JAPAN'S ECONOMIC ROLE IN ASIA

Conventional analysis of Japan's role in Asia focuses on direct economic linkages involving trade, direct investment and bank lending. Using a statistical technique called path analysis, this paper takes a broader approach that incorporates both the direct and indirect economic relations between Japan and the rest of Asia.

We find that Japan has a much stronger correlation with Asia in terms of real GDP growth than does either the US or Germany. Moreover, Japan acts as an important transmitter through which growth in the US and Germany impacts on Asian economies.

This Asia-Japan growth transmission relationship may reflect Japan's overseas investment strategy, which has focused on assimilating Asia as part of Japan's export sector, both for sales to the West and to Asia itself. This has created a special partnership between Asia and Japan, which ties the region to Japan's own economic cycles.

Given the strong economic ties, a sustained recovery of the Japanese economy will significantly benefit the rest of Asia. Nevertheless, along with the restructuring of the financial and corporate sectors in Japan and the Asian economies following the financial crisis, Japan's economic relationship with Asia may undergo profound changes in coming years. In particular, the opening up of the financial and corporate sectors in some crisis-hit economies, coupled with a less expansionist strategy on the part of Japanese firms abroad, may lead to the development of broader-based economic relationships between Asia and other major industrialized economies.

Introduction

A number of studies have shown that Japan plays an important role in Asia's economic growth and development.[1] Their assessments are mostly based on Japan's *direct* economic relationship with Asia, in terms of linkages involving trade, direct investment and bank lending. Given the increasing integration of the global economy, an understanding of the *indirect* economic linkages between Japan and Asia is also useful in arriving at a comprehensive assessment of the Japan-Asia economic relationship.

This paper attempts to assess Japan's direct and indirect economic relations with Asia by using a statistical technique called path analysis. It then looks for anecdotal evidence that would provide consistent explanations for the statistical patterns observed.

The paper is divided into three main sections. The first section discusses the design of our model, the underlying assumptions and estimation results. The second section relates our statistical findings to some observations on trade and investment patterns.

1 Asia in this paper is defined to consist of the following eight economies: Hong Kong, Indonesia, Malaysia, the Philippines, Singapore, South Korea, Taiwan and Thailand.

The final section discusses the implications of the observed growth transmission mechanism on Asia's short-term recovery prospects, and highlights issues relating to long-term restructuring that may warrant more in-depth analysis.

Quantifying Japan's Direct and Indirect Links to Asia

a. Methodology and Assumptions

To assess the direct and indirect impacts of Japan on Asia's growth, we use a special form of regression known as path analysis.[2] We hypothesise that growth in Asia is driven, or "caused", by growth in the G-3 countries (i.e. the US, Japan and Germany) plus a random error that represents all the shocks outside this system. The total impact of a specific country on Asia will be the sum of: (i) the direct impact of the country on Asia; and (ii) the indirect impact transmitted through the other two countries (e.g., how Japan affects Asia indirectly through its relationship with the US and Germany).

The validity of path analysis depends crucially on the postulated relationships that underlie it. Two critical assumptions used in our model are the following :

(i) causation runs mainly from the G-3 to Asia and not Asia to the G-3; and

(ii) the G-3 is a good representation of "external factors."

The first assumption can be justified on the basis that, as a group, the Asian economies are considerably smaller than each of the G-3 countries (Table 1). Also, Asia is much more externally oriented than is the G-3. This suggests that Asia is more exposed to external influences than are the G-3 countries.

Table 1 : **Pre-crisis Asia Compared, 1996**

	GDP (US$ bn)	Population (mn)	Foreign Trade as % of GDP	Share of trade with (%) :			
				US	Japan	Germany	Asia8
Indonesia	227.4	196.8	41%	17%	29%	3%	22%
Thailand	181.5	60.0	70%	18%	17%	3%	33%
Malaysia	99.2	21.2	158%	18%	13%	3%	44%
Philippines	82.8	71.9	64%	34%	18%	4%	24%
Korea	484.6	45.5	58%	17%	12%	4%	29%
Singapore	92.7	3.7	277%	18%	8%	3%	49%
Hong Kong	154.1	6.3	246%	21%	7%	4%	13%
Taiwan	272.3	21.5	80%	24%	11%	3%	41%
TOTAL	**1,594.6**	**426.9**	**98%**	**20%**	**12%**	**3%**	**43%**
US	7,661.6	265.5	19%		11%	4%	19%
Japan	4,599.7	125.8	17%	28%		4%	44%
Germany	2,341.4	81.9	41%	8%	3%		8%
UK	1,178.5	58.8	46%	12%	3%	11%	9%
China	834.0	1,232.1	35%	18%	20%	4%	37%
Latam 6	1,627.7	362.4	27%	51%	4%	2%	5%

Note: Latam 6 includes Argentina, Brazil, Chile, Colombia, Mexico and Venezuela.
Sources: CEIC, Datastream.

2 Also known as structural equation analysis, path analysis was originally developed in the early 1920s for applications in genetics research. Path analysis differs from traditional regression or correlation analysis in that it is constructed based upon an explicit set of postulated relationships of causation. While the results of path analysis are not proof of causation, they can be used as evidence that support the postulated causal relationships. Equally important, by estimating the causal relationships among different variables, path analysis enables us to measure both the direct and indirect effects that one variable has on another. Path analysis assumes that there are two types of variables: some are exogenous, meaning they are not influenced by other variables in the system, and others are endogenous, meaning they are affected by other variables in the system. Causation is postulated to run only from exogenous variables to endogenous variables; the causal relationship is assumed to be a linear one that satisfies the assumptions of conventional regression models.

The choice of G-3 countries as the external influences, rather than G-7 or G-22 groupings, is somewhat arbitrary but can be justified by the observation that the size of the fourth largest economy - the UK - is substantially smaller than the third one (Germany) and that of Asia as a whole. Including it and other countries in the model would risk weakening the assumption of one-way causative links.

b. Main Findings

Using data on real GDP growth rates during the period from 1971 to 1998, the correlation among Asia and the G-3 countries is presented in Table 2.[3] It shows that Japan has the highest "growth correlation" with Asia, followed by the US and Germany.

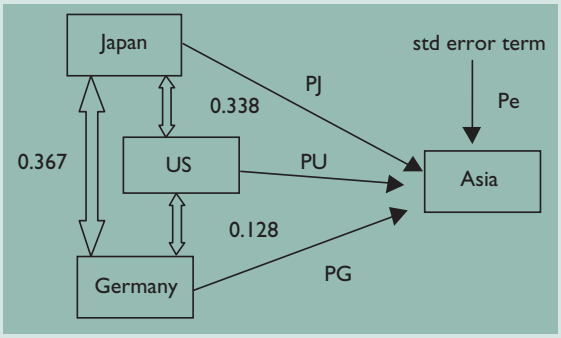
Table 2 : **Correlation of Regional Growth, 1971-98**

	Correlation with		
	Asia8	**US**	**Japan**
US	*0.346*		
Japan	*0.669*	0.338	
Germany	*0.272*	0.128	0.367

Two factors complicate the interpretation of the correlation measures. First, growth rates are not only correlated between Asia and the G-3 countries, but also among the G-3 themselves. For example, part of the correlation between Japan and Asia may be due to the stimulative effect of stronger growth in Japan on the US, which in turn stimulates Asia growth. Secondly, correlation between two variables may be due to their common association with a third variable. For example, many industralized economies slipped into recession in 1975 owing to the oil crisis.

By assuming a causation structure (Chart 1), path analysis allows us to extract information on these interrelations and decompose the raw correlations into their direct and indirect components.

Chart 1
Assumed Asia-G3 Growth Relationship



Note: The solid arrows of PJ, PU and PG represent the presumed direct impact of each of the G-3 countries on Asia, while the outlined double-arrows depict observed correlation coefficients between the growth rates of the G-3. The total direct and indirect impacts of a specific G-3 country on Asia will include:

1. *the presumed direct impact (say PJ in the Japan-Asia case); plus*
2. *indirect impacts of the specific G-3 countries on Asia transmitted via the other two G-3 countries (these indirect impacts can be estimated by summing up the products of the respective double-arrows and solid arrows, i.e. 0.338*PU + 0.367*PG); and*
3. *an independent error term that covers the impact of other exogenous factors.*

The results are shown in Table 3. For each G-3 country, its total impact on (correlation with) Asia, listed in *italics* in the left-hand column, is decomposed into direct and indirect impacts. The direct impact is printed in bold, while indirect impacts are shown under the columns for the other two G-3 countries.

The results suggest that Japan acted as a prime transmitter of the growth impact of the US and Germany on Asia. As much as 83% (i.e. 0.225

Table 3 : **Path Analysis of Regional Growth, 1971-98**

	Correlation with Asia8	Transmitted via		
		US	**Japan**	**Germany**
US	*0.346*	**0.135**	0.207	0.004
Japan	*0.669*	0.046	**0.612**	0.011
Germany	*0.272*	0.017	0.225	**0.030**

3 Composite growth rates for Asia are compiled by using 1990 US$ nominal GDP as weights.

out of a total correlation of 0.272) of the growth impact of Germany on Asia was routed through Japan. In the case of the US, 60% (0.207 out of 0.376) of the growth impact was transmitted via Japan. The reverse was not true, however, with 91% of Japan's total impact on Asia coming from its own growth. Finally, even after stripping off the indirect effects, Japan still ranked first in terms of the "first-order" correlations. Together, GDP growth of the G-3 countries explained roughly 46% of Asia's growth variation over the 1971-98 period (see Table 4).

There are interesting similarities and contrasts when applying the same decomposition technique to the growth correlation coefficients of individual Asian economies with the G3 countries. As indicated in Table 4, the G3 countries in general explained one-fifth to one-third of the changes in growth rates of the Asian economies covered in our study, with one exception - Taiwan, where the model explained a very high 60% of its growth variation. The explanatory power of the model on the Mainland, at 7%, was the lowest. It was not unexpected as the Mainland started to open up its economy only in the late 1970s.

Among the G-3 countries, Japan had the strongest growth correlation with each of the eight Asian economies except Taiwan. Also, Japan performed as the dominant direct and indirect transmitter of growth between the G-3 and the individual Asian economies, with the exceptions of Hong Kong and Taiwan, where the growth impacts

Table 4 : **Analysis of Correlation Between Growth Rates of Individual Asian and G-3 Countries**

	China	Hong Kong	Indonesia	Malaysia	Philippines	Singapore	South Korea	Taiwan	Thailand	ASIA8
US	**0.113**	**0.415**	**0.051**	**0.116**	**-0.052**	**0.185**	**0.271**	**0.664**	**0.055**	**0.346**
(t ratio)	(0.881)	(1.514)	(-0.869)	(-0.199)	(-0.803)	(0.217)	(0.593)	(3.835)**	(-0.734)	(0.848)
of which impacted through:										
US	0.184	0.266	-0.154	-0.038	-0.163	0.042	0.109	0.526	-0.135	0.135
Japan	-0.050	0.152	0.216	0.138	0.135	0.146	0.154	0.122	0.184	0.207
Germany	-0.021	-0.002	-0.012	0.017	-0.025	-0.004	0.007	0.016	0.006	0.004
Japan	**-0.146**	**0.532**	**0.553**	**0.442**	**0.273**	**0.435**	**0.513**	**0.585**	**0.515**	**0.669**
(t ratio)	(-0.665)	(2.399)**	(3.389)**	(1.980)*	(1.847)*	(2.080)**	(2.317)**	(2.472)**	(2.778)**	(3.617)**
of which impacted through:										
US	0.062	0.090	-0.052	-0.013	-0.055	0.014	0.037	0.178	-0.046	0.046
Japan	-0.148	0.449	0.639	0.407	0.399	0.433	0.456	0.361	0.544	0.612
Germany	-0.060	-0.007	-0.034	0.048	-0.070	-0.012	0.020	0.045	0.017	0.011
Germany	**-0.195**	**0.180**	**0.122**	**0.274**	**-0.066**	**0.131**	**0.236**	**0.323**	**0.229**	**0.272**
(t ratio)	(-0.776)	(-0.105)	(-0.517)	(0.666)	(-0.937)	(-0.167)	(0.293)	(0.890)	(0.251)	(0.185)
of which impacted through:										
US	0.024	0.034	-0.020	-0.005	-0.021	0.005	0.014	0.067	-0.017	0.017
Japan	-0.054	0.165	0.235	0.149	0.146	0.159	0.167	0.133	0.200	0.225
Germany	-0.164	-0.019	-0.093	0.130	-0.192	-0.033	0.055	0.123	0.047	0.030
F test	(0.642)	(4.226)**	(4.023)**	(2.137)	(1.196)	(1.896)	(3.055)**	(12.020)**	(3.165)**	(6.931)**
R2 (% of variance explained):	7%	35%	33%	21%	13%	19%	28%	60%	28%	46%

Note: Annual real GDP growth rates covering the period 1971-98 are used in the analysis.
F-test indicates the significance of the regression equation as a whole.
t-test indicates the significance of the path coefficients (which is also the "same-country" portion of the correlation breakdown) of the respective G3 country.
* *significant at 10% level.*
** *significant at 5% level.*

of the US were transmitted primarily by the US itself.

In other words, *all* of the eight Asian economies owed their growth correlation with Germany and the US (except Hong Kong and Taiwan) largely to the "Japan channel." The reverse was not true, however. There was no significant "US channel" or "Germany channel" through which Japan transmitted its growth impact on Asia. In fact, Japan was the sole transmitter of its own impact on Asia.

Indeed, taking the evidence literally, the "direct" effects of higher US growth on Indonesia, the Philippines, Malaysia and Thailand were actually negative. In other words, it was only because growth in the US and Japan were positively correlated that these ASEAN economies ended up with an overall positive growth correlation with the US.

In summary, although Japan as a trade partner of Asia may not be as important as the US, it has a greater influence on Asia's economic fortune both as a direct source of growth and as a transmitter of impacts from other growth sources.[4]

Explaining Direct and Indirect Growth Impacts

This section aims to explain Japan's overwhelming direct and indirect effects on Asia indicated by the model with reference to some observations on trade and investment patterns.

As seen from Table 1, Japan is a less important trade partner of Asia than the US. In terms of capital flows, although Japan has a clear lead in bank lending and tourist trips to Asia, its lead against the US in terms of direct investment in Asia is not clear cut (see Table 5). While Japanese investors dominate in Indonesia, Thailand, Taiwan, Hong Kong and China, US investors are more prominent in Malaysia, Philippines, Korea and Singapore.

Table 5 : **Sources of Capital and Tourist Flows to Asia Compared**

	Sources of FDI[1] (% of total)		Sources of BIS bank lending[2] (% of total)			Sources of visitor arrivals[3] (% of total)		
	Japan	US	Japan	US	Germany	Japan	US	Germany
China	**9**	8	**34**	4	11	**2**	1	0.3
Hong Kong	**36**	26	**49**	3	11	**17**	8	2
Indonesia	**15**	4	**44**	7	9	**12**	4	4
Malaysia	20	**21**	**38**	8	18	**5**	2	1
Philippines	11	**21**	13	**26**	12	18	**20**	3
Singapore	29	**44**	**39**	3	16	**16**	5	3
South Korea	20	**30**	**26**	10	10	**45**	10	1
Taiwan	**24**	21	**16**	11	11	**40**	13	1
Thailand	**40**	17	**56**	6	9	**12**	5	5

Figures in bold denote the country with the largest share.

1. *Due to definition differences, data are not comparable across countries. Figures refer to FDI utilized for China, FDI in manufacturing for Hong Kong and FDI commitments in manufacturing for Singapore. Figures for other countries refer to investment approved. Due to data availability, periods of data coverage vary as follows: China (1995-98); South Korea (1990-96); Indonesia, Hong Kong and the Philippines (1990-97); Singapore, Taiwan and Thailand (1990-98); and Malaysia (1991-98).*
2. *Shares of BIS bank lending data calculated are based on average of half-yearly stock figures covering the period from June 1994 to June 1998.*
3. *Shares of visitor arrivals calculated are based on yearly figures. Due to data availablity, periods of data coverage vary as follows: Germany's % share for Taiwan (1997-98); Thailand (1991-98); all other figures (1990-98).*

Sources: CEIC; country sources.

4 That said, it is obvious that these results seem at odds with the experience of Asian economies in the early-90s, when they continued to grow even when the Japanese economy was stagnant. A plausible explanation is that a rising yen in the 1992-95 period might have mitigated part of the negative impact by boosting Asia's competitiveness. After that period, the yen weakened but strong fiscal stimulus produced a rebound in Japan in 1996. In 1997, however, the Japanese economy faltered again and the yen continued to weaken, producing a "double whammy" scenario which might help to explain the severity of the eventual slowdown.

Nevertheless, two unique aspects of the Japan-Asia economic relationship, as discussed below, may have contributed to Japan's predominant influence.

a. "Complementary" Industrial Linkages

Some analysts suggest that there are broad distinctions between Japanese and American investment - or "production networks" - in Asia.[5] First, East Asian networks of Japanese corporations usually maintain close cooperation with their headquarters in Japan. They resemble integrated extensions of Japan's domestic production systems and complement the investment recipient's economy. In contrast, US-invested firms resemble offshore production units that are much more independent from their home bases. They represent a "net" shift of production from the US.

Second, Japanese production in East Asia is more focused on penetrating local markets. Thus they tend to have greater integration with local production and distribution networks. In comparison, US-invested firms are largely aimed at supplying their home market and hence, have less interaction with the local economy.

At the risk of overgeneralization, these observations suggest that Japan has built a stronger economic "partnership" with Asia than has the US. By tightly integrating with the production and distribution networks of their hosts, Japanese investors may have contributed more significantly to the growth of the host economy than their direct trade and investment data would suggest.

b. Triangular Trade Relationship

Aside from being more focused on selling to the local Asian markets, Japanese companies are more developed in using Asia as an export platform to sell to third-country markets like the US and Europe. This is in contrast to the US-Asia and Europe-Asia trade flows, which serve predominantly their respective direct home markets. Under the triangular trade structure, the stimulation of higher growth in the US (or Europe) on Japanese exports would boost Asian production indirectly as Japanese companies use their Asian facilities to support home production and to meet export orders. On the other hand, higher growth in Japan would induce fewer indirect flows through the US or Europe, as the operations of the latter two countries in Asia serve primarily their respective home markets.

In a recent study on Singapore's electronics industry,[6] it was found that Japanese companies sold over half (54%) of their products to non-home (i.e non-Japan) and non-host (non-Singapore) markets. The corresponding figures for US and European firms were just about one-third (32-37%, see Table 6). These findings underline the relatively strong orientation of Japanese firms in using Singapore as an export platform to third markets.

Table 6 : **Destination of Singapore Electronics Exports by Firm Nationality, 1990-94**

Firm Nationality	Total Sales (US$ bn)	Destination					
		Singapore	Other Asia	US	Japan	EU	Others
US	88.96	9.2%	10.0%	58.5%	4.1%	15.8%	2.2%
Japanese	31.78	34.4%	15.5%	17.7%	11.3%	11.0%	10.1%
European	15.26	15.1%	14.3%	12.1%	2.8%	47.9%	8.4%

Source: Poh-Kam Wong (1998), "Globalisation of US-Japan Production Networks and the Growth of Singapore's Electronics Industry," Institute of Development Economics, Tokyo.

5 Hiroyuki Itami (1998), "Overview: The Structural Upgrading of East Asian Economies and Industrial Networks," Institute of Development Economics, Tokyo.

6 Poh-Kam Wong (1998), "Globalisation of US-Japan Production Networks and the Growth of Singapore's Electronics Industry," Institute of Development Economies, Tokyo.

The same study also confirmed the relatively strong penetration of Japanese firms in the local (host) markets, with more than one-third of their production sold locally, compared with just one-tenth in the case of the US and one-eighth in the case of the EU.

The heavy penetration of host domestic markets by Japanese companies is not limited to the electronics industry or in Singapore alone. A separate survey done last year by the Export-Import Bank of Japan on 455 Japanese manufacturers with overseas affiliates in ASEAN reflected similar trends.[7] According to the survey (see Table 7), while export ratios of Japanese firms varied greatly across industries due to the transportability of their products, over 60% of total sales were destined to the host domestic markets. The same survey also indicated that among the key objectives of Japanese companies investing in the ASEAN economies, the top priority was domestic market penetration, followed by sales to third markets, and then by sales to home markets (see Table 8).

Table 7 : **Destination of Japan's Production in ASEAN5**[1]

	% of production	
	Domestic consumption	**Exports to Japan**
Textiles	46.5	23.3
Chemicals	78.3	7.6
Steel	85.9	12.5
General Machinery	73.3	12.9
Electrical & electronic equipment assembly	38.7	31.6
Electrical & electronic parts	47.8	19.6
Automobile assembly	95.1	2.0
Automobile parts	77.1	17.8
All industries	68.5	16.4

[1] *ASEAN5 include Thailand, Malaysia, Singapore, Indonesia and the Philippines.*
Source: Export-Import Bank of Japan (1998).

The economic linkages discussed above help to explain the trade deficit that Asia has been running against Japan - Asia is essentially a net importer of capital goods from Japan and a net exporter to the rest of the world. Furthermore, they partly explain why Japanese banks have such a high concentration of Asian loans in their portfolio: export credits and other forms of liquidity facilities are clearly necessary to make this strategy workable in view of the underdeveloped financial infrastructure of most Asian countries.

Implications for Asia's Recovery

To the extent that Japan is gradually recovering from its decade-long economic malaise, Asia should stand to benefit. This has to some

Table 8 : **Factors Driving Japanese Investment in Different Regions**

	(% of total respondent - multiple responses)			
	US-Canada	**EU**	**ASEAN**	**China**
Maintain and expand local market	69.6	68.9	**51.9**	61.4
Explore a new market	30.4	32.4	26.6	48.2
Extension of production base	16.3	14.9	27.8	22.9
Export to third countries	6.5	2.7	**39.2**	16.9
Secure inexpensive labour	3.3	2.7	26.6	22.9
Product development	23.9	21.6	6.3	12.0
Supply to assemblers (incl Japanese affiliates)	9.8	9.5	16.5	10.8
Reimport to Japan	4.3	1.4	**26.6**	12

Source: Export-Import Bank of Japan (1998).

7 The Export Import Bank of Japan (1998), "EXIM Japan 1998 Survey: The Outlook of Japanese Foreign Direct Investment."

extent already been reflected in a general rebound of Asia's exports to Japan (see Table 9) in recent months. Our analysis suggests that every 1% in Japan's GDP growth will lift Asia's GDP growth by 0.76%.[8]

A more fundamental issue is how Japan's partnership with Asia would evolve after the Asian financial crisis. It is too early to expect any obvious recovery in Japanese investment and bank lending in the region. Nevertheless, the strong recovery in intra-regional trade flows could be the first indications of a revival of indirect linkages. Specifically, strong rebound was reported in US imports from ASEAN of electrical appliances, machinery and other products with heavy Japanese investment content (see Table 10).

On the other hand, some Japanese firms seem to be embarking on a rethinking of their overseas investment strategy. The existence of excess capacity throughout Asia has put in doubt further expansion of Japanese investment, more so as demand in Asia remains subdued. More importantly, the strategy of some Japanese firms to compete by market share is also under serious challenge. Changes in corporate governance that put more emphasis on shareholder returns rather than on sales and production volumes are forcing Japanese companies to focus on their bottom lines. Also, Asian countries' urge to raise their own competitiveness may put them in more direct competition rather than complementary position versus Japan down the road. While it is too early to predict how the Asian crisis will impact on the unique Japan-Asia economic linkages, there is a possibility that Japan's impact on Asian growth may shrink over time as Asia grows bigger and develops

Table 9 : **Japan's Imports from Asia, Q2 1999**

	% change in US$ terms		
	vs Q1 99	vs Q2 98	vs Q2 97
Asia	9.9	3.2	-9.4
ASEAN	9.6	2.3	-14.6
By country			
China	11.0	2.0	-2.7
Hong Kong	3.0	-11.8	-28.5
Indonesia	13.5	4.4	-20.9
Malaysia	15.3	11.6	-12.4
Philippines	13.2	0.4	-3.6
Singapore	3.9	3.8	-11.4
S. Korea	13.0	12.6	-2.8
Taiwan	10.9	8.9	-6.4
Thailand	2.8	-6.0	-11.8

Source: CEIC

Table 10 : **ASEAN5 Exports to US in H1 1999, by SIC Type**

	% change in US$ terms			
	vs H2 98	vs H1 98	vs H1 97	vs H1 96
Chemicals and Related Products	20.1	15.6	-19.6	-8.5
Manufactured Goods	-1.9	6.6	21.2	43.0
Machinery and Transport Equipment	-6.2	2.8	7.6	10.4
Miscellaneous Manufactured Articles	-10.5	2.2	6.0	17.2
Commodities and Transactions	4.3	-0.4	43.9	34.7
Office Machinery and Data Processing	-6.8	6.0	16.2	24.7
Telecomm & Sound Equipment	-18.2	-2.8	-4.9	-8.5
Electrical Machinery, Apparatus & Appliances	0.1	1.3	1.7	0.7

Source: CEIC.

8 This "elasticity" measure of 0.76 was obtained from the linear model that is implied from our path analysis (see Annex for a discussion of the relation between the two), with Asia growth as the dependent variable and G3 growth as the independent variables. The corresponding coefficients for US and Germany were 0.19 and 0.03, respectively. A recent study by Deutsche Bank ("East Asia's Exchange Rate Dilemma", Deutsche Bank *Global Markets Monthly*, August 1999), in which Asia's GDP growth was regressed on G2 (US and Japan) growth and the USD/JPY rate using quarterly data from 1990, yielded much higher elasticity measures (1.24 for Japan and 0.87 for US). Yet, the relative dominance of Japan remained.

more broad-based relationship with other major industrial economies.

Conclusion

This paper argues that Japan is of great importance in Asia, not only because of the direct impact its demand has on its neighbours, but also because it acts as the channel through which a substantial portion of growth in the West is transmitted to Asia. This growth transmission role may be partly attributable to Japan's overseas investment strategy, characterised by complementary industrial relations with the host economies and a third-market export strategy. If Japan starts to rebound, the restoration of these indirect transmission channels is expected to reinforce Asia's recovery in the near term. Yet a complete return to the old relationship between Japan and Asia is questionable, given significant changes in Asian development strategy and economic structures triggered by the latest crisis.

- Prepared by the Research Department

ANNEX A

TECHNICAL NOTES ON PATH ANALYSIS

The path analysis performed in this paper is a system with three exogenous variables (G-3 growth, denoted X_{1-3}) and one endogenous variable (Asia region/ country growth, denoted Y). We postulate that they are depicted graphically by Graph 1 and algebraically by the linear model:

$$(1) \quad Y = \beta_0 + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \varepsilon$$

Where ε is an error term that represents the collective effect of all unmeasured variables. Standard assumptions of OLS regressions apply.

When we rewrite equation 1 in a standardised form, it becomes

$$(2) \quad \frac{Y-\mu_Y}{\sqrt{\sigma_{YY}}} = \beta_1\sqrt{\frac{\sigma_{11}}{\sigma_{YY}}}\left(\frac{X_1-\mu_1}{\sqrt{\sigma_{11}}}\right) + \beta_2\sqrt{\frac{\sigma_{22}}{\sigma_{YY}}}\left(\frac{X_2-\mu_2}{\sqrt{\sigma_{22}}}\right) + \beta_3\sqrt{\frac{\sigma_{33}}{\sigma_{YY}}}\left(\frac{X_3-\mu_3}{\sqrt{\sigma_{33}}}\right) + \sqrt{\frac{\sigma_{\varepsilon\varepsilon}}{\sigma_{YY}}}\frac{\varepsilon}{\sqrt{\sigma_{\varepsilon\varepsilon}}}.$$

Alternatively, if we use Z to denote standardised variables:

$$(2b) \quad Z_Y = p_{Y1}Z_1 + p_{Y2}Z_2 + p_{Y3}Z_3 + p_{Y\varepsilon}Z_\varepsilon,$$

where

$$p_{Yi} = \beta_i\frac{\sqrt{\sigma_{ii}}}{\sqrt{\sigma_{YY}}} \quad for \quad i = 1,2,3 \quad and \quad p_{Y\varepsilon} = \frac{\sqrt{\sigma_{\varepsilon\varepsilon}}}{\sqrt{\sigma_{YY}}}.$$

The p_{Yi}'s thus defined are called path coefficients. A direct method to obtain their values is by regression. However, here we calculate them algebraically to illustrate some of their properties. To do this, first note that correlation coefficients are themselves standardised measures and are invariant to whether the variables under consideration are standardised or not. Thus, the correlation between Y and each X_i, ρ_{Yi}, is:

$$(3) \quad \rho_{Yi} = Corr(Z_Y, Z_i) = Corr\left(\sum_{k=1}^{3} p_{Yk} Z_k, Z_i\right) = \sum_{k=1}^{3} p_{Yk}\rho_{ik}.$$

In other words, each correlation coefficient between the endogenous variable and an exogenous variable is "decomposed" into a linear function of correlations among the exogenous variables, with the path coefficients acting as weights. Also, note that, since by definition ρ_{ii} = 1, each path coefficient by itself represents the direct portion of the overall correlation for its corresponding exogenous variable.

In our current context, substituting the data supplied in Table 2 in equation (3), we obtain the three equations in three unknowns (the subscripts of the path coefficients are changed to reflect the G-3 countries):

$$\begin{aligned} 0.346 &= p_{US}(1) + p_{JP}(0.338) + p_{GE}(0.128) \\ (4) \quad 0.669 &= p_{US}(0.338) + p_{JP}(1) + p_{GE}(0.367) \\ 0.272 &= p_{US}(0.128) + p_{JP}(0.367) + p_{GE}(1) \end{aligned}$$

Solving this system of equations gives:

$$(5) \quad p_{US} = 0.135, \quad p_{JP} = 0.612, \quad \text{and} \quad p_{GE} = 0.03,$$

Substitute them back to the system of equations (3) gives us the decomposition of the correlation coefficients as shown in Table 3.

Finally, we can also get the estimate of $p_{Y\varepsilon}$ and in the process obtain a measure of how well this model fits the actual data. To do so, consider the variance of the standardised endogenous variable Z_Y, which by definition is 1:

$$(6) \quad Var(Z_Y) = Var\left(\sum_{i=1}^{3} p_{Yi} Z_i + P_{Y\varepsilon} Z_\varepsilon\right) = \sum_{i=1}^{3}\sum_{k=1}^{3} p_{Yi}\,\rho_{ik}\,p_{Yk} + P_{Y\varepsilon}^2 = 1$$

What equation (6) does is to divide the total observed variance of Y into its explained and unexplained components. As a result, substituting the previous results in the double summation term gives us a percentage measure of how much of the variance of the endogenous variable is contributed by the exogenous variables. This is also the R^2 that would result if standard OLS regression is used to estimate the model.

To illustrate this point, we show here the regression result of equation (1) using the same set of yearly growth data:

$$\begin{aligned} (7) \quad &\text{Asia} = 3.91 + 0.19\ \text{US} + 0.76\ \text{Japan} + 0.03\ \text{Germany} \\ &\qquad\quad (4.28) \quad (0.84) \quad\ (3.62) \quad\ (0.18) \end{aligned}$$

$$R^2 = 46.4\% \quad \text{Adj. } R^2 = 39.7\%$$

As seen, the R^2 is the same as the one reported in the path analysis in Table 2. The coefficients produced here, however, are different from those calculated above as they are estimates of the unstandardised equation (1), not the standardised equation (2b). In our current context, they can be interpreted as elasticity measures to show how Asia's growth is sensitive to growth in G3.

Reference

Johnson, Richard A., and Wichern, Dean W., "Applied Multivariate Statistical Analysis" *(3rd ed.)*, New Jersey: Prentice Hall, 1992.