China, America, and the Global Competition for Industry

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The views expressed herein are the author’s responsibility and do not necessarily reflect those of the MIT Industrial Performance Center or the Massachusetts Institute of Technology.
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Industrial Performance Center
M.I.T.

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The most impressive economic achievement of recent times has been the spectacular growth of the Chinese economy since the late 1970s. This remarkable performance has lifted hundreds of millions of Chinese out of the depths of poverty to a standard of living which, though hardly affluent by Western standards, is far removed from the hunger and hardships borne by previous generations. In the sheer numbers of people positively affected, the magnitude of this achievement surely has no precedent in world history.

The news here is full of references to China’s new economy. But the main headline isn’t the rising tide of prosperity in Guangdong or Zhejiang. Rather, it is the threat to Western industries, jobs, and wages posed by China’s enormous pool of low-paid workers. Almost daily we read of manufacturers – a ball-bearing maker in Connecticut, a kitchen appliance manufacturer in Wisconsin, an air conditioning factory in Syracuse -- forced to close or to move their operations to China.

Nor is the Chinese presence felt only in basic manufactured goods. The TVs and toasters bearing the “made in China” label have now been joined by semiconductors, 3rd and 4th generation cellphones, computers, digital cameras, telecom equipment, and associated software. Chinese industry is rapidly emerging as a significant competitor in global high-technology markets.

With almost three million American manufacturing jobs lost since the year 2000, calls for action are on the rise. Many manufacturers and their political supporters are mobilizing, warning of the prospect of global domination by Chinese industry, demanding stronger protections against low-cost Chinese imports, and pressing for a revaluation of China’s currency. Jobs, and the China connection, are likely to be central issues in the forthcoming presidential campaign. Similar concerns can be heard all over Europe and, particularly, in Japan.

The preoccupation with China today is reminiscent of the fears provoked by Japan’s growing industrial power during the 1980s. Many of those fears turned out, of course, to be misplaced. Hardly anyone at the time imagined the dramatic reversal of economic fortunes experienced by Japan during the 1990s.

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So is the current debate over China merely a rerun of the Japanese trade wars of fifteen years ago? Or is China different?

China clearly is different, for several reasons. One, of course, is its sheer size. Measured on a purchasing power parity basis, the Chinese economy, with its 750 million-strong workforce, today stands second only to the United States, and is already 60% larger than the Japanese economy, the world’s third largest, despite a per capita income only 15% of Japan’s -- just $4400 in 2002 in PPP-adjusted dollars.¹

Second, there is the extraordinary speed of China’s economic development. Its GDP has grown at an average annual rate of 8.6% since 1980, outpacing all other countries during that period. Between 1979 and 1999 it absorbed 10 percent of all foreign direct investment², and last year displaced the U.S. as the world’s top destination for FDI. The rapid emergence of China’s technology-based industries is an indication of this torrid pace of development. China’s science and engineering infrastructure is today the most advanced of all developing economies, and in some fields Chinese industry has made gains in ten years that took the Japanese decades to achieve. Yesterday’s successful manned space launch from the Gobi desert underlines China’s rapid technological progress.

The third differentiating factor is China’s complex and evolving political and security relationship with the West – and with the United States more specifically. China’s emergence as a regional superpower, and the possibility that it will seek a larger geopolitical role in the future, creates a strategic context for debate over economic and trade matters that is much different from the earlier interactions with Japan. Today the U.S. and China are adversaries on some strategic issues, while working together on others. But in both cases the Chinese government not only can ‘say no’ but does so on a regular basis. The complex and increasingly important strategic relationship between the two countries will color and sometimes dominate their economic relations going forward.

Fourth, despite the impressive move towards private enterprise and the market, China’s authoritarian system of government continues to raise questions among outsiders about the strength and permanence of its commitment to the fundamental building blocks of free market economies, including the rule of law, freedom of expression and communication, and private property rights.

For these and other reasons, the challenge posed to U.S. industry and the U.S. economy by China today is substantially different from the Japanese challenge of the 1980s.

But the challenge today is different not just because China is different from Japan, but also -- and equally important -- because of the profound changes in the organization of

¹ CIA, World Factbook,
² Yasheng Huang, “Why more is actually less: New interpretations of China’s labor intensive FDI”, September 2001
industry that have occurred over the past decade. Politically, the continuing dismantling of trade barriers and of restrictions on capital flows, and the liberalization of economies around the world, have opened up vast new spaces for both production and consumption, and today make it possible for investment capital, goods and services to move far more freely across national borders. In parallel, technological advances in transportation and communications have made these flows much more cost effective. And third, digitization and standardization of the interfaces between business functions enable production systems that once had to be housed within vertically integrated companies, and often too in a single physical location, to be broken up, or ‘modularized’, and the resulting pieces separated both organizationally and physically, sometimes by great distances.

The outcome of all this is that economic activity seems much more mobile than ever before, with specific activities able to migrate to the most favorable factor cost environment – wherever it is located -- without undermining the performance of the rest of the value chains to which they belong. The implications extend beyond manufacturing. Jobs in the service industries are also affected. And the pattern of mobility in each case is similar, with the outsourcing starting with low-skilled jobs and then moving up the skills ladder.

In electronics manufacturing, for example, offshore outsourcing began with simple printed circuit board assembly, then moved on to more elaborate manufacturing operations, and now extends to multi-billion dollar semiconductor wafer fabrication facilities.

In services, outsourcing began with basic back office work such as data entry, then extended to customer relations activities – call centers, on-line services – and then to more complex functions such as accounting and credit underwriting, and now to quantitative financial research, engineering, and design and product development services, where countries such as India and Russia, as well as China, can offer an abundance of technical talent at a small fraction of the cost of Western engineers, and high speed digital connections make it far easier to communicate from afar.

In this sense, China – vast as it is – is the symbol of a still larger set of questions about globalization, and we cannot hope to understand what the rise of the Chinese economy will mean for the U.S. until we understand what this powerful new model of distributed economic organization will mean for both countries. How far will the trend towards modularization and the spatial dispersion of value chains go? Is it irreversible? Are all jobs here in the United States that are potentially mobile now at risk? Will the new international division of labor leave any labor for us at all? Will wages, environmental regulations, and labor standards slide downhill as companies and governments compete with each other – in the one case for profits, in the other for jobs? Is there any way to avoid a ruinous race to the bottom, short of the imposition of equally ruinous protectionist barriers?
The IPC Globalization Study

For several years a team of researchers from the Industrial Performance Center has been studying these questions. The IPC’s Globalization Study differs from much other work in this field. We did not start out with any overarching theory about what globalization is or what it means. Our approach instead has been to investigate how it is actually working, from the bottom up, by studying the behavior and performance of individual firms in different industries and in different countries, and to try to build up a general picture from these micro-level observations.

Our research strategy was designed with the key questions in mind. Our industry portfolio includes two sectors – textiles and apparel, and electronics – in which the logic of pursuing a low labor-cost locational strategy would seem to be particularly strong (although for different reasons in each case). Textiles and apparel has the highest labor content of all manufacturing industries, and thus one of the strongest motivations to move to low-labor-cost locations. In the electronics sector the digitization and standardization of functional interfaces has gone further than in any other industry, and so the opportunity to ‘deverticalize’ and aggressively pursue low cost labor in those parts of the value chain where this makes sense is greatest. So we expect these two industries to be in the vanguard of the outsourcing trend. Conversely, if there are limits on outsourcing offshore in these two cases, the implications seem likely to be much broader.

We adopted a similar approach in choosing our geographic focus. For example, it includes Hong Kong and Taiwan, two societies that are no ordinary neighbors of mainland China. These two societies are literally on the front lines of globalization. Because of their ethnic and cultural affinities, and because of their proximity to China’s huge pool of low cost labor, we should expect the pressures to relocate industry to the mainland to be especially strong there. Conversely, any retention of industry in these societies would be a strong signal to the rest of the world that there are limits to outsourcing overseas.

In short, our strategy for investigating the process of globalization and its consequences for our own society includes looking at those industries and other societies where we expect the process to be furthest advanced.

The full range of industries and countries we have targeted in our research is shown in Figure 1. In the past 4 years our team has conducted 650 site visits and interviews as part of this research. B The IPC Globalization Project will be completed next year, and we will present a full report at that time. Today I have time only to make a few observations.

The first point – obvious perhaps, but important nonetheless – is that in evaluating the impacts of globalization on our society, it is necessary to differentiate between consumers, employees, and investors. Each set of stakeholders is affected differently, and within each group too there are winners and losers. A growing number of employees perceive their livelihood to be at risk as a direct result of globalization, but consumers
benefit from reduced prices or improvements in value. The threat to workers is real. A recent study by the Bureau of Labor Statistics estimated that almost a third of those whose jobs were displaced by international trade between 1979 and 1999 have not been fully re-employed, that 55% were working for wages 85% or less than their previous wage, and that up to a quarter had experienced pay cuts of 30% or more. The benefits to U.S. consumers are more difficult to measure, as are the benefits to U.S. firms. Among firms, there is a clear fault line between many small and medium sized companies who are struggling to cope with foreign competition, and large MNCs, many of whom see China, especially, as a huge potential market or as a source of low-cost parts, components, or even products. It has been estimated that half of China’s exports come from foreign manufacturers or their joint ventures in China. As one Wall Street economist put it recently, “We are criticizing the Chinese as if they were cleaning our clock and the only part of China that is cleaning our clock is the part that we put there.”

If we look carefully we can find evidence for these differences in the economic statistics. I will focus here on the manufacturing sector, not because there is something unique about manufacturing – as I’ve already noted, outsourcing to lower-wage societies is becoming an equal opportunity phenomenon, affecting many non-manufacturing sectors too – but because the figures are a bit easier to deal with in this case. One of the things they show is that from the perspective of the American consumer, manufacturing is actually becoming a more rather than less important part of the economy. For example, sales of durable goods in the U.S. have nearly doubled since 1990, and now account for 22% of all final purchases, compared with 15.7% at the beginning of the period. Put another way, the purchasing power of the U.S. economy has increased by 3 trillion dollars per year since 1990, and of that increase, 36% -- more than 1 out of every 3 dollars of additional spending -- was allocated to durable goods. When non-durable goods are also included (a category that includes food, fuel, and all other tangible products with a useful life of three years or less), the share of incremental spending increases to 56%. Over this same period, the share of services in America’s total purchasing fell, from 55 to 52%.

This is certainly at odds with the conventional picture of manufacturing as a sector in decline in the United States. Yet the number of manufacturing workers actually did decline during this period. How can we make sense of these contradictory trends?

One explanation, of course, is that imports of manufactured goods were increasing during this period. However, it would be mistaken to think that domestic manufacturing shrank as a result. During the 1990s, U.S. manufacturing output actually increased, by 35% -- a good story. Productivity increased even faster, by 48% -- a very good story from a competitiveness standpoint, and a necessary condition for improvements in the standard of living in the longer run. But the inevitable short run result was that the total number of manufacturing jobs fell. A rough estimate is that productivity gains displaced more than twice as many manufacturing jobs as did imports during the 1990s.

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A third possible explanation for the decline in measured employment is that more of the work that used to be done in-house by manufacturers was outsourced to service providers, whose employees are counted in a different column. It is difficult to measure this effect. But it is worth noting that for every dollar of durable manufactured goods production in the U.S. economy, more than 40 cents is generated by non-manufacturing firms (i.e., providers of business services of various kinds, distributors, retailers, and so on) – a point we will return to.

What about the most recent recession. Since it began, in early 2001, 2.6 million manufacturing jobs have been lost, while imports – especially from China – have increased strongly? Here again, a rough calculation indicates that the effect of imports on job losses was about 1/3 the combined effect of weaker demand and continued productivity gains. If you are a manufacturing worker and have just lost your job, it probably doesn’t much matter to you what the exact cause was. But the politically potent notion that the woes of manufacturing workers can all be laid at the door of the Chinese is exaggerated.

But what of the future? Even if the impact of China has been limited so far, is this just the beginning of a trend?

To gain insight into what may lie ahead, we need to go beyond macro-level generalizations and look at what is happening in individual industries. The IT industry is one of the most important to our economy, and it is also the industry in which value chain modularity and geographical dispersion have been taken furthest. At both the component level and the product level of the electronics segment of the industry, digital codification and standardization of the interfaces between functions have enabled a massive reorganization over the last 15 years. Vertically-integrated corporate structures have dissolved into a series of smaller aggregations of closely related activities on the value chain. Thus, for example, in the component sector the development of a digital interface between integrated circuit design and manufacturing has made it possible for fabless chip design houses, equipment vendors, (and now, increasingly, traditional component makers – or integrated device manufacturers) to make use of pureplay wafer foundries in Taiwan and Singapore (Figure 2).

At the product level there has been a similar segmentation. The industry is now dominated by two types of firms: one group, sometimes called the ‘lead firms’, focused on brand and product development, marketing, distribution, and after-sales service; and another group of contract manufacturers focused on selling, as services, many of the activities in the value chain that the lead firms have decided to outsource. In this second category there are two main sub-types. A group of mostly U.S.-owned firms focus on manufacturing and related services such as component purchasing and inventory management, testing, final assembly, and logistics. The operations of these Electronic Manufacturing Services (or EMS) firms now extend across the globe. The second group is comprised of Taiwan-based contract manufacturers, known in the industry as original

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4 See, for example, Tim Sturgeon, “Modular Production Networks: A New American Model of Industrial Organization”, MIT Industrial Performance Center Working Paper 02-002, March 2002
design manufacturers, or ODMs, which have focused primarily on personal computer
products and generate more of their revenue from design services (Figure 3).

Not everyone in the industry has adopted this pattern of modular production
networks. There are some firms in Europe, and more in Japan, which remain vertically
integrated. But even in Japan, where belief in the virtues of integrated corporate
structures is strong, the tide appears to be shifting.

What are the geographical consequences of this shift? Modularity has lowered the
entry barriers for new firms and has opened up new opportunities for parts of the world
previously on the periphery of the global electronics industry. However, the American
lead firms in product-level electronics retain control of product definition and design,
continue to lead the higher value-added segments of the industry, and control much of its
innovative trajectory.5 These activities are still, for the most part, located in the U.S.

The contract manufacturers are locating in places with both low and high operating
costs. Production of standardized, high-volume, price sensitive products like PCs,
cellphones, and consumer electronics has mostly already moved out of the U.S. This
capacity initially was widely dispersed across the developing world, but now appears to
be concentrating in China. But the American contract manufacturers continue to carry out
considerable amounts of work at their New Product Introduction centers in places like
Silicon Valley and the Boston area, where they work with their lead customers on co-
design, prototype development, and the development and validation of volume
manufacturing processes. Here, too, you can find high-mix production lines tuned to the
manufacturing of high value and low volume products. The big EMS firms say, in fact,
that they do not expect their production in the advanced economies to fall below 30% of
the total.

The Taiwanese ODMs, like their American EMS rivals, have moved large amounts of
low-end manufacturing into China to cut costs, while retaining higher-value activities in
Taiwan. But the sustainability of these latter activities will depend on the ability of the
Taiwan electronics industry to keep introducing new products ahead of the mainland and
producing them for a while in Taiwan before transferring production to China, while
simultaneously fending off an increasingly direct competitive challenge from the big
American contract manufacturers. This will be a tough task. On the one hand, Chinese
technological capabilities are rapidly advancing, while on the other the American EMS
firms have the advantage of being able to operate in a wider range of geographical
locations and a broader range of product markets than their Taiwanese rivals (see Figure).

Taiwan’s situation looks somewhat more secure in the field of electronic components,
where it successfully pioneered the pureplay IC fabrication foundry model ahead of
potential competitors during the 1990s and today maintains a leadership position in
CMOS process technology. Even here, however, China is emerging as an alternative
location, with two new pureplay foundries starting up in the Shanghai area.

5 Tim Sturgeon, op.cit.
What do these developments in the electronics sector tell us about the broader question of China’s impact on the global economy?

First, they remind us that the biggest impact is being felt not in the U.S. or in other advanced economies but in middle and lower-wage economies. The migration of American manufacturing jobs to the developing world has been underway for decades. While it may not yet have fully run its course, there is probably some irreducible minimum level of domestic manufacturing employment, and given the vigorous growth in domestic demand for manufactured products, that base is unlikely to be declining. For low-wage economies, however, it is less obvious that there is a bottom. The average manufacturing wage in China is just 20% of that in the Philippines, and only 25% of that in Mexico. Ross Perot’s famous ‘giant sucking sound’ of jobs disappearing over the border into Mexico, which was never really audible in the United States, ironically can today be heard loudly in Mexico itself, where 500 of 3700 maquiladora plants have been shut down in the last two years alone, as manufacturers migrate west across the Pacific to China.

Second, the electronics case shows us that value chain modularity has not only opened up new opportunities for manufacturing in China, but it has also reduced the entry barriers to firms specializing in product definition and innovative design, because these firms not only do not have to make the large investments needed to create their own manufacturing capacity but can also access the same, leading-edge capacity that is available to their better-established competitors. We also know that these new, innovative firms are more likely to set up shop in places like Silicon Valley than in Shenzen. In this sense, local clustering in the advanced economies and global-scale production networks are not only compatible but mutually reinforcing.

Third, the other side of the coin of value chain modularity and the increasingly specialized division of labor is the emergence of systems integration as a key factor in the organization of production. The work of systems integration – pulling new technologies into products or production processes; implementing new combinations of technologies; integrating skills, knowledge, and components from other firms; devising and implementing integrated solutions to support products throughout their life cycles – such work becomes increasingly important as value chains grow more complex and disaggregated. There are few studies of systems integration as a distinct economic activity, and almost no research on the scale of employment in this field or where it is most likely to be found. But the evidence from the electronics sector -- where both the lead firms and the contract manufacturers see the development of integrated solutions for their customers as a route to competitive advantage – suggest that the bulk of systems integration work continues to be carried out in the United States or other advanced economies.

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7 Juan Forero, “As China gallops, Mexico sees factory jobs slip away”, New York Times, 3 September 2003
Fourth, attempts to extrapolate or generalize on the basis of one industry’s experience should be made with humility. Industries differ. Moreover, even within the electronics industry, the degree of modularity varies (compare, say, the personal computer product segment with the hard disk drive segment, or CMOS fabrication with AMLCDs.) And in specific instances – such as when new product architectures are introduced -- production systems may actually move in the reverse direction, from more to less modular states. Even so, the emergence of modular, global-scale production networks is a broad trend in the economy, affecting many other major industries.

Fifth, it is important to recognize that the emergence of these modular production networks is a challenge to China no less than it is to the United States. Mastering original equipment manufacturing under the tutelage of the world’s most advanced lead firms has traditionally been an important pathway to economic development throughout East Asia. But increasingly demanding requirements imposed by Western lead firms on their suppliers, coupled with the rise of global contract manufacturers also based in the West, are complicating this traditional upgrading strategy. In China especially, a lack of trust in business relations and absence of rule of law have created a business environment that, as MIT Professor Ed Steinfeld has shown, limit the ability of Chinese enterprises to engage with these networks on favorable terms. Moreover, the Chinese government, by continuing to promote the development of traditional Japanese or South-Korean-style ‘national champions’ – firms that are highly diversified and vertically integrated – is helping to perpetuate an industrial structure that embodies “the very organizational characteristics that globalization seems to be driving into obsolescence.”

Finally, while the Chinese government appears committed to improving the business environment for both domestic and foreign firms, the possibility of a period of political instability that would make China a much less inviting place to do business cannot be ruled out. Those who today worry about the adverse consequences for the U.S. of China’s rising industrial power should bear in mind that the alternative is likely to be less attractive, by a large margin.

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### IPC Globalization Project

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- How do firms create and capture value in the new global production networks?
- What functions and activities to keep in-house?
- What functions and activities to keep at home?
- What is the likely impact of these decisions on home and host societies?

**Figure 1: IPC Globalization Project**
Electronic Components

Component definition
Innovative IC design
Detailed IC design
Wafer fab
Assembly and test
Marketing and distribution

Design tools/IP
Eab tools R&D

- Fabless design houses (e.g., Broadcom, Silicon Labs, VIA)
- IP Vendors (e.g., Artisan, ARM)
- EDA tool providers (e.g., Cadence, Synopsys)
- Process technology firms (e.g., Applied Materials, Nikon)
- Foundries (e.g., TSMC, UMC)
- Integrated device manufacturers (e.g., Intel, TI)

Figure 2: The Electronic Components Value Chain
- Branded lead firms (e.g., Dell, Hewlett Packard, etc.)
- Contract manufacturers
  - North American EMS firms (e.g., Celestica, Flextronics, Sanmina, etc.)
  - Taiwanese ODMs (Quanta, BenQ, Arima, etc.)
- Vertical integrated firms (Toshiba, Fujitsu, Matsushita, Phillips, etc.)

Figure 3: The Product-level Electronics Value Chain