Chapter 15
CHINA'S INDUSTRIAL DEVELOPMENT*

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I. INTRODUCTION

China's industries have achieved remarkable development since the start of reform in the late 1970s. Although this essay will outline both the quantitative and institutional dimensions of recent growth, its chief objective is to examine what we see as the central achievement of Chinese industry: the emergence of mechanisms for extending industrial capability, which we measure by the capacity to sell into overseas markets, to a growing array of products and sectors. This accomplishment, which only a few economies – among them Taiwan, South Korea, Israel, India, and Brazil – have matched since the end of World War II, ensures that China's recent boom represents a permanent shift rather than a temporary respite from centuries of poverty.

At the start of reform, Chinese industry had already attained substantial size. Chinese factories and mines employed more workers in 1978 than the combined total of all other third-world nations. Success with nuclear weapons and satellite technology demonstrated new technical strength. Yet visitors to Chinese factories encountered obsolete and dysfunctional products: vans and transformers that failed to keep out rainwater, sewing machines that leaked oil onto the fabric, power tillers rusting outside a factory that churned out fresh batches of unwanted inventory, and so on.

Three decades of reform have remade Chinese industry along many dimensions. Figure 15.1 displays real value-added growth in China's secondary sector (manufacturing, mining, utilities, construction) during the first quarter-century of accelerated growth

(from 1978) alongside comparable figures for Japan (from 1955), Taiwan (from 1960) and South Korea (from 1965). Results show Chinese growth outpacing Japan's, but lagging behind the smaller East Asian dynamos. Similar figures for labor productivity show Chinese performance surpassing the same East Asian neighbors. Qualitative changes were equally important. Reform has pushed China into global prominence as a leading exporter of manufactures. The composition of manufactured exports, which have come to dominate China's overseas sales, has shifted from textiles, garments, toys and other labor-intensive products to a more sophisticated mix led by various types of machinery and equipment. Globalization has also thrust China into cross-national networks for production, design, and research in a growing array of industries.

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We see the growing impact of market forces, expanded entry and intense competition as the central impetus stimulating efforts to expand capabilities and improve performance. Chinese experience shows that despite their undoubted benefits, neither privatization of enterprise ownership nor extensive deregulation, full price flexibility, rule of law and other widely recommended institutional changes must necessarily precede a broad-gauged advance of manufacturing capabilities.

Although competition provides a universal spur to industrial firms, the process of upgrading differs systematically across sectors. The importance of industry-specific characteristics in shaping the development process leads to the expectation that the evolution of Chinese industry will generally follow patterns established in other nations. Globalization, which multiplies the impact of international market forces on Chinese producers, should accentuate this tendency.

At the same time, China's large size, unusual history, and unique institutional arrangements also shape market structures. Variation across sectors and over time in the degree to which official regulation limits the penetration of foreign and private-sector competition into sectors initially dominated by state-owned enterprises (SOEs), for example, affects the intensity of competition, the growth and utilization of production capacity, the pace of innovation, and many other aspects of industrial activity. As a result, we expect outcomes that partly conform to international commonalities, but also reflect special features of China's economy.

Chinese industry is a vast subject that no single essay can encompass. In emphasizing the expansion of capabilities, we focus on two central questions. What are the consequences of China's substantial, though incomplete shift from plan to market? How far has China advanced toward creating a modern, technologically advanced manufacturing sector? To sharpen the focus of our answers, we emphasize specific industries: automobiles, beer, cement, garments, home appliances, machine tools and steel.

We preface our study with an historical sketch of industrial development under reform and a brief discussion of the extent to which market forces have shaped the evolution of industrial structures in China's transitional economy.

II. CHINA'S INDUSTRIAL REFORM

Pre-reform System

At the start of economic reform in the late 1970s, Chinese industry was largely state-owned and urban. In 1978, SOEs delivered 78 percent of industrial output and

employed 76 percent of all industrial workers; state firms also absorbed 84 percent of increments to industrial fixed assets during 1975-80 (Fifty Years 2000, pp, 18, 21, 58). The balance of industrial output came from smaller collective firms located in both urban and rural areas, most owned and directed by local governments. The origins of rural collectives date back to the Great Leap Forward of the late 1950s. During the 1960s and 1970s, these enterprises grew modestly under China's rural communes and were heavily focused on servicing agriculture (Perkins et al, 1977). Urban collectives concentrated on light industry; rural firms emphasized the manufacture of producer goods that were difficult to obtain under China's pre-reform plan system.

Resource allocation in industry was largely administrative, with prices set to ensure positive cash flows and accounting profits at all but the least efficient final goods producers. Almost all of these profits, in turn, were remitted to fiscal authorities, and served as the most important source of government revenue. Unlike the Soviet Union, central planning determined only a modest percentage of resource allocation and investment. Beginning in the 1960s, administrative authority over enterprises, planning and resource allocation increasingly devolved to governments at the provincial level or below. Wong (1986) estimates that by the late 1970s, less than half of industrial output remained under central control.

This decentralization contributed to severe fragmentation at the regional level as local governments deployed significant investment resources in an environment of limited opportunities for trade across administrative boundaries (Lyons, 1987). Donnithorne (1972) coined the term "cellular" to describe the resulting economic structure. As in the USSR, China's plan system emphasized quantity at the expense of

assortment, delivery, customer services, and other qualitative dimensions of production. This encouraged firms to pursue vertical integration in order to avoid dependence on unreliable suppliers. Despite its success in expanding industrial production, the pre-reform system's weaknesses, which included limited autonomy for firm managers, strict controls on labor mobility, and weak material incentives, stifled improvements in quality and productivity, which stagnated at low levels throughout the 1960s and 1970s (Field, 1983; Ishikawa, 1983; Rawski 1975a, 1980; Chen et al 1988).

Industrial Reform

Beginning in the late 1970s, China embarked on a program of enterprise reform. At the risk of considerable simplification, we may divide industrial reform into two periods. During the first 15 years, reform efforts focused on expanding the impact of incentives and market forces on the allocation of resource flows. Beginning in the mid-1990s, reform expanded to encompass the restructuring of resource stocks, including large-scale layoffs of redundant state-sector workers and privatization of government-controlled enterprises.

The initial phase of reform in the state sector consisted of two key components: increasing incentives and autonomy at the firm level, and the introduction of a unique system of dual-track pricing that partitioned both inputs and outputs into plan and market segments, with plan quotas transacted at official prices and market exchange relying on flexible prices that increasingly reflected forces of supply and demand (Naughton, 1995; Li, 1997, Lau et. al. 2001). The share of producer goods transacted at market prices rose

from zero in 1978 to 13 percent in 1985 and 46 percent in 1991. By 1995, 78 percent of producer goods were transacted at market prices (OECD, 2005, p.29).

Parallel initiatives allowed the entry of new firms into an increasing number of sectors formerly reserved for state enterprises. The number of industrial enterprises jumped from 936,000 in 1980 to 7.34 million in 1995.[1] Especially prominent in this regard was the emergence of township and village enterprises (TVEs), which were mostly owned and managed by township and village level governments. These firms could draw on labor released from farming by the introduction of the Household Responsibility System, and inputs now available in the market through the dual track system. The 1980s witnessed rapid increases in numbers of firms, particularly in rural areas (China Compendium 2005, p. 48; Bramall 2007, pp. 52-53). By the late 1980s, township and village-level collectives employed nearly 50 million workers (Bramall 2007, p. 78).

At the same time, new policies mandating favorable treatment of foreign direct investment (FDI) and a reduction in tariff barriers for these firms contributed to the rapid growth of a foreign enterprise sector, initially in the Special Economic Zones, and subsequently, throughout the coastal provinces. As a result, SOEs in many sectors experienced growing competition from both TVEs and foreign-linked firms.

This initial reform stage delivered large increases in output (Figure 15.1), particularly outside the state sector. The share of SOEs in industrial production plunged from 77.6 percent in 1978 to 54.6 percent in 1990 and 34.0 percent in 1995 (Fifty Years 2000, p. 21). Exports expanded rapidly, with foreign-invested firms and TVEs playing major roles in overseas sales. Productivity outcomes remain controversial, but there is

general agreement that improvements in total factor productivity in the state sector were modest at best, and tended to trail productivity gains outside the state sector (Jefferson et al 1999). Within the state sector, growing competition, declining subsidies, and gradual hardening of budget constraints moved enterprises toward market-oriented operations, but the pace of change remained modest and uneven.

Beginning in the mid-1990s, the scope of reform expanded to include major restructuring of inherited stocks of labor and capital. State sector firms, facing growing financial pressure from new competitors who avoided the redundant labor, cumbersome management structures, and costly fringe benefits inherited from the plan system, slashed tens of millions from their employment rolls. TVE privatization rapidly transferred most rural industries to private ownership (Li and Rozelle 2004). Amid considerable downsizing of the officially desired scale and scope of state ownership in China's reforming economy, corporatization, privatization, bankruptcy, and both market-based and administratively-managed mergers rapidly thinned the ranks of state-owned industrial enterprises, whose numbers dropped by 48.2 percent between 2001 and year-end 2004 (State Council Economic Census Group 2005; see also Garnaut et al 2005, Liu and Liu 2005).

With the exception of employment, which has stagnated or even declined since the mid-1990s as a result of the massive SOE layoffs, overall manufacturing trends remain largely unchanged since 1995, with continued rapid growth of output, product quality, exports, and labor productivity. The character of industrial activity, however, has changed substantially. The past decade has witnessed a steep increase in market-oriented business behavior driven by the rapid expansion of foreign invested firms, which now

employ more workers than the combined total of state and collective enterprises (Yearbook 2006, p. 505), accelerated growth of domestic private manufacturing, and the increasingly commercial orientation of state-controlled corporate groups like Baosteel and China Petroleum.

Table 15.1 captures the important role of foreign invested enterprises (FIEs) in Chinese industry as of 2002. At the two-digit level, the ten largest sectoral beneficiaries of FDI absorbed more than sixty percent of accumulated FDI going to industry through 2002. In these sectors, foreign invested firms recorded nearly half of total industry sales (including exports), exceeding seventy percent in electronics, and instruments and meters, but falling below thirty percent in textiles and non-metallic mineral products. Although FIEs were also significantly more export-oriented then their domestic counterparts, as suggested by their high share of sector exports, two-thirds of their sales went to the domestic market. This considerable presence of foreign-linked enterprises in the domestic marketplace exerted strong pressure on local firms competing in these venues.

INSERT TABLE 15.1 ABOUT HERE

The rapid growth of multinational firms' China-based operations, multiplication of cross-national supply networks, and steep expansion of manufactured exports have pulled growing segments of Chinese industry into the global business community. This integration process has stimulated substantial movement in the direction of standard international practices. Many facets of China's industrial system, including supply chain management, accounting practice, demand for MBA training, and industry associations, among others, reflect these new realities. At the same time, we also see the surprisingly persistent legacy of China's quarter-century of socialist planning: frequent government

intervention in commercial decision-making, official control of high-level personnel appointments in state-related enterprises, and SOE dominance among recipients of bank lending (and thus of investment spending) despite the ongoing decline of the state sector's share in manufacturing output.

III. ROLE OF MARKET FORCES IN CHINA'S REFORMED ECONOMY

We see China's reform as steadily expanding the opportunity for strong firms that raise quality and variety, improve service, and control cost to gain market share at the expense of weaker rivals. This conflicts with the findings of authors who extend Donnithorne's (1972) vision of China as a "cellular economy" with limited interregional links into the reform era (Boyreau-Debray and Wei 2003; Kumar 1994; Poncet 2002, 2003; Young 2000). These researchers buttress their perspective with information suggesting limited domestic trade expansion, absence of regional specialization, and small cross-provincial flows of commodities and capital.

The basic tenet of the cellular economy perspective is that some combination of official protection and weak physical or institutional infrastructure effectively reserves regional markets for local producers. Favored incumbents sheltering behind strong entry barriers enjoy partial or full immunity from the competitive pressures that underpin our analysis of Chinese market development.

While no one doubts the existence of barriers to domestic trade, abundant evidence confirms the retreat of local protectionism. As a result, domestic trade barriers are no longer a central economic issue in China's economy. As Naughton observes, "characterizations of Chinese provinces as quasi-autarkic protected economies simply

don't fit the facts" (2003, p. 227). Persistent claims of major internal trade barriers appear to arise from calculations based on incomplete transport statistics, excessive aggregation, or both.[2]

Survey analysis shows 70 percent of respondents reporting a weakening of local protectionism over ten years ending about 2003 (Li et al 2004, p.89). Travelers along China's expanding highway network can observe trucks streaming across wide-open provincial borders. The share of interprovincial flows in railway freight haulage rises in 12 of 14 years during 1990-2004, with the share of interprovincial shipments growing from 58.1 to 68.4 percent (calculated from data in various issues of Transport Yearbook).

Many phenomena, for instance the rapid expansion of logistics, branding, and national advertising, contradict the cellular economy perspective. China's press is filled with accounts of cross-regional competition and cross-provincial mergers among makers of appliances, automobiles, beer, machine tools, steel and many other products. Steinfeld, comments that "even the most established firms cope with increasing competition by aggressively discounting and expanding sales volume. . . by entering new product areas. . . or. . . by trying to export their way out of trouble" – implying the exact opposite of sheltered markets (2004, p.265). Studies by Bai et al. 2004; Naughton 2003, Park and Du 2003; Qi 2006; and Zhang and Tan 2004 provide additional evidence contradicting the cellular economy perspective.

Notwithstanding the incomplete nature of China's reforms and the well-documented presence of officially directed market segmentation, these observations demonstrate that both individual firms and whole industries typically experience strong

influence from fundamental pressures common to all market systems. This perspective, which remains subject to further verification, informs what follows.

IV. ANALYTIC FRAMEWORK

A. Introduction

How have Chinese market structures evolved? Starting from the late 1970s, liberalization and market expansion arising from the gradual demise of planning, the relaxation of control over international trade and investment, and improvements in transport and communication stimulated entry into formerly closed markets, intensified competition, and deepened market integration.

With market rivalries sharpening and official agencies embarking on a gradual, but accelerating process of reducing subsidies to weak firms, Chinese companies face a steady escalation of financial pressures. The dispersion of outcomes – not just wages, but also investment opportunities, housing, and medical and pension benefits – is increasingly aligned with enterprise financial results. This presages the decline and eventual disappearance of weak firms and the dismissal of redundant workers. Although ongoing subsidies for incumbents, imperfect exit mechanisms, and the veneer of prosperity arising from rapid growth slow the process of downward mobility, the basic consequence of economic reform – the idea that participants' economic future depends on financial outcome of market activity – has gradually came to the fore.

Two main themes are explored in what follows. The first of these relates to the shift towards a market economy that has occurred over the past two decades. Up to the early '90s, it was widely argued that the shift was limited by geographical segmentation

of markets, by political interference, and by the behaviour of state-owned enterprises. A blow-by-blow listing of barriers to the operation of markets might suggest many impediments of this kind; and yet the cumulative quantitative impact of such barriers would be difficult to assess. In what follows, we take an indirect approach, by looking at the way market structure has evolved in a range of industries of different kinds over the past twenty years. Different industries have different characteristics which affect their mode of evolution in market economies, and by looking across a range of industries of different types we can see whether patterns of development characteristic of market economies have been observed. Clearly, there are two very different situations involved here, since some industries have been long-established, while others have essentially grown up from scratch over the twenty-year period. We begin, in the next section with a brief sketch of the different types of industry to be considered; and we then look at the 'new' industries before turning to the adjustment paths followed by the 'old' industries.

The second theme relates to the question 'how far has China come?' How close has its 'industrial capability' moved towards that of advanced industrial economies? Before addressing these issues, it is worth pausing to ask what is meant here by 'capability'.

B. Some preliminary remarks

A firm's capability can be defined, for our present purposes, in two steps:

(a) The firm's ('revealed') capability relates to the range of products which it currently produces; specifically, for each (narrowly defined) product line, it refers to (i) the unit variable cost of production expressed as the number of units of materials, and labour input, required per unit of output product, and (ii) a measure or index of

'perceived' quality defined in terms of buyers' willingness-to-pay for a unit of the firm's product, as against rival firms' products. (It is worth noting that this index of 'perceived quality' can be raised not only by improving the physical attributes of the product, via R&D or otherwise, but also through improvement in reputation, brand image, and so on).

(b) Underlying the firm's revealed capability is the firm's 'underlying capability', which consists of the set of elements of 'know-how' held collectively by the group of individuals comprising the firm. The importance of this deeper notion of capability lies in the fact that some of these elements of 'know-how' will be useful in producing products not currently made by the firm[3] – and this will enhance the firm's ability to take advantage of new opportunities over time, as shifts occur in the underlying pattern of technology and demand which it faces.

A generic property of the class of models considered here is that competition between firms will generate some 'threshold' level of capability below which no firm can survive (in the sense of achieving any positive level of sales revenue at equilibrium). Thus there is a range, or 'window', of capability levels at any time, between the current 'top' level attained by any firm and this threshold – and any potential entrant must attain a capability that puts it into this window.[4]

It will be useful to begin with a few general remarks about some relevant industry characteristics. Two key characteristics that affect the different patterns of evolution of different industries are as follows:

(i) the first factor, labelled $1/\beta$ in Figure 15.2 relates to the process of capability building within the firms. Specifically, β represents the elasticity of the function specifying the level of fixed outlays required to achieve a given level of perceived

quality or a given level of productivity (Sutton 1998, chapter 3). If, for example, an increase in R&D spending leads to a substantial rise in product quality ('product innovation'), or a substantial fall in the unit cost of production ('process innovation'), then $1/\beta$ will be high. In this (narrow) sense, $1/\beta$ measures the 'effectiveness of R&D'. More generally, the firm may build up its capability using a variety of methods; what is common to all these methods is that they are costly – in all cases, the firm incurs some fixed and sunk cost in equipping individuals with new elements of 'know-how', whether these relate to product design, production routines, or other devices that enhance productivity or perceived product quality. Now if we are dealing with a standard commodity product, produced using equipment available for sale on the market, which can be operated effectively by low-skill workers, then the firm's opportunities for raising its level of capability relative to its rivals may be limited so that $1/\beta$ is low. On the other hand, if the firm can develop, or imitate, new and better routines in its production process, by way of training programs or otherwise, then $1/\beta$ will be correspondingly higher. As we move up vertically in Figure 15.2, we move from commodity-type industries where the relevant technology is largely 'embodied' in capital equipment bought in from outside, towards industries in which increasing efforts are devoted to the building up of in-house expertise and know-how.

INSERT FIGURE 15.2 ABOUT HERE

(ii) The second factor of interest, labelled σ in Figure 15.2, relates to the relationship between different (firms') products. These relationships arise both on the demand side ('substitutability') and on the supply side ('scope economies'). What σ

measures is the extent to which a firm that devotes additional effort to capability building can capture market share from its rivals. The value of σ can be affected, for example, by the cost of transport: in the cement industry, price differences across two different geographical regions may have only a modest impact on the pattern of market shares, in that they may induce switches of consumers only in some intermediate areas more or less equivalent from the rival plants; if this is the case, then σ is low. If, on the other hand, transport costs are low, then small price differences may induce larger shifts in market shares, and σ will be correspondingly higher. More generally, if buyers are insensitive to any differences between the product varieties offered by different producers, so that small price differences have a big impact on market shares, then σ is high.

A second form of linkage arises on the supply side: this linkage operates at the level of the underlying elements of know-how required in the production of rival products ('economies of scope'). Here, if a firm deepens its expertise in the production of one product line, this expertise can place it at an advantage on introducing a second product line, or – if it is already active in the production of that second line – in enhancing its previous level of productivity or quality in that second line.[5] At the opposite extreme, we might imagine the market to include a set of different product types, each based on an entirely different form of technology to the others. A firm investing heavily in its capability may take market share only from those rivals selling the same type of product to its own offering but will not take share from producers in other segments or ('sub-markets'). (For a practical illustration of this type of market, see the

discussion of the flow meter industry in Sutton 1998, chapter 5). This again constitutes the kind of linkage that is measured by σ, viz. and increase in a firm's spending on capability building is effective in allowing it to capture a larger share of the market as a whole.

Figure 15.2 shows the pattern of outcomes associated with different combinations of 1/β and σ; for the underlying analytical arguments, and empirical evidence supporting this summary picture, see (Sutton 1998), chapters 3-4. What the figure indicates is as follows: when the effectiveness of capability building is low, then its will be possible to sustain an increasingly fragmented market structure as the size of the market increases. It is important to note that this outcome does not necessarily emerge, however the underlying economic mechanisms permit a wide range of market structures to be supported.[6]

Now as we move up the vertical axis in Figure 15.2, two alternative patterns emerge, according as σ is low or high. When σ is low, we can once again sustain a fragmented market structure, but now the levels of effort devoted to capability building by firms will be intense, and R&D to sales ratio will be high. But as we move across the diagram to the top right hand corner (high 1/β, high σ), concentration must necessarily be high, independently of the size of the market. The key economic mechanism at work here is an 'escalation effect': as the market grows, the familiar tendency for new entry to occur, leading to a rise in the number of producers and a fall in concentration, does not operate. Instead, the enhanced profits available to a firm that commands a given share of the larger market induces increased investments in capability building by market leaders. Instead of having more firms, we have an unchanged number of firms, each supporting a

correspondingly greater level of R&D spending (or, more generally, spending on 'capability building').

It may be useful to note where various industries lie on this Figure; this can be done by reference to measurable 'industry characteristics' following (Sutton 1998); see Figure 15.3

INSERT FIGURE 15.3 ABOUT HERE

A comparison of Figures 15.2 and 15.3 allows us to make some preliminary observations as to the way in which market liberalization should be expected to affect the pattern of capability building, and the evolution of concentration, in different Chinese industries.

First, however, a general remark is in order. As noted earlier, the economic mechanisms we are concerned with here operate merely to place a lower limit of the level of market concentration; if, as was the case in Eastern Europe, the pre-liberalization regime favoured the creation and maintenance of highly concentrated industries in which a handful of large state-owned enterprises dominated, then the move to a free market environment is consistent with a fall in concentration. In the Chinese context, however, the most common starting point featured low concentration because dispersal of manufacturing formed part of China's military strategy and because Chinese economic planners generally ratified the efforts of individual provinces to build "full sets" of industries.[7] Rapid development of rural industry after 1978 accentuated the tendency for market concentration in Chinese industries to fall below the levels typical of similar industries in large market economies.

The impact of liberalization involves three important mechanisms (see Sutton 2000):

I As domestic firms come into closer competition with domestically based rivals, or with imports, prices fall, and the least capable firms may no longer be viable.[8] The result is a mixture of exit, and consolidation (aimed at restoring margins), leading concentration to rise. This mechanism operates across all industries, but is relatively weak when σ is low, as in cement.

II As we move up and across Figure 15.2, towards the top right corner (high σ, high $1/\beta$), a second mechanism plays an increasingly important role: this involves an escalation of efforts by surviving firms in respect of capability building, leading to higher levels of R&D spending and increased market concentration. This plays a central role in industries such as 'Domestic Electrical Appliances', on which we focus in the next section.[9] [10]

III The third mechanism relates to volatility of market shares. As competition intensifies, the market share gap between more capable firms in each market, and their less capable rivals, widens. Moreover, a firm's current ('revealed') capability is not always mirrored in its underlying ('dynamic') capability, i.e. its ability to adjust to shocks in its environment. It follows that shifts in the ranking of firms in the market are likely to occur; at its most extreme, this may lead to the displacement of old market leaders by new entrants. Again, this mechanism plays a central role in what follows.

V. The New Industries

China's economic boom has stimulated rapid expansion of many industries, typically in response to a surge in domestic demand arising from increased household incomes. Steven Klepper and several co-authors have discovered a two-stage process that typifies the evolution of firm numbers and industry concentration for new industries in competitive markets (e.g. Klepper and Graddy 1990; see also Sutton 1998). At the start, firms rush to participate in the new market, leading to 'excess entry'. Thereafter, the 'escalation' mechanism introduced in the preceding section kicks in: as competition intensifies, successful expansion of capabilities by some firms leads to increased concentration amidst growing production and sales, rising quality thresholds, ongoing product and process innovation, and falling prices. Firms that cannot expand sales sufficiently to support escalating R&D requirements in the face of shrinking profit margins leave the industry, resulting in a 'shakeout' that sharply reduces the number of active producers and raises the level of concentration.

This perspective, based on U.S. experience, aptly summarizes the process of market development in new Chinese industries. We focus on household appliances. In 1978, China's production of home appliances was minuscule. Since then, the emergence of new industries has pushed China into the ranks of global leaders in the manufacture of consumer durables. Table 15.2 summarizes physical output trends for several products. Refrigerators illustrate the trend. In 1978, China produced one model and only 29,000 units. Subsequently, annual output jumped to 4.6 million units in 1990, 12.8 million in 2000, and 29.9 million in 2005, with a commensurate expansion in the range of models.

Washing machines followed a similar trend, with annual output climbing from 4,000 units in 1978 to 6.6 million in 1990 and 30.4 million by 2005. Production of televisions, air conditioners, and other appliances recorded similarly steep increases.

INSERT TABLE 15.2 ABOUT HERE

In the Chinese context, two factors might have modified or offset the anticipated sequence of entry and shakeout. First, government tried to control the evolution of the market (Jiang 2001, p.168), but since official intervention favoured movement toward structures with modest numbers of large and relatively capable firms (Marukawa, 2001, p. 74), its influence may have complemented natural processes of market evolution. Second, the surge in demand in the 1980s and early 1990s could have been partly met by imports, thus stilling the growth of domestic production, but strict trade controls limited the share of imports during the 1980s (ibid., 61).

As a result, the evolution of China's home appliance sector closely follows Klepper's U.S.-based observations. The number of firms in each industry rose to very high levels during the latter half of the 1980s, but by the late 1990s, the population of appliance makers had begun a steep decline. Washing machine producers, for example, exceeded 180 in 1983, but by 1995, only 30 brands were visible in the market. Eight years later, four dominant Chinese firms shared the much larger domestic market with a comparable number of international manufacturers (Washers, 2003). Refrigerator producers numbered over 200 in 1988; a 2005 report noted "about 40 locally-owned household refrigerator and freezer makers in China, down from about 100 in the late 1990s," and predicted that the number would shrink to "fewer than 20" by 2007 (Jiang

2001, Consolidation 2005). In colour TVs, 87 firms were active in 1990; seven years later, this had fallen to 15.

Although we lack complete data, these shakeouts clearly produced rapid increases in concentration. The four-firm concentration ratio for washing machines jumped from 21% in 1982 to 72% in 1996; in fridges, it rose from 29% in 1988 to 37% in 1994; for colour TVs, it rose from 43% in 1993 to 68% by 1998 and over 70% in 2005 (Tang and Liu 2006). Table 15.2 includes additional data.

Despite the general trend toward concentration, the evolution of specific industries displays unexpected twists. The number of competitors in the market for home air conditioners rose during the 1980s, declined during the 1990s, then witnessed "a dramatic increase" from 2003, when "over 200 brands. . .entered the fray," followed by another steep decline to 69 firms in late 2005, of which 48, each with market share under one percent, seemed destined for a quick exit (Glut 2005). The balance between foreign and domestic firms is equally unstable. Overseas firms stormed into China's nascent home appliance market in the 1980s, retreated in the face of a powerful domestic response during the 1990s, then returned in force after 2000, particularly in washing machines, where Toshiba alone held a 20 percent share of the domestic market in 2001, and refrigerators, where local firms face "intense competition from multinationals" (Toshiba 2001, Consolidation 2005).

The color television sector illustrates the turbulence surrounding changes in market shares for home appliances and other new sectors. China's color TV industry is a big success. Figure 15.4 shows a classic "product cycle" pattern – initial imports followed by a steep rise in exports and an equally abrupt decline in the ratio of imported

components to export sales - that rocketed Chinese producers into a leading position among global exporters of televisions.

INSERT FIGURE 15.4 ABOUT HERE

The road to success, however, was long and costly. As late as 1990, no province achieved annual output even close to the capacity of plants imported prior to 1985. From the perspective of 1990, China's venture into the manufacture of color televisions appeared to be a costly disaster. The ensuing decade brought a dramatic turnaround as several regions led by Guangdong (home of TCL and Konka) and Sichuan (home of Changhong, the new industry leader) experienced a "takeoff" into mass production and large-scale export. Even then, success left a trail of failed initiatives in regions like Beijing that never attained the production level associated with facilities imported before 1985. With China's top four TV-makers holding 30% of the global market and 70% of domestic sales of color televisions, a Ministry of Commerce researcher summarized the outcome: "many money-loosing [sic] or uncompetitive TV makers still exist. . . although some real market players have emerged" (Wang and Dai 2004, Tang and Liu 2006**).**

With firms struggling to master new technologies and to stabilize their finances amid fierce competition, rapid shifts in market leadership are commonplace. Nanjing-based Panda was the industry's largest producer in 1993, with a market share of 11%. Over the next three years, Panda's position was rapidly eroded by the rise of Sichuan-based Changhong, which had ranked fourth in 1993 with a market share of 4%. Panda failed to anticipate Changhong's growing strength, and could not match Changhong's big price reduction in 1994. Lower prices sparked a big increase in sales that allowed

Changhong to grab sales at Panda's expense. By 1996, Changhong's market share had vaulted to 21% while Panda's had slumped to 5%.[11]

Changhong's top ranking was short-lived. The new leader faced powerful competition from TCL, which rose from third position in 1996 to supplant Changhong as market leader by 2003. Both TCL and Konka, another strong challenger, established production facilities near Changhong's home base with the aim of undercutting its former market dominance in western China. In 2004, the collapse of Changhong's partnership with a U.S. based importer saddled the firm with massive losses. Despite its impressive sales and large annual revenues, Changhong suddenly faced the task of simultaneously rebuilding its finances, maintaining its market share, and integrating new domestic and overseas projects into its operations (Buckley 2005, Changhong 2005, Global 2005**)**.

The cushion of local government financial support (Sugawara 2005) cannot protect firms like Changhong against market risk. In the television industry, as in many other new sectors (computers, telecommunications equipment, semi-conductors, etc.), rapid obsolescence of products, materials, and equipment multiplies the risk of failure. The sudden market shift toward plasma and flat-screen televisions has quickly devalued the supply chains and production experience that China's producers struggled to accumulate over twenty-five years. With their lack of 'underlying capability' now frighteningly apparent, Changhong and other big TV-makers must scramble to master new technologies, restructure supply chains, and reconfigure manufacturing facilities, incurring huge costs merely to participate in the treacherously shifting market with no promise of success or even survival. Chinese observers are quick to criticize Changhong and other firms that "lack their own core technologies, and compete by making products

for overseas brand labels using ruinous price competition to gain market share" (Li Fei 2003). With flat-screen prices dropping at dizzying rates, Japanese and Korean firms shouldering "the huge upfront costs required to remain. . . major player[s]" and industry executives anticipating that "only three or four TV makers can survive," the impressive achievements of China's television manufacturers cannot conceal the dangers that lie ahead (Flat TV 2007, p. 7).

If the evolution of these 'new' industries clearly follows patterns familiar from Western economies, what of the older established industries?

VI. Adjusting: The Established Industries

Cement. The pressures to adjust in a market environment vary sharply across industries. For the cement industry, even in a free market environment the high level of transport costs segments markets geographically, and the intensity of price competition and the extent of cross-hauling across different regions remains low. For Chinese cement makers, adjustment has posed relatively few problems.

Policy decisions and regulations have accentuated the natural tendency for local or regional market segmentation. In Beijing, for example, the BBMG Company is the only large producer. Operating all three large-scale plants in the city area, it supplies one-third of demand, the remainder being filled by forty small 'township companies' and by cross-hauling from firms in neighboring Hebei province. Environmental concerns have led the authorities to bar further plant building or expansion in the city area, in spite of the rapid increase in demand. BBMG operates profitably in this setting, and it has focussed its strategy on diversification into other types of construction materials. It has

several foreign joint venture partners, in areas ranging from ceramics to chipboard (Interview, 2 August 2004).

A contrasting case is that of the Sunnsy Company in Jinan city (Shandong). A long established producer, and the largest in its region, it ran at a loss for a decade during the 1980s. The firm launched a 'turnaround' strategy in 1990, which focused on expanding its penetration of regional cement markets, first in Shandong, and then in neighboring Hebei. By 2004, with annual cement output of 2.5million tons, or 12 times the level of 1990, Sunnsy had set its sights on extending sales into Beijing's booming construction sector and into nearby Tianjin (interview 3 August 2004).

Textiles and Apparel

At the outset of reform, textiles and apparel ranked among China's largest industrial sectors, representing nearly a sixth of the gross value of industrial output. Table 15.3 summarizes the evolution of the textile sector.[12] This sector was also an important source of export earnings, largely from the export of cotton fabric (as opposed to apparel).

INSERT TABLE 15.3 ABOUT HERE

The textile sector experienced rapid growth during the first decade of reform. The number of firms and employees more than doubled between 1980 and 1990, and output quadrupled. Exports rose steeply, with Chinese goods claiming a 7.5 percent share of global textile and apparel exports by 1990. Despite the rapid pace of overall industrial growth, familiar patterns persisted: textiles continued to deliver about one-sixth of all industrial production, exports hovered around one-fifth of total output, and fabrics contributed roughly three-fifths of overall export sales.

Between 1990 and 1997 (note that the coverage of data in Table 15.3 changes after 1997), steep growth of output and exports continued, but familiar patterns began to shift. Both employment and (after 1995) the number of firms began to decline, as did the textile sector's share in overall industrial output. The textile sector's share of China's exports jumped from one-fifth to one quarter, powered mainly by sales of garments, which occupied roughly two-thirds of China's textile exports after 1995.

Underlying these changes was a rapid process of internationalization. Table 15.1 shows that both textiles (i.e. manufacture of fabrics) and garments ranked among the leading recipients of foreign direct investment. The establishment of joint venture firms had a profound effect, particularly in the production of apparel. As noted above, rising exports of garments pushed the textile sector's share of China's exports sharply higher even as textiles began to retreat from its traditional position among China's largest industries.

Table 15.4 draws on results of China's 1995 industrial census to map out the ownership structure of textile and garment manufacturing. Along with internationalization, reflected in the new prominence of joint venture (JV) firms in exports of textiles and especially in the manufacture and export of apparel, the data reveal a substantial shift of market share from the formerly dominant state sector to urban collectives (COEs) and to rural firms (TVEs). The 1995 data essentially partition overall output into four roughly equal segments: SOEs, now confined almost entirely to the (slightly more capital-intensive) manufacture of fabrics; joint ventures, with a heavy emphasis on export oriented garment manufacture; urban collectives and TVEs, each providing roughly one-quarter of China's 1995 output of both textiles and apparel

INSERT TABLE 15.4 ABOUT HERE

Strong outward orientation and the further retreat of the state sector highlight the evolution of China's textile sector after 1995. Table 15.3 documents the continued rapid expansion of output and especially exports through 2005, with overseas sales of garments retaining the lead role established during the early 1990s. State-owned and state-controlled firms accounted for only 8.9 and 6.0 percent of textile-sector gross output value and export earnings in 2005 (Textile Report 2005, pp. 322-324).

With textiles designated as a "competitive sector," meaning that government maintains a more-or-less "hands off" policy and allows market outcomes to dictate the rise or fall of individual firms, the state sector's weak productivity and profit performance allowed urban collectives, TVEs, foreign firms and, most recently, private Chinese operators to add market share at the state sector's expense.

The entry and growth of foreign-invested firms (FIEs), whose activities were heavily tilted toward apparel exports, generated positive spillovers for the whole industry. Foreign-linked firms fostered important backward linkages in the sector for fabric (including dyeing) and accessories, e.g. zippers, buttons. Thick new supply chains clustered around export producers, especially in the coastal areas. This facilitated the emergence of vibrant new private firms, which tapped these networks in their quest to meet the demanding quality and delivery requirements of overseas customers, and more recently, domestic buyers.

Branstetter and Lardy (Chapter 16, Table 16.1) find that the number of firms authorized to engage in direct overseas sales (as opposed to consigning products to state trading firms) rose from 12 in 1978 to 800 in 1985, 12,000 in 1996, and 31,000 in 2000.

The beneficiaries of this liberalization included many producers of textiles and garments. The resulting interaction with overseas customers represents a central element in the growth of private firms in this sector.

The experience of the Nanjing-based Huarui (Ever Glory) Apparel firm, a private company founded in 1993, is illustrative. Ever Glory built its business from the outset on direct links to foreign buyers. Its first major relationship arose from repeated visits to the Shanghai sourcing office of the multinational retailer C & A. Following this success, Huarui focused its efforts on building links to a few large foreign customers. It deliberately pursued sales in Japan, the most demanding market, in order to force itself to attain high quality standards, which it then extended to its entire business. Huarui emphasizes close relations with its own suppliers, interacting on a continuing basis with these firms in order to develop good working relations – a strategy more familiar from the auto industry than among clothing firms (Interview, 9 August 2004).

The recent history of two other firms, Lanyan (Shandong) and Chenfeng (Jiangsu) shows important parallels with Huarui. Both firms acquired direct export rights in the early 1990s, and benefited from manufacturing to the demanding standards of overseas customers. Uniquely in the industry, these two firms have become more vertically integrated over time, building on their initial capabilities and reputations. Lanyan's operations started out in the manufacture of denim fabric; by 2004, they had become the world's 11th largest manufacturer of denim cloth. Building on their capability in denim production, Lanyan has expanded into the export of denim products, e.g. blue jeans, to the US, Japan and Korea; they provide the fabric, and their customers the designs (Interview, 4 August 2004). Chengfeng, which sells silk apparel to major US customers

including Gap, Liz Claiborne, and Jones of New York, has integrated backwards into hybrid cocoon production in order ensure high quality standards in their silk fabric. They have diversified into cotton apparel as well (Interview, 11 August 2004).

Adjustment, however, has not been easy for all firms. The combined annual profits of textile SOEs were negative throughout 1993-1999 (Textile Yearbook 2000, p. 3). As late as 2000, more than 31 percent of all SOEs that remained in the industry were losing money. Between 1999 and 2005, the number of SOEs in the industry declined from 4247 to 1480, but the share of loss-making firms remained high - 37.3 percent in 2005.[13] In 2005, value-added per worker and value added per yuan of net fixed assets in SOEs were only 60 and 40 percent, respectively, of the industry average, while profits per yuan of assets were only one-sixteenth of the industry average.

The Number 12 Textile Factory in Baoji, Shaanxi, which was originally established by the Rong family in 1938 and is now under the direct control of a provincial government corporation, is an intermediate case between the failing SOEs and the firms described above. This enterprise has survived in the short-run as an efficient exporter of medium-range cotton cloth (360-370 threads per inch), primarily to Japan, South Korea and Southeast Asia. A distinguishing feature of this firm, however, is the inability or unwillingness of its managers to engage in direct sales to overseas clients. Despite obtaining export rights around 2000, this firm chooses to employ middlemen rather than dealing directly with customers. This likely reflects their limited capabilities in finding customers.[14] Company management has also resisted vertically integrating, or moving into (or overseeing) higher-valued added stages in the production process, e.g. dyeing.

With growing pressure from private firms in the coastal areas, and falling cotton cloth prices, this firm's future is less than certain.

Rapidly rising exports are a clear indication of the growing capabilities of firms in this industry. This is nicely reflected in U.S. import data, which show both rising Chinese penetration and a shift into higher valued-added segments of each sub-market. At the 4-digit level, average penetration of Chinese products rose from 11.4% of U.S. apparel imports in 1987 to 12.6% in 1990, 15.7% in 1995, and 18.3% in 2000. Over the same period, the weighted average ratio of the unit value of imports from China to the unit value of all imports rises from 0.83 in 1987 to 0.91 in 1990, 1.06 in 1995, and 1.28 in 2000.[15] We observe similar, but slightly weaker behavior in textiles.

Efforts to raise capabilities reflect pressures from domestic as well as overseas customers. The expansion of household incomes and fashion consciousness has elevated quality requirements in the Chinese market for fabric and garments, which absorbs two-thirds of all sales by textile and apparel firms and one third of sales for FIEs. At the risk of some simplification, we can divide the domestic market for textiles and garments into two quality segments.[16] Prosperous, fashion-conscious buyers, mainly in urban areas, populate the upper segment, in which rising sales windows reflect growing customer demand for design, quality and branding. Firms that cannot keep pace with these rising standards find themselves forced to compete in the lower segment, where price remains the primary consideration.

As the upper segment grows in absolute and relative size, domestic firms, some with export experience, are emerging as industry leaders, investing heavily in developing their capabilities, and increasingly relying on their own designs and brand names. Firms

without export experience, especially those located in the coastal provinces, benefit from China's export success through their ability to tap a well-developed domestic supply chain. Exporters have also become an important conduit for information on international design and fashion trends. These circumstances have created a substantial premium on coastal location: one Shaanxi apparel manufacturer complained of a six-month information lag compared with coastal firms. This disadvantage encouraged them first to procure fabric and accessories from coastal firms, and subsequently to abandon manufacturing entirely and focus on design and marketing (Interview, 21 July 2005).

Steel. Table 15.5 summarizes steel industry trends during the past quarter-century. After quadrupling physical output during the two decades of reform, China emerged at the turn of the century as the world's largest steel producer, with 2000 production of 128.5 million tons. The following years saw a further steep increase, with crude steel output more than tripling to 418.8 million tons, or one-third of global production, in 2006. Over the same period, the number of firms in the industry more than doubled. In the wake of this massive growth, China's domestic steel market and major steel producers now exert important influence over global steel trends.

Insert Table 15.5 about here

Beyond the continuing expansion, China's steel industry presents a complex picture. While market forces continue to gain strength, official influence, both at the national level and below, remains stronger than in many other sectors. China's steel-makers display extreme heterogeneity in terms of scale, productivity, technology, and responsiveness to market forces. Some have achieved rapid progress toward international

quality and productivity standards, while others extend the former plan system's legacy of inefficient, tonnage-oriented production.

Industry-wide productivity and cost trends demonstrate impressive gains. Despite massive increases in output, sector-wide employment grew by only 32 percent between 1978 and 2005. As a result, output per worker rose more than 10-fold from low initial levels (Table 15.5). Trends for basic technical indicators, shown in Figure 15.5, indicate that gradual improvements have cumulated into substantial changes. The adoption of continuous casting, recycling of water, and other improvements has reduced the consumption of energy, electricity, and water per ton of steel.[17]

Insert Figure 15.5 about here

These results conceal enormous variation. Comparisons involving productivity and material consumption consistently show leading Chinese firms approaching norms for steel-making in advanced market economies. But wide variation among major Chinese producers, and the steel sector's long "tail" of poorly performing firms, push industry-wide averages far below the achievements of Chinese pace-setters.

Workers at Shanghai Baosteel, for example, turned out an average of 588 tons per man-year around 2000, comparable to 1999 productivity of 530-540 tons for French, German, and UK firms.[18] The distance between Baosteel and industry-wide domestic labor productivity of 51 tons per man-year in 2000 reflects the extraordinary variation among Chinese steel-makers. Micro-level data for 2005 on revenue per worker illustrate this phenomenon: the top five percent of all firms recorded revenue per worker more than six times the industry-wide average of RMB 800,008; the bottom five percent of firms

achieved revenue per worker less than a sixth the sector average (Industrial Microdata for 2005).[19]

Information on material inputs reveals a similar picture. Data for 2002 show the best Chinese firms attaining what Chinese industry sources describe as "advanced international levels": 395.35 kg. of coal per ton for iron smelting (vs. an international norm of under 400 kg.) and 156 kwh of electricity per ton of electric furnace steel (vs. a norm of 350 kwh/ton). The averages for all large and medium enterprises are much higher. Comparisons between "advanced" and "backward" producers indicate huge differences in utilization of energy and water per ton of steel, and also in emissions of SO2 and dust (Industry Report 2004, pp. 199-200; 2005, p.173).

As in textiles and apparel, the Chinese market for steel consists of two broad segments: a highly profitable upper tier that supplies makers of cars, home appliances, and other users whose fortunes increasingly rest on the quality of their products; and a less profitable lower tier, mainly serving construction. When steel-makers' monthly profits hit record levels in December 2004, 949 of 4947 producers recorded losses. A year later, monthly profits again topped RMB 100 billion, but the number of loss-makers jumped to 1,731 of 6649.[20]

Table 15.6, which presents 2005 results for Chinese steelmakers classified by ownership, illuminates this dual structure. The top panel shows that in steel, unlike many other sectors, labor productivity and profitability for state-sector firms compare favorably with industry-wide averages. The lower panel, based on the same firm-level data reveals a dual structure underlying these averages that cuts across ownership lines and across the four major steel subsectors.[21] Altogether, 26 percent of all firms reported making losses

in the boom year of 2005, with a slightly higher percentage of both SOEs and FIEs in the red (30.1 and 29.5).

Insert Table 15.6 about here

Visits to top-tier steel firms reveal the gradual shift toward emphasis on quality. At Beijing's Capital Steel (*Shougang*):

> in the 1980s, there was excess demand, even in the market for low quality steel. . . . in 1993, prices for [a superior variety] and for wire rods were the same. There was no reason to produce the higher-valued product. . . . There was no market justification for innovation, so we mostly produced [ordinary] wire rods. . . . Market demand set the tone. . . . When market competition became intense [in the mid- to late 1990s] . . . we were forced to . . . raise product quality. (Interview, August 2004).

At Jinan Steel: "Since the 1980s, quality control has become our life. Everything is focused on quality control. . . . In adding a new converter, the #1 emphasis is on the manufacturing process. . . and on quality. . . . This is true not only at our firm – every firm has shifted its basic focus to quality control" (Interview, August 2004).

Interviews illuminate the difficulties associated with upgrading as well as the complex relationships that contribute to success. In China, as elsewhere, the political economy of planning provided weak incentives for innovation, which encouraged firms to focus on quantity rather than quality or cost (Rawski 1980, Berliner 1976). Even after reform began to inject market forces into manufacturers' calculations, excess demand stifled incentives to innovate.

Efforts to improve steel-making facilities are costly, time-consuming, and risky. At Capital Steel, improvements to the hot-rolling mill required eight months for "putting the line into operation" (Interview, August 2004). Jiangsu Shagang Group Co. Ltd. imported China's first continuous casting line in 1989 (second-hand equipment from U.K.), but took two years to move the new equipment into production. Shagang officials report that many firms followed their lead, but with mixed results: success at a firm in nearby Jiangyin (Jiangsu), failure at a Fujian enterprise that installed new equipment but never managed to increase output (Interview, August 2004).

Improvements to production processes and upgrading the mix of products require more than technical skill and management expertise within the enterprise. Extensive cooperation is a key ingredient in building capabilities. In renovating its hot-rolling facilities, Capital Steel relied on SMD Denmark, one of its long-term equipment suppliers. Shougang's reliance on its equipment suppliers as a channel of capability building is a normal practice in the steel industry. A similar pattern occurred during the 1990s at Jiangsu Shagang, China's thirteenth largest producer. Its upgrading projects during the past decade involved collaborations with equipment suppliers from Switzerland (Concast, in continuous casting), the United States (Morgan, for wire rod rolling), and Germany (Siemens, for control systems).

A particularly deep and continuing involvement began with the installation by Fuchs (Germany) of Shagang's first electric arc furnace (EAF) in 1993-95.[22] A continuous relationship evolved between the two firms, leading to the installation of two more EAFs, the latest being in 2003. These extended ties between Shagang and Fuchs illustrate a standard pattern of mutually advantageous interactions between equipment

suppliers and buyers. When, for example, Shagang's engineers decided to attempt a modification of the process which would allow them to introduce molten iron into the EAF during the course of operation in an energy efficient way (i.e. without inducing a drop in temperature), they consulted Fuchs, and engineers from the two firms worked together on the project. This led to design modifications on the EAF which were not only of immediate benefit to Shagang, but also of long term benefit to Fuchs.

While such collaborations with equipment suppliers play a vital role in capability building in the industry, a second channel – of similar importance – involves international joint ventures. A notably successful example involves Shagang's link with Posco (Korea) in stainless steel. The partnership was initiated by Posco, which wanted to establish a presence in China, and approached a trading company under the (former) Ministry of Metallurgy, which suggested Shagang as a potential partner. Ownership is 80 percent Posco and 20 percent Shagang, giving Posco a strong incentive to develop the business; investment over the eight-year period has totaled one billion U.S. dollars, most associated with the construction of an entire rolling mill and production line. At the time of installation, Posco had 30 personnel on site; this has now fallen to about 18 at any time, out of a total plant employment of almost seven hundred. This joint venture has allowed Shagang to broaden its capabilities in a significant way, by establishing itself as one of only three Chinese producers of stainless steel.[23]

Even as steel producers respond to new market conditions with efforts to upgrade facilities and product mix, China's leaders continue to view state ownership and control of leading firms in steel and other key sectors as a central element in their vision of China as a "socialist market economy with Chinese characteristics." Although the scope of

these "key sectors" has contracted with the passage of time, governments at all levels include steel among the sectors marked for strong official influence. Following a tradition that dates from the Great Leap Forward of 1958-1960, steel production is ubiquitous – 27 of China's 31 province-level units produced at least two million tons of crude steel in 2005 (Yearbook 2006, p. 562).

Despite the conversion of many firms into shareholding companies, some listed on domestic or overseas stock exchanges, and inroads by private domestic and overseas investors through both entry and expansion, control of China's large steel producers remains concentrated in official hands. According to data compiled by the Iron and Steel Association, the output share of state sector firms fell from 60 to 52 percent between 1995 and 2005; these figures, which remain far larger than the state sector's overall share in industrial output (see Chapter 20, Prospects, Table 20.8) may overstate the retreat of official influence, which remains strong within the corporate segment of the steel industry (included in the residual category in Table 15.6).[24]

At the national level, official policy, as summarized in a 2005 statement, seeks to nurture a small number of large, Chinese-owned steel producers with world-class technology and global competitive strength. This goal motivates interventions aimed at consolidating China's steel sector, accelerating the absorption of new technology, channeling resources and opportunities to firms perceived as future industry leaders, promoting consolidation through mergers and acquisitions, and eliminating obsolete production facilities (OECD 2006).

The multiple interests of provincial and municipal governments as equity holders, development agencies, and tax collectors complicate efforts to restructure China's steel

sector. Many provincial and municipal governments see steel as a key element in their own industrial policies. Conflicts among policy objectives at different levels may ensue. With demand booming, many firms (and their official supporters) have opted for expansion rather than risk classification as "small and inefficient" operators that "should be prepared to join large players" (Steel Strategy 2005). Steel firms are big taxpayers: in 2004, steel-makers paid 79.9 percent of corporate income tax in Hebei and 91.2 percent in Hubei; steel firms provided 70 percent of total municipal revenue in Benxi (Kim 2006).

This complex web of interests sometimes leads sub-national governments to support Beijing's efforts, as when Hebei announces plans "to combine its 202 steel mills into 40 groups. . . over the next five years." Elsewhere, local authorities may contravene national policy, as when Jiangsu officials supported the unauthorized construction of an 8 million ton steelmaking facility (Gong Zhengzheng 2005a; Xu Shousong 2005).

China's steel industry operates under an unusual mixture of market imperative and official direction. Even as Beijing reiterates its determination to shape the industry's development path, the growing presence of foreign-invested firms, whose small share of industry output rose from 5.5 to 10.1 percent between 1995 and 2005, underlines the expansion of market pressures. China's 2005 decision to ban foreign firms "from becoming majority shareholders in Chinese steelmakers" has not halted the entry of formidable overseas firms into China's steel sector – including POSCO's joint venture with Shagang, Japanese JFE Steel's partnership with Guangzhou Iron & Steel, Mital's purchase of a 36.7 percent stake in Hunan's Valin Steel Tube in 2005, and Arcelor's 2006 acquisition of a 38.4 percent interest in Shandong's Laiwu Iron & Steel (OECD 2006, p. 22; JFE 2006; Yu Qiao 2006).

Recent M&A transactions illustrate the mixture of market forces and official influence surrounding the steel business. Market forces presumably dominate transactions involving international firms. Commercial objectives also motivate some domestic transactions, as with Shanghai Baosteel's purchase of a 5 percent interest in Handan Steel (Hebei), possibly foreshadowing a full takeover, apparently because "Handan Steel shares are undervalued" (Yin Ping 2006). However, the hand of regulation rests heavily on such efforts. CITIC Pacific Limited, a conglomerate with exquisite political connections, announced the purchase of "a 65 per cent stake in Shijiazhuang Iron and Steel Corp., the eighth biggest steel producer in Hebei, in November 2005. Seven months later, the transaction remained in regulatory limbo (Yin and Hui 2006).

Mergers among steel-makers often reflect bureaucratic choice rather than commercial logic.[25] Reports announcing the 2005 merger between Anshan Iron & Steel Group and Benxi Steel, two of China's top ten steel-makers, originated in Shenyang, the provincial capital, rather than Anshan or Benxi, and included statements by a Vice-Minister of the National Development and Reform Commission (formerly the State Planning Commission) and the Vice-Chairman of the China Iron & Steel Association (the former Ministry of Metallurgy), but no word from leaders of either firm (Wu Yong 2005b).

With the center's policy efforts at times opposing market forces and on occasion the interests of sub-national governments as well, Beijing's goals are not easily attained, especially in the short term. The recent stampede for growth, encouraged by buoyant demand and generous bank lending, has overrun official efforts to restrain capacity

expansion and encourage industry-wide consolidation. As anticipated by national plans, putative national champions Shanghai Baosteel, Anshan, and Wuhan have expanded through mergers as well as construction. The number of large-scale producers also continues to rise: 8 firms produced over 5 million tons in 2002, accounting for 36.7 percent of total output; in 2004, the comparable numbers jumped to 15 firms and 45.0 percent. But concentration ratios have moved in the opposite direction, with the sales share of the top four firms dropping from 32 to 18.5 percent between 2000 and 2004, and the share of the top ten firms in steel output falling from 48.6 to 39.0 percent between 2000 and 2005 (Industry Report 2005, pp. 165-166; OECD 2006, p.16).

Looking forward, China's steel sector displays an unusual mix of dynamism and drawbacks. Industry leaders have recorded impressive gains in technology, quality, and product mix – all former areas of weakness – while leading a massive expansion of production. Exports of know-how illustrate these growing capabilities. Capital Steel, for example, built wire bar rolling mills in South East Asia in the early 1990s; constructed a blast furnace in India (1997-1998), erected a blast furnace and converter in Zimbabwe (1998), and, more recently, a wide plate rolling mill in Vietnam. In addition, Capital sold an automation system for blast furnace operations which it had developed in-house to a U.S. buyer during in the early 1990s.

Trends in steel production and trade illustrate the rapid pace of progress. The composition of steel output has gradually shifted from wire rod and other basic construction materials toward sheets, tubes and strips, which expanded from 30 to 42 percent of finished steel output between 1980 and 2003 (Steel Yearbook 2004, front matter). Exports, which tilted toward pig iron, semi-finished products, and ferrous alloys

until 2003/04, saw a spurt in volume and a rapid shift toward overseas sales of finished products including flat-rolled steel and hot-rolled coil, bar and rods (Steel Yearbook 2005, pp. 166-169).

The behavior of imports is of particular interest. Even as critics question the ability of domestic producers to provide adequate supplies of "high value-added products, which are insufficient on the domestic market" (OECD 2006, p.10), steep reductions in imports decisively rebut concerns over the capacity of China's steel-makers to support domestic makers of cars, appliances, and other steel-using products. Table 15.5 shows an abrupt reversal of what had been a rapid run-up in imports of flat steel, with overseas purchases retreating swiftly from the 2003 peak. For carmakers, "following the expansion of capacity for automotive steel at Baosteel, Wuhan, and Anshan and improvements in assortment and quality, net imports of automotive steel declined by 2.19 million tons, or 40.10% during 2003/2004. . . . with new facilities soon entering production, import dependence should continue to weaken" – a prediction confirmed by subsequent reductions in imports (Steel Yearbook 2005, p. 122).

Past achievements have created confidence and capabilities that enhance future development prospects. High profits bolster the industry's capacity to finance further improvements. Beneficial contributions from the unusually broad array of supporting institutions inherited from the plan era will continue. This legacy includes universities, research institutes, and design centers focused on metallurgy, domestic engineering firms specializing in steel-making equipment, professional associations that circulate technical information and provide networks that facilitate recruiting, and the web of contacts

radiating from the former Metallurgy Ministry that put Posco executives in touch with Jiangsu Shagang, eventually resulting in a fruitful joint venture.

Along with these advantages, the industry faces two difficulties: overbuilding and excessive official involvement. China's steel industry figures prominently in endless official pronouncements railing against "blind investment," warning of excess capacity for low-end products and emphasizing the consequent dangers of oversupply, price declines, and losses. In 2004, a Chinese metal consultant warned that the industry was "in dire need of a massive shake-up due to fragmentation." Two years later, the Wall Street Journal finds "China Steelmakers Poised for Shakeout" (Gong Zhengzheng 2004; Oster 2006). But with demand and profits at a cyclical peak, roaring cash flow continues to mask potential weakness.

Although the overhang of excess capacity threatens short-term financial prospects, the current capacity bulge may also represent a prelude to fuller marketization within China's steel sector. Citing work by Zhou Qiren, C.H. Kwan notes that persistent excess capacity "is typically found in industries where the monopoly power of state-owned enterprises is beginning to fade and private enterprises are aggressively trying to enter the market." As private business enlarges its investments, incumbent state-sector rivals "attempt to maintain [market] shares by expanding. . . investments" (Kwan 2006, p. 2). From this perspective, excess capacity signals a possible transition to new circumstances in which commercial results rather than official fiat become the crucial arbiter of corporate success or failure. China's textile sector, in which loud complaints of overbuilding and official efforts to compel the destruction of redundant equipment preceded a major shift toward full marketization in the late 1990s, illustrates the

relevance of these observations.[26] If steel, where we see ample evidence of overbuilding as well as official plans "to aggressively cut backward steel production capacity" and "to limit construction of new steel mills," follows a comparable path, the problem of excess capacity may fade from the policy agenda within a few years.

A potentially more serious issue concerns the limited penetration of market forces into the steel industry's core dynamics even after 30 years of reform. In 1997, visitors to Anshan Steel were told that a decision to close a blast furnace required approval from Beijing (Interview, May 1997). While managerial autonomy has surely expanded in the intervening decade, press reports make it abundantly clear that steel-makers, especially the largest firms, confront extensive official supervision.

As noted above, mergers among steel-makers often reflect bureaucratic rather than commercial priorities. Official micromanagement pushes firms to scramble for regulatory favors, as when Wuhan Iron & Steel Group purchased a controlling interest in Liuzhou (Guangxi) Iron & Steel Group to **"**help Wuhan Steel win central government approval to build a 10-million-tonne-a-year steel plant at Fangcheng Port in southern Guangxi province in order to tap demand from local units of carmakers such as Toyota." One informant suggested that this initiative could give Wuhan Steel "a winning edge over [Shanghai] Baosteel," which aspires to expand in the same region (Wuhan 2005).

As the pace of change in global steel markets accelerates, the delays embedded in official decision-making could impose substantial costs. The 2005 policy announcement mentioned above was "drafted for more than two years" (Steel Strategy 2005). While Beijing bureaucrats jousted over the details, their provincial and local counterparts

superintended the construction of redundant steel-making capacity amounting to many millions of tons.

Another shortcoming of the regulatory system is its relentless support of large incumbent firms, which are showered with bank loans, tax breaks, and other benefits, while smaller interlopers, most in the private sector, face a hostile bureaucratic environment. Thus in 2005, the government's effort to "further control steel demand. . . to prevent a resurgence of overheating investment in China's steel sector and excessive steel production" focused on "small steel makers," who "will be prohibited from making goods for overseas clients with imported iron ore, steel scraps, billets, or ingots provided by overseas clients" (Gong Zhengzheng 2005b). Such policies postpone the winnowing of weak firms and consolidation of industry resources in the hands of strong competitors that the regulators hope to stimulate. They also obstruct the development of mini-mills, which have emerged as efficient competitors in the U.S. and elsewhere, and could potentially benefit from China's rising supply of domestic scrap. This particular initiative imposed additional costs by restricting the penetration of international standards into the small-scale segment of the industry.

Despite extensive official support, the large steel complexes developed during the plan era have not kept pace. The big centers at Anshan, Wuhan, Baotou, Chongqing, and Beijing show below average increases in value-added per worker as well as considerable declines in market share since 1990. New entrants, notably Shanghai-based Baosteel, but also less heralded firms like Jiangsu Shagang, consistently outperform the older firms that planners include among the proposed centerpieces of future development. In 2005, for example, Jiangsu Shagang reported revenue figures similar to those Wuhan and

Capital Steel despite employing under ten thousand workers (vs. 56 thousand at Capital and 98 thousand at Wuhan – see Industrial Microdata for 2005). In addition, Shagang requires just under 300 kwh of power to manufacture one ton of steel in its electric arc furnaces, nearly 100 kwh less than the current national average of 380-400 kwh. Similar gaps probably exist between traditional industry leaders and aggressive newcomers, including some private firms, in places like Tangshan (Hebei), which is now capable of producing more than 15 million tons per year (Wang and Zhang 2002).

Given the immense expansion of capacity and production, excess demand for Chinese steel cannot endure for long. Whatever the trigger - global recession, Chinese macroeconomic policy, or a market-induced slowdown in domestic demand growth from the auto or construction sectors – any slackening of demand will unleash market forces with the potential to sweep away whole swathes of today's steel-makers.

But will market forces prevail? If a shakeout and consolidation in China's steel sector were to undercut the commercial viability of familiar industry leaders, would government regulators permit newcomers to overtake, acquire, or even topple firms that have occupied the commanding heights of China's economy for fifty years? The future dynamics of China's steel industry may substantially depend on the extent of official tolerance for the sort of volatility that has roiled China's home appliance and textile sectors during the past 15 years.

Machine tools. China's machine tool sector, which predates 1949 (Rawski, 1980), occupied a central focus of the pre-reform plan system and was therefore a major recipient of technical support from the USSR and Eastern Europe during the 1950s.

China's subsequent isolation from international markets hurt the domestic industry, which continued to churn out conventional products while international machine-tool makers developed new varieties of computer controlled (CNC) equipment. When Chinese demand shifted toward CNC products in the 1990s, domestic producers found themselves forced to undertake a challenging transformation of their product mix in the face of escalating competition from overseas firms, new China-based joint ventures and, more recently, wholly-owned foreign firms. The transition process continues. To date, China's leading machine-tool firms have established themselves as producers and exporters of basic CNC tools. The challenge is now to reinforce existing strengths, extend capabilities, commercialize the production of increasingly complex products, and address long-standing limitations in quality control and supply chain management.

Published materials provide a quantitative overview of production and demand: results appear in Table 15.7. We focus on "metal-cutting machine tools" (*jinshu qiexiao jichuang*), to which we apply the term "lathes."[27] In the early 1990s, there were more than 800 domestic producers primarily involved in the annual manufacture of 150-200,000 conventional or non-CNC lathes. In addition, China turned out several thousand units of CNC equipment each year, primarily basic (single spindle, double axis) CNC lathes produced by SOEs under international licensing agreements or by recently established joint ventures.[28] Output of CNC lathes was highly dispersed, with individual firms producing no more than 125-150 units per year. Imports, amounting to between five and ten thousand units annually during the early 1990s, dominated the domestic market for CNC equipment, especially for sophisticated CNC machines (multiple spindle, multiple axis). At that time, CNC equipment represented between 35 and 40% of total

domestic expenditure on lathes, while imports, including CNC and non-CNC machines, captured more than half of the entire domestic market.

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In China, as elsewhere, machine tool sales follow the business cycle. During the 1990s, China's machine-tool manufacturers were hurt by falling demand resulting from the implementation of domestic anti-inflation policy in 1993/94 and from the Asian financial crisis of 1997/98. The slowdown in aggregate demand concealed a continuing shift of domestic demand toward CNC equipment that accelerated rapidly after 1999 as a new investment boom and widespread industrial upgrading generated a prodigious appetite for machine tools from makers of cars, trucks, machinery, power plant and construction equipment, and defense-related industries (Machine Tool Yearbook 2005, p. 23). Between 1999 and 2004, domestic consumption of CNC lathes increased more than four-fold from 15,532 to 68,155 units. Over the same period, domestic sales of lathes (CNC and non-CNC) rose from US$ 2.08 billion to US$ 7.06 billion, making China the world's largest market for machine tools. Of this, sales of CNC equipment increased from 45% to nearly 65% of the total.

The experience of Shenyang Machine Tool Limited, China's largest producer of CNC equipment, illustrates both the magnitude of these difficulties and the successful response of some firms.[29] At Shenyang, the years 1994-1998 "were a difficult period," with annual revenue dropping from around RMB1 billion in 1993 to RMB500-700 million during 1994-1997 even though "demand for machine tools did not decline." The problem: "we were producing goods that faced weak demand and not producing the [CNC] goods that were in high demand." Even though the firm began to sell horizontal

CNC lathes produced in cooperation with Yamazaki, a Japanese firm, in 1995, revenue remained depressed through 1999. Thereafter, both sales revenue and the share contributed by CNC products began to rise, with revenue doubling between 1999 and 2002 and rising by a further 170 percent to surpass RMB 4 billion in 2004. Output of CNC machines topped 3,000 in 2003 and 6,000 in 2004, with revenue from CNC equipment accounting for over half the firm's total sales in both years.

Shenyang's 2005 announcement of a recall on numerical control products sold prior to 2000 underlines the firm's success in improving product quality: "President Chen Huiren said the group would give a thorough check-up, repair and even provide brand-new machine tools for customers who purchased [its] numerical control products up to five years ago. . . . [because] the group's products, especially those made before 2000, did have some design and quality problems" (Wu Yong 2005a).

Shenyang's achievement in expanding both the volume and quality of CNC products is not unique. Published reports and field visits provide clear evidence of rising capabilities among both foreign-linked and domestic firms. In 2004, fourteen firms produced over 1,000 units of CNC lathes, and six obtained 85 percent or more of sales revenue from CNC products.[30] Domestic products, including equipment from entirely domestic firms, have become highly competitive with Taiwanese and Korean imports at the lower end of the price-quality spectrum. This in turn pushes foreign producers to reduce the cost and price of basic products by expanding domestic manufacturing operations and domestic procurement of components. Thus the manager of a Taiwan-owned firm located in Hangzhou reports that his CNC products undersell imports by 20

percent, in part because 60 percent of components are sourced domestically (interview, July 2005).

Although the single spindle, double axis machine remains the "bread and butter" of domestic firms, the average "complexity" of the lathes being produced by Chinese firms is rising, with a small number of firms moving slowly into the mid-range segment of the market. Simultaneously, we observe an increase in the degree of domestic outsourcing of key components, especially on the part of recently established joint ventures, including spindles, ball-screws, and numerical controls. New opportunities for local sourcing reflect rising capabilities outside the core machine tool makers. Overseas CNC producers have also begin to outsource the manufacture of key components to these same suppliers.[31]

The key challenge for firms entering the market for these mid-range products is the large variety of models that customers may prefer. Mastering the production of each variety requires time and expense – a start-up investment before sales begin. This initial cost is very large, but declines with the number of models a firm adds to its repertoire. A well-established firm such as Japan's Okuma will have a deep catalog of mid-range machines that it can produce on demand. The difficulty facing new entrants is that revenue from early sales will fall far short of production costs, which include large initial investments in learning. This issue is not unique to China: in India, the Ace firm set out to learn how to make mid-range machines before they had any customers (Sutton, 2001). The multiplicity of sub-divisions within the mid-range category of CNC machine tools means that rapid growth of overall demand will not spare new entrants like Ace in India

or Shenyang in China from a protracted interval of high start-up costs as they work to penetrate a succession of relatively small sub-markets.

Trade data demonstrate that Chinese firms not only survived the sales declines of the 1990s, but have established a profitable niche in both domestic and international markets for basic CNC lathes. In quantity terms, domestic producers have held slightly more than half of the domestic market in the face of steeply rising market volume (Table 15.7). Exports of CNC lathes, which averaged 1172 units during 1996-2000, jumped to 13,810 units in 2004; after hovering around US$200 million for a number of years, export value jumped to US$800 million in 2005 and $1.16 billion in 2006. Steep increases in the ratio of unit values between imported and exported CNC equipment suggest that, with domestic products capturing a larger share of the market for basic products, the quality mix of imports has increasingly shifted toward high-end, specialty products. Exports remain clustered in the lower range of the price-quality spectrum.

In the upgrading process, China's machine tool producers have benefited from the persistence of a large domestic market for conventional machine tools, which in turn reflects the incomplete penetration of new manufacturing methods and the substantial domestic market for inferior goods. Production of conventional lathes reached a peak of 177 thousand units in 1993, slumped as low as 111 thousand in 1998, recovered to 174 thousand in 2001, and then rose sharply to record levels of 270 and 337 thousand in 2003 and 2004. Continued strong demand for conventional lathes furnishes a financial anchor that allows domestic market leaders to fund their development of commercially viable CNC lathes in the face of tough competition from imports and, more recently, from joint ventures and China-based foreign firms. In India, by contrast, older manufacturers of

conventional machine tools disappeared as local markets were captured by imports and by Ace, a new domestic entrant that successfully marketed basic CNC lathes (Sutton 2001).

The growing presence of joint-venture or foreign-controlled machine-tool production facilities has figured crucially in the successful transition of Chinese firms into competitive manufacturers of CNC equipment. Initial Chinese efforts to master new varieties of machine tools began with various forms of technical licensing and short-term cooperation. These efforts proved inadequate, and soon gave way to new alliances that brought deeper integration between Chinese tool-makers and leading international suppliers, with some of the larger SOEs involved in multiple ventures. This trend has spread to ancillary products, with Harbin No, 1 Tool Corporation joining Germany's PVC in a venture intended to "provide coating service for tool companies in Northeast China" (Li Fangchao 2004). The common element in this new approach is protracted face-to-face interaction between Chinese and foreign personnel. A Chinese leader at a joint venture between Beijing #1 Machine Tool and Okuma (Japan) attributed the need for close cooperation to cultural shortcomings, explaining that "customs and traditions on the Chinese side have resulted in a lower standard of quality – we have a lot to learn from Okuma" (interview, July 2005).

The same motivation stands behind the newest form of Sino-foreign cooperation, initiatives by Chinese firms to acquire foreign machine-tool makers or to establish overseas facilities. Our Beijing-Okuma informant noted that both approaches seek the same objective: "shortening the time needed to close the technological gap." Thus Dalian Machine Tool acquired the U.S. firm Ingersoll Production Systems and

Crankshaft Equipment, Inc in 2003 and the German firm F. Zimmerman in 2004. Shenyang Machine Tool purchased Schiess AG of Germany, also in 2004. Shanghai Mingjing Machine Tool purchased Ikegai, Japan's oldest machine tool maker (Machine Tool Yearbook 2005, p. 22). In the meantime, Wuxi Kaiyuan Machine Tools Group, a specialized producer of grinding machines, launched UK-based Wuxi Machine Tools (Europe) "to handle technical sales, distribution and support for [its China-made] CNC grinders in this country and continental Europe as early as 2001 (Chinese Grinder 2001).

While solidifying their position in basic CNC machines, Chinese firms are pushing to master more difficult segments within this key sector. Industry leaders seek to penetrate markets for more complex and sophisticated equipment than the basic lathes that dominate current CNC output. Joint ventures and wholly-owned foreign firms may take the lead in pushing production of more sophisticated products beyond the current experimental stage. The Beijing-Okuma joint venture, for example, has begun batch production of vertical and horizontal CNC machining centers (July 2005 interview).

The process of upgrading remains challenging. While acknowledging this sector's considerable accomplishments, equipment users and the industry's own trade association are quick to identify multiple difficulties surrounding the manufacture and operation of Chinese machine tools. Problems cluster in three areas:

- Product quality, particularly reliability, durability, and speed (rather than precision). Informants in the shipbuilding industry, for example, report that imported control systems run for 80,000 hours vs. 10,000 for domestic products, and that the mean time between failures is 800 hours for "advanced international" machine centers vs. 600 for domestic equipment (Liu Yang 2003, p.34). High speeds (in excess of 15,000 revolutions per minute) are

essential to customers in the top tier of the market, including producers of aircraft, shipbuilding and military equipment.

- Customer service, including delivery time, which is identified as a "menkan" or threshold that firms must surpass to enter the market, and after-sales service, which receives harsh criticism from many users (Machine Tool Yearbook 2002, p. 8; Liu Yang 2003, p.34).

- Exterior finish and housing, which attract criticism on grounds of appearance and safety (e.g. Zhang Caiyun 2004, p. 25).

Quality issues, in turn, reflect difficulties associated with design, manufacturing processes, and procurement. An Anhui maker of farm machinery complains that "domestic makers haven't changed their designs for years," reports difference in machines with identical model numbers and manufacturing dates, and complains of non-uniform parts (Zhang Caiyun 2004, p.25). Another report notes that over 70 percent of CNC machine breakdowns occur in the cutting tool assemblies; within this number, over 70 percent are linked to electronic components. The implication that defective components account for half of all breakdowns for CNC machines focuses attention on limitations among component suppliers, which in turn reflects "the overall development level of Chinese industry" (Liu Xia 2004, p.75).

These difficulties raise deeper questions about the organization of China's machine-tool industry, long dominated by large, vertically-integrated state-owned firms. The number of firms producing conventional and CNC lathes dropped by more than half between 1993 and 2004 despite considerable entry by private and foreign-invested firms, whose share of machine-tool sales jumped from 20.7 to 38.4 percent during 2001-2005

(Machine Tools 10FYP 2006). In 2004 there were still more than 125 firms producing CNC machines, half of which were foreign-linked joint ventures or wholly-owned foreign firms. Given the mixed outcome of domestic firms' efforts to meet rising market requirements, it is not surprising to see further consolidation among domestic producers. Recent transactions include Qinquan Machine Tools merging with Shaanxi Machine Tools, The Hangzhou Group's purchase of Changchun #1 Machine Tool, Beijing Electronics Institute Hi-Tech Ltd. taking over Beijing #2 Machine Tool Ltd., and the Shenyang Machine Tool Group's buyout of the Yunnan CY Group and acquisition of a 28 percent stake in Jiaodakun Equipment Technology Ltd. (Machine Tools 10 FYP 2006).

At present, the balance between market forces and official guidance in determining the path of restructuring for China's machine tool sector remains unclear. Efforts to develop Shenyang, Dalian, and other traditional industry leaders may reflect technical capabilities that enhance these firms' long-term prospects. Financial data, however, suggest that emphasis on large firms and state ownership may conflict with market imperatives. Table 15.8 provides information for 2005 by ownership type on firm sales, exports, and profitability. Firms with over 50 percent state ownership, and former SOEs (and a small number of former COEs) that had been corporatized were more than two times larger than FIEs and four times larger than private firms. These larger firms, however, lagged significantly in terms of profitability, measured here in terms of profits per unit of sales revenue.[32] Profits for SOEs amounted to only 2.44 percent of sales, compared to 6.65 percent in private firms, and 10.38 percent in FIEs. Forty percent of SOEs operated in the red during 2005. Corporatized former SOEs fared only marginally better, with profits averaging 3.44 percent of sales. Exports present a similar picture,

with overseas markets absorbing a much larger share of sales for both FIEs and private producers than for SOEs and other firms.

INSERT TABLE 15.8 ABOUT HERE

With this financial background, it is hardly surprising to find critics questioning "the leading role of large and medium SOEs." Skeptical accounts associate state ownership with difficulty in retaining skilled workers as well as "lack of competitiveness, weak sales ability, [and] inability to fully utilize their capacity. . ." (Zhang Caiyun 2004, p.27; Yang and Yan 2001, p. 10).

The importance of machine tools to China's military industries suggests that the government will insist on a considerable degree of state ownership despite the weaknesses associated with this form of enterprise. The future of China's machine tool industry rests on the capacity of intense competition, strong innovative efforts, and deepening integration between Chinese and international producers and markets to overcome weaknesses linked to traditions of state ownership and vertical integration.

Beer. Unlike steel, autos and machine tools, where government retains a prominent role in strategic planning and even day-to-day management, beer is an industry in which domestic and international market forces have supplanted public sector administrators as the chief determinants of industry output, structure, growth, distribution, investment, and development strategy. Local producers find themselves swept up in a tidal wave of competition, often orchestrated by distant firms, including foreign multinationals, over which their local sponsors and erstwhile protectors have virtually no influence. Competitive pressures have defeated not only local Chinese firms, but also savvy

international players, several of whom have sold out to Chinese rivals (Qi 2001). Recent market dynamics parallel the forces that have determined the beer industry's structure in major market economies, where we see an interplay between the quest for scale economies in production, and the establishment of advertising-based national brands (on the U.S. and Japan, see Sutton 1991, Chapter 14).

Until recently, China's beer market was divided among a very large number of local and regional firms, with only a single nationally recognised brand (Tsingtao). The changing economic environment of the industry has led to a series of moves that set the scene for an escalation of brand advertising that will, in all likelihood, mirror the evolution of concentration in the U.S. market.

Following the reform, rising incomes stimulated a massive expansion of domestic beer consumption. Production jumped from 690,000 tons in 1980 to 22.3 million tons (2000) and 32.73 million tons (2005). The growth rate has declined: physical output grew by 123% during 1985/90 and 127% during 1990/95, but then by 42% and 40% during 1995/2000 and 2000/2005 (Yearbook 2006, p. 550). The reason for declining growth is evident: per capita consumption jumped from 0.7 liters in 1981 to 5.4 liters (1990) and 17.6 liters (2000), and is moving toward the global average of 23 liters per year (Yearbook, various issues; Wu 1999, p. 68).

This stunning growth encouraged international beer majors to jump into the China market. Initial efforts focused on production and marketing of high-priced premium brands yielded poor results, leading several overseas firms to abandon their China ventures, at least temporarily. A second round of initiatives by foreign firms, now aimed

at purchasing partial or controlling interests in Chinese breweries and then consolidating operations while maintaining local brand identities, has achieved much better results. In the meantime, domestic market leaders have worked furiously to expand market share and consolidate control, leading to a blizzard of mergers and buyouts. Tsingtao, China's largest brewery, has led the charge. Backed by tax rebates, low-interest loans, and official encouragement, the Shandong-based firm has acquired "more than 40 breweries. . . since 1997." Tsingtao's initiatives include an alliance with U.S. beer giant Anheuser-Busch, which, according to one Tsingtao executive, will "strengthen our status in the capital market" and, "more importantly. . . sharpen our expertise in business administration and market analysis" (Wang 2002; Wei 1997; Yatsko 1996; Zhou 2002) The acquisition binge included numerous mergers with firms beyond Tsingtao's Shandong base: new plants include breweries in Xi'an (Shaanxi province) and Yangzhou (Jiangsu). Tsingtao has also built a new plant in Shenzhen (Guangdong) (Wei 1997; Yatsko 1996.) These mergers make Tsingtao into a national (rather than regional) market power. Cross-provincial mergers, formerly rare, have become more common in recent years. The underlying difficulties are reflected in a 1996 report that management "expects Beijing to push provincial governments to facilitate Tsingtao's purchase of factories in their region" (Yatsko 1996).

Efforts by rival domestic firms to expand via mergers, acquisitions and alliances with overseas firms, have resulted in a rapid concentration of ownership and control. China had 800 independent brewers in 1995/96, a figure that has already fallen to 500. Meanwhile, the top three brewers account for 30% of industry sales, while the next three have a combined share of only 10% or so. While advertising levels were modest in the

1990s, the leading firms are now moving towards more expensive TV advertising campaigns, and it seems likely that concentration will rise further as the top three consolidate their positions.

Table 15.9 provides another view of this process: between 1994 and 2000, the output share of large breweries (200,000 annual tons and up) shot up from 5 to 42 percent, while beer from small firms (under 50,000 tons per year) dropped from 58 to 23 percent of national output. Sichuan illustrates the predicament of small breweries and the dominance of large producers. Only two local firms produced over 100,000 tons in 1997. With provincial output rising by 21.5% in 1998, the largest firm, Lanjian, broke the 200,000-ton barrier in 1998 and increased production to 467,000 tons in 2000. Lanjian stands out as the province's only strong and viable brewery. Average production for Sichuan's remaining 18 breweries was less than 50,000 tons in 1998. Small firms producing under 10,000 tons "basically belong to the ranks of loss-makers." Nationwide, 37% of breweries lost money in 1997. In 1998, the proportion of loss-makers jumped to "nearly half" nationally and reached 60% in Sichuan (Tao 2000).

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With regional, national, and international giants flexing their economic muscle in China's beer markets, small firms face growing difficulty. They lack distinctive products and unusual packaging (97% of Sichuan beer comes in standard bottles). For most small firms, joining forces with a powerful business group typically offers the only hope of survival. Thus Sichuan's #2 firm, the former Mianyang Yatai Brewery, was acquired by the Hong Kong-based Huarun group, which plans to expand production capacity to 500,000 tons.

VII: How far has China come?

Industrial Structure

Figure 15.6 illustrates changes in eight-firm concentration ratios for 535 four-digit manufacturing sectors between 1993 and 2002. The data show no clear trend either toward or away from concentration within individual sectors: CR8, the eight-firm concentration ratio measuring the share of the top eight firms in sector-wide sales increased in 280 industries and declined in 249. Among sectors in which CR8 changed by more than ten percentage points, the picture is equally balanced, with 134 industries experiencing CR8 increases of over ten percentage points and 112 recording similarly large declines. Nor is there any big difference between large and small industries: CR8 rose during 1993-2002 in 48% of sectors with above-median 2002 sales 2002 revenues, and in 56% of sectors with annual sales below the 2002 median.[33]

INSERT FIGURE 15.6 ABOUT HERE

This absence of major change in concentration is the resultant of complex forces that include strong pressures for consolidation as well as major opportunities for entry. China's leaders support industrial consolidation because they believe that, in the words of Vice-Premier Wu Bangguo, China's future standing "in the international economic order will be to a large extent determined by the position of our nation's large industrial groups" (August 1998 statement quoted in Nolan and Zhang 2004, p. 234). Many officials welcome a model of national development that assigns a key role to activist government. Impressed by the past successes of Japanese and Korean industrial policy, policy-makers announced plans to create "up to 50 giant State-owned enterprises" in the

wake of China's entry into the World Trade Organization. These firms, situated in sectors like coal, steel, aluminum, shipbuilding, and engineering, qualify for "preferential policies," including "governmental financial support" and preferred access to equity markets. The objective is "to increase competitiveness of Chinese industry in the globalized market" (Fu Jing 2001, Groups 2001).

Official statements and initiatives underscore China's continuing policy tilt toward large firms and industrial concentration. Policy-makers encourage, and often orchestrate mergers that increase the size of leading firms, most visibly in the steel sector. Public documents routinely applaud concentration, as when Wu Bolin, Director-General of the China Machine Tool Association, commented approvingly that "concentration within the machine tool sector rose further. . . with sales of the ten top firms reaching 42.1 percent of total sales revenue, an increase of 10.9 percentage points." (Machine Tool Yearbook 2005, p. 22).

Mergers and acquisitions, which first appeared during the 1980s, have expanded rapidly, with "2,263 whole or partial acquisitions of China-based companies" valued at more than US$100 billion announced during 2006 (Jefferson and Rawski 2002; Batson 2007). These totals include officially-orchestrated transactions. But with policy changes reflecting "the government's determination to encourage more acquisitions," so that "market barriers are having less of a drag on M&A activity," commercially-inspired restructuring, often involving overseas corporations, occupies a large and growing share of China's market for corporate ownership (Zhang Ran 2006; Hu Yuanyuan 2006). Overseas acquisitions by Chinese firms have also grown rapidly: transactions in Europe

and North America totaled €6 billion in 2005; in 2004, Chinese firms acquired 278 German companies (Pao, Li and Tian 2006).

At the same time, China's reform policies have included a succession of official measures that encourage the formation of new enterprises and the entry of existing firms into new markets and new trades. These include allowing TVEs to expand beyond local markets, the opening of China's economy to overseas direct investment, the gradual erosion of restrictions on private domestic firms, steps toward increasing access of small firms to domestic capital markets, and new provisions enabling individuals to form corporations (Jiang Wei 2006).

Industrial Capability

There are several ways of assessing China's progress in raising industrial capabilities. We can tabulate the spread of key international standards such as the ISO among Chinese firms. Alternatively, we can benchmark performance of Chinese firms against the standards of the advanced industrial economies. Finally, we can examine 'revealed performance' by looking at the product mix of Chinese exports, and their underlying quality.

The ISO 9000 family, which focuses on systems of quality management, is among the most widely recognized international standards. In 2000 the three standards ISO 9001, 9002 and 9003 were integrated into a single new benchmark, ISO 9001:2000. Achieving ISO qualification provides important advantages for firms that aspire to break into international markets or to supply components or services to multinational corporations. At the end of 2005, a total of 776,608 firms in 161 countries had attained this standard.

Chinese firms have embraced the ISO system with gusto: beginning with a 2001 figure of 7,413, Chinese qualifiers jumped to 143,823, forming the largest national contingent, at the end of 2005. Information about ISO/TS16949:2002, a complementary quality standard for the design, development, production, installation and servicing of automotive-related products, shows similarly enthusiastic Chinese participation. At the end of 2005, 17,047 firms have achieved this certification (out of an estimated potential market of 30,000), including 2,151 Chinese firms, trailing only the United States (with 3,693 qualifiers) (ISO Survey 2005).

Turning to benchmarking, we focus in some detail at the auto-components sector, which represents an extreme case in which the incentives to adjust are very high, and the institutional setting facilitates the rapid transfer of know-how. The leading international carmakers have, over the past generation, developed and codified their own working practices in a way that has become remarkably uniform across different countries. In parallel with this, they have forged close relationships with their immediate (i.e. 'first tier') component suppliers. To become a supplier, a firm needs to achieve very high standards of quality and productivity, and liberalization of trade typically leads to the rapid shakeout of all but the most capable suppliers. There are highly effective channels for transferring international best practice. First, carmakers work directly with suppliers, or use a two-way flow of engineering personnel, in order to transfer good practice. Second, suppliers have access to international consulting firms who specialize in the transfer of the appropriate production know-how. As a result, once the main international carmakers establish manufacturing facilities in a particular region, the speed of advance in capability among first tier suppliers is extremely rapid.

In China's case, when the new wave of carmakers arrived in the 1990s, they faced a government-imposed requirement to source some 70% of their components locally (a point to which we return below). The automakers' arrival induced many international first-tier producers to form joint ventures with Chinese suppliers, so that the industry's evolution during the 1990s led to a mix of international and domestic Chinese suppliers in the industry's top tier.

A measure of the effectiveness of the transfer of capability in this context is shown in Figure 15.7, where we look at the standard measure of supplier quality (parts per million found defective by the car-maker) for 2003 at one auto assembly plant associated with a multinational carmaker. International best practice currently demands that defect rates for the general run of parts lie below 100 ppm. The observations summarized in Figure 15.7 indicate that new generation auto-makers in China already enjoy a first tier supplier base that largely meets this standard.

INSERT FIGURE 15.7 ABOUT HERE

As we move down the supply chain, however, incentives become weaker. Figure 15.8 shows the profile of a typical first tier supplier of steering gear, also for 2003. Here, the defect rates for incoming components are very high (and are measured as a percentage, rather than 'parts per million'). First tier suppliers are typically mid-size firms, and they are reluctant to invest in training their own suppliers; moreover, they are more willing than are the car makers to tolerate a higher level of product defects in return for a lower price from their own ('second tier') suppliers. The result is a much slower rate of capability building – a pattern seen also in the U.S., Japan and Europe, though in the Chinese case the gap between first and second tier suppliers is particularly wide.

INSERT FIGURE 15.8 ABOUT HERE

Subsequent plant visits indicate rapid reduction in defect rates for components delivered to first-tier suppliers. Table 15.10 provides data for 2003 and 2006 from two major first tier suppliers of braking systems, one in a coastal area, the other in an interior province. The figures show substantial improvement in both firms, particularly the coastal enterprise, for which the proportion of second-tier suppliers operating within the international standard of 100 PPM rose from 28 to 80 percent between 2003 and 2006.

INSERT TABLE 15.10 ABOUT HERE

Benchmarking of quality and labor productivity in the assembly of auto seats and exhausts provides additional measures of how far China has progressed. (Sutton 2003 provides more detail). Quality here is captured at two points: final inspection by the supplier, or the "internal" rate, and the "external" rate as assessed by the customer, with the latter typically lower than the former.[34] In the case of seats, in which production processes are very similar across countries, five of the six Chinese firms we surveyed are only slightly below the international standard of one car seat set per man-hour. The sole remaining firm actually exceeds the standard by nearly fifty percent. As for quality, five of the 6 firms achieved external rates below 100 ppm, with half reporting internal rates well below the international standard of 2000 ppm. The best Chinese seat manufacturers are producing at or near world-class levels.

The picture for exhaust manufacturers is mixed. The comparison is also more complicated, largely because of differences in product complexity and capital intensity of the production process. Chinese exhaust firms have levels of labor productivity well below the international standard, but they have only been slightly less successful than

seat manufacturers in achieving the international external quality standard. Differences in labor productivity partially reflect higher labor intensity of the production process in China, but even the more capital-intensive firms have not achieved significantly higher levels of labor productivity. However, higher capital intensity, and in particular, the use of automated and robotic welders have helped reduce metal scrap rates, a significant component of variable costs, and lowered internal defect rates.

Peter Schott's (2007) detailed examination of Chinese exports to the United States develops important findings from the perspective of "revealed performance." First, Chinese goods have expanded more rapidly across the entire product spectrum of United States imports than exports from other nations. This result holds up controlling for countries' relative endowments. Second, in the 1990s, China's exports sold at a significant discount relative to those from countries with similar income levels, and from those from OECD countries. In the 1980s, by contrast, Chinese goods had actually sold at a premium. This behavior does not necessarily signal a decline in the relative quality of China's imports however. In a separate paper, Hallak and Schott (2005) find that the decline in relative prices is insufficient to explain China's rapidly rising share of U.S. imports, and that the underlying and "unobserved" quality of China's exports must have risen as well. In other words, quality upgrading has been at work.

Our own estimates of the R&D and capital intensity of China's exports point in the same direction. We utilize here the "Annual Line of Business Report for 1977," a unique study that provides ratios for "R&D to Sales" for United States 4-digit industries for 1977. We weight each industry's share in China's total exports by the same sector's 1977 R&D intensity (or capital-labor ratio) of that sector in the U.S. in order to obtain an

estimate of the implicit R&D (capital) content of China's exports which is expressed as a percentage of the U.S. average for 1977. Changes over time will be the product of changes in the composition of China's exports to more or less R&D or capital-intensive sectors.

Figure 15.9 graphs trends in the R&D and capital content of China's exports between 1987 and 2003. In 1987, for example, the average R&D to sales ratio of China's exports was 0.90 percent. This increased only slightly through the early 1990s, but then rose by nearly fifty percent between 1993 and 2003 to 1.6 percent (Figure 15.9).[35] Similar calculations (not shown) indicate that the capital intensity of exports rose sharply between 1987 and 1994, but then leveled off.[36] Clearly, there has been a pronounced shift in China's exports, first to slightly more capital-intensive industry, and second, to those coming from more knowledge-intensive industry the last decade, which coincides with the rapid run-up in FDI in China and the growing role of foreign-invested firms. Both of these developments are likely linked to the ongoing quality upgrading of China's exports suggested by Hallak and Schott.

INSERT FIGURE 15.9 ABOUT HERE

Conclusions

During the past three decades of reform-inspired growth, Chinese industry has delivered increases in output and labor productivity that compare favorably with the achievements of previous East Asian growth spurts. The expansion of quality and variety, features notably lacking under the pre-reform plan system, is equally impressive.

Reform-induced growth has stimulated interconnected upward shifts in capability, real wages (Chapter 6, Labor, Figure 6.1), and the skill content of output and especially exports. Changes in costs and capabilities propel a continuing transformation of China's export mix from unskilled labor-intensive (garments, toys, shoes) to skilled labor-intensive (machinery) and capital intensive (including high technology) sectors. This protracted boom has powered China's emergence as a major trading nation, with exponential increases in both exports and imports reflecting the products and requirements of industrial activity.

Our analysis focuses on the process of growth rather than its quantitative dimensions, and emphasizes the impact of China's sweeping but incomplete shift from plan to market in spurring the transformation of a rising proportion of Chinese manufacturers into dynamic, profit-seeking business entities oriented chiefly to commercial signals rather than official desires.

Marketization, entry, and competition are the key forces underlying China's industrial transformation. Beginning with relaxation of controls over the sales and procurement activities of rural industry in the late 1970s, gradual and incremental steps toward market opening have cumulated into massive change. Reduced tariffs, WTO-linked erosion of import barriers, improvements in domestic transport and communication, and expanded opportunities for foreign and domestic private businesses have created an economy in which wide-open competition is pervasive. New forms of entry – by township and village enterprises, joint ventures linking Chinese and overseas firms, domestic private business, restructured state firms, share-holding companies, wholly-owned foreign companies, and, most recently, individually-owned corporations –

have steadily expanded the scope and intensity of competition in China's markets for industrial products, materials, components, workers, managers, and ancillary services.

Intense competition and the associated pressure on profitability have pushed growing numbers of firms to focus on raising productivity and upgrading the quality and variety of their products. Rising domestic incomes and increased exposure to international markets, both of which raise the "sales windows" that sellers must occupy to maintain or expand their market positions, have intensified the rush to acquire capabilities and elevated the risks confronting laggards.

Observations from many sectors document robust progress in the capacity to manufacture a growing array of internationally competitive products. At the outset of reform, Chinese firms struggled to produce color TVs from imported production lines. In 2005, four Chinese firms controlled 30 percent of global sales of color TV sets (Tang and Liu 2006). In 1982, domestic critics asked why vehicle makers were not "putting an end to the history of producing outdated products for decades without a model change" (FBIS 10-15-1982, K21). Today, domestic and global car makers prepare to ramp up exports of China-made vehicles and parts while showering domestic auto buyers with price reductions and new models amid dizzying gyrations of market shares.

The picture of generalized progress summarized in widespread references to China's emergence as "the world's factory" conceals a plethora of outcomes. The level of manufacturing capability and the timing of advances toward international competitiveness vary widely across sectors, among regions and, within specific industries, among individual firms. The evolution of individual sectors reflects an array of industry-specific factors as well as economy-wide trends such as rising real wages and household

incomes, expanding openness to international trade and investment, and the growing ascendancy of market forces. The circumstances that vary across industries, or even within specific sectors, include the legacy of plan-era development, global technology trends, the extent of foreign trade and investment, the nature of industry-specific institutions, and the degree of official involvement in strategic decisions.

Although market economy experience leads us to anticipate a pattern of industrial growth in which bursts of entry give way to periods of consolidation that allow strong firms to accumulate market share by eliminating or absorbing weak rivals, differences in the circumstances confronting various sectors lead to wide variation in the pace and timing of changes in industrial structures. The past 15 years, for example, witnessed rapid increases in concentration among manufacturers of home appliances and beer, while cars and steel both experienced an upsurge of entry.

Cross-industry variations in the pace and timing of entry and consolidation create a kaleidoscopic outcome. Small firms are rapidly disappearing from some industries (beer, home appliances) but not others (steel). In home appliances, most of the large players are newcomers established during the reform era. In auto manufacture, the present structure encompasses both new (mostly international) and long-established firms. Today's market leaders in steel and machine tools include firms whose national prominence dates from the 1950s.

Official policy is one important determinant of sectoral development. Although the role of market forces has expanded, the impact of government intervention varies dramatically across industries. Officials now accept market outcomes in sectors like beer, textiles, and garments that have little strategic technology and only modest state-sector

involvement. But in sectors that are perceived as occupying the "commanding heights" of China's economy, official agencies at the national (and sometimes provincial or even local) level deploy a variety of instruments, including appointments, approvals (*pizhun*), tax holidays, interest-rate forgiveness, and direct intervention to influence major business decisions involving entry, investment, mergers, technology selection, and supply chains. Officials are keenly aware that the lure of access to China's flourishing domestic market enables them to extract concessions from foreign investors – for example regarding technology transfer or location of R&D activity – that smaller or less dynamic economies could not hope to obtain. Aside from foreign investment, official intervention in negotiations surrounding the price of imported iron ore, efforts to curtail investment in sectors seen as overbuilt, and government direction of mergers and corporate structures in steel, coal, aluminum, tobacco, and machinery, among others, illustrate how official involvement extends beyond the regulatory regime typical of major market economies.

The range of industries subject to intense government management has experienced a slow decline that has cumulated into dramatic change. Marukawa's (2001) study of China's television sector shows how the emergence of a buyer's market following episodes of excess entry can tip particular sectors toward market dominance. Excess supply may force producers into a scramble for markets that sweeps official regulations to the side. It is easy to imagine similar circumstances affecting China's steel and auto sectors, among others, following some future slowdown in demand.

Documentary sources indicate, and field research confirms the key contribution of international links to the advance of manufacturing capabilities. Information showing that foreign-invested firms regularly transact over half of China's exports and imports

demonstrates the vital role of direct foreign investment and the associated transfers of technology, production and organizational skills, managerial know-how, and marketing expertise. While access to low-cost labor motivated the initial phase of foreign investment, recent investments increasingly reflect the desire of global businesses to serve China's domestic market, to integrate Chinese operations into transnational production networks, and to tap China's abundant supplies of skilled workers, technicians, and engineers. Foreign-invested firms push both rivals and domestic suppliers toward higher standards. The experience of working with, observing, or competing against foreign firms enhances the knowledge and skill of managers, engineers, researchers, and workers across wide swathes of Chinese industry, raising both current and future productive potential.

Direct foreign investment and exports from foreign-linked firms cluster along China's eastern seaboard. During the past three decades, multiple advantages have permitted the China's coastal provinces to develop ahead of interior regions. In addition to the stimulus arising from deepening links to the global economy, coastal areas draw on their rich heritage of historic involvement in both domestic and overseas commerce. Ironically, China's seaboard now benefits from its limited access to large-scale investments under the pre-reform planned economy. This translates into a relatively small share for the state sector, which reduces legacy costs and enhances policy flexibility in comparison with interior regions burdened with large clusters of state-owned enterprises.

The importance of foreign links and the differential advance of coastal areas highlight the limitations of China's industrial boom. Even though China's open trade

policy has exposed nearly all sectors of manufacturing to the challenge and discipline of international competition, many enterprises, particularly those located in interior regions, lag far behind domestic and international best practice. Official efforts to shield client firms and their employees from the rigors of market competition, though diminishing, continue to obstruct the process of upgrading by blunting incentives and prolonging the lives of uncompetitive firms. In addition, the gains of high-performance firms cluster within the realm of production; industry has recorded much smaller advances along other segments of the industrial value chain, including R&D, design, product development, branding, and management of supply networks.

Chinese executives, researchers, and policy-makers are mobilizing to address these shortcomings. Accelerated privatization of state-owned firms, especially at the local and provincial levels, along with continuing reform of the financial system, promises to extend the reach of market forces. Expanding the development of non-production capabilities has become a major focus of industrial strategy. After quoting one specialist's view that "Chinese carmakers are simply cheap assemblers employed by foreign auto manufacturers, which is why they have barely any of their own core technologies," a 2006 report indicates that domestic car-makers, "acutely aware of the bind they are in. . . have begun developing their own brands." Thus Shanghai Automotive Industry Corp., in addition to its partnerships with Volkswagen and General Motors, "plans to spend more than 10 billion yuan (US$1.2 billion) on the development of 30 models by 2010" (Gong Zhengzheng 2006). Accounts of China's television manufacturers tell the same story: steep output increases, advances in low-cost production with no control over core technologies, leading to big investments in new

plants and in R&D intended to push Chinese firms into the ranks of advanced international producers (e.g. Tang 2006).

Ongoing domestic reform facilitates deepening engagement with global markets, and therefore promotes continued upgrading and capability-building among Chinese manufacturers. New legal provisions encourage novel forms of entry on the part of foreign firms, which can now operate fully-owned entities without domestic partners and can also acquire ownership stakes in existing Chinese firms (rather than forming joint ventures with specially-created subsidiaries of Chinese firms). Increased control over China-based facilities encourages overseas firms to expand the range of technologies and products transferred to their Chinese operations. It also accelerates their participation in China-based research and design activities, a trend already encouraged by the expanding supply of well-trained and modestly-priced Chinese university graduates. Erosion of entry restrictions is also visible on the domestic side, as barriers to the creation and expansion of private manufacturing continue to fade and investments across regional boundaries, formerly discouraged by local governments, are now seen as welcome enhancements to capital and employment.

Recent advances in Chinese manufacturing, although costly, uneven, and often foreign-led, are noteworthy both for their large scale and for the strong momentum that overwhelmed seemingly powerful obstacles, including intrusive and capricious regulation, extensive corruption, and weak systems of law, management, finance, and corporate governance. Looking forward, we anticipate continued expansion and deepening of manufacturing capabilities in the foreign-linked coastal regions that have dominated China's initial achievements, now bolstered by fresh impetus originating in China-based

R&D operations of both multi-national and domestic firms, and new streams of upgrading and innovation arising from the expansion of domestic and cross-border mergers and acquisitions, the spread of capabilities across sectors and regions and the overseas expansion of Chinese manufacturers.

Capitalizing on the potential to extend China's manufacturing boom calls for rolling back a variety of constraints. Expertise in supply chain management has emerged as a key determinant of performance in manufacturing. The development of tightly organized and well-managed supply chains contrasts starkly with the extreme vertical integration inherited from China's pre-reform plan system. Figures 15.7 and 15.8, which show wide performance gaps between first- and second-tier suppliers of auto components, illustrate both the achievements and the shortcomings of supply chain management.

Differential development of supply chains contributes to the large and growing gap separating industrial performance in coastal and interior regions. Field research shows that manufacturers in interior regions experience difficulty in securing reliable local suppliers. Managers at a leading maker of auto parts were only able to produce products that were less "quality-demanding" in their inland facility, in part because highly-qualified employees refuse assignments in interior locations. They also report that efforts to raise standards encounter broader cultural obstacles at interior plants, even though they regularly use workers from these same provinces to staff their superior coastal plants. Field visits reveal distinct regional differences in business capabilities and entrepreneurial energy, with industrial executives in Shaanxi province, for example, repeatedly commenting on their own firms' poor sales performance and indicating their

unwillingness to explore initiatives undertaken elsewhere by "southerners" (*nanfangren* – referring to inhabitants of central and southern coastal regions).

Regional differences are connected to a broader array of shortcomings arising from the plan era. Researchers observe negative links between high shares of state ownership, a common feature of China's interior regions, and a variety of desirable outcomes. State ownership magnifies weak elements in China's political economy: slow exit of faltering firms, ill-considered investment decisions leading to elevated levels of bad debt and financial risk, and limited development of markets for corporate ownership and control.

Broader institutional weaknesses, of which corporate governance, limited contract enforcement and weak intellectual property rights provide particularly relevant examples, also endanger future growth, especially in sectors that build on the accumulation and exchange of advanced technologies.

The remarkable accomplishments of Chinese industry since the start of reform, together with the confidence and optimism associated with past success create strong forward momentum. However, Japan's rapid shift from industrial juggernaut to prolonged stagnation, which arose from institutional weaknesses not unlike those that afflict China today, demonstrates that past success cannot ensure future prosperity. China's achievements have initiated a dynamic response from manufacturers above and below China in current world rankings of labor costs and technical sophistication. With global restructuring of entire industrial value chains poised to accelerate, future Chinese growth must depend on ongoing efforts to promote reform, upgrading, and consolidation. Chinese business and government leaders understand that past attainments provide no

guarantee of future success. This awareness encourages us to anticipate further rapid development of Chinese manufacturing, with capability-building and international competitiveness spreading to a growing array of industries during the coming decades.

Chapter 15 References

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NOTES TO CHAPTER 15

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[1] Fifty Years (2000, p. 16) shows 377,300 firms at and above the township level in 1980, to which we should add 558,700 firms operating at the brigade (*shengchan dui*) level (TVE Yearbook 1986, p. 12). Data for 1995 from Industry Census Summary 1996, p.3.

[2] Huenemann finds that finds that standard transport data "fail to capture a significant portion of the traffic, and the problem seems to get worse" during the 1990s (2001, p. 372). Rawski and Mead (1998) and Rawski (2005) also discuss the underestimation of transport volumes. Qi (2006) shows that disaggregation undermines the finding of limited capital market integration reported by Boyreau-Debray and Wei (2003).

[3] An early formulation of this idea appears in Rawski 1975b.

[4] China's pre-reform system, with its weak competition, segmented markets, low incomes, excess demand, and product prices set to allow mediocre firms to cover costs, ensured that most suppliers faced low thresholds and wide sales windows. Customers willingly accepted a wide range of products – including goods with "small defects." In the 1990s, for example, occupants of new housing provided by the Chinese Academy of Social Sciences immediately replaced the (defective) electrical switches installed by the builders.

[5] China's Haier Group, which used its expertise and reputation in refrigerators as a springboard to enter markets for air conditioners and televisions, provides an apt Chinese illustration.

[6] To illustrate this point, consider the case of a large number of cement plants arranged along the coastline from north to south. A fragmented market structure might involve each plant being owned by a different firm; if however, every second plant is acquired by a single firm, so that each competes only with the same independent local rivals as before, the (price) equilibrium in the market is unaffected, and the new form of market structure is viable and stable, just as was the old 'fragmented' structure.

[7] Printing equipment, a new industry in the 1950s, had spread to 21 provinces by 1980 (Machinery 1983), p. 89. Li Chengrui, a prominent Chinese economist, commented in 1975 that China's regions "all want to speed up production in their own area" and therefore "argue for large state investments in their own provinces" for every sector (Perkins et al 1977, p. 276).

[8] In China, rising incomes and export expansion tended to raise the lower threshold of sales windows, thus multiplying pressures on low capability firms

[9] Mechanisms I and II can be described as follows: as more firms enter the 'window', the lower threshold rises. Moreover, the incentives for firms to raise their investments in 'capability building' also rise: so that the top of the window (defined by the highest

capability attained by any firm) also rises. In other words, the process of entry pushes up the window. While these remarks relate to a single ('closed') economy, the same idea carries over to a multi-country setting: as a new country joins the global market, its firms 'enter the window', and the window itself shifts upwards – rendering some hitherto viable firms elsewhere non-viable. It is worth noting, finally, that having low wage rates in the 'entrant' country reduces the relevant threshold of capability that its firms must attain, but this effect can only partially offset shortenings in quality: even if wage rates become arbitrarily low, the fact that manufacturing firms need some bought-in inputs fixes a lower bound to their marginal costs of production – and this in turn implies that once quality falls below a certain threshold, the firm cannot achieve any positive sales at equilibrium.

[10] How wide, then, is the window? It turns out that it depends not only on the two parameters introduced in Figure 15.2, but also on (a) the nature ('toughness') of price competition in the market, and (b) the range of buyers' 'willingness to pay' for quality. In particular, if there are some customers who are indifferent to quality, and are concerned only with price, then an arbitrarily large fringe of low-cost, low-quality firms may be viable (see Sutton 1991, Chapter 3 for an example).

[11] Data in this paragraph come from interviews and from a variety of published reports.

[12] Chinese data on the textile sector (*fangzhi gongye*) typically include the manufacture of artificial fibers and yarn; production, dyeing and printing of fabric; and the manufacture

of garments, accessories (ribbon, rope, cord), shoes, hats, and textile machinery. Textile Report 2005, pp. 350-351 provides an English-language list of the major sub-sectors. Our focus here is on the manufacture of fabrics ("textiles" or "textile industry") and garments. A further complication arises because, starting in 1998, standard data exclude small firms with annual sales below RMB 5 million..

[13] The decline in SOE numbers is the result of aggressive government-led restructuring of textile SOEs entailing privatization and bankruptcy, as well as merger and acquisition. Data on SOE numbers and profitability from Textile Report 2000, p. 236 and Textile Yearbook 2000, p. 130 (for 1999) and from Textile Report 2005, p. 324.

[14] Commissions for intermediaries typically run 1 percent of sales. With 2005 profits averaging 4.0% of sales in spinning and weaving and -3.5 percent of sales in Shaanxi's textile sector (Textile Report 2005, pp. 336, 338, 344, 352), this firm's reliance on intermediaries probably represents a considerable charge against earnings.

[15] Results calculated from UNCOM trade data. Between 2000 and 2004, China's share of U.S. apparel imports increased even further to 26.8 percent, while the ratio of unit values fell to 1.01. The falling ratio of unit values may reflect an increase in lower quality imports from China following the removal of import quotas which provided incentives for exporting higher value goods. According to Evans and Harrigan (2004)**,** 74 (57) percent of China's apparel exports to the US in 1991 (1998) were under binding quotas.

[16] High-end imports constitute a third market segment, which we omit from this discussion.

[17] These indicators represent industry-wide consumption divided by steel tonnage rather than direct consumption in steel smelting.

[18] See http://www.sas.com/success/shanghaibaosteel.html
and http://www.uksteel.org.uk/nw49.htm, both accessed 8 June 2006.

[19] China Industrial Microdata is an annual compilation of enterprise-level data prepared by China's National Bureau of Statistics. Beginning in 1998, these materials are limited to state-owned enterprises and other firms classified as "above designated size" (*guimo yishang*), i.e. with annual sales above RMB5 million. In 2005, included firms accounted for 74.1 percent of industrial employment; the same source shows larger values of gross output and "revenue from principal business" (*zhuying yewu shouru*) for the included firms than for the entire industrial sector, indicating some unexplained difference in concept or scope (Yearbook 2006, pp. 505, 510, 513).

[20] See http://chinadataonline.org/member/hygk/hygkmshow.asp?code=32, accessed 30 January 2007. This source reports steel-makers' earning monthly profits of RMB 104 billion in both December 2004 and December 2005. However the annualprofit totals in this source, RMB629 billion for 2004 and 749 billion for 2005, conflict with the smaller profit figure of RMB 106.7 billion for 2005 shown in Yearbook 2006.\, p. 513. Although

this conflict raises questions about the monthly figures, the seasonal profit pattern remains credible.

[21] In the lower panel of Table 15.6, we classify 231 firms as "state owned" because "state capital" amounted to 50 percent or more of paid-up capital. The upper panel reflects yearbook data that places the number of state-owned firms at 407 (Yearbook 2006, p. 520).

[22] This was the sixth EAF installed worldwide by Fuchs, and its first in China. It has now installed a total of 11.

[23] The others are Shanghai Baosteel and Taiyuan Steel.

[24] The difference between the 2005 estimate of 52 percent and the lower figure in Table 15.6 probably reflects differences in the definition of the state sector. In Table 15.6, firms with more than 50 percent of paid-in capital from state funds are classified as SOEs. The higher SOE output share provided by the Iron and Steel Industry Association may include firms in which the state holds a "controlling" ownership share below 50 percent, as well as corporatized firms in which the state or a state institution is the major shareholder.

[25] OECD 2006, pp. 17-19 maps out recent mergers involving China's largest steel firms.

[26] Egan 1999 summarizes the structure and policy environment of China's textile and garment sector as of the late 1990s.

[27] In addition to lathes, the machine tool sector includes machines that grind and shape metals as well as woodworking equipment.

[28] For example, Baoji Machine Tool Works began producing limited quantities (under 150 units per year) of CNC lathes in the mid-1980s under a series of licensing agreements, first with Daewoo (Korea) and subsequently with Daikin (Japan); Beijing #1 Machine Tool started much later under a licensing agreement with Japan's Okuma, their future joint venture partner (Interviews, July 2005).

[29] Material in this paragraph comes from an August 2004 interview and from the 2004 and 2005 editions of the Machine Tool Yearbook.

[30] Machine Tool Yearbook 2005, pp. 6, 22. These figures pertain to members of an industry association and may therefore not be comprehensive.

[31] Personal communication from the president of a leading North American machine tool manufacturer.

[32] Profitability estimates based on the rate of return to assets, or profits divided by assets, paint a similar picture.

[33] Results based on Industrial Microdata for 2002. We focus on 1993-2002 because the industrial classifications used in Chinese statistics remained virtually unchanged during this period.

[34] Reworking or scrapping of defective products underlies the lower external rate.

[35] Both Schott's analysis and our own calculations produce results that seem likely to run ahead of the R&D intensity of domestic export production. The shift of assembly work for laptop computers and other products employing sophisticated imported components will lead the measured R&D content of exports to rise more rapidly than the R&D content of value added in domestic export production.

[36] We performed similar calculations for China's imports, which are significantly more R&D intensive than her exports, e.g. 1.7 versus 0.90 in 1987. Up through 1997, the R&D intensity did not rise, but the ensuing 6 years showed a marked increase. In 2003, the R&D to sales ratio was 2.6. The capital intensity of China's imports, however, has remained relatively constant, albeit higher than for exports.

Table 15.1

Chinese Industry in 2002: 15 Sectors Receiving Largest FDI Inflows (percent)

Manufacturing Sector

	Sector Share of Industry FDI	Export Share of Sector Output	FIE Share of Sector Exports	Sector Share of China's Industrial Exports
Instruments and meters	10.64	30.45	93.83	13.11
Electronics and telecommunications	7.88	32.16	91.12	19.01
Medical and pharmaceutical	7.03	9.11	56.34	3.42
Transportation equipment	6.50	6.55	64.03	2.78
Non-metal mineral products	6.14	14.75	76.48	2.74
Ordinary machinery	5.56	18.82	58.13	4.66
Garments	5.07	45.93	61.40	10.63
Beverages	4.30	4.76	58.93	0.48
Textiles	3.52	27.16	50.41	5.54
Paper products	3.37	8.84	77.85	0.86
Electric equipment and machinery	3.35	16.25	81.84	2.79
Food products	3.24	23.26	60.42	2.42
Smelting-Rolling of Ferrous Metals	3.15	7.87	49.13	2.41
Metal products	2.73	19.60	84.80	2.18
Plastics	2.18	17.30	79.19	1.44
Average	4.98	18.85	69.59	4.96
Total for top 15	74.66			74.47

Source: China Industrial Microdata for 2002

Coverage includes the entire state sector and other firms with annual sales in excess of RMB5 million (about US$600,000).

Table 15.2
Chinese Production of Home Electric Appliances
(Million units)

Year	Color Televisions	Refrigerators	Washing Machines	Air Conditioners
1978	0.004	0.03	0.0004	0.0002
1985	4.35	1.45	8.87	0.12
1990	10.33	4.63	6.63	0.24
1995	20.58	9.18	9.48	6.82
2000	39.36	12.79	14.43	18.27
2005	82.83	29.87	30.36	67.634
	Eight-firm Concentration Ratios CR8			
2000	54.1			
2002	47.7	82.0	72.4	35.1

Source: Output data from Yearbook 2006, p. 561; Concentration ratios calculated from data in *China Markets Yearbook*, 2001 and 2004 and from China Industrial Microdata for 2002.

Table 15.3
Overview of China's Textile and Apparel Sector, 1980-2005

	1980	1985	1990	1995	1997	2000*	2005*
Number of firms	37,900	46,700	83,800	102,500	79,200	20926	35,978
Employment (million)	5.02	9.46	12.43	12.43	10.65	8.11	9.78
Gross Output Value (RMB billion)	88.5	149.2	373.5	839.7	963.2	878.6	1625.0
Share of aggregate GVIO (%)	17.7	18.0	16.2	12.6	12.9	10.3	6.5
Exports (Billion $US)	3.6	5.5	12.5	38.0	45.6	49.4	117.5
Share of total exports (%)	19.8	20.2	20.1	25.5	24.9	19.8	15.4
Apparel share in sector exports (%)	37.4	38.7	40.9	63.2	69.7	68.8	62.6
Textile exports as % of world textile exports	4.6	6.2	7.5	11.7	13.7	14.7	24.1

* Data for 2000 and 2005 exclude firms with annual sales below RMB 5 million.

Source:
For 1980-1995: Shi Yuzhi 2001, p.67.
For 2000: firms, output, employment from Industry Yearbook 2001, pp.48, 49, 53
Export data from Yearbook 2001, pp. 589-590.
For 2005: Textile Report 2005, pp. 3, 4, 360, 364; Yearbook 2006, p. 516.
China share of global textile exports (including clothing) calculated from trade data posted at
http://stat.wto.org/StatisticalProgram/WsdbExport.aspx?Language=E
accessed 24 January 2007.

GVIO = Gross Value of Industrial Output (current prices)

Table 15.4
China's 1995 Output And Exports Of Textiles And Apparel, Classified By Ownership Of Producers
(RMB billion, current prices)

	Textile					Apparel					Totals	
Ownership	GVIO	Share of Total	Exports	Share of Total	Export Ratio	GVIO	Share of Total	Exports	Share of Total	Export Ratio	GVIO	Exports
SOE	1825.2	0.31	508.1	0.31	0.28	102.1	0.05	32.17	0.03	0.31	1927.34	540.26
JV	824.1	0.14	369.9	0.23	0.45	737.3	0.37	498.8	0.45	0.68	1561.35	868.72
COE	1852.2	0.31	388.7	0.24	0.21	631.9	0.31	285.3	0.26	0.45	2484.10	674.00
TVE	1382.8	0.23	374.4	0.23	0.27	547.9	0.27	286.4	0.26	0.52	1930.70	660.80
Total	5884.3	1.00	1641.1	1.00	0.28	2019.2	1.00	1102.7	1.00	0.55	7903.49	2743.78

Source: publications from 1995 Industrial Census

Note: data shown here reflect the "new" definition of gross output value (GVIO)

GVIO = gross value of industrial output
JV = joint ventures (between foreign and Chinese firms)
COE = urban collective enterprises
TVE = Township and village enterprises

Table 15.5

China Steel Overview: Production, Employment, and Trade

Year	Number of Firms	Crude Steel Output Mill. Tons	Sectoral Employment Millions	Output per Man-year Tons	International Trade in Finished Steel Million Tons			
					Imports		Exports	
					Total	Flat Products	Total	Flat Products
1978		31.8	2.14	14.9	8.6	4.0	0.3	n.a.
1980	1332	37.1	2.44	15.2	5.0	1.6	0.5	n.a.
1985	1318	46.8	2.68	17.5	19.6	5.7	0.2	n.a.
1990	1589	66.4	3.15	21.1	3.7	1.9	2.1	n.a.
1995	1639	95.4	3.42	27.9	14.0	6.8	5.9	3.7
2000	2997	128.5	2.52	51.0	15.6	14.1	5.4	3.5
2001	3176	151.6	2.32	65.3	17.2	14.9	4.7	1.8
2002	3333	182.4	2.39	76.2	24.5	21.2	5.4	1.8
2003	4119	222.3	2.56	86.8	37.2	33.2	7.0	5.2
2004	4992	282.9	2.61	108.4	29.3	25.1	14.2	5.8
2005	6604	353.2	2.81	125.7	25.8	22	20.5	8
2006	6639	418.8	2.80	149.6	18.5		43.0	

Sources:

Output and trade data for 2006 from Crude Steel 2007; output for prior years from Yearbook 2006, p. 562

Number of firms from Steel Yearbook 2005, p.145; ibid. 2003, p.139; for 2005 and 2006, China Data Online (below)

Employment data for 1980-2000 from Steel Compendium 2003, 1: 123
for 2001: Lee, Ramstetter, and Movshuk 2005, p. 119.
for 2002, calculated from data in Yearbook 2003, pp. 468, 473.
for 2003 and 2004, from Yearbook 2004, p. 521; Yearbook 2005, p. 491.
2005 (December) and 2006 (March) data from
http://chinadataonline.org/member/hygk/hygkmshow.asp?code=32).
accessed 30 January 2007

Imports and exports of finished steel for 1978: Yearbook 1989, pp. 378, 381.
aggregate data for 1980-2000 from Steel Compendium 2003, 1: 167, 171.
aggregate data for 2001-2005 from Yearbook 2004, pp. 664, 667; 2005, pp. 637, 639; 2006, pp. 745, 748.
data for flat steel products from Steel Yearbook 1986, p.529; 1991, p.304;1996, p. 103; 2001, pp. 145, 148;
2003, pp. 164, 167; 2005, pp. 410; 2005 data from OECD 2006, pp. 9-10.

Table 15.6

Ownership Structure of China's Steel Industry in 2005

Category	Firms	Ownership Shares in Industry-wide Results					Indicators of Firm Size, Productivity & Profitability					Percent of Firms Making Losses
		Number of Firms	Value Added VA	Labor L	Fixed Assets NVFA	Profits Π	Workers per firm	VA/L RMB 1000s	NVFA/L RMB 1000s	Profit as Percent of Sales	Profit as Percent of Total Assets	
All Firms*	6649	100	100	100	100	100	422	205.9	238.4	4.8	5.5	26.0
SOE	249	3.7	42.0	38.2	51.7	55.3	4149	229.1	333.0	6.9	6.3	30.1
FIE	313	4.7	9.7	5.7	8.3	10.3	387	415.1	445.4	4.7	5.9	29.5
Private	3837	57.7	18.7	25.1	11.1	10.8	183	154.4	104.2	2.6	4.3	25.0
Residual #	2251	33.9	29.6	31.0	28.9	23.6	421	192.2	207.5	3.7	4.8	26.7

Results for firms ranked in decending order of total profit for 2005

Average Profit Rate (and percentage of loss-making firms)

Ownership		Iron Smelting	Steel Smelting	Steel Rolling	Ferrous Alloys	Total
SOE	profit rate	1.94	6.79	7.16	0.38	6.89
	percent Π< 0	27.7	30.8	22.1	50	30.1
FIE	profit rate	-1.11	8.33	4.08	2.1	4.68
	percent Π< 0	35	25	28.3	43.8	29.5
Private	profit rate	1.8	2.42	3.2	0.76	2.61
	percent Π< 0	29.3	30.7	16.4	44.4	25
Residual #	profit rate	4.95	2.79	3.86	1.81	3.65
	percent Π< 0	27	25.8	18.3	41.8	26
Total	profit rate	3.12	4.73	5.14	1.24	4.76
	percent Π< 0	28.6	28.1	17.9	43.5	26

* Excludes non-state firms with annual sales below RMB5 million

Residual category includes shareholding and collective enterprises.

Note: Profit rate is the sales-weighted average of profits measured as a percentage of sales revenue.

Source: Calculated from China Industrial Microdata for 2005.

Table 15.7
Production, Consumption, Trade and Pricing of Lathes, 1996-2006

	1996	2000	2001	2002	2003	2004	2005	2006
Number of domestic producers	n.a.	n.a.	382	410	391	388	376	n.a.
Employment	n.a.	208634	195900	190734	177118	172932	164000	n.a.
PHYSICAL UNITS								
Production	177400	176598	192109	231951	306848	389284	451456.15	n.a.
of which CNC	8100	14053	17521	24803	36813	51861	59639	n.a.
Consumption	146790	158417	190069	231501	282989	311000	n.a.	n.a.
of which CNC	16910	23480	28535	39982	52383	68155	n.a.	n.a.
Imports	52840	63444	61114	75959	75338	65411	n.a.	n.a.
of which CNC	10000	11155	13208	18276	23320	30104	37135	n.a.
Exports	83450	81625	63154	76409	99197	143695	n.a.	n.a.
of which CNC	1190	1728	2194	3097	6750	13810	n.a.	n.a.
VALUE TOTALS (US$ Billion)								
Sales of Domestic Producers	1.19	1.56	1.88	1.79	2.30	4.15	5.1	7
of which CNC	0.18	0.49	n.a.	n.a.	0.74	1.36	2.18	n.a.
Consumption	2.64	2.57	3.29	3.60	4.89	7.06	10.8	12.9
of which CNC	1.12	1.27	n.a.	n.a.	2.87	n.a.	n.a.	n.a.
Imports	1.48	1.25	1.64	2.08	2.91	3.43	6.5	7.1
of which CNC	0.93	0.81	1.10	1.45	2.18	n.a.	n.a.	n.a.
Exports	0.21	0.25	0.23	0.26	0.32	0.24	0.8	1.16
of which CNC	0.02	0.03	0.04	0.03	0.06	0.10	n.a.	n.a.
Import Share in Absorption (%)*	60.2	48.7	49.8	57.6	59.5	46.8	60.2	54.9
Unit Value CNC Imports ($US)	93400	72972	83586	79558	93396	113972	120399	n.a.
Unit Value CNC Exports ($US)	18487	19676	16317	11172	8148	7531	n.a.	n.a.
Ratio of unit values Import:Export	5.1	3.7	5.1	7.1	11.5	15.1	n.a.	n.a.
Unit Value of CNC domestic sales by domestic Producers	22927	36998	n.a.	n.a.	22937	33008		

Sources: Machine Tool Yearbook and World Survey, various years; Machine Tool 10FYP 2006; Machine Tool Imports 2006
* Imports divided by domestic production + imports - exports.

Notes: CNC Consumption in US collar terms for 2000 and 2003 calculated from other data within the table.
CNC Production U.S. dollar terms calculated from percentage share of total output for 1996, 2002, 2003.

Table 15.8
Summary Information for Lathe Manufacturers, 2005

Firm Type	Number of Firms	Average Sales (Mill. RMB)	Exports as percent of Output	Profits as percent of Sales	Percentage Breakdown by Ownership		
					Sales	Exports	Profits
SOE	85	142.3	6.31	2.44	26.93	20.66	14.58
FIE	67	73.05	24.93	10.38	10.68	33.58	24.99
Private	222	33.03	12.56	6.65	16.12	24.7	24.27
Other	126	169.74	3.72	3.44	46.27	21.06	36.16
Average		91.27	8.2	4.43	100	100	100

Notes:
SOEs are defined to be firms in which 50% or more of ownership is by the state; A similar definition applies to FIEs and private firms. "Other" is a residual category consisting largely of corporatized firms with "legal person" or "faren" shareholders holding majority ownership.

Source: China Industrial Microdata for 2005

Table 15.9

The Scale of Beer Producers in China, 1994-2000

Number of Firms and Output Share in by Firm Size

		1994	1995	1996	1997	1998	1999	2000
Number of Firms		655	656	589	550	495	474	495
Average Size (1000 tons)		21.6	25.1	30.6	34.3	40.2	44.3	45.1
Above 200,000 tons	Number	3	7	8	13	18	19	20
	Share (%)	**5.4**	**12.1**	**14.5**	**21.4**	**31.3**	**35.2**	**41.8**
100,000 —200,000 tons	Number	21	23	28	28	26	25	26
	Share (%)	19.9	18.6	21.8	20.9	17.1	17.1	16.7
50,000 —100,000 tons	Number	36	44	47	57	60	62	60
	Share (%)	16.6	19.1	18.2	20.1	21.2	21.1	18.9
Below 50,000 tons	Number	595	552	206	452	391	368	389
	Share (%)	**58.1**	**50.2**	**45.5**	**37.6**	**30.4**	**26.6**	**22.6**

Source: Light Industry Yearbook, 1995-2001.

Table 15.10

Defect Rates for Suppliers to Two First-tier Manufacturers of Braking Systems

Percent of Suppliers in Achieving Various Defect Rates

Location	Coastal		Interior	
Year	2003	2006	2003	2006
PPM	% of Firms	% of Firms	% of Firms	% of Firms
< 50	8	58	5	30
50-100	20	22	7	10
100-300	21	5	8	15
300-500	22	10	25	15
500-1000	14	1	14	10
1000-2500	9	4	18	8
2500-5000	6	0	8	4
5000+	0	0	15	8
Average PPM	634.5	158.5	1967.5	1070

Source: 2006 interviews.

Figure 15.1
Asian Growth Spurts: Real Growth of Secondary-Sector Value-added Over 26 Years

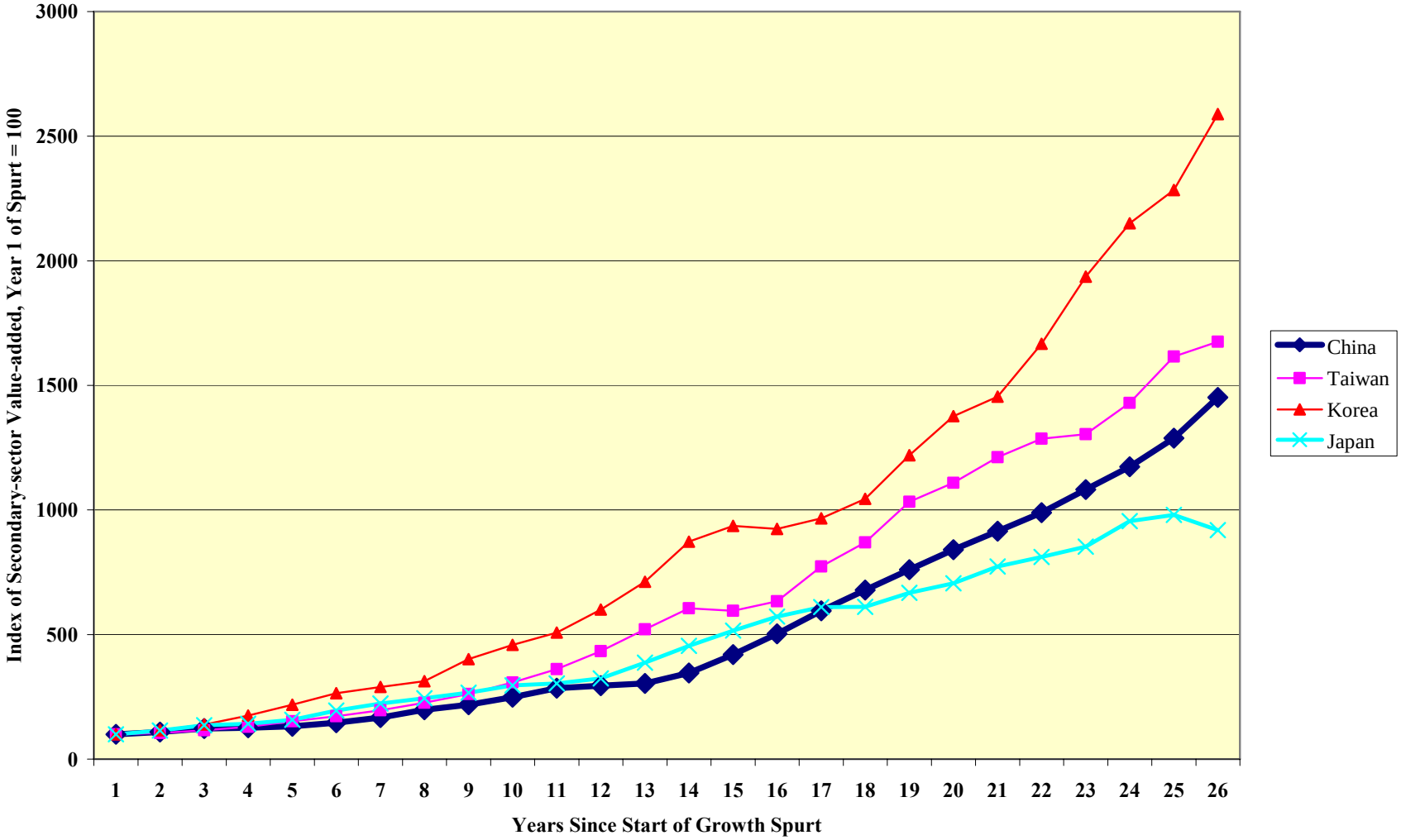


Figure 15.2
Industry Characteristics

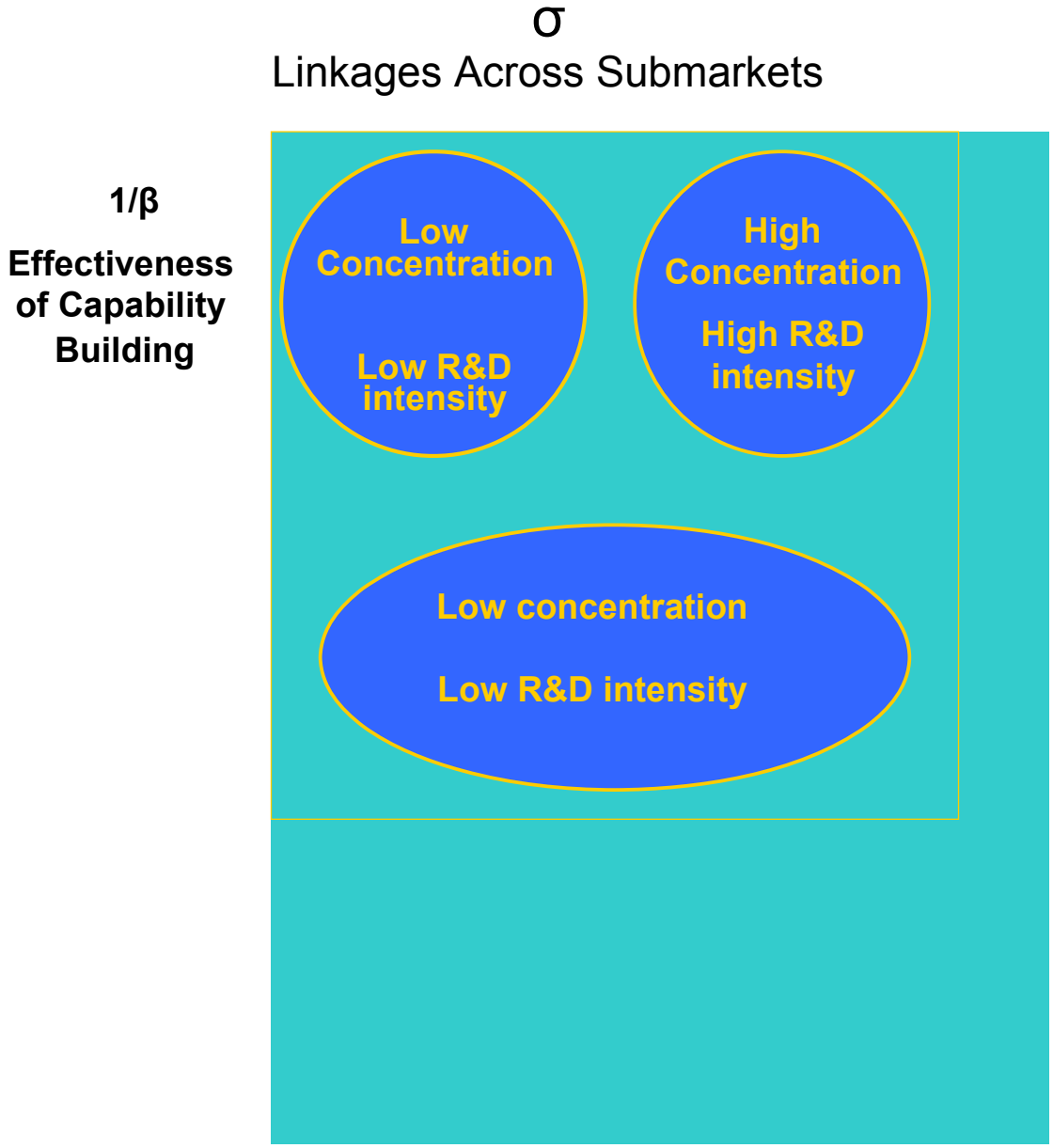


Figure 15.3
Examples of Industry Characteristics

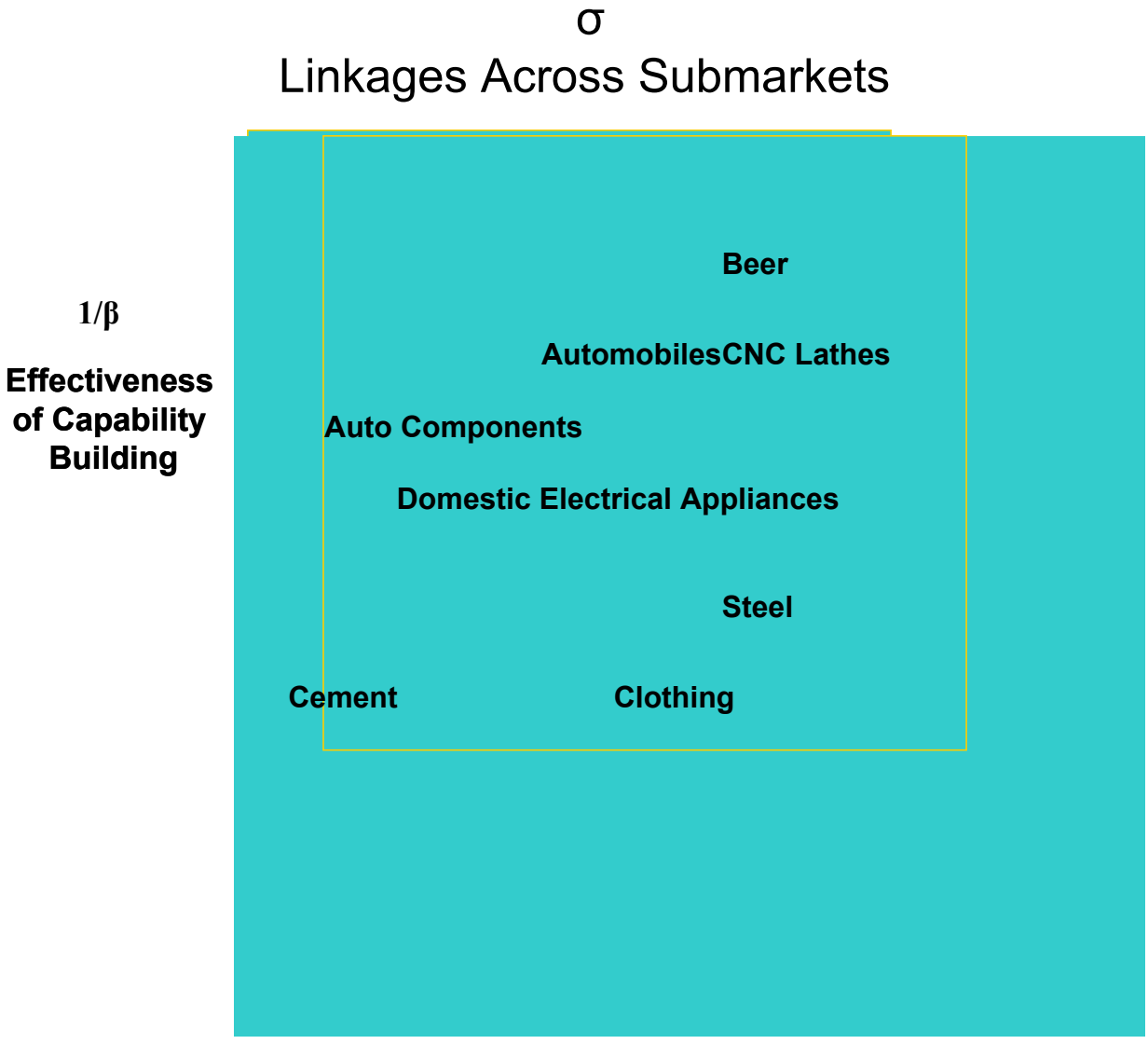


Figure 15.4
China's Trade in TVs and Components
1992-2003 (US$ million - left scale) and percent

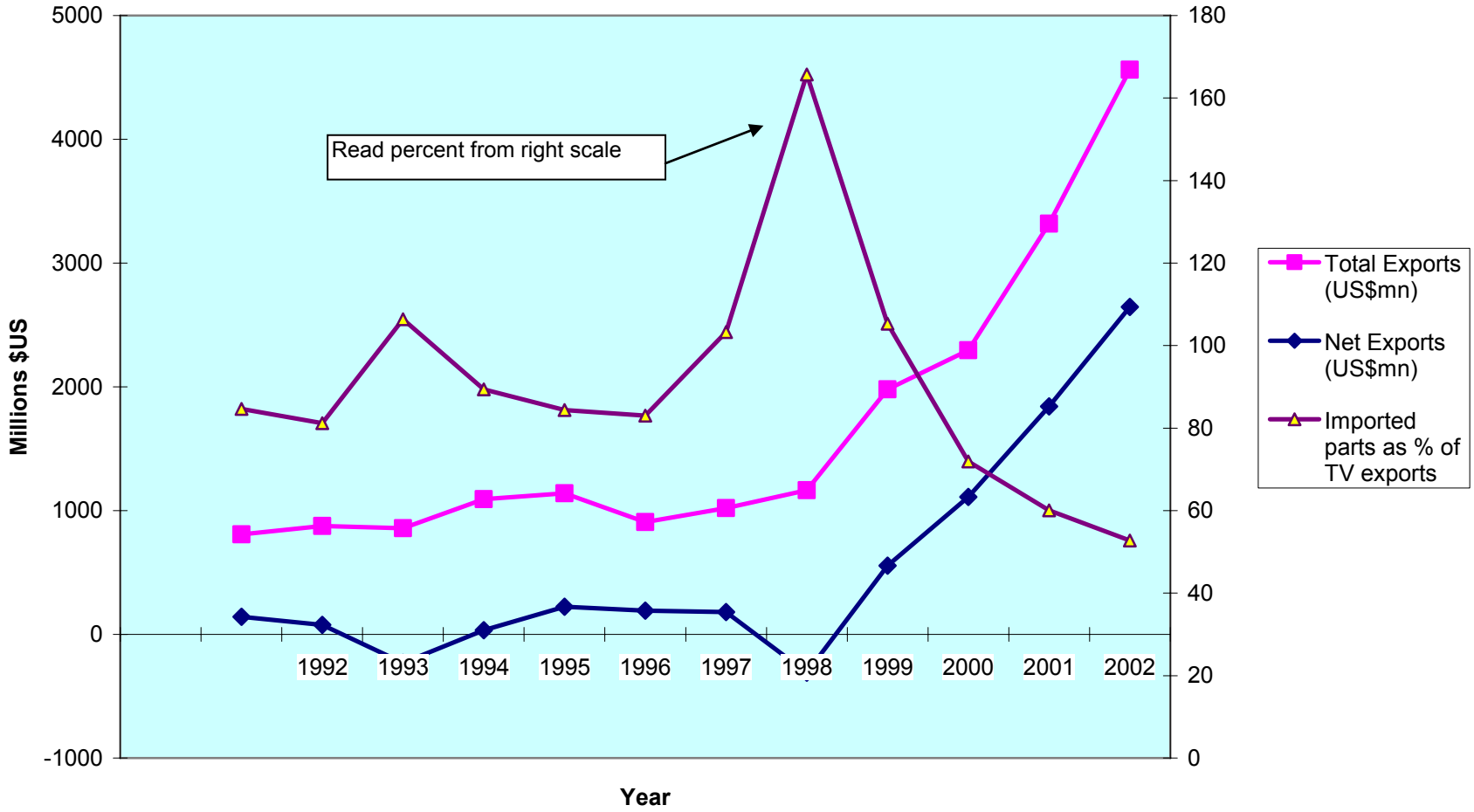


Figure 15.5
Steel Sector: Technical Development Indicators, 1978-2005

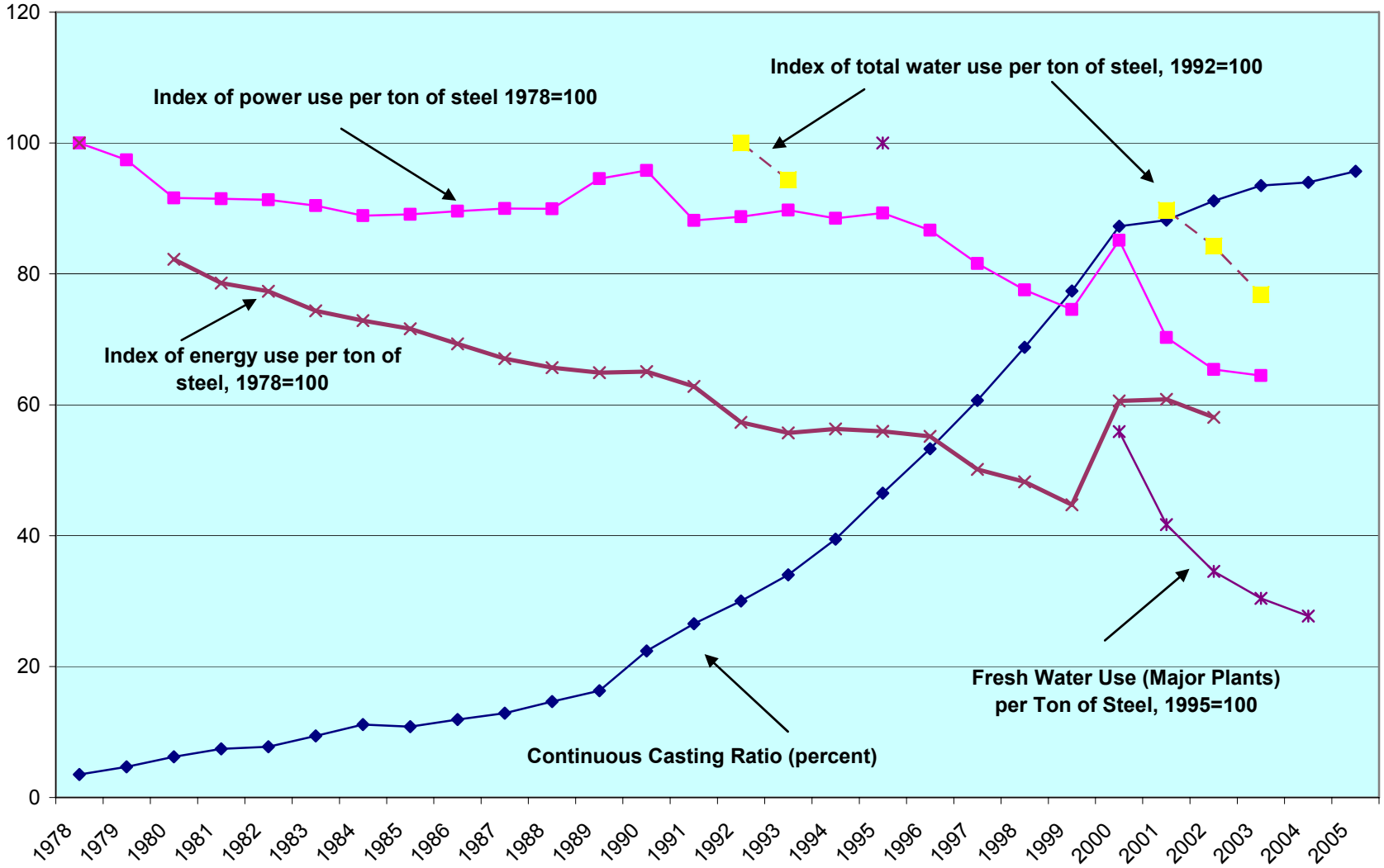


Figure 15.6
Eight-firm Concentration Ratios for 4-digit Chinese Manufacturing Sectors, 1993 and 2002

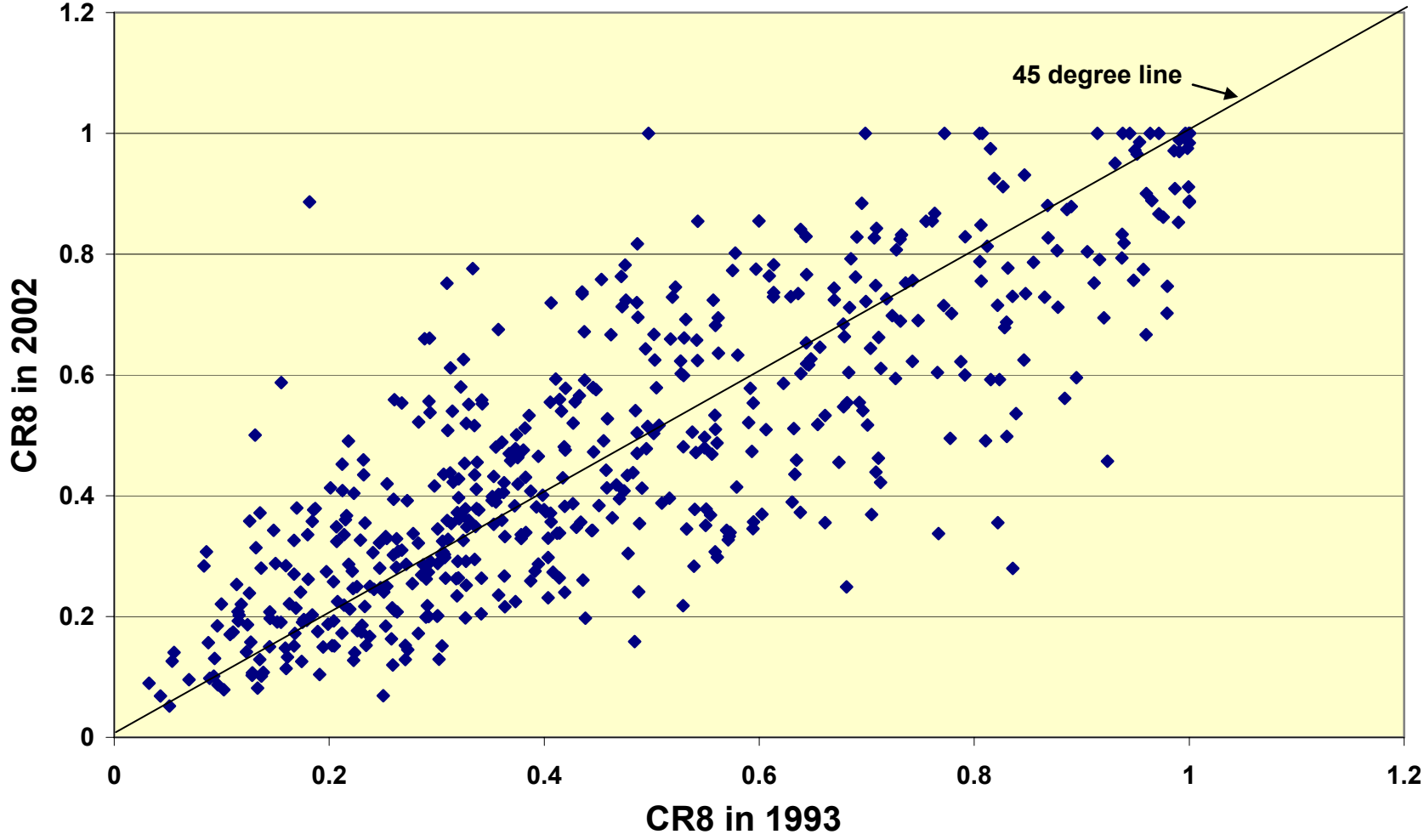
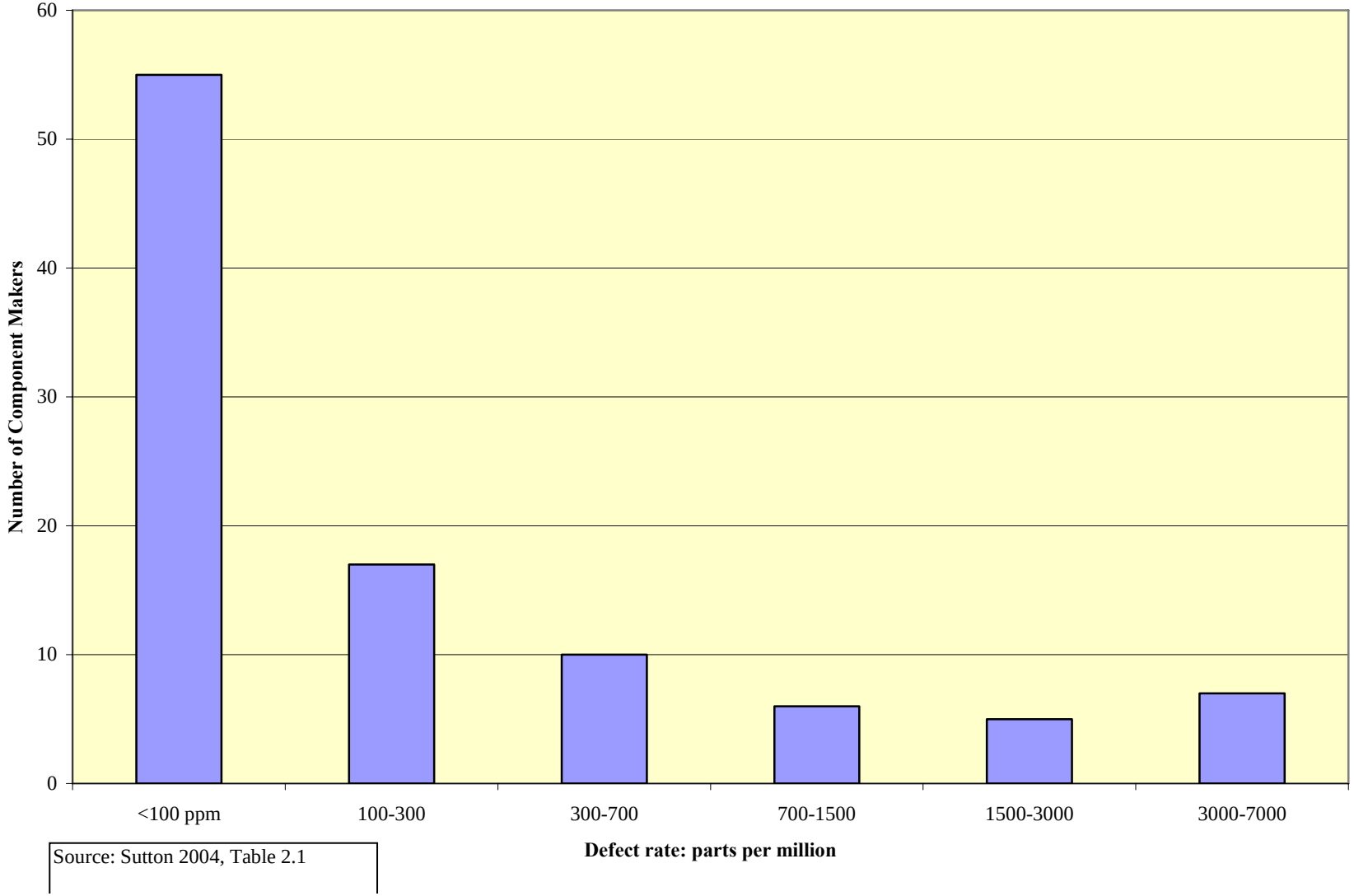
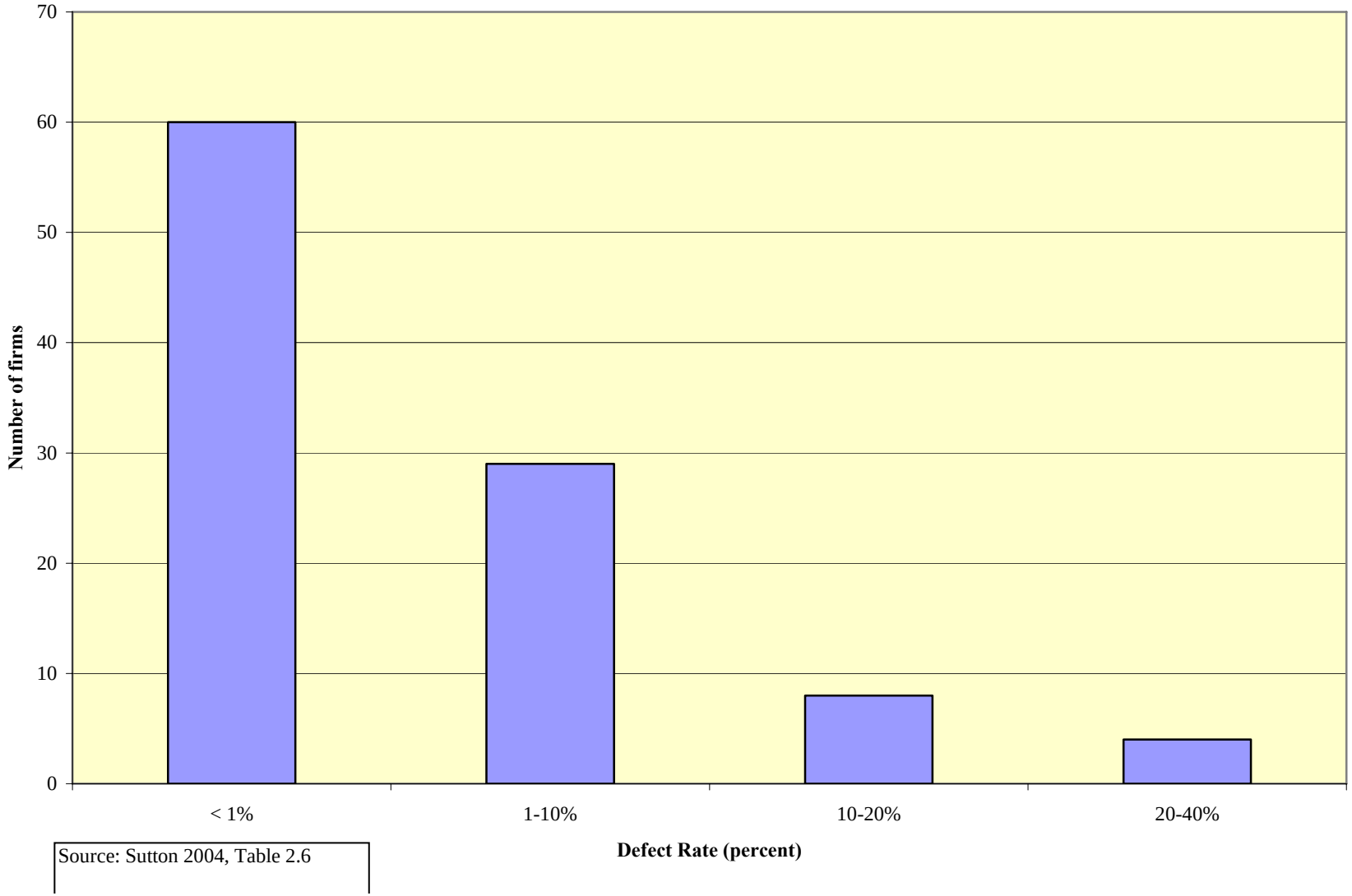


Figure 15.7: Defect Rate for Component Suppliers to a Multi-national Car Maker, 2003



Source: Sutton 2004, Table 2.1

Figure 15.8: Defect Rates: Component Suppliers to a Chinese Maker of Steering Gear, 2003



Source: Sutton 2004, Table 2.6

Figure 15.9
R&D Intensity of China's Exports, 1987-2003