

# IMF Working Paper

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## ASEAN: A Chronicle of Shifting Trade Exposure and Regional Integration

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**IMF Working Paper**

Asia and Pacific Department

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**Abstract**

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The paper characterizes trade exposure and regional integration in six ASEAN economies during 1997–2008. For this, the paper uses the 2000 Asian Input Output Tables which are extrapolated using National Income Accounts and COMTRADE data. On the demand side, the paper shows that the level and geographical nature of external exposure varies across the ASEANs, and has changed over time. In particular, there was a shift in the external demand exposure of ASEANs from mature markets, including the United States, to China and ROW. In addition, the share of China in East Asia’s final demand, especially investment, rose sharply while that of Japan fell. On the supply side, the paper documents the rise of China into a “global factory” and the steady shift in regional production and integration from Japan and the United States to China.

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## Contents

I. Motivation.....	3
II. The Analytical Framework of Asian Input Output Tables .....	5
III. A Decomposition of Value Added: The Demand Side .....	8
IV. Regional Integration and Production Networks in Asia: The Supply Side .....	10
V. Concluding Remarks .....	11
References.....	33
Table	
1. Asian Input Output Table, 2000: A Schematic Representation.....	13
Figures	
1. Final Demand Shares of I/O Economies, 1997–2008 .....	14
2. Final Consumption Demand Shares of I/O Economies, 1997–2008.....	15
3. Final Investment Demand Shares of I/O Economies, 1997–2008 .....	16
4. Demand Side: Domestic and External Exposure, I/O Economies.....	17
5. Demand Side: Domestic Exposure—Consumption and Investment, I/O Economies .....	18
6. Demand Side: Domestic and External Exposure, ASEAN Economies.....	19
7. Demand Side: Domestic Exposure—Consumption and Investment, ASEAN Economies .....	20
8. Demand Side: Exposure to External Final Demand, ASEAN Economies .....	21
9. Demand Side: Domestic and External Exposure, Non-ASEAN Economies .....	22
10. Demand Side: Domestic Exposure—Consumption and Investment, Non-ASEAN Economies .....	23
11. Demand Side: Exposure to External Final Demand, Non-ASEAN Economies.....	24
12. Supply Side: Output Shares of I/O Economies, 1997–2008 .....	25
13. Supply Side: Value Added Shares of I/O Economies, 1997–2008 .....	26
14. Supply Side: Ratio of Value Added to Output in I/O Economies, 1997–2008.....	27
15. Supply Side: Sources of Intermediate Inputs, ASEAN Economies .....	28
16. Supply Side: Sources of Intermediate Inputs, Non-ASEAN Economies .....	29
17. Production Integration in I/O Economies, 1997–2008.....	30
Appendix.....	31

## I. MOTIVATION

The decade since the Asian crisis has seen many parallel trends which have changed the contours of the global economy irrevocably. A number of these trends are now well known and documented—the rise of China as a global powerhouse, the relative decline of Japan, and consumption boom in the United States which culminated in the historical global recession and financial crisis of 2008. Behind these trends were unmistakable shifts in the shares of output, value added, and demand among economies and in cross-border production processes.

The ASEAN economies play an important role in these shifting contours of the global economy. With their rapid growth, they are progressively becoming more prominent on the world stage. They are also an integral part of the debate on global imbalances. Indeed, among the corollaries to the global debate on imbalances—large current account deficits in the United States mirrored in current account surpluses other regions around the globe—is a questioning of the continued relevance of the export-led growth model for the ASEANs, especially as prospects of a rapid demand recovery in the United States remain dim.

So what happened in the ASEANs as the global economy transformed? A key hypothesis in the literature on the ASEANs is that their external exposure increased. Prima facie evidence cited in favor this “excessive” external exposure argument is the over 50 percent share of exports in GDP suggested by *gross* trade statistics. However, given the substantial role of imported intermediate inputs and re-exports in trade, gross trade statistics potentially overstate the role of mature markets in Asia’s external demand. Specifically, recent analyses (such as ECB, 2009) conclude that emerging Asia’s exposure, taking the region as a whole, on exports is only about 33 percent of GDP. These lower estimates avoid double counting in exports (which arises from the use of gross trade data), and account for global production networks, intra-regional trade, and regional integration of production processes. A key here is that standard trade elasticities of GDP to imports do not fully account for the role of intermediate inputs, and neglecting intermediate inputs overstates external exposure. This distinction is important in the context of the ongoing debate on external exposure of the ASEANs and their role in global rebalancing.

Other important shifts took place as well. The geographical composition of Asia’s and the ASEANs external trade shifted with a larger share of exports going to non-mature markets and, within the region, to China. With these shifting patterns of trade, the analysis of external exposure needs to be again fine tuned. The ASEAN’s gross exports may not be an accurate indicator of their external exposure as some of these exports pass through the regional production lines, and are therefore more akin to intermediate inputs into the regional production chains. Moreover, with the rapid growth of China, there may be other points of aggregate demand contact between the ASEANs and China which are independent of both parties’ exposure to other markets. More specifically, the ASEANs may be suppliers for final consumption and investment in China and amongst themselves. And these aggregate demand

links in the region may have become more important with the region's rising size and influence in the global economy.

A series of logical questions follow: How dependent are the ASEANs on external demand? Are there cross-economy differences, with some ASEANs more "exposed" than others? Has this exposure increased over time? Does the more intensive integration of the economies into regional and global production chains matter for these computations? Could it be that for the region as a whole, external exposure has not changed or changed very little, but that the channels through which this is manifest have become more roundabout? Establishing the extent of this exposure, and answering some of these questions, is naturally essential for sound policy recommendations and management.

This paper aims to answer a few of these questions in a consistent, tractable framework. Specifically, it uses the Asian Input Output (AIO) tables. These tables are produced every five years. The latest available tables are for 2000. In this paper, the 2000 I/O tables are extrapolated using National Income Accounts and COMTRADE data to estimate I/O tables for 1997–2008. Such an extrapolation method is proposed in Pula and Peltonen (2009). This extrapolation process involves updating the input-output coefficients and the demand side. COMTRADE data provide a detailed breakdown of trade by economy, geographical destination, and economic sector.

The main results of the paper relate to the shifts in the contours of the global economy in a decade since the Asian crisis. Among the changing contours are the rise of China as a global powerhouse, both on the demand side and the supply side. These changes were manifest in the unmistakable shifts in the shares of output, value added, and demand among economies and in cross-border production processes. China's share in global output increased significantly, and it emerged as the "global factory" with a steady shift in regional production and integration patterns from Japan and the United States. The shares of the ASEAN, Korea, and the United States were largely intact on the demand side. Within this increase in final demand there was a significant difference in the growth of final consumption and investment. For the United States, the share in consumption rose while the share of investment fell.

As regards external exposure, for the ASEANs, the level and geographical nature of external exposure varied, and changed over time. There was a measurable shift in external demand exposure of the ASEANs from mature markets, including the United States, to China and ROW. This diversification in the ASEANs external exposure suggests that the export-led growth model may not yet be passé after all. A testimony to this hypothesis is early resurgence of the ASEANs from the global recession.

The remainder of this paper is organized as follows. Section II introduces salient features of the 2000 Asian I/O tables and sets out the analytical framework. Section III examines the demand side and quantifies changes in the ASEAN's external exposure over time. Section IV traces the evolution of the ASEAN's production processes, including through coefficient

matrices and characterizes the fundamental changes that have taken place in global value added and output, noting the ascendancy of China as a “global factory”. Section V concludes.

## II. THE ANALYTICAL FRAMEWORK OF ASIAN INPUT-OUTPUT TABLES

A schematic diagram of the Asian I/O tables at the economy level is shown in Table 1. The ten economies on which detailed information is available in the tables are Indonesia, Malaysia, Philippines, Singapore, Thailand, China, Taiwan Province of China, Korea, Japan, and United States, henceforth I/O economies. On the demand side, the tables provide information on domestic and imported inputs (and therefore the I/O coefficients) and on final demand broken down by private and public consumption and investment. Final demand is further broken down by the economy that it is sourced from. This provides a useful breakdown of demand into domestic and external supply sources. Data is also available on exports by the I/O economies to Hong Kong SAR, EU, and rest of the world (henceforth non-I/O economies) to obtain total demand for each economy’s output. On the supply side, intermediate inputs—from domestic and imported sources (I/O and non-I/O economies)—are grossed up by taxes and value added to obtain total output supply of an economy. The equality of demand for an economy’s output and its supply is ensured by a statistical discrepancy term on the demand side.

### A. The Demand Side and External Exposure

In the I/O tables, total demand for economies’ output satisfies the following equation:

$$(1) \quad A_t X_t + F_t + L_t = X_t$$

where  $A$  is a  $10 \times 10$  matrix of input coefficients  $a_{ij} = A^{ij}/X^j$  for the ten economies in the Asian I/O tables,  $X$  is  $10 \times 1$  vector of total outputs, and  $F$  is  $10 \times 1$  vector of sum of final demands in I/O economies, and  $L$  is  $10 \times 1$  vector of the sum of I/O economies’ exports to non-I/O economies. The  $10 \times 1$  matrix  $A_t X_t$  is total intermediate demand. Rearranging equation (1) gives:

$$(2) \quad X_t = (I - A_t)^{-1} (F_t + L_t) \equiv B_t (F_t + L_t)$$

where  $B$  is the Leontief inverse matrix. Equation (2) relates total output, net of intermediate inputs, to final demand. This netting out of intermediate imports is important for ASEAN EMs, and is not done in standard analyses which typically compute home economy GDP elasticities to *gross* imports, foreign demand or GDP. Netting out of intermediate imports is a defining feature of this paper, and other similar analyses, and provides a more accurate measure of external exposure.

Equation (2) can be used to decompose output in economy  $i$  as being induced by demand in economy  $i$  and other I/O economies and exports to non I/O economies. In particular, this

decomposition provides the share of output in economy  $i$  that is *attributable* to domestic demand as:

$$(3) \quad X_t^{\text{id}} = b_t^{\text{ii}} F_t^{\text{ii}} \quad \text{for all } i = 1, \dots, 10.$$

The portion of output attributable to external demand is therefore:

$$(4) \quad X_t^{\text{if}} = X_t^{\text{i}} - X_t^{\text{id}} \quad \text{for all } i = 1, \dots, 10.$$

The portions of output can be further segregated into parts that are attributable to domestic/foreign consumption and investment, by economy and by year. These decompositions can therefore provide detailed breakdowns of external exposure in the ASEAN EMs (and other I/O economies) by components of aggregate demand, by partner economy and by year.

The translation of these decompositions of output to value added is straightforward, and uses the ratio of value added to output which is expressed as:

$$(5) \quad V_t = \Theta_t X_t$$

where  $V$  is a  $10 \times 1$  vector of value added in I/O economies, and  $\Theta_t$  is a  $10 \times 10$  diagonal matrix whose elements are the ratios of value added to total output in I/O economies.

### B. The Supply Side and Production Linkages

On the supply side, a unit of output in economy  $i$  requires inputs from economy  $i$  itself and from other I/O and non-I/O economies. As noted above, these inputs—domestic and imported—are added to taxes and value added to derive the value of total output. Continuing the notation from above:

$$(6) \quad A_t^* X_t + C_t^* X_t + T_t + V_t = X_t$$

where  $A^*$  and  $C^*$  are  $10 \times 10$  (diagonal) matrices of sums of inputs coefficient for intermediate inputs imported from I/O and non-I/O economies, respectively;  $T$  and  $V$  are  $10 \times 1$  vector of taxes and value added, respectively; and  $X$  is the output vector. Total intermediate inputs are therefore:

$$(7) \quad I_t^{\text{i}} = A_t^* X_t + C_t^* X_t \quad \text{for } i = 1, \dots, 10.$$

These inputs can then be decomposed into domestic and imported inputs, and imported inputs can be broken down by economy for each year. Specifically, along the lines of the analysis above, domestically and foreign sourced inputs, respectively, are:

$$(8) \quad I_t^{\text{id}} = a_t^{\text{ii}^*} X_t^{\text{i}} \quad \text{for all } i = 1, \dots, 10.$$

and

$$(9) \quad I_t^{if} = I_t^i - I_t^{id} \quad \text{for all } i = 1, \dots, 10.$$

The shares of domestic and foreign inputs provide useful measures of the integration of production processes and external exposure from the supply side.

An interesting visual picture of the integration of production processes can be constructed using the B matrix in (2). This matrix contains information about production structures of economies. The diagonal elements of the matrix reflect the intensity with which inputs are sourced internally and the off-diagonal elements reflect the intensity of imported inputs in the production process.

With this framework, it is useful to dispel some reservations about the use of I/O analysis. First, while the availability of a more recent I/O table would undoubtedly provide an updated picture of regional and global integration for the ASEANs, an approximation which extrapolates the 2000 table is nevertheless useful. The extrapolation methods do a satisfactory job of capturing the key elements of production processes (Pula and Peltonen, 2009).

A second reservation often expressed about the use of these tables is that they do not involve prices and deal exclusively with quantities. This is true. However, this reservation needs to be tempered by the counterargument that the extent of substitution in production (and possibly consumption) may well be limited in the short run, and possibly over the medium term due to market imperfections and rigidities in trade patterns due to a variety of factors. Indeed, the degree of substitution in consumption and production is an empirical question. Equally the argument turns on the size of trade price elasticities. If they are small, then quantity effects dominate and I/O computations are still a reasonable approximation.

Finally, the lack of dynamic and second round effects is often cited a shortcoming of the analysis. A counterargument is that in large dynamical systems of the sort that are used or needed to analyze these issues, the new steady state to which economies gravitate are typically specified exogenously. The comparative static analyses from the I/O tables can be viewed as providing these steady states. While the paths that economies traverse across steady states in dynamical models are interesting, there is little convincing analysis in the literature of the robustness of these dynamic paths to parameter values and calibrations. The comparative static analyses of the I/O tables are not subject to these caveats and are, in many respects, more transparent than the large, dynamic models. More importantly, the I/O framework handles a much larger amount of detail in production and consumption processes than is possible in large dynamic models. In addition, the I/O tables can provide readily usable results and rules of thumb on a wide variety of comparative static questions.

### III. DECOMPOSITION OF VALUE ADDED: THE DEMAND SIDE

We now address the first central question of this paper: How exposed are the ASEANs to external demand? To answer this question, we look at the shares of the I/O economies in the domestic final, consumption and investment demand in the region. We then decompose GDP/value added in six ASEAN economies along various dimensions to examine its exposure to demand, domestic and external. These decompositions are also compared to those for non-ASEAN I/O economies, namely China, Korea, Japan and the United States.

#### A. The Evolution of Final Demand

Over the last decade, the structure of final demand in I/O economies changed significantly. Consistent with its high growth rate, China's share in final demand among I/O economies more than doubled from 6 percent in 1997 to 15 percent in 2008 (Figure 1). Interestingly, almost all of this increase in China's share came at the expense of Japan where low consumption growth has weighed on the economy now for an extended period. The shares of the ASEAN, Korea, and the United States were largely intact.

Within this increase in final demand there was a significant difference in the growth of final consumption and investment. Consistent with the rapid growth of consumption in the United States, its share in the I/O economies' final consumption has been rising almost continuously over a decade. At the same time, investment growth has been relatively slower, and corporate savings have been high.<sup>1</sup> For China, the rapid growth of final demand was more on account of higher investment and its share of final investment in the region rose threefold to nearly 30 percent, although its share of consumption in region also doubled to 10 percent. Again the shares of the ASEANs and Korea in final consumption and investment demand remained steady, while that of Japan fell significantly (Figures 2 and 3).

#### B. Domestic and External Final Demand Exposure of Value Added

##### ASEAN Economies

- Among the ASEANs, domestic demand accounts for more than 50 percent of value added in Indonesia, Philippines, and Thailand. For Malaysia and Singapore, this ratio has been significantly lower (30 percent). These ratios have been broadly steady since the Asian crisis in Malaysia, Philippines, and Thailand. For Indonesia, exposure to external demand fell noticeably by at least 10 percentage points, whereas for Singapore and Taiwan Province of China it increased by about 10 percentage points (Figures 4 and 5).

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<sup>1</sup> The rise in corporate savings in the United States and other advanced economies has been documented extensively, including in the WEO, 2006.

- On the domestic front, investment became a more dominant contributor to value added in Indonesia and Thailand, and the contribution of consumption receded (Figure 6). In Taiwan Province of China, there a decline in exposure of value added to both domestic consumption and investment. For Malaysia, Philippines and Singapore, there was no identifiable pattern, and the contributions of consumption and investment fluctuated, reflecting individual economy circumstances.
- The external exposure of all ASEAN economies to mature markets—United States, Japan, and the EU—fell (Figure 8). In particular, the exposure of the ASEAN’s value added to the United States declined for all economies, without exception. The exposure to China rose, most noticeably for Taiwan Province of China, but also for Malaysia, Philippines, Singapore, and Thailand. Indonesia’s exposure to China stayed almost unchanged. Most significantly, the exposure to the ROW rose for all the economies (except Indonesia), as the ASEANs successfully diversified their export markets.

### **Non-ASEAN Economies**

- Among the non-ASEANs, China and Korea are roughly similar in their domestic and external exposure. Japan and the United States fall into the category of economies in which domestic exposure of value added significantly exceeds external exposure. External exposure for all non-ASEAN economies increased over the last decade, reflecting the ongoing global integration, although by differing margins (Figure 9). That said, these external exposure, translated into absolute terms imply substantially difference amounts across economies, given differences in their sizes. In this vein, the small increase in the external exposure of the United States reflects a quantitatively large increase in absolute amount.
- Among the non-ASEANs, in China the contribution of consumption fell noticeably, especially since 2000, and was partly offset by the increased contribution of investment for an overall increase in exposure to external demand noted above (Figure 10), a phenomenon similar to Taiwan Province of China. For the other non-ASEAN economies, the shifts in exposure to domestic demand components were more muted, except for Japan where sluggish domestic consumption and investment continued to contribute to receding share to value added (with the exception of 2008).
- Like the ASEANs, the exposure of China and Korea to mature markets also declined (Figure 11). Again, the exposure to the United States fell, and exposure to ROW increased significantly especially for China. Interestingly enough, for Japan and United States, exposure to final demand in China rose noticeably. In Japan, the exposure to mature markets rose, while the U.S. exposure to mature markets fell. For both economies, the ROW became a larger contributor to GDP and value added.

## IV. REGIONAL INTEGRATION AND PRODUCTION NETWORKS IN ASIA: THE SUPPLY SIDE

### A. Output, Value Added and Intermediate Demand

The striking rise of China has been extensively documented in the popular press and academic literature, statistical gaps notwithstanding. In this section we examine this rise, and the changes that it has induced in the global and regional production chains. While there is, admittedly, substantial noise in the data, the broad contours of the story match the now extensive anecdotal evidence, and provide a useful quantification of the trends.

The contours of the supply side mirrored the demand side. With high growth rates and a shift in production processes to China, it may well have had the largest output among the I/O economies by 2008, surpassing the share of the United States (Figure 12). Again a large part of this increase came at the expense of Japan where the share of output dwindled by almost 10 percentage points to 15 percent between 1997 and 2008. The decline in the share of the United States was an even more striking 17 percentage points to 33 percent of the I/O economies total output. Interestingly, the ASEANs maintained their share in output and value added.

The shifts in value added shares were in the same direction as output, but were much less dramatic (Figure 13). The United States was still the largest economy in the region in terms of value added, but China's nominal GDP appeared to have caught up with that of Japan. An upshot of the relative changes in output and value added was that the ratio of value added-to-output in China did not rise very much. China had become the "global factory" but given the shift in production processes and the rise of the global supply chain across national boundaries, its contribution to global value added was relatively lower, and in its own production processes the ratio of value added to output was also lower than other economies (Figure 14).

Where did economies source their intermediate inputs from? Again the evidence is mixed (Figure 15). Among the ASEANs, the proportion of intermediate inputs in total output from external sources increased for Singapore, Thailand, and Taiwan Province of China; declined for Indonesia; and moved sideways for Malaysia and the Philippines. The share of imported inputs in Korea, Japan, and the United States also increased. The notable (and surprising) exception is China where the share of imported inputs in output declined. The share of domestic inputs rose by almost 20 percentage points to 75 percent (Figure 16). This is quite consistent with the idea that regional production processes became more integrated. It is to this cross-border integration of production processes that we now turn.

### B. The Integration of Production

Production processes in the region have two striking features. First, in all I/O economies, including the ASEANs, domestic inputs constitute the biggest component among inputs by a large margin, as shown in Figures 15 and 16.

Second, focusing entirely on the cross-economy linkages among the I/O economies, there was a remarkable shift in the production linkages across borders, especially in Asia (Figure 17). The intensity of integration of production processes among economies is captured in the contour plots, which are presented for four years (a contour plot can be provided for each year). The dark blue areas in these plots represent low levels of integration (keeping in mind that the intra-economy integration of production—which is much higher than cross-economy integration—is not shown here). As the intensity of integration in production processes rises, the colors of the plot change from light blue to yellow. The red areas represent the highest level of integration. The source economies for intermediate goods are on the horizontal axis and the destination economies are on the vertical axis.

With this color coding, the predominance of Japan—and to a lesser extent of the United States—as the primary destination for inputs from ASEAN economies is unmistakable in the contour plots until 2000. There were also strong production links between Malaysia and Singapore. Towards the middle of the decade, the shift to China as the ASEAN’s destination hub for intermediate goods exports in the region appears to have been complete, replacing Japan and the United States as predominant destination economies. Further deepening of these production linkages with China has continued since 2005, especially for Malaysia, Singapore, Thailand, Taiwan Province of China, and Korea. Malaysia, Thailand and Taiwan Province of China remained relatively more engaged with Japan.

## V. CONCLUDING REMARKS

The contours of the global economy have changed dramatically over the last decade. A key element of these changing contours was the rise of China as a global powerhouse, both on the demand side and the supply side. Behind these trends were unmistakable shifts in the shares of output, value added, and demand among economies and in cross-border production processes. The ASEAN economies played an important role in these processes, and with their rapid growth became more prominent on the world stage. They are also an integral part of the debate on global rebalancing.

Against this backdrop, this paper contributes to the global rebalancing debate by characterizing trade exposure and regional integration in six ASEAN economies, China, Japan, Korea and the United States during 1997–2008. As its analytical framework, the paper uses the 2000 Asian Input-Output Tables and extrapolates them using National Income Accounts and COMTRADE data.

On the demand side, the paper finds that the structure of final demand in I/O economies has changed. China’s share in final demand among I/O economies has increased significantly, while that of Japan has declined. The shares of the ASEAN, Korea, and the United States were largely intact. Within this increase in final demand there was a significant difference in the growth of final consumption and investment. For the United States, the share in consumption rose and the share in investment fell. China’s share in consumption also rose,

but its share in investment rose even more. Again the shares of the ASEANs and Korea in final consumption and investment demand remained steady, while that of Japan fell significantly. As regards external exposure, the level and geographical nature of external exposure varies across the ASEANs and changed over time. There was a measurable shift in external demand exposure of the ASEANs from mature markets, including the United States, to China and the rest of the world.

On the supply side, the paper documents the rise of China into the “global factory” and steady shift in regional production and integration patterns from Japan to China. Notwithstanding this greater cross-border integration of production processes, the domestic inputs are still the largest component of output in all economies. And there are large differences in the ratio of valued added to output across economies.

Table 1. Asian Input-Output Table, 2000: A Schematic Representation

	Intermediate Demand (A)										Final Demand (F)										Export (L)			Statistical Discrepancy (QX)	Total Outputs (XX)	
	code	Indonesia (AI)	Malaysia (AM)	Philippines (AP)	Singapore (AS)	Thailand (AT)	China (AC)	Taiwan (AN)	Korea (AK)	Japan (AJ)	U.S.A. (AU)	Indonesia (FI)	Malaysia (FM)	Philippines (FP)	Singapore (FS)	Thailand (FT)	China (FC)	Taiwan (FN)	Korea (FK)	Japan (FJ)	U.S.A. (FU)	Export to Hong Kong (LH)	Export to EU (LO)			Export to R.O.W. (LW)
Indonesia	(AI)	A <sup>II</sup>	A <sup>IM</sup>	A <sup>IP</sup>	A <sup>IS</sup>	A <sup>IT</sup>	A <sup>IC</sup>	A <sup>IN</sup>	A <sup>IK</sup>	A <sup>IJ</sup>	A <sup>IU</sup>	F <sup>II</sup>	F <sup>IM</sup>	F <sup>IP</sup>	F <sup>IS</sup>	F <sup>IT</sup>	F <sup>IC</sup>	F <sup>IN</sup>	F <sup>IK</sup>	F <sup>IJ</sup>	F <sup>IU</sup>	L <sup>IH</sup>	L <sup>IO</sup>	L <sup>IW</sup>	Q <sup>I</sup>	X <sup>I</sup>
Malaysia	(AM)	A <sup>MI</sup>	A <sup>MM</sup>	A <sup>MP</sup>	A <sup>MS</sup>	A <sup>MT</sup>	A <sup>MC</sup>	A <sup>MN</sup>	A <sup>MK</sup>	A <sup>MJ</sup>	A <sup>MU</sup>	F <sup>MI</sup>	F <sup>MM</sup>	F <sup>MP</sup>	F <sup>MS</sup>	F <sup>MT</sup>	F <sup>MC</sup>	F <sup>MN</sup>	F <sup>MK</sup>	F <sup>MJ</sup>	F <sup>MU</sup>	L <sup>MH</sup>	L <sup>MO</sup>	L <sup>MW</sup>	Q <sup>M</sup>	X <sup>M</sup>
Philippines	(AP)	A <sup>PI</sup>	A <sup>PM</sup>	A <sup>PP</sup>	A <sup>PS</sup>	A <sup>PT</sup>	A <sup>PC</sup>	A <sup>PN</sup>	A <sup>PK</sup>	A <sup>PJ</sup>	A <sup>PU</sup>	F <sup>PI</sup>	F <sup>PM</sup>	F <sup>PP</sup>	F <sup>PS</sup>	F <sup>PT</sup>	F <sup>PC</sup>	F <sup>PN</sup>	F <sup>PK</sup>	F <sup>PJ</sup>	F <sup>PU</sup>	L <sup>PH</sup>	L <sup>PO</sup>	L <sup>PW</sup>	Q <sup>P</sup>	X <sup>P</sup>
Singapore	(AS)	A <sup>SI</sup>	A <sup>SM</sup>	A <sup>SP</sup>	A <sup>SS</sup>	A <sup>ST</sup>	A <sup>SC</sup>	A <sup>SN</sup>	A <sup>SK</sup>	A <sup>SJ</sup>	A <sup>SU</sup>	F <sup>SI</sup>	F <sup>SM</sup>	F <sup>SP</sup>	F <sup>SS</sup>	F <sup>ST</sup>	F <sup>SC</sup>	F <sup>SN</sup>	F <sup>SK</sup>	F <sup>SJ</sup>	F <sup>SU</sup>	L <sup>SH</sup>	L <sup>SO</sup>	L <sup>SW</sup>	Q <sup>S</sup>	X <sup>S</sup>
Thailand	(AT)	A <sup>TI</sup>	A <sup>TM</sup>	A <sup>TP</sup>	A <sup>TS</sup>	A <sup>TT</sup>	A <sup>TC</sup>	A <sup>TN</sup>	A <sup>TK</sup>	A <sup>TJ</sup>	A <sup>TU</sup>	F <sup>TI</sup>	F <sup>TM</sup>	F <sup>TP</sup>	F <sup>TS</sup>	F <sup>TT</sup>	F <sup>TC</sup>	F <sup>TN</sup>	F <sup>TK</sup>	F <sup>TJ</sup>	F <sup>TU</sup>	L <sup>TH</sup>	L <sup>TO</sup>	L <sup>TW</sup>	Q <sup>T</sup>	X <sup>T</sup>
China	(AC)	A <sup>CI</sup>	A <sup>CM</sup>	A <sup>CP</sup>	A <sup>CS</sup>	A <sup>CT</sup>	A <sup>CC</sup>	A <sup>CN</sup>	A <sup>CK</sup>	A <sup>CJ</sup>	A <sup>CU</sup>	F <sup>CI</sup>	F <sup>CM</sup>	F <sup>CP</sup>	F <sup>CS</sup>	F <sup>CT</sup>	F <sup>CC</sup>	F <sup>CN</sup>	F <sup>CK</sup>	F <sup>CJ</sup>	F <sup>CU</sup>	L <sup>CH</sup>	L <sup>CO</sup>	L <sup>CW</sup>	Q <sup>C</sup>	X <sup>C</sup>
Taiwan	(AN)	A <sup>NI</sup>	A <sup>NM</sup>	A <sup>NP</sup>	A <sup>NS</sup>	A <sup>NT</sup>	A <sup>NC</sup>	A <sup>NN</sup>	A <sup>NK</sup>	A <sup>NJ</sup>	A <sup>NU</sup>	F <sup>NI</sup>	F <sup>NM</sup>	F <sup>NP</sup>	F <sup>NS</sup>	F <sup>NT</sup>	F <sup>NC</sup>	F <sup>NN</sup>	F <sup>NK</sup>	F <sup>NJ</sup>	F <sup>NU</sup>	L <sup>NH</sup>	L <sup>NO</sup>	L <sup>NW</sup>	Q <sup>N</sup>	X <sup>N</sup>
Korea	(AK)	A <sup>KI</sup>	A <sup>KM</sup>	A <sup>KP</sup>	A <sup>KS</sup>	A <sup>KT</sup>	A <sup>KC</sup>	A <sup>KN</sup>	A <sup>KK</sup>	A <sup>KJ</sup>	A <sup>KU</sup>	F <sup>KI</sup>	F <sup>KM</sup>	F <sup>KP</sup>	F <sup>KS</sup>	F <sup>KT</sup>	F <sup>KC</sup>	F <sup>KN</sup>	F <sup>KK</sup>	F <sup>KJ</sup>	F <sup>KU</sup>	L <sup>KH</sup>	L <sup>KO</sup>	L <sup>KW</sup>	Q <sup>K</sup>	X <sup>K</sup>
Japan	(AJ)	A <sup>JI</sup>	A <sup>JM</sup>	A <sup>JP</sup>	A <sup>JS</sup>	A <sup>JT</sup>	A <sup>JC</sup>	A <sup>JN</sup>	A <sup>JK</sup>	A <sup>JJ</sup>	A <sup>JU</sup>	F <sup>JI</sup>	F <sup>JM</sup>	F <sup>JP</sup>	F <sup>JS</sup>	F <sup>JT</sup>	F <sup>JC</sup>	F <sup>JN</sup>	F <sup>JK</sup>	F <sup>JJ</sup>	F <sup>JU</sup>	L <sup>JH</sup>	L <sup>JO</sup>	L <sup>JW</sup>	Q <sup>J</sup>	X <sup>J</sup>
U.S.A.	(AU)	A <sup>UI</sup>	A <sup>UM</sup>	A <sup>UP</sup>	A <sup>US</sup>	A <sup>UT</sup>	A <sup>UC</sup>	A <sup>UN</sup>	A <sup>UK</sup>	A <sup>UJ</sup>	A <sup>UU</sup>	F <sup>UI</sup>	F <sup>UM</sup>	F <sup>UP</sup>	F <sup>US</sup>	F <sup>UT</sup>	F <sup>UC</sup>	F <sup>UN</sup>	F <sup>UK</sup>	F <sup>UJ</sup>	F <sup>UU</sup>	L <sup>UH</sup>	L <sup>UO</sup>	L <sup>UW</sup>	Q <sup>U</sup>	X <sup>U</sup>
Freight and Insurance	(BF)	BA <sup>I</sup>	BA <sup>M</sup>	BA <sup>P</sup>	BA <sup>S</sup>	BA <sup>T</sup>	BA <sup>C</sup>	BA <sup>N</sup>	BA <sup>K</sup>	BA <sup>J</sup>	BA <sup>U</sup>	BF <sup>I</sup>	BF <sup>M</sup>	BF <sup>P</sup>	BF <sup>S</sup>	BF <sup>T</sup>	BF <sup>C</sup>	BF <sup>N</sup>	BF <sup>K</sup>	BF <sup>J</sup>	BF <sup>U</sup>					
Import from Hong Kong	(CH)	A <sup>HI</sup>	A <sup>HM</sup>	A <sup>HP</sup>	A <sup>HS</sup>	A <sup>HT</sup>	A <sup>HC</sup>	A <sup>HN</sup>	A <sup>HK</sup>	A <sup>HJ</sup>	A <sup>HU</sup>	F <sup>HI</sup>	F <sup>HM</sup>	F <sup>HP</sup>	F <sup>HS</sup>	F <sup>HT</sup>	F <sup>HC</sup>	F <sup>HN</sup>	F <sup>HK</sup>	F <sup>HJ</sup>	F <sup>HU</sup>					
Import from EU	(CO)	A <sup>OI</sup>	A <sup>OM</sup>	A <sup>OP</sup>	A <sup>OS</sup>	A <sup>OT</sup>	A <sup>OC</sup>	A <sup>ON</sup>	A <sup>OK</sup>	A <sup>OJ</sup>	A <sup>OU</sup>	F <sup>OI</sup>	F <sup>OM</sup>	F <sup>OP</sup>	F <sup>OS</sup>	F <sup>OT</sup>	F <sup>OC</sup>	F <sup>ON</sup>	F <sup>OK</sup>	F <sup>OJ</sup>	F <sup>OU</sup>					
Import from the R.O.W.	(CW)	A <sup>WI</sup>	A <sup>WM</sup>	A <sup>WP</sup>	A <sup>WS</sup>	A <sup>WT</sup>	A <sup>WC</sup>	A <sup>WN</sup>	A <sup>WK</sup>	A <sup>WJ</sup>	A <sup>WU</sup>	F <sup>WI</sup>	F <sup>WM</sup>	F <sup>WP</sup>	F <sup>WS</sup>	F <sup>WT</sup>	F <sup>WC</sup>	F <sup>WN</sup>	F <sup>WK</sup>	F <sup>WJ</sup>	F <sup>WU</sup>					
Import Duty and Sales Tax	(DT)	DA <sup>I</sup>	DA <sup>M</sup>	DA <sup>P</sup>	DA <sup>S</sup>	DA <sup>T</sup>	DA <sup>C</sup>	DA <sup>N</sup>	DA <sup>K</sup>	DA <sup>J</sup>	DA <sup>U</sup>	DF <sup>I</sup>	DF <sup>M</sup>	DF <sup>P</sup>	DF <sup>S</sup>	DF <sup>T</sup>	DF <sup>C</sup>	DF <sup>N</sup>	DF <sup>K</sup>	DF <sup>J</sup>	DF <sup>U</sup>					
Value Added	(VV)	V <sup>I</sup>	V <sup>M</sup>	V <sup>P</sup>	V <sup>S</sup>	V <sup>T</sup>	V <sup>C</sup>	V <sup>N</sup>	V <sup>K</sup>	V <sup>J</sup>	V <sup>U</sup>															
Total Inputs	(XX)	X <sup>I</sup>	X <sup>M</sup>	X <sup>P</sup>	X <sup>S</sup>	X <sup>T</sup>	X <sup>C</sup>	X <sup>N</sup>	X <sup>K</sup>	X <sup>J</sup>	X <sup>U</sup>															

Source: Reproduced from *Asian International Input-Output Table, 2000*, Institute of Developing Economies, JETRO.

Figure 1. Final Demand Shares of I/O Economies, 1997–2008

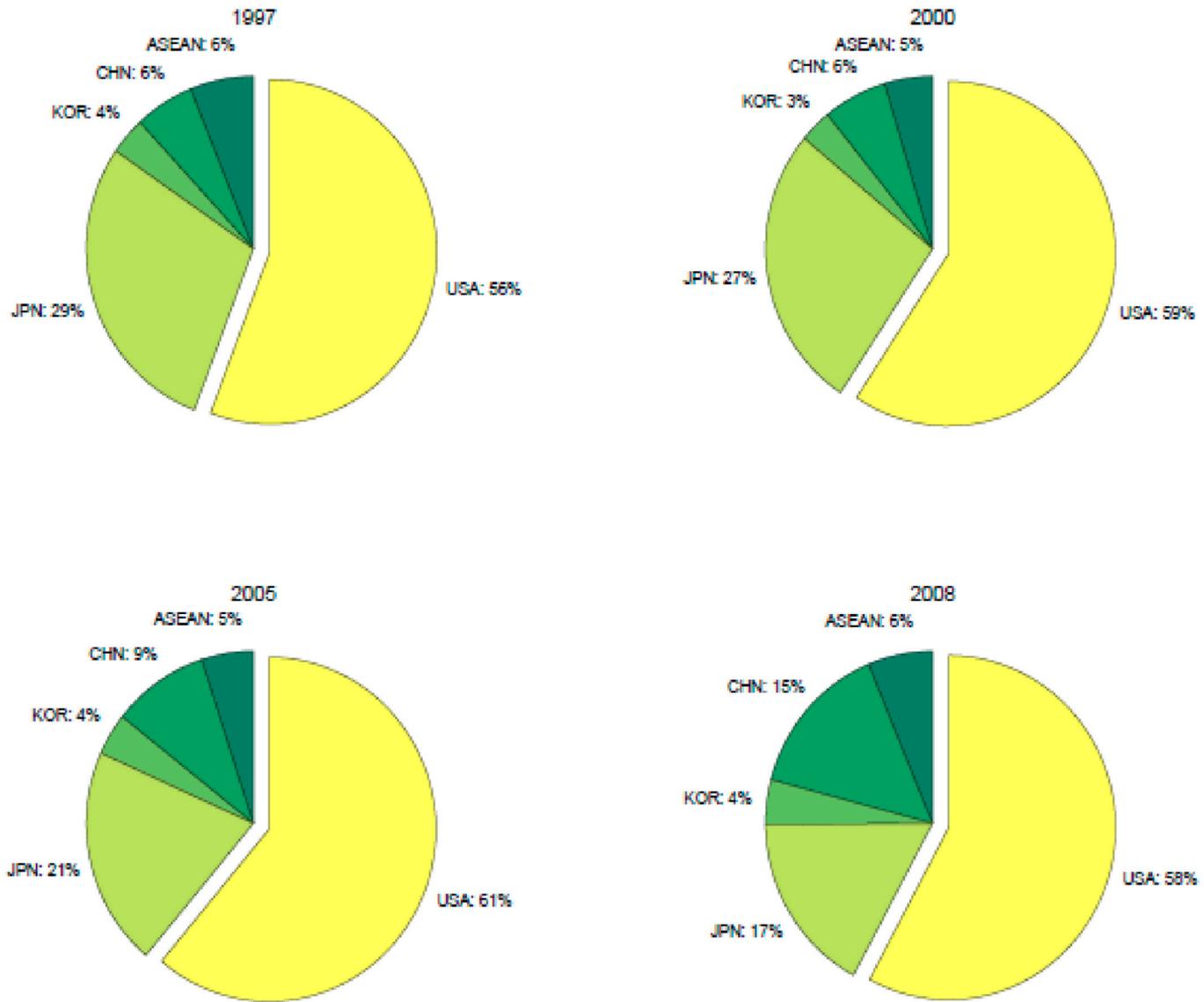


Figure 2. Final Consumption Demand Shares of I/O Economies, 1997–2008

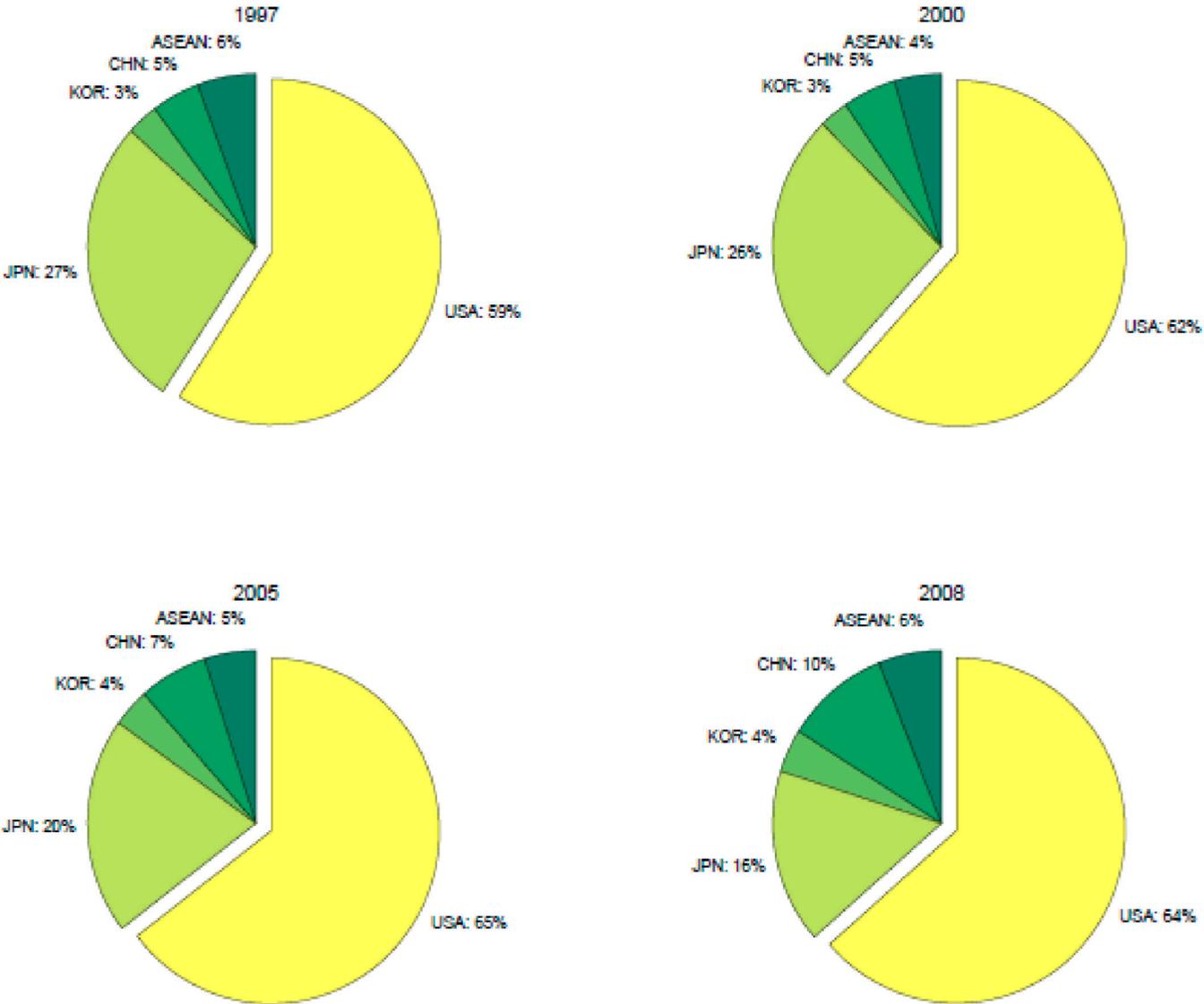


Figure 3. Final Investment Demand Shares of I/O Economies, 1997–2008

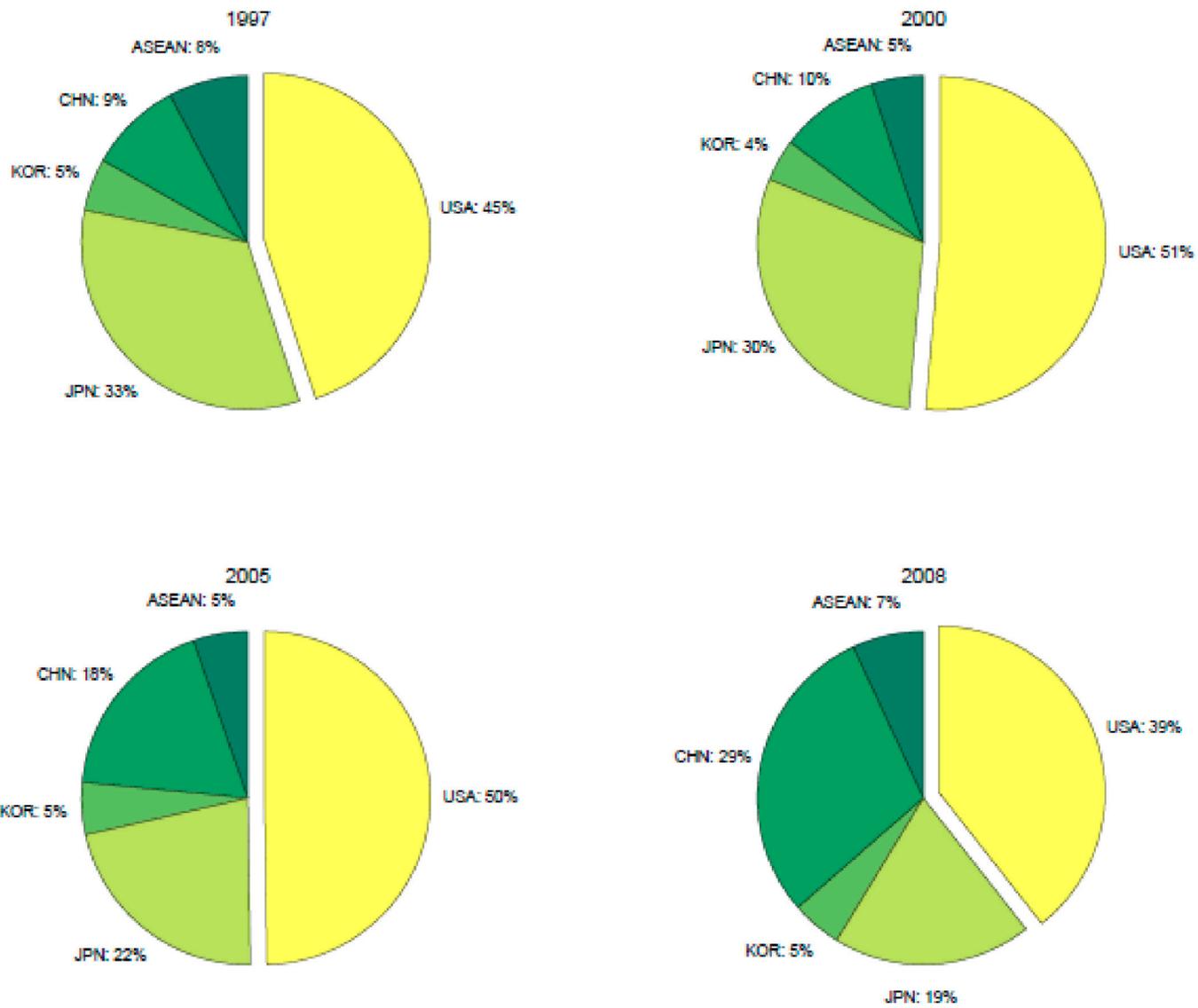


Figure 4. Demand Side: Domestic and External Exposure, I/O Economies

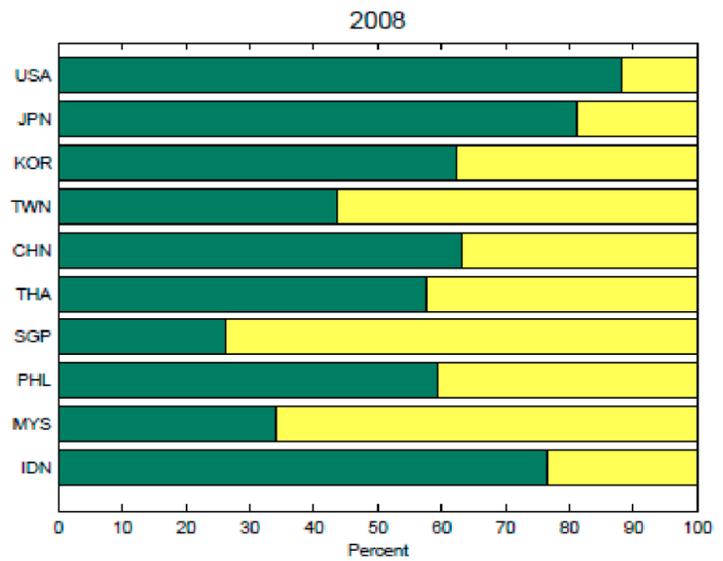
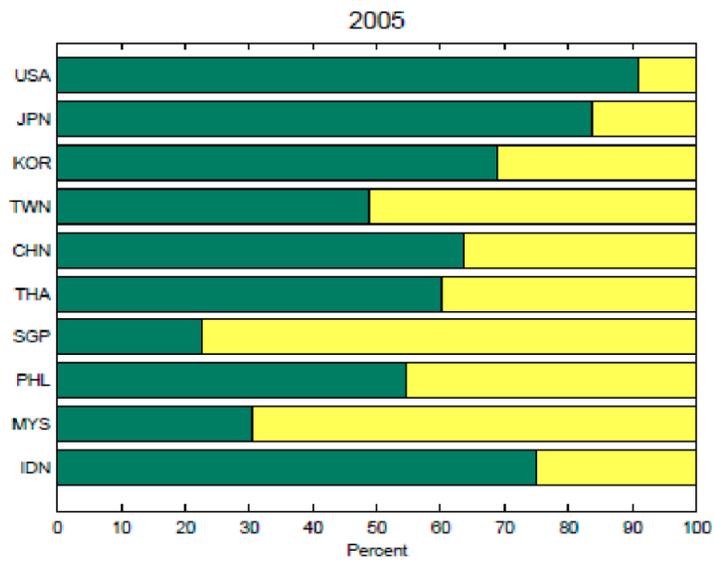
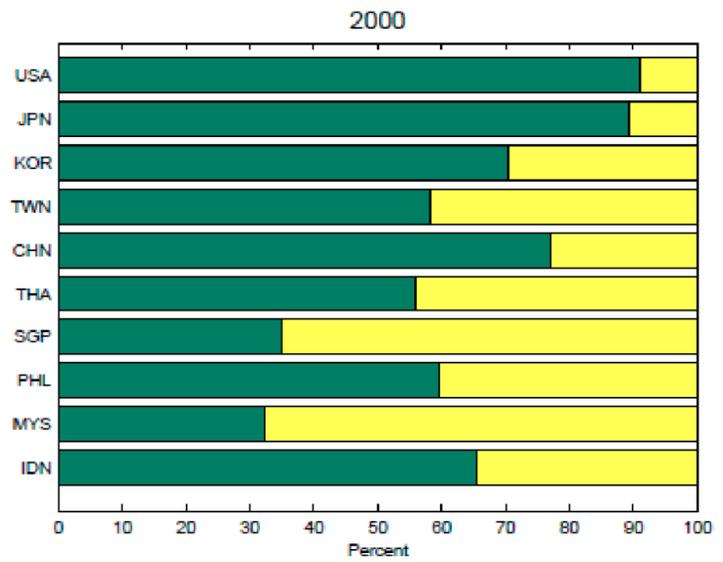
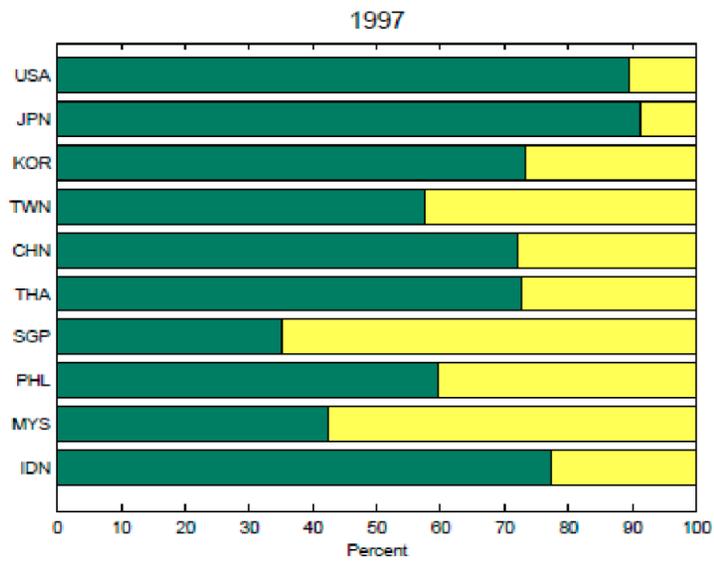


Figure 5. Demand Side: Domestic Exposure—Consumption and Investment, I/O Economies

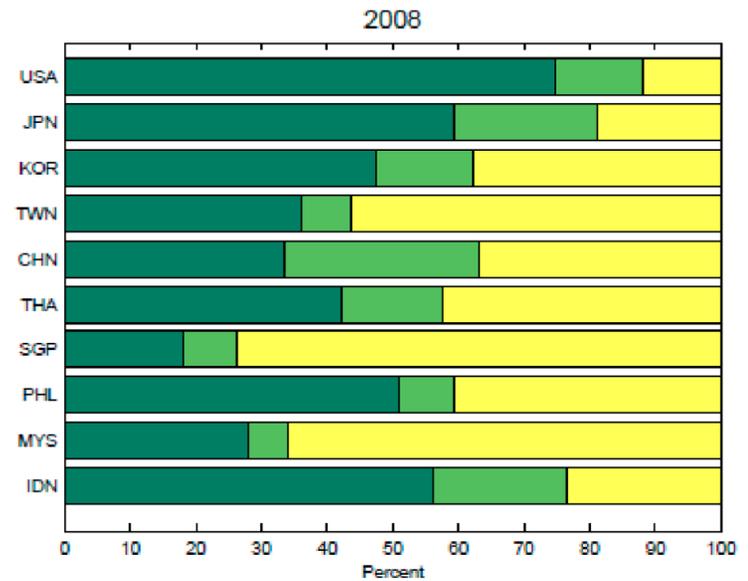
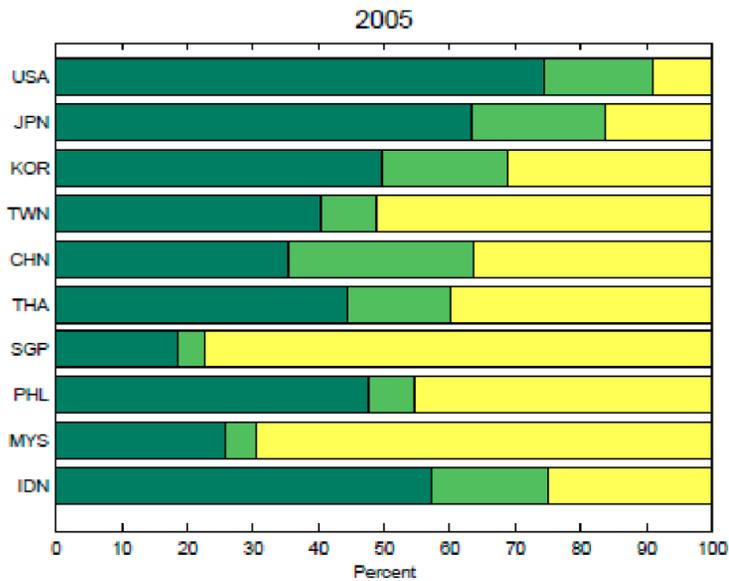
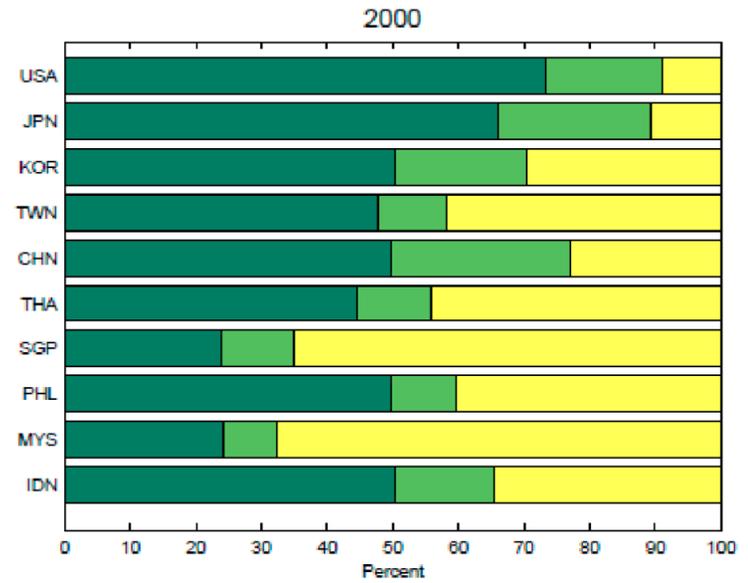
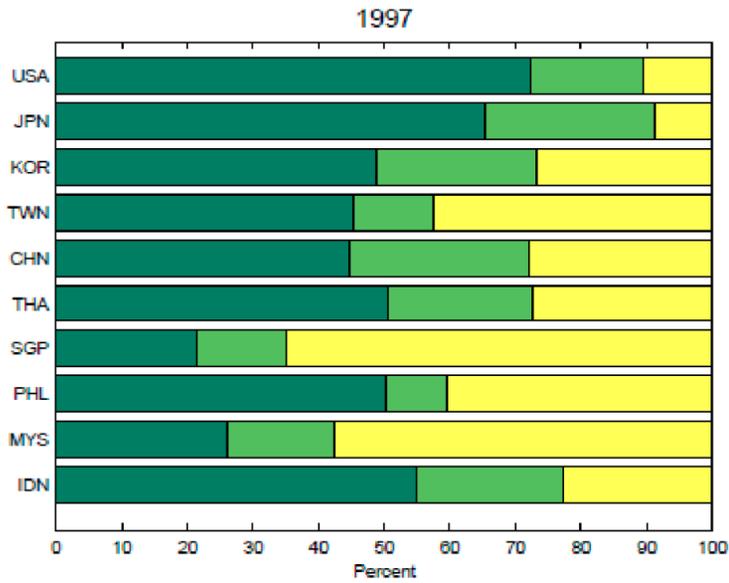


Figure 6. Demand Side: Domestic and External Exposure, ASEAN Economies

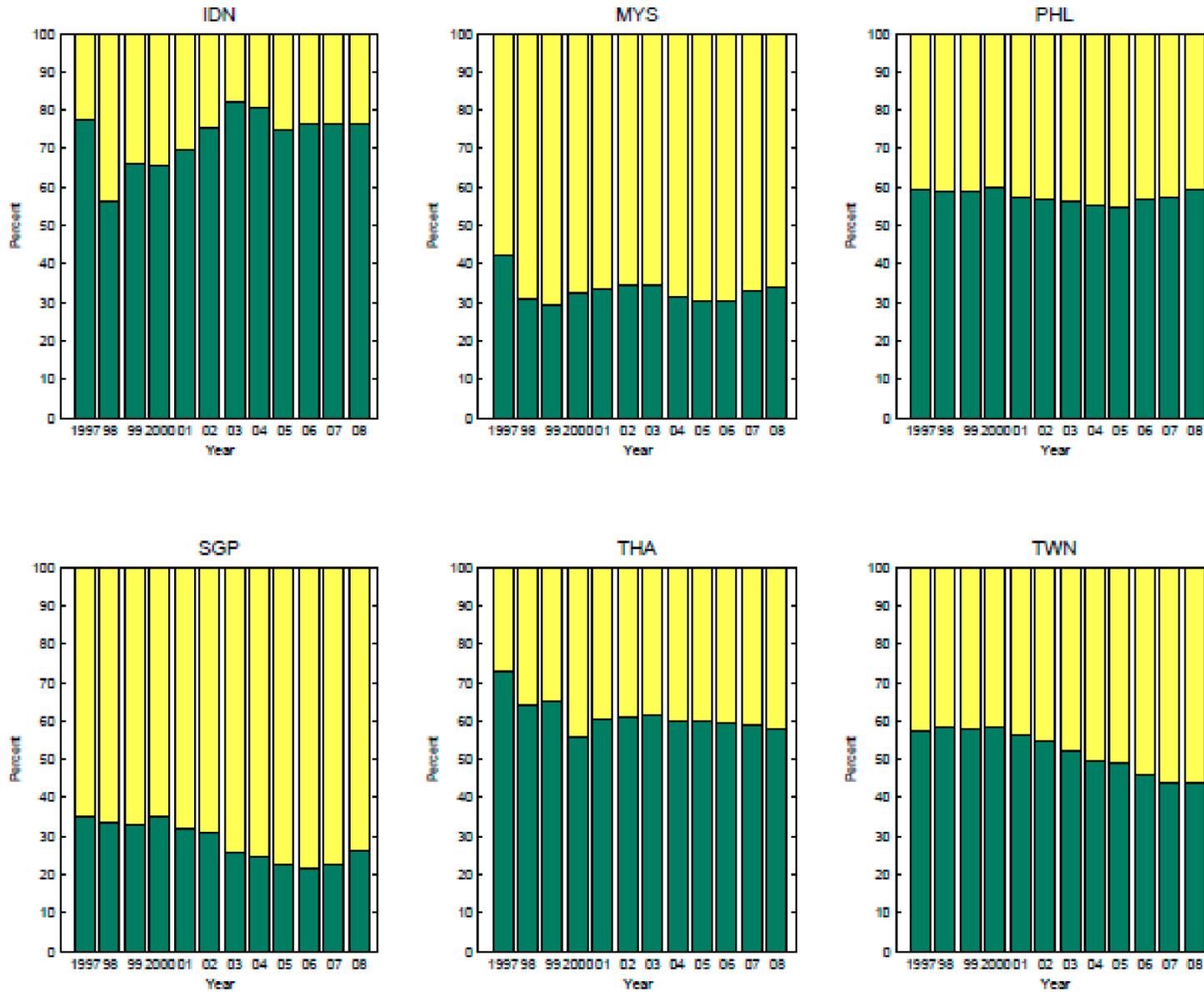


Figure 7. Demand Side: Domestic Exposure—Consumption and Investment, ASEAN Economies

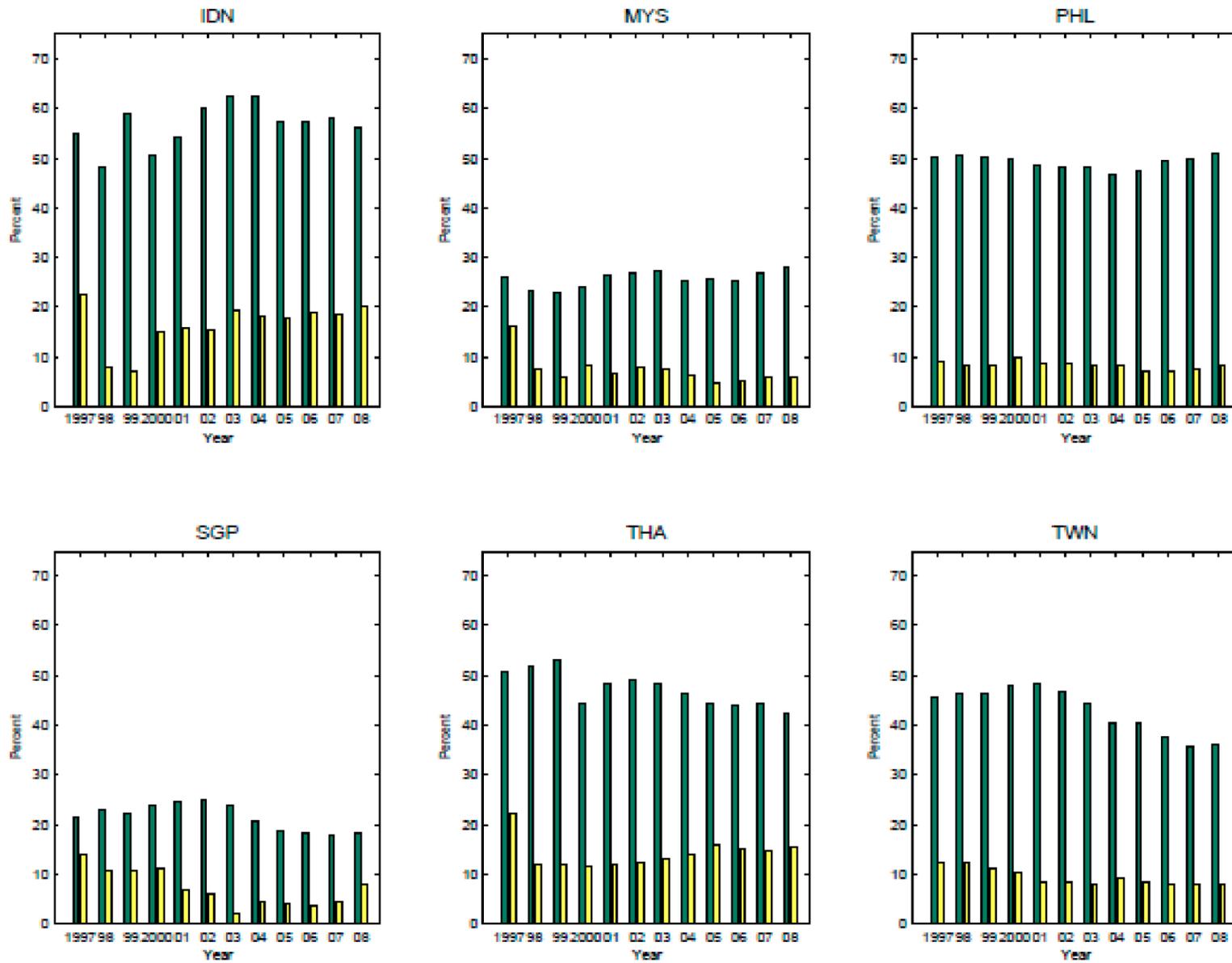


Figure 8. Demand Side: Exposure to External Final Demand, ASEAN Economies

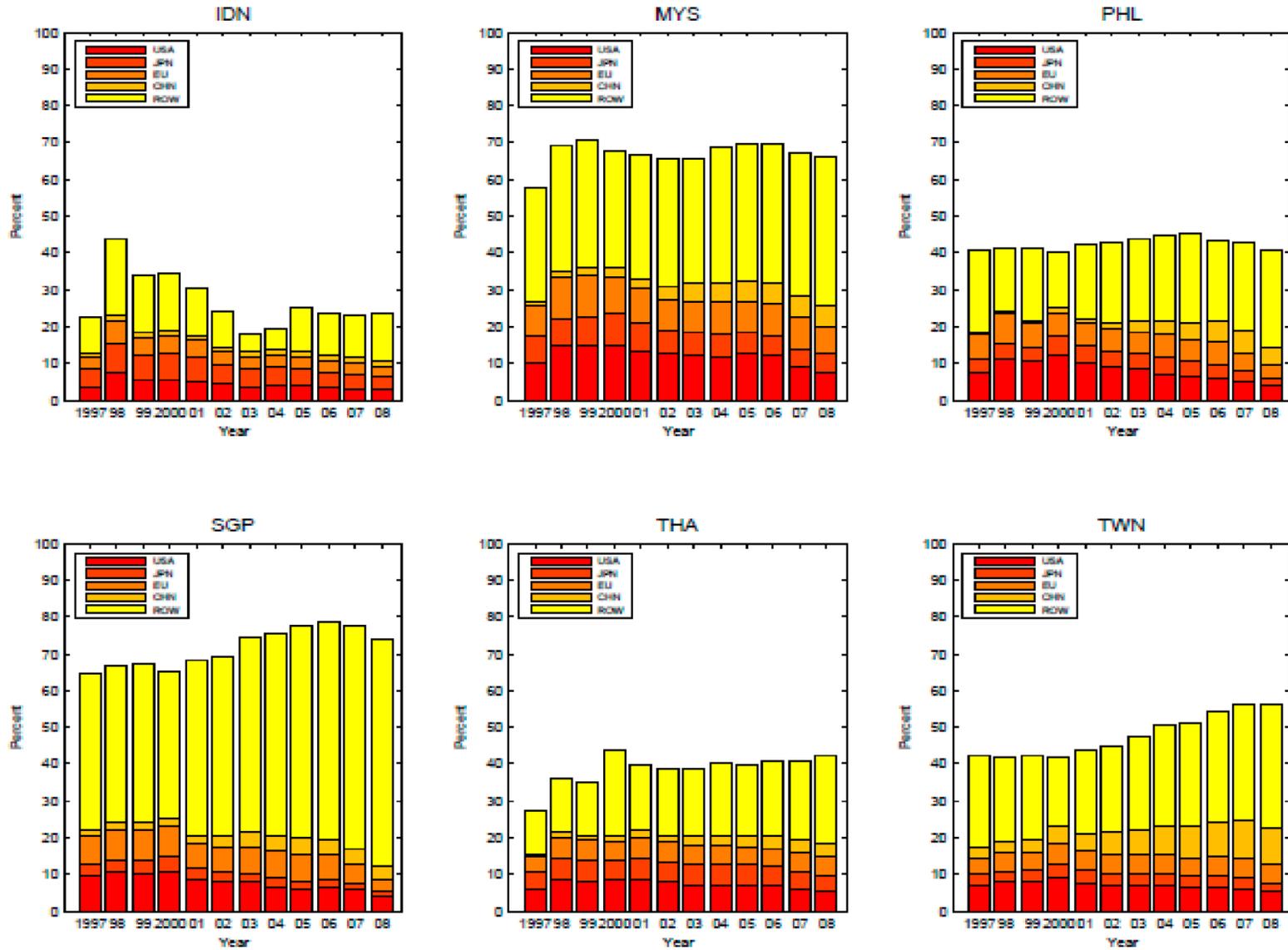


Figure 9. Demand Side: Domestic and External Exposure, Non-ASEAN Economies

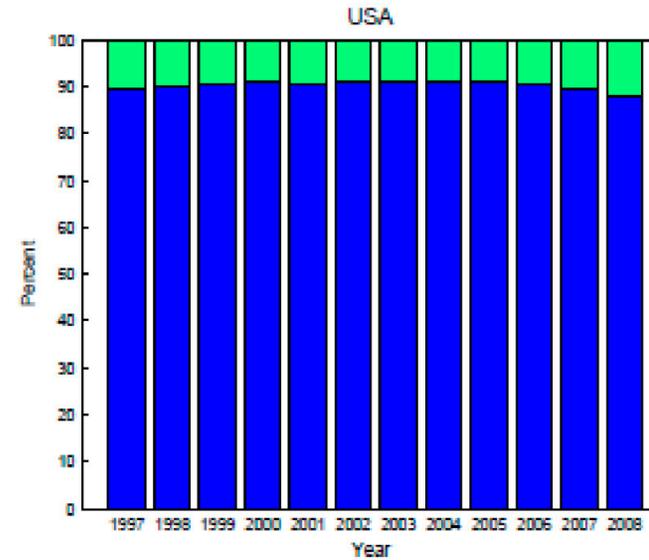
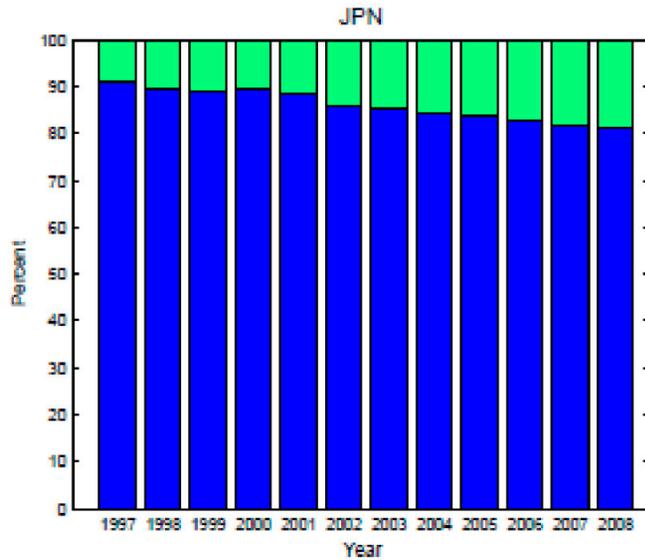
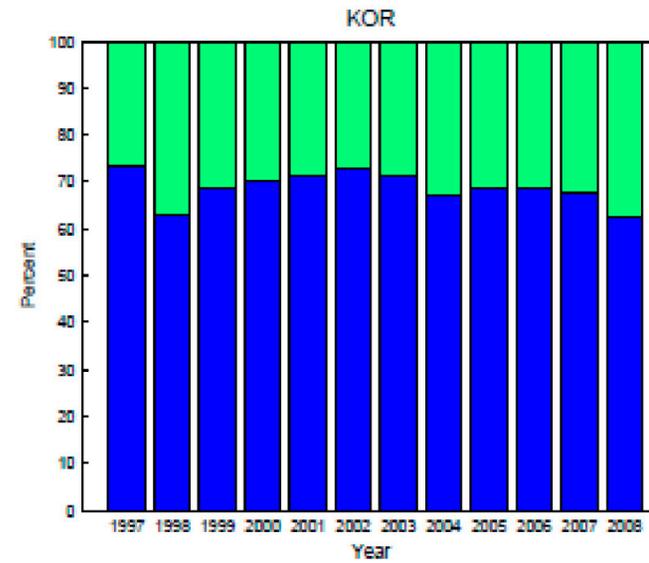
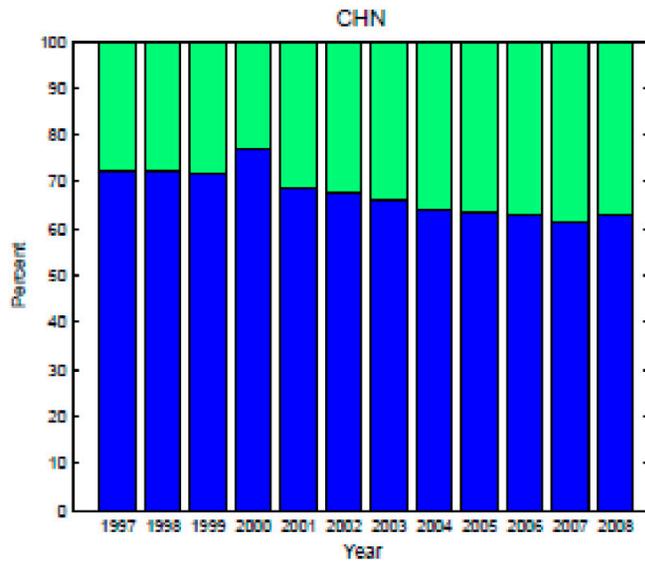


Figure 10. Demand Side: Domestic Exposure—Consumption and Investment, Non-ASEAN Economies

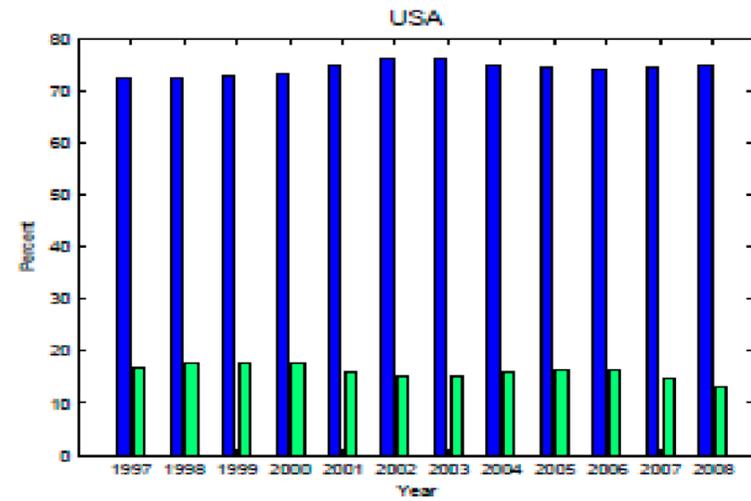
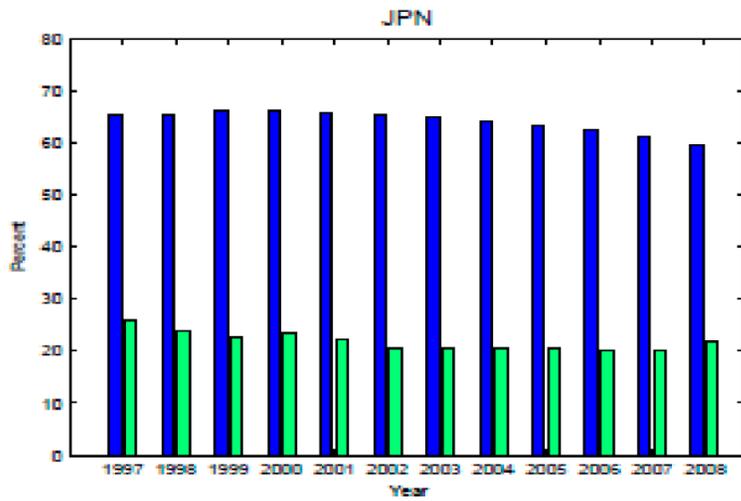
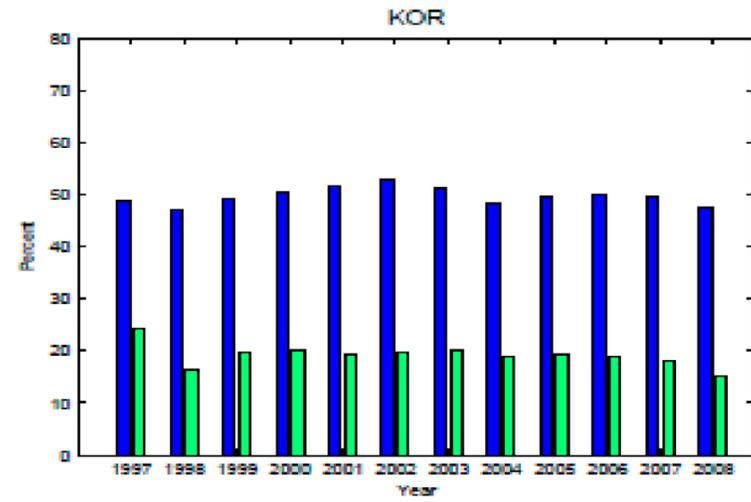
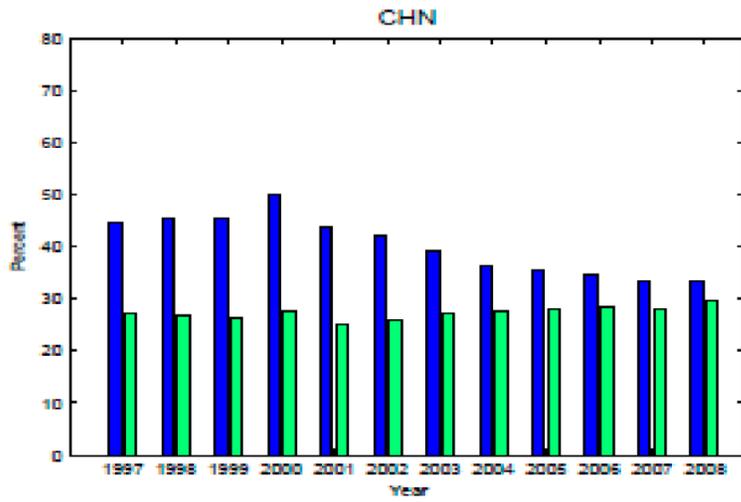


Figure 11. Demand Side: Exposure to External Final Demand, Non-ASEAN Economies

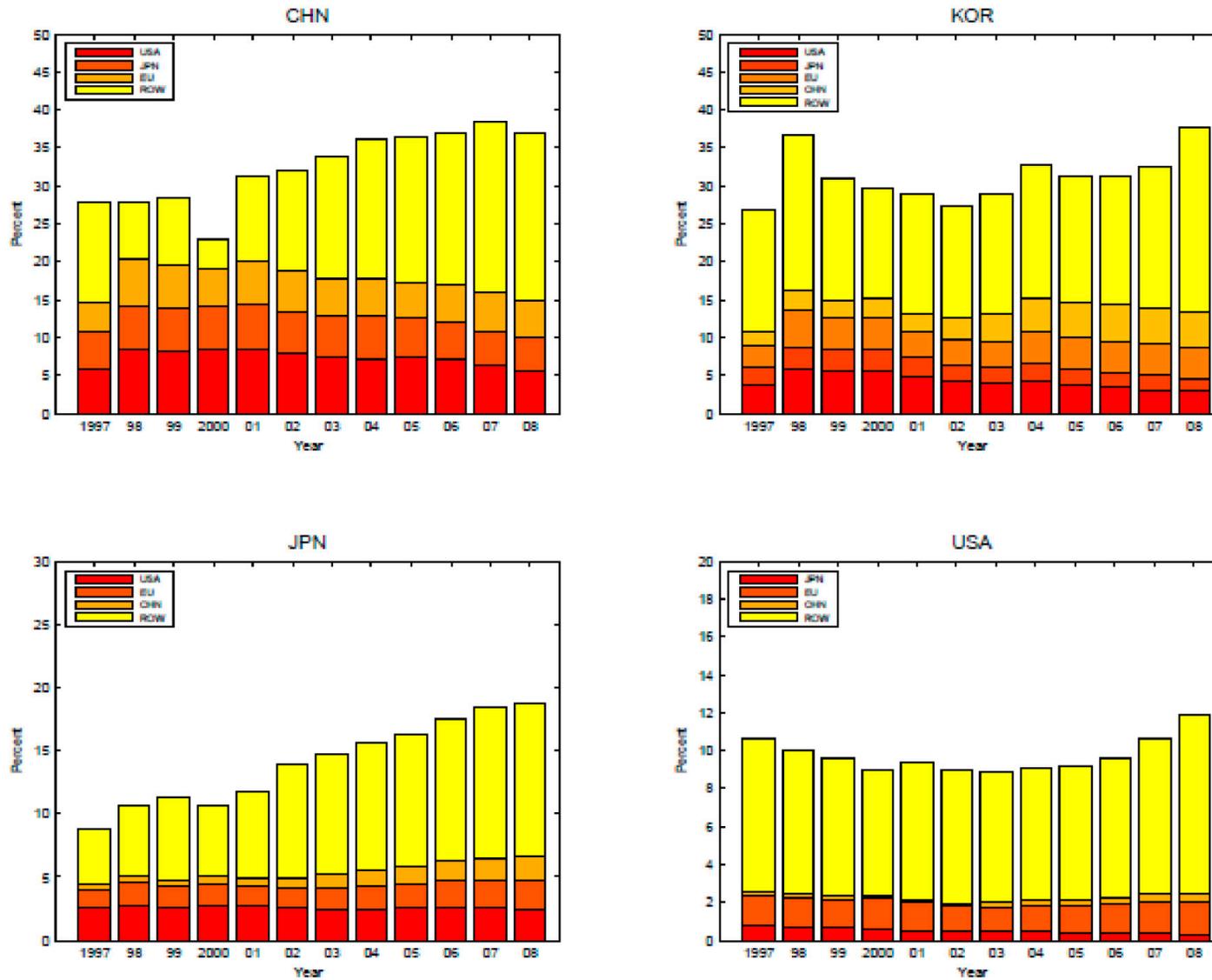


Figure 12. Supply Side: Output Shares of I/O Economies, 1997–2008

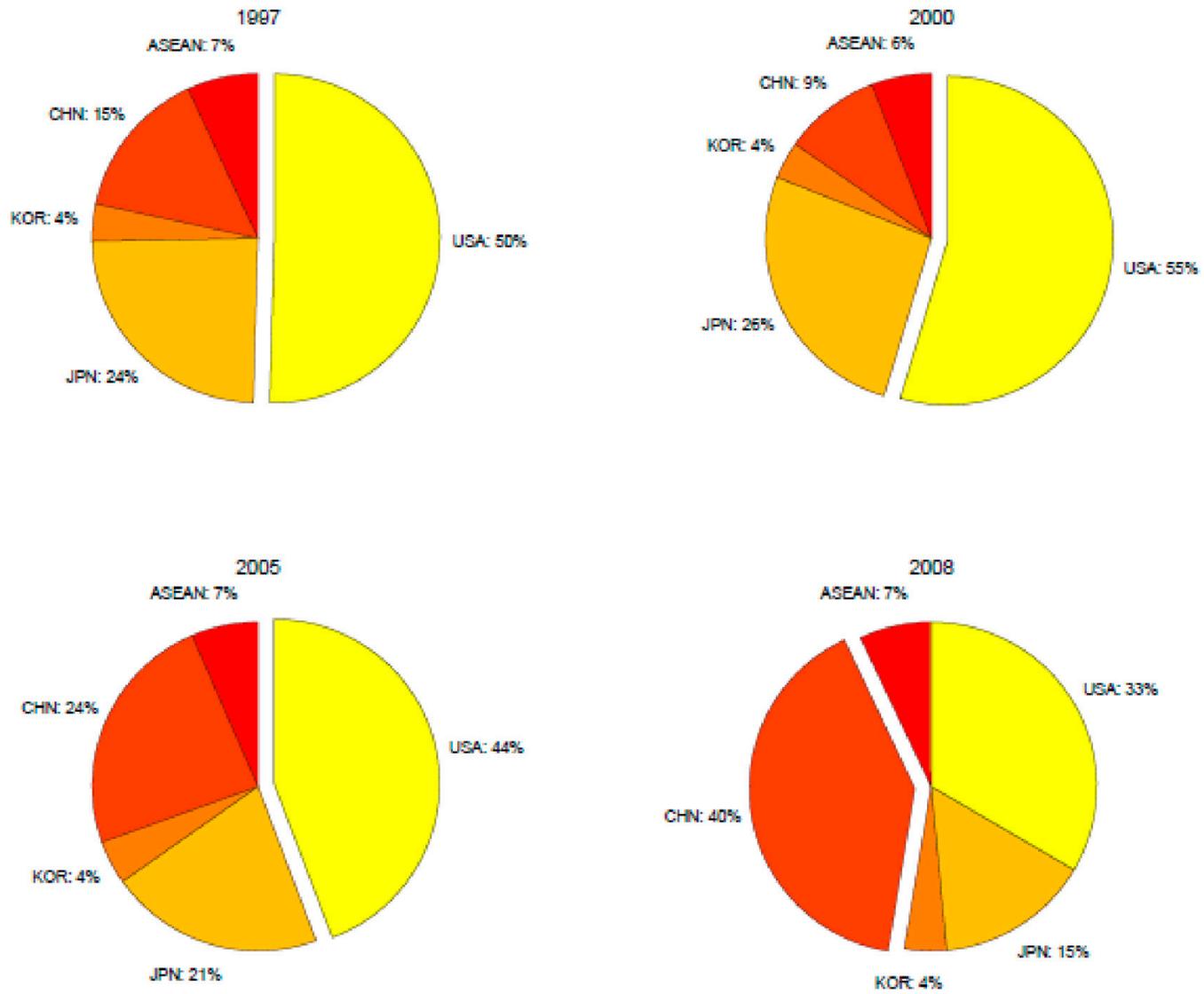


Figure 13. Supply Side: Value Added Shares of I/O Economies, 1997–2008

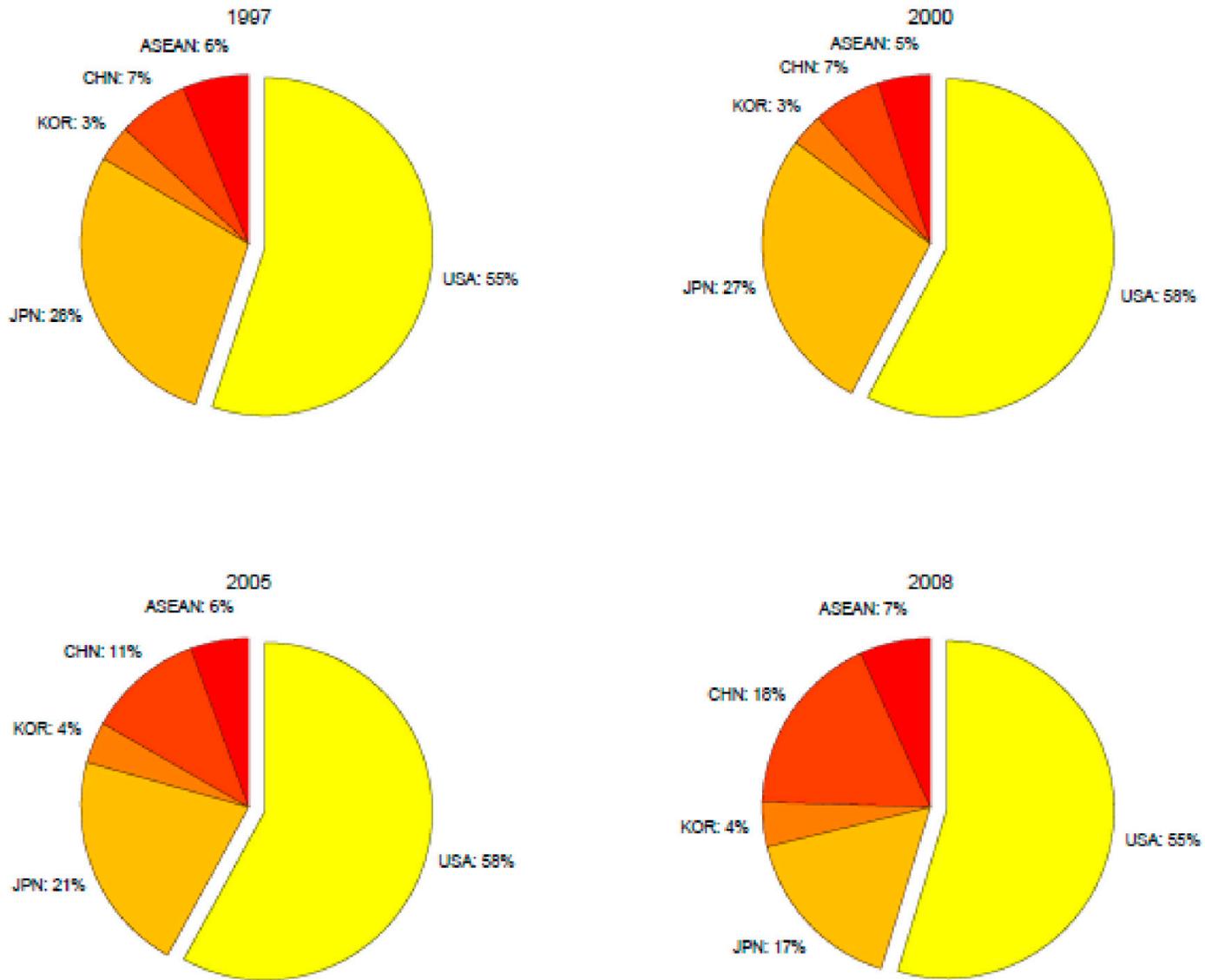


Figure 14. Supply Side: Ratio of Value Added to Output in I/O Economies, 1997–2008

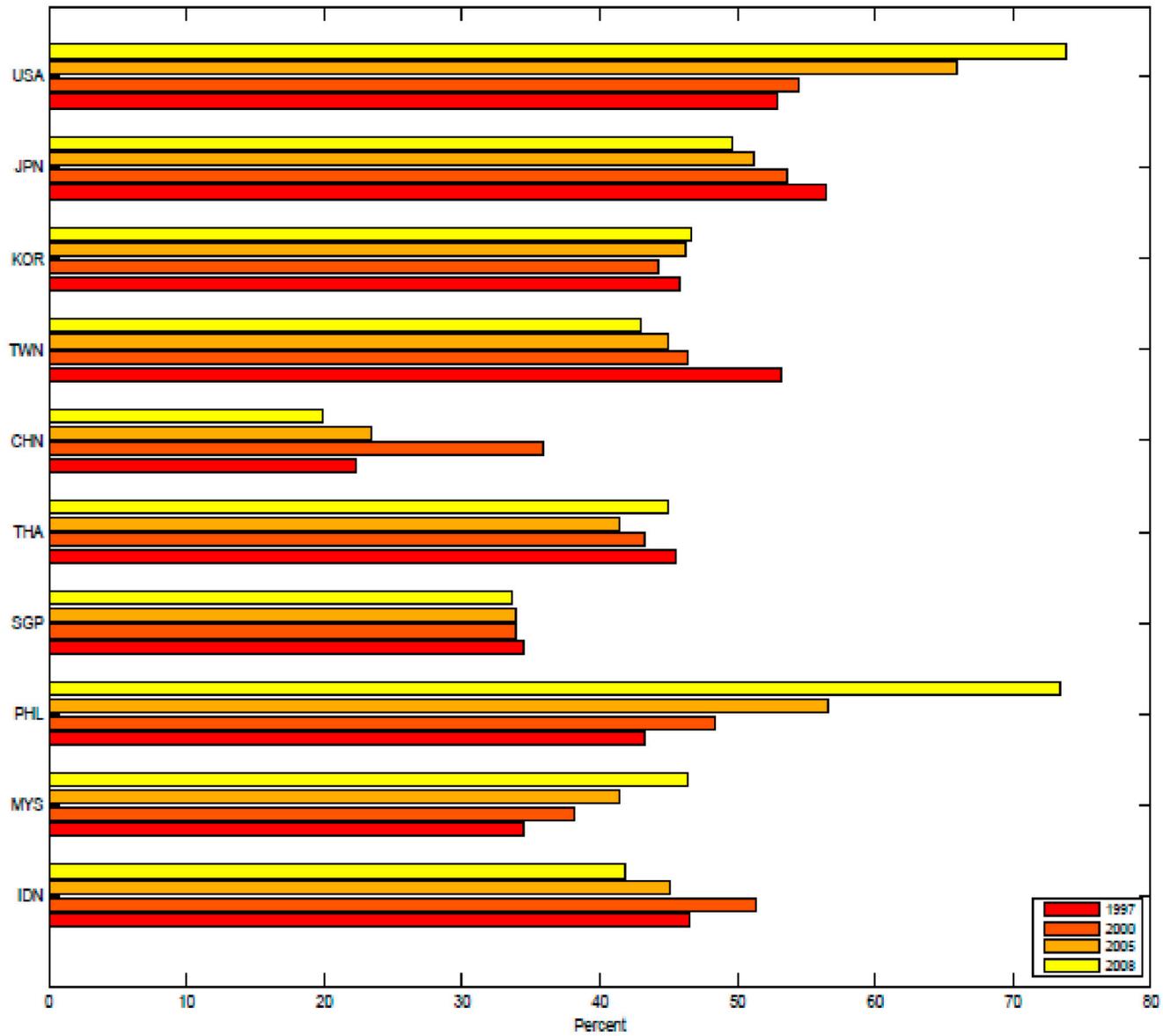


Figure 15. Supply Side: Sources of Intermediate Inputs, ASEAN Economies

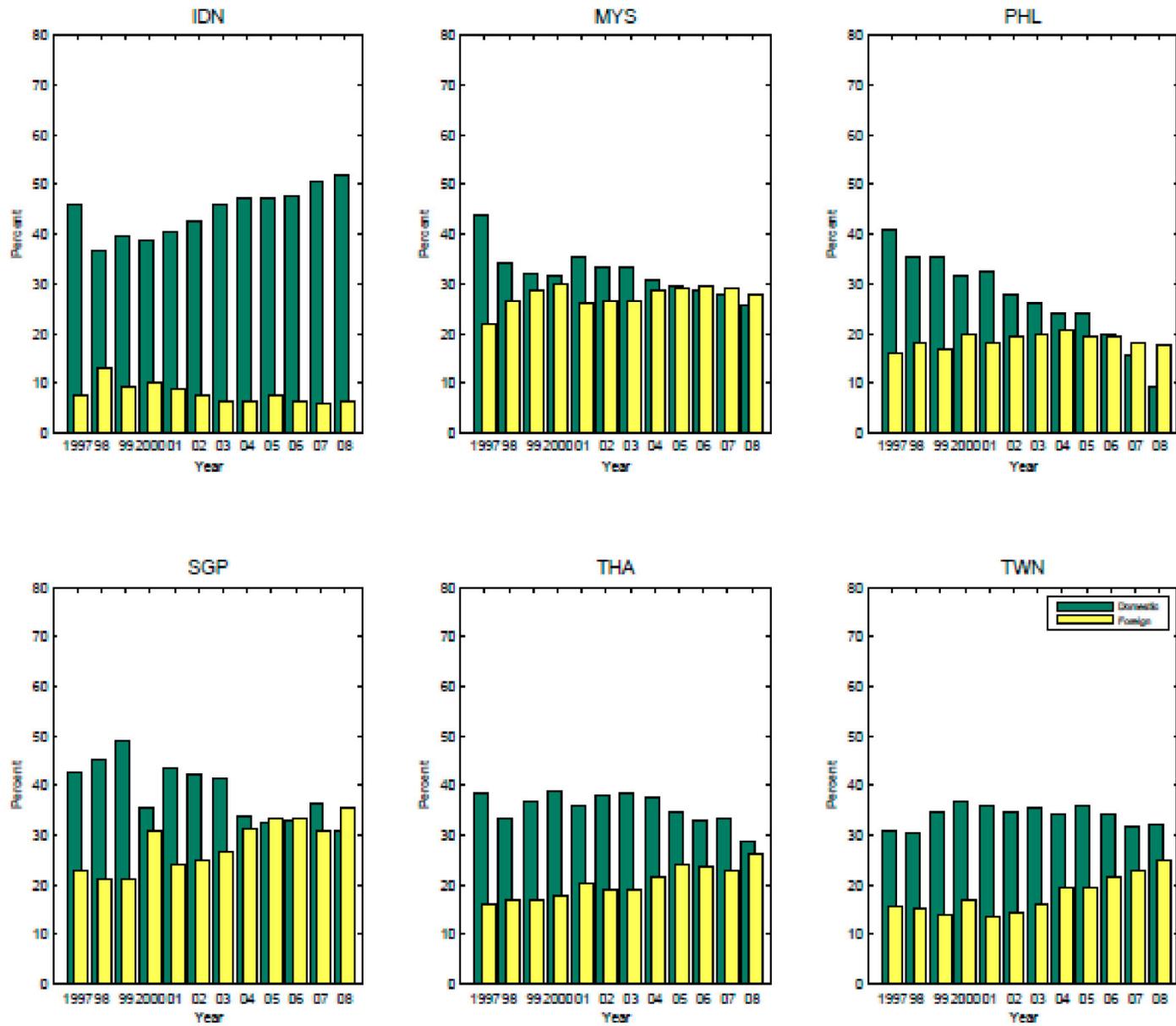


Figure 16. Supply Side: Sources of Intermediate Inputs, Non-ASEAN Economies

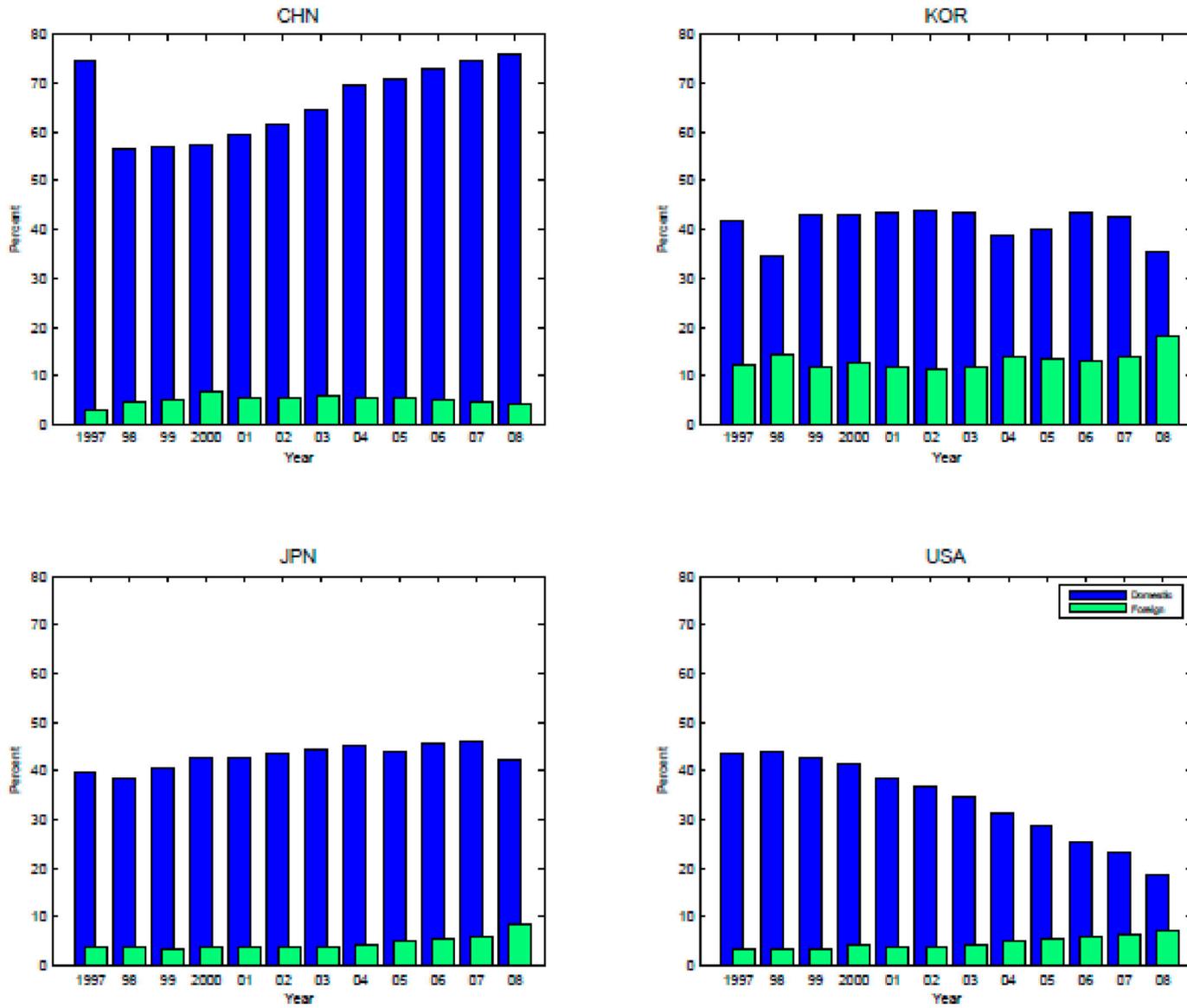
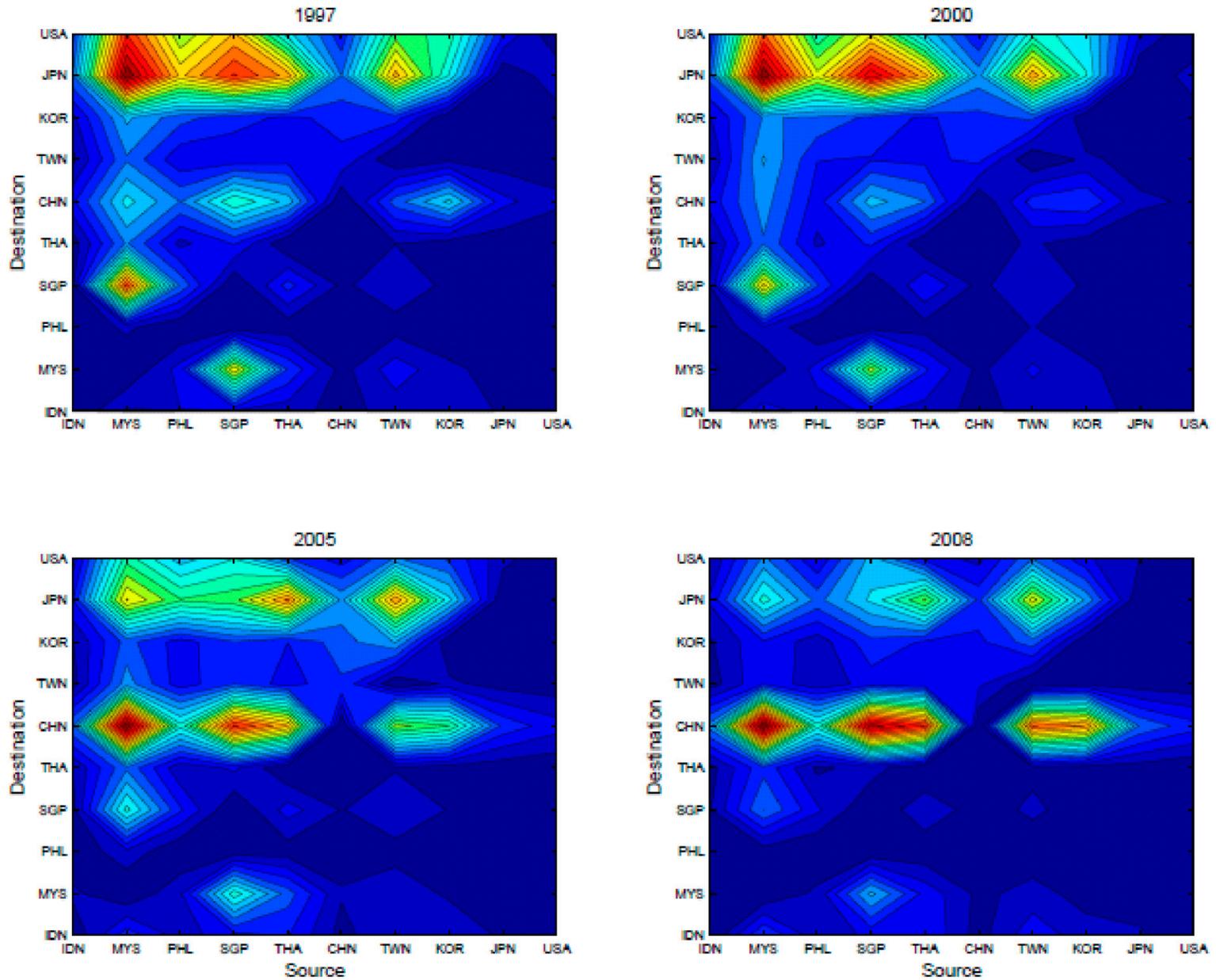


Figure 17. Production Integration in I/O Economies, 1997–2008



## Appendix

The updating procedure builds on Pula and Peltonen (2009). Broadly, the procedure involves taking the 2000 AIO table and extrapolating the entries using *nominal* growth rates. Figure 1 is a schematic representation of the Asian I/O table. The table can be divided into various blocks: intermediate demand (A), final demand (F), and exports (L). The elements in these blocks were updated as follows:

### *Intermediate demand (A)*

- Value added: Growth rates of value added are calculated from National Accounts data for each economy (data from CEIC).
- Total output: Since total output data for the AIO economies are not available except for the year 2000 (with the exception of the United States), the ratio of output to value added in the manufacturing sector of each economy is used as a proxy to estimate economy total output from GDP figures. Data on manufacturing value added are taken from National Accounts data, while data on manufacturing output is taken from industrial production data, (both taken from CEIC database).
- Imported inputs: For imported intermediate inputs, we update using two data sources. Firstly, National Accounts data on imports were used to estimate the growth rate of overall imports, including goods and services. Secondly, to capture changes in the direction of trade, COMTRADE data for intermediate goods are used. Since COMTRADE only covers merchandise trade, we assume that the change in imports by direction and type are similar for goods and services. Let  $i, j$  stand for source and destination economy, respectively. Then

$$\text{int } M_{t+1}^{*ij} / \text{int } M_t^{*ij} = (M_{t+1}^{NA} / M_t^{NA}) * \frac{(\text{int } M_{t+1}^{COMij} / \text{int } M_t^{COMij})}{(M_{t+1}^{COM} / M_t^{COM})}$$

where *int* stands for intermediate, *M* for imports, and the superscripts *NA* and *COM* for National Accounts and COMTRADE, respectively.

- Freight and insurance, import duties: We assume that their shares remain unchanged, and growth rates are set equal to the growth rate of total imports from National Accounts.
- Domestic intermediate inputs: This is estimated as the residual, equal to total imports less total imported inputs.

### Final demand (F)

Final demand for each economy is updated separately for consumption and investment.

- Consumption and investment: National Accounts data are used to update these series. Consumption is taken as the sum of private and government consumption expenditure, while investment is defined as the sum of gross fixed investment and inventories.
- Imported final goods and investment goods: growth rates are calculated as in the case of intermediate imports, replacing intermediate goods imports data with consumption and investment goods.

$$cM_{t+1}^{*ij} / cM_t^{*ij} = (M_{t+1}^{NA} / M_t^{NA}) * \frac{(cM_{t+1}^{COMij} / cM_t^{COMij})}{(M_{t+1}^{COM} / M_t^{COM})}, \text{ and}$$

$$capM_{t+1}^{*ij} / capM_t^{*ij} = (M_{t+1}^{NA} / M_t^{NA}) * \frac{(capM_{t+1}^{COMij} / capM_t^{COMij})}{(M_{t+1}^{COM} / M_t^{COM})}$$

where  $c$  stands for consumption and  $cap$  for capital goods.

- Freight and insurance, import duties: Same as intermediate block.
- Domestically produced final goods: Residual, estimated as total final consumption less sum of imported final goods, for each type of good.

### Export block (L)

Exports to Hong Kong SAR, EU15, and ROW are calculated in a similar manner, using both National Accounts and COMTRADE data. The formula is as follows.

$$(EX_{t+1}^{*ij} / EX_t^{*ij}) = (EX_{t+1}^{NA} / EX_t^{NA}) * \frac{(EX_{t+1}^{COMij} / EX_t^{COMij})}{(EX_{t+1}^{COM} / EX_t^{COM})}$$

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- Mori, T. and H. Sasaki, 2007, “Interdependence of Production and Income in Asia-Pacific Economies: An International Input-Output Approach,” Bank of Japan Working Paper No. 07-E-26.
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