

The global business revolution, the cascade effect, and the challenge for firms from developing countries

Peter Nolan, Jin Zhang and Chunhang Liu*

The global business revolution since the 1980s has witnessed an unprecedented degree of industrial consolidation and concentration of business power at a global level. Firms with powerful, globally recognised technologies and/or brands constitute the ‘systems integrators’ at the apex of extended supply chains. This paper examines the supply chains in four different sectors: aerospace, telecommunications, automobiles and beverages. It finds that these sectors have striking similarities in the way in which the core systems integrators have stimulated industrial concentration across the whole supply chain. This ‘cascade effect’ has profound implications for firms from developing countries in catching up at the firm level.

Key words: Global business revolution, Industrial consolidation, Cascade effect, Value chain, Catch-up

JEL classifications: F02, L00, M00, O00, O03, 049

1. Contrasting views on globalisation and industrial structure

The nature and determinants of industrial structure are among the most important issues in economics. In the history of economics, there have been radically contrasting views on the basic determinants of industrial structure. For most of the twentieth century, industrial structure was heavily influenced by state industrial policy. Since the 1980s, the end of communist central planning and of inward-looking development strategies in poor countries, together with widespread privatisation and liberalisation, ushered in the epoch of ‘globalisation’.¹ This provides an opportunity to test the validity of the various competing views of the determinants of industrial structure under free market conditions.

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Address for correspondence: Dr Jin Zhang, Judge Business School, University of Cambridge, Trumpington Street, Cambridge CB2 1AG, UK; email: j.zhang@jbs.cam.ac.uk

*University of Cambridge, UK; University of Cambridge, UK; and China Industrial Development Research Center, Beijing.

¹ This is the second epoch of modern ‘globalisation’. The first epoch was brought to a halt by the wars of the twentieth century, the rise of communism and the inward-looking economic policies of non-communist developing countries.

There is a substantial empirical literature analysing the nature and determinants of industrial structure prior to the epoch of modern ‘globalisation’.¹ However, there is still a dearth of empirical analysis of the nature and causes of the trends in industrial structure in the epoch of globalisation, and of the implications of these trends for both theory and policy. The assembly and interpretation of evidence on this issue is critical for understanding the current epoch.

This paper is based on extensive empirical research undertaken by the authors in the four industries of aerospace, automobile, telecommunications and beverages. It develops an original analytical framework—the ‘cascade effect’ (see Section 3.1)—to explain recent dramatic changes in industrial concentration across the whole supply chain of these four industries. It aims to provide an original insight into the determinants of industrial structure in the epoch of globalisation, as well as drawing out both theoretical implications and practical policy implications, especially for firms and policy-makers in developing countries.

1.1 *Mainstream view*

The ‘mainstream’, ‘neoclassical’ view of the competitive process is that the perfectly competitive model best describes the essence of capitalist competition. Departures from it are viewed as exceptional and typically arising from government intervention, including protection and nationalisation. At the heart of the mainstream view is the self-equilibrating mechanism of market competition. It is believed that the basic driver of the capitalist process, competition, ensures that if any firm enjoys super-normal profits, rivals will soon enter to bid away those profits and undermine any temporary market dominance that the incumbent enjoys. The neoclassical approach emphasises the importance of competition between small firms as the explanation for the prosperity of the advanced economies. Milton Friedman, for example, believed that there is ‘a general bias and tendency to overemphasize the importance of the big versus the small’: ‘As I have studied economic activities in the United States, I have become increasingly impressed with how wide is the range of problems and industries that can be treated as if they were competitive’ (Friedman, 1962, pp. 120–3).

Mainstream economists tend to believe that managerial diseconomies of scale set in after firms reach a certain size. The classic expression of this view was contained in Marshall’s *Principles of Economics*:

[H]ere we may read a lesson from the young trees of the forest as they struggle upwards through the benumbing shade of their older rivals. Many succumb on the way, and a few only survive: those few become stronger with every year, they get a larger share of light and air with every increase of their height, and at last in their turn they tower above their neighbors, and seem as though they would grow on for ever and for ever become stronger as they grow. But they do not. One tree will last longer in full vigour and attain a greater size than another; but sooner or later age tells on them all. Though the taller ones have a better access to light and air than their rivals, they gradually lose vitality; and one after another they give place to others, which though of less material strength, have on their side the vigour of youth . . . [I]n almost every trade there is a constant rise and fall of large businesses, at any one moment some firm being in the ascending phase and others in the descending (Marshall, 1920, pp. 315–6).

¹ Pratten (1971) analysed industrial structure in a number of UK industries. Prais (1981) analysed industrial structure in several industries in the UK, Germany and the USA. Chandler (1990) analysed industrial structure in the USA, Great Britain and Germany. Chandler (1997) extended the analysis to include small European nations, Italy, Spain, France, Japan, South Korea, Argentina, the USSR and Czechoslovakia. Scherer (1996) analysed the structure of a number of industries in the USA.

Despite the fact that during the epoch of globalisation, mergers and acquisitions have reached new heights,¹ it is widely argued that global concentration levels have not increased.² It is observed that there is a high rate of disappearance of companies from the Fortune 500 (Wolf, 2004, p. 226). Based mainly on the analysis of shareholder returns, mainstream economists believe that mergers and acquisitions mostly fail.³ The explanation that is usually advanced for mergers and acquisitions is the pursuit of power and wealth by CEOs, who are alleged to pursue their own interests at the expense of shareholders, rather than industrial logic. It is argued also that in the epoch of globalisation markets have become so large that it is hard for any firm or small group of firms to dominate a given sector.

Insofar as there was evidence of increased industrial concentration over the course of the twentieth century, the argument was made by mainstream economists that this was due to government policies rather than to advantages of large-scale production. Hayek argued that it was 'largely due to the influence of German socialist theoreticians, particularly Sombart, generalising from the experience of their country, that the inevitable development of the competitive system into "monopoly capitalism" became widely accepted' (Hayek, 1944, p. 49).

In recent years, the argument has gained ground that advances in information technology have created the possibility for a radical change in the nature of the firm. Activities that were formerly rational to carry out within the firm now can be performed by networks of small firms connected by the internet (Castells, 2000). In his widely-read book, *The Company of Strangers* (2005), Seabright argues that in the last 25 years, technological changes have transformed business to the disadvantage of large firms: 'In the two and a half decades since [Alfred Chandler published *The Visible Hand*], more and more large firms, particularly in the traditional production industries, have found themselves outperformed by smaller, nimbler competitors' (Seabright, 2005, p. 166).⁴

This is widely thought to herald the rise of a new form of the 'Post-Fordist' economic system based around 'clusters' of small businesses that can both compete and cooperate at different times (Piore and Sabel, 1984; Porter, 1990). This view appears to be strongly reinforced by the rapid rise in the extent of outsourcing of activities that were formerly carried on within the firm. In Coasian terms (Coase, 1988) the boundaries of the firm have shifted. Many researchers argue that the large corporation is being 'hollowed out', and rapidly becoming an 'endangered species': 'While big companies control ever larger flows of cash, they are exerting less and less direct control over business activity. They are, you might say, growing hollow' (Malone and Laubacher, 1998, p. 147).

The spread of global markets has greatly reinforced the belief that 'catch-up' at the level of the firm is the normal path of capitalist development. In this view, there are limitless opportunities for firms from developing countries to 'catch-up' if they compete on the free market of the 'global level playing field'. This view is expressed powerfully in Thomas

¹ Global mergers and acquisitions rose from an annual level of around US\$260 billion in the early 1990s to a peak of US\$3,173 billion in 2000, falling to US\$1,060 billion in 2002. Thereafter, mergers and acquisitions rose to US\$2,507 billion in 2005 (Moore, 2006). Global mergers and acquisitions have reached US\$3.7 trillion in 2006, surpassing the peak of US\$3.4 trillion in 2000, according to Thomson Financial.

² See, for example, Wolf (2004): 'Global M&A activity rose more than five-fold between 1995 and 2000. Yet the surge in cross-border M&A does not seem to have increased concentration' (Wolf, 2004, p. 224).

³ Meeks (1977), is the classic study of this topic. The view that 'most mergers fail' is repeated remorselessly among mainstream academics of all ideological persuasions.

⁴ Like many other writers who hold similar views, Seabright analysis of the firm (Chapter 10 of *The Company of Strangers*) provides no empirical evidence whatsoever.

Friedman's book (Friedman, 2005), *The World is Flat*: 'The explosion of advanced technologies now means that suddenly, knowledge pools and resources have connected all over the planet, leveling the playing field as never before, so that each of us is potentially an equal—and competitor—of each other' (Friedman, 2005).¹ The view that the 'world is flat' is strongly reinforced by the explosive growth of China during the epoch of globalisation. The world is widely thought to have become 'flat' for individuals, countries and firms from developing countries, due to liberalisation, privatisation and the information technology revolution.

1.2 Non-mainstream view

From the earliest stages in the development of modern capitalism, there were economists who believed that capitalism contained an inherent tendency towards industrial concentration. Marx, in *Capital* Vol. I, argued that there was a 'law of centralization of capital' or the 'attraction of capital by capital'. The driving force of concentration was competition itself, which pressured firms into lowering the cost of production by investing ever larger amounts of capital in new means of production and in 'the technological application of science', which in turn creates barriers to entry. In the early 1970s, on the eve of the modern epoch of globalisation, Hymer visualised the possible outcome of the capitalist process if existing restrictions on merger and acquisition were lifted:

Suppose giant multinational corporations (say 300 from the US and 200 from Europe and Japan) succeed in establishing themselves as the dominant form of international enterprise and come to control a significant share of industry (especially modern industry) in each country. The world economy will resemble more and more the United States economy, where each of the large corporations tends to spread over the entire continent, and to penetrate almost every nook and cranny (Hymer, 1972).

In fact, Marshall's *Principles of Economics* provides numerous explanations for 'the advantages that a large business of almost any kind, nearly always has over a small one' (Marshall, 1920, p. 282). These included economies in procurement, transport costs, marketing, branding, distribution, knowledge, human resources and management (Marshall, 1920, pp. 282–4). By contrast, his explanation of 'managerial diseconomies of scale' resorts to an analogy ('the trees in the forest') without logic or evidence.

Penrose's path-breaking book, *The Theory of the Growth of the Firm*, addresses directly the issue of possible limits to the growth of the firm. Like Marshall, she identifies a number of potential advantages that can be enjoyed by the large firm (Penrose, 1995, pp. 89–92). She considers that the most significant advantages for the large firm are those that she terms 'managerial economies'. Penrose concludes that there are no theoretical limits to the size of the firm: 'We have found nothing to prevent the indefinite expansion of firms as time passes, and clearly if some of the economies of size are economies of expansion, there is no reason to assume that a firm would ever reach a size in which it has taken full advantage of all these economies' (Penrose, 1995, p. 99).

Chandler has demonstrated the central role of the large, oligopolistic firm in technical progress in the business history of today's high-income countries. This was, in its turn, central to the whole growth dynamic of modern capitalism. He has shown that the modern industrial enterprise 'played a central role in creating the most technologically advanced, fastest growing industries of their day'. These industries, in turn, were 'the pace-setters of

¹ Friedman's book is a best-seller. It was hugely popular among participants at the Davos Economic Forum in 2006, and won the Financial Times/Goldman Sachs 'Business Book of the Year' award.

the industrial sector of their economies'. They provided an underlying dynamic in the development of modern industrial capitalism (Chandler, 1990, p. 593). Chandler emphasises the paradox that even as the number of firms in a given sector shrinks, competition between increasingly powerful firms can intensify: 'market share and profits changed constantly, which kept oligopolies from becoming stagnant and monopolistic' (Chandler and Hikino, 1997, p. 31).

Recently, studies on the role of the core firm and their function in governing the value chain show that the participation of firms from low-income countries in the global economy is therefore not governed just by trade policies but also by the strategic decisions of the core firms in the value chains. For firms from low-income countries, access to developed country markets has become increasingly dependent upon entering into the global commodity chains of core firms based in high-income countries (Bonacich *et al.*, 1994; Dolan and Humphrey, 2000; Gereffi, 1999; Gereffi *et al.*, 2003; Schmitz and Knorringa, 2000).

The succession of studies that purport to show the irrationality of mergers and acquisitions are almost entirely based on the analysis of the consequences for shareholder value in the short term. The much smaller number of studies that analyse the long-term impact of mergers and acquisitions on business survival and growth show a different story (Boston Consulting Group, 2004; Chandler, 1990; Nolan, 2001A, 2001B). They suggest, rather, that well-selected and well-executed mergers and acquisitions that have a clear strategic purpose can increase the business capability of the firm concerned. They can strengthen the firm's presence in given geographical markets, increase its access to technologies it formerly did not possess, acquire scarce human resources, add valuable brands to its portfolio, and enable long-term savings through economies of scale and scope in procurement, research and development and marketing.

2. The evidence: the global business revolution¹

This section examines four sectors in order to see the degree to which there are common patterns of industrial concentration across a wide range of industries. At one extreme is the commercial aircraft industry. A single large commercial aircraft costs over \$200 million. At the other extreme is the soft drinks industry. A single serving of a soft drink or a beer costs only around one dollar. In between are the automobile and telecommunications industries. Between them they comprise a large segment of modern economies, and embrace a wide range of technologies.²

2.1 Aerospace³

Large commercial aircraft and advanced military aerospace equipment contain bundles of the world's most advanced technologies. The design, assembly, marketing and upgrading of this equipment embodies powerful economies of scale and scope. The design of a new aircraft requires enormous investments with significant 'up-front' costs during the launch stage. While the cost of failure is high, so is the reward for success. A successful new plane

¹ For a more extensive analysis of the issues contained in this section, see Nolan (2001A, 2001B).

² In 2005 the Fortune 500 companies in these sectors had a combined revenue of US\$3.8 trillion.

³ The issues in Section 3–4 are analysed in more detail in Nolan, Zhang and Liu (2004). Due to limitations of space, this section focuses only on commercial aircraft. However, the military aircraft industry has also witnessed intense consolidation during the past decade, with equally profound consequences for the supply chain.

can lock up its chosen market segment for over 20 years, producing sales of US\$25–40 billion and huge profits. Owing to the ‘bet-the-firm’ nature of new aircraft launches, every new aircraft design requires rigorous market analysis based upon the company’s deep knowledge of its customers. The industry has large economies of scale in assembly, which come from spreading planning efforts and high tooling costs over large outputs of one type of aircraft. There are economies achieved through learning effects, obtained in the course of producing more units of a given aircraft model. Having a family of aircraft with common platforms enables the manufacturer to spread given R&D outlays over a larger number of aircraft, and to obtain economies of scale in procurement of components, and to achieve large operating benefits for customers. Branding is critical in the aerospace industry. A large installed base is in itself the best demonstration of product reliability, operating efficiency and technology leadership.

By the late 1960s, the US commercial aeroplane industry had reduced to just three main producers: Boeing, McDonnell Douglas and Lockheed. The competitive pressure from Boeing on its rivals was intense. By the mid-1990s, Lockheed had ceased production of the Tristar and McDonnell Douglas was in deep financial difficulties in its commercial aeroplane division. In 1997 came the path-breaking merger of Boeing and McDonnell Douglas. Following the merger, Boeing accounted for over 80% of the world’s total commercial aircraft in service. From the 1950s to the 1970s, there were several European companies each manufacturing large jet airliners (by the standards of the time).¹ By the late 1960s it was apparent that none of them was able to compete with Boeing. In 1970, France and Germany decided to join forces to build a family of large commercial aeroplanes that could challenge Boeing’s dominance, and preserve a wide array of high technology supplier industries within Europe. They were later joined by Britain and Spain. Without massive support from the respective governments, Airbus could never have become established. By the early 2000s, Airbus had overtaken Boeing in the market for large commercial aircraft. The two companies are now locked in head-to-head duopolistic rivalry. Boeing has staked much of its future on the medium-sized 787 (‘Dreamliner’), while Airbus has done the same with the super-large A380. The USSR possessed a highly sophisticated aerospace industry that produced thousands of large jet passenger planes.² If the USSR had followed a suitable path of system reform, the Soviet aircraft industry could have become a formidable challenger to the West’s leading companies in both civilian and military sectors (Nolan, 1995). Today, that industry is in ruins.³

The systems integrators, Airbus and Boeing, have huge procurement budgets, totaling more than US\$29 billion annually in Boeing’s case. They focus increasingly on coordinating and planning the supply chain, rather than direct manufacture. As much as 60–80% of the end-product value of aerospace products is now derived from the external supply network (Murman *et al.*, 2002, p. 18). Airbus pioneered the concept of final assembly of large sub-systems. However, Boeing has taken the lead over Airbus in reorganising its supply chain. In each aircraft programme, Boeing selects risk-sharing partners who develop and design important subsystems of the aircraft. These require massive research and development (R&D) investments. Boeing’s top suppliers invest

¹ These included the UK’s de Havilland (Comet), Vickers (VC10), Hawker Siddeley (Trident) and BAC (BAC 111), Germany’s VFW (VFW 614), France’s Sud Aviation (Caravelle) and the Netherlands’ Fokker.

² Tupolev alone produced almost 2000 Tu-134s and 154s, which placed it roughly on a par with McDonnell Douglas, though far short of Boeing. Antonov and Ilyushin also produced large commercial aircraft.

³ President Putin is reconstructing a unified Russian aerospace industry with majority state ownership, but it remains to be seen how successful this endeavour will be in catching up with the global industry leaders.

hundreds of millions of dollars in R&D annually and they own increasing amounts of the intellectual property embedded in the aircraft. As aircraft technology becomes more complex and the cost pressure increases, the systems integrators have pushed more development and design activities down the supply chain to its subsystems integrators.

In 2000, Boeing started to implement the Toyota Production System (TPS), converting its production system from batch processes to assembly line processes. TPS requires just-in-time delivery of parts, which in turn called for changes in suppliers' operations. In 1999, Boeing centralised the procurement function and radically pruned the number of suppliers. Between 2000 and 2005, it reduced direct suppliers from 3,600 to 1,200. In the supplier structure for the new B787, Boeing deals directly with just seven or eight first-tier suppliers. The reduction in the number of direct suppliers allows Boeing to enjoy closer collaboration with its direct suppliers and maintain tight control over the aircraft design and assembly as technology and cost requirements continue to increase.

The way in which Airbus and Boeing reorganised the institutional structure of the supply chain in order to reduce the number of suppliers and nurture large-scale sub-systems integrators constitutes a form of industrial policy, with the systems integrators picking and nurturing 'winners'. They each penetrate deeply into their respective supply chain. Surrounding each of them is an 'external firm' in which control by the core systems integrator extends across the boundary of the legally-owned entity: 'If we are to succeed in the face of increasing global competition and greater demands for cost improvements from our customers, then *our entire extended enterprise* must operate under Lean principles and a Lean philosophy.' (Mike Sears, former Boeing CFO) (Sears, 2001).

In order to meet the demands of the systems integrators, the major sub-system and key component suppliers themselves need to invest heavily in R&D, and to expand in order to benefit from cost reduction through economies of scale and scope. A powerful merger movement has taken place at all levels of the supply chain, and the level of concentration in the upper reaches of the aircraft industry supply chain has increased rapidly. Through continuous merging and acquiring 'core businesses' that meet their strategic goals, and through divesting 'non-core businesses' in order to 'upgrade' their asset portfolio, a group of giant sub-systems integrators have established or strengthened their competitive position in businesses covering one or more aircraft sub-systems. All these suppliers have their headquarters and their main production facilities in developed countries, especially the USA. Leaders in their respective industries, they are all global giants themselves, with billions of dollars in revenues and large R&D outlays (Table 1). They dominate every major subsystem of the aircraft industry.

Engines are by far the most expensive aircraft subsystem, requiring enormous development costs and R&D outlays. There are now only three engine makers who are able to produce large modern jet aircraft engines that meet the continuously advancing demands of Boeing and Airbus. These are GE, Rolls-Royce and United Technology (Pratt & Whitney). Aircraft structures are dominated by a handful of companies, including Vought Aircraft (which is the sole supplier of major structures for the B747), BAE Systems (which is the sole supplier of wings for Airbus), Finmeccanica (Alenia), Mitsubishi Heavy Industries, Fuji Heavy Industries and Kawasaki Heavy Industries. Honeywell is by far the most powerful firm in the supply of avionics systems, including communication and navigation systems, flight instrument systems, flight management systems, as well as traffic alert and collision avoidance technologies. It is also at the forefront of power distribution, and pneumatic and landing systems. Honeywell was selected to supply the core avionics systems for both the A380 and the B787. Smiths Industries, Goodrich and Rockwell Collins

Table 1. *Leading aerospace sub-systems integrators*

Company	Revenues (2005) US\$ billion	R&D spending (2004/5) US\$ million
GE	157.2	2,961
of which: GE aero engines	11.0	n.a.
United Technologies	2.7	1,203
of which: Aerospace division	15.0	n.a.
Honeywell	28.9	478
BAE Systems	20.2	2,042
Finmeccanica	15.1	1,893
Thales	13.4	569
Rolls-Royce	10.9	519
Snecma	8.9	980
Smiths	5.1	252
Goodrich	4.5	237
Rockwell Collins	2.8	210
Cobham	1.8	90

Sources: *Fortune*, 31 July 2006 and DTI (2005).

are major competitors in the supply of avionics and other control systems. Each of these supplies sub-systems to both Boeing and Airbus, and each has positions on both the A380 and B787. The supply of landing gear, wheel and braking systems is dominated by Snecma's Messier-Bugati and Messier Dowty subsidiaries, and by Goodrich. Each of these supplies complete landing sub-systems to both Boeing and Airbus. Between them they have close to 80% of the global market for brakes on commercial aircraft (see company websites).

Even the smaller sub-systems on the large aeroplanes are dominated by a small number of powerful sub-systems integrators. The wiring systems on large commercial aircraft are immensely complex. Snecma (through its subsidiary Labinal) is the world leader in the supply of wiring systems. It supplies the main part of the wiring systems for both the A380 and the B787. Jamco is sole supplier to Boeing for aircraft lavatories. Meggitt supplies the fire and smoke detectors for almost all large commercial aircraft. Recaro and B/E Aerospace account for most of the market for seats on large commercial aircraft. Many critically important components and materials are supplied by specialist aerospace divisions of giant global firms. Michelin, Goodyear and Bridgestone are the only firms capable of supplying tyres for large commercial aircraft. Saint-Gobain is the sole supplier of aircraft glass to Airbus. Alcoa and Alcan account for most of the world's supply of aluminum for aircraft assembly. Each A380 will use around one million Alcoa 'lockbolts'.

2.2 *Automobiles*

The global stock of automobiles has grown from around 150 million in 1950 to around 800 million in 2000, and is predicted to rise to around 1,600 million in 2030 (DaimlerChrysler, 2005). In 1960, there were 42 independent automobile assemblers in the 'Triad' regions of North America, Western Europe and Japan. By 2005, that number had shrunk to just 12 firms, through an intensive process of merger and acquisition. The top five auto assemblers now account for 58% of total automobile output in the Triad regions and the top ten account for 83% of total vehicle output (DaimlerChrysler, 2005). Even the leading

automobile firms face threats to their survival arising from the intensity of oligopolistic competition.

In order to survive this ferocious competition, the leading assemblers must spend large amounts on R&D, in order to make vehicles lighter in weight, and to improve fuel efficiency, safety, durability and reliability. Each of the main automobile assemblers spends between US\$2–8 billion annually on R&D (DTI, 2005). They also each spend several billion dollars each year on building their brands.

The leading auto assemblers each spend several tens of billions of dollars annually on procurement of materials and components. GM, for example, has an annual procurement budget of around US\$80 billion. As the leading automobile assemblers have grown in terms of the scope and size of their markets since the 1970s, so also has the intensity of pressure they have imposed upon their supply chains. The pressure upon suppliers is felt most visibly in terms of price. The price pressure on North American assemblers has been so intense in recent years, that several of them have become large loss-makers and filed for bankruptcy under Chapter 11.

However, the relationship is far from arms-length. There is a deep interaction between the direction of the core strategic suppliers' R&D and the needs of the assemblers. The leading auto assemblers have put intense pressure on leading components suppliers to invest large amounts in R&D to meet the assemblers' needs. The 14 giant components suppliers in the Fortune 500 spend on average over US\$1 billion annually, and the industry leaders, Bosch, Delphi and Denso each spend over US\$2 billion on R&D (DTI, 2005). The assemblers have selected a group of powerful sub-system integrator firms, who are able to partner them in their global expansion: 'We're looking for the top suppliers to help us grow in the market place. As we grow, they will grow with us' (GM website). The leading auto assemblers work together to plan the supplier firm's investment in new production locations close to the assemblers. Leading components suppliers such as Bosch, Delphi, Valeo and Michelin, each have more than 100 production plants across the world, near to the assembly plants.

The strategic suppliers themselves are deepening their relationship with their own suppliers to something beyond a simple price relationship. For example, Delphi is developing a group of its own 70–80 key 'strategic suppliers': 'These are the suppliers we'd like to grow with, they understand our cost models, where we are going, and being increasingly willing to put more of their research and development and engineering money behind projects for us' (*Financial Times*, 30 June 2003).

The auto components industry has been through a dramatic transition during the past two decades, under intense pressure from the cascade effect. The number of component makers expanded from an estimated 20,000 in 1950 to over 40,000 in 1970. However, by 1990 the number had fallen to under 30,000. During the epoch of revolutionary growth and consolidation of the vehicle assemblers, the number of component makers shrank to less than 5,000 in 2000, and is predicted to fall still further, to less than 3,000 by 2015 (DaimlerChrysler, 2005).

A handful of component makers has emerged, mainly through merger and acquisition, to dominate the upper reaches of the auto components supply chain. The combined revenues of the 14 giant auto components firms in the Fortune 500 amounts to a total of around US\$291 billion (*Fortune*, 31 July 2006), which amounts to around 55–60% of the total estimated spending by the auto assemblers on procurement.¹ In each segment of the

¹ This is a rough estimate based on the fact that GM spends around US\$80 billion on procurement, and accounts for around 16% of total global automobile sales.

vehicle, a handful of sub-systems integrators, each with their own supply chains, dominate the global market. For example, three firms (Michelin, Bridgestone and Goodyear) account for 55% of total world production of car tyres (*Financial Times*, 6 June 2006); three firms (Asahi, St Gobain and NSG) account for 75% of the world output of auto glass (Pilkington, 2005); three firms (GKN, NTN and Delphi) account for 75% of the global market for constant velocity joints (GKN and NTN, *Annual Reports*, 2005); two firms (Bosch and Delphi) account for around 75% of the world's production of diesel fuel injection pumps (*Ward's Auto World*, January 2000); two firms (Johnson Controls and Lear) account for over one-half of all the automobile seat systems supplied to auto assemblers in Europe and North America (Lear and Johnson Controls websites, 2006); and two firms (Bosch and Continental) account for around 50% of the global total of ABS/ESC¹ brake systems (Continental and Forbes websites, 2005).

In addition, pressure from the cascade effect has been a major stimulus for the high-speed consolidation in the steel industry and, to a lesser extent, in the aluminium industry. Following their merger, in 2006 Arcelor-Mittal accounted for an estimated 26% of the total global production of automotive steel, and the top five firms (Arcelor Mittal, Nippon Steel, JFE, US Steel and Thyssen Krupp) accounted for 54% of global auto steel production (Mittal, 2006). In the aluminium industry, the top five firms (United Company Rusal, Alcoa, Alcan, Chalco and Hydro) now account for 44% of total global production, and the top ten for 57% (*Financial Times*, 31 August 2006).

2.3 Telecommunications

Privatisation and liberalisation of the telecommunications services industry in the 1990s unleashed a wave of international expansion and consolidation. A small group of super-large telecoms services companies emerged from this process. By 2005, the top ten telecoms firms had revenues of between US\$35 billion and US\$95 billion. They all had their headquarters in high income economies. They had mainly built extensive international operations. Where permitted to do so, they had participated heavily in the acquisition of formerly state-owned telecoms assets in developing and former communist countries.² The giant telecoms firms benefited from advantages of scale, through their ability to build global brands, offer global services, and lower costs through large procurement budgets. The leading telecoms firms such as NTT, Verizon, Deutsche Telecom and Vodafone have annual procurement budgets of US\$15–25 billion. Their intimate knowledge of the end customer helped place them in a position to integrate their supply chains in order to meet their needs.

Alongside the transformation of the telecoms services industry, the telecom equipment industry experienced high-speed institutional change in the 1990s. Under intense pressure to meet the technical demands of the telecoms service providers, with their enormous procurement budgets, the telecoms equipment industry witnessed intense consolidation as the industry leaders sought increased scale, particularly in order to increase their R&D capability through both direct spending and the acquisition of smaller companies with specialist technical knowledge. By 2002, the top ten telecoms equipment makers, all with their headquarters in high-income countries, accounted for 57% of the total global telecoms equipment market (Xing, 2005). In the mobile handsets market, which only emerged as a mass market in the late 1990s, the sector is already highly concentrated. In

¹ Anti-locking Brake Systems and Electronic Stability Control Systems, respectively.

² There still are important restrictions on the international expansion of the leading telecommunications firms, notably in China and India, and, to some extent, within Western Europe.

2006, the top five firms in the sector, all with headquarters in high-income countries, accounted for 81% of the global market, the top two alone (Nokia and Motorola) accounting for 56% of the global market (*Financial Times*, 29 September 2006).

Institutional change in the industry entered a new phase in 2005/6, stimulated by technical change. New technologies have created the possibility for 'convergent' services that offer a combination of 'triple play', including video, voice and data, which can be provided by broadband and include VoIP ('voice-over-the-internet protocol' telephony). The new technologies have created the possibility of a new form of telecommunications firm providing all these services in a combined 'bundled' package to customers. The telecoms industry is being restructured at high speed, with fixed line, mobile, cable, satellite, internet and media companies all participating in the 'convergent' institutional restructuring of the industry. This places intense pressure on the telecoms equipment makers to meet the needs of the 'converged technologies' of the giant telecoms services companies in the new epoch of telecommunications: 'Equipment suppliers are being forced to offer end-to-end solutions to a consolidating base of carrier customers that are in the middle of major network transformations ... As carrier consolidation continues to drive increased vendor instability, existing players will need to seek merger and partnership opportunities to compete within the new market structure' (*Financial Times*, 7 April 2006).

In 2005/6 a new round of industry consolidation was unleashed among the telecoms equipment makers in order to meet the intense pressure to supply new converged technologies. In rapid succession, Cisco acquired Scientific Atlanta, Ericsson acquired Marconi, Alcatel merged with Lucent, and Nokia and Siemens merged their telecoms equipment divisions. Following this hectic round of mergers and acquisitions, the top three firms in the sector (Ericsson/Marconi, Nokia/Siemens and Alcatel/Lucent) accounted for 75% of total global sales of wireless telecoms equipment (*Communications Weekly*, 26 June 2006), and were poised to dominate the epoch of convergent technologies. The top five telecoms equipment makers each spend US\$2–5 billion on R&D, amounting to between 10–17% of their revenue (DTI, 2005).

Pressure from the cascade effect in the telecoms industry does not end with the leading telecoms equipment suppliers. Semiconductors are a critically important part of the technical progress in the equipment industry, just as they are in the computer and consumer electronics industries. The level of industrial concentration in the industry is high. The leading semiconductor firms typically supply the whole range of industries using their products, enabling them to benefit from 'economies of scope' in applying new technologies across several closely-related sectors. The top ten firms, all with headquarters in high-income countries, account for 49% of the total global market for semiconductors (*DigiTimes.com*, March 2006). However, within individual sub-sectors, the level of industrial concentration is even higher. Meeting the needs of the world's leading telecoms equipment makers necessitates large scale and a high level of spending on R&D. In the supply of integrated circuits to the wireless telecommunications industry, the top five firms accounted for 44% of total global sales revenue in the sector in 2005, and the top ten firms, all with headquarters in high-income countries, for 65% (*IC Insights*, 16 November 2005).

The impact of the cascade effect penetrates even deeper down the industry supply chain. The manufacture of silicon wafers has witnessed high-speed consolidation as the firms in the sector struggle with the large capital costs and high level of R&D spending required to meet the exacting demands of the semiconductor makers. Following the latest round of industrial concentration in the sector, the top two firms in the sector, one American and one Japanese, account for 63% of total global revenue in the sector (*Financial Times*, 21

September 2006). The sector supplying the equipment to manufacture semi-conductors is even more highly concentrated. The leading firm in the sector, Dutch-based ASML, accounts for 57% of global sales in the sector (*Financial Times*, 19 January 2006).

2.4 Beverages¹

Since the 1980s, the global beverage industry has witnessed high-speed consolidation. In the carbonated soft drinks sector, just two firms now account for around three-quarters of total global sales. In the broader category of non-alcoholic drinks, just five firms account for over one-half of the global market. The beer industry lags some way behind, but the trend towards consolidation is clear, with emergence of super-large global firms, such as Anheuser-Busch, SAB Miller and Inbev.² The closely-related food industry has undergone its own process of consolidation, resulting in the emergence of a group of super-large international firms, such as Nestle, Unilever and Sara Lee. The beverage and food industries are both experiencing intensifying pressure from the emergence of giant retailers such as Wal-Mart, Metro, Carrefour and Tesco.³

The massive procurement expenditure on material inputs and services by the world's leading beverage producers has increased the pressure for consolidation from the higher reaches of the supply chain. In many areas, the cascade effect pressures on the supply chain from the beverage industry are applied simultaneously by the food industry. This cascade effect has stimulated a wave of consolidation in the beverage industry's supply chain. Moreover, as the higher reaches of the supply chain have struggled to meet the global needs of the world's leading beverage companies, the process of consolidation within their ranks has produced further cascade pressure on the supply chain of these firms, as they struggle to lower costs, and achieve the technical progress necessary to meet the fierce demands of the world's leading system integrators who stand in the middle of their respective supply chains.

The global consumer packaging industry is a huge industry, worth about US\$300 billion annually. The top ten global packaging firms account for between 40 and 80% of global markets, depending on the sector. The world's leading beverage firms interact closely with the leaders of the packaging industry to work together to find ways to meet their needs better through innovations in product and process technologies. Key pressures on the packaging industry have included cost and weight reduction, improved customer safety, increased product life and enhanced appearance. Technical progress has also been achieved through contributions from the primary material suppliers in the aluminum, steel, PET resin industries, as well as in the suppliers of machinery. The world's leading beverage firms have interacted with this process at every step, acting as 'systems integrators' for the overall process of technical progress, and nurturing institutional change so that leading suppliers have sufficient scale to meet the beverage companies' strict requirements.

Over 200 billion beverage cans are consumed annually. Since the late 1980s, the world's metal can industry has consolidated rapidly. Three firms now stand out as the global industry leaders,⁴ with a combined global market share of 57% (*Financial Times*,

¹ Unless otherwise indicated, data in this section are taken from Nolan, Zhang and Liu (2004). For a detailed study of the 'cascade effect' in the global beverage industry see Nolan (2007).

² In the USA, the top three firms account for around 80% of the market. In Japan and Europe, the top two or three firms account for over 70% of the respective markets.

³ There are now more than 30 giant retail groups with annual revenues of more than \$10 billion, including seven super-giants with revenues of over \$50 billion (*Fortune*, 26 July 2004).

⁴ These are Ball, Crown and Rexam.

2 November 2005). The metal can industry is a major consumer of both aluminum and steel, and places intense pressure on the steel and aluminum industries to achieve technical progress, improve product quality and lower costs. The other major users of primary metals have also consolidated at high speed during the global business revolution, including the automobile, aerospace, construction and household durable goods industries. They also place great pressure on the steel and aluminum industries, which have experienced intensive consolidation. The top five firms produce 44% of total world production of aluminium (*Financial Times*, 31 August 2006), and an even higher share of the aluminum sheets for beverage cans. In the steel industry, leading steel firms focus on high value-added, high technology products for global customers, including steel for beverage cans. Although the top ten firms account for 'only' around 27% of total global output by weight, following the merger of Arcelor and Mittal Steel, they account for around three-fifths of total global sales revenue from the steel industry (Nolan and Rui, 2004).

Glass bottles are still the main form of primary packaging in the beer industry, and, despite its relative decline, the glass bottle remains an important form of packaging for soft drinks, especially in developing countries. Following successive rounds of merger and acquisition in the 1990s, the glass bottle industry has become highly consolidated. The two super-giants of the industry (Owens-Illinois and Saint-Gobain) now account for around 68% of total glass bottle production in Europe and North America (Owens-Illinois and St Gobain, *Annual Reports*). Between them they produce more than 60 billion glass bottles annually.

PET (plastic) bottles were developed in the late 1960s, and quickly became the most important form of primary packaging in the soft drinks industry, though they still have a less important place in the beer industry. In recent years, the industry has become increasingly concentrated. By 2003, excluding the production by beverage companies for self-consumption, the top four firms accounted for almost two-thirds of the total production of PET bottles in North America and Europe, respectively. Much of the technical progress in the PET bottle industry has been achieved by specialist machine builders, who make two different types of machinery, namely 'pre-forms' and the equipment that 'blows' the pre-forms into their final bottle form. Each of these sectors is dominated by specialist high technology firms. One firm alone (Husky) accounts for around three-quarters of the total global market for high volume PET injection machines (Husky, *Annual Report*), while another specialist firm (Sidel)¹ has a near monopoly on the purchase of advanced blowing equipment by the world's leading beverage companies.

In the supply of beverage filling line equipment, the high value-added, high technology segments of the market supplying the world's leading beverage companies are dominated by just two firms (KHS and Krones), the product of remorseless mergers and acquisitions (M&A), which together account for almost nine-tenths of global sales of high-speed beverage bottling lines (KHS and Krones, *Annual Reports*). The world's leading beverage companies have bought machines almost exclusively from these two companies because of their high levels of reliability, low operating costs, high speed, more consistent filling height and low rates of damage to bottles and product. Each of them spends heavily on R&D.

The advertising and communication sector, which is crucial for branding global businesses, has witnessed intense M&A activity, alongside the global expansion of their

¹ In 2003, Tetra Laval, the Swedish/Swiss packaging giant, acquired Sidel. With the weight of Tetra Laval behind it, Sidel will be in an even better position to maintain its leading position in the global PET pre-form blowing industry.

main customers. The world's top ten spenders each spend on average of US\$2–3 billion per company annually. They account for a large share of the revenues of the leading advertising and marketing firms. In addition, the advertising and communication companies face increasingly powerful global media companies, such as Disney, News International, Time Warner and Viacom, with which they place their products. The advertising and communication industry has become polarised into a small number of immensely powerful firms and a large number of small firms. By 2001, the top four firms in the sector¹ accounted for almost three-fifths of total global advertising revenue.

The world's leading beverage companies are among the largest purchasers of trucks.² Their truck fleets are enormous, amounting to hundreds of thousands of trucks for the industry leaders. The world's leading truck manufacturers experience intense pressure from their global customers to lower costs and improve technologies. This intensifies the pressure to increase scale in order to achieve greater volume of procurement and push down costs across their own value chains, including suppliers of truck components (engines, brake systems, tyres, exhaust systems, seats, informatics and ventilation systems) and materials (steel, aluminum and plastics). Greater scale also enables them to achieve faster technical progress through economies of scope (coordinated technical progress that can be used in different divisions of the company), in order to provide the customer with greater reliability, lower fuel costs, greater safety and more effective ability to meet pollution control requirements. Since the 1980s, industrial concentration in the truck industry has greatly increased. By the late 1990s, the world's top five truck makers accounted for one-half of total global sales in terms of the number of units sold (DaimlerChrysler, 2005) but an even higher share of the total market value, as the leading truck companies tended to produce far higher technology vehicles. In 2003, industry leader Daimler-Chrysler's truck division alone had revenues of US\$36 billion, operating profits of US\$1.1 billion, and spent US\$1.3 billion on R&D.

3. Interpreting the evidence

3.1 *Systems integrators*³

The period of the global business revolution has witnessed massive asset restructuring, with firms extensively selling off 'non-core businesses' in order to develop their 'core businesses' and upgrade their asset portfolio. The goal for most large firms became the maintenance or establishment of their position as one of the handful of top companies in the global market-place. Although the intensity abated in the wake of the collapse of the late 1990s stock market bubble, the merger and acquisition process has continued at a high level in recent years. An unprecedented degree of industrial concentration has been established among leading firms in sector after sector. By the 1980s, there was already a high degree of industrial concentration within many sectors of individual high income countries (Pratten, 1971; Prais, 1981). However, the global business revolution saw, for the first time, the emergence of widespread industrial concentration across all high income countries, as well as extending deeply into large parts of the developing world.

¹ WPP, Omnicom, Interpublic and Publicis.

² Either directly, or through their 'third party' logistics suppliers. Most beverages are delivered to customers by truck.

³ The notion of 'systems integrators' has been analysed in literature by authors such as Rothwell (1992), Langlois (1992), Brusoni *et al.* (2001), Dosi *et al.* (2003) and Hobday *et al.* (2005).

By the early 2000s, within the high value-added, high technology, and/or strongly branded segments of global markets, which serve mainly the middle and upper income earners who control the bulk of the world's purchasing power, a veritable 'law' had come into play: a handful of giant firms, the 'systems integrators', occupied upwards of 50% of the whole global market.¹

3.2 Cascade effect

The process of concentration through the simultaneous de-merger of non-core businesses and merger of core businesses is cascading across the value chain at high speed. In sector after sector, leading firms, with powerful technologies and marketing capabilities, actively select the most capable among their numerous suppliers, in a form of 'industrial planning', adopting 'aligned suppliers' who can work with them across the world. Thus, across a wide range of activities, a cascade effect is at work, in which intense pressures develop for first tier suppliers of goods and services to the global giants to themselves merge and acquire, and develop leading global positions. These, in their turn, pass on intense pressure upon their own supplier networks. The result is a fast-developing process of concentration at a global level in numerous industries supplying goods and services to the systems integrators.

3.3 Planning and coordination: the external firm

If we define the firm not by the entity that is the legal owner, but, rather, by the sphere over which conscious coordination of resource allocation takes place, then, far from becoming 'hollowed out' and much smaller in scope, the large firm can be seen to have enormously increased in size during the global business revolution. As the large firm has 'disintegrated', so has the extent of conscious coordination over the surrounding value chain increased. In a wide range of business activities, the organisation of the value chain has developed into a comprehensively planned and coordinated activity. At its centre is the core systems integrator. This firm typically possesses some combination of a number of key attributes. These include the capability to raise finance for large new projects, and the resources necessary to fund a high level of R&D spending to sustain technological leadership, to develop a global brand, to invest in state-of-the-art information technology and to attract the best human resources. Across a wide range of business types, from fast-moving consumer goods to aircraft manufacture, the core systems integrator interacts in the deepest, most intimate fashion with the major segments of the value chain, both upstream and downstream. This constitutes a new form of 'separation of ownership and control', in which the boundaries of the firm have become blurred.

3.4 Competition

From a mainstream perspective, 'greater competition' is equated with a larger number of firms in a given sector. In the heterodox view, 'greater competition' is equated with increased intensity of competition between powerful oligopolistic firms. Far from stifling 'competition', powerful oligopolies can produce increasingly intense competition as giant global firms struggle with other such firms, applying greater resources in R&D and

¹ Even in less well-known sectors, the share of system integrators has typically become very high. For example, the global market share of the top two firms in the financial information sector stood at 86% and at 77% in electronic games; the share of the top three firms stood at 71% in legal publishing and at 62% in artificial joints; the share of the top five firms stood at 77% in recorded music; and the share of the top six firms stood at 60% in water management (Nolan, 2001A).

Table 2. *Dominance of the global big business revolution by firms based in high-income countries*

	Population (2000)		GNP (2000) ^a		GNP (2000) ^b		Fortune 500 companies (2003) ^c		FT 500 companies (2003) ^d		Top 700 companies by R&D spend (2002/3)	
	Million	%	\$b.	%	\$b.	%	No.	%	No.	%	No.	%
HIEs	903	15	24,828	80	24,781	55	472	94	480	96	697	100
L/MIEs	5,152	85	6,336	20	20,056	45	28 ^e	6	20 ^f	4	3	negligible

Notes: ^aat official rate of exchange; ^bat PPP dollars; ^cranked by sales revenue; ^dranked by market capitalisation; ^eChina = 14, India = 4, Brazil = 3, Russia = 3, Mexico = 1, Malaysia = 1, Venezuela = 1, Thailand = 1; ^fRussia = 7, China (all floated in Hong Kong) = 4, India = 3, Mexico = 3, Brazil = 2, India = 1.

GNP, gross national product; HIEs, high income economies; L/MIEs, low/middle income economies.

Sources: *Financial Times*, 27 May 2004; World Bank (1998, 2002); *Fortune*, 26 July 2004; DTI (2003).

marketing, and leveraging greater procurement budgets to lower costs and stimulate technical progress across the supply chain.

3.5 Challenges for developing countries

The high-income economies contain just 15% of the world's total population (see Table 2). Firms with headquarters in these countries account for 94% of the companies listed in the 'Fortune 500', which ranks firms by sales revenue (Table 2). They account for 96% of the firms in the 'FT 500' list of the world's leading firms, ranked by market capitalisation. They account for almost 100% of the firms included in the list of the world's top 700 firms ranked by expenditure on research and development, which is a critical indicator of the distribution of global business power. Five high-income countries, the USA, Japan, Germany, France and the UK, accounted for 82% of R&D in the global top 1,250 companies (DTI, 2006). There is not a single firm from the low/middle income countries in the list of the world's 'top 100 brands' (Sorrell, 2004). Firms from developing countries are joining the 'global level playing field' at a point when the concentration of business power has never been greater. In developing countries that have liberalised their business systems, oligopolies have rapidly been established, not only by the world's leading systems integrators in each of the industries analysed in this paper,¹ but also in the upper reaches (at least) of the supply chain of these industries. Whether this makes a positive or a negative contribution to 'development' is beyond the scope of this paper.

4. Conclusion

Mainstream, neoclassical economists consider that opening up developing economies to global competition provides broad opportunities for indigenous firms to catch up with firms that have their headquarters in high-income countries. This view is based on the belief that the basic tendency of capitalism is competition with strict limits to growth of firm size: they believe that by forcing weak firms to compete with strong ones, the weak can

¹ The telecoms services sector remains the most protected of these sectors at the level of the systems integrators, but even in these countries the supply chain in this industry is comprehensively dominated by the global leaders in telecommunications equipment production.

learn from the strong, imitate them and overtake them. They believe that the epoch of global free trade and free movement of capital, allied with the revolution in information technology, has produced wide possibilities for firms from poor countries to catch up with those with their headquarters in rich countries. In other words, the world of vastly expanded global markets is 'flat'.

But, in fact, the epoch of the global business revolution since the 1980s has witnessed an unprecedented degree of industrial consolidation and concentration of business power at a global level. Alongside a huge increase in global output in the sectors analysed in this paper, the number of firms has shrunk and the degree of global industrial concentration has increased greatly. The 'commanding heights' of the global business system are almost entirely occupied by firms from high-income countries. This presents a deep challenge for indigenous firms and policy-makers from developing countries.¹

The most easily visible part of the structure of industrial concentration is the well-known firms with powerful, globally recognised technologies and/or brands. These constitute the 'systems integrators' or 'organising brains' at the apex of extended value chains. As they have consolidated their leading positions, they have exerted intense pressure across the whole supply chain to minimise costs and stimulate technical progress. The close coordination by the systems integrators of legally independent firms across the supply chain constitutes a new form of separation of ownership and control.

However, the challenge is even deeper than at first appears. This paper has examined the value chains in four industrial sectors, with widely different products. It has shown that they have striking similarities in the way in which the core systems integrators have stimulated a comprehensive transformation of industrial structure across the whole supply chain. At every level there has taken place an intense process of industrial concentration, mainly through merger and acquisition, as firms struggle to meet the strict requirements that are the condition of their participation in the systems integrators' supply chains. This cascade effect has profound implications for the nature of competition. It means that the challenge facing firms from developing countries is far deeper than at first sight appeared to be the case. Not only do they face immense difficulties in catching up with the leading systems integrators, the visible part of the 'iceberg', but they also face immense difficulties in catching up with the powerful firms that now dominate almost every segment of the supply chain, the invisible part of the 'iceberg' that lies hidden from view beneath the water.

At the dawn of the twenty-first century, the reality of the intense industrial concentration among both systems integrators and their entire supply chain, brought about through pressure from the cascade effect, presents a comprehensive challenge for both indigenous firms and policy-makers from developing countries.

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¹ It is notable that Japan and South Korea grew to the developed state through state intervention in trade and industrial policies. In addition, they accomplished 'catch-up' before the current challenges of globalisation.

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