

A Comparison of Recent Assessments of the High -Tech Competitiveness of Nations

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ABSTRACT: *The Technology Policy and Assessment Center at Georgia Institute of Technology, primarily with support from the U.S. National Science Foundation (NSF), has been working on “High Tech Indicators” of national technological competitiveness since 1987. This paper summarizes the Technology Competitiveness Indicators for 33 nations in 1999 and provides vertical comparisons with the same research project results conducted in 1993 and 1996. Also, the authors compare the Georgia Tech HTI with the U.S. Council on Competitiveness Innovation Index; The World Competitiveness Yearbook (edited by the International Institute for Management Development, Lausanne, Switzerland); and the competitiveness rankings generated by researchers at the United Nations University in Maastricht. The paper concludes with observations about the differences in country rankings generated by these different efforts to measure national competitiveness.*

Introduction

In modern society, national economic competitiveness is largely technology-based. Science and technology (S&T) constitute the most dynamic and decisive factors in the new productive forces. With the phenomenal spread of the technological revolution on a global scale, science and technology are permeating all aspects of the materials and cultural life of society. They have become an important means of raising labor productivity and a substantial cornerstone for the edifice of modern civilization. Experiences both at home and abroad have shown that, to modernize, a country has to rely on science and technology. Nations that succeed rely heavily on technology for economic expansion. Assuredly science and technology will be the core of competitiveness in the future (WCY, 1998, 1999, 1999-2000; OECD 1999, 2000; Antonell and DeLiso, 1997; Archibugi and Michie, 1998).

A variety of studies of technology-based competitiveness conducted in the past decade have sought to measure advances in science and technology, predict S&T trends, evaluate national business environments, and suggest ways of maintaining national competitiveness (WCY, 2000; Mani, 2000; M. E. Porter and Stern, 1999; Porter, 1998; Clark and Guy, 1998; Sirilli, 1997; Rausch, 1995; Van Raan, 1988). Generally speaking, data underlying indicators of national competitiveness can be divided into two types: 1) “hard” statistical data and “soft” data. Statistical data include, for example, gross domestic product (GDP), GDP per capita, research and development (R&D) expenditures, R&D personnel, exports of goods and services, educational infrastructure, etc. These data can be collected from international, regional or national statistics. Soft data, typically are derived from surveys of experts, interviews, and case studies. The U.S. Council on Competitiveness Innovation Index, developed by Professors Michael E. Porter of the Harvard Business School and Scott Stern of MIT's Sloan School, offers a method for assessing the strengths of national innovation systems (Porter and Stern, 1999). Their 1999 studies projected the innovation

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capabilities for the U.S. and 24 other nations based on a set of quantitative indicators. The *World Competitiveness Yearbook* (WCY, 2000) annually ranks the ability of a nation to provide an environment that sustains the competitiveness of enterprises. Sunil Mani and his colleagues at The United Nations University use time-series data on the exports of high technology products to analyze certain indicators of high tech competitiveness (Mani, 2000). Keith Pavitt and Luc Soete (1980), and others (Eaton and Kortum, 1996; Griliches, 1990; Dosi, Pavitt, and Soete, 1990; Trajtenberg, 1990), have used patent data to analyze the relative competitiveness of various countries, to construct 'Revealed Technology Advantage' indexes for various countries, and to describe and contrast the global location of inventive activity in different industries.

Researchers at Georgia Tech have been working on Technology-based Competitiveness Indicators (HTI) since 1987 (Porter et al., 2000, 1996, 1991; Roessner et al., 1997, 1996, 1995, 1992, 1988). We investigated the feasibility of a set of country-level indicators of international competitiveness in high technology industries; generated four "input" and three "output" indicators; gradually expanded the set of target countries to examine in detail the indicators' reliability and validity; and developed, refined, and tested quantitative formulae for these seven indicators. After a ten year research effort, indicator work at Georgia Tech has shifted to periodic indicator data collection and reporting (every three years). Results have appeared in several recent volumes of the U.S. National Science Board's *Science and Engineering Indicators*. Time-series comparisons of the 1990, 1993, 1996, and 1999 indicators are presented and analyzed in a recent working paper (Porter, Roessner, Newman and Jin, 2000).

In this paper we summarize the 1999 Georgia Tech web survey results and tabulate these against those from 1993 and 1996. We then compare these with the results of three other efforts to measure and rank national competitiveness: the US Innovation Index, the *World Competitiveness Yearbook*, and the United Nations University's (Maastricht, The Netherlands) research work.

Georgia Tech Indicators of High-Tech Competitiveness

Researchers at Georgia Tech's Technology Policy and Assessment Center (TPAC) have been generating technology-based competitiveness indicators – "*High Tech Indicators*" or *HTI* -- since 1987. We initially demonstrated the feasibility of a set of country-level indicators of international competitiveness in high technology industries. Since 1990, we have compiled HTI every three years, with a combination of consistent statistical and expert opinion components comprising the indicators. Over time, and with the support and guidance of the Science Indicators Unit of the U.S. National Science Foundation, we have expanded the set of target countries to 33. We have examined, and continue to assess, the indicators' reliability and validity.

In 1987 we compiled data for 20 countries representing a range of regions and extent of industrialization. The second (1990) and third (1993) phases gathered data on an expanded set of 28 countries (29 countries in 1990 – Germany subsumed West Germany and East Germany; also Russia replaced the USSR after the 1990 survey). The 1996 HTI added Poland, Venezuela, and South Africa, but dropped Hong Kong because of its absorption into China in 1997, so the total number of countries totaled 30. (Regularization of statistics for China and Hong Kong remains problematic even for 1999, particularly in sorting out exports.) For the 1999 HTI we added Ireland, Israel, and the Czech Republic, yielding a total of 33 countries. Only limited "backfilling" of statistical measures has been feasible. The countries are usually clustered in presentations as follows:

- The "Big Three" – United States, Japan, and Germany
- Western Europe (UK, France, Netherlands, Italy, Switzerland, Sweden, Spain, and Ireland)

- English Heritage Nations + Israel (Canada, Australia, South Africa, New Zealand, and Israel)
- Eastern Europe (Russia, Poland, Hungary, and Czech Republic)
- Asian Tigers (Singapore, South Korea, and Taiwan)
- Asian Cubs (Malaysia, China, Thailand, Indonesia, Philippines, and India)
- Latin America (Mexico, Brazil, Argentina, and Venezuela)
- Israel.

EXPERT OPINION COLLECTION

The expert opinion questionnaire has remained essentially the same since 1990. Significant revision and country expansion from 1987 to 1993 discourage our inclusion of 1987 and 1990 results in this comparative analysis. In our 1999 questionnaire, we made minor changes:

- Adapted for web-based surveying
- Added 'software' as one of nine sectors about which we inquired in the last question
- Made minor format changes.

The 1999 HTI questionnaire contains 16 questions (from A to P). Question A indicates the country being addressed. Question B requests self-assessment of one's familiarity with technology-intensive development in that country. All the other questions from C to P relate to the seven competitiveness indicators. These consist of four "Input Indicators":

- National Orientation to achieve technological competitiveness (**NO**)
- Socioeconomic Infrastructure to support a technology-based economy (**SE**)
- Technological Infrastructure to enable development, production, and marketing of technology-based goods (**TI**)
- Productive Capacity to efficiently manufacture such goods (**PC**)

and three "Output Indicators":

- Technological Standing in manufacturing and export capabilities for high technology products (**TS**)
- Technological Emphasis in export mix (**TE**)
- Rate of Technical Change (**RTC**).

For instance, questions C (Strategy), D (Cultural values), E (Influential groups), and F (Entrepreneurial spirit) contribute to **NO**; questions G (Mobility of capital) and L (Foreign firms encouraged) contribute to **SE**. Similarly, all other questions address a given aspect of one of these designed indicators that is not adequately treated via statistical measures.

The conceptual definitions of the seven indicators are the same as those used in the earlier studies. The Input Indicators (leading indicators) reflect national propensity for future technology-based competitiveness. The Output Indicators gauge current competitiveness. With the exception of Technological Emphasis (**TE**), each indicator is comprised of both statistical and expert opinion data. Details are available on the TPAC website (<http://tpac.gatech.edu>).

The International Technology Indicators Panel includes both resident and foreign observers of given countries. Our criteria for inclusion include direct knowledge of the country and of the bases for technological competitiveness. Prototypical experts include embassy science attaches, faculty members, and industry professionals. Attendees at international conferences and participants in journal advising and

publishing relating to technology analysis, forecasting, management, and so forth are good candidates for the Panel.

The 1999 HTI expert opinion data were obtained from responses of the International Technology Indicators Panel during summer and fall, 1999. The resulting group of 303 experts (up from 207 in 1996) collectively provided 336 responses (up from 265 in 1996). The average number of responses per country was 10.2, ranging from 6 to 22. Only Ireland had 6 responses; 6 others had 7 responses; 8 or more experts assessed the other 26 countries. Most responses come from inside the country (79.2 % vs. 20.8 % outside).

STATISTICAL DATA

The statistical measures reflect our explorations of a wide range of potential indicator components. Selection criteria include pertinence to our competitiveness model; availability of component measures for all, or near all, of the target countries; data quality; data accessibility for time-series construction; convergent validity (components show reasonable correlation with each other across countries); and divergent validity (components differentiate among countries). The following data sources exemplify those used to construct our indicators:

- United Nations Statistical Office, Commodity Trade Statistics Section – 1997 exports (most recent available, for TS, TE and RTC) (United Nations, *COMTRADE*, 1999, New York)
- Reed Electronics Research, Ltd., *Yearbook of World Electronics Data 1999/2000*, Surrey, UK (collection of data on electronics production, data processing equipment purchases, sales, and exports, for TI, PC, TS, TE, and RTC)
- The PRS Group's Five-Year Investment Risk Assessment Index (for NO) (from *The Political Risk Letter*, for July 1, 1999)
- Harbison-Myers Human Skills Index (for SE) (derived from the World Bank's *1999 World Development Indicators*, New York: Oxford University Press)
- Numbers of scientists and engineers (for TI) (United Nations, *Statistical Yearbook, 1998*, New York)
- International Monetary Fund, *Directory of Trade Statistics Yearbook*, 1998, Washington, D.C. (for TE).

INDICATOR DEFINITIONS AND SCALING

We combine survey and statistical measures to compute the value for the seven indicators. Indicator formulae are presented as "S-scores" -- each component's raw data values are rescaled from 0-100. Components are then averaged to generate indicators with approximately a 0 to 100 range. For survey data, 100 reflects the highest response for a question (a "5" on a 1-5 questionnaire item response range). For statistical data, 100 typically represents the value attained by the country with the largest value among all 33 target countries. Details of this process appear in earlier papers (Porter et al., 2000, 1996; Roessner et al., 1997, 1996).

National Orientation (NO) indicates a country's commitment to technology-based development along a number of dimensions: government policy, political stability, entrepreneurial spirit, and acceptance of the idea that development should be technology-based. Table 1 includes NO for 1993, 1996, and 1999. The behavior of NO is quite regular. Recall its formulation – it is comprised of weighted responses to 4 expert opinion items (5-point scale responses, so these do not result in extreme differences) plus a scaled investment risk assessment value.

Socioeconomic Infrastructure (SE) indicates the strength of each nation's educational system, mobility of capital, and encouragement of foreign investment. Table 1 displays SE over time. Strong socioeconomic infrastructure is not restricted to the OECD nations. The three Tigers (Singapore, South Korea, and Taiwan)

are striking in their parity with the heavily industrialized nations. Ireland and Israel, as with NO, stack up well on SE. While Singapore, Taiwan, and Ireland lag a bit on tertiary education, their strong SE is not unduly driven by any single component.

Technological Infrastructure (TI) captures the strength of a nation's scientific and engineering manpower, its electronic data processing purchases, the relationship of its R&D to industrial application, and its ability to make effective use of technical knowledge. The composition of this indicator includes four expert opinion items plus a measure of purchases of electronic data processing (EDP) equipment, and number of scientists and engineers in R&D. Even on our S-score basis, the U.S. swamps all others on EDP purchases (U.S. scores 100, trailed by Japan at 39 and Germany at 15, down to Indonesia at 0.3). Numbers of scientists and engineers also vary extremely. Rescaled, the U.S. scores 100, followed by Japan (73) and Russia (67), on down to Malaysia (0.2).

Productive Capacity (PC) concerns capabilities to manufacture technology-intensive products. It combines the value of electronics production with three survey items related to manufacturing and managerial capabilities. Electronics production values exert considerable influence as they range widely. The U.S. scales at 100 on electronics production followed by Japan at 61, with a marked drop to China (19), Germany (15), UK and South Korea (13), and Singapore (12).

High Tech Standing (TS) measures current high tech production and export standing (Table 1). TS incorporates three components – an expert opinion item (rating technology-intensive production), overall high tech exports, and the value of electronics exports. As noted for the input indicators, the skewed distributions on statistical components exert strong influence on the resulting indicator, even though each component is scaled separately for the 33-country set (S-scores). This effect appears for TS, with the U.S. the 1999 benchmark (score of 100) for both overall high tech exports and electronics exports. On overall high tech exports, the U.S. is followed by Japan (59) and Germany (54); for electronics, the U.S. is followed by Japan (98) and Singapore (61).

Table 1 consolidates the results of indicator calculation for the four input indicators and for TS, the most compelling output indicator. (Refer to the report on the web site: <http://tpac.gatech.edu> for TE and RTC.) Table 2 translates these results into national rankings. Note the general stability in HTI for the leading nations (the Big Three and Western Europe—the first two groupings in the table). TI and PC differentiate within this group far more than do NO and SE, with the U.S. and Japan notably outdistancing the others. American and Japanese dominance is even more striking on TS. The third grouping in the table consists of four “English heritage” nations: Canada, Australia, South Africa, and New Zealand. All except South Africa show marked increases in NO, very high SE, solid TI, and significant PC. These are potential high tech competitors of the future. The fourth grouping is made up of four Eastern European countries, Russia, Poland, Hungary, and the Czech Republic. They, too, display national orientation to compete in high tech, with improving SE, TI, and PC (with the exception of some decline in TI for Russia). Their future high tech prospects appear bright, even though present TS is weak. The fifth group consists of the Three Tigers: Singapore, South Korea, and Taiwan. Their NO is pronounced; SE and PC are top tier; TI trails the leading countries. The sixth group includes six Asian economies of considerable diversity: Malaysia, China, Thailand, Indonesia, the Philippines, and India. They evidence strong NO, lagging SE, and lagging TI and PC, but note strong advances by China and India. Latin America, our seventh group, generally lags on the input and output indicators. Two newcomers to HTI, Ireland and Israel, show significant technological competitiveness as small economies. They are clearly committed to high tech (NO) and quite strong on the other input indicators.

Comparison of Georgia Tech HTI with the Innovation Index

In 1999 the U.S. Council on Competitiveness published *The New Challenge to America's Prosperity: Findings from the Innovation Index*, by Porter and Stern. The "innovation index" (II) is constructed by identifying and weighting 8 measures that include both statistical data and, interestingly, two survey items from the WCY World Competitiveness Report (e.g., R&D funding, openness to trade, GDP per capita) based on the strength of their statistical relationship to international patenting activity. It provides "an indication of the relative capability of the economy to produce innovative outputs...." The eight measures were identified on the basis of their ability to predict the value of a primary measure of national innovative output: the per capita number of patents granted in the U.S. to establishments in the country. Regressions were conducted using historical data (1973-1993) for 17 OECD member countries that overlap and, using the 8 measures thus identified and data on the 1985-1993 trajectory of each measure for each country, index values for 1995 were predicted. Similar index values were calculated for 8 emerging economies based on more limited data since 1990. These latter values thus depend on the assumption that "innovative capacity" in developing economies is driven by the same factors as those at work in OECD countries. Thus, their model is probably better suited for highly developed economies, less so for emerging economies.

It is interesting to compare HTI with the "Innovation Index." Both HTI and the Index contain current as well as predicted values for their respective target variables, so that it is possible to compare current (1996 HTI vs. 1995 II) as well as future (HTI 2008, based on 1993 input values,¹ vs. II 2005) country rankings. Tables 1 and 2 tabulate HTI values and the resultant national rankings for 1993, 1996, and 1999. Table 3 shows the Innovation Index values for 1995 (selected 13 of their 17 OECD countries overlap our 33 target countries) and their rankings (consolidated by the authors) along with projected Innovation Index for selected years 1999 and 2005³. Table 3 also shows the scores and rankings for a composite HTI "input" score, INPUT-93. This is simply the numerical average of the four input scores for 1993. The country rankings are what the 1993 INPUT scores would project for approximately 2008, fifteen years later. As noted above, the methodology for projecting Innovation Index values into the future was expanded to include eight emerging economies: China, India, Ireland, Israel, Malaysia, Singapore, South Korea, and Taiwan, all of which are included in our 33 target countries. Their projected Innovation Index values for selected years 1995, 1999, and 2005 (the same years as with the 13 OECD countries) are also listed in Table 3.

[Tables 1-3 approximately here]

Some observations:

- The U.S. leads on both HTI (TS) and the Innovation Index for 1995.
- Closest competitors on HTI (TS) match our sense of the economic competition (Japan, Germany, UK, surprising Singapore, France, and so on). The Innovation Index reflects high tech patenting more than export potential (the U.S. is followed by Switzerland, Japan, Sweden, and Germany); the UK is marginal on this measure.
- Both sets of current indicators point to the broadening of technology-based competitiveness across countries (e.g., the Asian Tigers). HTI portrays a much wider basis of such competition. In particular, we show countries such as China, India, and Malaysia to be serious technological competitors, now, whereas the Innovation Index shows them lagging most OECD countries even through 2005.
- Both point to the broadening of technology-based competitiveness over time. The Innovation Index warns of potential loss in relative innovativeness by the U.S. out to 2005, more than for any other

¹ HTI lead indicators are intended to predict national high tech competitiveness in roughly a fifteen-year time frame. Thus the appropriate input data would be 1993 HTI.

³ The 1999 Council on Competitiveness Report offers 1995 as the most recent calculated Index. Values for the emerging nations are shown with projections for 1999 and 2005. OECD national projections are shown only as changes in ranks.

country indexed. HTI projects the U.S. maintaining its technological leadership (note the U.S. is very strong on each of the four input indicators purported to be predictive for the coming 15 years). However, the other nations are projected to gain dramatically “across the board” relative to the U.S. and other current leaders.

- HTI projections for 2008 are quite consistent with the Innovation Index projections for 2005, perhaps surprisingly so, given the absolute character of HTI scores and the per capita basis for Index scores. Among the 11 nations whose scores are projected by both HTI and the Innovation Index, the U.S., Japan, and Germany continue to lead, with India, Malaysia, and China bringing up the rear. HTI scores Singapore, Malaysia, and Taiwan more highly than the Innovation Index (4th vs. 14th for Singapore, 13th vs. 19th for Malaysia, 10th vs. 15th for Taiwan), probably reflecting the Innovation Index’s reliance on patenting as the basis for its modeling exercise, designed more for developed than developing nations.

Comparison with the International Institute for Management Development’s Competitiveness Measure

A research team from the International Institute for Management Development (IMD) in Lausanne, Switzerland conducts annual studies of world competitiveness and has published the *World Competitiveness Yearbook* (WCY) in April of each year since 1987 (WCY, 2000). WCY is the most comprehensive assessment of the competitiveness of nations. It analyzes and ranks 47 economies (all 29 OECD countries along with 18 other newly industrialized and emerging nations that are important in the world economy) according to criteria grouped into eight Competitiveness Input Factors (Domestic Economy, Internationalization, Government, Finance, Infrastructure, Management, Science & Technology, and People). These Input Factors cover 290 criteria. They include 139 quantitative criteria (an additional 41 criteria are included in the yearbook as valuable background information, but are not considered in the overall rankings) ranging from economic growth to computer usage and labor regulations, plus 111 items drawn from a survey of experts. The IMD measures the ability of nations to provide firms “with an environment that sustains the domestic and global competitiveness of the firms operating in their borders.” Table 4 shows IMD country rankings for 1997-1998 for each of these 8 input factors for our 33 target countries.

[Table 4 (IMD Rankings) approximately here]

The IMD ratings are based on a theoretical framework consisting of four factors that are assumed to shape the environment for national competitiveness:

- Attractiveness to foreign investment vs. aggressiveness in international markets;
- Emphasis on domestic, traditional economic activity vs. on companies with international operations;
- Reliance on natural resource assets vs. transformation processes (“created comparative advantage”);
- Promotion of individual risk taking vs. preservation of social cohesiveness.

These four variables form the basis for individual measures of the eight Input Factors, e.g., savings rates, foreign direct investment, fiscal policies, availability of capital, technological infrastructure, management efficiency, R&D personnel, and attitudes and values. Thus, the criteria used to generate rankings are, not surprisingly, similar to those that underlie HTI.

The IMD has used a consistent methodology and approach for the past ten years and therefore can provide 5-year competitiveness trend data for each country analyzed. Statistical data were acquired from international and regional organizations, private institutions and national institutions. The survey data relied on an extensive network of 34 Partner Institutes around the world who provide (or ensure that the sample of

local experts provides) IMD with first hand, up-to-date information on their countries. The panel of experts for 2000 consisted of 3,263 within-country executives representing domestic and international companies. In order to limit the volatility of the survey data, IMD weights survey-derived data 1/3 and the statistical data 2/3 so that the survey data comprise one third of the eight compiled input factor scores and the Overall Competitiveness scores for each country. This one-third to two-thirds balance between soft and hard data is somewhat arbitrary, but has regularly been applied since it was first used in 1994.

Comparing the IMD rankings for 1999 with our HTI 1999 rankings, we have some observations:

- Generally, the IMD rankings are consistent with HTI rankings for 1999. WCY 2000 shows that the U.S. has maintained the top position as the world's most competitive nation. Most European nations have moved up in the rankings. Ireland is ranked seventh this year; it shows significant technological competitiveness as one of the smaller countries in our HTI study. Asian nations vary in their competitive performance, and Latin America generally lags.
- There are some notable differences in the relative positions of several countries, e.g., China, India, France, Japan, Germany, and South Korea all rank lower on the IMD scores than on HTI. On the other hand, Australia and New Zealand rank significantly higher on the IMD scale than on HTI. Without detailed analysis of the multiple measures that make up the IMD country scores, there is no readily apparent explanation for these differences.

HTI Compared with the UNU/INTECH Rankings

Sunil Mani and his colleagues from The United Nations University and Institute for New Technologies (UNU/INTECH) at Maastricht use time-series data on the exports of high technology products from selected developing countries to examine and analyze various indicators of high tech competitiveness (Mani, 2000). They consider the composition of a country's exports as one of the best indicators of technological development, use product specialization of exports as a way to classify the developing countries, and examine the case of Singapore – the largest exporter of high tech products in the developing world. They apply the OECD definition of high technology to the COMTRADE database, available on-line from the UN Statistics Division, to generate country scores defined as the ratio of high tech exports to total manufactured exports. (This basically equates to our definition of Technological Emphasis (TE), which is not analyzed here.) The analysis shows that developing countries are increasingly becoming exporters of manufacturing products, as against primary products in the past, and the technology content of their exports is also increasing significantly (nearly a quarter of their exports is in high tech products). The share of developing countries in total world high tech exports has increased dramatically, too. But these high tech exports are concentrated among the more developed of the developing countries.

[Tables 5 and 6 approximately here]

UNU/INTECH's study employs time-series data on the exports of high tech products alone from developing countries to analyze the capacity for high tech competitiveness for these developing countries. Tables 5 and 6 show the resulting data and country rankings. These data are the ratio of high tech exports to total manufactured exports in 1999 for each country listed. The data for UNU-99 are from UNU/INTECH's work (9 countries in common with ours), and the data for WDI-99 are from the World Bank (17 countries in common with ours). The World Bank's scores and rankings differ from those generated by UNU/INTECH because the WDI data are based on the U.S. Department of Commerce definition of high-tech (the same definition used to calculate the trade component of Georgia Tech/HTI TS scores) on the basis of the Standard International Trade Classification revision 1.

UNU/INTECH also examined trends in the number of patents granted in the USA to researchers from 14 countries or regions (Australia, China, Germany, Hong Kong, India, Ireland, Israel, Japan, Malaysia, Singapore, S. Korea, Taiwan, UK, and USA) since 1985. Their study shows that the patenting rate for many of the developing countries has increased dramatically in recent years, especially for S. Korea and Taiwan. China and Singapore show the fastest growth in US patents, though the number of patents granted to each is still small. These results suggest the possibility of significant high tech competitiveness from some essentially developing countries. We share the view with UNU/INTECH that patent data are an important indicator of national high tech competitiveness, and are currently working to incorporate patent data in future HTI.

Some observations:

- Asian nations that concentrate on high tech exports (e.g., Singapore, Malaysia, the Philippines, Thailand, South Korea) also tend to be successful high tech competitors measured using an absolute scale such as HTI's Technical Standing (TS). This is also true for the non-Asian nations ranked by UNU: Ireland and the Netherlands.
- UNU/INTECH concentrates its study on exports of high tech products from developing countries (especially from those who have a high rate of development in high tech industries), including export structure, location of manufacturing products, technological complexion (content), and the main features of exports.
- UNU/INTECH takes Singapore, a leading exporter in high tech products from developing countries, as a case study, and provides more detailed information about its efforts to improve its national high tech competitiveness. Singapore's government took a series of strong measures in the past decade to develop local S&T capabilities, such as establishing the National S&T Board in 1991 (for developing the local S&T capability through promoting and strengthening the technology infrastructure), formulating the Second Five-Year National S&T Plan in 1996, and initiating new policies to change industry structure (very strong push into specialized high tech products for export markets), etc. The government in Singapore has also actively promoted various types of technical education and thereby increased the supply of scientists and engineers. Subsequent to these efforts, both the gross investments in R&D and the number of scientists and engineers engaged in R&D have shown dramatic increases. Singapore has rapidly improved its indigenous capability to design, manufacture, and export high tech products. Our study shows that Singapore has the highest scores in NO (National Orientation) among the 33 target countries, and has a leading rank in most of the other six indicators among developing countries analyzed.

Comparative Overview: HTI with II, UNU, and IMD

It is helpful to compare HTI with the other three rankings of countries on measures of competitiveness by using graphical visualization of the rankings and by ordering all countries in declining order by their HTI 99 rankings. Figure 1 displays such rankings for II 99, UNU 99, and IMD 98.² The similarities and differences described earlier in this paper are now more apparent.

[Figure 1 about here]

What stands out to us are the following. First, the Innovation Index rankings match those of HTI (the TS indicator, Technological Standing) with the exception of countries that have relatively small economies but are "highly innovative" (Switzerland, Sweden, Australia, New Zealand), and several newly industrialized

² The World Bank's WDI data were not included in Figure 1 because they do not in themselves represent measures of national competitiveness.

countries that are relatively “less innovative” (Singapore, China, India, Taiwan, Malaysia). HTI’s absolute measures of competitiveness and the Innovation Index’s per capita measure of innovativeness largely explain the first group of country disparities, while the Index’s reliance on patent output as the primary measure of country innovativeness largely explains why the developing nations of Asia, with their less developed patent systems, lag HTI by this measure. Ireland seems to be an anomaly. Second, regarding the UNU/INTECH rankings, the large conceptual difference between HTI’s definition of competitiveness as related to world market share and UNU’s definition based on the composition of exports explains the wide disparities observed for nearly all countries included in both studies. Finally, the figure shows that HTI and IMD rankings are quite similar for most countries, with only a few exceptions: Japan (IMD considerably lower than HTI), South Korea (IMD considerably lower than HTI), Australia and New Zealand (IMD considerably higher than HTI), and Argentina (IMD considerably higher than HTI).

Concluding Observations

The comparisons described in this paper reflect some similarities in approach to measuring national rankings related to “competitiveness,” but the differences in definitions, approach, and purpose of each approach clearly outweigh the similarities. HTI sought to measure high tech competitiveness on an absolute scale; the innovation index sought to measure “innovative capacity” on a per capita basis; the World Competitiveness Yearbook (IMD) measured the environment for competitiveness; and UNU/INTECH measured export specialization. Only HTI and the Innovation Index were explicitly intended for projections of future national performance. Interestingly, HTI, IMD scores, and the Innovation Index all combine statistical measures with survey data, reflecting their bases in explicit conceptual models of the processes by which nations become competitive or innovative. The complexity of the processes leading to these outcomes clearly cannot be captured adequately using existing statistical data alone.

The conceptual background upon which these various measures of competitiveness are based also varies widely. We sought to forecast the competitiveness of the newly developed and developing nations of the world, and thus drew upon the theoretical and empirical literature on processes of adoption, absorption, and institutionalization of technological capability to develop competitiveness based in high tech exports. As a consequence, the extension of our model to OECD member nations is not fully appropriate. The Porter/Stern innovation index suffers from the reverse: the model was based on historical data from OECD nations and then applied to developing nations. The IMD model does not distinguish between the developed and developing nations and in this sense may have reduced validity when applied to nations at quite different stages of development.

The Porter/Stern conceptual model shares our tenet that “input indicators” can provide leading indicators of future technologically based competitiveness – but their regression model links input indicators to 3-year lagged innovative outputs, vs. our roughly 15-year horizon. Their input indicators concentrate heavily on R&D and R&D linkages, whereas ours treat more widely varied facets of the basis for developing technological competitiveness. We would treat their target output indicator, patenting, as an input indicator, with our output measures focusing on technology-based export competitiveness. Emphasis on patenting as the measure of innovative output greatly underestimates the competitiveness of potent emerging economies such as China that lack well-established patent systems.

Differences in the country rankings between HTI and those of the Innovation Index reflect the conceptual and empirical differences between “competitiveness” and “innovativeness,” as well as the difference between absolute and normalized country data. The ability to compete internationally in high-tech markets is assuredly influenced by a nation’s capacity for indigenous technological innovation, but the two are by no means the same. A nation may be competitive, at least for a while, without being highly

innovative (Singapore serves as an example), and innovative nations are not necessarily able to compete internationally (e.g., Ireland) because of their size, their recent emergence as an innovative nation, their emphasis on exports, or their technological emphasis.

We found that existing statistical data series have serious weaknesses and gaps that make reliance on them alone problematic for development of indicators of competitiveness, particularly for the range of countries of interest. Researchers from IMD and Porter/Stern share the same experience with us in this point. One difference is that the IMD weights soft data as 1/3 in its ranking computation and HTI currently weights soft data approximately twice as heavily as statistical data.³ The “study period” is another difference: the World Competitiveness Yearbook is published annually whereas HTI takes three years as its research cycle; the Innovation Index and the UNU rankings are, so far, one-time events.

The UNU/INTECH rankings are probably the least comparable to HTI’s measure of competitiveness because of the Maastricht researchers’ concern for measuring country specialization in high tech products for export, rather than actual competitive performance. The data suggest that in many cases specialization does lead to future competitive performance on an absolute basis, but the UNU analysts were not explicitly attempting to make such projections. When combined with additional data on patents and other indicators of competitiveness being studied at the UNU, the Maastricht researchers may generate country scores that are more comparable to ours.

It is widely accepted that a country's high tech competitiveness cannot be reduced to a few indicators; it is shaped by political, economic, cultural, and educational features of countries. The factors affecting competitiveness are numerous and the relationships surely nonlinear. At the present time, we are initiating a review and revision of the HTI. We are addressing questions such as: what other component measures might enhance the validity of indicators (e.g., patent statistics); how the operational definition of “high tech” should be modified to better account for emerging technologies and for the economic significance of innovation in nonmanufacturing industries; and what alternative analyses might enhance the value of HTI to various users. Suggestions are most welcome!

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Table 1: Georgia Tech HTI Scores for 1993, 1996, and 1999

COUNTRY	NO (National Orientation)			SE (Socioeconomic Infrastructure)			TI (Technological Infrastructure)			PC (Productive Capacity)			TS (Technological Standing)		
	1993	1996	1999	1993	1996	1999	1993	1996	1999	1993	1996	1999	1993	1996	1999
USA	69.9	75.5	78.4	84.0	85.1	87.0	87.5	94.8	96.1	89.8	89.4	88.1	90.0	91.4	95.4
JAPAN	85.3	73.8	79.5	72.7	62.3	63.2	83.7	81.7	78.3	92.7	94.4	83.4	90.8	93.9	82.7
GERMANY	75.2	76.5	73.8	69.8	62.9	71.8	66.6	62.4	64.1	65.0	61.6	65.3	60.5	59.2	58.7
UNITED KINGDOM	63.2	70.9	72.4	65.6	65.5	78.0	57.5	59.4	59.8	49.0	52.3	53.6	49.3	48.6	53.8
FRANCE	74.2	75.9	75.4	63.8	64.9	71.7	60.0	61.3	58.0	56.1	64.1	65.5	45.6	45.7	48.0
NETHERLANDS	68.5	81.3	68.9	67.7	74.7	74.2	54.4	55.7	53.1	50.5	56.3	56.0	35.1	40.3	38.7
ITALY	59.2	66.3	63.1	53.6	59.3	59.7	50.5	48.6	48.4	51.8	51.4	47.1	31.5	29.5	26.2
SWITZERLAND	71.5	57.8	66.0	62.0	59.6	60.5	55.4	51.1	54.8	53.4	52.9	55.6	32.5	30.5	32.8
SWEDEN	83.0	66.8	64.2	66.6	65.3	68.7	55.5	53.7	55.5	52.8	52.6	47.0	28.0	32.2	30.2
SPAIN	55.9	63.8	66.7	64.4	59.3	68.4	36.4	39.1	40.1	52.3	43.6	44.7	18.3	16.0	18.4
IRELAND			92.2			75.6			48.0			55.9			32.7
CANADA	60.1	69.0	78.5	78.3	82.5	91.7	49.5	47.5	53.5	48.1	40.2	52.8	24.0	28.1	35.4
AUSTRALIA	66.8	66.2	78.4	63.9	60.6	83.2	45.8	51.3	53.0	41.3	47.7	51.6	15.6	20.6	19.5
SOUTH AFRICA		49.1	50.2		51.0	53.6		40.3	40.5		30.0	28.7		15.4	14.3
NEW ZEALAND	57.1	66.7	67.3	70.0	74.3	70.9	41.9	48.3	45.9	34.6	45.6	39.6	16.8	13.5	16.8
RUSSIA	32.5	48.9	51.1	39.4	50.7	53.7	58.4	55.6	52.9	31.8	42.6	39.1	14.7	19.0	15.2
POLAND		69.4	69.6		54.2	58.4		35.0	38.2		39.0	44.3		18.8	18.4
HUNGARY	66.7	67.0	73.7	54.0	47.7	60.9	41.4	36.4	43.0	36.8	39.8	42.2	15.4	17.1	20.9
CZECH REPUBLIC			68.2			58.9			41.5			44.6			16.4
SINGAPORE	92.7	88.4	87.9	73.5	75.7	71.9	40.5	41.6	38.9	54.6	54.0	53.7	35.8	46.7	51.5
SOUTH KOREA	81.9	78.9	74.9	69.6	64.6	73.5	42.6	44.4	44.6	46.4	50.5	48.8	28.7	32.6	32.7
TAIWAN	81.1	90.2	90.7	74.5	76.3	74.2	37.4	43.0	43.6	43.0	49.9	53.7	27.0	31.5	35.2
MALAYSIA	81.1	81.0	69.5	63.7	62.6	58.9	34.2	31.9	31.9	47.5	43.1	44.1	24.3	28.2	30.8
CHINA	62.3	65.2	65.3	46.4	44.8	52.4	38.6	39.3	46.4	33.2	32.8	41.9	20.7	22.5	44.2
THAILAND	67.5	63.5	50.7	51.0	48.7	46.5	26.7	28.1	20.5	33.4	33.1	30.6	17.2	18.1	16.6
INDONESIA	62.5	54.8	53.9	49.5	35.2	43.8	25.3	17.8	19.2	24.8	19.6	23.7	11.0	11.2	14.0
PHILIPPINES	43.1	75.1	60.9	57.5	63.4	63.7	25.1	35.7	24.4	34.9	46.2	42.6	12.6	14.9	15.0
INDIA	52.4	57.4	67.7	46.4	46.0	48.4	33.0	39.3	46.8	38.6	49.1	51.3	13.5	18.3	20.8
MEXICO	47.9	54.8	41.8	47.7	45.5	40.4	25.2	30.2	21.8	27.2	31.7	24.8	11.6	20.1	19.8
BRAZIL	63.6	58.0	61.5	55.1	53.1	49.1	41.6	37.4	40.4	48.1	40.3	39.6	15.5	19.1	18.2
ARGENTINA	45.0	41.4	41.3	63.2	49.4	53.3	25.5	27.4	27.5	32.2	31.0	31.0	12.7	9.6	11.3
VENEZUELA		45.0	39.8		47.7	49.4		27.9	21.3		25.1	24.3		10.5	7.7
ISRAEL			92.0			74.1			58.2			50.6			29.5

Table 2: Georgia Tech HTI Country Rankings, 1993, 1996, and 1999

COUNTRY	NO (National Orientation)			SE (Socioeconomic Infrastructure)			TI (Technological Infrastructure)			PC (Productive Capacity)			TS (Technological Standing)		
	1993	1996	1999	1993	1996	1999	1993	1996	1999	1993	1996	1999	1993	1996	1999
USA	10	8	7-1	1	1	2	1	1	1	2	2	1	2	2	1
JAPAN	2	10	5	5	14	17	2	2	2	1	1	2	1	1	2
GERMANY	7	6	11	7	12	11	3	3	3	3	4	4	3	3	3
UNITED KINGDOM	16	11	13	11	7	4	6	5	4	11	9	10	4	4	4
FRANCE	8	7	9	14	9	12	4	4	6	4	3	3	5	6	6
NETHERLANDS	11	3	16	9	5	6-1	9	6	10	10	5	5	7	7	8
ITALY	20	17	24	21	17-1	20	10	11	13	9	10	16	9	12	17
SWITZERLAND	9	23	21	17	16	19	8	10	8	6	7	7	8	11	11
SWEDEN	3	15	23	10	8	14	7	8	7	7	8	17	11	9	15
SPAIN	22	20	20	12	17-2	15	20	20	24	8	17	18	16	24	22-1
IRELAND			1			5			14			6			12-1
CANADA	19	13	6	2	2	1	11	13	9	12-1	21	11	14	14	9
AUSTRALIA	13	18	7-2	13	15	3	12	9	11	17	14	12	19	16	21
SOUTH AFRICA		27	30		21	25		17	22		28	30		25	30
NEW ZEALAND	21	16	19	6	6	13	14	12	17	21	16	25-1	18	27	25
RUSSIA	27	28	28	27	22	24	5	7	12	25	19	27	22	19	28
POLAND		12	14		19	23		24	26		23	20		20	22-2
HUNGARY	14	14	12	20	25-1	18	16	22	20	19	22	23	21	23	18
CZECH REPUBLIC			17			21-1			21			19			27
SINGAPORE	1	2	4	4	4	10	17	16	25	5	6	8-1	6	5	5
SOUTH KOREA	4	5	10	8	10	9	13	14	18	15	11	15	10	8	12-2
TAIWAN	5-1	1	3	3	3	6-2	19	15	19	16	12	8-2	12	10	10
MALAYSIA	5-2	4	15	15	13	21-2	21	25	27	14	18	21	13	13	14
CHINA	18	19	22	25-1	29	27	18	18-1	16	23-1	25	24	15	15	7
THAILAND	12	21	29	22	24	31	23	27	32	22	24	29	17	22	26
INDONESIA	17	25-1	27	23	30	32	25	30	33	27	30	33	27	29	31
PHILIPPINES	26	9	26	18	11	16	27	23	29	20	15	22	25	26	29
INDIA	23	24	18	25-2	27	30	22	18-2	15	18	13	13	23	21	19
MEXICO	24	25-2	31	24	28	33	26	26	30	26	26	31	26	17	20
BRAZIL	15	22	25	19	20	29	15	21	23	12-2	20	25-2	20	18	24
ARGENTINA	25	30	32	16	23	26	24	29	28	23-2	27	28	24	30	32
VENEZUELA		29	33		25-2	28		28	31		29	32			33
ISRAEL			2			8			5			14			16

Table 3: Country Scores and Rankings: HTI and Innovation Index

COUNTRY	HTI SCORES AND RANKINGS		INNOVATION INDEX SCORES AND RANKINGS			
	INPUT-1993	RANKINGS (~2008)	INDEX-1995	RANKINGS-1995	PROJECTED RANKINGS-1999	PROJECTED RANKINGS 2005
USA	82.8	2	145.23	1	3	4
JAPAN	83.6	1	119.59	3	1	1
GERMANY	69.2	3	104.89	5	5	5
UNITED KINGDOM	58.8	12	36.12	10	10	10
FRANCE	63.5	6	69.71	6	6	6
NETHERLANDS	60.3	8	48.26	8	9	
ITALY	53.8	15	13.78	16	12	
SWITZERLAND	60.6	7	137.02	2	2	
SWEDEN	64.5	5	110.55	4	4	
SPAIN	52.2	16	9.51	18	13	
IRELAND			(~10)	17	18 (~11)	18 (~12)
CANADA	59.0	10-1	60.13	7	7	
AUSTRALIA	54.4	14	47.25	9	8	
SOUTH AFRICA						
NEW ZEALAND	50.9	18	19.11	14	11	
RUSSIA	40.6	25-1				
POLAND	49.4	20				
HUNGARY	49.7	19				
CZECH REPUBLIC						
SINGAPORE	65.3	4	(~22)	11	14 (~42)	14 (~90)
SOUTH KOREA	60.1	9	(~11)	15	17 (~17)	16 (~32)
TAIWAN	59.0	10-2	(~20)	12-1	15 (~30)	15 (~50)
MALAYSIA	56.6	13	(~0)	19	19 (~0)	19 (~3)
CHINA	45.1	21	(~0)	20	20 (~0)	20 (~2)
THAILAND	44.7	22				
INDONESIA	40.5	27				
PHILIPPINES	40.2	28				
INDIA	42.6	23	(~0)	21	21 (~0)	21 (~1)
MEXICO	40.6	25-2				
BRAZIL	52.1	17				
ARGENTINA	41.5	24				
VENEZUELA						
ISRAEL			(~20)	12-2	16 (~20)	17 (~20)

Source: References (M.E. Porter et al., 1999 and Mani, 2000)

1. INPUT-93: Numerical average of the four HTI input values for 1993. This would project competitiveness of nations in about 15 years, or approximately 2008.
2. INDEX-95: Innovation Index value for 1995. The values for 8 emerging countries in all selected years (in brackets with approximate sign '~') are 'projected data' measured from Fig. 2-6 in Reference [M.E. Porter et al., 1999, p.37]. India, China, and Malaysia have registered virtually no international patenting (Innovation Index value) through the mid- to late 1990s.

3. RANKINGS-95: Rankings by Innovation (or projected Innovation) Index values for 1995. RANKINGS-99 and RANKINGS-2005: Rankings by Projected Innovation Index values for 1999 and 2005. Rankings for 8 emerging countries in 1999 and 2005 begin with 14 (i.e., after 13 OECD countries, because reference [M.E. Porter et al., 1999] didn't provide concrete projected Innovation Index values for these 13 OECD countries after the year 1995 and gave their rankings only).

Table 4: IMD Country Rankings by Input Factor & Country (1997-98)

COUNTRY	General Index		Domestic Economy		Internationalization		Government		Finance		Infrastructure		Management		Science & Technology		People	
	G-97	G-98	1-97	1-98	2-97	2-98	3-97	3-98	4-97	4-98	5-97	5-98	6-97	6-98	7-97	7-98	8-97	8-98
USA	1	1	1	1	1	1	7	13	1	1	1	1	3	1	1	1	12	8
JAPAN	9	18	6	15	32	34	28	27	5	23	20	21	7	24	2	2	11	11
GERMANY	14	14	26	21	7	8	25	36	9	7	7	7	25	20	3	3	19	21
UNITED KINGDOM	11	12	19	19	4	5	8	10	8	6	16	17	14	18	14	17	23	25
FRANCE	19	21	29	36	10	10	35	42	16	16	15	14	20	23	4	4	25	23
NETHERLANDS	6	4	16	13	6	6	22	17	2	2	12	8	3	4	12	11	10	9
ITALY	34	30	30	29	27	19	44	44	34	29	32	28	27	26	35	31	27	26
SWITZERLAND	7	7	32	28	26	17	5	8	3	3	9	11	9	12	5	5	6	7
SWEDEN	16	17	31	26	11	14	38	35	14	13	4	4	6	6	21	15	17	17
SPAIN	25	27	33	31	14	18	21	23	21	22	21	25	28	28	27	30	26	27
IRELAND	15	11	5	6	12	7	12	6	20	15	22	23	12	10	7	8	20	19
CANADA	10	10	21	12	19	22	9	7	10	12	6	6	10	11	9	12	2	6
AUSTRALIA	18	15	22	25	28	27	14	9	18	14	8	9	19	17	24	21	14	10
SOUTH AFRICA	44	42	42	40	46	45	34	31	36	31	33	35	37	38	40	39	46	46
NEW ZEALAND	13	13	34	30	22	16	3	4	15	17	13	13	11	9	16	23	8	15
RUSSIA	46	46	45	46	37	30	46	37	46	46	46	45	46	46	26	19	41	33
POLAND	43	45	39	41	44	43	45	46	45	43	36	36	44	43	42	44	35	41
HUNGARY	36	28	44	42	21	26	39	26	38	30	23	20	40	35	28	27	29	30
CZECH REPUBLIC	35	38	36	43	24	29	41	40	35	36	29	27	42	42	44	37	24	28
SINGAPORE	2	2	3	2	2	2	1	1	6	10	11	15	1	2	8	9	5	1
SOUTH KOREA	30	35	13	34	45	46	32	34	43	45	34	31	26	34	22	28	22	22
TAIWAN	23	16	17	8	30	32	20	14	23	19	28	26	18	7	10	7	18	21
MALAYSIA	17	20	2	3	17	24	4	3	19	28	27	24	17	22	25	24	33	34
CHINA	27	24	14	5	29	20	6	5	40	42	40	40	34	30	20	13	31	24
THAILAND	29	39	12	16	25	37	18	22	29	44	42	41	31	41	32	43	37	35
INDONESIA	39	40	11	9	35	36	27	24	39	35	39	38	41	44	41	42	44	44
PHILIPPINES	31	32	20	23	31	28	11	19	28	40	44	44	30	27	29	32	38	40
INDIA	41	41	24	18	43	42	31	28	37	33	45	46	39	32	30	29	45	45
MEXICO	40	34	41	22	38	40	29	25	42	39	26	33	38	33	46	45	40	38
BRAZIL	33	37	25	39	41	39	16	21	41	41	41	42	29	29	36	36	36	37
ARGENTINA	28	31	37	24	20	21	17	30	31	32	30	29	35	40	37	40	28	36
VENEZUELA	45	43	46	45	42	41	42	39	32	37	31	30	45	45	45	46	42	42
ISRAEL	26	25	15	27	34	33	36	33	30	27	24	22	24	19	13	10	16	16

Source: (WCY, 1998)

1. IMD made rankings for 47 countries covering the 33 GT/HTI nations. This table shows the 33 target nations (in 8 country sets) only and retains the ranking number with 47 countries.
2. G-97 and G-98: General Rankings in 1997 and 1998.
3. 1-97 and 1-98 to 8-97 and 8-98: Rankings by WCY's 8 input factors (i.e., Domestic Economy, Internationalization, Government, Finance, Infrastructure, Management, Science & Technology, and People) in 1997 and 1998 respectively.

Table 5: Country Scores and Rankings: HTI and UNU Scores and Rankings

COUNTRY	HTI SCORES AND RANKINGS		UNU SCORES AND RANKINGS	
	INPUT-1993	RANK-INGS (~2008)	UNU SCORES 1999	UNU RANKINGS 1999
USA	82.8	2	32%	5
JAPAN	83.6	1	26%	9
GERMANY	69.2	3		
UNITED KINGDOM	58.8	12		
FRANCE	63.5	6		
NETHERLANDS	60.3	8	27%	7-1
ITALY	53.8	15		
SWITZERLAND	60.6	7		
SWEDEN	64.5	5		
SPAIN	52.2	16		
IRELAND			47%	4
CANADA	59.0	10-1		
AUSTRALIA	54.4	14		
SOUTH AFRICA				
NEW ZEALAND	50.9	18		
RUSSIA	40.6	25-1		
POLAND	49.4	20		
HUNGARY	49.7	19		
CZECH REPUBLIC				
SINGAPORE	65.3	4	57%	1
SOUTH KOREA	60.1	9	27%	7-2
TAIWAN	59.0	10-2		
MALAYSIA	56.6	13	49%	3
CHINA	45.1	21		
THAILAND	44.7	22	31%	6
INDONESIA	40.5	27		
PHILIPPINES	40.2	28	53%	2
INDIA	42.6	23		
MEXICO	40.6	25-2		
BRAZIL	52.1	17		
ARGENTINA	41.5	24		
VENEZUELA				
ISRAEL				

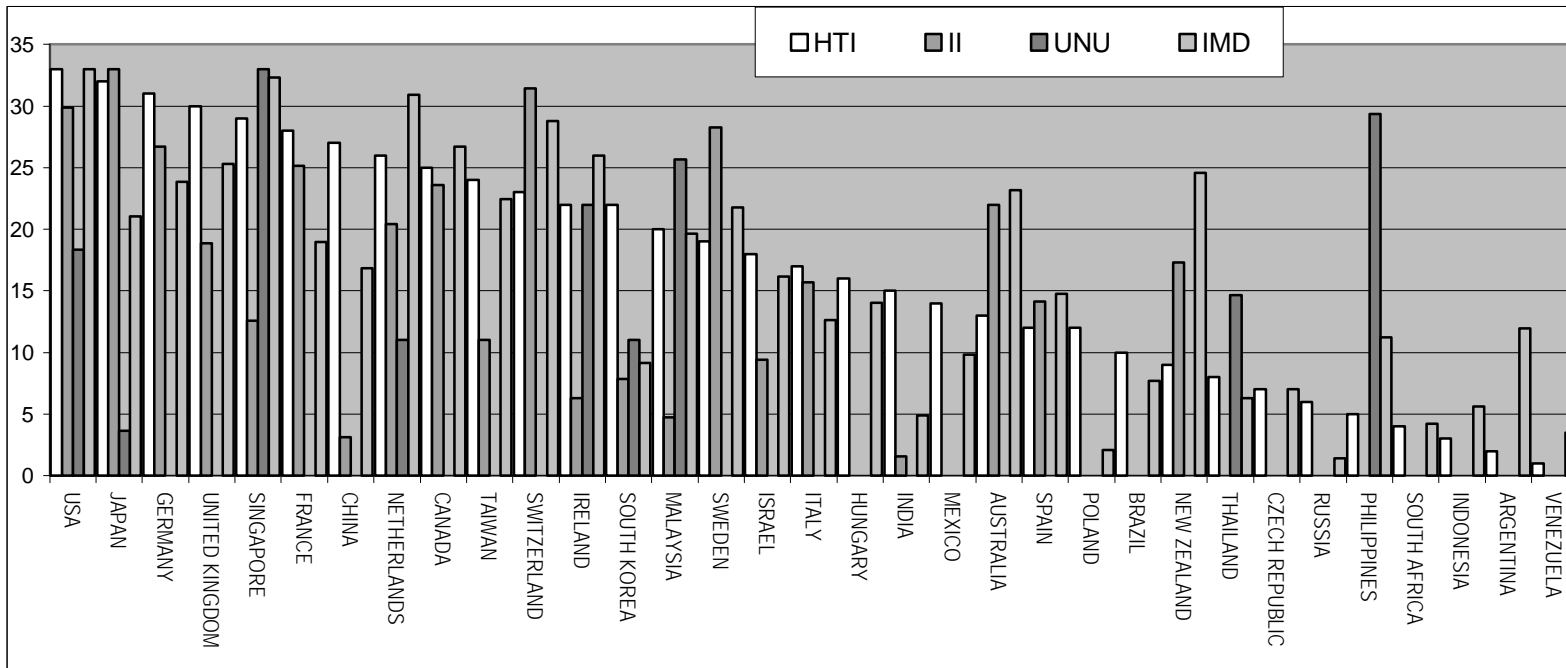
Note. UNU-99 from Reference (Mani, 2000), they are percentage share of high tech exports to total manufactured exports in 1999 for each country. The data of UNU-99 are from UNU/INTECH's work (9 countries the same as GT/HTI).

Table 6: Country Scores and Rankings: HTI and WDI Scores and Rankings

COUNTRY	HTI SCORES AND RANKINGS		WDI SCORES AND RANKINGS (FROM UNU)	
	INPUT-1993	RANKINGS (~2008)	WDI SCORES 1999	WDI RANKINGS 1999
USA	82.8	2	44%	5-1
JAPAN	83.6	1	38%	12
GERMANY	69.2	3	26%	17
UNITED KINGDOM	58.8	12	41%	8
FRANCE	63.5	6		
NETHERLANDS	60.3	8	44%	5-2
ITALY	53.8	15		
SWITZERLAND	60.6	7	28%	16
SWEDEN	64.5	5	34%	13
SPAIN	52.2	16		
IRELAND			62%	3
CANADA	59.0	10-1		
AUSTRALIA	54.4	14	39%	9-1
SOUTH AFRICA				
NEW ZEALAND	50.9	18		
RUSSIA	40.6	25-1		
POLAND	49.4	20		
HUNGARY	49.7	19	39%	9-2
CZECH REPUBLIC				
SINGAPORE	65.3	4	71%	1
SOUTH KOREA	60.1	9	39%	9-3
TAIWAN	59.0	10-2		
MALAYSIA	56.6	13	67%	2
CHINA	45.1	21		
THAILAND	44.7	22	43%	7
INDONESIA	40.5	27		
PHILIPPINES	40.2	28	56%	4
INDIA	42.6	23		
MEXICO	40.6	25-2	33%	14-1
BRAZIL	52.1	17		
ARGENTINA	41.5	24		
VENEZUELA				
ISRAEL			33%	14-2

Note: WDI-99 data are from the World Bank (17 countries the same as GT/HTI). Differences in scores are the result of differences in the definition of "high tech" used by the UNU researchers and the World Bank.

Figure 1: Countries Ordered by HTI Ranking Compared with Innovation Index, UNU/INTECH, and IMD Rankings



Note: HTI, Innovation Index, and UNU rankings are from 1999 data; IMD rankings are from 1998 data. In this figure, rankings run from high to low, the reverse of the tables, to accommodate the different numbers of countries covered by the respective indicators.