

# Global Technological Competitiveness: The Rise of China – 1993-2005

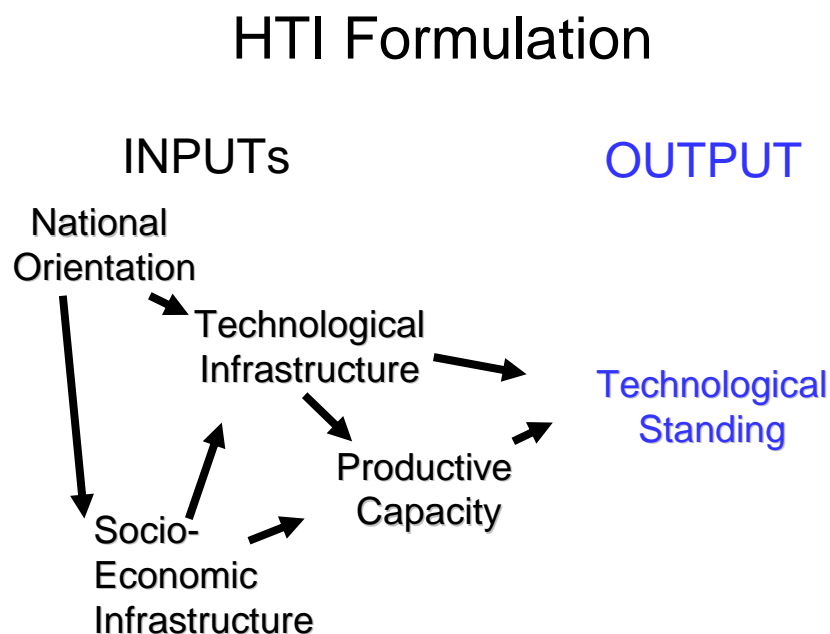
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## Introduction

Georgia Tech has been compiling national High Tech Indicators (HTI), with support from the U.S. National Science Foundation (NSF)<sup>3</sup>, since the late 1980s [see: //tpac.gatech.edu]. The focus is on anticipating likely changes in export competitiveness of 33 highly developed and rapidly industrializing nations. The primary purpose is to provide policy-makers and others with a means to gauge present high technology competitiveness & likely future high technology competitiveness of industrializing countries.

HTI were developed as empirical manifestations of a conceptual model with four input factors (c.f., Roessner et al., 1992). The model posits that technology-based competitiveness depends on the conjunction of 1) national orientation to so compete, 2) socio-economic infrastructure, 3) technological infrastructure, and 4) productive capacity. Current standing is tracked with one output factor addressing high technology export activity. Figure 1 sketches the hypothesized relationships.

Figure 1.



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The indicators are defined as follows:

- **National Orientation (NO)**: Evidence that a nation is taking directed action to achieve technological competitiveness. Evidence of such action could be manifested at the business, government, or cultural levels, or any combination of the three.
- **Socioeconomic Infrastructure (SE)**: The social and economic institutions that support and maintain the physical, human, organizational and economic resources essential to the functioning of a modern, technology-based industrial nation.
- **Technological Infrastructure (TI)**: The institutions and resources that contribute to a nation's capacity to develop, produce, and market new technology.
- **Productive Capacity (PC)**: The physical and human resources devoted to manufacturing products, and the efficiency with which those resources are used.
- **Technological Standing (TS)**: The current world market share in high technology products, reflecting not only current export market share statistics but also current manufacturing capability.

The traditional HTI are synthesized from 7 statistical sources (drawing upon the United Nations Statistical Office, the World Bank, UNESCO, WIPO, Reed Yearbook of World Electronics, PRS Political Risk Letter, IMD World Competitiveness Report) and expert opinion data. The 2005 expert opinion consists of 361 assessments of technology-based capabilities in a given nation. We here report on selected findings from our recently finalized HTI-2005 report (Porter et al., 2006). Detailed operational definitions of the indicators are provided therein, along with details on the statistical data sources.<sup>4</sup> That and earlier reports, the expert opinion survey, and papers spotlighting interesting findings over the years are available at //tpac.gatech.edu.

Note that the indicators are relative. They are composed for the set of countries included in HTI – presently 33. Each component is scaled from 0-100, with 100 representing the highest national value for statistical components and the highest possible response for the scaled questions.

We are presently in the process of changing the HTI. The new, “**Statistics-only**” HTI augment the **Traditional HTI** with additional statistical sources (detailed in Porter et al., 2006). These expand treatment of contributing factors to technology-based, manufactured products, and they also expand coverage of factors pertinent to knowledge-intensive services and processes. The plan is to then use the expert opinion responses as auxiliary information to lend insight into evolving capabilities. At present we only present Statistics-only HTI results for 2005. These are quite interesting in providing a different emphasis. HTI are indicators of national export competitiveness so they are not normalized (e.g., using per capita measures). However, the Traditional HTI incorporate the expert opinion responses whose 1-5 scaling suppresses the sometimes extreme differences between newly industrializing and highly advanced economies. When HTI were originated in the 1980’s, this was essential to provide insights into emerging capabilities. In addition, at that time statistical data sources covering this range of countries were quite impoverished. We believe the situation now warrants more data-based comparisons. In this paper, we report:

- Traditional HTI for “Past” comparisons – time series from 1993-2005
- Statistics-only HTI for “Present” comparisons -- 2005

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<sup>4</sup> To give the flavor of these indicators that combine statistical and expert opinion measures, here is the formulation for TI, where “Q’s” are question responses on a 1-5 scale:

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

- EDP = Electronic data processing equipment purchases for 2005 as obtained from the Reed Electronics Research
- S&E = The number of scientists and engineers engaged in research and experimental development as defined by UNESCO primarily from 2001.
- Q7 & Q8: output of indigenous academic S&E
- Q9: assessing linkages of R&D to industry
- Q11: ability to make effective use of technological knowledge

The most striking change over the past years is the emergence of China as a bona fide technological competitor – the focus of this short article.

### The Past: Trends, 1993--2005

The rise of China over the past 12 years has been amazing. By our measures, China has surpassed Japan and Germany to become the second strongest high technology competitor. Table 1 consolidates results for our set of 33 countries. These are ordered by current Technological Standing (TS). We also show results here for a composite of the four leading indicators – “INPUT,” here scaled to a maximum possible 100 (the average of NO, SE, TI, and PC).

**Table 1. Range of High Tech Indicators (Traditional)**

COUNTRY	Input Factor-1993	Input Factors-2005	Tech Standing-1993	Tech Standing-2005	COUNTRY	Input Factor-1993	Input Factors-2005	Tech Standing-1993	Tech Standing-2005
USA	83	84	90	83	ISRAEL	n/a	67	n/a	25
<b>CHINA</b>	<b>45</b>	<b>66</b>	<b>21</b>	<b>74</b>	PHILIPPINES	40	46	13	23
JAPAN	84	73	91	73	AUSTRALIA	54	65	16	23
GERMANY	69	71	60	65	HUNGARY	50	53	15	22
UNITED KINGDOM	59	68	49	48	CZECH REPUBLIC	n/a	56	n/a	21
SINGAPORE	65	65	36	48	THAILAND	45	43	17	21
FRANCE	64	62	46	45	SPAIN	52	49	18	20
SOUTH KOREA	60	63	29	45	INDIA	43	53	13	20
NETHERLANDS	60	63	35	40	BRAZIL	52	47	15	19
TAIWAN	59	62	27	38	NEW ZEALAND	51	58	17	19
IRELAND	n/a	60	n/a	36	RUSSIA	41	46	15	17
MALAYSIA	57	55	24	36	POLAND	n/a	52	n/a	15
SWEDEN	65	68	28	32	SOUTH AFRICA	53	43	22	15
SWITZERLAND	61	58	33	32	VENEZUELA	n/a	35	n/a	14
ITALY	54	57	32	29	INDONESIA	41	35	11	14
CANADA	59	62	24	28	ARGENTINA	42	41	13	13
MEXICO	37	43	12	26					

Figure 2 shows these results graphically for ten Asian countries plus the USA. The meteoric rise of China dominates the picture. Note the dramatic advance over this 12-year period on Technological Standing (vertical axis). This is a composite measure reflecting both technology-based export intensity and expert opinion on national competitiveness. But also note the dramatic gains on the composite leading indicators – INPUT (horizontal axis). This suggests that China’s vector of economic might well continue to ascend.

Figure2. Change in Competitiveness, 1993-2005: INPUT vs. Technological Standing [Traditional HTI]

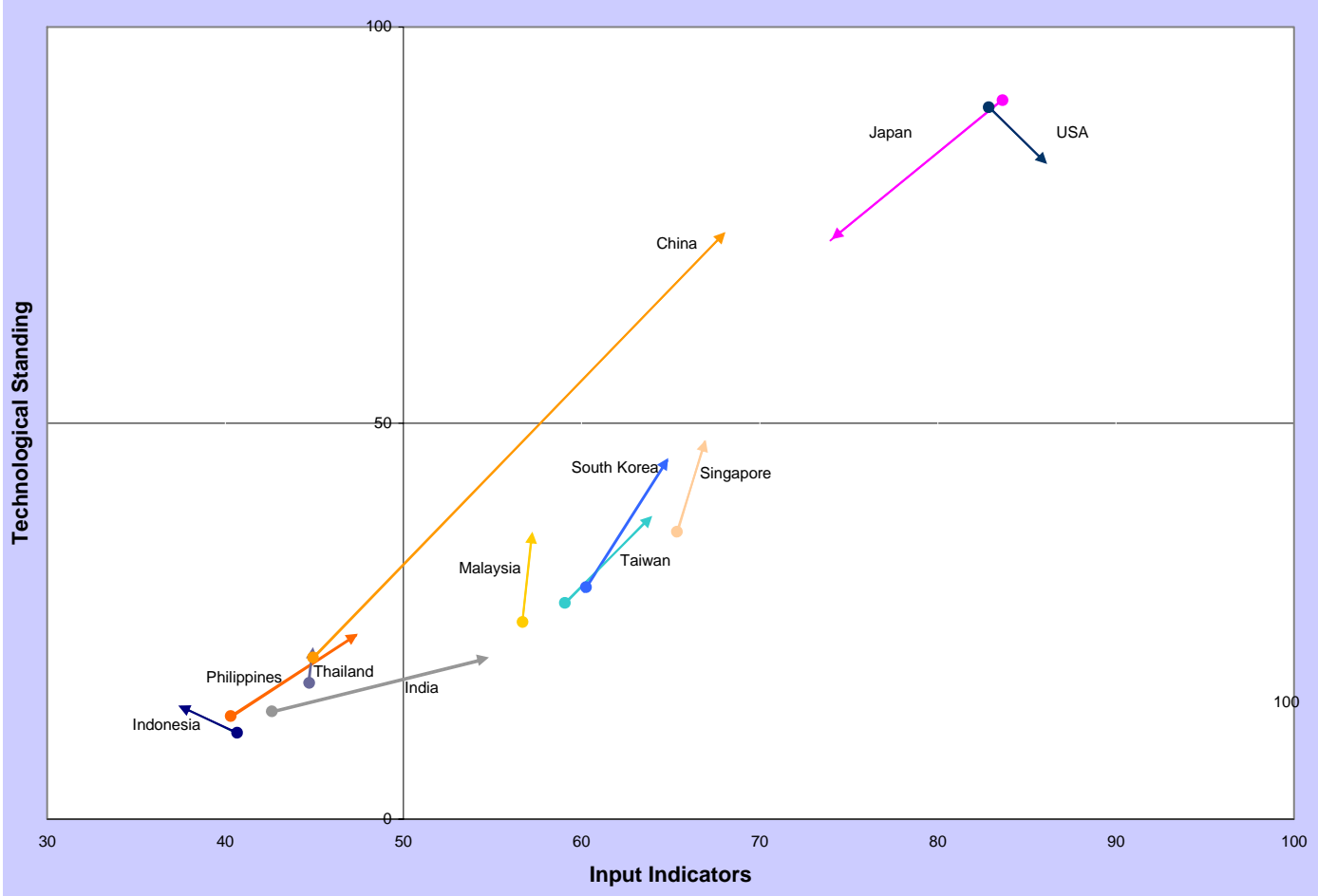
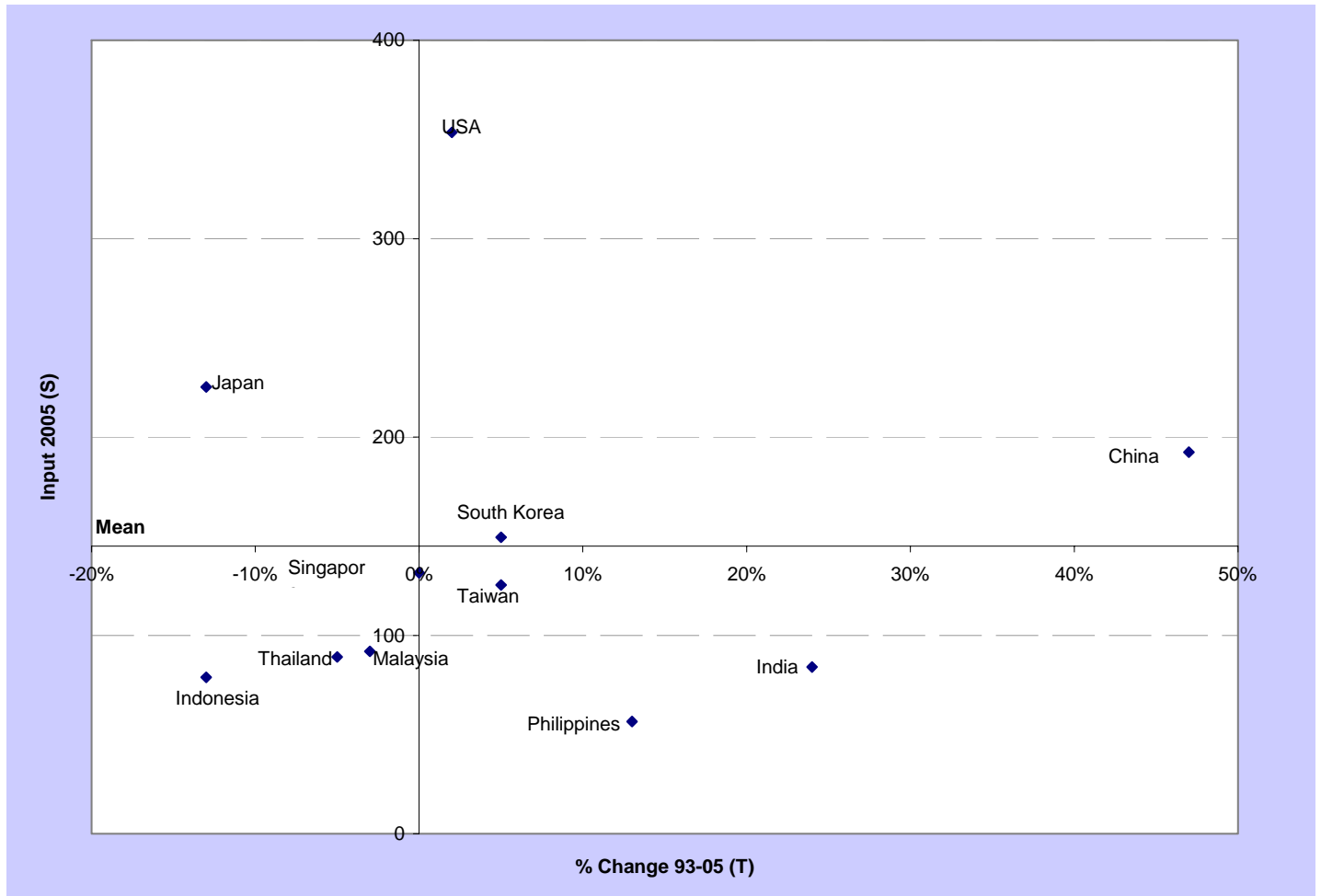


Figure 3 provides another contrast, focusing on INPUT, the composite leading indicator. Here we profile the ten Asian countries included in HTI with the USA as a benchmark. This is a mixed diagram. On the vertical axis is the INPUT score for 2005 (Statistics-only version as the sum of NO, SE, TI, and PC). The horizontal axis presents the percent change in INPUT from 1993 to 2005 (using the Traditional HTI metrics). Note that China dominates in terms of increase in INPUT over this period. China also shows a strong current INPUT score, trailing only the USA and Japan among these countries. China has leapfrogged over the Asian Tigers (South Korea, Singapore, and Taiwan) that were well ahead in 1993. To the extent the indicators do indeed get at propensity for future technological competitiveness, China's future looks strong.

**Figure 3. Scattergram of Percent Change and Input Score [Traditional HTI]**



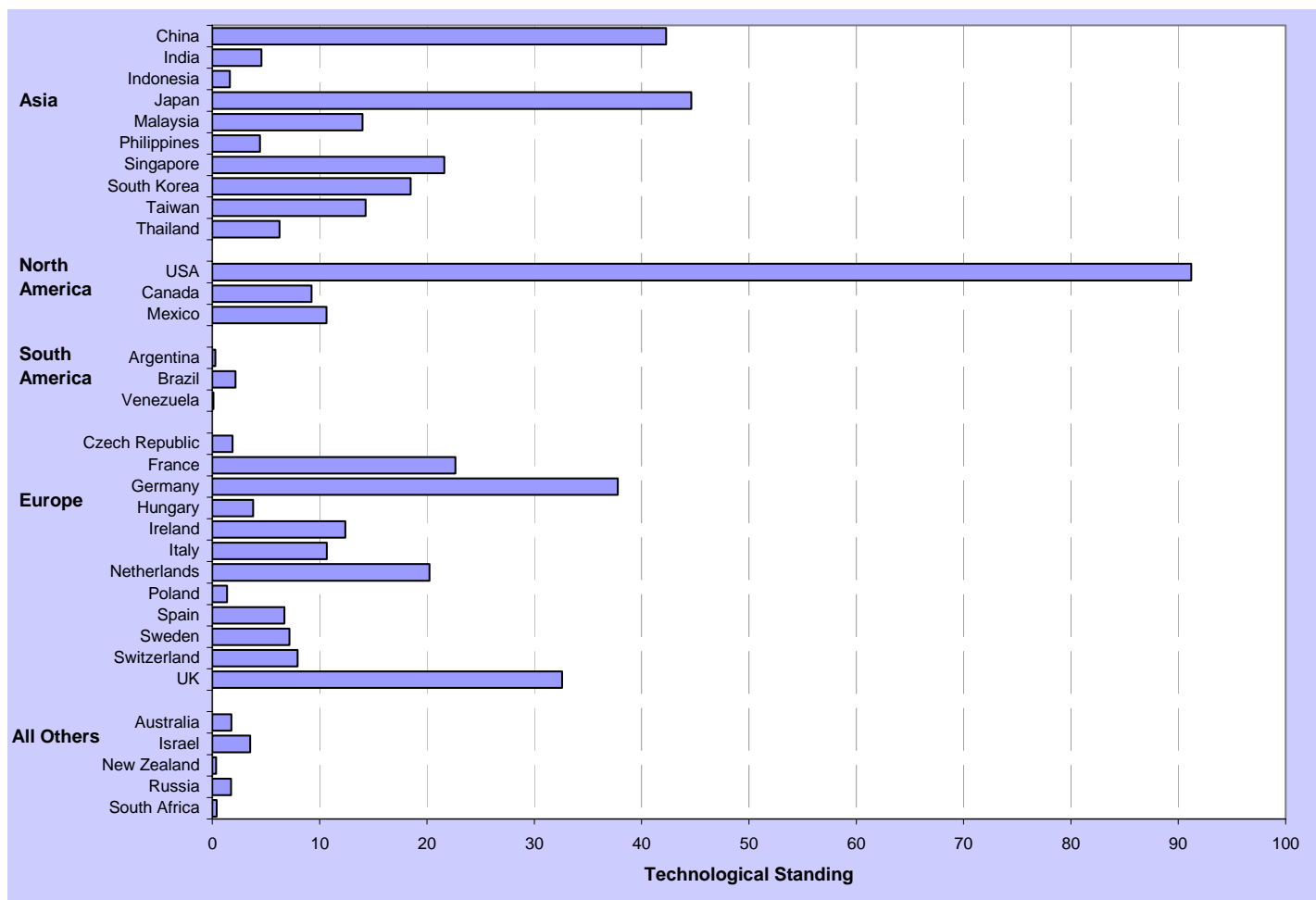
### **The Present: New Perspectives on High Tech Competitiveness**

Figures 4 and 5 present the HTI-2005 results (Statistics-only measures). We include all 33 nations for comparison, as we do not have time series comparisons to offer on the Statistics-only HTI.

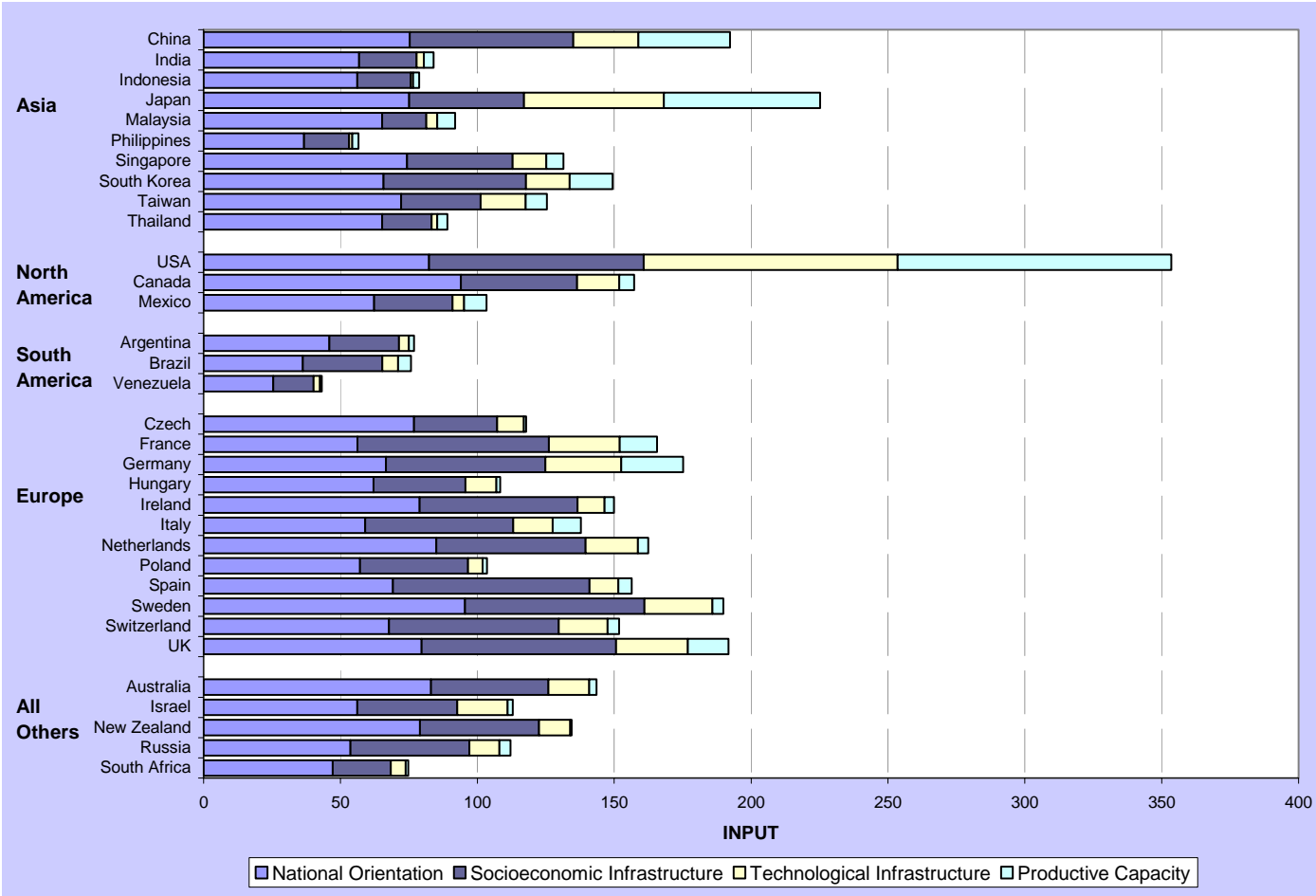
Figure 4 shows current Technological Standing (TS). The Asian countries appear as a group at the top, followed by other geographical regions. Note Asia's strength overall, relative to, for instance, Europe. Setting aside the expert opinion components, note that China still shows powerfully, almost on a par with Japan.

Figure 5 shows INPUT-2005. Embedded in each bar are the respective contributions of NO, SE, TI, and PC to the overall INPUT indicator. Overall, again we see dramatic evidence of China's strength. China significantly trails only the USA and Japan, being essentially on par with leading Western European nations on this composite leading indicator of future competitiveness. As per our conceptual model (Figure 1), NO and SE, the foundational Input indicators show particularly strongly for China.

**Figure 4. Technological Standing 2005 - All countries (Statistics-only)**



**Figure 5. INPUT Indicator Breakout 2005 - All countries (Statistics-only)**



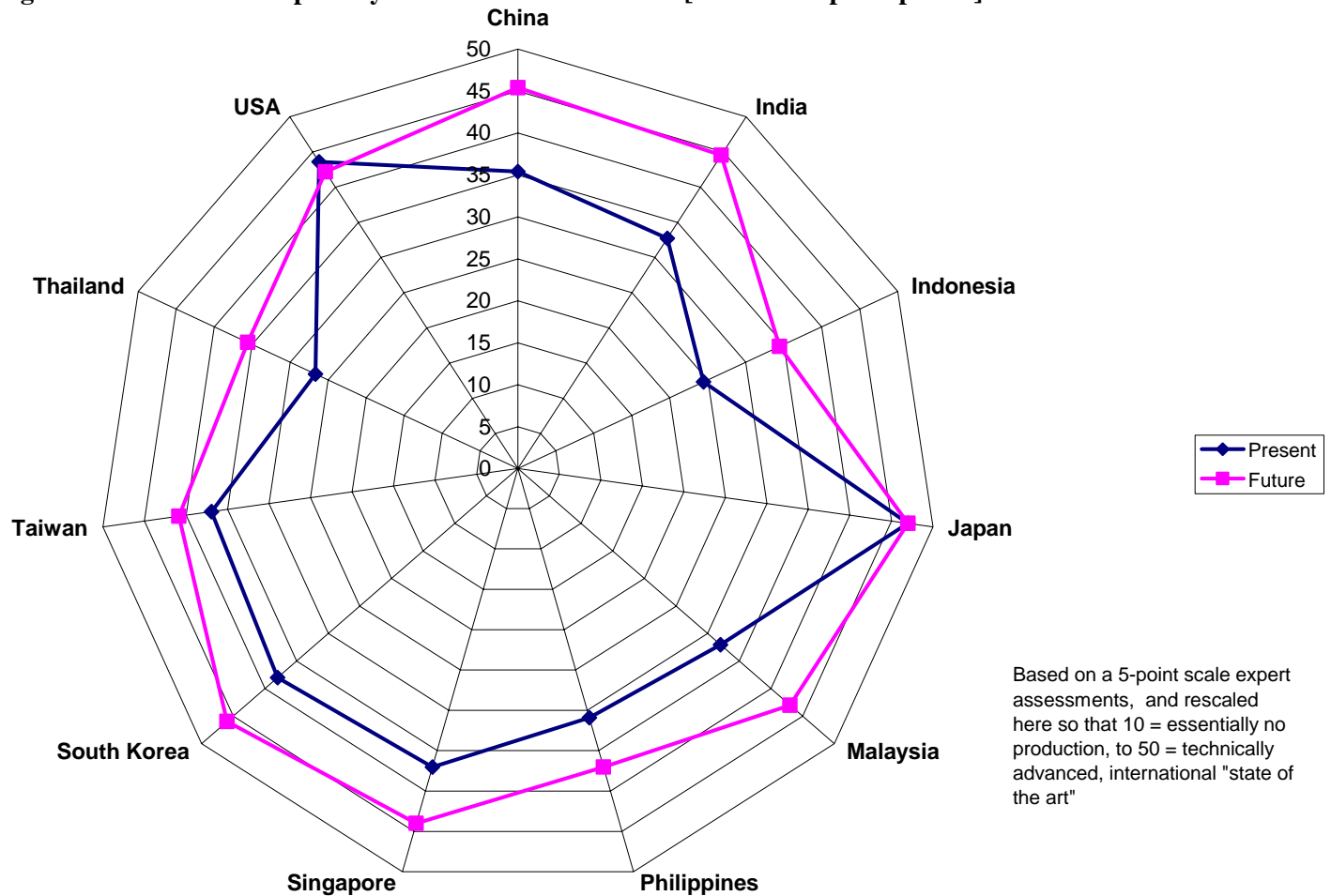
## The Future: Prospects for Technological Competitiveness

One question we pose to our panel of country experts concerns national high tech production capability at present and 15 years in the future. Figure 6 shows the responses for the 10 Asian countries, with the USA. On a scale of 0-50, China is presently gauged at 35, with an anticipated rise to 45. The scaling includes descriptions of “40” as “products well-respected for quality and value in international markets,” and “50” as “products considered technically advanced, ‘state-of-the-art’ in international markets.” As a benchmark, the USA is gauged presently at about 44, essentially holding steady over the coming decade or so (at 43). Again, China’s future in terms of these indicators looks bright.

All of the remaining Asian countries addressed are expected to enhance their technology-intensive production capabilities. Our expert panelists expect especially large steps toward global prominence for India, China, and Malaysia.

Figure 6.

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



Although the U.S. appears to be doing well and outdistances its competitors in terms of the four input measures and Technological Standing, Asia, in general, is advancing strongly. The 10 Asian countries included in HTI appear to be generally committed to developing capacity to compete globally with technology-based products and knowledge-based services. The three Tigers – Singapore, South Korea, and Taiwan – compete effectively in international markets, on a par with Western European nations. However, China is making stupendous strides toward becoming the world leader in technological products. Its pace of progress appears to have accelerated in recent years. It will likely be a (or “the”?) technological superpower of the future. For now, Japan, although slipping somewhat since 1993, remains the leading Asian nation on most of these indicators. China is definitely challenging its position.

We acknowledge that a country's high tech competitiveness cannot be fully captured by a few indicators. Competitiveness is affected by a complex set of political, economic, cultural, and educational factors. Other competitiveness indicators emphasizing different measures may tell a different story. However, the consistent, rapid high tech growth of China as signaled by HTI is worth note and additional exploration.

## References

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