

High Tech Indicators
Technology-based Competitiveness of 33 Nations
2007 Report

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Executive Summary

This report presents the traditional Georgia Tech High Tech Indicators (“HTI”) for 2007. It provides time series comparisons for 1993, 1996, 1999, 2002/3, 2005, and 2007. These compare 33 countries on a present competitiveness indicator, Technological Standing. We also provide four leading indicators – National Orientation, Socioeconomic Infrastructure, Technological Infrastructure, and Productive Capacity – that point toward future competitiveness prospects. We don’t strive to report HTI findings here, other than to note that China has replaced the USA at the top on Technological Standing. This reflects certain peculiarities of HTI, but more importantly, an astounding rise over the past 15 years.

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

Reed Elsevier, from the *Yearbook of World Electronics Data 2006/2007*, generously provided: electronics data processing purchases, electronics production, and electronics exports.

The PRS Group, Inc. kindly provided the January 2007, issue of the *Political Risk Letter*, from which we draw the 5-year investment risk forecast index.

We also draw upon other data resources, particularly from the United Nations, as indicated in the Appendix.

Overview

High Tech Indicators – Traditional - 2007 [**HTI(T)-07**] compares the technological competitiveness of 33 nations, including a large number of industrializing economies. This continues a series prepared every three years since the late 1980's. Note:

- We shifted the cycle – we now name the indicators according to the year in which they are produced instead of the year of the latest data source used; key point – the “2002/3” HTI really lags the “1999” HTI by only three years. Also, we have shifted to a 2-year cycle to align with Science & Engineering Indicators.
- This (2007) is a transition year. We herein provide HTI in the traditional format, as composite indicators based on a mix of statistical time series data and expert panel judgments.
- We are developing a new data series based solely on statistical measures. In conjunction with this changeover, we expand the statistical coverage to address “information economy” (i.e., service) elements to expand HTI focus beyond technology-intensive manufactured products. We will report on High Tech Indicators – Statistics Only – 2007 in another report as we refine the statistical components.

Country coverage remains consistent with recent years (33 countries). We generally report herein using the geo-categories introduced in HTI-2005:

- *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
- *Other* – Australia, Israel, New Zealand, Russia, South Africa

The countries are listed alphabetically within regional grouping, with the exception of the U.S., placed first to expedite U.S. comparisons.

Traditional HTI Indicator Definitions

The conceptual definitions of the traditional indicators follow. They are the same as those used in the 1993-1996-1999-2002/3-2005 studies. Each indicator is comprised of both *statistical data* (“S”) and data from a *survey of experts* (“E”). Full operational definitions of the indicators and sources of data for the indicators appear in the Appendix. A complete listing of indicator scores for the years 1993 to 2007 are available in Tables section.

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; for statistical data, 100 typically represents the value attained by the country with the largest value among the 33-country set. “0” reflects the lowest possible value – the minimum value for survey items. In the event a country has a negative statistical value (e.g., Foreign Direct Investment), values are adjusted upward to have the lowest negative value set as an S-score of 0. Thus, this is a relative scaling so that a country’s apparent “decline” over time or low score is only relative to the other countries in the set of 33. [In 2007, we have also provided data to the NSF that are rescaled to locate the USA at 100.]

Questions used and statistical data sources, and variable definitions are detailed in the HTI Appendix: Indicator Formulations and Data Sources (included herein). The questions are also available, as posed, in the HTI 2007 Survey at //tpac.gatech.edu.¹

We present one Output indicator – Technological Standing – and four Input indicators – National Orientation, Socioeconomic Infrastructure, Technological Infrastructure, and Productive Capacity.

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

S: value of high tech exports; value of electronics exports

¹ Although the online survey orders the questions A through P, this report and all past reports discuss the survey in terms of numbered questions. Question 1 is item C on the web survey, Question 2 is item D, etc... Question 14a is item P 1 (present) and Question 14f is item P 1 (future).

E: question addressing current high technology production capability.

The emphasis on electronics reflects our assumption that this has been a vital contributor to much high technology development in recent years.

Traditional Indicator formulation: $TS = (X)/3 + (A2)/3 + (Q14a)/3$

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.

S: investment risk index (constructed from the Political Risk Services data series)

E: questions addressing national strategy, implementation, entrepreneurship, and attitudes toward technology.

Traditional Indicator formulation: $NO = Q1 + (Q2 + Q3)/2 + Q4 + F1V/4$.

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.

S: Harbison-Myers Human Skills Index (from UNESCO data on % in higher education and % in secondary school)

E: questions addressing national policies toward multinational investment, mobility of capital.

Traditional Indicator formulation: $SE = (Q5 + Q10 + HMHS)/3$.

Technological Infrastructure (TI). Institutions and resources that contribute directly to a nation's capacity to develop, produce, and market new technology. Central to the concept are the ideas of economic investment and social support for technology absorption and utilization. These could take the forms of monetary payments, laws and regulations, and social institutions. Also included is the physical and human capital in place to develop, produce, and market new technology.

S: number of scientists in R&D; electronic data processing purchases

E: questions addressing technical training and education, contributions to knowledge, R&D with industrial relevance, technological mastery.

Traditional Indicator formulation: $TI = [(Q7 + Q8)/2 + Q9 + Q11 + EDP + S\&E]/5$.

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

S: electronics production

E: questions addressing supply of skilled labor, indigenous component supply, indigenous management capability.

Traditional Indicator formulation: $PC = [((Q6+Q12+Q13)/3)+A26/2]/1.5$

Expert Panel

From the outset in the mid-1980's, we have sought statistical data to inform the HTI indicator set. However, many of the core conceptual aspects of the indicators did not lend themselves to regular statistical series. That is improving and, hence, we are developing an alternative, statistics-only HTI series. However, even as we do so, we find that many essential components must "reach" to find statistics relating to them. So, we remain interested in what experts can tell us about the underlying capabilities for technological competitiveness. This year we have further tightened the checks on our expert responses.

Expert opinion data were obtained from a survey of the International Technology Indicators Panel running from February 15 through June 28, 2007. Surveys were completed through a website interface [\[at http://tpac.gatech.edu/\]](http://tpac.gatech.edu/), with most invitations via e-mail. The resulting expert responses were screened to yield 392 high quality responses (procedure is explained below). This yielded an average of almost 12 responses per country. All countries' bases for technological competitiveness were judged by at least 10 respondents, after filtering, except for Russia with 9.

Individual responses are generally complete for all core (i.e., used herein) items. Total possible core item responses equals 15 questions X 421 = 6315; we received 6296 = 99.7%. For the sector-specific questions (sub-items of Question P concerning status of aerospace, etc.), the completion rate is lower – 93.8%.

Variance among respondents gives useful information on the relative coherence of the information obtained. Do knowledgeable observers share perceptions of the status of a range of contributing factors? As noted, we have gathered and filtered to 10 or more responses per country, with one small exception (Russia with 9).

Are respondents for certain countries less in agreement than for others? Overall, the item standard deviations range from 0.60 to 0.85. The countries with the greatest

disparity among respondents are Russia (SD = 0.85); Brazil (0.84); Australia, Indonesia and the USA (0.80); Spain (0.79); and Venezuela (0.74).

Within-country Item standard deviations for the 15 items used in HTI(Traditional) average 0.70 (Standard Deviation of those SD's is 0.12). To illustrate using the first particular item noted with that within-country SD (Israel, Question 7), 7 responses of "5," 3 of "4," and 1 of "3" yield this degree of variance. This strikes us as a reasonable level of agreement. Only two questions elicit a wider range of responses, on average. Question 3 (do influential groups favor technological development?) at a SD of 1.01 and Question 1 (does government have a deliberate strategy to promote technology-intensive production for export?) with SD of 0.84 exceed 0.78. Using those two questions to illustrate, the range of country responses (averages over respondents) for Q3 is from 2.6 to 4.8; the range for Q1 is from 2.0 to 4.8. This sort of across-country variability compares reasonably to the degree of within-country variability. The responses thus seem reasonably robust.

The Appendix includes a sampling of insightful comments received.

Panel Background

Beginning in the late 1980's, we have worked together with our National Science Foundation colleagues to invite selected professionals to serve on the International Technology Indicators Panel. Our criteria include direct knowledge of the country and of the bases for technological competitiveness. Prototypical experts include embassy science attaches, faculty members, and industrial professionals. Attendees at international conferences and participants in journal advising and publishing relating to technology analysis, forecasting, management, and so forth also are good candidates for the Panel. We also apply "snowball" procedures – inviting respondents to ask colleagues whom they deem qualified to participate too. We seek balance among multiple perspectives, and between indigenous and external "watchers." We invite various persons who appear to meet these criteria to participate, but ultimately self-selection comes into play. The respondents indicate their familiarity on a self-report scale item.

Over time, turnover in membership has been high. Only about one-third (33.6%) of the 2007 respondents had participated in 2005. The overall number of respondents has ranged around 400 for 2003 (412), 2005 (386), and 2007 (421).²

Screening

We discarded respondents who rated their expertise as low and/or provided responses that deviated markedly from their peers.

² Internal TPAC document, "hti07-respondent summary.doc" keeps track of number of respondents by country over time and other details.

The principles at work in screening responses are:

- a. Examine the self-rating
- b. Examine average response deviation from the mean (across the 15 items that we use in constructing HTI
Q1-13; Q14a; Q14aF)
- c. Check # of respondents per country.

Stepwise process:

1. Examine each respondent self-rating "1" (less familiar); if we have at least 6 other respondents for that country; discard this response.
2. Drop any responses that have a large (greater than 5) number of missing question responses.
3. Check that respondent's average absolute deviation on the 15 items, adjusting accordingly for missing items.
4. Check respondents with a self-rating of 2 ("moderately familiar"). If their average deviation is > 1 , discard.
5. Check respondents with a self-rating of 3 or 4. If their average deviation is greater than >1.5 , discard.

The primary Excel file provides individual responses, by item, by country. One can peruse these to get a sense of the degree of consensus reflected. Intermediate rows of all blanks reflect removal of responses by individuals who gauged their knowledge of the country's technological competitiveness as "1" – "less familiar." Since we obtained a sufficient number of raw responses for each country to meet the threshold, all "1's" were eliminated. Blank rows with an entry in Column A reflect respondents excluded based on the indicated formula due to high discrepancy with the set of respondents (high absolute deviation).

Below each country's respondent entries are rows giving the # of responses, mean, and standard deviation for each item. In Column B of each "StDev" row is the mean of the standard deviations for the 14 items used in HTI(T). These average 0.73 +/- 0.08 (responses range from 1-5, with one exception, Q3, scaled 1-6). The one country that showed a particularly high spread, India, was closely reviewed.

Beyond applying the formula, we examined problematic respondents. Only ten showed a sum of absolute deviations averaging greater than 1. The highest (1.44 – for Korea) was removed as this reduced the 14 key item SD's by almost 11% for Korea. The three respondents for India with absolute deviations averaging greater than 1 were considered as a set. Their removal reduced India's key item average SD by 18%, so they were also removed. The outlier at 1.30 for New Zealand was removed, reducing its key item SD by 11%. Responses for Venezuela tended to have high standard deviations (mean of 0.88 across the key items). The two respondents showing at 1.16 and 1.00 average absolute deviation were not so different from some other respondents (other high absolute deviations were 0.96 and 0.84). Furthermore these two tended to

counter each other's perspectives, so they were not removed. Given Venezuela's somewhat controversial politics, diversity in perspectives does not seem unreasonable. The other three respondents with average absolute deviations of 1.04 were retained as not affecting results sharply – in other words, not deviating highly from the other respondents (one each for US, UK, and Brazil). [Selected comments in Appendix 2 offer some thoughts on the situation in Venezuela.]

Results: INPUT Indicators

At this time (July, 2007), we provide HTI(T)-07 results to facilitate their incorporation into S&EI. We will later provide a Summary Report that also treats the HTI(S)-07 results. This section highlights some interesting points in the tables and charts.

NOTE; HTI incorporate statistical series data that are often updated over time. For instance, several of the series, such as scientists & engineers, routinely lag several years for certain countries. As improved values are incorporated, and we obtain those, we include them in our HTI calculations. Thus, selected indicator values may be slightly revised over time. We also note that the graphical values in *S&EI-2006* in Figure 6-20 are rounded and deviate slightly from the more exact (and updated) values provided in Appendix Table 6-9.

Cautions in interpreting indicator values – these are relative “S-scores” among a select group of 33 highly developed and industrializing nations. A “decline” could well reflect actual increase in capabilities, but at a rate slower than others. Also, these indicators blend scaled items (with limited scoring range) with statistical items (that can vary enormously). Additionally, HTI focuses on national capability to compete in international markets; values are not normalized. Many other sources of indicator series report on per capita or other normalized data – their relative positioning will differ greatly from HTI. On some indicators, small economies will obviously be dwarfed by giant ones. On the other hand, some other indicator series would suggest that nations such as China are not major players; we believe that HTI provides a critical alternative perspective. [Some comments in Appendix 2 relate to economic scale considerations.]

All this said, HTI (Traditional) especially offers insight in tracking national shifts over time. We report herein on HTI-1993 through HTI-2007. This enables generating a grounded assessment of which industrializing countries are positioning themselves more favorably on the leading indicators to suggest future gains in technological competitiveness. Again, be aware that HTI were developed to track changes by those industrializing economies; inclusion of OECD nations was mainly to provide benchmarking. The indicator components are more appropriate for tracking industrializing than highly developed countries.

Results shown in charts here use the standard traditional S-scores. In 2007, we have also provided data to the NSF that are rescaled to locate the USA at 100. For an

indicator on which the USA is not already at 100, this is a simple multiplication of all S scores by 100/USA value.

National Orientation (NO):

Scanning changes in NO over time (See Figure 1):

- Japan (current NO at 75.7) had drifted downward from 1993, but shows a rebound from 2005 to 2007 to approach comparability with the US (78.0).
- The Asian Tigers -- Singapore, South Korea, and Taiwan -- have drifted downward somewhat from their leadership position in the 1990's, now appearing at levels similar to the US.
- Ireland and Israel entered HTI in 1999 with the highest NO values in that year; they have also moderated somewhat since then. Ireland has actually bounced back from a lower NO value in 2005 to lead the pack at 83.4.
- 16 of the 33 countries present strong National Orientation toward technology-based competitiveness (ranging from 69.2 to 83.4). Figure 2 shows the distribution. These leaders include the OECD and Asian Tiger nations predominantly.
- A next NO tier includes 15 nations (ranging from 54.7 to 66.0). This group includes France and China which one might have expected to be in the top tier.
- Two nations trail – Argentina (46.3) and Venezuela (33.5).

Comparing NO-07 with NO-05, the notable changes are:

- Rise: Russia (+15.6), Indonesia (+10.7), Ireland (+9.3)
- Decline: China (-11.7), Australia (-10.1), and Italy (-9.1)

Given that NO(T) derives mainly from expert opinion, it can react quickly to changing climates. China's reversion from a higher NO position in 2005 might signal an important shift toward moderating rampant economic growth (or it might be that the 2005 score was an anomaly as the current NO value is in line with all prior NO levels since 1993). Ireland's increase followed decreases since 1999, so this may be largely noise in the indicator. Russia's marked increase could indicate an important emerging commitment following an extended dormancy. Indonesia's increase reverses a downward drift since 1993. Australia was near its current level in 1993 and 1996, then rose to about 10 points higher (1999, 2003, 2005), but now has declined.

The selected comments (Appendix 2) offer some interesting perspectives, particularly on Russia, Ireland, Italy, and Venezuela.

Figure 1. National Orientation: 1993-2007

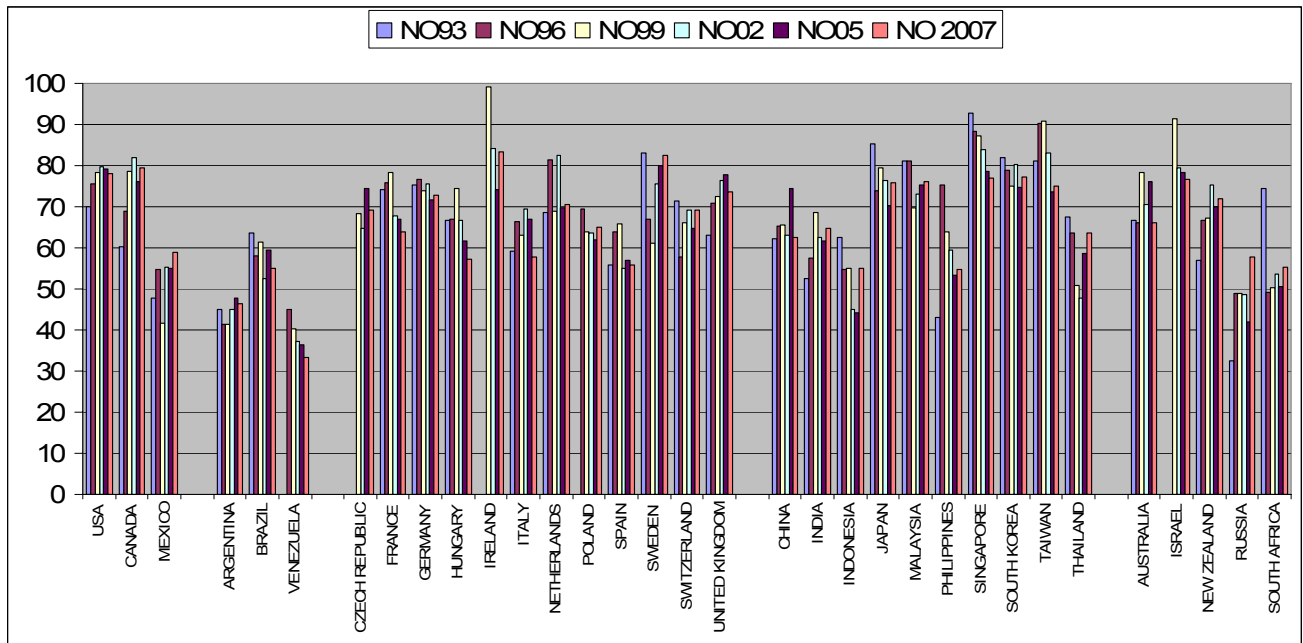
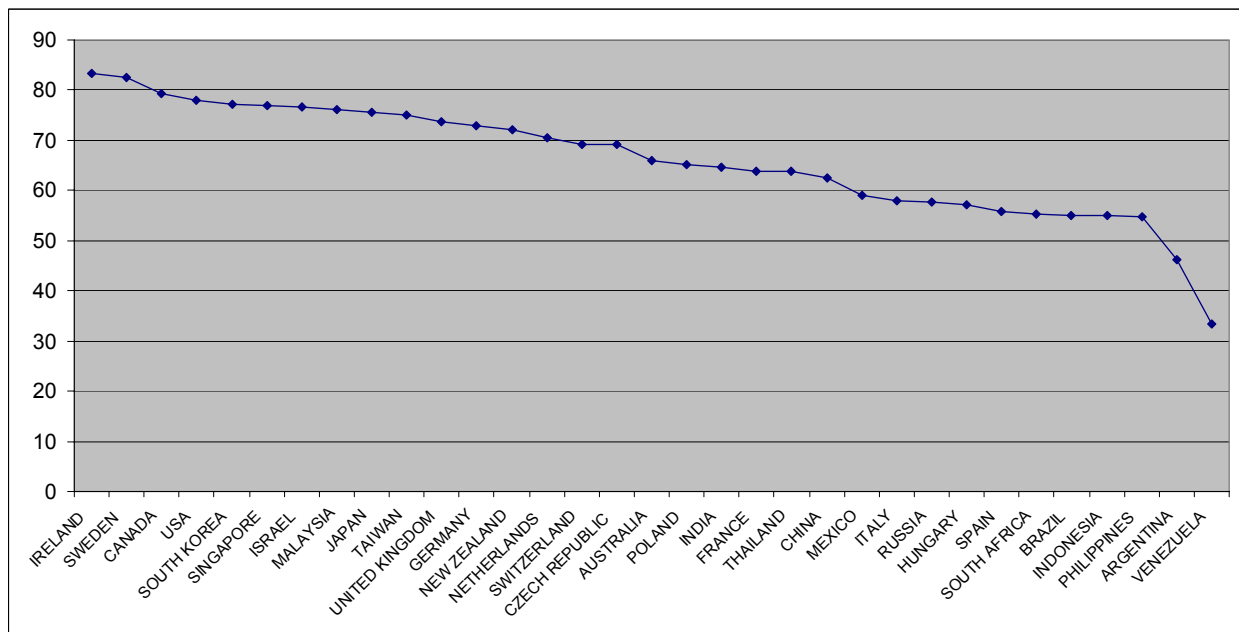


Figure 2. National Orientation, 2007



Socioeconomic Infrastructure (SE)

Scanning changes in SE over time (See Figure 3):

- The US continues to lead in SE (87.9).
- A plot by descending SE score in 2007, Figure 4, is quite linear, from the US down to Venezuela (40.6). As with NO, the OECD and Asian Tiger nations show strongly.
- Seven nations are notably lower than the others – beginning with the lowest scoring country: Venezuela, Indonesia, Brazil, Mexico, South Africa, The Philippines, and India.

SE-07 correlates highly with NO-07 (0.84). However, we don't see the extreme changes from 2005 in SE that we did for NO (Figure 1). The leading gainers and losers:

- Rise: South Korea (+8.5), Thailand (+7.9), New Zealand (+7.7), Argentina (+7.7), and Indonesia (+7.7)
- Decline: Venezuela (-7.2) and Australia (-7.0)

Russia (+6.2 for SE) and Indonesia have increased notably in NO and SE (and TI) – potential barometers of things to come if these sustain. Conversely, Venezuela and Australia show major drops on both NO and SE.

Figure 3. Socioeconomic Infrastructure: 1993-2007

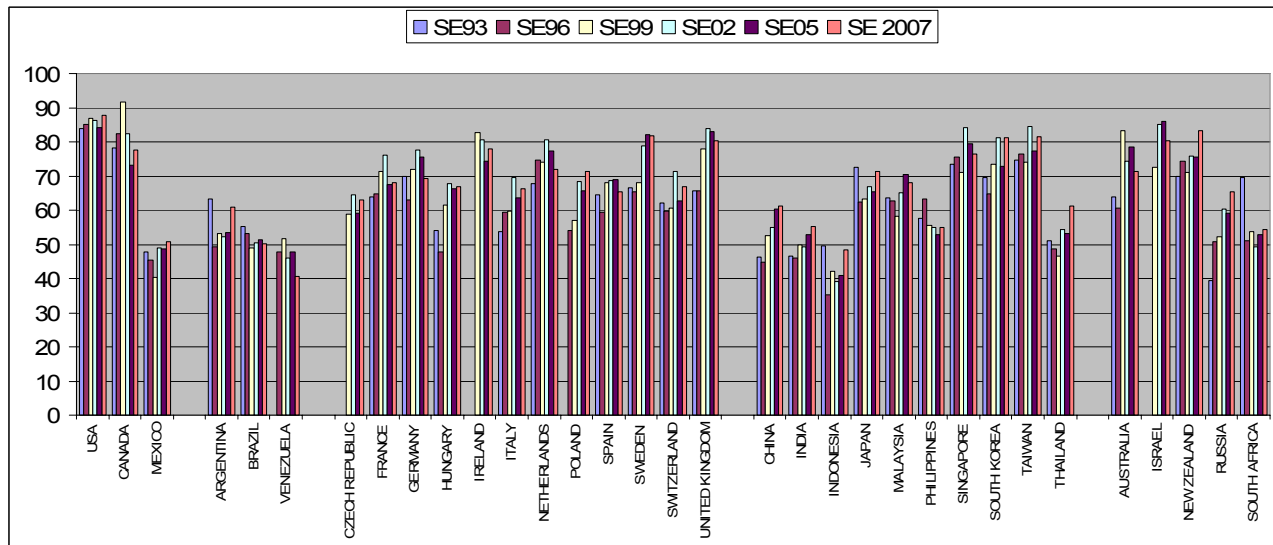
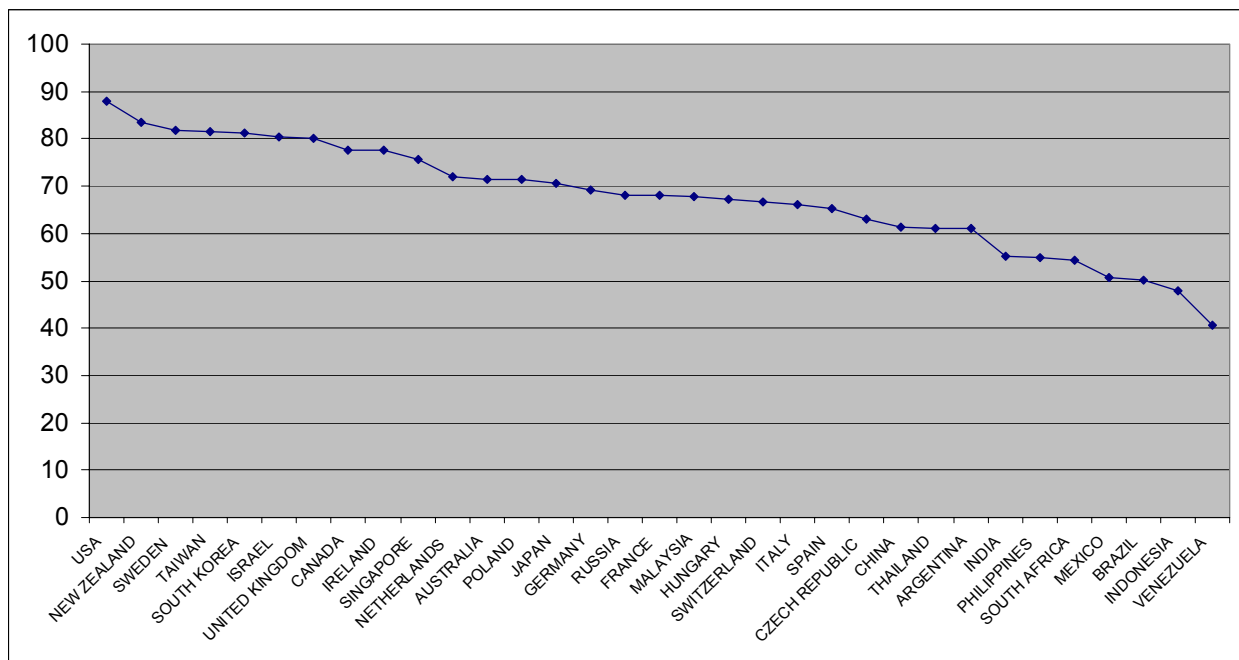


Figure 4. Socioeconomic Infrastructure, 2007



Technological Infrastructure (TI)

A plot of the TI values since 1993 sends strong signals (Figure 5):

- The US dominates. Its relative advantage over #2 Japan continues to expand.
- The other prominent feature over time is the ascendancy of China over this period, although it dipped from 2005 to 2007 (now standing ahead of #4 UK, behind #3 Germany)
- A plot of TI-07 in descending order (Figure f) finds a big gap between the US and Japan, followed by a moderately sloping line for all others.
- Three trailers are Venezuela, The Philippines, and Thailand.

Changes in TI between 2005 and 2007 are relatively modest:

- Rise: Indonesia (+6.6), Spain (+4.8), Mexico (+4.1), and Russia (+4.0)
- Decline: Singapore (-6.8), The Philippines (-5.9), and Sweden (-5.6)

Figure 5. Technological Infrastructure: 1993-2007

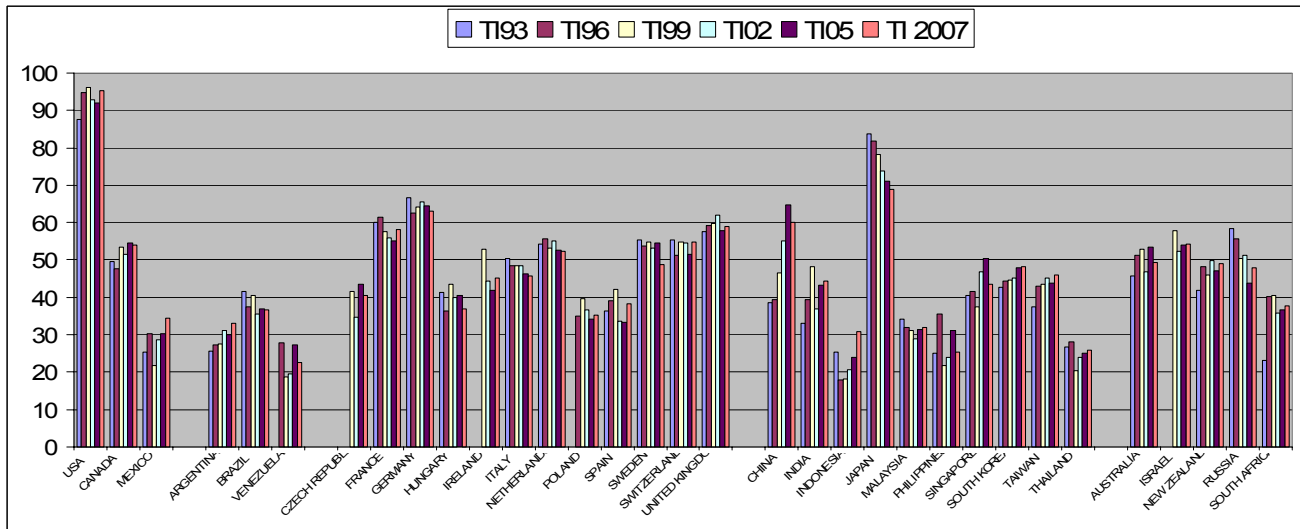
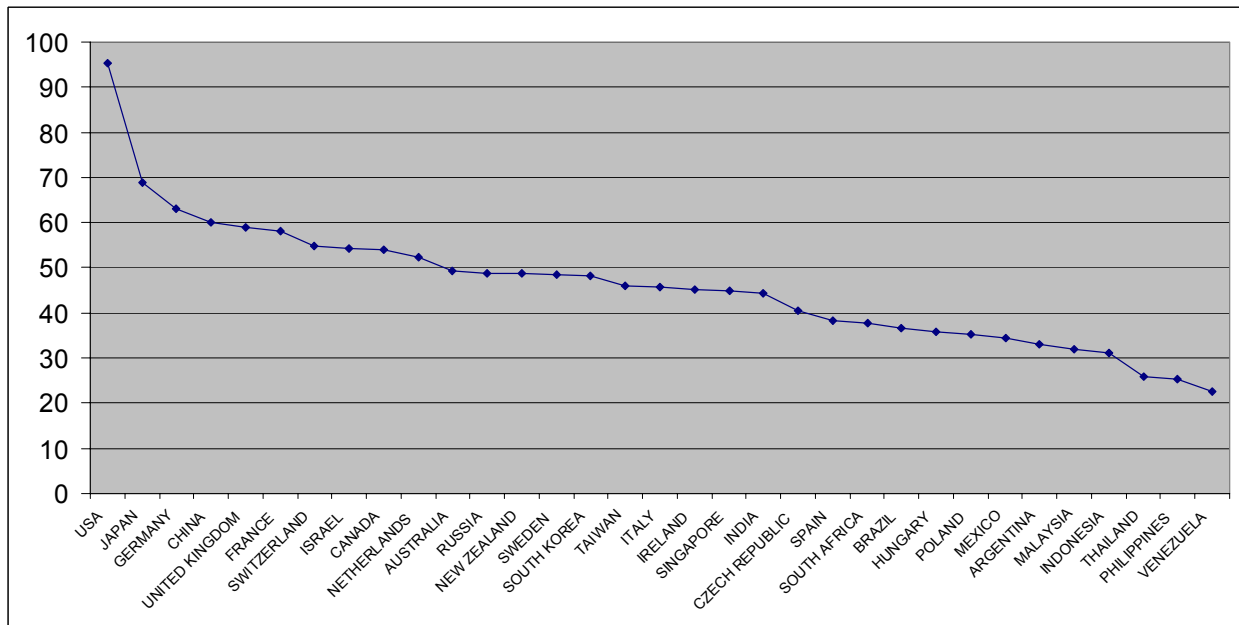


Figure 6. Technological Infrastructure, 2007



Productive Capacity (PC)

A plot of the PC values since 1993 (Figure 7) shows quite interesting changes:

- In 2007, Japan -- the leader in 1993-96 and ~co-leader through 2005 -- has slipped considerably behind the emergent leader, the US.
- Since 1996, China has leapt from a lowly 32.8 to 85.2, approaching second positioned Japan with another big gain in 2007
- A plot of PC in descending order (Figure 8) again finds the upper echelon dominated by OECD and Asian Tiger nations.
- Venezuela anchors as the lowest score (32.2) by a sizable margin below South Africa (40.3), with Thailand, Argentina, Indonesia, Brazil, The Philippines, and Spain also in the 40's.

Changes in PC between 2005 and 2007 are uneven:

- Rise: China (+12.7), Mexico (+7.7), New Zealand (+6.6), Malaysia (+6.8), and South Korea (+6.6)
- Decline: Venezuela (-6.3), The Philippines (-5.2)

Figure 7. Productive Capacity: 1993-2007

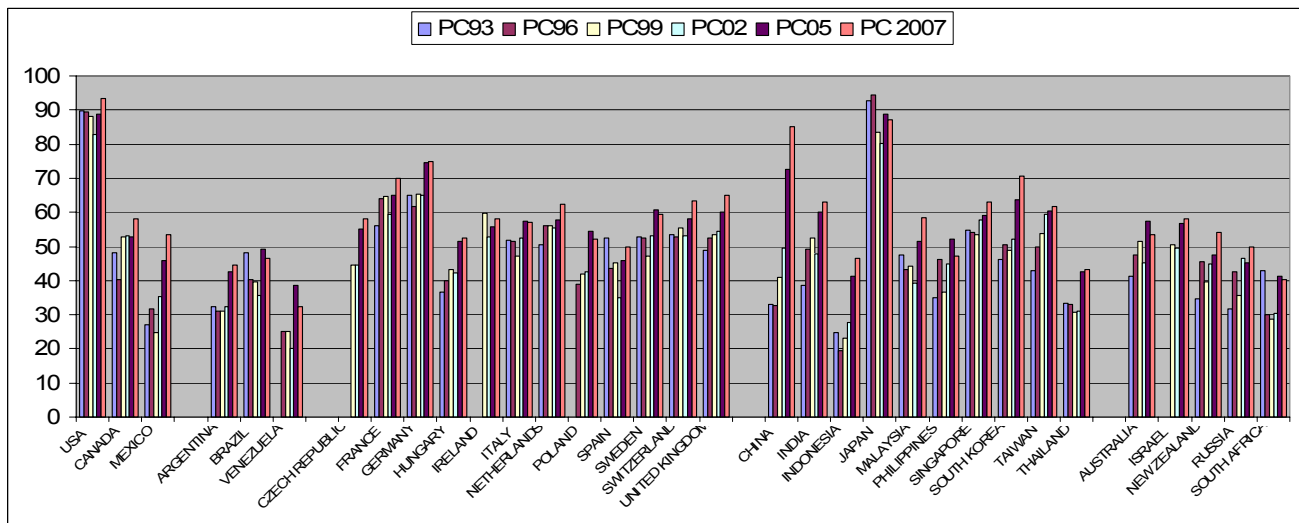
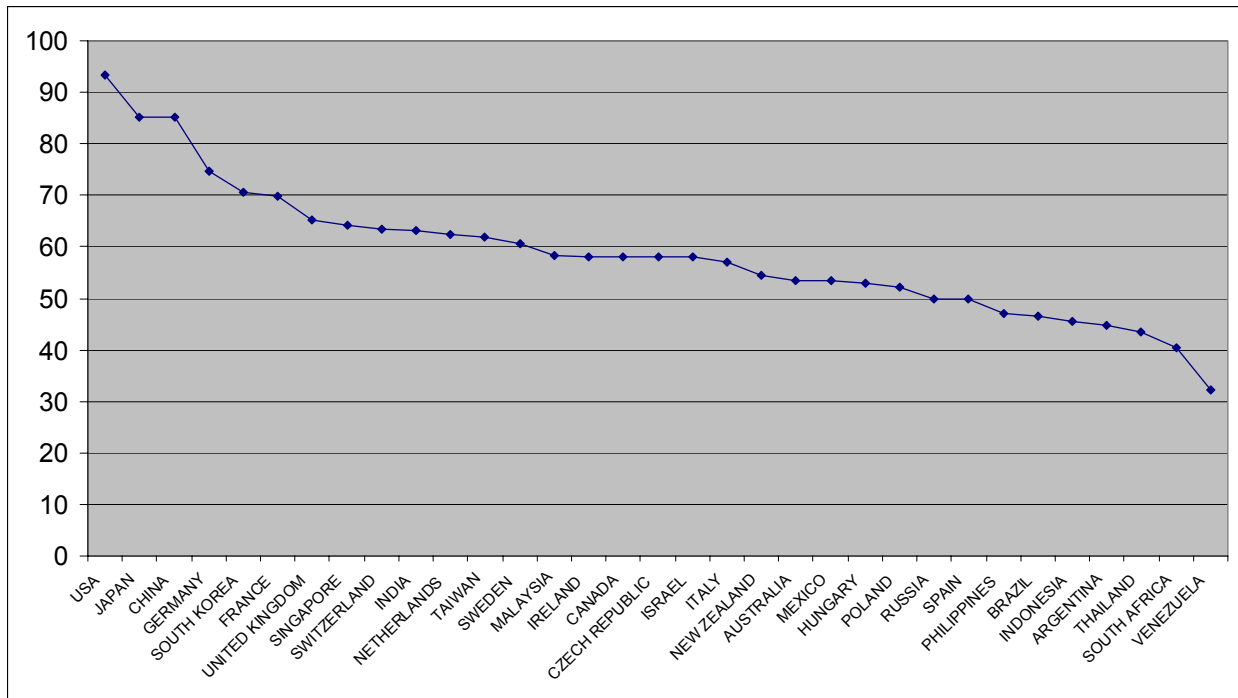


Figure 8. Productive Capacity, 2007



Besides bringing up the rear on each of the four Input indicators, Venezuela also stands out as a decliner between 2005 and 2007 on SE, TI (-4.7, just below the leaders), and PC. The Philippines also shows as both low and declining on TI and PC.

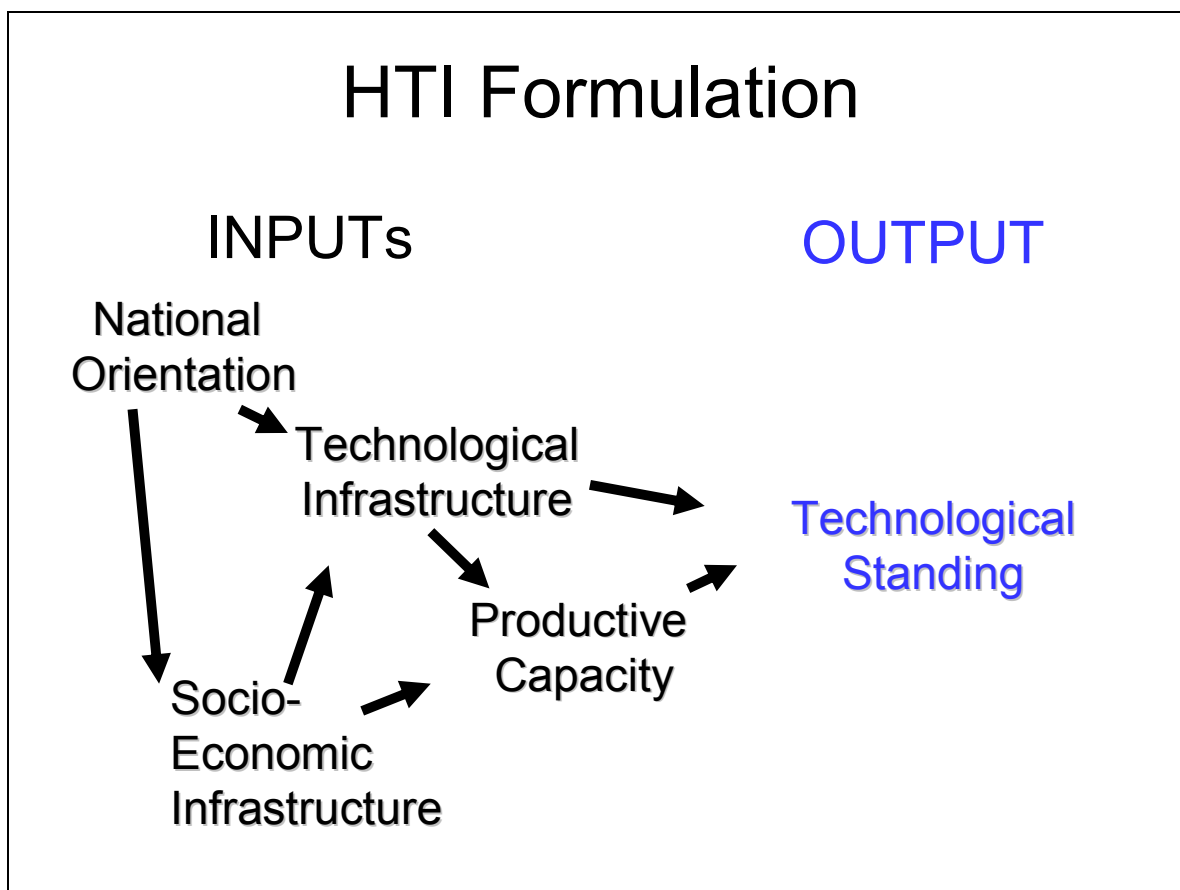
China's profile is intriguing. It is extremely high and rising fastest on PC. It shows very strong on TI, but with a dip from 2005 to 2007. It is 'middling' on NO and SE, and showed a sharp drop on NO from 2005 to 2007. And it is now #1 on TS. What does this portend for its future development? The indicators suggest tremendous short-term momentum for continued growth in technological competitiveness, but some flags of potential concern longer term.

PC correlates highly with TI (0.84). As we have observed previously, the four leading indicators split into two subgroups. Correlations between (NO or SE) and (TI or PC) range from 0.52 to 0.64 – considerably less than within the subgroups (as noted, NO with SE is 0.84, and PC with TI is 0.84, for 2007).

NO and SE act as long-term infrastructural elements. TI and PC are more proximate predictors of future Technological Standing (TS). Figure 9 sketches the relationships

schematically. Correlations with TS differ dramatically: NO-TS is 0.44 and SE-TS is 0.34; but TI-TS is 0.75 and PC-TS is 0.92. Conceptually this is reflected in Figure 9. However, the degree of association is undoubtedly colored by indicator composition as TI, PC, and TS incorporate relatively more statistical components that accentuate the range of differences among these countries, relative to expert opinion items.

Figure 9. The HTI Predictive Model



INPUT:

This composite simply averages the four Input Indicators: NO, SE, TI, and PC. Figure 9 might suggest differential treatment. In some prior year HTI's we reported on the INPUT-Sum. Conceptually these are essentially the same – an overall leading indicator of potential future high tech competitiveness. Computationally, INPUT-Sum is just 4x INPUT. INPUT retains the 0-100 scale, whereas INPUT-Sum makes visualization of the four indicators together attractive (e.g., as a stacked bar chart).

Figure 10 shows the progression of INPUT over this 15-year time period. Recall that the indicators use relative 0-100 component scoring (S-scores). [For easier viewing, the reader may wish to zoom in.] Some observations:

- General stability is the rule.
- North American countries have increased on this leading indicator composite.
- South American countries have not – Argentina has since 1996; Brazil is essentially stable; Venezuela shows a bit of decline. Overall, this is the weakest geo-group.
- European nations, both Eastern and Western, show a generally upward incline (Spain is pretty stable).
- Asia is surprisingly mixed on INPUT changes. China is the strongest riser anywhere, with India also showing marked increase. Japan has dipped, although tipping upward for 2007. The Tigers are quite high, with Singapore steady over time and South Korea and Taiwan increasing. 7 of 10 Asian countries represented show a 2007 over 2005 positive change.
- For the five Other countries Russia shows notable increase, as do Australia (not for 2007) and New Zealand. Israel is steady and very high. South Africa lags.
- With a broad brush, note how comparable the Asian country scores (probably excepting Indonesia, the Philippines, and possibly Thailand) are to the European ones.

Figure 10. INPUT: 1993-2007

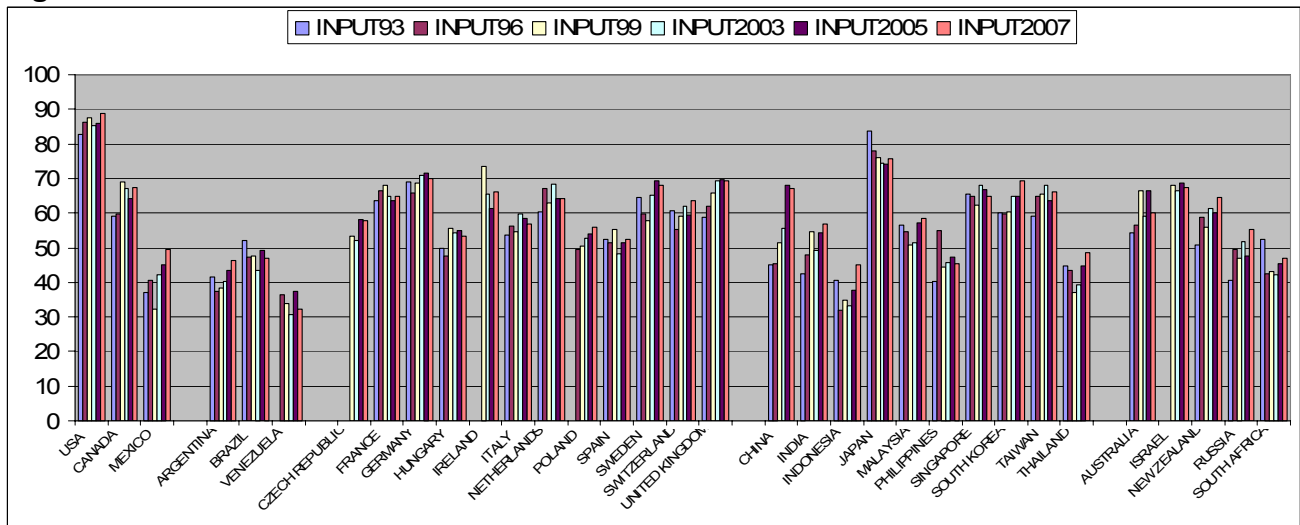
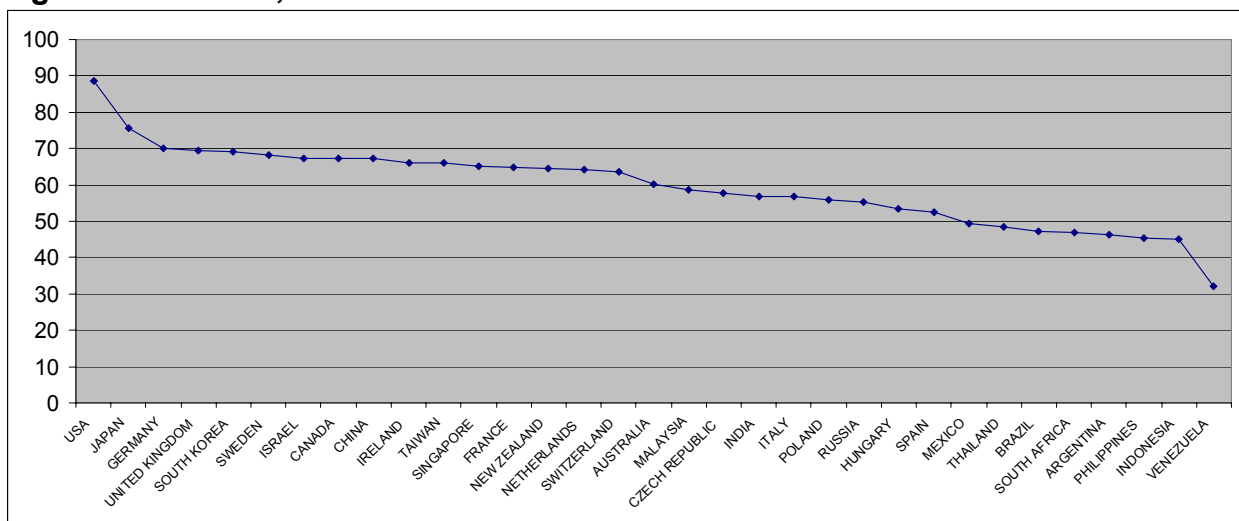


Figure 11 shows INPUT (average of NO, SE, TI & PC) for 2007. Some observations:

- For 30 of 33 of these select countries, INPUT shows a gentle slope from Germany (at 70) to Indonesia (at 45). Of course, cumulatively this is a sizable range.
- The USA stands ahead, by itself.
- Japan, despite relative decline since 1993, is the strong second.
- Venezuela is the laggard.
- One could parse the middle 30 nations into two groups. There is a modest drop from the higher tier of 14 (through Switzerland) to the next tier of 16 (beginning with Australia).

Figure 11. INPUT, 2007



Results: Technological Standing (TS)

A plot of the TS values since 1993 (

Figure 12) shows quite interesting results:

- The US peaked at 95.4 in 1999; it is now down to 76.1.
- Japan peaked at 93.9 in 1996, it is now down to 66.0 (recall that the indicators are relative).
- China has increased from 22.5 in 1996 to 82.8 in 2007 - #1 position.
- Figure 13 shows the TS order in 2007. The range is wide (given that TS is a composite of three S-score components, each with a maximum potential range of 0-100. The top tier includes 4 nations. China leads at 82.8, followed by the US and Germany (66.8), with Japan close.
- There follows a big drop to the next tier of 5 countries: France, Singapore, South Korea, UK, and Netherlands (all score in the 40's).
- A gentle slope then slides from 34.5 (Taiwan) to 17.6 (Brazil).
- The laggards are Venezuela (8.4), Argentina (13.7), Russia (rather surprising -- 15.8) and Indonesia (16.1).

Changes in TS between 2005 and 2007 find only one large riser and a number of significant decliners:

- Rise: China (+8.9)
- Decline: Japan (-7.1), USA (-6.8), Ireland (-6.3), Venezuela (-5.8), and The Philippines (-5.4).

Interestingly, the countries showing sizable declines in 2007 include the two traditional leaders (USA and Japan), a small rising star (Ireland), and the two laggards on Input Indicators (Venezuela and The Philippines).

Figure 12. Technological Standing: 1993-2007

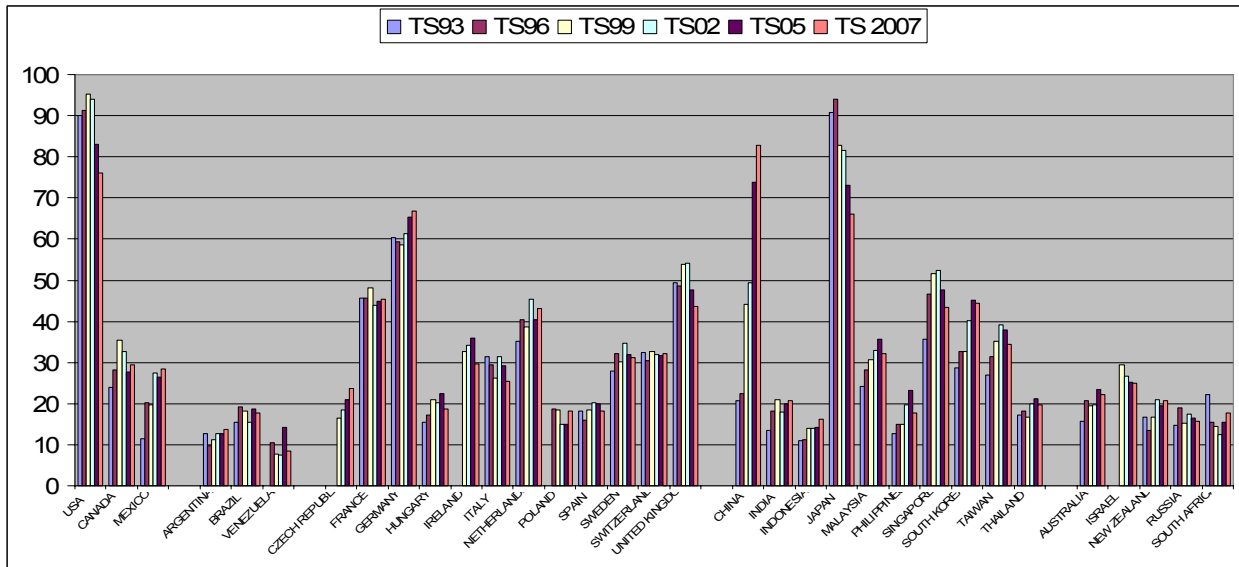
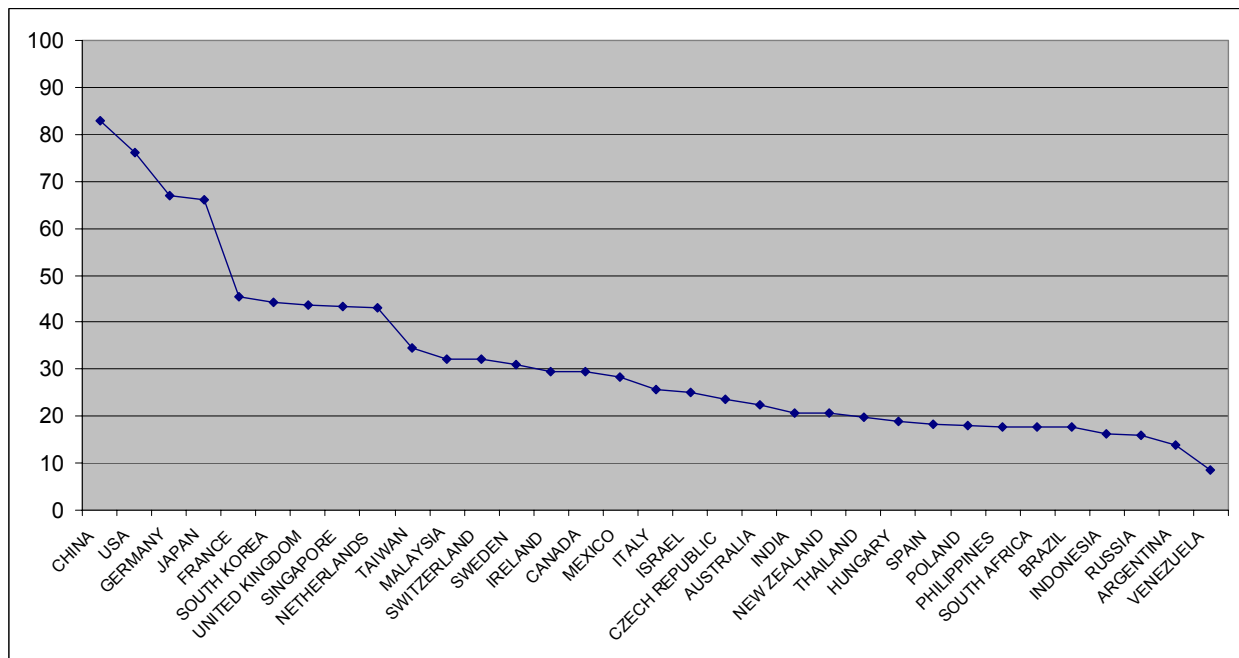


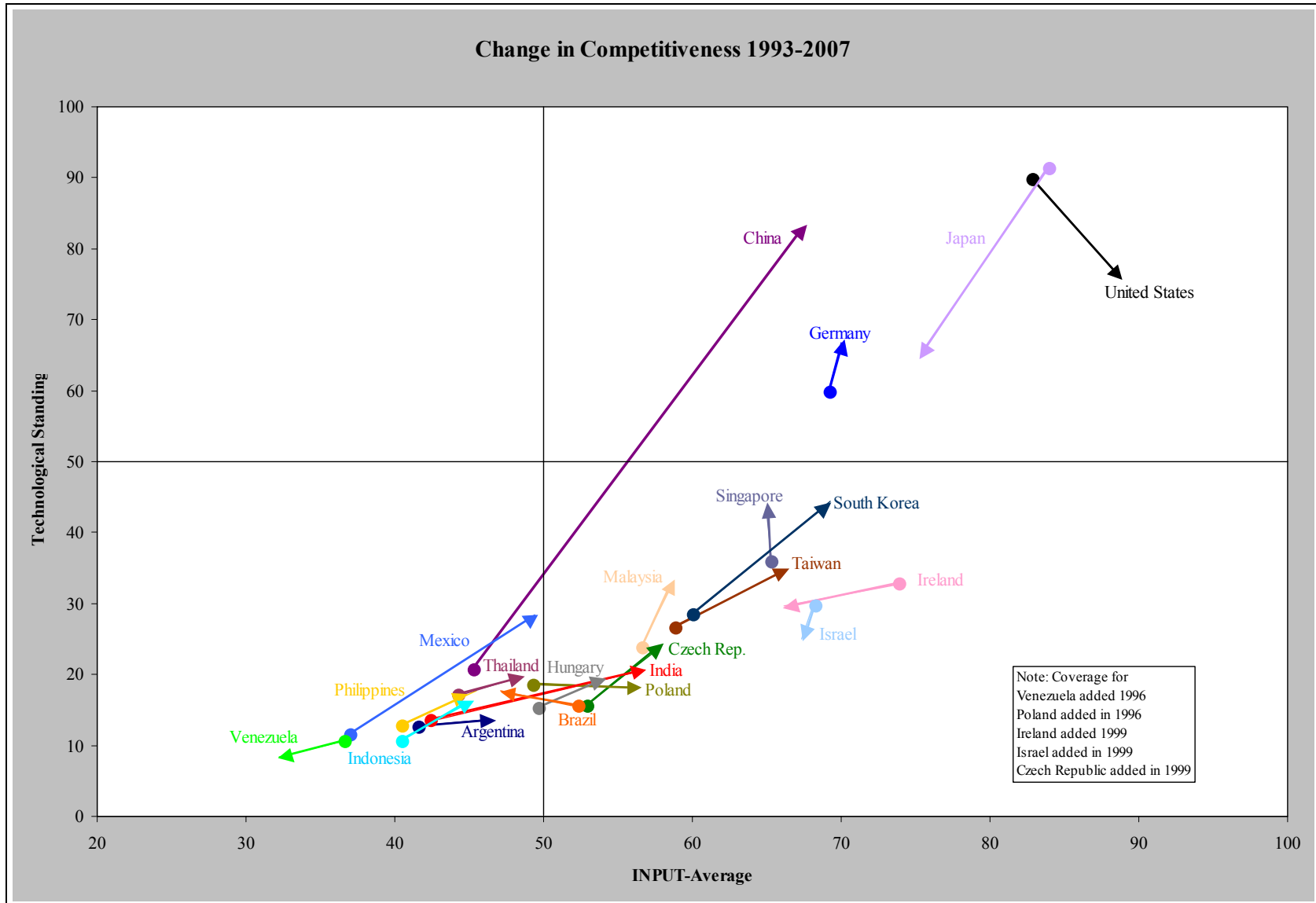
Figure 13. Technological Standing, 2007



Interpretation of these results must take into account the nature of the indicator mix of statistical and expert opinion measures, huge differences in the scales of the country economies, and so forth. For TS, we should especially beware of the emphasis on electronics exports data. This is included as an explicit component (A2) and it represents a portion of the multi-category high tech exports (X). Electronics production clearly favors such Asian economies as China and Taiwan. That said, these nations are not slouches in R&D relating to other emerging high tech domains (e.g., nanotechnology, where China's publication activity trails only the USA, and its patenting trails the USA and arguably Japan).

The change in China is particularly clear when you look at long-term trends within the indicators. Figure 14, which looks at the average of the input indicators versus the output indicator, graphically depicts the meteoric rise of China.

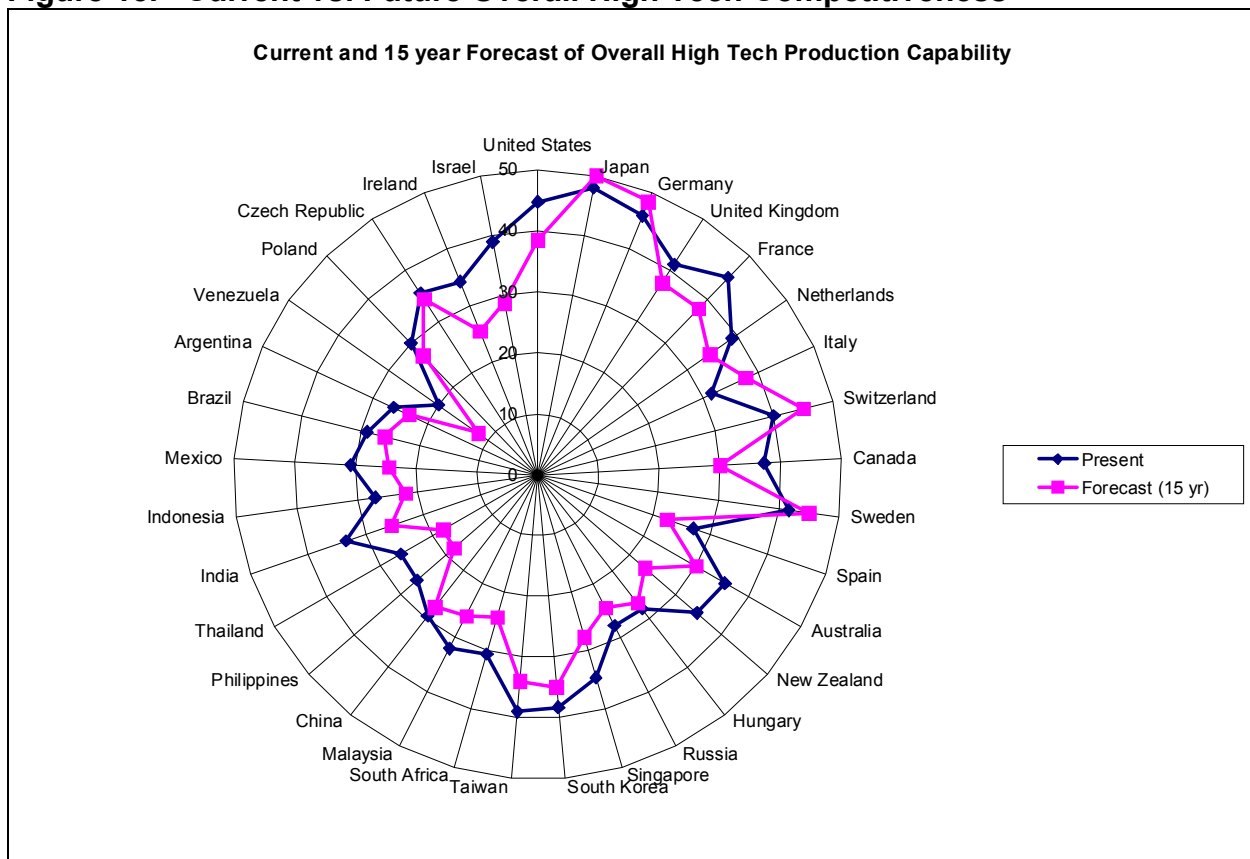
Figure 14. Change in Competitiveness



Industrial Sector Data

Due to the general nature of our panel selection criteria, we are very cautious in interpreting the survey's sector-specific item responses on current and 15-year future prospects. Note that although we collect sector specific data, we do not use the results in the indicator calculations. We only use the overall current assessment (Question P: item 1) in the output indicator – Technological Standing. In past reports, we also used the overall future assessment (Question P: item 1F) as a component in an output indicator called Rate of Technical Change (RTC). Unfortunately, RTC proved to be too unstable, so we have stopped reporting RTC data. Although we do not directly use the data, we do continue to collect it as we experiment with improved formulations. Those data are available should others wish to analyze them. Figure 15 presents a radar chart showing the variations among countries. Note the general expectancy for increased technological competitiveness.

Figure 15. Current vs. Future Overall High Tech Competitiveness



Next Steps. Over the coming months we will be analyzing the HTI-07 data further. We aim to address “knowledge economy” facets and enhance the statistical bases of these indicators. We anticipate providing HTI(S)-07 by the end of the year.

Suggestions are most welcome

Tables

Table 1. INPUT, National Orientation, and Socioeconomic Infrastructure

Country/economy	INPUT = (NO + SE + TI +PC)/4						National Orientation						Socioeconomic Infrastructure					
	INPUT-93	INPUT-96	INPUT-99	INPUT-03	INPUT-05	INPUT-07	NO-93	NO-96	NO-99	NO-03	NO-05	NO-07	SE-93	SE-96	SE-99	SE-03	SE-05	SE-07
North America																		
United States	82.8	86.2	87.4	85.4	86.0	88.7	69.9	75.5	78.4	79.8	79.2	78.0	84.0	85.1	87.0	86.4	84.2	87.9
Canada	59.0	59.8	69.1	67.2	64.2	67.3	60.1	69.0	78.5	81.8	76.3	79.4	78.3	82.5	91.7	82.4	73.1	77.7
Mexico	37.0	40.6	32.2	42.0	45.0	49.4	47.9	54.8	41.8	55.2	55.1	59.0	47.7	45.5	40.4	49.0	48.7	50.7
South America																		
Argentina	41.5	37.3	38.3	40.2	43.4	46.3	45.0	41.4	41.3	44.9	47.7	46.3	63.2	49.4	53.3	52.4	53.3	61.0
Brazil	52.1	47.2	47.6	43.5	49.3	47.1	63.6	58.0	61.5	52.5	59.6	55.1	55.1	53.1	49.1	50.5	51.3	50.3
Venezuela	-	36.4	33.9	30.7	37.5	32.2	-	45.0	40.2	37.2	36.5	33.5	-	47.7	51.7	46.0	47.8	40.6
Europe																		
Czech Republic	-	-	53.3	52.1	58.1	57.7	-	-	68.2	64.6	74.4	69.2	-	-	58.9	64.4	59.1	63.0
France	63.5	66.5	68.1	64.8	63.6	65.0	74.2	75.9	78.5	67.9	66.8	63.9	63.8	64.9	71.5	76.2	67.3	68.0
Germany	69.2	65.9	68.8	70.9	71.6	70.0	75.2	76.5	73.8	75.6	71.6	72.8	69.8	62.9	71.8	77.5	75.5	69.3
Hungary	49.7	47.7	55.6	54.2	54.9	53.4	66.7	67.0	74.5	66.7	61.7	57.1	54.0	47.7	61.4	67.9	66.2	67.0
Ireland	-	-	73.6	65.5	61.5	66.1	-	-	99.2	84.1	74.0	83.4	-	-	82.6	80.7	74.2	77.9
Italy	53.8	56.4	54.6	59.9	58.5	56.7	59.2	66.3	63.1	69.4	67.0	57.8	53.6	59.3	59.7	69.4	63.5	66.2
Netherlands	60.3	67.0	63.0	68.4	64.3	64.3	68.5	81.3	68.9	82.4	69.6	70.5	67.7	74.7	74.2	80.6	77.2	72.0
Poland	-	49.4	50.6	52.8	54.0	56.0	-	69.4	63.9	63.7	61.8	65.1	-	54.2	57.0	68.3	65.6	71.3
Spain	52.2	51.5	55.3	48.2	51.3	52.3	55.9	63.8	65.8	55.1	56.9	55.9	64.4	59.3	68.2	68.8	69.0	65.3
Sweden	64.5	59.6	57.7	65.2	69.3	68.1	83.0	66.8	61.1	75.5	80.1	82.5	66.6	65.3	67.9	78.9	82.0	81.8
Switzerland	60.6	55.3	59.2	62.0	59.3	63.6	71.5	57.8	66.0	69.2	64.6	69.2	62.0	59.6	60.5	71.2	62.8	66.8
United Kingdom	58.8	62.0	65.9	69.2	69.7	69.5	63.2	70.9	72.4	76.5	77.7	73.6	65.6	65.5	78.0	84.0	82.9	80.2
Asia																		
China	45.1	45.5	51.4	55.7	68.0	67.2	62.3	65.2	65.5	63.0	74.3	62.6	46.4	44.8	52.7	55.0	60.4	61.2
India	42.6	48.0	54.8	49.2	54.4	56.8	52.4	57.4	68.5	62.5	61.6	64.6	46.4	46.0	50.0	49.3	52.8	55.1
Indonesia	40.5	31.8	34.7	33.1	37.6	45.1	62.5	54.8	55.1	45.1	44.2	54.9	49.5	35.2	42.2	39.1	40.8	48.5
Japan	83.6	78.1	76.1	74.4	74.0	75.7	85.3	73.8	79.5	76.4	70.3	75.7	72.7	62.3	63.2	67.0	65.5	71.2
Malaysia	56.6	54.7	50.7	51.5	57.2	58.5	81.1	81.0	69.6	73.0	75.4	76.0	63.7	62.6	58.2	64.9	70.4	67.9
Philippines	40.2	55.1	44.5	45.8	47.4	45.5	43.1	75.1	63.8	59.3	53.2	54.7	57.5	63.4	55.6	55.0	52.9	54.9
Singapore	65.3	64.9	62.3	68.1	66.9	65.0	92.7	88.4	87.2	83.8	78.5	76.9	73.5	75.7	71.2	84.2	79.5	76.5
South Korea	60.1	59.6	60.4	64.7	64.8	69.2	81.9	78.9	74.9	80.4	74.7	77.1	69.6	64.6	73.5	81.1	72.7	81.3
Taiwan	59.0	64.8	65.5	68.1	63.7	66.1	81.1	90.2	90.7	83.0	73.6	75.0	74.5	76.3	74.2	84.4	77.2	81.6
Thailand	44.7	43.4	37.1	39.2	44.9	48.5	67.5	63.5	50.7	47.7	58.7	63.7	51.0	48.7	46.5	54.2	53.2	61.1
Others																		
Australia	54.4	56.4	66.5	59.2	66.4	60.1	66.8	66.2	78.4	70.5	76.2	66.0	63.9	60.6	83.2	74.3	78.4	71.4
Israel	-	-	68.1	66.5	68.7	67.3	-	-	91.4	79.5	78.4	76.7	-	-	72.5	85.0	85.8	80.3
New Zealand	50.9	58.7	55.9	61.4	60.0	64.6	57.1	66.7	67.3	75.1	70.0	72.0	70.0	74.3	70.9	75.9	75.7	83.3
Russia	40.6	49.4	46.8	51.6	47.5	55.2	32.5	48.9	48.9	48.6	42.0	57.7	39.4	50.7	52.4	60.4	59.2	65.4
South Africa	52.5	42.6	43.2	42.3	45.3	46.9	74.4	49.1	50.2	53.7	50.6	55.2	69.6	51.0	53.6	49.1	52.8	54.3

Table 2. Technological Infrastructure, Productive Capacity, Technological Standing, and Expert Opinions

																			Expert Opinion: Perception of Hi Tech Production Capability-07	
Technological Infrastructure							Productive Capacity						Technological Standing							
Country/economy	TI-93	TI-96	TI-99	TI-03	TI-05	TI-07	PC-93	PC-96	PC-99	PC-03	PC-05	PC-07	TS-93	TS-96	TS-99	TS-03	TS-05	TS-07	Current	Future
North America																				
United States	87.5	94.8	96.1	92.7	91.9	95.5	89.8	89.4	88.1	82.8	88.7	93.4	90.0	91.4	95.4	93.9	82.9	76.1	44.8	38.5
Canada	49.5	47.5	53.5	51.5	54.5	53.9	48.1	40.2	52.8	53.1	52.7	58.1	24.0	28.1	35.4	32.6	27.6	29.4	37.3	30.0
Mexico	25.2	30.2	21.8	28.7	30.4	34.5	27.2	31.7	24.8	35.4	45.8	53.4	11.6	20.1	19.8	27.3	26.3	28.4	30.8	24.5
South America																				
Argentina	25.5	27.4	27.5	31.0	30.1	33.2	32.2	31.0	31.0	32.5	42.6	44.7	12.7	9.6	11.3	12.7	12.7	13.7	26.2	23.3
Brazil	41.6	37.4	40.4	35.4	36.9	36.6	48.1	40.3	39.6	35.8	49.3	46.5	15.5	19.1	18.2	15.4	18.7	17.6	29.0	26.0
Venezuela	-	27.9	18.6	19.5	27.2	22.5	-	25.1	25.1	20.3	38.5	32.2	-	10.5	7.7	7.5	14.3	8.4	20.0	12.0
Europe																				
Czech Republic	-	-	41.5	34.7	43.6	40.6	-	-	44.6	44.6	55.0	58.1	-	-	16.4	18.5	21.1	23.6	35.6	34.4
France	60.0	61.3	57.7	55.9	55.1	58.1	56.1	64.1	64.7	59.2	65.0	69.9	45.6	45.7	48.0	44.0	45.0	45.3	45.0	38.0
Germany	66.6	62.4	64.1	65.5	64.5	63.0	65.0	61.6	65.3	65.0	74.6	74.8	60.5	59.2	58.7	61.4	65.4	66.8	45.8	48.3
Hungary	41.4	36.4	43.5	40.0	40.5	36.9	36.8	39.8	43.1	42.2	51.4	52.5	15.4	17.1	20.9	20.3	22.4	18.8	27.9	26.7
Ireland	-	-	53.0	44.2	41.9	45.3	-	-	59.6	53.0	55.7	58.0	-	-	32.7	34.3	35.9	29.6	34.2	25.5
Italy	50.5	48.6	48.4	48.4	46.4	45.8	51.8	51.4	47.1	52.3	57.3	57.1	31.5	29.5	26.2	31.4	29.3	25.5	31.5	37.7
Netherlands	54.4	55.7	53.1	55.2	52.5	52.4	50.5	56.3	56.0	55.5	57.8	62.5	35.1	40.3	38.7	45.3	40.3	43.0	39.0	34.4
Poland	-	35.0	39.7	36.6	34.1	35.4	-	39.0	41.9	42.5	54.5	52.3	-	18.8	18.4	14.9	14.9	18.1	30.0	27.3
Spain	36.4	39.1	42.2	33.7	33.5	38.3	52.3	43.6	45.2	35.1	45.8	49.8	18.3	16.0	18.4	20.3	20.0	18.2	27.0	22.5
Sweden	55.5	53.7	54.7	53.2	54.5	48.8	52.8	52.6	47.2	53.0	60.8	59.3	28.0	32.2	30.2	34.6	31.9	31.1	41.7	45.0
Switzerland	55.4	51.1	54.8	54.6	51.5	55.0	53.4	52.9	55.6	53.1	58.2	63.5	32.5	30.5	32.8	31.9	31.8	32.2	40.0	45.0
United Kingdom	57.5	59.4	59.8	62.0	58.0	59.0	49.0	52.3	53.6	54.5	60.1	65.1	49.3	48.6	53.8	54.1	47.7	43.6	41.1	37.5
Asia																				
China	38.6	39.3	46.5	55.2	64.7	60.0	33.2	32.8	41.0	49.6	72.4	85.2	20.7	22.5	44.2	49.3	73.9	82.8	29.4	27.5
India	33.0	39.3	48.3	37.0	43.2	44.4	38.6	49.1	52.4	47.8	59.9	63.1	13.5	18.3	20.8	17.9	20.0	20.7	33.3	25.6
Indonesia	25.3	17.8	18.2	20.7	24.1	30.7	24.8	19.6	23.2	27.7	41.1	46.5	11.0	11.2	14.0	14.0	14.2	16.1	27.0	22.0
Japan	83.7	81.7	78.3	73.8	71.1	68.8	92.7	94.4	83.4	80.3	88.9	87.2	90.8	93.9	82.7	81.6	73.1	66.0	48.0	50.0
Malaysia	34.2	31.9	31.0	28.8	31.4	31.9	47.5	43.1	44.2	39.1	51.5	58.3	24.3	28.2	30.8	32.8	35.8	32.2	32.0	26.0
Philippines	25.1	35.7	21.9	24.0	31.1	25.2	34.9	46.2	36.7	45.0	52.2	47.1	12.6	14.9	15.0	19.6	23.2	17.7	26.4	18.3
Singapore	40.5	41.6	37.4	46.7	50.3	43.5	54.6	54.0	53.4	57.7	59.2	63.0	35.8	46.7	51.5	52.4	47.7	43.4	34.6	27.7
South Korea	42.6	44.4	44.6	45.2	48.0	48.1	46.4	50.5	48.8	52.3	63.8	70.5	28.7	32.6	32.7	40.1	45.2	44.4	38.3	35.0
Taiwan	37.4	43.0	43.6	45.3	43.7	46.0	43.0	49.9	53.7	59.6	60.3	61.8	27.0	31.5	35.2	39.3	37.9	34.5	39.0	34.0
Thailand	26.7	28.1	20.5	23.9	25.0	25.9	33.4	33.1	30.6	30.9	42.5	43.4	17.2	18.1	16.6	20.0	21.1	19.8	26.0	18.0
Others																				
Australia	45.8	51.3	53.0	46.9	53.5	49.4	41.3	47.7	51.6	45.2	57.4	53.5	15.6	20.6	19.5	19.6	23.3	22.3	35.6	30.0
Israel	-	-	57.8	52.3	54.0	54.3	-	-	50.6	49.4	56.6	57.9	-	-	29.5	26.7	25.1	25.1	38.9	28.8
New Zealand	41.9	48.3	45.9	49.8	47.0	49.0	34.6	45.6	39.6	44.7	47.5	54.1	16.8	13.5	16.8	21.0	19.3	20.6	34.5	23.3
Russia	58.4	55.6	50.4	51.2	43.9	47.8	31.8	42.6	35.6	46.5	45.1	49.9	14.7	19.0	15.2	17.5	16.5	15.8	27.8	24.4
South Africa	23.0	40.3	40.5	35.9	36.5	37.7	43.0	30.0	28.7	30.4	41.3	40.3	22.1	15.4	14.3	12.5	15.4	17.7	30.6	24.3

HTI 2007 Appendices

*Technology Policy and Assessment Center**
Georgia Institute of Technology
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Appendix 1: 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 2007 study:

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

This document only treats the Traditional (T) versions.

Traditional (T): All are S scores of the indicated components.

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

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.

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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.

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 $S = 100$). For statistical data, 100 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.” 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 0-40); then multiply by 2.5 (making the scale 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:

$$TS (T) = [SQ14a+SX2007+SA22007]/3$$

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" in the present.

X2007 = The value of high tech exports as drawn from the United Nations Statistical Division (UNSD) COMTRADE trade statistics for 2005. 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 Division COMTRADE database.

Date: Data are from 2005.

Unit: 1,000's of US Dollars

Data Source Location: Data were online from United Nations Statistical Division, Commodity Trade Statistics Database (COMTRADE).

Reference: United Nations Statistical Division, Commodity Trade Statistics Database, *COMTRADE*, New York, United Nations, 2007.

A22007 = The value of electronics exports in 2007 (forecasted) as obtained from the Reed Electronics Research.

Date: Data are based on a 2007 forecast.

Unit: 1,000's of US Dollars

Data Source Location: Data is available from the *Yearbook of World Electronics Data 2006/2007*, however for the purposes of this project, the statistical data series was obtained directly from Reed Electronics Research in electronic form as drawn from their *Full Statistical Database 1985-2007*. [<http://www.rer.co.uk>]

Reference: Reed Electronics Research. 2007. *Yearbook of World Electronics Data 2006/2007*. Surrey, United Kingdom. Reed Electronics Research Ltd.

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:

$$\text{NO (T)} = [\text{SQ1} + \text{S} ((\text{Q2} + \text{Q3}) / 2) + \text{SQ4} + \text{SF1V2007}] / 4$$

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?

F1V2007 = The *Political Risk Letter* 5-year investment risk assessment index for January 1, 2007, from the PRS Group; rescaled from D- = 1 to A+ = 12.

Date: Data are drawn from the 1 January 2007 letter.

Unit: N/A

Data Source Location: Political & Economic Forecast Table, Political Risk Letter, PRS Group, January 1, 2007. [<http://www.prsgroup.com>]

Reference: PRS Group, Political Risk Letter, New York, January 1, 2007.

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:

$$\text{SE (T)} = [\text{SQ5} + \text{SQ10} + \text{SHMHS}] / 3$$

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 $W42007 + 4 * W62007$.

W42007 = The net percentage of students enrolled in secondary education in 2005. 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 2005

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 2007.

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 2007.

W62007 = The gross percentage of students enrolled in tertiary education in 2005. 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 2005.

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 2007.

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 2007.

Technological Infrastructure (TI)

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

Formula:

$$\text{TI (T)} = [\text{S}((\text{Q7}+\text{Q8})/2)+\text{SQ9}+\text{SQ11}+\text{SEDP2007}+\text{SS\&E2007}]/5$$

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?

EDP2007 = Electronic data processing equipment purchases for 2007 as obtained from Reed Electronics Research

Date: Data are based on estimates of 2007 purchases.

Unit: 1,000 of US Dollars

Data Source Location: Data is available from the *Yearbook of World Electronics Data 2006/2007*, however for the purposes of this project, the statistical data series was obtained directly from Reed Electronics Research in electronic form as drawn from their *Full Statistical Database 1985-2007*. [<http://www.rer.co.uk>]

Reference: Reed Electronics Research. 2007. *Yearbook of World Electronics Data 2006/2007*. Surrey, United Kingdom. Reed Electronics Research Ltd.

S&E2007 = The number of scientists and engineers (excluding technicians) engaged in research and experimental development as defined by UNESCO.

Date: Data are drawn from different years with many from 2003, but some have not been updated in several years.

Unit: Number of Individuals

Data Source Location: UNESCO Web Site, Statistics, Data Center, *Human Resources in R&D / Personnel employé dans la R - D*, Institute for Statistics, UNESCO, May 2007.

Reference: UNESCO, Institute for Statistics, *Human Resources in R&D*, New York, United Nations, May 2007.

Productive Capacity (PC)

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

Formula:

$$PC (T) = [S(Q6+Q12+Q13)+SA262007/2]/1.5$$

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.

A262007 = The value of total electronics production for 2007 as obtained from the Reed Electronics Research.

Date: Data are an estimate of 2007 production.

Unit: 1,000's of US Dollars

Data Source Location: Data is available from the *Yearbook of World Electronics Data 2006/2007*, however for the purposes of this project, the statistical data series was obtained directly from Reed Electronics Research in electronic form as drawn from their *Full Statistical Database 1985-2007*. [<http://www.rer.co.uk>]

Reference: Reed Electronics Research, 2007, *Yearbook of World Electronics Data 2006/2007* Surrey, United Kingdom, Reed Electronics Research Ltd.

INPUT (T)

This composite simply averages (as INPUT) the four Input Indicators: NO, SE, TI, and PC. In the past, we sometimes calculated INPUT (Sum) – which is just INPUT multiplied by 4. Conceptually these two are equivalent – an overall leading indicator of potential future high tech competitiveness. INPUT 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 the average.

Formula:

$$\mathbf{IN (T) = [NO (T) + SE (T) + TI (T) + PC (T)]/4}$$

Appendix 2: Selected Expert Opinion Comments

These comments have been edited for pertinence clarity and to assure that no one's identity is disclosed. They are provided to share insights and give some sense of the perspectives of respondents. The total number of substantive comments was not high (this sample reflects, roughly, 25%); we have also compiled selected procedural comments for our own process improvement.

One respondent suggested expanding coverage to include Pakistan, Iran, and Turkey.

(11) Argentina:

Since the crisis of 2002, the Argentine economy is growing at high annual rates, and this generates new business. There is increasing conscience about the necessity of changing the country's technological profile to a high-tech one. The government is also doing efforts to promote some of the high tech sectors, such as, for instance, biotechnology and nanotechnology. Argentina has large capabilities in areas such as biomedicine and biology.

(27) Australia:

The structure of this survey does not fit well with a country like Australia, which is a niche exporter of high tech products and services. We are largely an importer of major technological systems and largely an exporter of low VA resource-based products. But Australia has strong capabilities to integrate an adapt imported systems to develop highly efficient production systems for domestic services and the production of export commodities. Australia has very specific strengths in high tech – e.g., mining software, medical instruments. In other words, Australia is not located on a Kn production function regression line.

(1) Czech Republic:

Computers are only assembled, as virtually all parts are imported. Software industry is mostly adapting existing products. However, there are islands of positive deviations where high-value added programs are developed; these firms are then bought by large US software firms (e.g., NetBeans and Sun Microsystems). Aerospace industry is in trouble and the Boeing involvement was a flop. However, tiny private firms producing parts for space research and satellites do exist.

(23) France:

The know-how is here but the cost of setting up and successfully running operations in France remain extremely expensive compared to other European and North American countries. The scientific, medical and technological capacity is here but is slowed down, even handicapped, by social unrest, trade union influence, fiscal constraints and a general distaste for risk.

(40) Ireland:

Ireland has a dual industry structure - multinationals and indigenous. All multinational very high tech - perform 72% of Irish private sector R&D - some only manufacturing plants, others full service. Examples: HP, Inter, IBM, Google, Microsoft, Eli Lilly, Pfizer, Merck, Intel, etc. 800 US companies (50% of manufacturing employment). Nearly full employment, 10% emigrants from central Europe. Highest S&T graduates in Europe.

(59) Ireland:

The policies of the Irish government have led to a dramatic change over 5 years. The development of Science Foundation Ireland, as well as the PRTLTI from HEA have transformed the research landscape and the involvement of the social partners has been total. The most recent Program for Government has re-emphasized the need for research as part of national development strategy, leading to Ireland moving ahead of the Lisbon Agenda.

(41) From Italy:

The main problems you want to consider in assessing Italy competitiveness are: brain drain (more than 5% researchers leave the country permanently). Excessive bureaucracy -- lack of merit-based criteria in financing R&D projects, general distrust versus technology, family capitalism, many CEOs come from the founding families mafia.

(48) From Italy:

Italy has a superb, high-class school system (up to Master's level). However, because of cultural and social issues, not enough resources are dedicated to R&D. Often times, well experienced non-graduate workers are preferred to skilled, qualified graduate level engineers and technicians.

(32) Japan:

The question of entrepreneurship is difficult to apply to Japan. All Japanese companies (with 2 notable exceptions) are part of a KEIRETSU (or ZAIBATSU), which is basically part of giant monopoly. It is very difficult to start a company in Japan due to restrictions on capital required for incorporation; furthermore, it's virtually impossible to sell products into companies in a ZAIBATSU from outside unless it's an emerging market (medical devices, for example).

(53) New Zealand:

NZ is an odd one – has a small but developed economy and society, with a very well-educated population that is quick to adopt new technologies (eg very high rates of adoption and use of PC's – and self management of these, cell phones, new consumer electronics etc), but all of these are imported. This is because our manufacturing sector shrank dramatically in the 1980s after import protection and subsidies were removed (as occurred across the economy), and government 'got out of the economy'. More recently, some of our more successful innovative manufacturers have moved off shore (to China etc) to take advantage of cheaper production costs there.

From the 1980s for 15 years or so Government has had a very hands-off approach – leaving the 'market' to bring forward new ideas etc. Likewise, it has not really invested in education for hi-tech development (eg engineering). For about 5 years or so government has been talking up the importance of a knowledge-based/lead economy and the importance of technology (including and biotech) in NZ's development, and has recently been trying to promote centres of excellence within the tertiary education sector. Also the 2007 budget indicated that government will soon introduce tax rebate incentives for private sector research (which Australia, our nearest neighbour, has been doing for 20 or more years) – but it seems these will be restricted in scope. Yet our agriculture industry is world leading in terms of new products, processes etc – especially the dairy industry – which has always shown willingness to innovate with new products and processes. Elsewhere, we have a small number of very smart niche hi tech developers and

innovators (eg in GPS/tracking, wireless, software, wind and alternative energy generation etc, and in new drugs/medicines). However, the venture capital sector is weak, and the trading and merchant banks tend to be very conservative and risk averse.... so, many NZ innovators tend to take or sell their ideas off-shore.

In summary, NZ's government and business leaders talk a lot about the knowledge economy and the need for NZ to position itself as a provider to the world of advanced know-how and specialist technology-based niche products and services – but there is little leadership, and science funding priorities and plans are short-horizon and forever changing. For this reason, I don't see that we will make much improvement in the next 10 years or so – especially with the current craze of globalisation (which here means everyone else can come in with their products and displace local enterprise). If advances happen in technology-based development, it will be in spite of, rather than because of, the present government and business leadership.

(55) Russia: In last few years there is an increase of "oil money" going into R&D and technology-intensive production. Russian pharmaceutical industry is slowly but steadily coming back from decline - some started to form substantial research divisions, hiring those Russian scientists, who studied and worked in the US. I consider it a new and hopeful sign of rising high tech capability.

(21) Singapore:

Singapore is small relative to neighbors and globally. They are influential beyond their size, but in absolute numbers, they are still small. One strategy is to import expertise. They have been reasonably successful with this to date. Because of limited scale of Singapore there are not many local players with significant R&D scale.

(50) South Africa:

South Africa has a plural economy. I have tried to answer for the country as a whole. If I had focused on the urban population I would have ranked most things higher, if on the rural the rankings would be lower.

(52) From S. Africa:

South African government institutions have and are creating excellent studies and documents on matters related to all the above. Extremely relevant workshops are held with participants representing a significant body of knowledge and experience. My perception is that good plans are thus created. But as with so many other ventures in South Africa, execution remains problematic resulting in plans that never come to full fruition.

Another issue: many international businesses, as part of requirements of doing business in South Africa, would contribute to social upliftment projects that add needed value to the disadvantaged sector of society. The same international companies would create R&D centres in many parts of the world and thereby advance science and technology there. China and India are prime examples where involvement (R&D centres) by the internationals contributed to their current positions as science and technology powerhouses. There is a lack of such initiatives in South Africa. I am aware of only one small research centre created by a huge international IT company. Even this centre focuses on third world research challenges of social upliftment (is necessary), but little contribution to science and technology as such.

My perception of start-up financing: there are some government related programs with limited

funds and basically risk-averse managers. There "does not exist" a true venture capitalist spirit/culture in South Africa; we do have excellent, risk averse, bankers. I am even somewhat disappointed with the approach to new ventures of one of our major and nationally hailed entrepreneurs who made it big internationally. There is an underlying risk averseness with institutions with resources to create new ventures. Compare this to a small country such as Israel.

(37) Sweden:

Sweden is small Nordic country - with a high rate of R&D intensive Multi National Corporations such as AstraZeneca (Pharma) Ericsson (Telecom) Volvo (Automotive) ABB (Robotics) and Atlas Copco (Industrial Machinery). Some 50 percent of GDP comes from export and the Swedish population (home market) is not more than 9 million . As a result, Sweden is highly dependent on manufacturing and a never ending chain of innovation among the companies.

(54) Switzerland:

Switzerland has very specialized competences in niche markets.

(20) Venezuela:

The technological issue in Venezuela has been very strongly affected by political factors in the last 3 years that overwhelm any other considerations.

(33) Venezuela:

A law has been passed that forces industry to spend part of its budget in scientific research, either in industry or in universities. This is a positive step, but the overall system is badly planed and there is a very big uncertainty in the future. Also, many of the best talents (specially young professionals) are leaving the country looking for a better future.