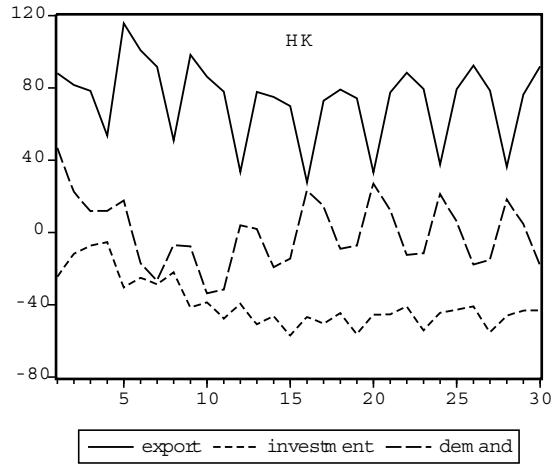
10
15
20
25
30
export
investment
demand


HK
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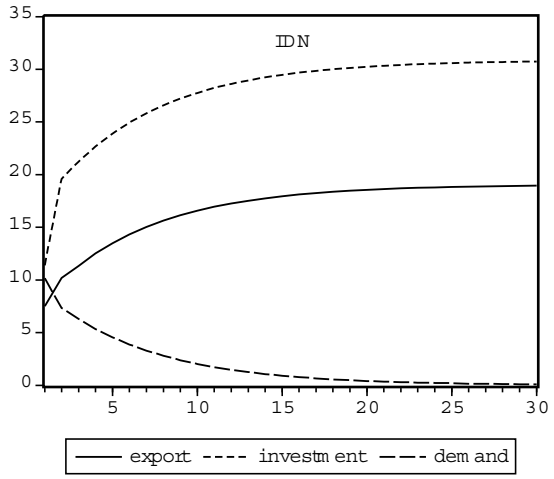
80
40
0
-40
-80
5
10
15
20
25
30
export
investment
demand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15
10
5
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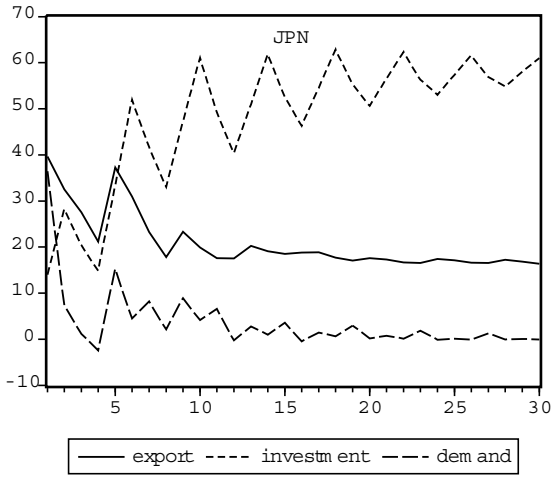
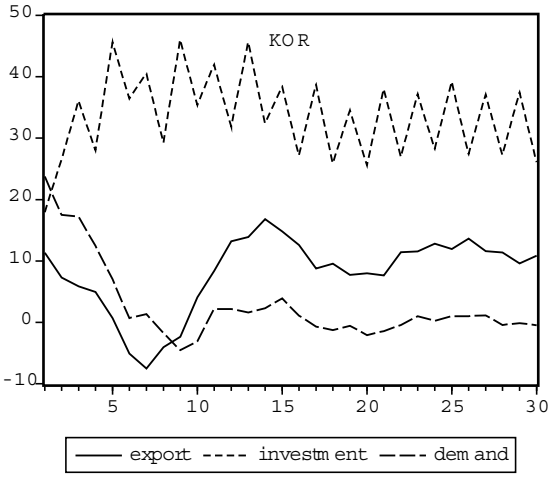
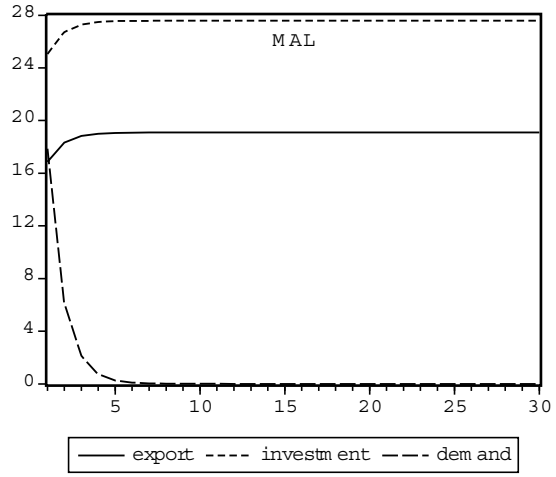
5
10
15
20
25
30
export
investment
demand


JPN
70
60
50
40
30
20
10
0
-10
5
10
15
20
25
30
export
investment
demand


KOR
50
40
30
20
10
0
-10
5
10
15
20
25
30
export
investment
demand


MAL
28
24
20
16
12
8
4
0
5
10
15
20
25
30
export
investment
demand

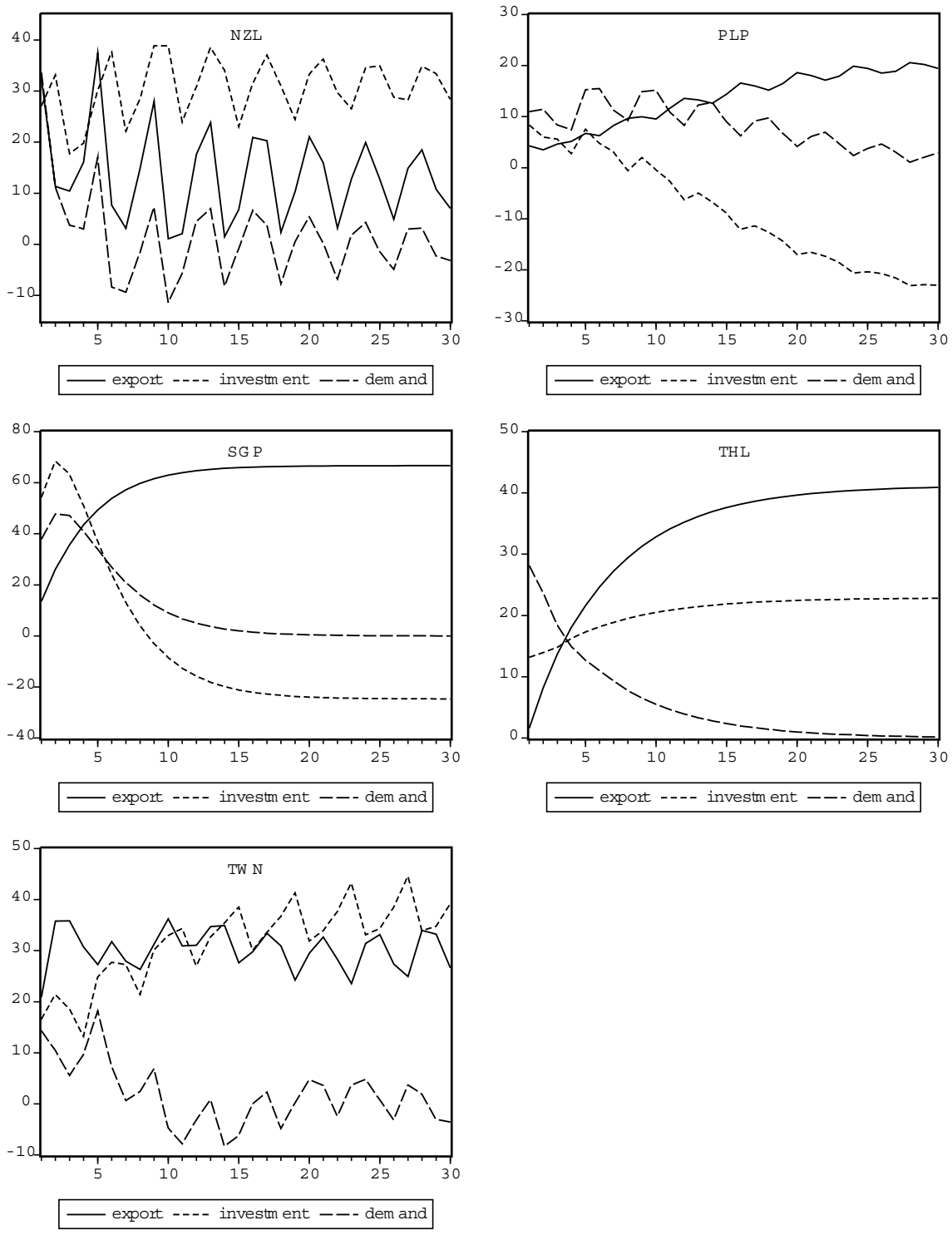


Figure 3: Impulse responses of GDP to structural unit shocks (in 2002 p.c. PPP US $)

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