

## Taiwan's Transition from an Industrializing Economy towards a Knowledge-based Economy

Shin-Horng Chen and Meng-chun Liu  
Chung-Hua Institution for Economic Research, Taipei

The trajectory of Taiwan's economic development towards export-oriented industrialization has been well documented. This traditional perspective no longer adequately accounts for the current economic reality in Taiwan, however. Instead, Taiwan is following the steps of the developed countries to evolve towards a knowledge-based economy (KBE).

Since knowledge is an intangible good, in its most basic form a KBE should be qualitatively different from an economy based on materials or manufactured goods. The greatest impact of the concept of a KBE may have been to stimulate the reorganization of world production. In a KBE, a firm's sustainable competitive advantage has to be built on its possession of knowledge rather than of primary inputs. In addition, the separation between innovation and production may become the norm because the two are increasingly organizationally disintegrated, leading to alliance capitalism. Therefore, it can be argued that a KBE undermines the basis for the formation of traditional oligopolies thus giving rise to rivalry among industrial networks formed from a multiplicity of firms aligned with different knowledge bases. It follows not only that innovations often result from the collective efforts of inter-related firms, but also that the value chain need not be completely internalized within a single firm. As a result, firms tend to build their sustainable competitive advantage on knowledge, by leveraging and aligning both their internal and external networks on an international scale.

In 1996 knowledge-based industries (KBIs) comprised 40.6% of Taiwan's economy ([Table 1](#)). This share was substantially smaller than the average for the OECD countries, but the share of KBIs in Taiwan increased 11.5% per year on average from 1991 to 1996 (in nominal terms), well above the 9.9% average growth rate for all industries combined. The lion's share of Taiwan's KBIs is found in the service sector, but these firms may not be so knowledge-intensive in an absolute sense, because in general service industries in Taiwan are low in information content ([Table 2](#)). By contrast, Taiwan performs much better in the knowledge-intensive manufacturing sectors. In particular, Taiwan's high-technology manufacturing sectors accounted for 19.5% of total manufacturing value-added, similar to their share in major OECD countries. Taiwan's knowledge-based manufacturers do not perform so well in technology trade, however, with six major knowledge-based manufacturing sectors suffering a deficit in international technology trade.

We adopt a multidimensional approach to evaluate Taiwan's progress as a KBE in an international context. Following OECD and APEC,<sup>1</sup> we collect some KBE-related indicators for 13 selected countries and group them under five broad categories: KBE economic structure, ICT infrastructure, knowledge investment, knowledge enterprises, and knowledge institutions. We use Principal Component Analysis to calculate a factor score for the sample countries for each category. In general, Taiwan does not compare favorably with the other countries on these KBE indicators, except in the category of knowledge institutions ([Table 3](#) and [Figure 1](#)). In terms of KBE economic structure, Singapore ranks highest among the 13 countries sampled, while Taiwan ranks only seventh. The United States outranks all the others in ICT infrastructure, where Taiwan ranks tenth. Similarly, Taiwan's rankings in knowledge investment (tenth) and knowledge enterprises (seventh) place it in the bottom half of the list. In knowledge institutions, however, Taiwan ranks second only to the United States. In order to become more knowledge-intensive Taiwan needs to take a systemic approach to raise its capabilities on all major KBE fronts.

We also present case studies on the PC and IC industries to throw light on the way in which Taiwan's IT hardware manufacturers are becoming more knowledge-intensive. The main thrust of these case studies is that in the manufacturing sector, the KBE can involve much more than high-technology production. Set against the background of globalization, these industries in

---

<sup>1</sup> OECD, *Science, Technology, and Industry Scoreboard 1999: Benchmarking Knowledge-Based Economies*, Paris: Organization for Economic Cooperation and Development, 1999 and APEC *The Promotion of Knowledge-Based Industries in the APEC Region*, Singapore: A sia-Pacific Economic Co-operation, 2000.

Taiwan are evolving from manufacturing-based subcontractors to become providers of integrated service packages. In this process, networking is important on two accounts. First, the long-standing contractual relationships between Taiwanese firms and global brand marketers has facilitated reciprocal and concurrent knowledge flows between the two sides and these flows in turn have helped build up the Taiwanese firms' capabilities. Together with outreach by Taiwanese PC firms, these capabilities have enabled the Taiwanese firms to shoulder the essential coordination functions in the global supply chain of their OEM customers. In the IC industry, cross-border ethnic social networks and the decentralized industrial structure have facilitated the formation of intensive industrial networks between Taiwan and Silicon Valley. Second, electronic networking is playing an increasingly important role in linking Taiwan's PC and IC firms to the global supply chain and in increasing their value-added.

IT hardware production is part of the knowledge-based economy, but the more important parts are software and applications. The traditional core of the Taiwanese IT story lies in the former, but more weight is now being given to the latter. However, Taiwan's performance in information application remains unimpressive compared to the performance of the United States, Japan, and Singapore. Having said that, our econometric analysis of output elasticities shows that IT services do have significant impacts on industrial productivity in Taiwan, especially in the manufacturing sector as a whole.

While Antonelli<sup>2</sup> tends to interpret such effects in the context of localized technological change and national innovation systems, we are reluctant to go so far in Taiwan's case given Taiwan's much smaller knowledge base. However, it suffices to say that IT significantly reduces the costs of communication and hence facilitates economic efficiency in transactions and production, which in turn promotes economic growth. In addition, our empirical results can be further discussed in the context of what Solow called the 'IT productivity paradox.'<sup>3</sup> In relation to this, Kraemer and Dedrick's<sup>4</sup> research showed no positive correlation between IT spending and productivity in a sample of Asian countries, compared to non-Asian countries. In contrast to these findings, our results prove that IT services in Taiwan have significant impacts on industrial productivity.

Nevertheless, on balance, Taiwan remains far below the apex of the international pyramid of a KBE. For one thing, brand marketers are in the driving seat of the global PC industry. To pursue the development of its own KBE, Taiwan needs to re-orient its economic activities to become more software- and service-based and to become more innovation-oriented.

---

<sup>2</sup> C. Antonelli, "Localized technological change, new information technology and the knowledge-based economy: The European Evidence," *Evolutionary Economics*, 1998.

<sup>3</sup> Solow once noted that he could see the impacts of IT everywhere, except in productivity. R. Solow, "We'd better watch out," *New York Times Book Review*, July 12, 1987, p. 37.

<sup>4</sup> K. Kramer and J. Dedrick, "Information technology in Southeast Asia: Engine of growth or digital divide," paper presented at the ASEAN Roundtable 2000, *New Development Paradigms in Southeast Asia: The Challenge of Information Technology*, Singapore: Institute of Southeast Asian Studies, October 12-13, 2000.

**Table 1: Growth of Knowledge-based Industries in Taiwan**

Unit: %

	Year	All Industries	Knowledge-based Industries	Knowledge-based Manufacturing Industries	Knowledge-based Service Industries
As a proportion of GDP	1991	100.0	37.7	6.1	31.7
	1994	100.0	39.2	5.7	33.5
	1996	100.0	40.6	6.8	33.7
Growth rate in value-added (nominal)	1991-94	9.8	11.2	7.6	11.9
	1994-96	10.2	12.1	20.5	10.6
	1991-96	9.9	11.5	12.6	11.3

*Note:* Knowledge-based manufacturing industries include aerospace, computer and data-processing equipment, pharmaceuticals, telecommunications, semiconductors, scientific instruments, automobiles, electrical equipment, chemical products, machinery, other transport equipment. Knowledge-based service industries include transport and storage, communication services, finance, insurance, and real estate, commercial services, and social and personal services.

*Source:* Council for Economic Planning and Development, based on Input-Output Tables.

**Table 2: Distribution and Growth of Manufacturing Sectors by Technology Intensity (selected countries)**

Unit: %

	High		Upper Medium		Lower Medium		Low	
	1997 share	1991-97 growth	1997 share	1991-97 growth	1997 share	1991-97 growth	1997 share	1991-97 growth
	U.S.A.	16.0	1.37	31.9	2.91	21.7	1.63	30.4
Japan	14.7	0.03	34.1	0.32	27.6	0.17	23.9	-0.41
Germany	9.7	-4.59	38.0	-1.69	32.1	-0.61	20.2	-3.09
France	12.2	0.61	28.8	0.14	28.8	-0.23	30.2	0.07
UK	13.9	-0.08	30.7	1.35	21.1	0.66	34.3	0.60
Korea	18.5	3.81	29.0	1.14	30.9	-2.23	21.6	-5.96
Taiwan	19.5	11.79	25.2	3.01	34.0	1.23	20.9	-1.95

*Source:* Wu, Rong-I, 'Competitiveness Analysis of Taiwan's Industrial Technology', paper presented at the Conference on the Measurement of Industrial Technology Competitiveness in the Knowledge-Based Economy, Taipei, 23-24 August 2000.

**Table 3: Principal Component Analysis of KBE Indicators for Selected Countries**

	KBI	ICT	K investment	K enterprises	K institutions
Australia	-1.13	0.54	-0.63	-0.92	0.05
Canada	-0.54	2.10	-0.50	-0.59	0.98
France	-0.49	-0.15	0.90	-0.58	-1.13
Germany	-0.68	0.02	0.78	0.16	-0.71
Italy	-1.73	-2.16	-2.19	-1.86	-0.60
Japan	-1.05	-1.78	1.97	1.09	-1.95
Korea	-0.78	-2.63	-1.56	-0.48	-2.01
Netherlands	1.83	1.06	0.28	-0.26	0.79
Singapore	3.89	-0.51	-1.33	-0.09	-0.04
Sweden	0.90	1.58	3.35	1.43	-0.28
UK	0.44	0.00	-0.49	-0.60	0.69
US	-0.15	3.27	0.35	3.09	3.09
Taiwan*	-0.51 (7)	-1.36 (10)	-0.93 (10)	-0.38 (7)	1.11 (2)

*Note:* \* Figures in parentheses denote Taiwan's ranking among the 13 countries.

Figure 1: Comparison of Japan, Korea, United States, and Taiwan in KBE-related Indicators



