Changes in National Technological Competitiveness: 1990-93-96-99

================================

Alan L. Porter, J. David Roessner, Xiao-Yin Jin, and Nils C. Newman[1]

ABSTRACT: *Georgia Tech's Technology Policy and Assessment Center, with support from the US National Science Foundation, has been generating High Tech Indicators (HTI) – measures of national technology-based export competitiveness since 1987. This paper reports the HTI results for 33 nations in 1999 in comparison with those of 1990, 1993, and 1996.*

HTI includes four "input indicators" and a key "output indicator" – technological standing. We construct a new composite input indicator here and examine its predictive capability. Input indicators for 1990 and 1993 show intriguing relationships to 1999 technological standing.

We compare the indicators for various groups – leading and emerging Western economies, rapidly developing Asian economies, former East Bloc nations, and lagging Latin American countries. The United States presently exhibits a dominant position, but signs strongly point toward increasingly broad-based competition in technology-based products.

[1] Alan L. Porter is Director of the Technology Policy and Assessment Center (TPAC), and Professor of Industrial & Systems Engineering (ISyE) and of Public Policy, Georgia Tech, Atlanta, GA 30332-0205, USA, Tel: +1 404 894 2330; Fax: +1 404 894 2301, e-mail: alan.porter@isye.gatech.edu. J. David Roessner is Co-Director of TPAC and Professor of Public Policy Emeritus, Georgia Tech, and Associate Director, Science and Technology Policy Program, SRI International, e-mail: roessner@mindspring.com. Nils Newman and Xiao-Yin Jin are Senior Researchers at TPAC, Georgia Tech, 781 Marietta Street, Atlanta, GA 30332-0525, USA, Newman's e-mail: newman@mindspring.com; Jin's e-mail: j.xiyiu@isye.gatech.edu.

Introduction

In modern society, national competitiveness is based primarily on technology. Science and technology constitute the decisive factors in the new productive forces. Developing nations that succeed rely heavily on technology for economic expansion. We believe that science and technology will constitute the core of competitiveness in the future [1-4].

A variety of studies on technology-based competitiveness indicators have been conducted during the past decade to measure change in technical capabilities, predict trends in technology-aided development, assess the business environment, and inform policy for enhancing national competitiveness [5-20]. Generally speaking, the data used for measuring national competitiveness can be divided into two types. First, hard (or statistical) data provide much information – e.g., gross domestic product (GDP), GDP per capita, R&D expenditures, R&D personnel, exports of goods and services, educational infrastructure, etc. These data can be collected from international, regional, or national statistical sources. Second, soft (or expert opinion) data complement the statistics – e.g., compile the opinions of a set of knowledgeable persons. After data processing and mathematical calculations (hard data, soft data or their combination), the results can be used to measure and compare national competitiveness. Several recent indicator compilations provide interesting contrasts to our work [21-23]; we plan to compare these in a forthcoming paper.

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 [24-38]. We initially demonstrated the feasibility of a set of country-level indicators of international competitiveness in high technology industries, generating four "Input" and three "Output" indicators. Since 1990, we have compiled HTI every three years, with quite consistent component statistical and expert opinion components. 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.

This paper describes the results of our latest survey and compares these to our 1990, 1993, and 1996 indicators. The paper is organized in three sections. In the first section, we summarize the 1999 web survey and statistical research background, including country coverage, expert opinion gathering, and statistical measures. In the second section, we compare findings from 1990 to 1999. In the third section, compare grouped 'country sets' of our 33 target countries (i.e., The big 3, Western Europe, English Heritage Nations, Eastern Europe, Asian Tigers, Asian Cubs, and Latin America) analyzed in our study.

The Conduct of HTI

Country Coverage

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 have 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)

Expert Opinion Collection

In earlier years, “soft data" from HTI experts were collected by mail and fax, then e-mail was added, and most recently, web-based questionnaires. For 1999, we published our questionnaire on the web (http://tpac.gatech.edu/hti99/) with background materials and followed up by e-mail to invite experts to participate in this HTI Panel. The web-based approach considerably facilitates collection internationally. This is vital as we seek persons familiar with technology-based economic development in specific countries. One problem is that some experts, especially those from developing countries, are unable to access the Internet. This problem should lessen in the future.

The expert opinion questionnaire has remained essentially the same from 1990 on. Significant revision and country expansion from 1987 to 1990 discourages our inclusion of 1987 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
- 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 we feel 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; under HTI, see the Appendix: Current Indicator Formulations).

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. We seek balance among multiple perspectives. Over time turnover in membership is brisk – only 24% of the current respondents also participated in 1996. We invite various persons who appear to meet these criteria, but ultimately self-selection comes into play. The respondents indicate their familiarity on a self-report scale item. In our 1999 web survey, this self-rated expertise showed: 27.1% as expert, 44.0% as highly familiar, 26.2% as moderately familiar, and 2.7% as less familiar. Due to the general nature of our expert inclusion criteria, we are cautious in interpreting sector-specific item responses on current and 15-year future prospects.

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). Most experts (283/303, about 93%) responded for only one country. Twenty (20) experts responded for two or more countries. Among the 303 experts, 72 of them responded both in 1996 and 1999.

With respect to missing answers, we divide the responses into two groups. For questions A to O (15 questions), generally speaking, the HTI experts responded for all questions. The total answers for these 15 questions should be 15 x 336 = 5040, if experts answered every question; we received 5027 answers (99.7%). For question P (the last, multi-part question), we asked the respondents to characterize present and future (roughly 15-year time horizon) technology-intensive production in each of nine sectors for which they feel reasonably familiar. We received 5545 answers (91%).

Statistical Data Collection

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, *Direction of Trade Statistics Yearbook*, 1998, Washington, D.C. (for TE).

We seek the most recent data available for each HTI compilation, but readers should be wary of lags on some components. We are currently investigating new data sources and invite suggestions via e-mail or the TPAC website.

Indicator 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 [25-29].

HTI Findings From 1990 to 1999

A Composite Leading (Input) Indicator

To enable comparisons, we present the 1999 HTI results together with those from 1990, 1993, and 1996. 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 website: http://tpac.gatech.edu for TE and RTC.)

Space for Table 1 approximately here

Figure 1 graphically depicts a composite input indicator ("INPUT") for 1990, 1993, 1996, and 1999. This is simply the average of NO, SE, TI, and PC for a given country and year. We explored alternative compositions using the 1999 data, including a multiplicative version. Conceptually, the case could be made for either. According to our model [c.f., 31, 37], a nation that aspires to enhance its technology-based export competitiveness ought to evidence strength in all four inputs – NO, SE, TI, and PC. The additive model implies that strength on one of these four dimensions could compensate for weakness on another. The multiplicative model implies that weakness on any one could seriously impede effective development.

Space for Figure 1 approximately here

The composite indicator computed as the average (equivalently, the sum) correlates 0.90 with that computed as a product (NO x SE x TI x PC). Converting to S-scores does not alter this relationship. Rank scores for the average and multiplicative versions of INPUT correlate 0.995. A useful benchmark is the separate rating respondents provide on present and future (15 years ahead) technological competitiveness. Average 1999 INPUT correlates higher (0.89) than does the multiplicative input composite (0.79) with present "rated competitiveness" (i.e., expert opinion item inquiring about technological competitiveness), and higher as well with future rated competitiveness (0.85 vs. 0.69). [Conversely, the 1999 multiplicative version correlates more highly with current TS – 0.88 vs. 0.79, but this is not as suitable a gauge of an "input" indicator. We thus choose the average of NO, SE, TI, and PC as the composite input indicator, INPUT. We elect not to convert this average of S-scores into its own S-score to make comparisons of INPUT scores over time somewhat easier.

Table 2 shows how this composite, average INPUT indicator compares with its components in correlating with current TS, current rated competitiveness, and future rated competitiveness. Among the individual input indicators, TI and PC appear more "short term oriented." They correlate considerably more strongly with current TS and current rated technological competitiveness. In contrast, NO correlates more strongly with future rated competitiveness. The composite, INPUT, does well with both future and present competitiveness. Consistent with our model, INPUT correlates more highly with perceived future competitiveness than does present TS. (Not shown in Table 2, present rated competitiveness also correlates highly with future competitiveness – 0.87.)

Space for Table 2 approximately here

Does Input Predict Future Technological Competitiveness?

Of more interest, the cumulation of 10 years of comparable indicators allows examination of how well the earlier (e.g., 1990, 1993) input indicators relate to later (1999) TS. The duration is not as long as the 15 years our model targets, but it nonetheless warrants study. Figure 2 shows these three values for each available country. We have data for 27 of the countries, except we are missing 1990 INPUT for Mexico. The 1990 INPUT composite correlates 0.81 with 1999 TS; 1993 INPUT correlates 0.87 with 1999 TS. The most striking feature of Figure 2 is that, despite these high correlations, TS99 shows much greater disparities among the countries than do the INPUT indicators. Or, one could say that the high expectations for future competitiveness for the industrializing nations have not yet generally been fulfilled.

Space for Figure 2 approximately here

Let's take another cut at this issue. The Georgia Tech HTI model explicitly aims at anticipating future high tech competitiveness of *industrializing* nations; it does not aspire to predict for the highly developed nations. So, let's re-examine relations between 1990/1993 INPUT and 1999 TS for the industrializing nations, excluding our OECD countries, excepting Spain.

Space for Figure 3 approximately here

Figure 3 shows the 12 "industrializing" nations of our set for which data are available for 1990-99. They are reordered here by 1999 technological standing (TS) to provide another perspective to that of Figure 2. The correlations are considerably less than for the set of 27 countries (Figure 2) – 1990 INPUT correlates 0.51 with 1999 TS and 1993 INPUT correlates 0.71 with 1999 TS. Within this set, countries with the highest INPUT indicators in 1990 and 1993 (Singapore, South Korea, Taiwan, Malaysia) did considerably outperform the others on TS in 1999. Focusing on 1990 INPUT, the anomaly is China. However, for 1993, we see China advancing more than any other on INPUT (Brazil also advanced greatly). If we remove China, the correlations between INPUT and TS regain levels comparable to the full set (0.83 for 1990 INPUT and 1999 TS; 0.86 for 1993 INPUT and TS) (Table 3). So, INPUT does seem to relate pretty strongly to later high tech competitiveness, though imperfectly.

Space for Table 3 approximately here

Individual Input Indicators as Predictors of Technological Competitiveness

The HTI model aims to predict about 15 years forward, but two of the input indicators, TI and PC, seem relatively shorter horizon. Table 3 presents correlations of the 1990 and 1993 input indicators with TS for 1999 several ways. First, for the 15 industrializing countries for which the HTI model should be best suited, the correlations are notably weak – none exceeding 0.56 except for NO and INPUT (the average of all four) for 1993. The picture changes remarkably if we exclude China, as an outlier. Except for TI, all the input indicators show markedly stronger relationship with TS-99. Given the time lapse between the input and output measures is only 6 or 9 years here, we would have anticipated that TI and PC would be stronger predictors than NO or SE. Instead we find an ordering of NO as the strongest predictor of future technological standing, followed closely by PC, then by SE, with TI trailing weakly.

This result prompted us to explore the correlations further. The leading indicators for the full set of available countries (26 available for 1990 and 27 for 1993) show high correlations to TS-99 for TI and PC, and moderate ones for NO and SE, as we would anticipate. To finish the comparisons, the bottom row of Table 3 shows the correlations for a set of 12 OECD nations. Here the relationship between TS-99 and TI or PC for 1990/93 is extremely strong – 0.9 or higher in each case. Our tentative interpretation is that, for this medium time frame (6 or 9 years), different input indicators predict future high tech competitiveness for nations that are highly developed (TI and PC) and for nations that are industrializing (NO and PC). The data are somewhat noisy (e.g., consideration of China as an outlier is key to the interpretation just made). Undoubtedly other country combinations could yield different results (e.g., including Spain or Singapore in the most developed group; moving New Zealand or Australia to the industrializing group).

Behavior of the Individual Input Indicators

This section examines the four individual input indicators in turn. We point out interesting differences among countries for 1999 and changes over time. We illustrate how changes on component measures can reflect in indicator changes.

Note to Editor & Reviewers: If space permits, we would include additional figures showing the evolution of NO, SE, TI, PC and TS over time. Doubting this to be the case, this section just refers to Table 1 for these data.

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 each time period – 1990, 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.

Using the "Big Three" (U.S., Japan, Germany) as a benchmark, note how many countries exhibit comparable NO levels – commitment to high tech development is widespread. Note also that this includes Eastern Europe.

Two of our newcomers, Ireland and Israel, lead in NO, along with Singapore and Taiwan. Ireland is the only country in 1999 to receive the highest 5-year investment risk rating from Political Risk Services. Singapore and Taiwan have been consistently high on NO in since 1993.

Notable declines during the time period (e.g., drops of 10 or more points) show for Sweden, Malaysia, and Thailand from 1993 to 1999, and Switzerland (1990 to 1999). Sweden dropped on each of the five component measures from 1993 to 1999. Declines for Malaysia and Thailand come from drops in estimated investment risk and entrepreneurial spirit. Recall that HTI are *relative* indicators. Hence, a "decline" on NO or another indicator does not imply an actual drop, just that other countries in the HTI set have advanced faster.

NO Increases of 10 or more points appear for many countries -- Spain, Canada, Australia, New Zealand, Russia (1993-99), The Philippines (downturn from 1996-99), China, India, Mexico, UK, U.S., Hungary, Singapore, Taiwan. Reasons for the increases vary. For example, of the component measures that make up NO, increases for Spain, Canada, and Australia were driven mainly by change of social acceptance of technology (Q. D). NO increases for New Zealand and The Philippines were due mainly to increases in the investment risk index (on our 100-point S scaling, New Zealand increased 18 points and The Philippines 55 points over this 6-year period). Russia showed moderate increases on each of the 5 NO component measures.

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.

Along with the U.S., Canada and Australia lead on SE and show sizable increases from 1993-99. Canada shows especially high on tertiary education and encouragement of foreign-owned firms; Australia, on secondary education and encouragement of foreign-owned firms. Others increasing by 10 or more points from 1990-99 include: UK, Sweden, Hungary, China, India, and Brazil.

The Eastern and Western European nations display generally increasing SE. The Latin American countries show relative declines. For instance, each of Mexico, Brazil, and Argentina show increases on both secondary and tertiary education participation, yet their Harbison-Myers Index S-scores decline because other countries increased more.

SE interpretation demands some attention to its composition. "HMHS" is the widely used Harbison-Myers Human Skills Index. It includes percentage in secondary and tertiary education. Values range to 148% for Australia for secondary education, reflecting UNESCO data categorization difficulties. However, as with our other indicators, each component is separately normalized to reduce such artifacts. So, the resulting scores benchmark against Canada in 1999 (S score of 100 = highest of the 33 country set). Singapore's SE score of 72 equals that of Germany, despite Singapore's relatively weak HMHS S-score of 48, reflecting its compensating high scores on the two expert opinion items that round out SE.

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).

There continues to be much greater variation in TI among the 33 nations than was the case for either NO or SE (Table 1). The U.S. stands out, increasing its lead over this time period. Its S-scores range from 91-100 on each component.

The Asian Cubs (particularly Malaysia, Thailand, Indonesia, and the Philippines – not China and India) lag, as do the Latin American countries, excepting Brazil. As detailed, the EDP and "number of Scientists & Engineers" components of TI exert heavy influence compared to the four expert opinion items in this patterning. For instance, the countries just noted as relatively low on TI show S-scores on EDP purchases and number of Scientists & Engineers in the range of 0.3 to 2.4, far below their S-scores for the questionnaire items.

Few of the 33 countries show much change in TI from 1993 to 1999. Shifts of 10 or more points appear only for India – an increase. India shows increases on every TI Component. Those increasing 10 or more points from 1990-99 include the U.S., Italy, Spain, Canada, New Zealand, Hungary, China, and Brazil.

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).

Productive Capacity clearly separates the U.S. and Japan from the rest of the countries in our sample (Table 1) – with the U.S. usurping top position from Japan. The relative distancing of the U.S. from Japan since 1996 is attributable to shifts in electronics production (changes on the three expert opinion items are small). While most nations showed modest changes in absolute value of electronics production ($Billion), the U.S. increased by $71B and Japan declined by $44B from 1996 to 1999. The U.S. position is so strong that even China's remarkable doubling of electronics production from $33B to $65B(third in the world behind the U.S. at $345B and Japan at $212B) increases its S-score on this measure only from 12 to 19.

France has overtaken Germany on this indicator, forming the next tier. The French increase is driven by gains on perceived availability of manufacturing labor and industrial management capabilities.

At the next level, the Asian Tigers rate on a par with the remaining OECD countries on PC, aided by their strong electronics production.

Over time, Japan shows a relative decline; France, Switzerland, Canada, Australia, New Zealand, Hungary, China, The Philippines, India, and Argentina show notable gains during the time period. China's is mostly attributable to the increased electronics production already noted. Conversely, gains by Australia and India are attributable completely to the survey items (perceived gains in production skills). Eastern Europe, in general, shows upward tendencies.

Overall: The pattern of the four "leading" indicators shows more of a mixed picture than was the case in earlier years. In 1993, for instance, the (then Four) Tigers had emerged as obvious challengers to the developed nations of the West, with several of the "Asian Cubs" (notably Malaysia, the Philippines, and Indonesia) following not far behind. The 1999 results show considerable consistency but also considerable differences. Regionally, the former Eastern Bloc nations demonstrate moderately positive gains on all four indicators over this period. The Latin American countries show negative tendencies on all four indicators since 1993.

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).

Since 1990, Japan and the U.S. remain well ahead of all others in high tech competitiveness; however the U.S. has forged into a notable lead over Japan. The U.S. advance traces back to marked gains on overall high tech exports and on electronics exports; strangely, the U.S. has slipped a bit on the expert opinion measure relative to Japan.

Germany is considerably closer to the other leading nations (UK, Singapore, France) than to the U.S. and Japan on TS. The "Big Three" are more truly "The Big Two" now. This distancing is due less to any decline in Germany than to the remarkable gains by the U.S.

The elevation of Singapore's position since 1993 is amazing – particularly in that two of the three components that make up TS are absolute (not per capita or otherwise normalized) measures of electronics and high tech exports. Its high tech exports are about 97% electronics, so our inclusion of electronics export as a separate component of TS certainly benefits Singapore. No matter – Singapore's $70B in high tech exports ranks fifth in the world on an absolute basis (the 1999 TS draws upon 1997 export data, the most recent available when calculations were completed in early 2000).

Other nations spread out considerably on the TS measure, generally changing modestly since 1993. An argument could be made that the TS component, X97, high tech exports for 1997 (the most recent year available), is the 'real' output target. The disparities in high tech exporting are huge:

"Top 10" High Tech Exporters for 1997

- US $258 Billion
- Japan 152
- Germany 140
- UK 105
- France 90
- Singapore 70
- Netherlands 59
- China 50
- Taiwan 49
- South Korea 46

Below them,

- Next 10 nations $10--42B [led by Malaysia]
- Next 13 nations $0.8--9B

So, the range in high tech exporting in this elite group of 33 nations is from less than $1 billion to $258 billion! [For details on what X97 includes, see the Appendix on the website: http://tpac.gatech.edu.]

Big gainers on TS over this time period are Canada, Singapore, and China. China's move is not at all based on the questionnaire item; it reflects the country's enormous increase in electronics (and overall high tech) exporting.[2]

The Russian pattern is anomalous (low number of respondents in 1993 and 1996 may contribute to instability here as Russian TS spurted in 1996, then fell back in 1999).

Two of the just-added countries show strongly – Ireland and Israel. Both are bolstered by highly favorable expert opinion responses, but particularly for Ireland, high tech export data confirm strength.

Present vs. Future: We asked our expert panel to estimate high tech production capability at present and in 15 years for each of nine sectors and overall. Figure 4 compares present and 15-year overall estimates provided by the 1999 panel. Keep in mind that these are simply subjective judgments (responses on 1-5 scales, averaged and multiplied by 10 to yield a maximum score of 50). As such there is a marked ceiling effect. For instance, Japan, currently gauged at about 47 can at most be projected to increase 3 points. Nonetheless, the message conveyed here is striking – excepting Germany and the UK, every country is expected to increase its high tech export capability over the next 15 years. For most of these 33 nations, the projected gains are large – e.g., for all groups except the Big Three and the highly industrialized Western European countries. The anticipated result over the coming decades is **a marked broadening of the high tech playing field**.

[2] A side-note reflecting the perils in tallying China's exports – the reported value of their 1997 electronics exports ($79B) significantly exceeds the value of their overall high tech exports ($50B). Our interpretation is that one has two estimates here – one high and one low. We believe the inclusion

Space for Figure 4 approximately here

Country Set Comparisons

The previous sections discussed results for each indicator across countries. Here we seek to gain perspective by considering sets of countries, across indicators.

The U.S. has fared extremely well during the 1990's according to both our input and output indicators. HTI were developed to track the emergence of industrializing nations; comparisons among the existing leading nations are only secondary. We do not include all the leading OECD nations. Having said that, we note general stability in HTI for the leading nations (The Big Three and Western Europe – the first two groupings in each chart). TI and PC differentiate within this group far more than do NO and SE – with the U.S. and Japan notably outdistancing the others. The American and Japanese dominance is even more striking on TS – technological standing – and its key component, high tech exports.

The third grouping in the charts consists of four "English heritage" nations – Canada, Australia, South Africa, and New Zealand, plus Israel (tough to classify!). All except South Africa show marked increases in NO, very high SE, solid TI, and significant PC. In other words, we anticipate these to increase as potent high tech competitors. Canada, in particular, is making great strides (it is the leading gainer on the survey item on high tech capability from 1996 to 1999). [As with all these results, obviously our indicators cannot tell the whole story – that requires extensive knowledge of manifold factors within a country.]

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 (NO), with improving SE, TI, and PC (excepting some decline in TI for Russia). Their future high tech prospects appear bright, even though present TS is weak.

---

of re-exports from China through Hong Kong really inflates the electronics estimate from Reed; the lower high tech estimate from the UN Statistical Office seems more solid.

The fifth group consists of the Three Tigers – Singapore, South Korea, and Taiwan. Look at their profile in Table 1 and the figures. Their NO is pronounced; SE and PC are top tier; TI trails the leading technological countries. They have "arrived" – Singapore trails only four countries on TS; South Korea and Taiwan evidence strength comparable to most Western European nations. (Our electronics emphasis does particularly favor them.) Their technological emphasis (TE – not addressed in this paper) is pronounced (Singapore leads all).

The sixth group includes six Asian economies of considerable diversity – Malaysia, China, Thailand, Indonesia, The Philippines, and India. Again, a scan across the HTI generally shows strong NO, lagging SE, and lagging TI and PC (but note strong advances by China and India). China's EDP purchases rank fifth in the 33-country set and its electronics production ranks third. China's 1999 jump on TS is remarkable, prodded particularly by its electronics exports (also third in our set of countries). The Asian Cubs are growing, albeit unevenly, in high tech competitiveness.

HTI do not show general "Asian Contagion" effects for either the Asian Tigers or Cubs. Output indicators (particularly RTC, not shown in this paper) suggest effects on some component measures. Input indicators do not, implying that the Asian nations are not backing off commitment to build potent high tech futures.

Latin America, our seventh group, generally lags on the input and output indicators.

Two newcomers to the HTI, Ireland and Israel, show significant technological competitiveness as smaller economies. They stand forth as committed to high tech (NO) and quite strong on the other input indicators. Present capabilities (TS) are also notable.

Concluding Observations

This review of HTI results from 1990 through 1999 shows reassuring consistency across time. The U.S. is doing well. In terms of the four input measures and Technological Standing, we have outdistanced our nearest competitors according to these measures. [As macroeconomic evidence, the US has had its longest period of economic expansion since World War II.]

When HTI development was initiated in the mid-1980's, a small clique of technologically advanced nations dominated. The sense in profiling a country set including newly industrializing countries was of a "ski slope." High tech exporting "belonged to" the leading OECD countries. The present results might be likened to a gentler "beginners' ski slope" – competition is real (e.g., Malaysia exports more high tech than Italy; Singapore, China, Taiwan, and South Korea are among the "Top 10" high tech exporters in 1997). [Again, we acknowledge that interpretation is not straightforward; much of Malaysia's exports come from multinational companies headquartered elsewhere; however the data show that the country has moved well beyond the manufacturing platform model of some years ago.]

Our projection of dramatically broadening, international high tech competition conveys critical implications for corporate planning and government policy making. The profiles vary by sector but the overall pattern is compelling: *National high tech competition is shifting from a steep slope toward a broad plateau.* High tech production will diffuse dramatically over the coming years. No longer will a few leading nations dominate (to pursue the metaphor -- no skiing in 2015). The US and Japan are projected to remain in the lead, but the gap will close across the board as nations continue to invest in the factors that enhance their ability to compete in high tech products internationally.

It is widely accepted that a country's high tech competitiveness can't be reduced to a single indicator because it is related to political, economic, cultural, and educational dimensions. The factors affecting competitiveness are complex. However, our new average "INPUT" measure seems to offer an attractive shorthand, easy-to-grasp index reflecting a country's likely future prospects.

The essence of "indicators" is prediction. What can these derived measures tell us about the future? We suggest differentiating the relatively stable countries (i.e., most OECD nations) from those changing more rapidly (i.e., the industrializing nations). For the stable set over the short term (e.g., 3 years or so), current technological standing (TS) is the best predictor of future TS. For our target group of industrializing countries, especially looking longer term, we offer our input indicators. The average of these four indicators, "INPUT," appears to relate quite strongly to performance over a mid-term period (i.e., 6-9 years). Our data don't yet stretch over our target 15-year horizon. As discussed previously, the individual input indicators vary considerably in their predictive behavior. For the industrializing nations, TI is markedly weaker in predicting TS 6-9 years out, than are NO, PC, and SE.

The ramifications of these observed shifts in technological competitiveness fall beyond the scope of this paper. Yet, we must point to their profound potential. Consider the cross-national implications of shifts. As a nominal example, because South Korea grows its shipbuilding through the 1980's, Sweden losses a significant piece of its employment base in the 1990's. Recent American and Chinese gains may partly mean a larger world-size technological pie, but they also threaten other national enterprises to an extent. High Tech Indicators have a role to play in national policymaking, trade negotiations, and technological planning.

As we revise the HTI framework for the future, we welcome suggestions. In particular, we are seeking to heighten consideration of information economy facets (e.g., services) and to capture emerging technology leading edge capabilities.

References

1. OECD 2000 Project Report: *A New Economy: The Changing Role of Innovation and Information Technology in Growth*, also OECD 1999 Project Report: *OECD Science, Technology and Industry Scoreboard 1999: Benchmarking Knowledge-based Economies*. see website: http://www.oecd.org/dsti/sti/stat-ana/prod/growth.htm.
2. D. Archibugi, J. Howells & J. Michie, 'Innovation Systems in a Global Economy', *Technology Analysis & Strategic Management*, 11 (4), 1999, pp. 527-539.
3. D. Archibugi & J. Michie (Eds), *Trade, Growth and Technical Change* (Cambridge, Cambridge University Press, 1998).
4. G. Antonell & N. De Liso (Eds), *Economics of Structural and Technological Change* (Routledge, 1997).
5. M.E. Porter, *On Competition, (*Boston, Harvard Business Review Books, 1998).
6. J. Clark & K. Guy, 'Innovation and Competitiveness: A Review', *Technology Analysis & Strategic Management*, 10 (3), 1998.
7. G. Sirilli, 'Science and Technology Indicators: The State of the Art and Prospects for the Future', in: G. Antonell and N. de Liso (Eds), *Economics of Structural and Technological Change* (Routledge, 1997).
8. A. Young, *Measuring R&D in the Services*, STI Working Paper, OECD/GD (96) 132, Paris, 1996.
9. B. Godin (INRS/CIRST), 'The State of S&T Indicators in the OECD Countries', Reference Paper Submitted to Statistics Canada, August 1996.
10. J. Eaton & S. Kortum, 'Trade in Ideas: Patenting & Productivity in the OECD,' *Journal of International Economics*, 40 (3-4), 1996, pp. 251-278.

11. L. M. Rausch, *Asia's New High -Tech Competitors--An SRS Special Report*, US National Science Foundation, NSF 95-309, Arlington, VA, USA, 1995.
12. H. Grupp, 'Science, High Technology and the Competitiveness of EU Countries', *Cambridge Journal of Economics*, 19, 1995, pp. 209-223.
13. B. G. Hickman (Ed.), *International Productivity and Competitiveness*, Oxford university Press, 1992.
14. Zvi Griliches, 'Patent Statistics as Economic Indicators: A Survey', *Journal of Economic Literature*, 18, 1990, pp.1661-1707.
15. G. Dosi, K. Pavitt & Luc Soete, *The Economics of Technical Change and International Trade*, (New York, Columbia University Press, 1990).
16. M. Trajtenberg, 'Patents as Indicators of Innovation,' in: *Economic Analysis of Product Innovation*, (Cambridge, MA, Harvard University Press, 1990).
17. A.F.J. Van Raan (Ed.), *Handbook of Quantitative Studies of Science & Technology* (North Holland, 1988).
18. 'Science and Technology Indicators: Their Use in Science Policy and Their Role in Science Studies: Select Proceedings of the First International Workshop', International Workshop on Science and Technology Indicators (1st: 1988, Leiden, Netherlands).
19. Z. Griliches, *R&D, Patents and Productivity*, (Chicago, IL, Chicago University Press, 1984).
20. K. Pavitt & Luc Soete, 'Innovative Activities and Export Shares: Some Comparisons between Industries and Countrie s', in K. Pavitt (Ed.), *Technical Innovation and British Economic Performance*, (Macmillan, London, 1980), pp.38-66.
21. *The World Competitiveness Yearbook (WCY) 1998-2000*, Edited by WCY Research Team, International Institute for Management Development (IMD), Lausanne, Switzerland (on line web: http://www.imd.ch/wcy.html).
22. S. Mani, *Exports of High Technology Products from Developing Countries: Is it real or a Statistical Artifact?* Working Paper, UNU/INTECH, The Netherlands, March 2000.
23. M. E. Porter & S. Stern, *The New Challenge to America's Prosperity: Findings from the Innovation Index*, (Washington, DC, Council on Competitiveness, 1999) (also, see website: http://www.compete.org/).
24. X-Y Jin, A. L. Porter, J. D. Roessner, N. C. Newman & R. G. Heikes, '15-Year Forecast of National High-Tech Competitiveness for 33 Nations', 20th International Symposium on Forecasting (abstract published in ISF 2000 book, p.58), Lisbon, Portugal, June 21-24, 2000.
25. A. L. Porter, J. D. Roessner, N. C. Newman & X-Y Jin, *1999 Indicators of Technology-Based Competitiveness of 33 Countries-- Summary Report*, Atlanta, TPAC, Georgia Institute of Technology, final report to National Science Foundation, March 3, 2000.
26. J. D. Roessner, A. L. Porter & N. C. Newman, *1996 Indicators of Technology-based Competitiveness of Nations--Summary Report*, Atlanta, TPAC, Georgia Institute of Technology, final report to National Science Foundation, July 1997, Sections edited into *Science & Engineering Indicators- 1998*, National Science Board, Washington, DC, p. 6-33 -- 6-37 and Appendix 6-23.
27. A. L. Porter, J. D. Roessner, N. C. Newman & D. Cauffiel, 'Indicators of High-Tech Competitiveness of 28 Countries', *International Journal of Technology Management*, 12 (1), 1996, pp. 1-32.
28. J. D. Roessner, A. L. Porter, N. C Newman & D. Cauffiel, 'Anticipating the Future High-Tech Competitiveness of Nations: Indicators for Twenty-Eight Countries', *Technological Forecasting and Social Change*, 51 (1), 1996, pp. 133-149.
29. J. D. Roessner, A. L. Porter, N. C. Newman & D. Cauffiel, *Implementation and Further Analysis of Indicators of Technology-Based Competitiveness--Executive Summary*, Atlanta, TPAC, Georgia Institute of Technology, final report to National Science Foundation, March 1995.
30. J. D. Roessner & A. L. Porter, 'New High Tech Competitors', *Science and Engineering Indicators 1993*, (Washington, DC, National Science Board, 1994), pp. 186-190, [highlights of our research]; reprinted in *SINET - Social Indicator Network News* (38), Spring, 1994, pp. 7-9.
31. J. D. Roessner, A. L. Porter & H. Xu, 'National Capacities to Absorb and Institutionalize External Science and Technology', *Technology Analysis & Strategic Management*, 4 (2), 1992, pp. 99-113.

32. A. L. Porter & J. D. Roessner, with H. Xu & T. Seaman, *Indicators of National Competitiveness in High Tech Industries--Phase II: Data Extension, Reliability, Validity, and Sensitivity Analyses*, Atlanta, TPAC, Georgia Institute of Technology, final report to National Science Foundation, May 1991.
33. A. L. Porter & J. D. Roessner, *Indicators of National Competitiveness in High Technology Industries*, Atlanta: Georgia Institute of Technology, final report to National Science Foundation, 1991.
34. A. L. Porter, J. D. Roessner & H. Xu, 'High Technology Competitiveness: Indicators for 29 Countries', Portland International Conference on the Management of Engineering and Technology, Portland, OR: Portland State University, 1991, pp. 804-807.
35. J. D. Roessner & A. L. Porter, 'Achieving Technology-Based Competitiveness in Developing Countries', In: M. Chattcrji (Ed), *Technology Transfer in the Developing Countries*, (London, Macmillan, 1990).
36. A. L. Porter, J. D. Roessner, T. J. Kuehn & R. Drew, 'National Competitiveness in High Technology Manufacturing', Manufacturing International 1988 Conference, Atlanta, GA, 17-18 April, 1988.
37. J. D. Roessner, A. L. Porter & S. J. Fouts, 'Technology Absorption, Institutionalization, and International Competitiveness in High Technology Industries', In: T. M. Khalil, B. A. Bayraktar and J. A. Edosomwan (Eds.), *Technology Management I*, (Geneva, Inderscience, 1988), pp. 779-790.
38. A. L. Porter, J. D. Roessner, T. J. Kuehn & R. C. Drew, 'National Competitiveness in High Technology Manufacturing', *ASME Manufacturing International `88, Proceedings, Volume II*, Symposium on Management and Economics, 1988, pp. 67-74.

Table 1: Indicator Values for Each Year

	NO				**SE**				**TI**				**PC**				**TS**			
COUNTRY	**1990**	**1993**	**1996**	**1999**	**1990**	**1993**	**1996**	**1999**	**1990**	**1993**	**1996**	**1999**	**1990**	**1993**	**1996**	**1999**	**1990**	**1993**	**1996**	**1999**
USA	65.8	69.9	75.5	78.4	84.8	84.0	85.1	87.0	83.6	87.5	94.8	96.1	83.0	89.8	89.4	88.1	85.2	90.0	91.4	95.4
JAPAN	81.4	85.3	73.8	79.5	70.1	72.7	62.3	63.2	77.1	83.7	81.7	78.3	92.8	92.7	94.4	83.4	92.9	90.8	93.9	82.7
GERMANY	82.0	75.2	76.5	73.8	78.1	69.8	62.9	71.8	63.6	66.6	62.4	64.1	65.5	65.0	61.6	65.3	63.7	60.5	59.2	58.7
UNITED KINGDOM	58.2	63.2	70.9	72.4	57.2	65.6	65.5	78.0	51.9	57.5	59.4	59.8	44.6	49.0	52.3	53.6	44.6	49.3	48.6	53.8
FRANCE	74.5	74.2	75.9	75.4	62.5	63.8	64.9	71.7	54.1	60.0	61.3	58.0	53.7	56.1	64.1	65.5	44.7	45.6	45.7	48.0
NETHERLANDS	71.9	68.5	81.3	68.9	76.2	67.7	74.7	74.2	53.4	54.4	55.7	53.1	54.3	50.5	56.3	56.0	37.0	35.1	40.3	38.7
ITALY	56.9	59.2	66.3	63.1	53.2	53.6	59.3	59.7	35.1	50.5	48.6	48.4	40.6	51.8	51.4	47.1	31.9	31.5	29.5	26.2
SWITZERLAND	82.3	71.5	57.8	66.0	65.1	62.0	59.6	60.5	53.8	55.4	51.1	54.8	45.6	53.4	52.9	55.6	29.6	32.5	30.5	32.8
SWEDEN	62.8	83.0	66.8	64.2	52.1	66.6	65.3	68.7	47.6	55.5	53.7	55.5	56.6	52.8	52.6	47.0	29.7	28.0	32.2	30.2
SPAIN	46.3	55.9	63.8	66.7	72.4	64.4	59.3	68.4	29.3	36.4	39.1	40.1	37.4	52.3	43.6	44.7	15.1	18.3	16.0	18.4
IRELAND				92.2				75.6				48.0				55.9				32.7
CANADA	45.1	60.1	69.0	78.5	73.7	78.3	82.5	91.7	41.4	49.5	47.5	53.5	36.6	48.1	40.2	52.8	26.8	24.0	28.1	35.4
AUSTRALIA	53.9	66.8	66.2	78.4	64.3	63.9	60.6	83.2	46.2	45.8	51.3	53.0	33.2	41.3	47.7	51.6	19.4	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	47.5	57.1	66.7	67.3	63.1	70.0	74.3	70.9	32.7	41.9	48.3	45.9	19.5	34.6	45.6	39.6	10.5	16.8	13.5	16.8
RUSSIA	44.7	32.5	48.9	51.1	46.3	39.4	50.7	53.7	57.2	58.4	55.6	52.9	32.7	31.8	42.6	39.1	15.6	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	58.3	66.7	67.0	73.7	49.0	54.0	47.7	60.9	25.0	41.4	36.4	43.0	27.9	36.8	39.8	42.2	14.4	15.4	17.1	20.9
CZECH REPUBLIC				68.2				58.9				41.5				44.6				16.4
SINGAPORE	75.0	92.7	88.4	87.9	70.1	73.5	75.7	71.9	38.5	40.5	41.6	38.9	46.9	54.6	54.0	53.7	37.6	35.8	46.7	51.5
SOUTH KOREA	72.4	81.9	78.9	74.9	72.5	69.6	64.6	73.5	38.7	42.6	44.4	44.6	48.2	46.4	50.5	48.8	33.3	28.7	32.6	32.7
TAIWAN	75.0	81.1	90.2	90.7	77.8	74.5	76.3	74.2	39.5	37.4	43.0	43.6	47.7	43.0	49.9	53.7	31.7	27.0	31.5	35.2
MALAYSIA	64.6	81.1	81.0	69.5	50.6	63.7	62.6	58.9	24.7	34.2	31.9	31.9	39.4	47.5	43.1	44.1	23.1	24.3	28.2	30.8
CHINA	36.2	62.3	65.2	65.3	30.0	46.4	44.8	52.4	27.5	38.6	39.3	46.4	18.7	33.2	32.8	41.9	14.6	20.7	22.5	44.2
THAILAND	46.9	67.5	63.5	50.7	53.9	51.0	48.7	46.5	18.0	26.7	28.1	20.5	23.4	33.4	33.1	30.6	15.6	17.2	18.1	16.6
INDONESIA	44.0	62.5	54.8	53.9	44.9	49.5	35.2	43.8	18.5	25.3	17.8	19.2	17.0	24.8	19.6	23.7	12.8	11.0	11.2	14.0
PHILIPPINES	33.1	43.1	75.1	60.9	59.3	57.5	63.4	63.7	15.1	25.1	35.7	24.4	28.1	34.9	46.2	42.6	9.3	12.6	14.9	15.0
INDIA	50.9	52.4	57.4	67.7	26.2	46.4	46.0	48.4	31.6	33.0	39.3	46.8	37.4	38.6	49.1	51.3	17.2	13.5	18.3	20.8
MEXICO	21.4	47.9	54.8	41.8	48.5	47.7	45.5	40.4		25.2	30.2	21.8		27.2	31.7	24.8	15.6	11.6	20.1	19.8
BRAZIL	53.4	63.6	58.0	61.5	37.1	55.1	53.1	49.1	26.2	41.6	37.4	40.4	29.7	48.1	40.3	39.6	18.2	15.5	19.1	18.2
ARGENTINA	40.9	45.0	41.4	41.3	49.3	63.2	49.4	53.3	21.4	25.5	27.4	27.5	18.9	32.2	31.0	31.0	8.6	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

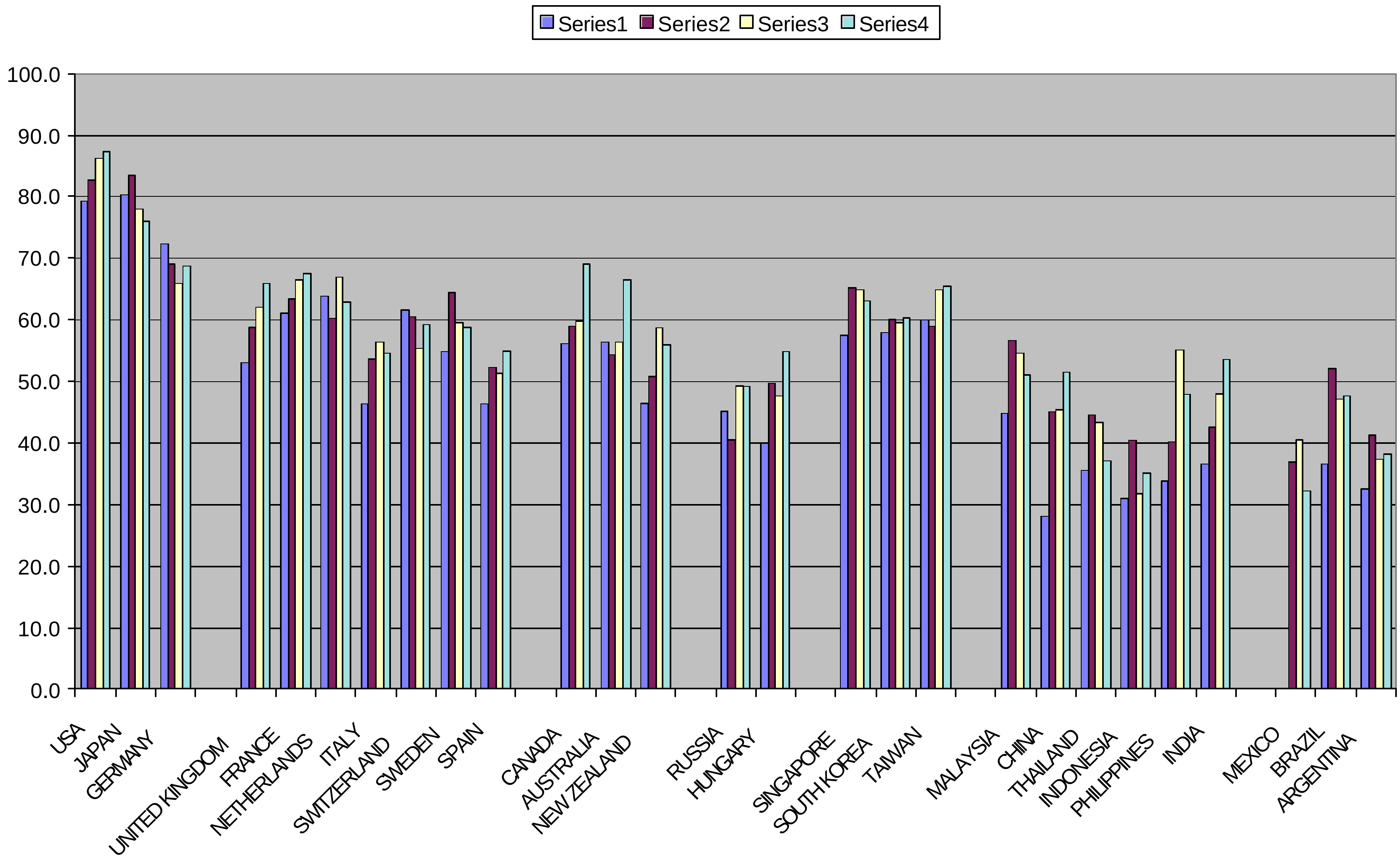
Table 2: Correlations Among Measures, 1999

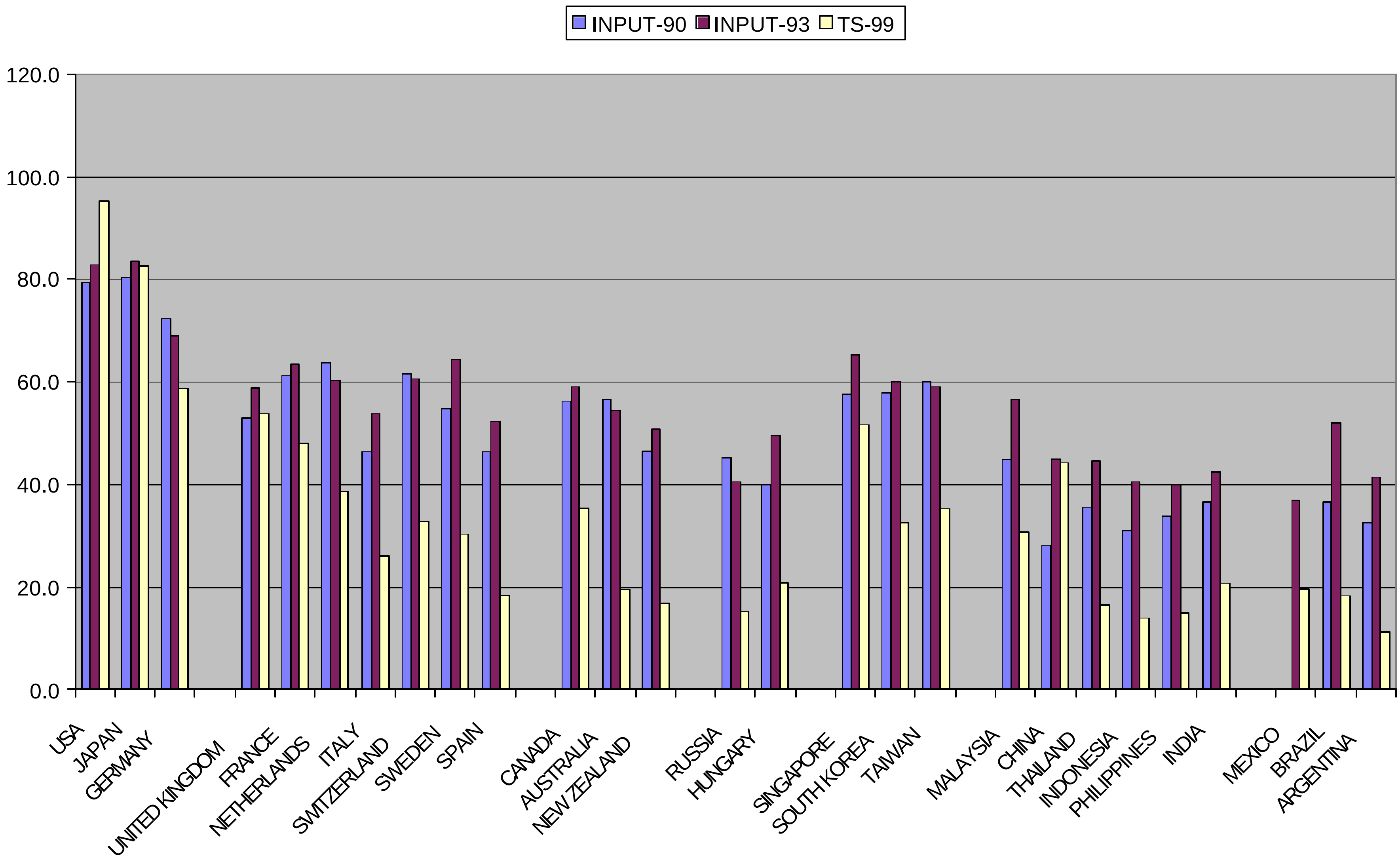
	NO	SE	TI	PC	INPUT	TS99
TS99	0.54	0.53	0.81	0.88	0.79	1
Present Rated Competitiveness-99	0.72	0.68	0.86	0.86	0.89	0.76
Future Rated Competitiveness -- 1999 + ~15 years	0.87	0.65	0.70	0.78	0.85	0.65

Table 3: Correlations of 1990-93 Input Indicators with 1999 Technological Standing

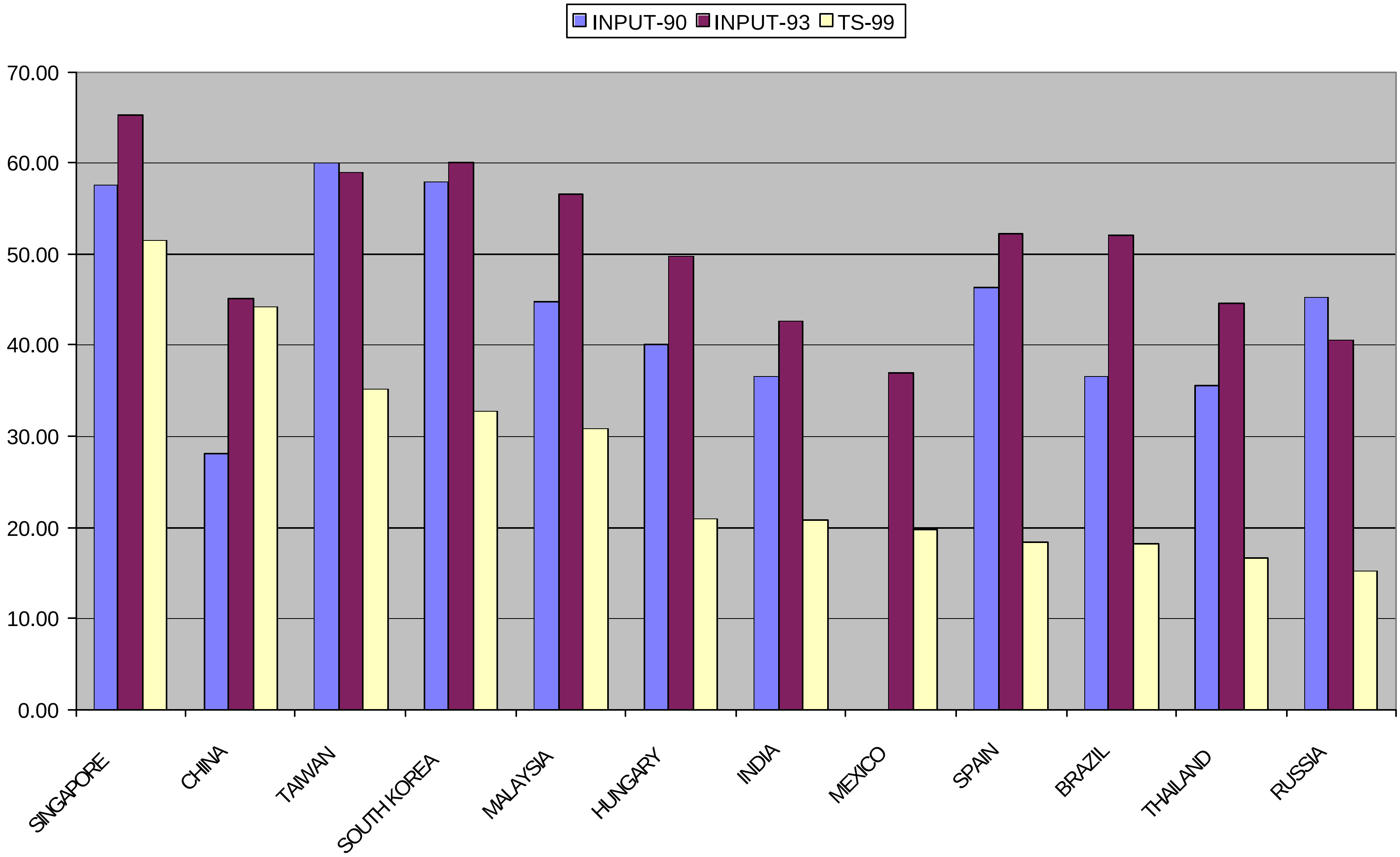
	INPUT 1990	INPUT 1993	NO 1990	NO 1993	SE 1990	SE 1993	TI 1990	TI 1993	PC 1990	PC 1993
15 Industrializing Countries	0.51	0.71	0.56	0.74	0.26	0.47	0.32	0.29	0.51	0.51
14 Industrializing Countries (without China)	0.83	0.86	0.79	0.83	0.54	0.70	0.39	0.28	0.82	0.68
All available Countries	0.81	0.87	0.59	0.54	0.52	0.61	0.81	0.82	0.86	0.87
12 Highly Developed Countries	0.89	0.93	0.49	0.47	0.6	0.61	0.94	0.97	0.9	0.93

Figure 1. Composite Competitiveness Predictor (INPUT) 1990-99





INPUT-90
INPUT-93
TS-99
120.0
100.0
80.0
60.0
40.0
20.0
0.0
USA
JAPAN
GERMANY
UNITED KINGDOM
FRANCE
NETHERLANDS
ITALY
SWITZERLAND
SWEDEN
SPAIN
CANADA
AUSTRALIA
NEW ZEALAND
RUSSIA
HUNGARY
SINGAPORE
SOUTH KOREA
TAIWAN
MALAYSIA
CHINA
THAILAND
INDONESIA
PHILIPPINES
INDIA
MEXICO
BRAZIL
ARGENTINA



INPUT-90
INPUT-93
TS-99
70.00
60.00
50.00
40.00
30.00
20.00
10.00
0.00
SINGAPORE
CHINA
TAIWAN
SOUTH KOREA
MALAYSIA
HUNGARY
INDIA
MEXICO
SPAIN
BRAZIL
THAILAND
RUSSIA

Figure 4. Present vs. Future High Tech Competitiveness Ratings