The long-run dynamics of big firms: the 100 largest employers, from the US, UK, Germany, France, and Japan, 1907-2002

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1. Introduction

The growth of large firms has long been of interest in Economics and Economic History, both within national economies and in the global economy. In his *Principles of Economics* (1890 and 1910 editions), Marshall used an analogy of the "forest" for an industry or economy and suggested that, while the "trees" or firms in the forest would grow and die, the forest itself would be constantly renewed. However, with the advent of the joint stock company, he conceded that some firms might grow to a very large size and better survive. Later, Chandler (1977 and 1990) suggested that large firms came into existence in certain industries where there were advantages in internalizing market transactions. Some firms, he argued, used first-mover advantage, investing in production, distribution, and management, and grew in size and survived over the long term. In the terminology of Hannah (1999), such firms are the "giant redwoods" of the forest, surviving over a long period of time. However, using capitalization as the measure, the latter writer found deaths among the trees of the forest more common than survivals.

This chapter considers changes in the size, industrial composition, and survival of the major firms in major economies, from the beginning of the twentieth to the beginning of the twenty-first centuries. It thus traces industries and firms which had their origin in the "first" industrial revolution, largely related to steam power (railways, coal mining, textiles, iron and steel, and heavy engineering), which dominated at the beginning of the twentieth century. It

then charts the rise of industries and firms of the "second" industrial revolution, largely related to electricity, the internal combustion engine, and new chemical processes, which come to dominate the middle years of the twentieth century. It then charts the rise of firms and industry in large part related to the "third" industrial revolution of information and communications technology (ICT), many of which are firms in services and retail.

The chapter is motivated by two sets of interlinked analytical and theoretical considerations. The first set of considerations concerns the pattern of change and continuity in a population of large firms as measured by employment. Here the objective is to conceptualize, dimensionalize, and analyze the pattern of change and continuity in this population of firms over time. For our sample of firms, the biological analogy of the trees of the forest is not entirely appropriate since Marshall was referring to firms in a competitive market, especially in one industry. To date, most work of this kind has been done on manufacturing and mining companies which have existed in largely competitive markets (Chandler 1990; Hannah 1999). By contrast, our population also includes service firms and state-owned enterprises which historically have been less subject to competition, especially from abroad, or which have enjoyed monopoly positions. Nevertheless, such organizations have played a very important role in the growth of the modern business enterprise and are essential to take into account when considering whether there has been a "third' industrial revolution. The challenge is to map a pattern for all such enterprises in terms of size and composition and consider their survival over time and their country of origin. We are also concerned to conceptualize and identify major periods of change in the population.

The second set of considerations relates to explanations of these same patterns of change and continuity. Three broad sets of explanations will be used. These are not set out as hypotheses, because the variables are broad and interrelated and the data does not allow for

statistical testing. Rather they are presented as broad sets of explanations and propositions intended to frame the analysis.

The first set of explanations concerns the interaction between technology and markets. This was classically stated by Smith (1776) who analyzed the interaction between market size and competition and the division of labor in terms of the introduction of technological and organizational change. Schumpeter (1939 and 1942) later developed an analysis in term of periods of "creative destruction" when technology and markets interact to bring about major change. In this chapter, the advent of new technologies, in particular general purpose technologies with broad applicability and facilitating organizational change (Helpman 1998), may be seen as interacting with periods of market growth and extension so as to stimulate new entrants into the population, some of which survive and others of which exit or die. The general proposition here is that the advent of new technologies and the size and nature of markets have driven major changes in the pattern of large firms.

The second set of explanations concerns the influence of the state and the more or less supportive role it has played in creating and sustaining large firms. The literature on the role of the state has recently been surveyed and state-based explanations for big firm growth and survival suggested by Hancké (2002). Here the general proposition is that a significant proportion of firms grew in size and survived under state support and the withdrawal of such state support has similarly had an effect on the population of firms.

A third set of explanations relates to factors more internal to the firm and concerns strategy and structure in a broad Chandlerian sense (Chandler 1962, 1977, 1990). Under this heading we include the adoption of strategies leading to internal growth (investment in production, distribution, and management), vertical or horizontal integration, diversification, multinationalization, the role of mergers and acquisitions, and the adaptation of organizational forms. The proposition here is that large firms entered into our population and survived or

declined over the course of a century mainly because of their own strategic and structural decisions.

The chapter proceeds as follows. The next section outlines the data which is available for the US, UK, Germany, France, and Japan, on the basis of which the study has been designed. The second section explores size, composition, survival, national origin, and periods of change over time. Finally, explanations are offered for patterns, similarities and differences with previous work are considered, and possibilities for further research are suggested.

2. Data, design, and definitions

Firm size is here measured by employment. Earlier studies have examined large firms by assets, turnover, or equity (Chandler 1990; Fruin 1992; Schmitz 1995; Hannah 1999; *Fortune* various). As with all measures, these entail some disadvantages e.g. problems of asset and turnover valuation, the use of different national accounting practices, and the existence of non-quoted companies. The use of employment also has disadvantages e.g. part-time and temporary workers may be excluded from company figures, or alternatively they may be counted as "whole" workers. An employment measure also obviously favors labor-intensive firms and industries which may not be asset rich nor have high market valuations. Of course, similar objections about bias may be raised concerning capital-intensive or high valuation firms. Thus, there is no "right" answer to the question of measurement, though value added would be highly desirable, if it could be constructed. Here the contention is that employment offers an alternative and important measure of how firms have changed over time. It also offers an insight into firms for those interested in the human capital and labor relations aspects of business (Jeremy 1991; Cassis 1997; Fiedler 1999; Wardley 1991 and 1999).

We take firms from five countries – the US, UK, Germany, France, and Japan. These were chosen as representing the five major capitalist economies of the twentieth century. The countries were also selected because lists already existed for the UK, Germany, and Japan for the early years or could be added to from various other sources (see Appendix 1). Of course, this provides a "synthetic" top 100 firms, and we leave out large firms in countries such as Italy, the Netherlands, Switzerland, Russia, China, and India. However, it is likely that we capture a significant proportion of the top 100 global companies through the twentieth century. It should be noted here that, for all the organizations in this study, employment covers not just employment in the country of origin, but global employment throughout the world.

For the purposes of analysis, we consider the top 100 at five periods in time, in part in line with earlier research, but also seeking relatively "normal" years about a quarter century apart. Thus, the years around 1907 provide our initial date before the First World War and by which time many giant firms had already come into existence. The period around 1935 lies between the interwar depression and the outbreak of the Second World War. Here it should be noted that the data for Germany comes from 1938 when that country was further into war production than the US, UK, or France. However, the 1938 database for Germany (Fiedler 1999) is particularly good and it was decided to make use of it. A shorter time period is then taken up to around 1955 which provides a benchmark date following initial post-war reconstruction. The period around 1972 provides a date at the end of the post-war boom. We present data for 2002 by way of our terminal date. Again we note that, depending on the availability of data, the exact dates may vary within a number of years, both within and between countries (see Appendix 1).

In terms of the coverage and reliability of the data, for the 1907 period we are most confident about the German and French companies. We also have confidence that we have

included most British companies, though there may be some underestimation. We are less confident that we have the full number of American firms, and again there may be a small underestimation. For 1935, there may also be missing UK, American, and Japanese companies, though again this is small. The post-Second World War data for the five countries are good, with the possible exception of Japan, where the complexities of some group companies may lead to a small underestimation. We take the position that rather than wait to construct the perfect dataset, analysis of existing datasets is desirable to start to understand patterns and to provide explanations for changes in big business (Jeremy and Farnie 2001; Wardley 2001).

The firms include some organizations which to date have always been state concerns (national post offices). However, whereas in some countries the telephone system has always been private (US), in other countries it has been a part of the public postal service and / or has moved between the two sectors (UK, Germany, Japan). Other firms, such as utilities, railways, and coal, have moved between the public and private sectors. This also included tobacco companies in France and Japan. On the other hand, we exclude from the analysis government departments, municipalities, and bodies such as the National Health Service in the UK, in other words, state organizations which do not operate for profit and for which output has not been charged or charged only at a nominal price.

In terms of ownership, we consider companies which are more than 50% owned by another firm to be part of the latter company. Firms such as Unilever and Shell which have joint nationality are attributed to one country, in these cases the UK. In the case of mergers, we identify the core or prime merging company and take it as a survivor and the other firms as deaths. Finally, firms are coded by standard industrial classification (SIC). For this we use the British 1968 SIC which provides a roughly mid-century baseline. Where firms operate in

a number of industries, we have assigned them to what we consider to be their main area of activity.

The full data set will be made available on the authors' website and direct from the authors on request.

3. Analyzing the top 100

In terms of size, Table 1 shows the minimum number for entry into the top 100 grew from 18,996 in the period around 1907 to 113,000 in 2002. This reflects an annual rate of growth of 2.1% over the period 1907-35, rising to 3.2% in 1935-55 and 3.9% 1955-72. Thereafter the annual rate of growth decelerated to 3.3% in the years 1972-2002. Over the whole time period, the mean rose from 53,417 to 222,129 and the median from 33,650 to 183,819. Over time, changes in the mean and median follow a broadly similar rising trend and a similar deceleration in the final period.

The maximum size grew from 486,318 in the period around 1907 to 1,300,000 in 2002. The maximum has been very much affected by large public concerns (which took the top place in the first three observations – Preußisch-Hessische Staatseisenbahn, Deutsche Reichsbahn, and British Transport Commission). Only in the two later periods (1972 and 2002) have private sector firms topped the list – AT&T and Wal-Mart. The coefficient of variation (the standard deviation expressed as a percentage of the mean) shows that the dispersion in the population has become less over time – in other words, these big firms have become more similar in size over the century.

Table 2 shows total employment of these giant firms as a percentage of the total labor force of the five countries. It will be seen that this more than doubled from 4.1% in the period around 1907 to 8.4% in the mid-1950s where it stabilized through to the 1970s. Thereafter,

the number has fallen to 7.7% in 2002, a figure still significantly larger than the start date. Thus, after a long period of increase, in the most recent period these giant firms have come to represent a reduced proportion of total employment in these countries.

In terms of composition, Tables 3 and 4 show that the main sectors in the period around 1907 were railways and (albeit a long way behind) metals, mining, and food, drink, and tobacco. The table then shows the long-term decline in the number of large firms in railways, mining, textiles, mechanical engineering, and shipbuilding. The two periods 1935-55 and 1955-72 were the "golden age" of manufacturing, with around two thirds of total firms for these years coming from the manufacturing sector. However, it should be noted that vehicles continues to rise over the whole period, from 3 at the beginning of the twentieth century to 15 at the beginning of the twenty-first century. From the 1970s, a significant change takes place with the rise of retailing and services. By 2002, the largest single groups of firms come from retailing, services, vehicles, and communications. Table 4 shows the significance of state enterprises up to the 1970s (with around 20 in the top 100) and their subsequent decline (to less than 10). As an aside, it will be noted that we have no examples from certain SIC industry categories – agriculture, leather goods, timber and furniture, and professional services where firms have not attained a large size by employment.

We turn next to survival and country of origin of firms. Here a caution is appropriate. Survival is not necessarily a good thing. It may reflect a successful firm, but it may also reflect the absence of competition, protection, and inefficiency. Equally, a large proportion of survivors in a country may reflect a healthy economy or represent a failure to develop big firms in new sectors. Similarly, for a country to have a large number of big firms may also be a sign of state support and protection which may have negative effects and which may not be sustainable in the long-term. Big enterprises are neither unambiguously good nor bad; it

depends on why they are big and what they do with their resources. Having stated this caveat, the intrinsic interest of considering a population of large firms over time remains.

In terms of entry, survival, and exit from the top 100, Table 5 shows the number of entrants and exits has risen over time since the mid-1930s. Overall, taking the whole period, death was more common than survival. In total, 11 firms survive over the long-term from 1907 to 2002. A further 25 firms survive in an independent form outside the top 100. In total, therefore over a third of firms in the top 100 in the period around 1907 are still in business at the beginning of the next century. (A separate analysis (not reported in the Table) shows that the top 25 firms had higher survival rates in the top 25 than firms lower down had of surviving in the their part of the distribution.)

Note overall the rising number of new entries and exits per annum since the mid-1930s. The final period 1972-2002 has the highest number of new entrants, with an average of 2.0 per annum. As an aside, the number of firms which re-enter the top 100 over the period is small: it is at its highest after the Second World War and reflects post-war reconstruction and restructuring in Germany and Japan, with the re-entry of firms such as Thyssen, Gelsenkirchener Bergwerks-AG, Nippon Steel, and Mitsubishi Heavy Industry.

In more detail, the 11 survivors over the century are the Preußisch-Hessische Staatseisenbahn (Deutsche Bundesbahn), Deutsche Reichspost (Deutsche Post), US Post Office, General Post Office (Royal Mail), La Poste, National Post Office (Japan Post), Réseau de l´Etat (SNCF), Friedrich Krupp (Thyssen Krupp), General Electric, Siemens, and General Motors. It is will be noted that 7 of these are state-owned enterprises. Some of the 25 survivors outside the top 100 are still very large companies such as Exxon, VEBA (now E.on), Mitsubishi Heavy Industry, and Prudential. Others are now much smaller companies some of which have transformed their core activities. These include firms such as American Car & Foundry (which changed its name to ACF Industries and continues to exist as an

independent specialist engineering firm), the German steel producer Gutehoffnungshütte-Haniel (successfully changing into a transport and logistics company), and the former French steel and mining company de Wendel (today a holding company in finance and real estate).

In terms of country of origin, Table 6 shows that the US contributes the largest number of corporate giants through all years. Thus, it has between 40 and 50, around double the next country. The UK contributed the second largest number at the beginning of the time period (23) and sees fluctuation around this over the next two time periods. However, it has also seen the biggest fall, down to 9 in 2002. Germany has consistently ranked either second or third, with a mean of 17 companies. France has seen the biggest fall and rise, from 10 at the beginning of the period, down to 6 in the 1950s, but rising to 19 in 2002. Japan had 8 global giants before the First World War and the same number before the Second World War. Thereafter, this fell back to 3, but since then has risen to 9 and then 11. However, it should be remembered that there may be some small understatement of Japanese figures because of the difficulty of measuring employment in pre-war *zaibatsu* and post-war *keiretsu* companies. In summary, on national contribution, the most striking features are the stability of the US over the whole period, the relative decline in the number of UK companies, and the parallel rise of Japanese and especially French companies from 1955 onwards.

We turn next to the timing of changes in size, composition, survival, and country of origin. In terms of size, the period with the highest growth was the years 1955-72, in other words after postwar reconstruction and during the long post-war boom. Compositional change was highest in the years 1972-2002. This is reflected in the disappearance of textile firms from the tables, the decline in the number of chemical, metal, mining, and engineering companies, the rise of retailing and financial services, and the appearance for the first time of firms in miscellaneous services. The period 1907-1935 was also one of high compositional change, with the decline in the number of railways and mechanical engineering companies,

the entry for the first time of electricity and chemical companies, and the rise of petroleum, vehicle, retailing, textile, electrical, and metal manufacturing firms. The period when compositional change is least is over the two time periods 1935-55 and 1955-72. However, during those years, shipbuilding firms disappeared from the rankings, the number of textile, metal, railway, and petroleum companies declined, and electrical engineering, chemical, utilities, vehicles, and retailing firms grew.

Turning to timing by entry, exit, and survival, the periods with the largest number of new entrants per year are in the second half of the twentieth century. Thus the average annual number of new entrants rises from 1.7 in 1907-35 to 2.0 in 1972-2002. A further breakdown of the figures (not reported in the table) suggests that much of the acceleration in the latter period was from the 1990s onwards. The period when there is most change in country of origin is the final time period with the decline in the number of British firms and the rise of French companies. The only comparable period in terms of change in country of origin is the post-Second World War years, with the more easily understandable decline and then revival of German and Japanese companies. In conclusion, in terms of the timing of change, the period of maximum change is at the end of the twentieth century, with a large number of exits and new entrants, major compositional change, and major changes in country contributions. The next most turbulent period is the beginning of the twentieth century, with significant changes in size, composition, and survival.

4. Explaining long-run dynamics

There are a number of patterns to be explained – changes in composition, size, entry and exit, country of origin, and the timing of change. We take each of these in turn and attempt to assess the effect of the three sets of explanations outlined at the beginning – changes in

technologies and markets, the changing role of the state, and the effect of differences in corporate strategy and structure.

Compositional change in large part reflects major technological changes over the century, especially the impact of new general purpose technologies. Industries of the "first" industrial revolution, largely related to steam power (railways, coal mining, textiles, iron and steel, and heavy engineering), dominate the list in the years around 1907. However, there are already a few firms from new sectors (electrical, telegraph and telephone) which have entered the top 100 by this date. Over the next two periods, covering broadly 1935-55 and 1955-72, the industries of the "second" industrial revolution, largely related to electricity, the internal combustion engine, and new chemical processes, come to dominate the list. Thus, the number of railway and mining companies decline – in large part through the process of merger and acquisition and nationalization in Europe. During these years, new power generation, electrical, and chemical related companies enter. The development of road transport is seen in the rise of vehicle and related firms (tires, other components, and petroleum). After the Second World War, these are also joined by aircraft companies. Such firms, along with chemicals, rise steadily up to the 1970s. From then onwards, firms enter the list whose growth is in large part related to the "third" industrial revolution of information and communications technology (ICT). These are not the manufacturers of such technologies, since such firms tend not to be labor intensive. Nor are they manufacturers in general since ICT in that sector has tended to be labor-saving. Rather they are the users of these technologies in retail, distribution, and services which use information technology and modern transport and communications systems to obtain economies of scale and scope in areas where this was not previously possible (Freeman and Soete 1997; David and Wright 2005). By the beginning of the twenty-first century, these firms dominate the list.

There are a number of possible explanations of the rise in size. The rise in the size of state enterprises explains some of the overall increase, but mainly at the top end of the distribution and, given the decline in the number and size of such enterprises over time, this is not the major factor in driving the overall increase in size. A more important explanation is again in terms of the progressive application of technologies which allowed firms to manage greater scale and scope of operations in particular industries e.g. vehicles, electricals, and food and drink. Here also we stress the progressive introduction of new business communications and processing technologies from the early twentieth century onwards (Yates 1989). Similarly, in recent decades, the introduction of ICT has allowed the growth of new giants in retailing (Wal-Mart and Carrefour), distribution (Fedex and United Parcel Service), and in services such as catering (Compass and Sodexho). The rise in size has also been driven by the increase in effective demand in national markets and, in the post-Second World War period, the steady growth of international markets. Over the whole period, the processes of growth have been a combination of both internal growth and growth by merger and acquisition. There has also been a growing multinationalization of these companies, including increasingly via cross-border acquisitions (Jones 2005). Unfortunately, from the data available, it is not possible to quantify and distinguish the relative contribution of these various determinants and processes.

As stated, the data shows that a few giant firms have tended to pull out the distribution in the population. However, it will be remembered that the coefficient of variation has fallen over the long-term, especially since the 1950s. In other words, overall firms in the top 100 have tended to become more equal in size. Some of this decline in variation around the mean reflects the decline in the size of massive state enterprises (national postal and railway companies) and non-state monopolies (AT&T). However, although there are signs that limits to growth in state firms and in manufacturing may have been reached, the phenomenon of

Wal-Mart with 1,300,000 employees and other large retailing and distribution companies shows that this is not the case in all industries.

Turning to long-term entry, exit, and survival, it will be remembered that entry / exit per year increased over time from the mid-1930s. It will also be recalled that over the whole period, 11 firms survived in the top 100, of which 7 were state-owned enterprises. A further 25 firms survived outside the top 100, of which 5 were one-time state-owned enterprises (such as Veba in Germany and the former French and Japanese tobacco monopolies). There are, therefore, several tasks in terms of explaining the long-term story over the twentieth century. One is to explain why only 11 organizations survived within the top 100, with most of these being state-owned enterprises. A further task is to explain why a larger number of 36 survived over the whole period. Putting this the other way around, it is necessary to explain why, of the top 100 population in 1907, 89 had exited the top 100 and 64 had died by 2002.

Of the 89 exits from the top 100, we have seen that 25 continued to exist. This leaves 64 deaths to be explained. There are two main reasons for deaths. The first is technological change and the decline of certain sectors (railways, mining, and later manufacturing). The second is mergers and acquisitions, including government nationalization in the middle years of the twentieth century in Europe. In practice, these two factors have often been inter-related, though mergers and acquisitions have taken place in both technologically mature and new industries. It is notable that overall, very few deaths have been caused by bankruptcies (Armstrong Whitworth and two US railway companies). However, failing firms have usually been the target of acquisitions (as in the case of Republic Steel, Montgomery Ward, and Firestone in the US and AEG in Germany).

From this small sample of survivors, it is difficult to draw firm conclusions about causes of long-term survival over the whole period. Of the 11 long-term survivors, 7 are state-owned enterprises. However, none of the 25 which survived outside the top 100 were

state-owned over the whole time period. On the other hand, five of them were state-owned enterprises over three of the four time periods. State ownership is undoubtedly one factor contributing to longevity, but only explains a small number of survivors, inside and outside the top 100.

Of the 4 private-sector firms which survived in the top 100 over the whole period, General Electric and Siemens were in expanding industries and managed over time to diversify successfully into newer and higher value activities. General Motors was in an expanding industry and more recently has successfully expanded into financial services. Thyssen Krupp was in a sector which has not expanded continually, but has benefited from merger and progressive diversification into newer areas of its sector. All the companies have long been multinational. An additional 19 firms survived in the top 100 over three time periods – 13 over 1907-72 and 6 over 1935-2002. No pattern emerges in terms of size, sector, or country from this further group of survivors. In the case of all these private-sector survivors, it would seem that a residual explanation in terms of corporate strategy and structure may be important. However, any fuller explanation would require a detailed analysis of the business histories of all the surviving firms.

Explanations of national contributions in part reflect the size of markets and national economies. To correct for this, we have calculated each country's gross domestic product as a proportion of the total gross domestic product of all five countries (actual figures not reported here). We then compare the percentages with each country's contribution of big firms. On this basis, it is not surprising that the US has the largest number of big firms. However, it would seem that it always had fewer large firms than its size warrants and this has been most marked in the post-Second World War period. By contrast, the UK has been over-represented relative to its size, especially in 1955 and 1972; the present figure is roughly comparable with the relative size of its gross domestic product. Before the Second World War, Germany had a

number of large firms roughly commensurate with its size; since then it has been underrepresented. In the case of Japan, before the Second World War, it had a number of big firms roughly equivalent to its share of GDP; since that time, it has been significantly underrepresented. France was roughly proportionately represented up to the 1970s, but since then has come to be significantly over-represented.

The size of national economies, therefore, cannot fully explain some of the relative position of countries nor changes over time. Other explanations must be sought, including particular conjectural explanations. In the case of Japan, its fall from 8 to 3 between 1935 and 1955 reflects the break-up of the *zaibatsu* companies and the effects of the post-war loss of foreign assets. A parallel, but smaller, fall in Germany from 21 to 16 over the same period reflects similar circumstances. From then onwards, German numbers stagnate at 14. Japanese numbers grow from 3 to 9 and to 11 by 2002. This reflects the post-war growth of the Japanese economy. However, as stated, Japan does not have the number of large global firms commensurate with the size of its national economy. This may in large part reflect the failure of Japanese financial and retailing firms to establish themselves as multinational giants.

One striking phenomenon to explain is the change in the fortunes of UK and French firms. The UK starts the twentieth century with twice as many giants as France (22 compared to 10), reflecting the earlier development and more international orientation of British companies and the slow growth in the big firm sector in France, as noted by other commentators (Kogut 1997; Fridenson 1997; Levy-Leboyer 1980; Smith 2006). The gap narrows in the interwar years (15 compared to 11) and widens again by 1955 (25 compared to 6). The size of the latter gap is striking. Thereafter, between 1972 and 2002, the two countries roughly change place: the UK falls from 22 to 9 and France rises from 13 to 19. In the case of the UK, this in part reflects the disappearance of the vehicle industry and electrical

firms. However, it leaves Britain with about as many giant firms as the size of its economy warrants. A part of the explanation for the UK decline and the French increase may be the role of the state and national champions. As Hancké (2002) shows, through the 1980s, the French state helped preserve employment in a number of large firms, especially in vehicles, electricals, and related industries. By contrast, from the late 1970s onwards, the UK state eschewed such policies. However, this state-based explanation does not account so well for the entry of such French firms as Sodexho, Veolia, Bouygues, and major French retailers. Any further explanation would require a detailed analysis of the histories of these firms.

Finally, we turn to the main time periods of change. The period 1907-35 saw significant change in size, composition, and exits, but less change in country rankings. This was the period of the rise of the new global corporate economy of the twentieth century, based on new manufacturing industries. The next two time periods, 1935-55 and 1955-72, saw more change in size and country of origin, but medium change in exits and less change in composition. The final time period saw big change on all measures - size, composition, exits, and country of origin. This period marks the re-making of the global corporate economy, with the decline of manufacturing and state enterprises and the rise of new retailing and service firms. The explanation for the two peak periods of change at the beginning and end of the twentieth century would seem to be twofold: the advent of new technologies, in particular general purpose technologies; and, especially for the latter period, relatively high levels of market competition as reflected in the greater openness of national economies. The greater stability in mid-twentieth century likewise reflects the consolidation of technological innovation and lower product market competition, constrained by tariffs and cartel-type arrangements in some sectors and countries.

In summary, different sets of explanations seem better to account for different aspects of the changing pattern of large firms in our population. Size seems to be largely driven by

technology and market interactions. Nesting within this, firm strategy and structure are important where policies of integration, diversification, multinationalization, and acquisitions have played an important role. The state influenced size and survival mainly at the top end of the distribution. Composition is also largely driven by technology and market interactions. The role of the state and the firm are of lesser importance in explaining compositional change. Technology and market interactions also have a significant effect on survival. Here, however, the state has played a role, albeit a declining one. Also, in terms of which specific firms in specific industries survive, company strategy and structure are clearly important factors, but are difficult to determine. Country of origin is not much driven by technology, but the size of markets plays a role. Here the state also offers some explanation of survival, death, and entry by companies from different countries. Again, it is more difficult to determine the role played by corporate strategy and structure. The timing of change is best explained by waves of creative destruction as technologies and markets interact. The state plays a lesser role in the timing of change, except with the case of nationalizations mid-century and to a lesser extent privatizations at the end of the century. Corporate strategy and structure, especially mergers and acquisitions, may be important in explaining timing, but again it is difficult to determine the extent of this in the absence of detailed company histories.

We summarize by sets of explanations. Overall interactions between technology and markets would seem to have most effect on the population of firms. Next, corporate strategy and structure have a significant effect, in terms of strategies of integration, diversification, multinationalization, and mergers and acquisitions. However, corporate strategy and structure remain something of a residual. Overall, state intervention and support has least effect and this declines over the century, though with the exception of recent privatizations and possibly the French story.

5 Conclusions

This chapter has charted major changes in a population of top 100 firms by employment drawn from the five major industrial economies of the twentieth century. In summary, the size of these firms has grown progressively over time, though with a deceleration in the final quarter of the century. This deceleration is also reflected in their smaller proportion of total employment in the countries concerned. Though the top organizations (often state-owned) have always been significantly larger than the rest, over time the firms have become more similar in size. Compositional changes show the following: the long-term decline of railways, mining, and metals; the rise and then decline of manufacturing industries, with the exception of vehicles which rises throughout; and, in the final period, the rise of retailing and services of various kinds. Entry and exit increases progressively over time from the mid-1930s, and overall death is more common than survival. In every year, reflecting the size of its economy, the US tops the list, with between 40 and 50 giant enterprises. The UK comes second or third in four time periods, but then falls dramatically. The main gainers in terms of catch-up over the long term are Japan and especially France. Finally, in terms of periods of change, the beginning and especially the end of the twentieth century see the highest rate of change on most of the measures. The former period sees the move from the industries and firms of the "first" industrial revolution to the "second"; the latter sees the move from the "second" to the "third" industrial revolution.

Various explanations are offered for these trends. It has been argued that size is mainly driven by a combination of technology and markets and, nesting within that, corporate strategy and structure, especially in terms of integration, diversification, multinationalization, and mergers and acquisitions. These factors also drive the timing of change and periods of greater turbulence in the population. Changes in composition are largely the result of

technological and market developments, though mergers and acquisitions and nationalizations and privatizations play a part. The country of origin rankings broadly reflect the size of national economies and the catching up of Japan and France in the post-Second World War period. In the latter country in particular, national championship may have played some part in its recent increasing contribution. Entry and exit are largely a phenomenon of compositional and market change and mergers. Survival of particular private sector firms is the most difficult to explain and remains as something of a residual factor.

This chapter suggests similarities and differences with earlier findings. However, a caveat here must be that earlier work has differed in terms of measurement criteria, time periods, and number of countries covered. We cannot consider these in detail here, but present a concluding overview.

In terms of size by employment, the chapter confirms earlier work by Fiedler on Germany (1999) and White (2001) on the US and Wardley (2003) and White (2003) on firms from a larger number of countries. These have suggested a long-term increase in the size of firms by employment, but with a deceleration and fall relative to total employment in the final time period. Overall, big firms are getting bigger, but not their contribution to total employment. The chapter might also seem to lend some support to the Langlois (2003) "vanishing hand" argument in that the deceleration of growth in the final time period might indicate some vertical disintegration, divestiture, and outsourcing. However, we stress that in our population size continues to increase. Clearly no limits to size have been reached, at least in retail and services.

Taking composition, the chapter has similarities with recent research which has gone beyond the Chandlerian emphasis on industrial firms in manufacturing and mining. Thus, it confirms work which stresses the early importance of large firms outside the industrial sector, the importance of state corporations, the rise and decline in the number of "second' industrial

revolution manufacturing firms, and the later rise of retailing and services (Jeremy 1991; Cassis 1997; Fiedler 1999; Wardley 2003). The chapter also questions the appropriateness of the Marshallian analogy, based on free competition between private sector industrial firms, as a basis for comprehending the population of large twentieth century employers.

In terms of periods of change, this chapter does not confirm Fiedler's suggestion of declining turbulence over time and greater stability in his population of German firms by employment. Nor does the chapter confirm Hannah (1998, 1999) who suggests roughly similar change over each of his time periods for large firms by capitalization. By contrast, our work shows that the beginning and especially the end of the twentieth century saw greater turbulence in the population than other periods. This is more in line with the findings of Louca and Mendonca (2002), though their population is US manufacturing firms by assets.

In the case of survival, Chandler posited first-mover advantage and continuity. Of course, he did not use employment as the basis of his analysis. Nevertheless, our findings question his emphasis on continuity. More specifically, they contradict Fiedler who showed a rising survival over time for his population of large German firms by employment. By contrast, our work suggests survival decreased over time. Overall, death was much more common than survival, as suggested by Hannah (1998, 1999).

Survival also relates to country of origin. In recent years, a number of authors have contested comparative conclusions drawn by Chandler (1990). Thus, for the early period, Wardley (1999, 2003) has suggested that top British firms were larger and more diverse than their US and German counterparts. To this Cassis (1997) and Hannah (1998, 1999) have suggested that, using capitalization over their time periods, Britain contributed a larger number of firms than its size would warrant and that British firms had higher survival rates than firms in other countries. Our data support this for all years up to the final period, when the number of British firms declined significantly. Our data also clearly shows the rise in the

number of French firms in a way which has been little remarked until now. White (2002), using employment, also suggested that in recent years the UK number has fallen and the US and France have risen. However, he also has the German and Japanese numbers falling.

Finally, by way of further research, there is scope to improve the basic dataset and to include new firms. This includes improvement in the Japanese data, especially data on group companies. There already existe databases of the top 100 in the UK, Germany, and Japan for these years. The completion of US and French domestic lists will allow us to do more detailed analyses of 500 firms. In addition, there is scope to construct a database including big firms from outside our five countries. Of course, it would be extremely useful (albeit also a major challenge) to complete the major task of bringing together the existing employment, asset, turnover, and capitalization data so as better to ascertain the links between the various aspects of the large business enterprise. Finally, more fine-grained work on sub-periods and in particular on the company histories of survivors would provide more insight into the determinants of growth and survival.

Table 1 Size of top 100 firms

	1907	1935	1955	1972	2002
Minimum	18,996	30,000	49,188	82,000	113,000
Maximum	486,318	703,546	801,199	777,869	1,300,000
Mean	53,417	83,808	138,621	185,195	222,129
Median	33,650	49,685	79,575	122,800	183,819
Sum	5,341,747	8,380,811	13,862,142	18,519,530	22,212,911
Standard deviation	64,457	92,053	145,168	140,190	150,566
Coeficicent of variation	1.21	1.10	1.05	0.76	0.68

Table 2 Number of employees in top 100 firms as percentage of total employment in US, UK, Germany, France, and Japan

	1907	**1935**	**1955**	**1972**	**2002**
Employees top 100 (in millions)	5.342	8.381	13.862	18.520	22.213
Total labor force (in millions)	129.436	150.745	164.492	219.556	288.677
Employees top 100 as% of total labor force	*4.1*	*5.6*	*8.4*	*8.4*	*7.7*

Note: Global employment as sum of total labor force in US, UK, Germany, France, and Japan, mainly based on: Bairoch (1968); OECD (1995a); OECD (1995b); and ILO (2002).

Table 3 Industrial composition of top 100 firms

Industry	**1907**	**1935**	**1955**	**1972**	**2002**
Mining	5	5	6	4	1
Food, drink, tobacco	8	7	4	5	5
Petroleum	1	6	7	3	3
Chemicals	0	3	4	9	1
Metal manufacture	11	16	12	7	1
Mechanical engineering	5	3	3	5	1
Instrument engineering	0	0	2	4	0
Electrical engineering	4	6	11	18	11
Shipbuilding	3	3	1	0	0
Vehicles	3	7	12	13	15
Other metal	0	1	1	0	0
Textiles	2	4	1	2	0
Brick, pottery, glass, cement	0	0	0	1	1
Paper, printing	0	1	1	0	0
Other manufacturing	0	3	4	4	1
Construction	0	0	0	0	2
Gas, electricity, water	0	2	4	4	4
Transport & communication	55	27	18	13	14
Retailing	1	5	7	8	26
Banking, insurance, finance	1	1	1	0	6
Miscellaneous services	0	0	1	0	8

Note: Firms are grouped by their main activity. We include military and defense organizations owned by government as either engineering or shipbuilding where they were organized as separate companies, for example Military and Naval Arsenals.

Table 4 Sectoral composition of top 100 firms

Sector	**1907**	**1935**	**1955**	**1972**	**2002**
Mining	5	5	6	4	1
Manufacturing	38	60	63	71	39
Services	2	6	9	8	40
Transport, communications, public utilities, construction	55	29	22	17	20
	100	100	100	100	100
State	20	17	19	19	9

Table 5 Long-run dynamics of top 100 firms

	1907-1935	**1935-1955**	**1955-1972**	**1972-2002**	**1907-2002**
New entrants In top 100	47	35	34	61	-
New entrants per year	1.7	1.8	1.9	2.0	1.9
Re-entrants In top 100	-	1	5	3	-
Survivors In top 100	53	64	62	36	11
Survivors in any independent form outside top 100	30	49	63	38	25

Table 6 Country of origin of top 100 firms

Country	**1907**	**1935**	**1955**	**1972**	**2002**
USA	40	45	50	42	47
UK	23	15	25	22	9
Germany	19	21	16	14	14
France	10	11	6	13	19
Japan	8	8	3	9	11

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Appendix 1: Data Sources

US

Pre-Second World War period, Wardley (1999) and unpublished own research; 1955, 1972, and 2002, *Fortune 500* and own research.

UK

1907, 1935, and 1955, Shaw (1983), Johnman (1986), Jeremy (1991); 1972 and 2002, *The Times 1000, Europe's 5000 Largest Companies*, Oslo 1975, and our research. We are kindly indebted to Les Hannah, Alison Sharp, and Peter Wardley for advice and data.

Germany

1907, 1938, and 1973, Fiedler (1999); 1955, unpublished own research; 2002 *Fortune 500* and own research.

France

For all years, Cassis (1997) and unpublished own research.

Japan

We owe a considerable debt to Professor Takashi Abe, Osaka University, for making available his Japanese data set and for explaining aspects of large firms in Japan. We have subsequently added to and re-interpreted his data, in particular by adding together the figures for *zaibatsu* companies for 1907 and the figures for military and naval arsenals for 1935. We are entirely responsible for these additions and re-interpretations.

In the case of 24 observations, estimates have been made, usually on the basis of interpolation between years. Requests for the data sets used to generate the results presented in this chapter should be made directly to the authors.

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