Journal of Management and Social Sciences
Vol. 2, No. 2, (Fall 2006) 111-143

High Tech Competitiveness: Spotlight on Asia

Alan L. Porter[*][1]
Xiao-Yin Jin[*]
Nils C. Newman[*]
David M. Johnson[*]
J. David Roessner[*]
Lawrence Rausch[*]
Derek Hill[*]

ABSTRACT

Beginning in the late 1980's the Technology Policy and Assessment Center (TPAC) at Georgia Tech has been measuring the capability of nations to compete in technology-enabled exports. The resulting "High Tech Indicators" (HTI) contribute to the U.S. National Science Foundation (NSF) Science & Engineering Indicators[1].Our focus has been on the rapidly industrializing countries; we include a number of highly developed countries as benchmarks.

In the early days, the inclusion of a number of Asian nations as potential high tech competitors to the Organisation for Economic Co-operation and Development (OECD) seemed somewhat whimsical. Obviously, the U.S., Japan, and the leading Western European countries were far-removed from the up-and-coming Asian economies. That is no longer the case. In this report, we profile the emergence of the Asian nations as bonafide global competitors. To do so, we emphasize longitudinal comparisons from 1993 through 2005 using our traditional HTI measures for 10 Asian countries plus the U.S. as a benchmark, with selected comparisons to the full set of 33 HTI countries. We then offer a new perspective for 2005 based on our newly formulated statistical HTI measures.

JEL Classification : 033; 057;

Keywords : Rate of Technological change; High Technology Indicators; Competitiveness Ranking

---

[*] The material presented by the authors does not necessarily portray the viewpoint of the editors and the management of the Institute of Business and Technology (BIZTEK).

[*] Alan L. Porter is Co-director of the Technology Policy and Assessment Center (TPAC), Professor Emeritus of Industrial & Systems Engineering (ISyE), and of Public Policy, School of Public Policy, Georgia Tech, Atlanta, e-mail:alan.porter@isye.gatech.edu.
[*] Xiao-Yin Jin is Research Associate at TPAC, Georgia Tech, 685 Cherry Street, Atlanta, e-mail:j.xiyiu@isye.gatech.edu.
[*] Nils C Newman is President of the Intelligent Information Services Corporation (IISC), Atlanta, USA, e-mail:newman@iisco.com.
[*] David Johnson is a Student of the School of Industrial and System Engineering., Georgia Tech., e-mail:gtg846g@mail.gatech.edu.
[*] J. David Roessner is Co-director of TPAC, Professor Emeritus of Public Policy, Georgia Tech, Dr., Prescott, USA, e-mail:david.roessner@pubpolicy.gatech.edu.

---

[1]Support for the current indicators has been provided by the Science Indicators Unit, Science Resources Studies Division, National Science Foundation under Contract D050144. [Any opinions, finding, and conclusions are those of the author and do not necessarily reflect the views of the National Science Foundation.

1) BACKGROUND: NATIONAL TECHNOLOGICAL COMPETITIVENESS INDICATORS

National competitiveness is mainly, in deed, technology-based competition. Science and technology constitute the most dynamic and decisive factors in the new productive forces. They have become an important means of raising labor productivity and a substantial cornerstone for the edifice of a modern economy. We believe that science and technology will be the core of national competitiveness in the future [c.f., Antonelli et al.(1997), Archibugi. et al. (1998), Clark et al. (1998), Grupp (1995), OECD (2001, 2000), Porter and Cunningham (2005)], The World Competitiveness Yearbook (WCY 2006).

Several national competitiveness indicators, attuned to technological capabilities, have emerged (c.f., Roessner et al., 2002). The U.S. Council on Competitiveness Innovation Index helps assess the strengths of 25 national innovation systems (Porter and Stern, 1999). The World Competitiveness Yearbook ["WCY," published annually by the International Institute for Management Development (IMD), Lausanne, Switzerland] ranks the ability of some 60 nations to provide an environment that sustains the competitiveness of enterprises. The Commission on Science and Technology for Development (CSTD, 2002) of the United Nations Conference on Trade and Development (UNCTAD) reviewed various national technological competitiveness indicators as it devised "Indices of Technological Development" for over 200 countries in 2002 [www.unctad.org/Templates/Page.asp?intItemID=2696&lang=1 -- see "indicators; CSTD, 2002].

Additional initiatives explore ways to measure technological competitiveness. Mani (2000) keyed on exports of high technology products to gauge high tech competitiveness. Many researchers have used patent data to get at 'revealed technology advantage' and other competitiveness metrics (c.f., Patitt et al., 1980; Eaton et al., 1996, Griliches, 1990). Kleinknecht et al. (2002) consider the non-straightforward association of "input" factors (UNIDO calls "drivers") to desired "outputs" (technology-based products and services -- UNIDO calls "performance" indicators). A conference focused on quantitative methods of measuring technology competitiveness in the emerging knowledge-based economy (Taiwan Institute of Economic Research, 2000). HTI are situated in this milieu that seeks to measure status and prospects of countries' technology-based productive capacities to inform industrial, trade, and policy deliberations.

2) GEORGIA TECH'S HIGH TECH INDICATORS

Our recent report (Porter et al., 2006) relates the evolution of HTI, citing our series of papers that related methods and findings (c.f., Roessner et al., 1988, setting forth the model and initial results; Porter et al., 2001, on time series comparisons). We draw upon the time series of the traditional HTI for 1993, 1996, 1999, 2003, and 2005 herein. HTI has been computed every three years from 1987 through 2002. [The two earlier HTI sets, 1987 and 1990, are too different from the succeeding series to include in considering trends.] In 2002 we shifted to naming the indicators according to the year in which they appear (2003) instead of the year in which most of the data are reported (2002). In 2005, we shifted to a two-year reporting cycle.

Our model was developed explicitly to forecast technological competitiveness for emerging economies. It posits four "Input" indicators:

National Orientation (NO) -- Evidence that a nation is undertaking directed action to achieve technological competitiveness. Such action can be manifested at the business, government, or cultural levels, or any combination of the three.

Socioeconomic Infrastructure (SE) -- The social and economic institutions that support and maintain the physical, human, organizational, and economic resources essential to the functioning of a modern, technology-based industrial nation.

Technological Infrastructure (TI) -- Institutions and resources that contribute directly to a nation's capacity to develop, produce, and market new technology.

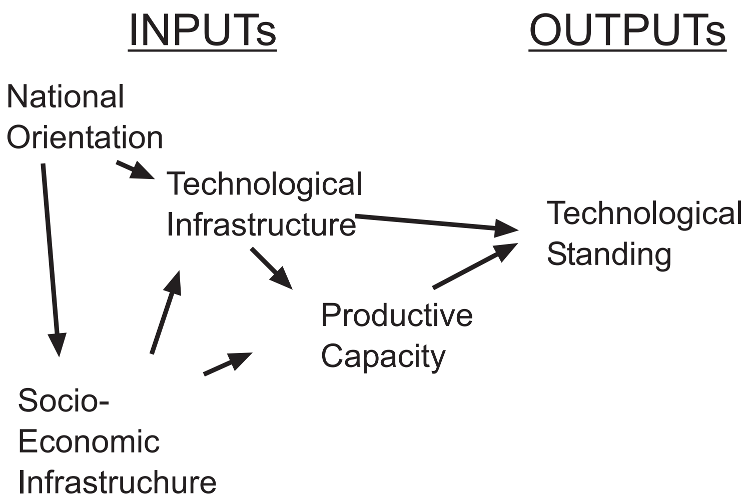
Productive Capacity (PC) -- The physical and human resources devoted to manufacturing products, and the efficiency with which those resources are used.

We also sum these four indicators to report a composite "INPUT" indicator. We hypothesize that these are leading indicators for our "Output" indicator:

Technological Standing (TS) -- An indicator of a country's recent overall success in exporting high technology products.

Our initial model simply postulated that the four Inputs should drive Output (technology-based competitiveness) on the order of 15 years out. Figure 1 presents a somewhat refined causal model in which NO and SE are more indirect (more distant) influences, while TI and PC are more proximate (more immediate) ones. We are just now accumulating sufficiently long time series to assess whether the model works. These results suggest a further refinement to consider that both the strength and the degree of positive change in each of the four leading indicators likely contributes to emerging national competitiveness. This model is for industrializing nations. It does not try to predict future export strengths for the highly developed economies, although one would generally expect some relationship there as well.

Figure: 1
HTI Causal Influences



Each of these five indicators blends statistical data with expert opinion questions that address important components of the indicators that are hard to get at using available statistical series. For HTI-05, expert opinion was gathered via a web survey[at http://tpac.gatech.edu/]. Figure 2 shows 1 of 14 topical questions as posed. We obtained 361 usable responses (at least 9 for each of our countries, with the sole exception of 6 for Australia).

Figure :2
Sample Question Posed to Experts (a Technological Infrastructure item)

The conceptual definitions of the traditional indicators remain consistent, even as we now transition to statistics-only components. The Appendix provides full details on the composition of the indicators and the data sources used.Ê Raw data are transformed to "S-scores." Each indicator component is scaled from 0 to 100 and then averaged to generate comparable indicators on this range. For survey items, 100 represents the highest response category for a question; for statistical data, 100 typically represents the value attained by the country with the largest value among the target country set. Thus, this is a relative scaling so that an apparent low score, or decline over time, is only relative to the other countries. The S-Scores and Ranks for these 10 Asian Nations derive from our full set of 33 countries.

Our 2005 HTI Report (Porter et al., 2006) presents the updated traditional HTI and the current reformulation of the indicators toward statistics-only HTI. Statistics-only HTI were initiated in 2003, based on assessment of HTI performance and the desirability of better reflecting competitiveness in knowledge-oriented economies (Porter et al., 2004). These were generated again in 2005. We report here on those 2005 results, but contrasts with the 2003 results are not in order because many of the measures are static over this two-year span. The statistics-only HTI draw on a broader repertoire of secondary statistical measures than do the traditional HTI. They better address technology-enabled service ("knowledge") facets, in addition to measures pointing toward export of manufactured products. They, thus, provide new perspectives on evolving global competitiveness in technology-enabled goods and services.

Country coverage has expanded from 20 in 1987 to 33 since 1999. Along the way East and West Germany were combined and Hong Kong subsumed into China, with Russia replacing the USSR. Added in 1996 were Poland, Venezuela, and South Africa; and in 1999, Ireland, Israel, and the Czech Republic. So, not all HTI values are available since 1993. Coverage in HTI-05 is for:

- North America – United States, Canada, Mexico
- Latin America – Argentina, Brazil, Venezuela
- Europe – Czech Republic, France, Germany, Hungary, Ireland, Italy, Netherlands, Poland, Spain, Sweden, Switzerland, UK
- Asia – China, India, Indonesia, Japan, Malaysia, Philippines, Singapore, South Korea, Taiwan, Thailand
- Others – Australia, Israel, New Zealand, Russia, South Africa

This paper focuses on the 10 Asian nations, along with the U.S., with selected contrasts for all 33 countries. We first present changes from 1993 to 2005 using the traditional HTI.

We then shift to consider the situation as of 2005 using the statistics-only HTI. Finally, we offer interpretations and implications.

3. TRANSITION: EMERGENCE OF ASIAN TECHNOLOGICAL COMPETITIVENESS, 1993-2005

The essential data for this report reside in Tables 1 and 2. These include the specific traditional HTI values from 1993 through 2005, and the statistics-only HTI for 2005. We provide these as a resource for those interested in specific values. That said, we will use discrete figures to spotlight comparisons of special interest as we go.

High Tech Indicator Values for 10 Asian Countries + the U.S.: 1993-2005

Table :1
Input, National Orientation, Socio-economic Infrastructure

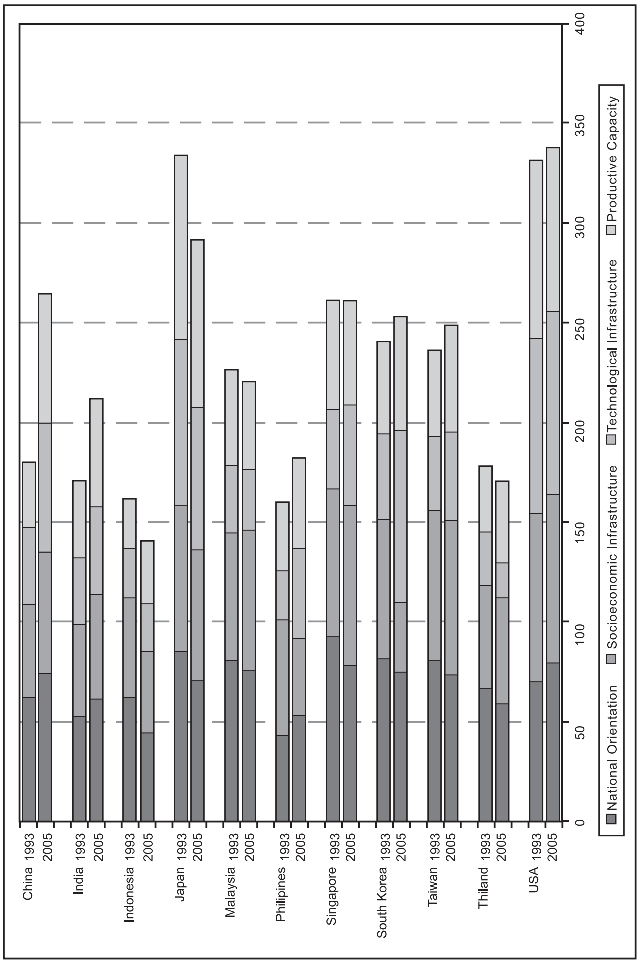
	INPUT=Sum of NO + SE + TI + PC						National Orientation						Socio-Economic Infrastructure					
COUNTRY	INPUT-93	INPUT-96	INPUT-99	INPUT-03(T)	INPUT-05(T)	INPUT-05(S)	NO-93	NO-96	NO-99	NO-03(T)	NO-05(T)	NO-05(S)	SE-93	SE-96	SE-99	SE-03(T)	SE-05(T)	SE-05(S)
USA	331.2	344.8	349.6	341.7	337.9	353.5	70.0	75.5	78.4	79.8	79.3	82.4	84.0	85.1	87.0	86.4	84.2	78.4
China	180.4	182.0	205.6	222.8	264.8	192.3	62.3	65.3	65.5	63.0	74.3	75.3	46.4	44.8	52.7	55.0	60.4	59.8
India	170.4	192.0	219.2	196.6	212.0	84.0	52.4	57.4	68.5	62.5	61.6	56.8	46.4	46.0	50.0	49.3	52.8	21.0
Indonesia	162.0	127.2	138.8	132.6	141.1	78.8	62.5	54.8	55.1	45.1	44.2	56.2	49.5	35.2	42.2	39.1	40.8	19.6
Japan	334.4	312.4	304.4	297.6	291.4	225.2	85.3	73.8	79.5	76.4	70.3	75.1	72.7	62.3	63.2	67.0	65.5	42.0
Malaysia	226.4	218.8	202.8	205.9	220.7	91.9	81.1	81.0	69.7	73.0	75.4	65.2	63.7	62.7	58.2	64.9	70.4	16.1
Philippines	160.8	220.4	178.0	183.3	182.4	56.6	43.1	75.1	63.8	59.4	53.2	36.7	57.6	63.4	55.6	55.0	52.9	16.4
Singapore	261.2	259.6	249.2	272.4	261.1	131.5	92.7	88.4	87.2	83.8	78.5	74.3	73.5	75.7	71.2	84.2	79.6	38.6
South Korea	240.4	238.4	241.6	259.0	252.5	149.4	81.9	78.9	74.9	80.4	74.7	65.8	69.7	64.6	73.5	81.1	72.7	52.0
Taiwan	236.0	259.2	262.0	272.2	248.9	125.4	81.1	90.2	90.7	83.0	73.6	72.1	74.5	76.3	74.2	84.4	77.2	29.1
Thailand	178.8	173.6	148.4	156.7	170.4	89.0	67.5	63.5	50.8	47.7	58.7	65.2	51.0	48.7	46.5	54.2	53.2	18.1

Table :2
Technological Infrastructure, Productive Capacity, Technological Standing, Current & Future High Tech Production Capability

	Technological Infrastructure						Productive Capacity						Technological Standing						Expert Opinion: Perception of	
COUNTRY	TI-93	TI-96	TI-99	TI-03(T)	TI-05(T)	TI-05(S)	PC-93	PC-96	PC-99	PC-03(T)	PC-05(T)	PC-05(S)	TS-93	TS-96	TS-99	TS-03(T)	TS-05(T)	TS-05(S)	Current Hi Tech Production Capability-05	Future Hi Tech Production Capability-05
USA	87.5	94.8	96.1	92.7	91.9	92.7	89.8	89.4	88.1	82.8	82.5	100.0	90.0	91.4	95.4	93.9	82.9	91.2	43.6	42.1
China	38.6	39.3	46.5	55.2	64.7	23.8	33.2	32.8	41.0	49.6	65.4	33.5	20.7	22.5	44.2	49.3	73.9	42.3	35.8	45.8
India	33.0	39.3	48.3	37.0	43.2	2.7	38.6	49.1	52.4	47.8	54.5	3.5	13.5	18.3	20.8	17.9	20.0	4.6	32.7	44.6
Indonesia	25.3	17.8	18.2	20.7	24.1	0.8	24.8	19.6	23.2	27.7	32.0	2.3	11.0	11.2	14.0	14.0	14.2	1.7	24.4	34.4
Japan	83.7	81.7	78.3	73.9	71.1	51.1	92.7	94.4	83.4	80.3	84.4	57.1	90.8	94.0	82.7	81.6	73.1	44.6	47.5	47.5
Malaysia	34.3	31.9	31.0	28.8	31.4	4.0	47.5	43.1	44.2	39.2	43.5	6.5	24.3	28.2	30.8	32.8	35.8	14.0	32.0	43.0
Philippines	25.2	35.7	21.9	24.0	31.2	1.3	34.9	46.2	36.7	45.0	45.1	2.2	12.6	14.9	15.0	19.7	23.2	4.4	31.4	34.3
Singapore	40.5	41.6	37.4	46.7	50.3	12.4	54.6	54.0	53.4	57.7	52.7	6.2	35.8	46.7	51.5	52.4	47.7	21.6	37.0	44.0
South Korea	42.6	44.4	44.6	45.3	48.0	16.0	46.4	50.6	48.8	52.3	57.1	15.7	28.7	32.6	32.7	40.1	45.2	18.5	38.0	46.0
Taiwan	37.4	43.0	43.6	45.3	43.7	16.5	43.0	49.9	53.7	59.6	54.3	7.6	27.0	31.5	35.2	39.3	37.9	14.3	36.9	40.8
Thailand	26.8	28.2	20.5	23.9	25.0	2.0	33.4	33.1	30.6	30.9	33.4	3.7	17.2	18.1	16.6	20.0	21.1	6.3	26.7	35.6

We begin our story with the 1993 HTI results. Figure 3 shows INPUT values as of HTI-93. Note that INPUT is the sum of four indicators whose theoretical range is from 0-100, thus its theoretical maximum is 400. Again, this is a relative scaling to help compare these countries. [The discrete values are available in Tables 1 and 2.] As of 1993, Japan was #1 in the world on the composite INPUT indicator (nudging ahead of the U.S.). The "Asian Tigers"3 – Singapore, South Korea, and Taiwan – follow, but well behind Japan. Note that, even then, these rapidly advancing Asian economies INPUT indicators compare to the leading Western European ones.

Figure :3
Comparison of Asian INPUT Scores, Breakout: 1993 and 2005 (Traditional)

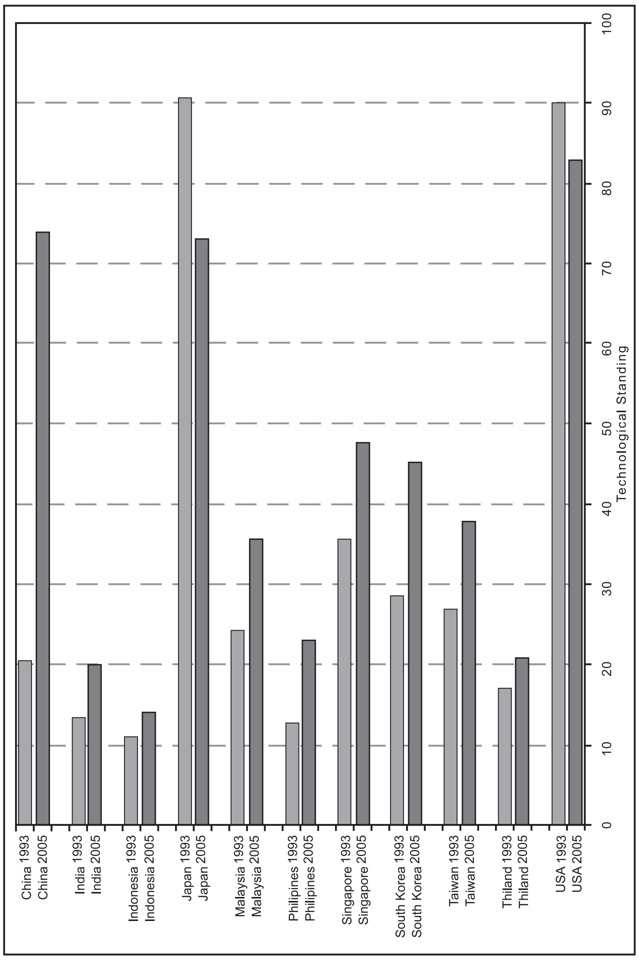


Of the "Asian Cubs," Malaysia leads, trailing in INPUT just behind the Tigers. Note that China and India do not show great strength in these measures. Based just on INPUT scores, one would not have predicted the explosive rise of China as a technology-intensive competitor.

[3] Hong Kong, the fourth Tiger, was included in HTI-93, but we prefer to focus here on the present set of HTI nations. The HTI-93 report is available at //tpac.gatech.edu for anyone wishing to explore such country variations.

Figure 4 presents our Output indicator, Technological Standing (TS), as of 1993. Again, Japan leads the world (just a touch ahead of the U.S.). The three Tigers trail far back, followed by Malaysia. Notice the huge range with Japan at 91, followed by the Tigers at 27-36. Comparing to Western Europe, we see the leaders – Germany the UK, and France (ranging from 46-61) – as well ahead of the Tigers. On the other hand, the Tigers are quite comparable to the next tier of European powers that HTI addresses – The Netherlands, Switzerland, Italy, Sweden -- (28-35).

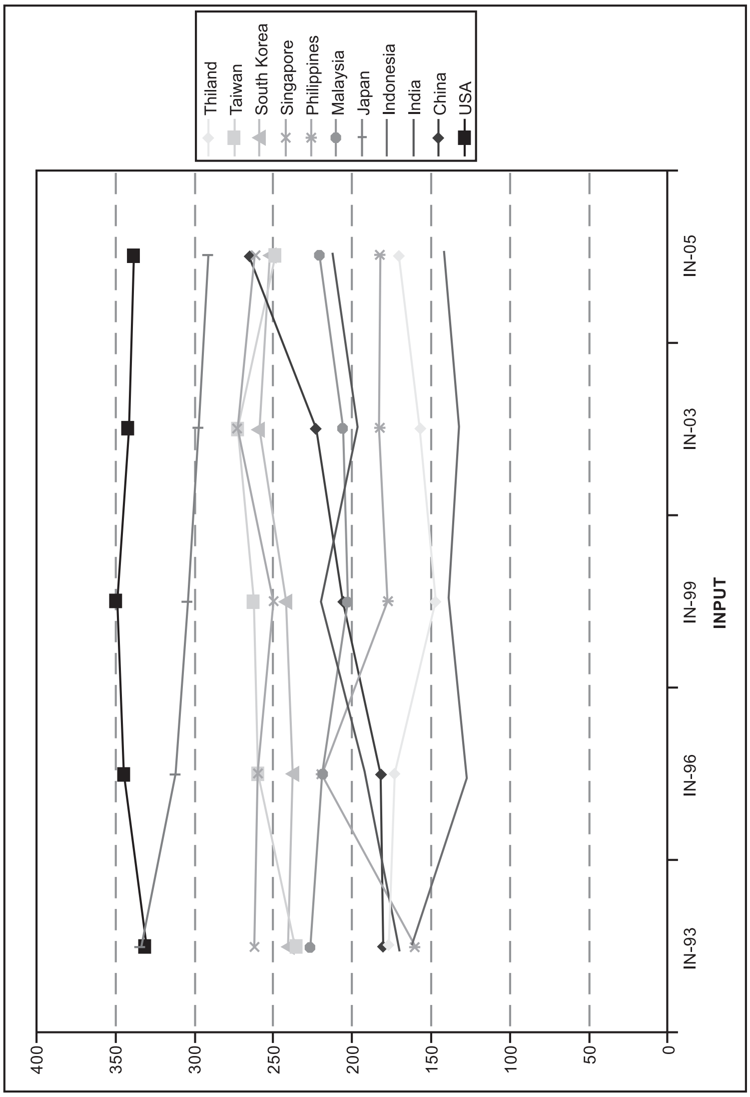
Figure :4
Comparison of Asian Technological Standing Scores: 1993 and 2005 (Traditional)



Our next series of charts tracks the changes in the traditional HTI from 1993-2005.
Figure 5 INPUT 93-05
Figure 6 NO 93-05
Figure 7 SE 93-05
Figure 8 TI 93-05
Figure 9 PC 93-05
Figure 10 TS 93-05

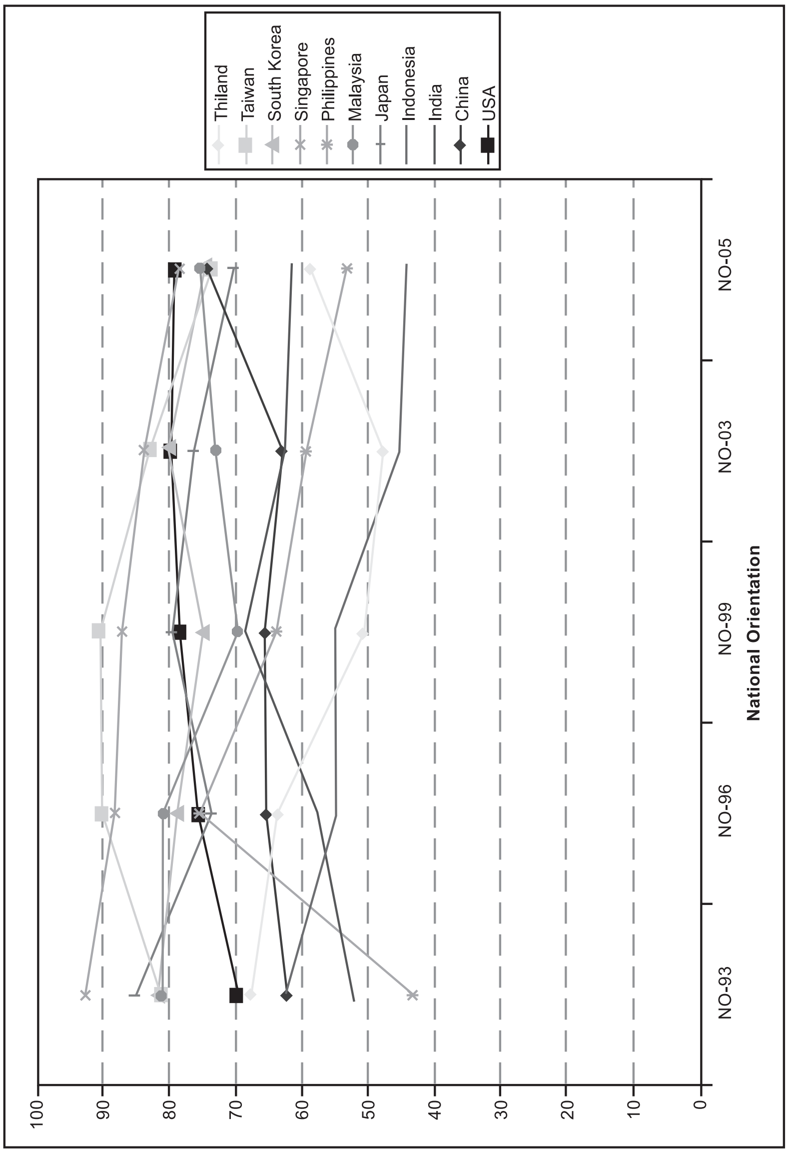
Figure 5 shows how INPUT has evolved from 1993 to 2005.

Figure :5
Input Scores: 1993-2005 (Traditional Input Scores: 1993-2005 (Traditional)



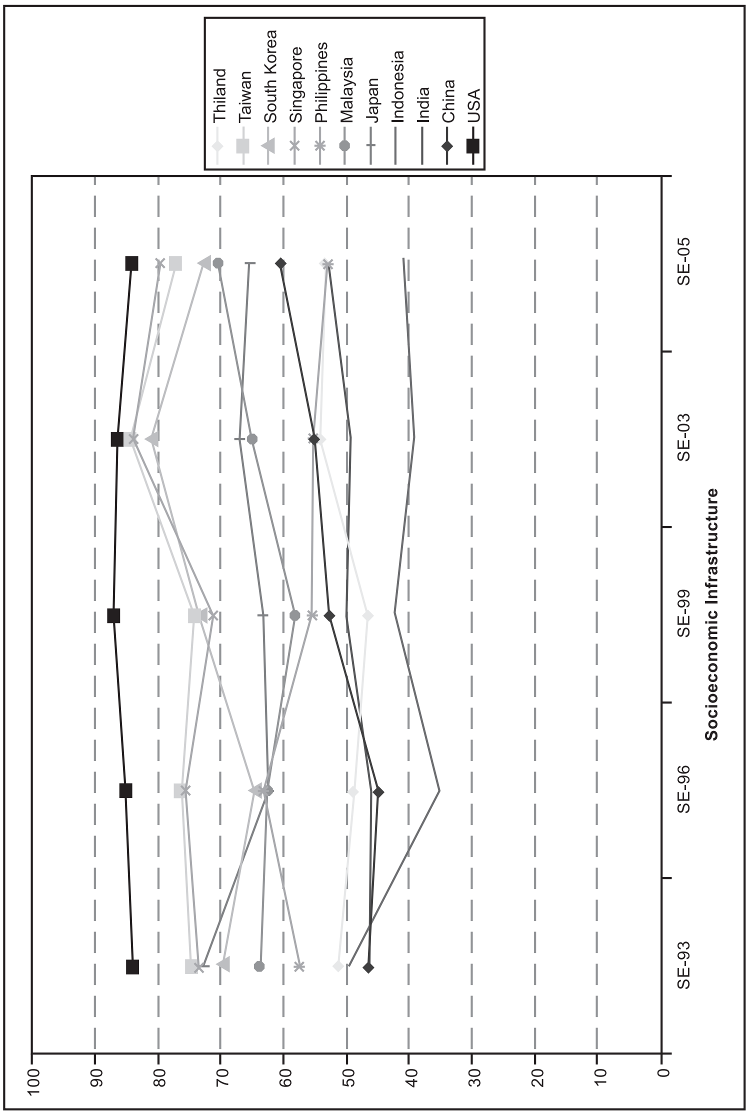
National Orientation concerns a country's commitment to develop technology-based capacity. Figure 6 shows the progression of the Asian 10. The most recent values show strong commitment from the three Tigers plus Malaysia, Japan, and China. All are within striking distance of the U.S. [The global leaders among our 33 countries is Sweden at 80.] Over time, since 1993, three countries have increased their NO score by about 20% -- The Philippines (which started very low) and China and India. One country has decreased most notably – Indonesia.

Figure : 6
National Orientation: 1993-2005 (Traditional)



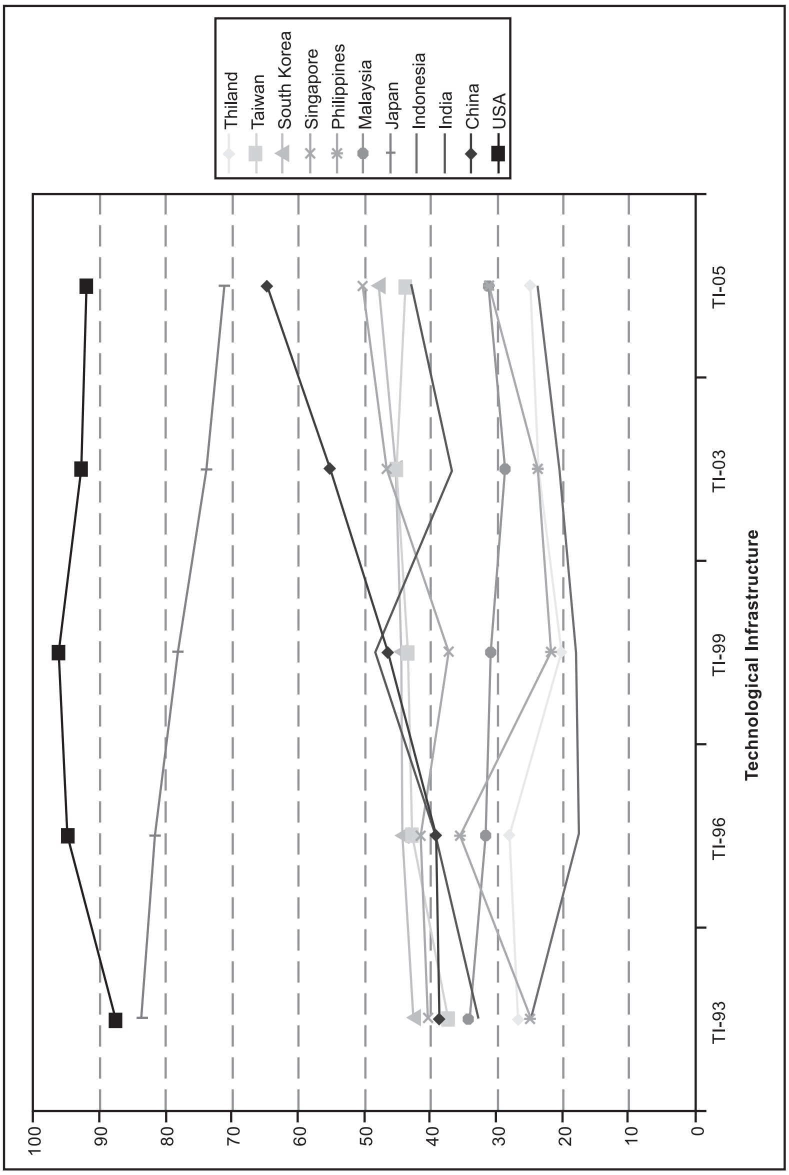
SE reflects a country's socio-economic infrastructure deemed useful in effecting technologically based economic capabilities. Our global benchmark is Israel at 86. The Asian Tigers show strongly (73-80), as does Malaysia (70). Japan is a little lower at 66, having slipped somewhat since 1993. China follows. Comparing countries between 1993 and 2005, most hold quite steady (which makes sense for such infrastructure). We see the largest drop for Indonesia. By far the largest increase is for China (30%), followed by India (14%).

Figure : 7
Socioeconomic Infrastructure: 1993-2005 (Traditional)



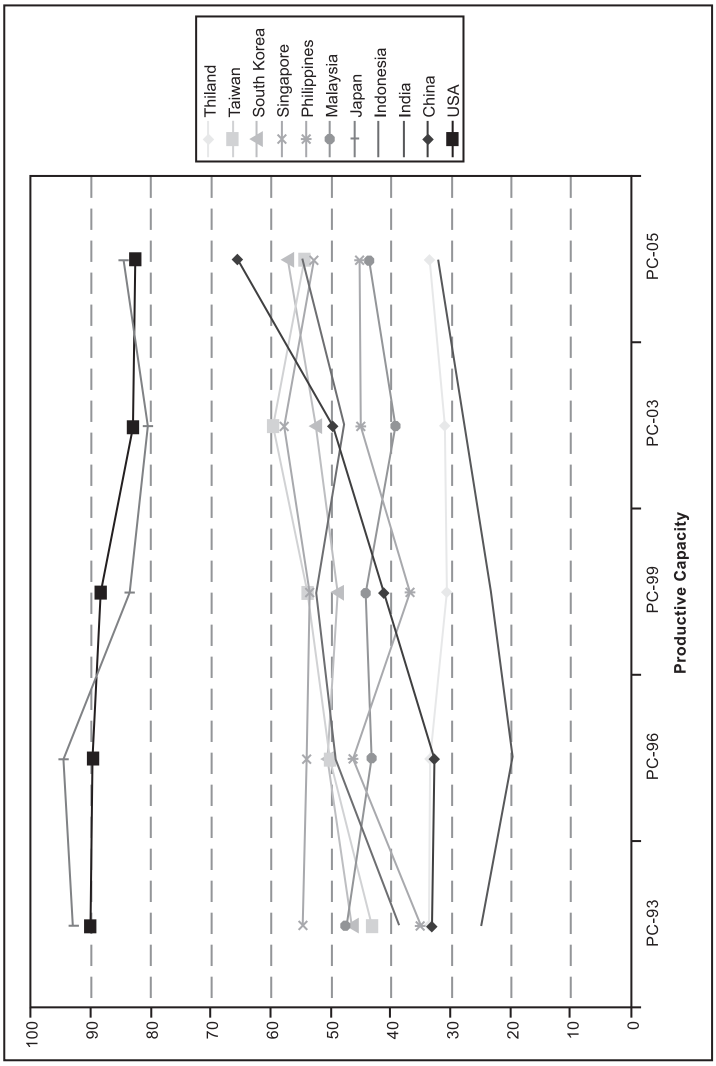
TI and PC appear more closely linked to technology-enabled products (and services), as per Figure 1. Technological Infrastructure finds the U.S. as the benchmark leader for 2005 (scoring 92). Japan remains in second place, although it has slipped since 1993 (again, these indicators are relative). China follows in Asia at 65 and, strikingly, also for the full set of 33 countries. China's rise since 1993 (67% increase) also leads all of these nations. Most nations have remained fairly stable. In Asia, notable increases show for India (31%), Singapore and The Philippines (24%), Taiwan (17%) and South Korea (13%). The Philippines' increase is from a very low base. Interestingly, Malaysia which showed nearly at the level of the three Tigers on NO and SE, and has invested heavily in its Multimedia Corridor and related technological initiatives, does not show strongly on TI.

Figure :8
Technological Infrastructure: 1993-2005 (Traditional)



On PC, productive capacity relating to technology-intensive goods, Japan leads the world (scoring 84), followed closely by the U.S. (83), with a substantial drop to Germany in third position (71), and then China (65). A number of substantial competitors, including the leading Western European countries and the Asian Tigers, score in the 50's. Also, now in this range is India. In terms of change since 1993, four of the Asian 10 are relatively stable; four show gains ranging from 23-29%, and two have sky-rocketed – India, gaining 41%, and China, 97%.

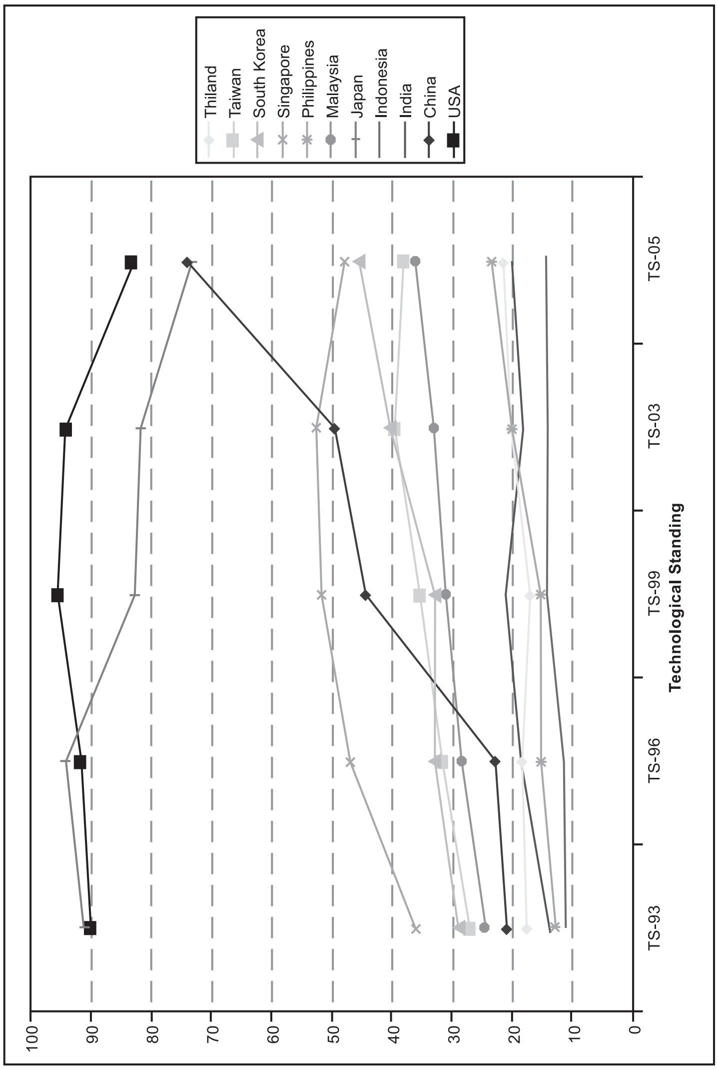
Figure :9
roductive Capacity: 1993-2005 (Traditional



The standout message in scanning these Input indicators across 13 years is the magnitude of increase by China in all of them. Literally, the global competitive landscape has changed. For many years, HTI reported on "The Big Three" (U.S., Japan, and Germany). Were we to use such a grouping today, it would be "The Big Four." Furthermore, the increasing Chinese strength in these enablers suggests that the country will continue to increase its competitiveness markedly over the coming decades.

The HTI model (Figure 1) tracks the Input indicators out of interest in future technological competitiveness, as gauged by TS – Technological Standing – i.e., high tech export capabilities. Figure 9 tracks change in TS from 1993 through 2005. The U.S. is the benchmark nation in 2005 (scoring 83). It is followed by China (74), Japan (73), and Germany (65). China has arrived.

Figure : 10
Technological Standing: 1993-2005 (Traditional)



Behind Germany, TS drops sharply to the 40's, including two of the Tigers (Singapore – 48, and South Korea – 45) and two Western European powers (the UK – 48, and France – 45).

Change in TS for the Asian countries is interesting. Only one has dropped (Japan from 91 to 73, on this relative standing measure). The current benchmark nation, the U.S., has also dropped (from 90 to 83), so that other nations have been able to show an average 31% increase. That figure is heavily distorted, however, by China, which has increased 258% (from 21 to 74). [The median increase is 15% for the set of nations.] Within the Asian 10, excepting Japan, all have increased at least 23%. Besides China, the strongest increases occur for The Philippines (84% from a low start), South Korea (58%), India (48% from a low start), Malaysia (47%), and Taiwan (41%).

Traditional HTI combine statistical measures which can range over orders of magnitude (e.g., high tech export value) and survey items (scaled 1-5). This tends to moderate differences among nations. That said, we note thatour measures are not per capita, so the prominence of a small nation like Singapore is remarkable.

4) A NEW PERSPECTIVE: STATISTICS-ONLY HTI-05

We now switch to consider the statistics-only HTI for 2005. These provide new perspectives in several regards, particularly:

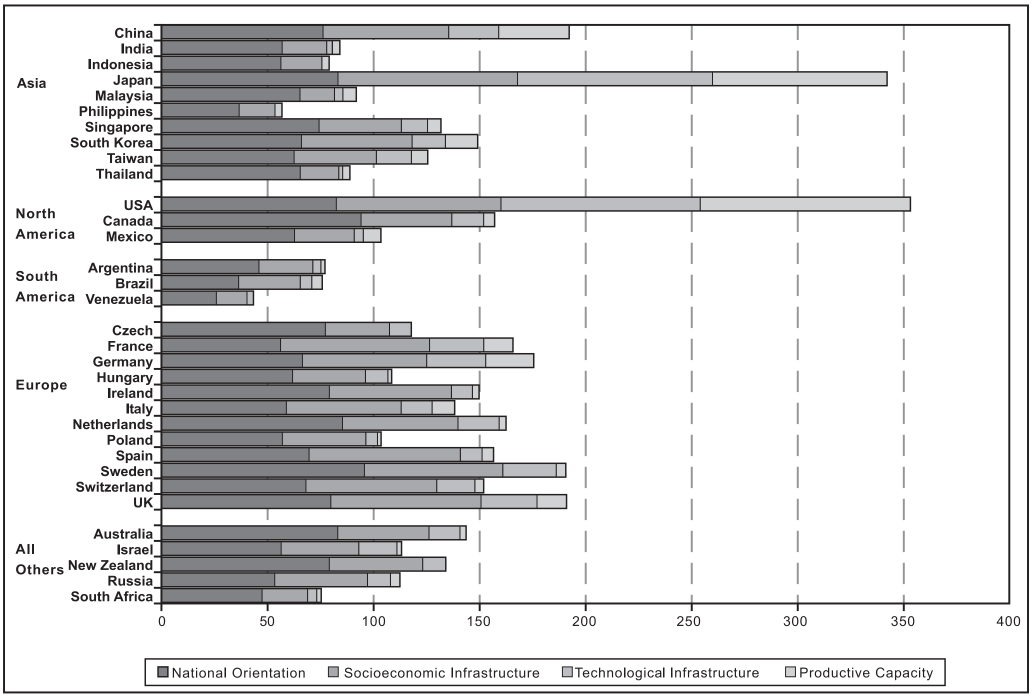
- All measures are statistical, so free to range widely
- Coverage is expanded to incorporate more "knowledge economy" considerations – i.e., service as well as manufactured products

The Appendix lays out the components and how these are combined to form the indicators.

These comparisons are cross-sectional; we just do not yet have adequate time series to compare temporally. We thus include non-Asian countries in the following charts to enrich such comparisons. In general, the statistics-only HTI accentuate the relative standing of the U.S.

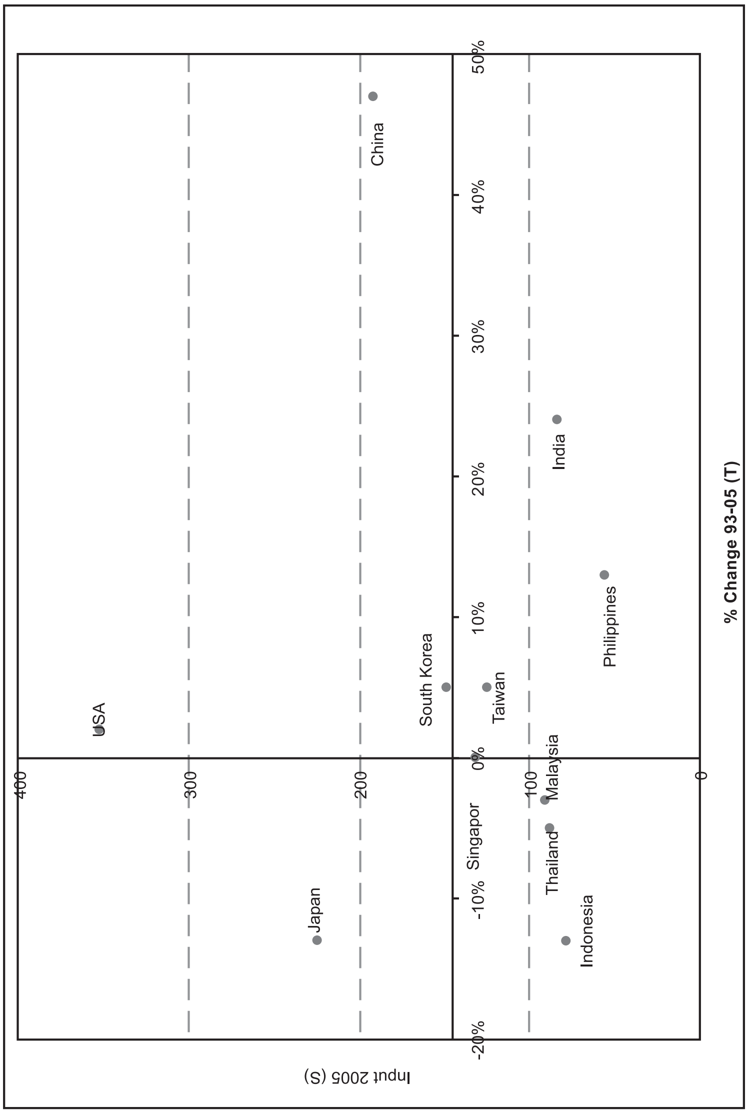
Figure 11, INPUT composite indicator for 2005, suggests the U.S. has particularly well-positioned capabilities to continue as a high tech power. Japan remains #2, but these indicators distance it from the U.S. much more so than do the traditional HTI. Most interesting here is the strong showing of China, which places third (at 192), closely followed by the UK (192) and Sweden (190).

Figure :11
INPUT Indicator Breakout 2005 - All countries (Statistics-only)



Looking ahead, what do the INPUT values suggest about future technological prospects? Figure 12 plots the recent statistics-only INPUT values against the Percent change in INPUT (traditional) from 1993 to 2005 for the Asian 10 + the U.S.

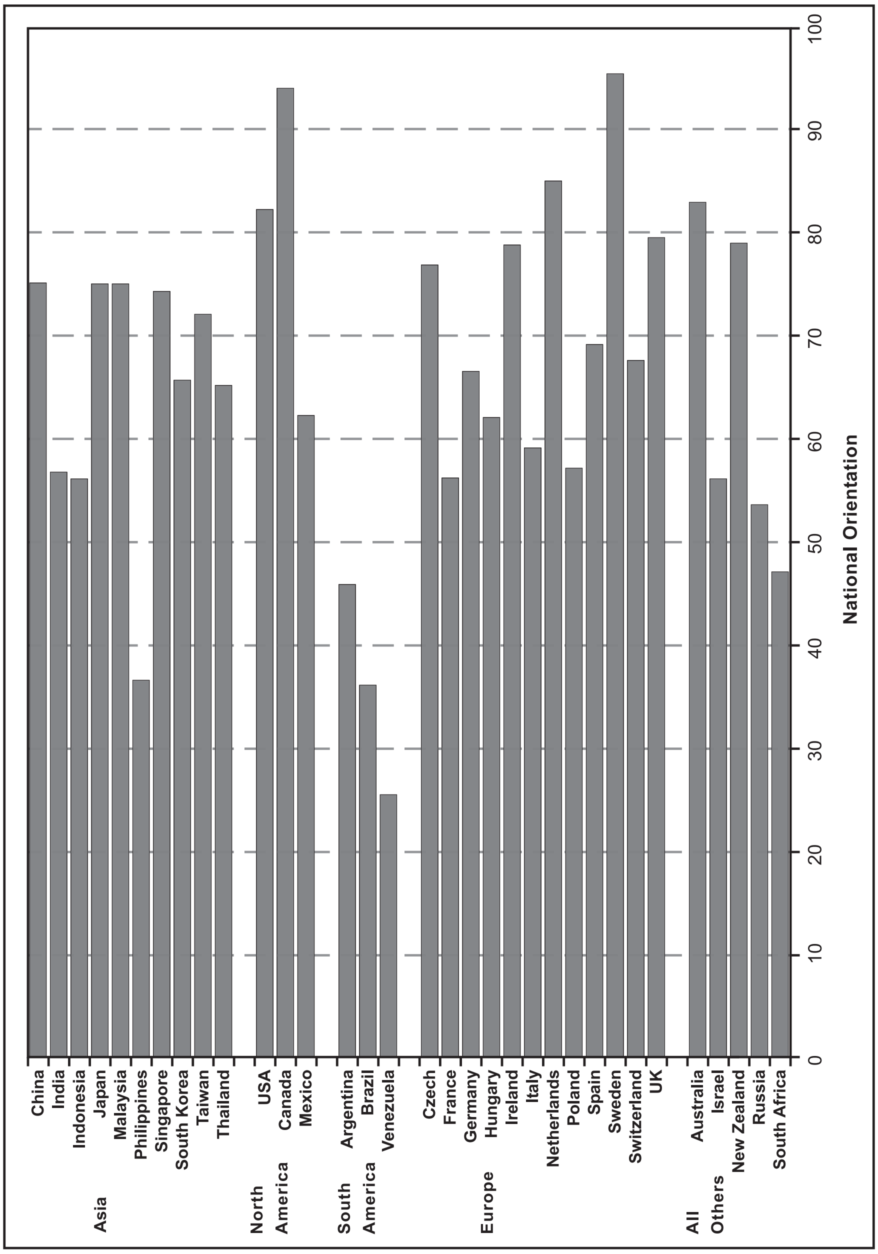
Figure : 12
Scattergram of Percent Change and Input Score



National Orientation (NO) (Figure 12) among the Asian 10 is generally strong, with the exception of The Philippines. The others divide into two tiers:

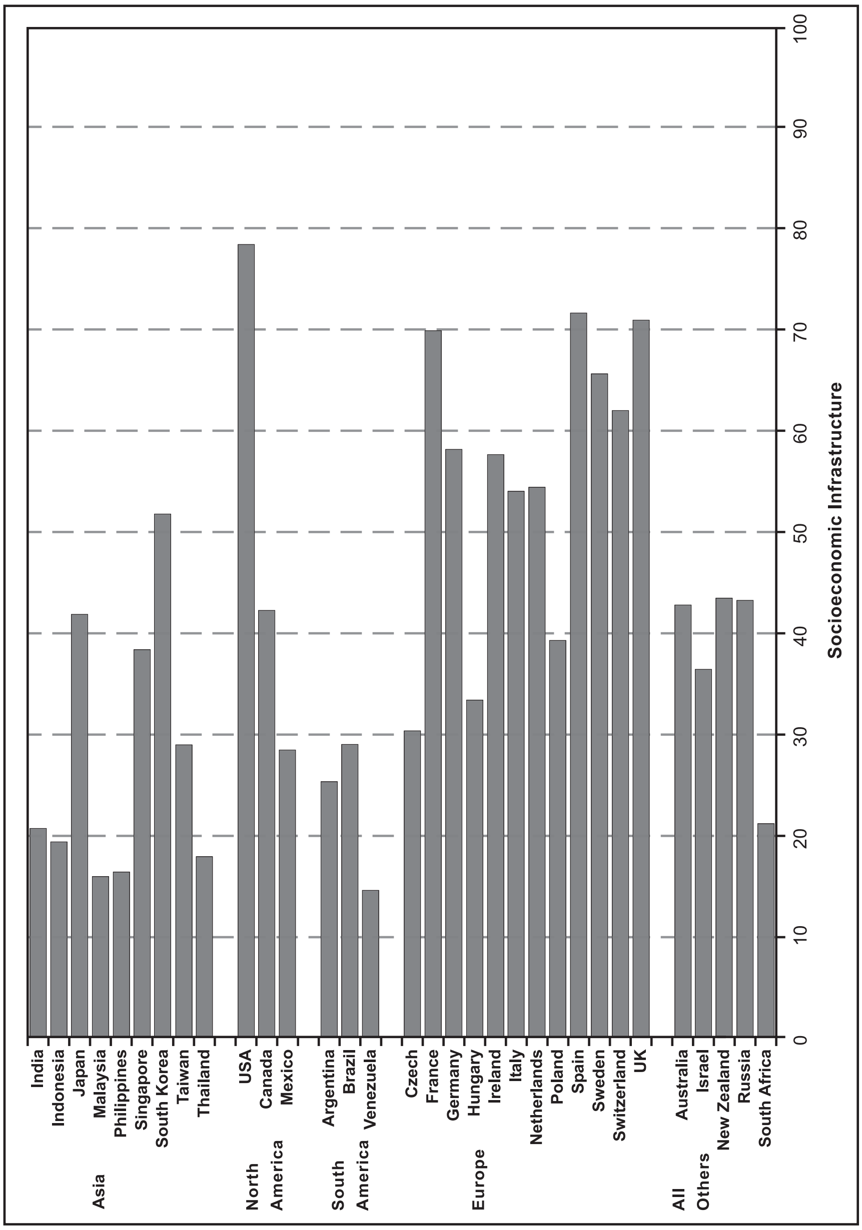
- High NO – China, Japan, Singapore, Taiwan
- Moderately High NO – South Korea, Malaysia, Thailand, India, Indonesia

Figure : 13
National Orientation 2005 – All countries (Statistics-only)



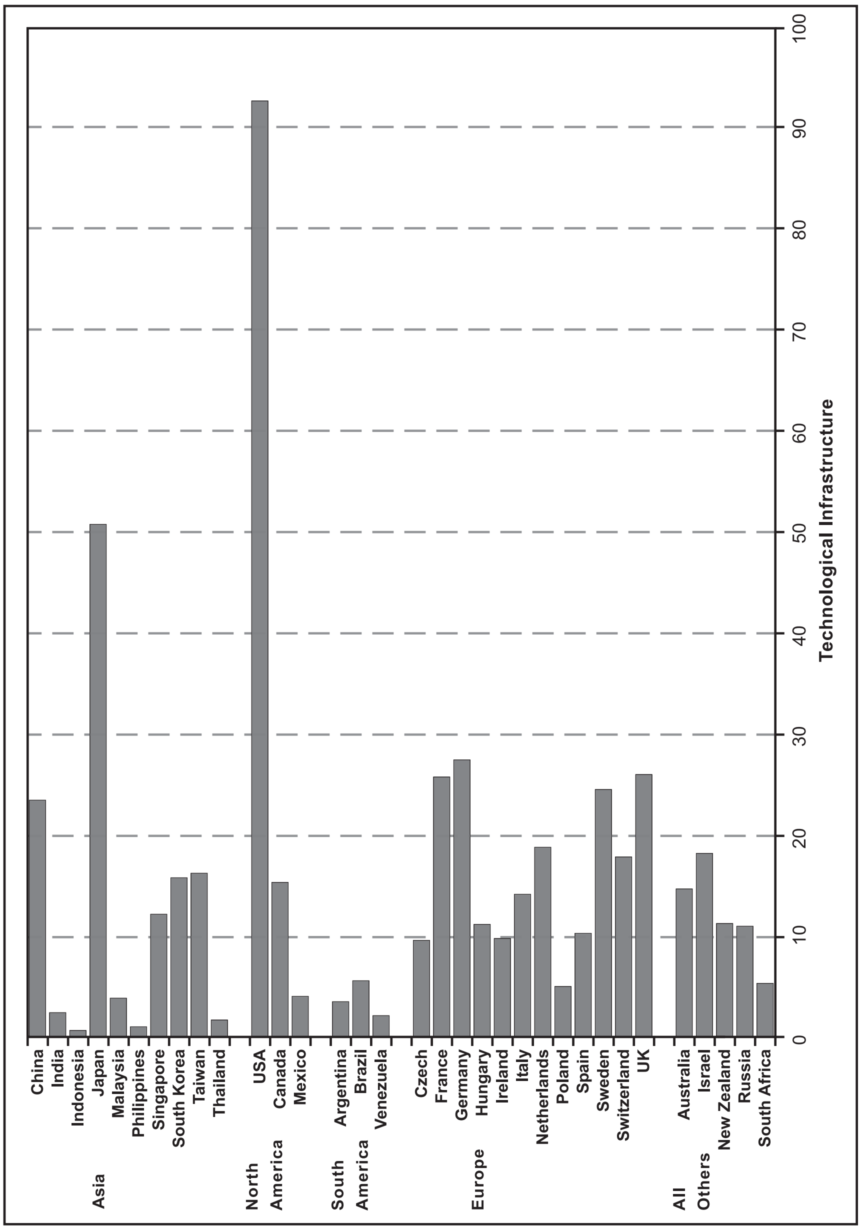
Socio-economic Infrastructure (SE) (Figure 13) is not so strong. Somewhat counter-intuitively, Japan, Singapore, and Taiwan score lower than China and South Korea. ??explore why – look at components – FDI seems a key cause, but also PatApNon vs. HMHS; look at question responses too The others score quite low.

Figure : 14
Socioeconomic Infrastructure 2005 - All countries (Statistics-only)



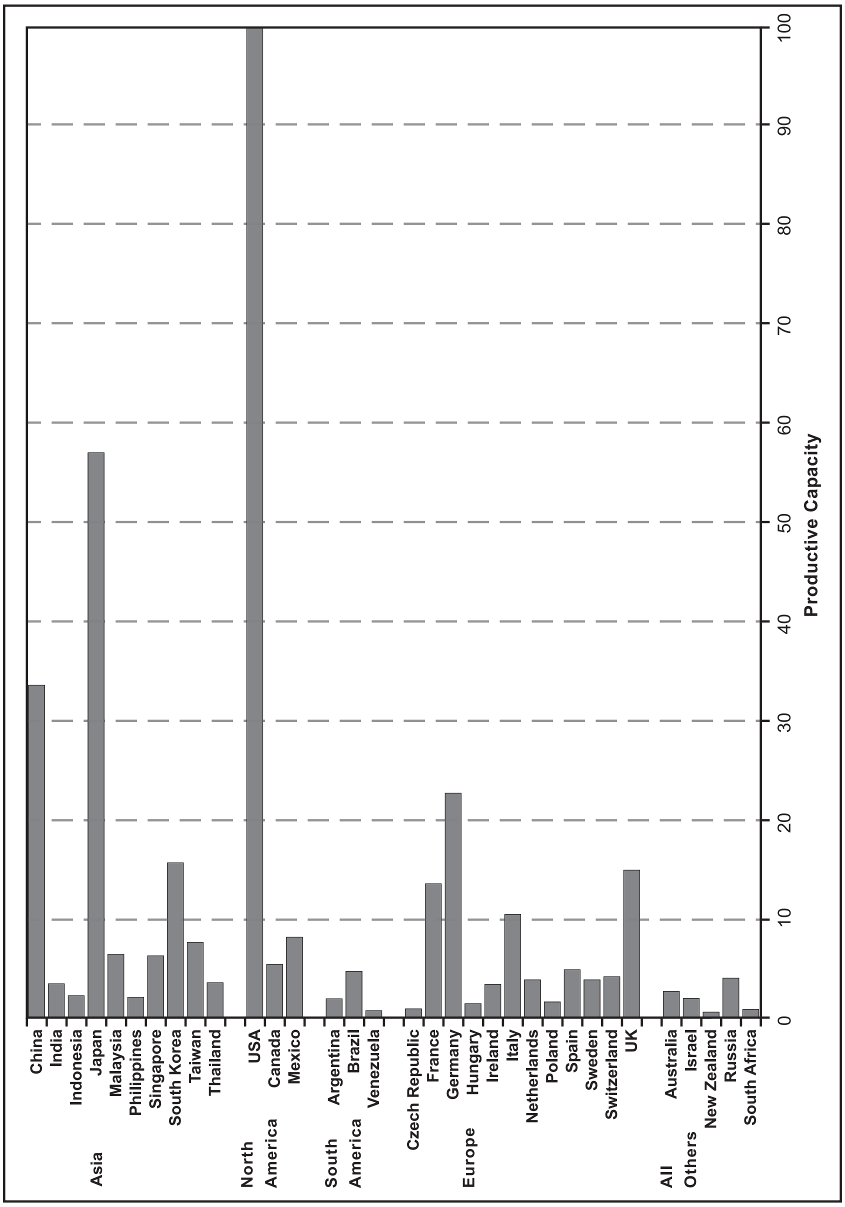
Technological Infrastructure (TI) (Figure 14) is dramatically different using the statistics-only formulation. Here the U.S. goes "off scale" at 93, followed by Japan (51), and no other country as much as 30. Among the Asian country set, China is second (24), a level just short of the major European technological powers (Germany, UK, and France score 26-28). The three Tigers are next tier (12-17), with the others very low.

Figure :15
Technological Infrastructure 2005 - All countries (Statistics-only)



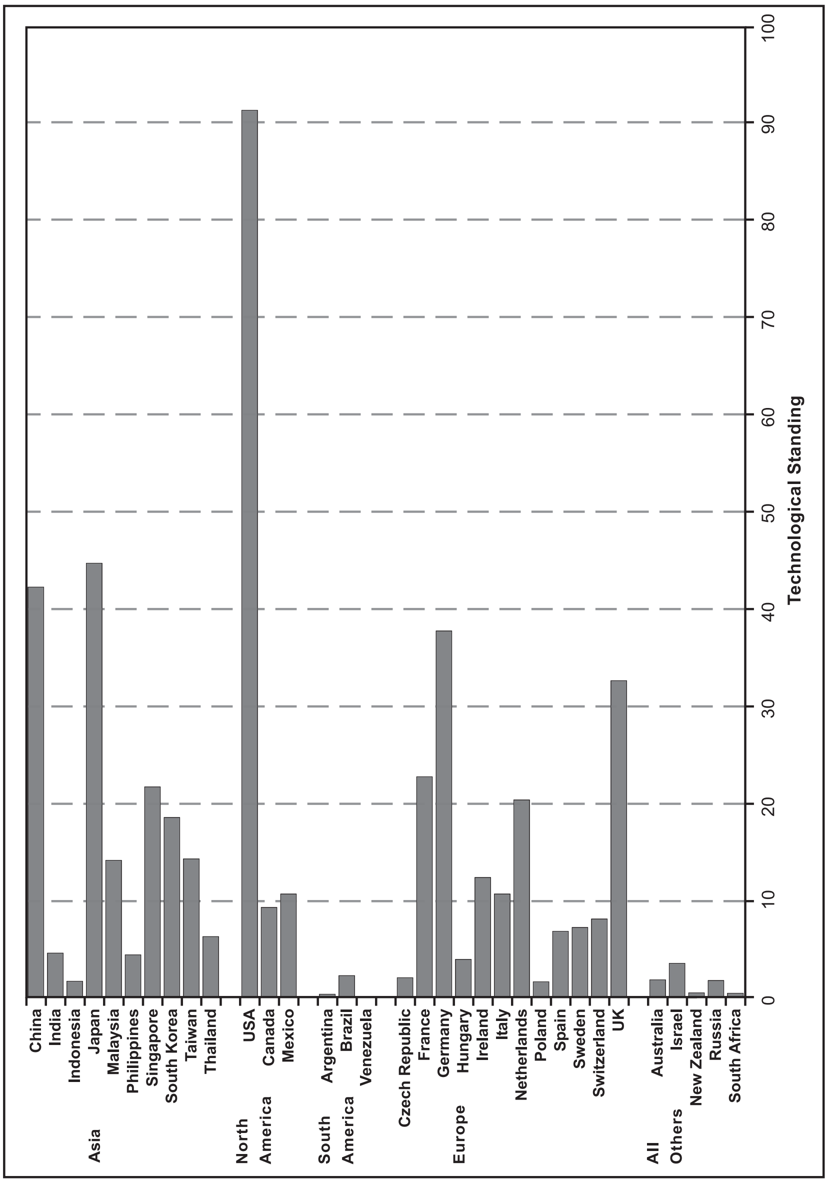
Productive Capacity (PC) (Figure 15) is also extreme. The U.S. is again way above all others (at 100), followed as a distant second by Japan (57). China is next (34), trailed by Germany (23), South Korea (16), the UK (15), France (14), and Italy (10). All other Asian countries come in below 8.

Figure : 16
Productive Capacity 2005 - All countries (Statistics-only)



National technological competitiveness is measured using Technological Standing (TS) (Figure 16). Again, the U.S. is an outlier – at 91. And, again, Japan is second overall (45), with China close (42), followed by Germany (38) and the UK (33). In Asia, the Three Tigers– Singapore (22), South Korea (18), and Taiwan (14) – and Malaysia (14) follow. There is a big drop-off to the others, including India26-28). The three Tigers are next tier (12-17), with the others very low.

Figure : 17
Technological Standing 2005 - All countries (Statistics-only)



Malaysia's profile is particularly intriguing. Sometimes, it seems a close follower of the Tigers; sometimes, well behind.

5) INTERPRETATIONS AND IMPLICATIONS

Figure 17 consolidates the changing INPUT and TS profiles over time. Our HTI-05 Report contains a version with the full set of countries for which our data span the 1993 to 2005 period. The striking 'mover' there is the same – China.

Figure :18
Change in Competitiveness, 1993-2005: INPUT vs. Technological Standing (Traditional)

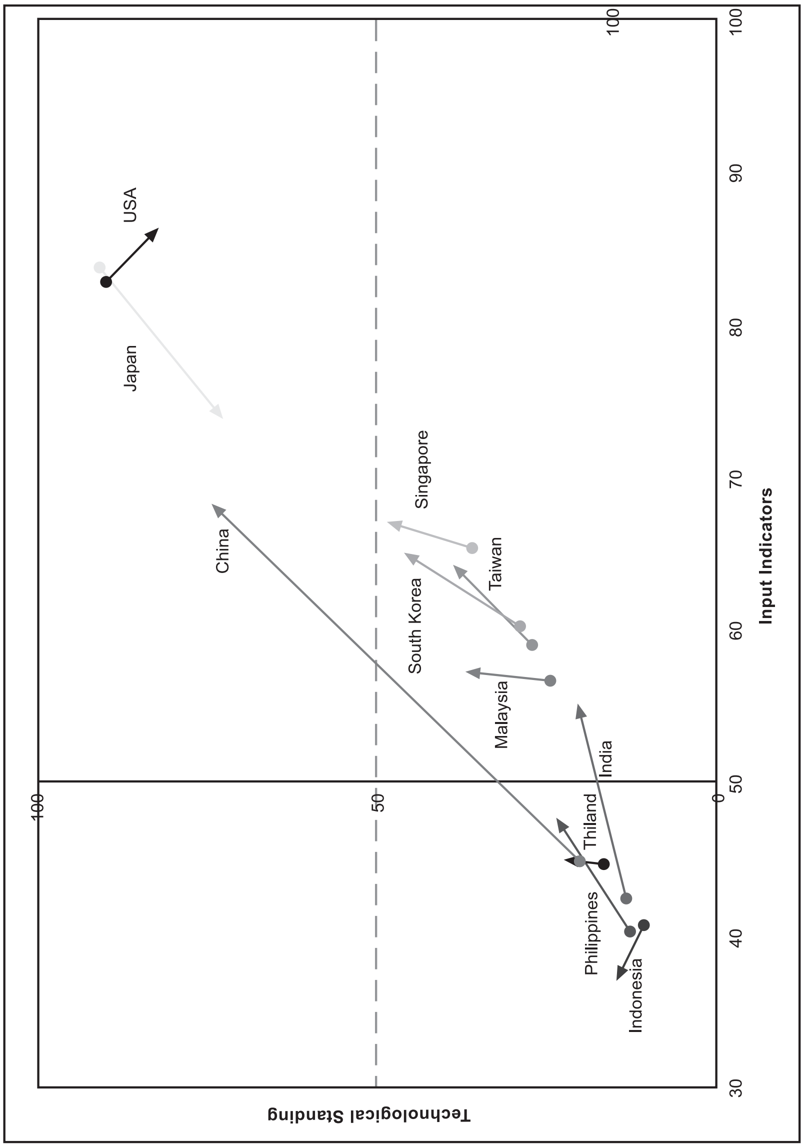
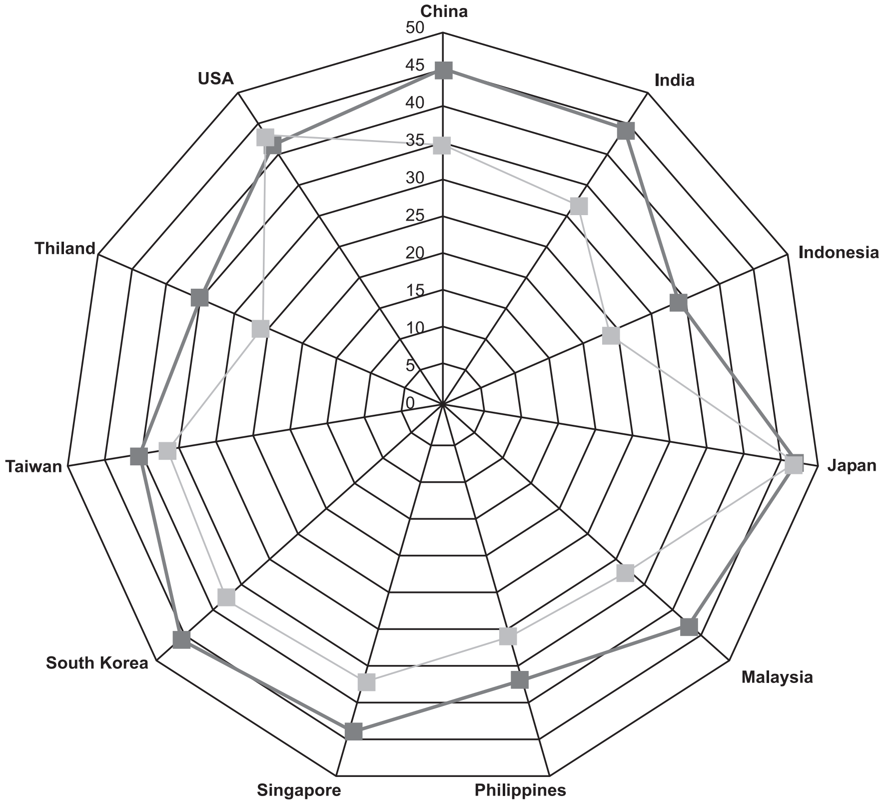


Figure 18 presents a radar chart of our experts' responses as to perceived national high tech production capacity as of 2005, and approximately 15 years in the future. The U.S. remains steady and high., as does Japan. All of the remaining Asian countries addressed are expected to enhance their technology-intensive production capabilities. Our expert panelists expect especially large steps toward global prominence for India, China, and Malaysia. The scaling includes descriptions of "40" as "products well-respected for quality and value in international markets," and "50" as "products considered technically advanced, 'state-of-the-art' in international markets."

Figure : 19
High Tech Production Capability: Present vs. Future 2005 [based on expert opinion]



Based on a 5-point scale expert assessments, and rescaled here so that 10 = essentially no Production, to 50 = technically advanced, International "state of the art"

Georgia Tech's High Tech Indicators (HTI) are evolving. As the world shifts increasingly into an 'information economy', we seek to track economic strength in information-intensive activities. Our statistics-only version of HTI place far more weight on factors likely to reflect in high tech services and knowledge-intensive products. The 2005 statistics-only HTI results should be considered preliminary. In generating HTI-07 we anticipate investigating possible refinements of these indicators. As noted, some of the new components are highly volatile. We will also check on potential complementary components that tap additional important dimensions.

Table :3
HTI-93 to HTI-05 Traditional INPUT and Technological Standing ValuesA

COUNTRY	IN-93	IN-96	IN-99	IN-03	IN-05	TS-93	TS-96	TS-99	TS-03	TS-05
US	82.8	86.2	87.4	85.43	84.47	90.02	91.37	95.37	93.9	82.92
China	45.1	45.5	51.4	55.69	66.2	20.65	22.54	44.21	49.32	73.91
India	42.6	48	54.8	49.15	52.99	13.46	18.32	20.83	17.87	19.96
Indonesia	40.5	31.8	34.7	33.14	35.28	10.99	11.18	14.03	13.97	14.18
Japan	83.6	78.1	76.1	74.4	72.85	90.79	93.95	82.68	81.56	73.05
Malaysia	56.6	54.7	50.7	51.48	55.18	24.3	28.18	30.79	32.82	35.75
Philippine	40.2	55.1	44.5	45.83	45.59	12.6	14.87	15.01	19.65	23.18
Singapore	65.3	64.9	62.3	68.11	65.28	35.77	46.72	51.53	52.36	47.68
S. Korea	60.1	59.6	60.4	64.74	63.13	28.67	32.64	32.68	40.06	45.22
Taiwan	59	64.8	65.5	68.06	62.22	26.99	31.46	35.16	39.26	37.92
Thailand	44.7	43.4	37.1	39.18	42.6	17.19	18.08	16.63	19.99	21.14

Table : 4
HTI-93 to HTI-05 Traditional Input and TS Ranks (Based on the full country set*)

COUNTRY	IN-93	IN-96	IN-99	IN-03	IN-05	TS-93	TS-96	TS-99	TS-03	TS-05
US	2	1	1	1	1	2	2	1	1	1
China	21	24	22	18	7	16	15	7	6	2
India	23	21	19	24	22	24	21	19	26	24
Indonesia	26	30	31	32	32	28	28	31	30	32
Japan	1	2	2	2	2	1	1	2	2	3
Malaysia	13	17	23	23	20	13	13	14	13	12
Philippine	27	16	27	26	26	26	26	29	23	20
Singapore	4	6	12	6	8	6	5	5	5	5
S. Korea	9	10	13	13	10	10	8	12	9	7
Taiwan	11	7	10	7	14	12	10	10	10	10
Thailand	22	25	30	31	30	18	22	26	22	22

* Notes:

1. For HTI-93 there are 28 countries, including Hong Kong

2. For HTI-96, there are 30 countries; Poland, Venezuela and South Africa were added, and Hong Kong was dropped.

3. Since HTI-99, there are 33 countries; Ireland, Israel and the Czech Republic were added in HTI-99.

Table : 5
HTI-93 to HTI-05 Traditional Input and TS Ranks (Among 10 Asia Countries)

COUNTRY	IN-93	IN-96	IN-99	IN-03	IN-05	TS-93	TS-96	TS-99	TS-03	TS-05
China	6	8	6	5	2	6	6	3	3	1
India	8	7	5	7	7	8	7	7	9	9
Indonesia	9	10	10	10	10	10	10	10	10	10
Japan	1	1	1	1	1	1	1	1	1	2
Malaysia	5	6	7	6	6	5	5	6	6	6
Philippine	10	5	8	8	8	9	9	9	8	7
Singapore	2	2	3	2	3	2	2	2	2	3
S. Korea	3	4	4	4	4	3	3	5	4	4
Taiwan	4	3	2	3	5	4	4	4	5	5
Thailand	7	9	9	9	9	7	8	8	7	8

The U.S. appears to be doing well and outdistances its competitors in terms of the four input measures and Technological Standing.

1. Asia, in general, is advancing strongly. The 10 Asian countries included are generally committed to developing capacity to compete globally with technology-based products and knowledge-based services.

2. The three Tigers – Singapore, South Korea, and Taiwan – compete effectively in international markets, on a par with Western European nations.

3. China continues to make stupendous strides toward becoming the world leader in technological products. Its pace of progress appears to have accelerated in recent years. It will likely be a (or "the"?) technological superpower of the future.

4. Japan remains the leading Asian nation on most of these indicators, although China is challenging its position. Comparing its standing over time, Japan has slipped (relatively) somewhat since 1993.

A country's high tech competitiveness can't be fully captured by a few indicators. Competitiveness is affected by a complex of political, economic, cultural, and educational factors. On the one hand, we want to maintain consistent measures to enable time series comparisons (i.e., our traditional HTI series). On the other, we recognize changing dynamics involving national economies and their emphases (e.g., increasing knowledge-intensive services and products). We have thus introduced the broadened, statistics-only HTI now. We will continue to refine these indicators and explore their interpretation. We invite suggestions on what alternative measures and analyses would enhance the value of HTI to various users.

REFERENCES

ANTONELLI, G. AND DE LISO, N. (EDS), 1997. Economics of Structural and Technological Change, Routledge.
ARCHIBUGI, D. AND MICHIE, J. (EDS), 1998. Trade, Growth and Technical Change, Cambridge University Press.
CLARK, J. & GUY, K., 1998. Innovation and Competitiveness: A Review, Technology Analysis & Strategic Management, Vol. 10, No. 3, pp. 363-395.
CSTD, 2002. -- UN Commission on Science and Technology for Development, Panel on Indicators of Technology Development, Paper I: Overview of Existing Technology

Indicators, and Paper II: Indices of Technological Development, Geneva, 22 -24 May.
EATON, J. AND KORTUM, S., 1996. Trade in Ideas: Patenting & Productivity in the OECD, Journal of International Economics, 40 (3-4), pp. 251-278.
GRILICHES, Z., 1990. Patent Statistics as Economic Indicators: A Survey, Journal of Economic Literature, Vol. 18, pp.1661-1707.
GRUPP, H., 1995. Science, High Technology and the Competitiveness of EU Countries, Cambridge Journal of Economics, 19, pp.209-223.
KLEINKNECHT, A., VAN MONTFORT, K., AND BROUWER, E., 2002. The Non trivial Choice between Innovation Indicators, Economics of Innovation and New Technology, Vol. 11, No. 2, pp.109-121.
MANI, S., 2000. Exports of High Technology Products from Developing Countries: Is it real or a Statistical Artifact? Working Paper, UNU/INTECH, Netherlands.
OECD 2001 Project Report: Science, Technology and Industry Scoreboard 2001: Towards A Knowledge-Based Economy (see web: http://www.oecd.org/publications/e-book/92-2001-04-1-2987/).
OECD 2000 Project Report: A New Economy? The Changing Role of Innovation and Information Technology in Growth, at web: http://www.oecd.org/dsti/sti/statana/prod/growth.htm.
PAVITT, K. and Soete, L., 1980. Innovative Activities and Export Shares: Some Comparisons between Industries and Countries, in K. Pavitt (Ed.), Technical Innovation and British Economic Performance, Macmillan, London, pp.38-66.
PORTER, A. L., ROESSNER, J. D., NEWMAN, N. C., JIN, X-Y AND JOHNSON, D. M., 2006. High Tech Indicators: Technology-Based Competitiveness Of 33 Nations -- 2005 Final Report, Report to the Science Indicators Unit, Science Resources Studies Division, National Science Foundation, under Contract D050144, Technology Policy And Assessment Center, Georgia Institute Of Technology, 685 Cherry Street, Atlanta, Georgia 30332-0345, September 4.
PORTER, A. L. AND CUNNINGHAM S. (Eds), 2005. Tech Mining: Exploiting New Technologies for Competitive Advantage, Wiley.
PORTER, A. L., ROESSNER, J. D., NEWMAN, N. C., KONGTHON, A., AND JIN, X-Y., 2004. Review and Revision of High Tech Indicators 2003, Report to the Science Indicators Unit, National Science Foundation (Contract D020024).
PORTER, A. L., ROESSNER, J. D., JIN, X-Y., AND NEWMAN, N. C., 2001. Changes in National Technological Competitiveness: 1990, 1993, 1996, 1999, Technology Analysis & Strategic Management, Vol.13, No.4, pp.477-496.
PORTER, M. E. AND STERN, S., 1999. The New Challenge to America's Prosperity: Findings from the Innovation Index, Council on Competitiveness, Washington, D. C. (in Web: http://www.compete.org/).
ROESSNER, J. D., PORTER, A. L., NEWMAN, N. C., AND JIN, X -Y., 2002. A Comparison of Recent Assessment of the High- Tech Competitiveness of Nations, International Journal of Technology Management, Vol. 23, No. 6, pp.536-557.
ROESSNER, J. D., PORTER, A. L., AND FOUTS, S. J., 1988. Technology Absorption, Institutionalization, and International Competitiveness in High Technology Industries, In: Khalil, T. M., Bayraktar, B. A. and Edosomwan, J. A. (Eds.), Technology Management I, Geneva, Interscience, 1988.
TAIWAN INSTITUTE OF ECONOMIC RESEARCH (TIER), 2000. The Proceedings of International Conference on the Measurement of Industrial Technology Competitiveness in the Knowledge-Based Economy, Taipei, Taiwan, August 23-24.
WORLD COMPETITIVENESS YEARBOOK (WCY) 2006, Edited by The IMD Research Center, International Institute for Management Development (IMD), Lausanne, Switzerland (at web: http://www01.imd.ch/wcc/).

ACKNOWLEDGEMENTS

We expressly thank the following organizations who graciously provided critical data for the HTI:

IMD World Competitiveness Yearbook 2005, provided by IMD, Lausanne, Switzerland, www.imd.ch/wcc"

The PRS Group, Inc. kindly provided the January, 2005, issue of the Political Risk Letter

APPENDIX: HTI 2005 INDICATOR FORMULATIONS AND DATA SOURCES

Beginning with HTI-03, we are investigating a new indicators approach based solely on statistical measures. In conjunction with this changeover, we have expanded HTI statistical coverage to address "information economy" (i.e., technology-intensive service) elements to expand HTI coverage beyond technology-intensive manufactured products. So, we have the following two data sets in our HTI 2005 study:

- Traditional (T) -- [Survey questions + old statistics components]
- Statistics-only (S) -- [new and more inclusive statistics components without survey data]

The formulas for HTI (T) and (S) are as follows:

Traditional (T):

NO (T) = [Q1 + (Q2 + Q3)/2 + Q4 + F1V]/4.
SE (T) = (Q5 + Q10 + HMHS)/3.
TI (T) = [(Q7 + Q8)/2 + Q9 + Q11 + EDP + S&E]/5
PC (T) = [(Q6 + Q12 + Q13)/3 + A26/2]/1.5.
TS (T) = (X + A2 + Q14a)/3
IN (T) = [NO (T) + SE (T) + TI (T) + PC (T)]

Statistics-only (S):

NO (S) = [F1V+WVS {V27}]/2
SE (S) = [HMHS + FDI + PatApNon]/3
TI (S) = [EDP+S&E+ RATIOROYL + ICTCON + PatApRes + BIBLIO + R&DEXP]/7
PC (S) = [A26 + MVA + SVA]/3
TS (S) = [X + A2 + ROYLR + SOCSE]/4
IN (S) = [NO (S) + SE (S) + TI (S) + PC (S)]

All the "Q" items (questions) are based on responses to our survey. We invite persons to answer closed-form questions as part of our International Technology Indicators Panel. This is conducted as an electronic survey with e-mail invitations, with most responding to our web-based survey instrument [www.tpac.gatech.edu/hti.php]. In the survey, respondents first assess their "familiarity with technology-intensive development in this country" on a 1-4 scale (1 = less familiar, to 4 = expert). They then answer a series of questions (Questions 1-14 or Questions C-P on the web). This expert opinion information is combined with several statistical sources to compose the Traditional High Tech Indicators (T) as detailed below.

For each statistical source we herein describe the data source and provide a formal citation reference. In a number of cases data were provided directly to us, rather than from a formal publication. In addition, many sources are now dynamic; that is, the contents of a data table are updated on an ongoing basis. Hence, the cited source table is apt to give some changed values if one refers to it some time later.

Below are all the indicator formulations, both Traditional (T) and Statistics-only (S), with definitions and the data source for each of above 12 indicators.

Raw data are transformed to "S-scores." Each indicator component is scaled from 0 to 100 and then averaged to generate comparable indicators with a 0 to 100 range. For survey items, 100 represents the highest response category for a question (nearly all items are scaled 1-5, so 1 transforms to S = 0; 5 transforms to S = 100)[4]. For statistical data, 100

[4]Scaling varies by question – see: http://www.tpac.gatech.edu/hti2005/question.php. For example, Q14's parts all correspond to:

1. Essentially no production in this sector
2. Nearly all production in this sector is relatively low value-added assembly
3. Some indigenous production capability in this sector, largely of standard products
4. Considerable indigenous manufacturing activity in this sector with products well-respected for quality and value in international markets

Extensive indigenous manufacturing activity in this sector with products considered technically advanced, "state-of-the-art" in international markets.

typically represents the value attained by the country with the largest value among the 33-country set. Thus, this is a relative scaling so that an apparent "decline" over time or low score is only relative to the other countries in the set of 33. Depending on the component, two classes of scaling are used:

- Absolute 0; Relative 100: for some items there is a true zero minimum (e.g., high tech exports cannot be negative) and a relative maximum (i.e., divide by the highest national value).

- Relative 0; Relative 100: for the remaining items, add the most negative country value to the raw scores, then divide by the highest national value to obtain 0-100 scaling.

We noted some apparent inconsistencies in reviewing HTI from 1993 through 2005. The actual calculations appear consistent, but the reported formulas differ slightly. In some places we call for averaging of S-score component question items, whereas elsewhere we call for taking the S-score of the averaged raw question items. These are equivalent for question items that use a “fixed maximum and minimum.”[5] That is we note that question responses range from 1-5, which we score 10-50. To get S scores, we subtract 10 (making the scale be 0-40); then multiply by 2.5 (making the scale be 0-100). Transitivity applies – subtracting a constant from each component, then multiplying by a second constant equates to subtracting the constant from the sum, then multiplying by the second constant.

We also observed that sometimes the formulas don’t specify averaging question items being combined. For instance, in NO, just below, Q2 and Q3 are combined this way. It seems most straightforward to so average (in principle taking the S-scores using a suitably adjusted multiplier is equivalent).

TECHNOLOGICAL STANDING (TS)

The current world market share in high technology products reflects not only current export market share statistics but also current manufacturing capability.

Formula: **TS (T) = [SQ14a+SX-2003+SA2-2005]/3**
TS (S) = [SX-2003 + SA2-2005 + SROYLR + SSOCSE]/4

Q14a = Please characterize present and future technology-intensive production in this country. Judge the production in each of ten sectors for which you feel reasonably familiar: first, today, and second, 15 years in the future. Part "a" pertains to "Overall technology-intensive production in this country."

X-2003 = The value of high tech exports as drawn from the United Nations Statistical Office (UNSO) COMTRADE trade statistics for 2003. High tech exports were defined in accord with the U.S. Department of Commerce's DOC3 definition, excluding missiles and ordinance. It includes STIC Revision 2 codes 51, 52, 54, 58, 712, 713, 714, 716, 718, 75, 76, 772, 776, 792, 87, and 88. All UN trade data is obtained directly from the United Nations Statistical Office.

Date: Data are from 2003.
Unit: 1,000’s of US Dollars
Data Source Location: Data were online from United Nations Statistical Office, Commodity Trade Statistics Database.
Reference: United Nations Statistical Office, Commodity Trade Statistics Database, COMTRADE, New York, United Nations, 2005.

[5] We have discovered that the expert component of the PC (T) value we reported and that appears in S&EI 2006, was based on a “sample maximum.” In prior years we used a “Fixed Maximum,” as we do for other Question-based indicators. So, for PC (T) series continuity (from 1993 forward), we should go back to using a fixed maximum. [The “sample maximum” was introduced as an attempt to help address the ceiling effect. Given that we are introducing the Statistics-only scores, we think it best to leave “Traditional” HTI as it has been calculated.]

A2-2005 = The value of electronics exports in 2005 (forecasted) as obtained from the Reed Electronics Research.

Date: Data are based on a 2005 forecast.
Unit: 1,000's of US Dollars
Data Source Location: Data is available from the Yearbook of World Electronics Data 2004/2005, however for the purposes of this project, the statistical data series was obtained directly from Reed Electronics Research in electronic from as drawn from their Full Statistical Database 1985-2005. [http://www.rer.co.uk]
Reference: Reed Electronics Research. 2005. Yearbook of World Electronics Data 2004/2005. Surrey, United Kingdom. Reed Electronics Research Ltd.

ROYLR: Royalty/license fees, receipts (Balance of Payments)

Date: Data are primarily from 2002.
Unit: Current US Dollars
Data Source: World Bank World Development Indicators 2004 (CD).
Reference: World Bank, April 2004, World Development Indicators 2004, New York, World Bank.

SOCSE: Export of Computer, communications and other services. Data are reported as a percentage of commercial service exports. Dollar value is calculated from the total Commercial Services Exports.

Date: Data are primarily from 2002.
Unit: Current US Dollars
Data Source: World Bank World Development Indicators 2004 (CD).
Reference: World Bank, World Development Indicators 2004, New York, April 2004.

NATIONAL ORIENTATION (NO)

Evidence that a nation is taking directed action to achieve technological competitiveness. Evidence of such action could be manifested at the business, government, or cultural levels, or any combination of the three.

Formula: **NO (T) = [SQ1+S ((Q2+Q3)/2)+SQ4+SF1V-2005]/4**
NO (S) = [SF1V-2005+SWVS {V27}]/2

Q1 = To what extent does this country's government evidence a deliberate strategy to promote technology-intensive production for export?

Q2 = To what extent do this country's basic cultural values associate technology and technological change with desirable social development?

Q3 = How closely do influential groups (e.g., unions, trade associations, religious organizations) in this country associate technology with desirable social development? For instance, one could imagine some groups not being favorably disposed toward introduction of more technologies. Or, some societies may emphasize redistributive measures, such as land reform, over technology-intensive industrial development?

Q4 = Please rate the presence of an "entrepreneurial spirit" in this country. That is, to what extent are its citizens, especially the business community, predisposed toward innovative action and economic risk-taking?

F1V2005 = The Political Risk Letter 5-year investment risk assessment index for January 1, 2005 from the PRS Group; rescaled from D- = 1 to A+ = 12.

[6]Four digit numbers at the end of statistical variables (e.g., F1V2005) represent the year from which the data are drawn.

Date: Data are drawn from the 1 January 2005 letter.
Unit: N/A
Data Source Location: Political & Economic Forecast Table, Political Risk Letter, PRS Group, January 1, 2005. [http://www.prsgroup.com]
Reference: PRS Group, Political Risk Letter, New York, January 1, 2005.

WVS {V27} = World Values Survey Trust Question (V27)

Date: Data represent responses from a range of years (1994-1999).
Unit: N/A
Data Source Location: http://www.worldvaluessurvey.org
Reference: Ronald Inglehart, Miguel Basanez, Jaime Diez-Medrano, Loek Halman and Ruud Luijk, Editors, 2004 Human Beliefs and Values, Mexico City, Mexico, Siglo XXI Editores.

SOCIOECONOMIC INFRASTRUCTURE (SE)

The social and economic institutions that support and maintain the physical, human, organizational and economic resources essential to the functioning of a modern, technology-based industrial nation.

Formula: **SE (T) = [SQ5+SQ10+SHMHS]/3**
SE (S) = [SHMHS + SFDI + SPatApNon]/3

Q5 = Aside from the amount of financial resources, it is also important to assess the extent to which such resources can be mobilized to support technology-intensive development. Please judge the mobility of capital in this country.

Q10 = To what extent are foreign-owned firms encouraged to do business in this country?

HMHS = Harbison-Myers Human Skills Index. The formula for the index is W4+4*W6.

W4 = The net percentage of students enrolled in secondary education in 2002. The percentage is based on the number of individuals in school vs. the total number of individuals who could be enrolled as defined by UNESCO and adjusted for local practice.

Date: Data are primarily from 2002.
Unit: N/A
Data Source Location: UNESCO Web Site, Gross and Net Enrolment Ratios, and Gender Parity Index, secondary (ISCED 2&3), for school years 1998/1999 to 2004/2005, UNESCO, May 2005.
Reference: UNESCO, Institute for Statistics, Gross and Net Enrolment Ratios, and Gender Parity Index, secondary (ISCED 2&3), for school years 1998/1999 to 2004/2005, New York, United Nations, May 2005.

W6 = The gross percentage of students enrolled in tertiary education in 2002. The percentage is based on the number of individuals in school vs. the total number of individuals who could be enrolled as defined by UNESCO. The values are not adjusted for local practice.

Date: Data are primarily from 2002.
Unit: N/A
Data Source Location: UNESCO Web Site, Gross Enrolment Ratios, and Gender Parity Index, tertiary (ISCED 5&6), for school years 1998/1999 to 2004/2005, UNESCO, May 2005.
Reference: UNESCO, Institute for Statistics, Gross Enrolment Ratios, and Gender Parity

Index, tertiary (ISCED 5&6), for school years 1998/1999 to 2004/2005, New York, United Nations, May 2005.

FDI = Foreign Direct Investment (Net Inflow, Balance of Payments)

Date: Data are primarily from 2003.
Unit: Current US Dollars
Data Source: World Bank World Development Indicators 2004 (CD).
Reference: World Development Indicators 2004, New York, World Bank, April 2004.

PatApNon = Patent applications by non-residents

Date: Data are primarily from 2001.
Unit: Applications
Data Source Location: WIPO Website (http://www.wipo.int/ipstats/en/statistics/patents/index.html)
Reference: Industrial Property Statistics, Patent Applications Filed and Patents Granted, Geneva, WIPO, 2001.

TECHNOLOGICAL INFRASTRUCTURE (TI)

The institutions and resources that contribute to a nation's capacity to develop, produce, and market new technology

Formula: **TI (T) = [S((Q7+Q8)/2)+SQ9+SQ11+SEDP-2005+SS&E]/5**
TI (S) = [SEDP-2005+SS&E+ SRATIOROYL + SICTCON + SPatApRes + SBIBLIO + SR&DEXP]/7

Q7 = To what extent is this country capable of replenishing and increasing its supply of qualified, graduate-level (post-baccalaureate) scientists and engineers via local (indigenous) training and educational institutions?

Q8 = How would you characterize this country's contribution to the international pool of significant scientific and technical knowledge?

Q9 = To what extent do R&D activities in this country relate to industrial enterprise?

Q11 = The acquisition of "technological mastery" (the ability to make effective use of technological knowledge) is critical to development of technology-intensive products. To what degree has this country achieved technological mastery?

EDP2005 = Electronic data processing equipment purchases for 2005 as obtained from the Reed Electronics Research

Date: Data are based on estimates of 2005 purchases.
Unit: 1,000 of US Dollars
Data Source Location: Volume 3, Table 2.4.4, *Yearbook of World Electronics Data 2004/2005*, Reed Business Information Ltd, England, 2005. [http://www.rer.co.uk]
Reference: Reed Electronics Research. 2005. *Yearbook of World Electronics Data 2004/2005.* Surrey, United Kingdom. Reed Electronics Research Ltd.

S&E = The number of scientists and engineers engaged in research and experimental development as defined by UNESCO.

Date: Data are drawn from different years with many from 2001.
Unit: Number of Individuals
Data Source Location: UNESCO Web Site, *Science and Technology, Research and development (R&D) personnel by occupation (1996-2002)*, Institute for Statistics, UNESCO,

May 2005.
Reference: UNESCO, Institute for Statistics, *Science and Technology, Research and development (R&D) personnel by occupation (1996-2002)*, New York, United Nations, May 2005.

RATIOROYL: Ratio of royalty and license receipts /royalty and receipts payments (Balance of Payments)

Date: Data are from 2002.
Unit: Current US Dollar/Current US Dollar
Data Source: World Bank World Development Indicators 2004 (CD).
Reference: World Development Indicators 2004, New York, World Bank, April 2004.

ICTCON: "Connectivity" measure defined as the minimum set of measures necessary for ICT access, comprising Internet hosts per capita, PCs per capita, telephone mainlines per capita, and mobile subscribers per capita.

Date: Data are from 2001.
Unit: N/A
Data Source: http://www.unctad.org/en/docs/iteipc20031_en.pdf
Reference: United Nations Conference on Trade and Development, *Information and Communication Technology Development Indices*, New York & Geneva, United Nations, 2003.

PatApRes: Patent applications by residents.

Date: Data are from 2001.
Units: Applications
Data Source Location: WIPO Website (http://www.wipo.int/ipstats/en/statistics/patents/index.html).
Reference: Industrial Property Statistics. 2001. *Patent Applications Filed and Patents Granted during 2001*, Geneva, WIPO.

Biblio: A measure of scientific and technical publishing as indicated by bibliometric measures on data from the EI Compendex database, accessed via the Engineering Village 2 website.

Date: Data are publications for 2004.
Unit: N/A
Data Source: GT/TPAC bibliometric analyses
Reference: Georgia Institute of Technology, Technology Policy and Assessment Center.

Methodology: Six emerging technologies (ETs) were selected based on the RAND Science & Technology Policy Institute industrial Critical Technologies survey. Coverage in EI Compendex was notably superior to that in INSPEC for each. We retrieved samples of 4000 records for each ET for 2004.

Emerging Tech	**EI Compendex Class. Code**	**Limits**	**EI Pub. Count**
Nano (Crystal) Structures & Mtls	933.1	Year=2004	27848
Advanced materials for comp/comm tech	(549.3 OR 712.1)	Year=2004	23550
Semiconductor Devices & IC's	714.2	Year=2004	46464
Optics	(741.1 OR 741.3)	Year=2004	83158
Biotech	461.*	Year=2004	67797
Fuel/Solar Cells	(702.2 OR 702.3 OR 801.4.1)	Year=2004	11479

We calculate an S-Score as a measure of publication activity of a country (CountryTotal) compared to the publication total of the leading country (USATotal), expressed as a percentage. That is: (CountryTotal/USATotal * 100)
Six S-Scores are calculated for each country (one per ET) and the average of those six S-Scores is the indicator value.

R&DEXP: Research and Development Expenditures.

Date: Data are from a range of years.
Unit: US Dollars
Data Source: World Competitiveness Report 2005 (http://www.imd.ch/wcc).
Reference: IMD World Competitiveness Yearbook 2005, International Institute for Management Development (IMD), Lausanne, Switzerland.

PRODUCTIVE CAPACITY (PC)

The physical and human resources devoted to manufacturing products, and the efficiency with which those resources are used.

Formula:

PC (T) = [S((Q6+Q12+Q13)/3)+SA26-2005/2]/1.5 [7]
PC (S) = [SA26-2005 + SMVA + SSVA]/3

The PC (T) values reported in Science & Engineering Indicators 2006 differ slightly. This is because we used a relative scaling -- the "maximum" country value on the question items, combined, as 100. That was done in the context of an effort to reduce ceiling effects on survey responses. However, since HTI are moving to the Statistics-only formulation, and we want to retain time series comparability, we herein revert to the absolute 100 scaling for these question items used
historically.

Q6 = Please rate the quantity and quality of skilled manufacturing labor available in this country.

Q12 = To what extent does a system of indigenous producers of components for technology-intensive products exist?

Q13 = Please rate indigenous industrial management capabilities to develop, produce, and market technology-intensive products.

A26-2005 = The value of total electronics production for 2005 as obtained from the Reed Electronics Research.

Date: Data are an estimate of 2005 production.
Unit: 1,000's of US Dollars

Data Source Location: Volume 3, Table 2.3.4, Yearbook of World Electronics Data 2004/2005, Reed Business Information Ltd, England, 2005. [http://www.rer.co.uk]
Reference: Reed Electronics Research, 2005, Yearbook of World Electronics Data 2004/2005 Surrey, United Kingdom, Reed Electronics Research Ltd.

[7] The PC (T) values reported in *Science & Engineering Indicators 2006* differ slightly. This is because we used a relative scaling -- the "maximum" country value on the question items, combined, as 100. That was done in the context of an effort to reduce ceiling effects on survey responses. However, since HTI are moving to the Statistics-only formulation, and we want to retain time series comparability, we herein revert to the absolute 100 scaling for these question items used historically.

MVA: Manufacturing Value Added.

Date: Data are from primarily 2001.
Unit: Current US Dollars
Data Source: World Bank World Development Indicators 2004 (CD).
Reference: World Development Indicators 2004, New York, World Bank, April 2004.

SVA: Services Value Added.

Date: Data are from primarily 2001.
Unit: Current US Dollars
Data Source: World Development Indicators 2004 (CD), World Bank.
Reference: World Development Indicators 2004, New York, World Bank, April 2004.

INPUT (T, S)

This composite simply sums up (as INPUT (Sum)) the four Input Indicators: NO, SE, TI, and PC. In the past, we sometimes calculated INPUT (Average) – which is just INPUT Sum divided by 4. Conceptually these two are equivalent – an overall leading indicator of potential future high tech competitiveness. INPUT (Average) retains the 0-100 scale, whereas INPUT (Sum) makes visualization of the four indicators together attractive (e.g., as a stacked bar chart). Our default form is "INPUT" (IN) which is really INPUT (Sum).

Formula: **IN (T) = [NO (T) + SE (T) + TI (T) + PC (T)]**
IN (S) = [NO (S) + SE (S) + TI (S) + PC (S)]