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Leading Manufacturing Sectors in the USA and Japan During 1899-1937 and Organizational Innovations: Embeddedness for Corporate Strategy

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LEADING MANUFACTURING SECTORS IN THE USA AND JAPAN DURING 1899-1937 AND ORGANIZATIONAL INNOVATIONS: EMBEDDEDNESS FOR CORPORATE STRATEGY

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Abstract

Organizational innovations (OIs) such as scientific management, integration of mass production and mass distribution, and particular types of corporate governance played a preponderant role in the economic development of the USA during the period 1880s to 1920s . To provide some further evidence of this role, historical data analyzed by Kuznets (1971) are scrutinized in this paper by calculating total factor productivity (TFP) for manufacturing sectors in the USA, and the impact of OIs on leading sectors is briefly explored in the light of these TFPs. Thus this paper provides quantitative evidence that leading sectors are linked with OIs during the examined period. In the light of this evidence the following proposition is made: leading sectors and OIs can be considered as a process of 'embeddedness' (Granovetter, 1985) for corporate strategy, governance, and leadership.

INTRODUCTION

Organizational innovations (OIs)[1] such as scientific management, integration of mass production and mass distribution, and particular types of corporate governance played a preponderant role in the economic development of the USA during the period 1880s to 1920s[2]. To provide some further evidence of this role, historical data analyzed by Kuznets (1971)[3] are further scrutinized in this paper by calculating total factor productivity (TFP) for manufacturing sectors in the USA, and the impact of OIs on leading sectors is briefly explored in the light of these TFPs. Thus this paper provides quantitative evidence that leading sectors are linked with OIs during the examined period. In the light of this evidence the following proposition is made: leading sectors and OIs can be considered as a process of 'embeddedness' (Granovetter, 1985) for corporate strategy, governance, and leadership. This proposition can be deemed as an extension or a sub-theme of Chandler's (1962, 1981) suggestion that there is a close interplay between strategies and organizational structures[4]. In other words, corporate strategy, governance and leadership can be operational only in the broader context of leading firms and sectors as well as their OIs[5,6]. In the first section the American manufacturing sectors will be examined, whereas in the second section the Japanese industries will be explored.

1 USA

Kuznets (1971) analyzed the structural changes of all industries in the USA in terms of shares in total output and growth for the period from 1880 to 1948. Chandler says in this respect: "...Kuznets's data

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[1] See Sanidas (2002a) for a historical review of OIs in the USA and Japan since the 1850s.
[2] For evidence on the impact of OIs on sectoral manufacturing growth in the USA in the most recent period after World War II see Sanidas (2001) and Sanidas (2002b). Similarly, for Japan see Sanidas (2002b).
[3] This author has analyzed sectoral data in order to indicate that technology,- not in the sense of OIs, but rather in the classical sense of technical innovations (TIs) or embodied technology (for example a new machine),- played a substantial role in the growth of key sectors.
[4] Chandler (1962) analyzed this interplay in a landmark study of 70 large corporations. In this respect see also Thompson and Strickland (2001, p. 363).
[5] Here, emphasis is on OIs, though TIs can also play a parallel strong role in this process of embeddedness.
[6] The process of embeddednes proposed here is also present in more recent periods such as that of after World War II (cf. the strategies and governance developed by Japanese firms within the context of *Keiretsu* and the just-in-time process, Keys *et al*, 1994). Presumably, other countries besides the USA and Japan have experienced the same process.

support the assertion that the industries spearheading American economic growth were those dominated by a small number of large managerial enterprises..." (Chandler, 1990, p. 226) In this section, the data used by Kuznets are more scrutinized in order to link sectoral growth with OIs.

Two variables will be examined, namely the growth in the real output of manufacturing sectors, and the corresponding TFPs[7]. Although the data for this period are not as comprehensive as that of the last 50 years, available records from official American sources are used to construct these two variables on a 2-digit SIC equivalent sub-sector basis. The results can be deemed to be quite accurate for the purpose of this analysis, which is to detect differences in each one of the two variables (real output and TFP) between the sub-periods1899-1914, 1915-1929, and 1930-1937 and relate these differences to various OIs. Unfortunately, no relevant data are available for the computation of TFPs before 1899. Table 1 summarizes the results analyzed in this section. In this Table, it can be seen that, although the rate of average annual growth in real output was almost as high during 1915 to 1929 as it was during 1899 to 1914, the TFP average annual growth was substantially much higher during 1915 to 1929[8]. For the period 1930 to 1937, as might be expected, both real output and TFP declined equally because of the consequences of the Great Crash. In addition, sectoral growth in terms of real output and TFP can be grouped into several categories as shown in Table 2, thus differentiating leading sectors from non-key sectors. We can observe in this Table that manufacturing sectors, such as Transportation, and Machinery (both Electrical and other) led the American supremacy in industrial development especially during the second half of the Second Industrial Revolution (1915-1929).

[7] TFP is used according to the usual assumptions (see Jorgenson 1990, 1995)
[8] A pronounced slowdown of industrial productivity during the period 1890 to 1913 was also observed by David (1990, p. 356).

Table 1 Summary of sectoral productivity growth in the USA from 1899 to 1937

	Empl/t (000)	Real Output (in 1929 $)	Output Deflator	Annual Aver/e TFP(%) growth	% Real Output Growth	Number Establ/s	Empl/t per Establ/s
Food							
1899	476	6041	0.43			42000	11
1914	760	11050	1.48			51502	15
1929	872	13730	1.00	1.60	3.03	55325	16
1937	1049	16862	0.86	0.31	2.85	48763	22
Textiles							
1899	716	2076	0.50			5930	121
1914	1013	3500	0.61	-0.15	4.57	6756	150
1929	1190	6662	1.00	0.76	6.02	7415	160
1937	1209	7231	0.73	0.81	1.07	6096	198
Wood							
1899	602	2037	0.35			32456	19
1914	718	1940	0.53	-1.26	-0.32	37949	19
1929	651	1583	1.00	0.22	-1.23	20928	31
1937	473	1142	1.06	-2.58	-3.48	11747	40
Paper							
1899	100	332	0.60			1895	53
1914	182	794	0.65	-0.24	9.28	2344	78
1929	258	1761	1.00	1.31	8.12	2973	87
1937	301	1834	1.03	0.21	0.52	3084	98
Chemicals							
1899	170	829	0.63			7669	22
1914	269	1713	0.74	-0.28	7.11	10698	25
1929	382	4254	1.00	1.18	9.89	9327	41
1937	377	4911	0.89	0.79	1.93	8337	45
Rubber							
1899	39	37	2.70			301	130
1914	89	174	1.73	1.75	24.68	342	260
1929	172	1102	1.00	2.61	35.56	525	328
1937	150	1089	1.01	-0.84	-0.15	578	260
Clay, Glass etc							
1899	243	505	0.54			11571	21
1914	405	1203	0.51	0.33	9.21	14793	27
1929	372	1655	1.00	1.18	2.50	8788	42
1937	331	1622	1.00	-0.09	-0.25	6114	54
Non-electrical machinery							
1899	456	1468	0.52			8995	51
1914	774	2266	0.56	-0.35	3.62	15792	49
1929	769	4250	1.00	2.05	5.84	8529	90
1937	795	4393	1.00	-0.18	0.42	7327	109
Transportation							
1899	70	312	0.54			3404	21
1914	331	1000	0.90	-0.21	14.70	4151	80
1929	631	5365	1.00	2.04	29.10	2246	281
1937	680	5894	0.91	-0.17	1.23	1958	347
Total man/g							
1899	4850	21984	0.50			204754	24
1914	7513	36434	0.64	-0.35	4.38	268436	28
1929	9660	71220	1.00	0.94	6.37	206663	47
1937	9786	74687	0.90	-0.16	0.61	166794	59

	Empl/t (000)	Real Output (in 1929 $)	Output Deflator	Annual Aver/e TFP(%) growth	% Real Output Growth	Number Establ/s	Empl/t per Establ/s
Tobacco							
1899	140	472	0.56			14959	9
1914	196	770	0.64	-0.12	4.21	13951	14
1929	126	1284	1.00	0.20	4.45	1888	67
1937	98	1484	0.88	0.20	1.95	852	115
Apparel							
1899	364	1203	0.52			12619	29
1914	618	2289	0.60	0.07	6.02	18015	34
1929	681	3866	1.00	0.74	4.59	22470	30
1937	779	3055	0.98	-1.67	-2.62	16389	48
Furniture							
1899	111.2	1277	0.35			2614	43
1914	169	985	0.74	-0.57	-1.52	4844	35
1929	248	1392	1.00	1.68	2.75	5491	45
1937	225.4	1256	0.90	-0.39	-1.22	4469	50
Printing							
1899	244	965	0.42			24363	10
1914	406	1805	0.52	-0.06	5.80	34241	12
1929	566	3122	1.00	0.63	4.86	27364	21
1937	555	2871	0.94	-0.94	-1.00	22674	24
Petroleum							
1899	31	173	0.72			308	101
1914	60	429	0.92	-0.04	9.87	591	102
1929	133.8	4737	1.00	0.22	66.95	922	145
1937	138.6	6150	0.85	-0.28	3.73	934	148
Leather							
1899	265	1435	0.41			5785	46
1914	341	1959	0.56	-0.10	2.43	6798	50
1929	351	1747	1.00	0.61	-0.72	4285	82
1937	362	1510	0.94	-0.45	-1.70	3249	111
Primary and fabricated metals							
1899	591	2209	0.84			14949	40
1914	1107	5362	0.66	0.05	9.52	25205	44
1929	1549	10641	1.00	1.25	6.56	13785	112
1937	1635	9895	0.98	-0.62	-0.47	11933	137
Electrical							
1899	49	190	0.49			592	83
1914	156	627	0.58	0.39	15.33	1048	149
1929	421	1735	1.00	2.25	11.78	1861	226
1937	374	1801	0.91	0.69	0.48	1597	234
Miscellaneous							
1899	138	434	0.50			14123	10
1914	293	842	0.72	-0.11	6.27	21504	14
1929	290	2334	1.00	1.68	11.81	12545	23
1937	288	1687	0.92	0.08	-3.47	10690	27

Sources:

i) Creamer *et al* (1960) for the data of nominal output and real output (1929 prices) (Table A-10), and total capital stock in 1929 prices (Table A-8).

ii) US Bureau of the Census (1975) for the data on number of employees, payroll, value added, and establishments (Series P 58-67).

Notes:

a. TFP, as estimated, includes as inputs the number of employees, materials or intermediate goods, and stock of capital.

b. The output deflator used in the calculation of the TFP is derived from the series of nominal and real output.

c. The materials series used in the calculation of the TFP is derived from the series of nominal output and value added.

d. Some numbers for some years are only estimates; this does not affect the overall picture of Table 1.

Table 2 Sectoral Growth in the USA (1899-1937, based on the sub-periods of Table 1)

Category	Very high growth in output (above 12%) and very high growth in TFP (around 2%)	High growth in output (above 6%) and high growth in TFP (around 1.2%)	Average (or low) growth in output (about 2%) and Average (or low) growth in TFP (around 0.70%)	Very high growth in output and low or average growth in TFP or vice-versa.
Sectors	Transportation Electrical Machinery Rubber	Paper Chemicals Clay, Glass etc Primary and Fabricated Metals Miscellaneous	Tobacco Textiles Apparel Wood (lowest) Printing Leather	Food (high TFP) Furniture (high TFP) Petroleum (low TFP) Non-Electrical Machinery (very high TFP)

What have been the reasons for the differences between the period 1899-1914 and 1915-1929, and for the differences between sectors in terms of OIs? First, during 1915-1929, the expansion took place through an expansion in firm size. This can be testified by reference to several factors, such as vertical integration, integration of mass production and distribution, and a continuous evolutionary technological improvement[9] (as opposed to the revolutionary technological improvement which took place in the last three decades of the 19th century). Statistical support for this expansion through integration can be seen in Table 1, with reference to the ratio of the number of employed people per establishment. This ratio increased dramatically during 1915-1929. Note, that although these developments (vertical integration and integration of mass production and distribution) started at the end of the 19th century and continued during 1899-1914, it was not until

[9] Both OIs and TIs constitute technological innovations.

1915-1929 that these changes spread out into all layers of the economy and not just in the largest companies (for the latter, details can be found in Chandler, 1962, 1977, 1990).

Second, the initial steps of rationalization in industrial production, better known as Scientific Management or Taylorism, started during 1890 to 1910 and did not really become applicable until later during 1915-1929 and beyond, especially with the advent of Fordism in the Transportation sector. Tugwell (1927) and, more recently Nyland (1989) in their detailed accounts confirm the conclusion that applications of Taylorism[10] became increasingly prevalent in the American economy during WWI and in the 1920s.

Tugwell (1927, in particular chapter four) provides a detailed account of many industrial cases that benefited from various applications of scientific management (such as time-and-motion studies). He suggests that productivity increases that took place in American manufacturing between 1914 and the mid 1920s were due to a large extent to the advent of applications of Taylor's principles[11]. As can be clearly seen from Tables 1 and 2, the sectors which grew most rapidly both in terms of real output and TFP were those for which Scientific Management, Taylorism, and Fordism became most applicable, that is mainly the Transportation, Electrical Machinery, Primary and Fabricated Metals, and Non-Electrical Machinery sectors (Chandler, 1977; Tugwell, 1927). It is worth noting for the Non-Electrical Machinery sector that although its real output did not grow very fast, its TFP did, thus confirming that productivity increases were due to OIs (as well as TIs). Overall, Tugwell (1927, p. 126) argued that:

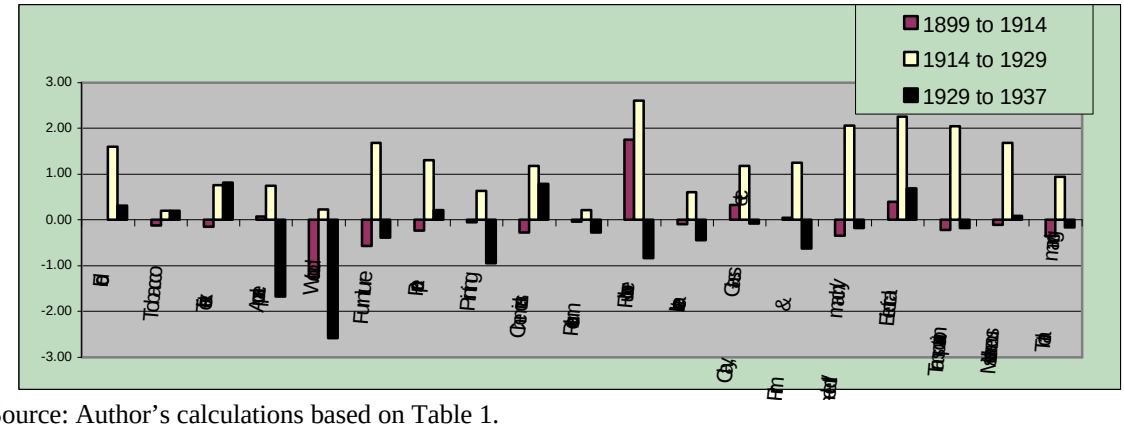
> *"…So far as specific cases go, it would appear that scientific management has contributed enormously to increased productivity. Judged by the test of measuring material outputs before and after the introduction of the system, the cases cited above, and others, show a definite correlation between the introduction of the system and increased productivity…"*

Third, and as a corollary to the second point, since TFP seems to be so small before 1915, one could conclude that almost all growth in real output took place because of corresponding increases

[10] For example through Fordism, cf. Nyland (1989, p. 141, and generally chapter four).
[11] These principles are extensively analyzed, for instance, in George (1972).

in capital, labor and materials. However, OIs during 1880-1914 "allowed" the increases in these inputs to take place because they set the right organizational and managerial environment for such growth of inputs and output. Specific reference is made here to OIs such as vertical integration, or integration of mass consumption and mass distribution, centralization of the management process, replacement of owners by salaried managers, as well as the replacement of the domestic system by the factory system. Most likely, the domestic system almost completely disappeared by the end of the 19th century (Chandler, 1977), but the new system had to still work itself out for another 15 years before it also contributed to some extent to the sharp increase in TFP.

Figure 1 USA, TFP Manufacturing Sectors, Average Annual % growth, 1899 to 1937

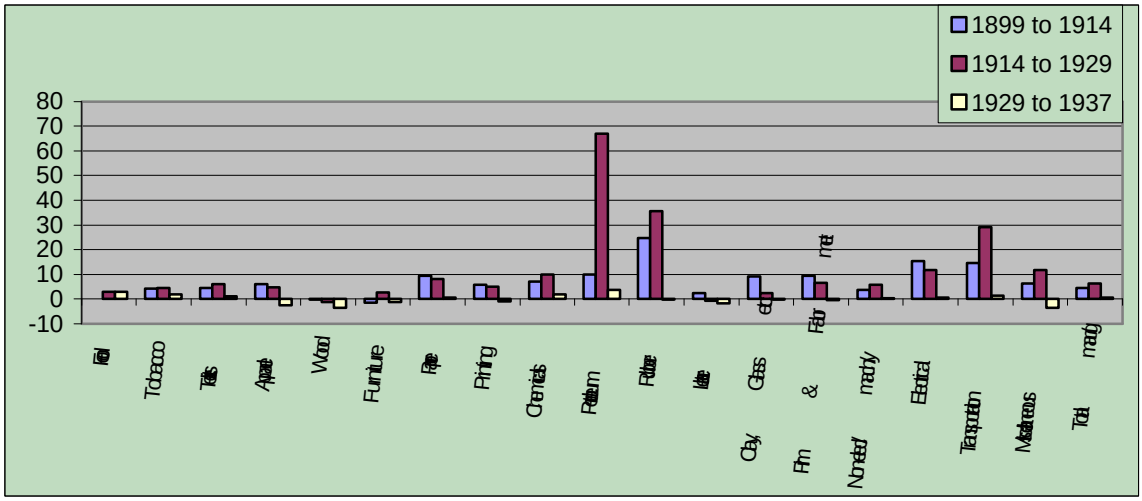


Source: Author's calculations based on Table 1.

In order to further support the above comments, Figures 1 and 2 summarize the TFP and real output annual growth rates for the three sub-periods examined. TFPs and real output did not grow in a parallel way in all sectors; for instance, though the petroleum industry's real output grew by about 65% annually from 1914 to 1929, TFP only grew by 0.22% annually during the same period. On the contrary, although the electrical industry's real output grew by about 12% p.a. during 1914-1929, TFP grew by 2.25% p.a. during the same period. These differences are due to various reasons, one of them being differences in OIs and differences in technical innovations (TIs). In the above examples, the petroleum industry grew so fast primarily because of capital investment (hence a low TFP), whereas the electrical industry had a much higher TFP growth mainly because pioneering electrical companies such as GE had set such an internal organization that new products were produced in mass by following Tayloristic and Fordist methods. Here particular reference is also made to the passage from the functional form of corporate governance to the

divisional form of governance. Similar comments apply to other industries such as the transportation (Chandler, 1977, 1985, 1990).

Figure 2 USA, Manufacturing Sectors, Real Output, Average Annual % Growth, 1899-1937



Source: Author's calculations based on Table 1.

The very strong growth of several sectors during the period under consideration can also be detected through the number of large firms founded per year during this period. Figure 3 shows the founding dates of the largest 500 American companies of 1994 (Harris Corporation, 1996). More precisely, Table 3 shows the number of firms founded for selected sub-periods. Thus, it can be seen that during 1899-1914 and 1915-1929, the number of companies founded increased substantially as a consequence of mainly two factors: OIs such as vertical and horizontal integration of firms, and overall economic growth.

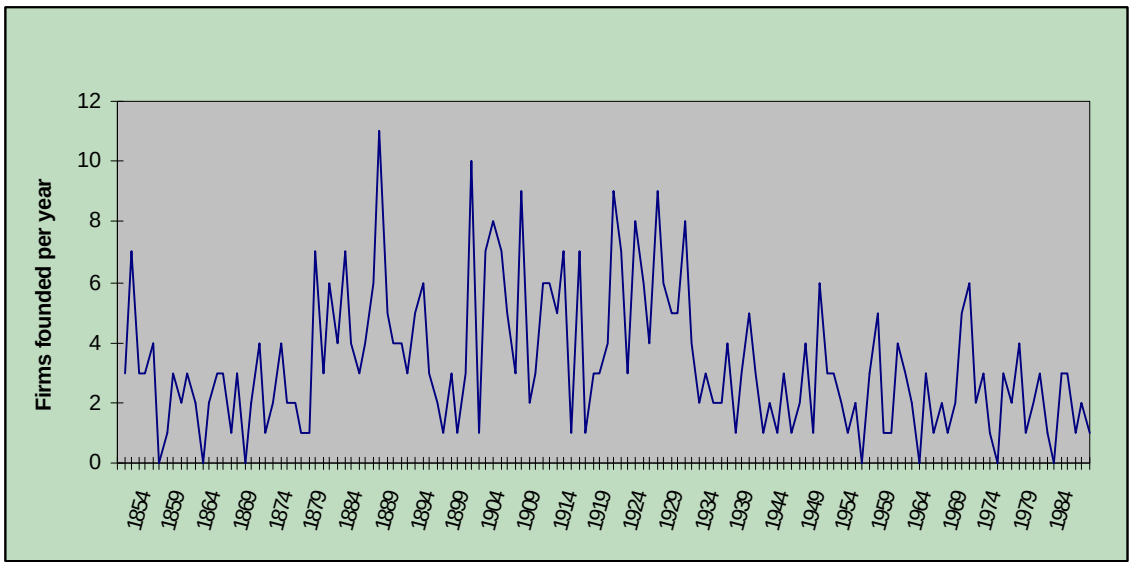
Table 3 Number of the largest 500 American companies founded during sub-periods between 1851 and 1986

Sub-period	1851-1866	1867-1882	1883-1898	1899-1914	1915-1929	1930-1944	1945-1959	1960-1974	1975-1986
Number of companies founded	40	50	64	87	81	37	38	34	23

All these developments regarding the growth of leading sectors and firms during the period 1899 to 1929 and the introduction of major OIs such as integration of mass production and mass distribution, scientific management, Fordism, all created a process of embeddedness for corporate

strategy, governance, and leadership according to Chandler's (1962) thesis. Other studies are needed to determine more precisely this process.

Figure 3 Founding dates of the largest 500 American companies of 1994



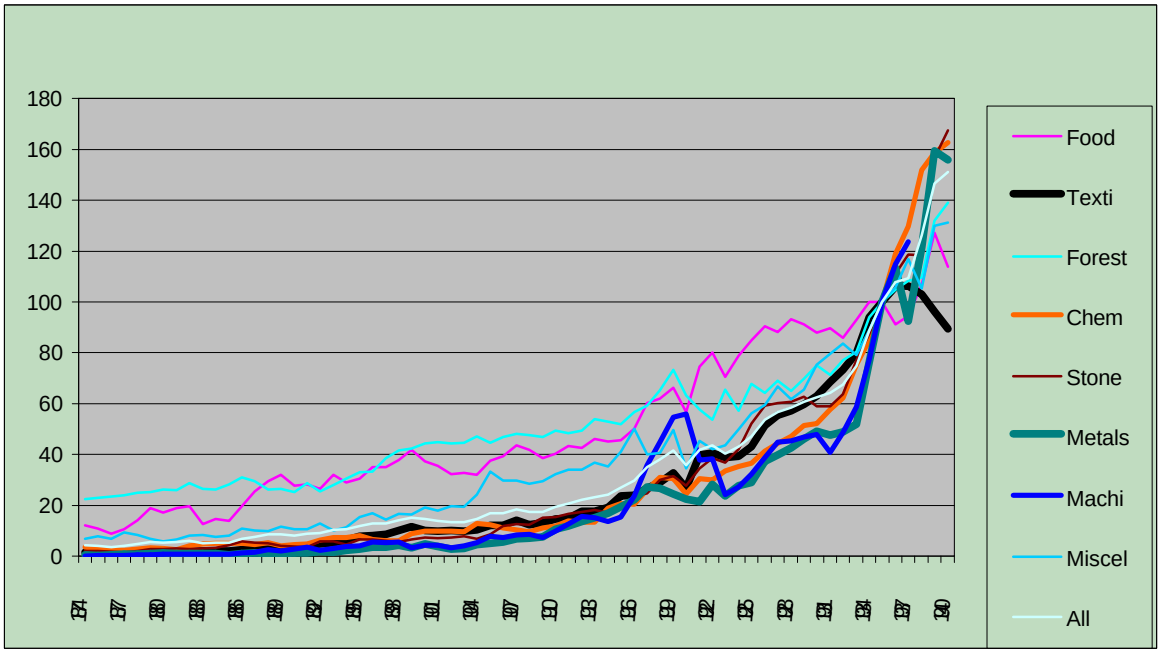
2 Japan

In Japan, there are two main reasons why a detailed analysis similar to that for the USA is not possible or is not as important. First, a detailed analysis is not possible because of lack of basic data since only 8 manufacturing sectors (see Figure 4) have appropriate records and capital stock is not included in them. Second, a detailed analysis is not important because for most of the period examined the textiles industry consistently constituted about a third of total manufacturing. Figure 4 shows the data for real output of these 8 sectors. It is obvious from this graph that the index of total production has very closely followed that of textiles. Also it can be seen that in the 1930s the sub-sectors of machinery, chemicals and metals have accelerated their growth. To see this picture more clearly, two more figures are shown.

Figure 5 shows the 5-year moving average of the sub-sectors textiles, food, forest products, stone, and miscellaneous, whereas Figure 6 shows the 5-year moving average of the sub-sectors textiles, chemicals, metals, machinery, and miscellaneous. It becomes clearer in these graphs that textiles became a strong leading sector in the last 15 years or so of the 19th century. The sub-sector

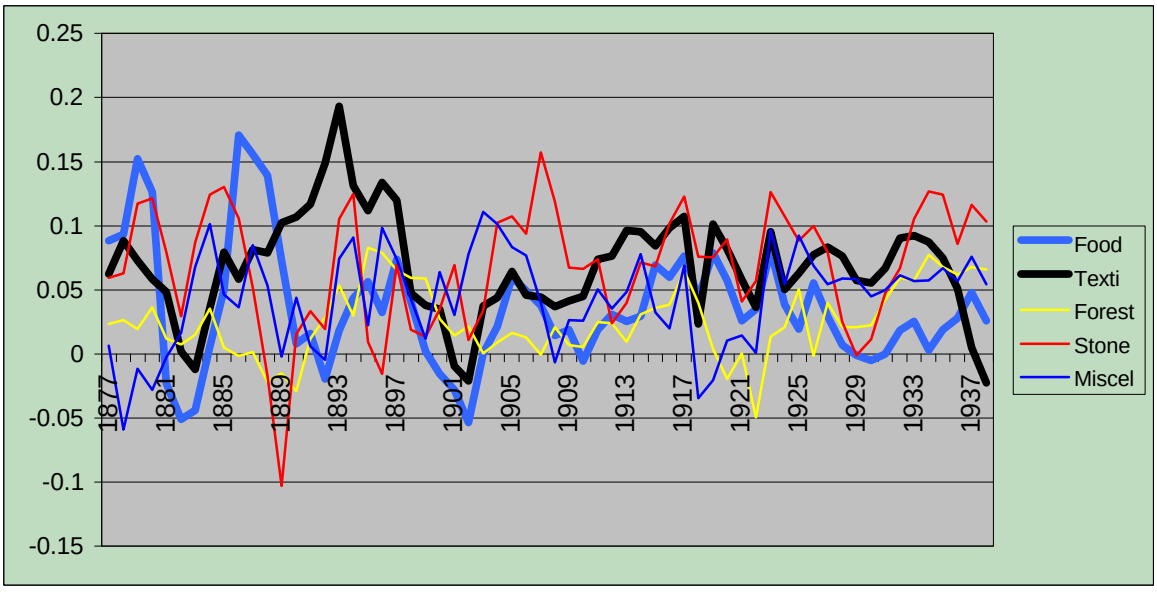
machinery followed its own path both at the beginning of the period examined and from WWI to the 1920s. This latter part of the path is primarily explained through the fact that the demand generated by the combating nations dissipated after WWI. Another important observation is that both the machinery and metals industries grew together and had some exceptional rates of growth in some sub-periods such as those at the end of the 19th century and again at the beginning of the 20th century.

Figure 4 Japan, Real Output Indexes for 8 industries



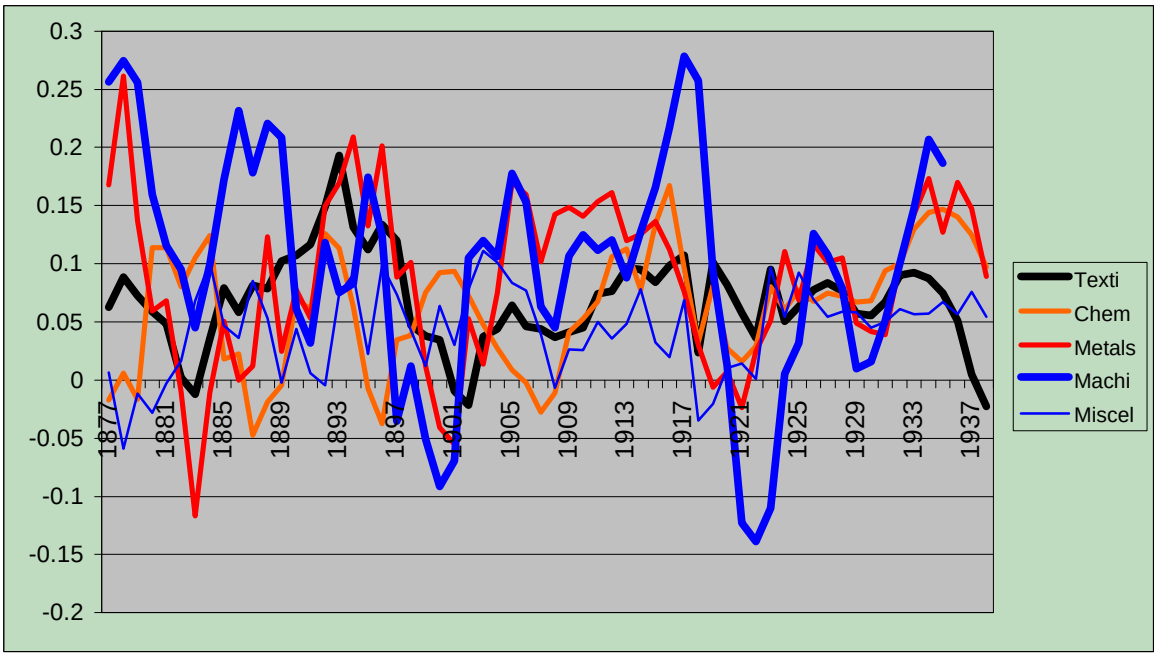
Source: Graphs based on data provided in Klein and Ohkawa (1968)

Figure 5 Japan, Manufacturing sectors, 5-year moving average of growth rates



Source: Graphs based on data provided in Klein and Ohkawa (1968)

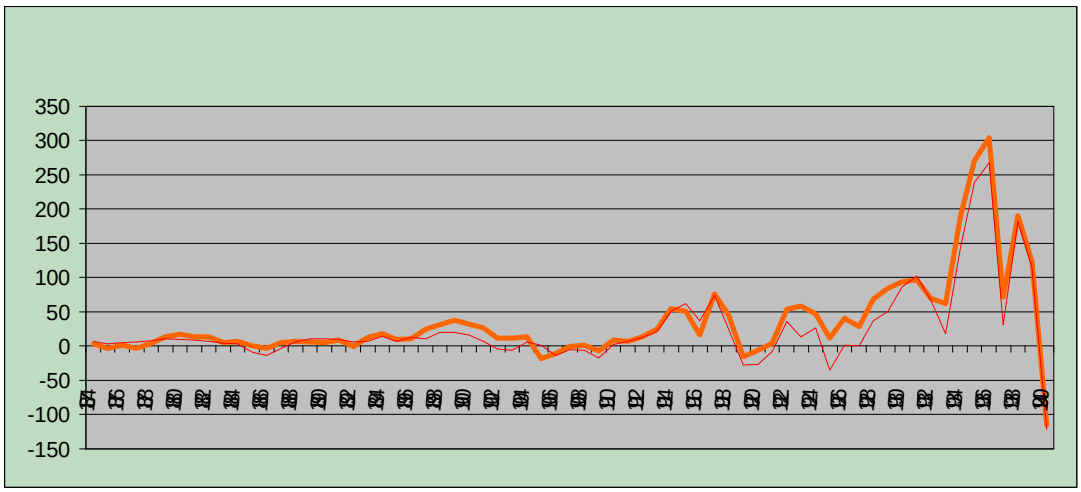
Figure 6 Japan, Manufacturing sectors, 5-year moving average of growth rates



Source: Graphs based on data provided in Klein and Ohkawa (1968)

In order to see more clearly the periods where there was some important divergence of growth rates between sub-sectors, cointegration analysis was used and two cointegrating vectors were calculated to detect these periods. Figure 7 shows the results, whereby it becomes obvious that the main divergence and structural changes took place firstly in the 1930s and to a lesser extent in the period of WWI, the 1920s, and at the turn of the 20th century.

Figure 7 Japan 8 industries, 1874 to 1940, 2 cointegrating vectors



These brief remarks can now be related to OIs in Japan during the examined period. The appearance of large conglomerates, the *zaibatsu*, (Yui and Nakagawa, 1989) at the end of the 19th

century created a unique Japanese corporate culture that shaped Japanese economy for more than a century. In addition, according to the analysis provided by Fruin (1992), focal factories (decentralized, flexible and innovative functional rather small firms) took off, on a big scale, in the 1930s. Also, during and just after WWI, the Japanese industrial system, and in particular the machinery sub-sector was re-organized and many new firms were created, mainly as a response to foreign demand.

These OI-related structural shifts coincided with some institutional changes as well, which always play a preponderant role in business in Japan. For example, the government in the 1880s initiated large scale privatization, or in the 1930s it encouraged industrial growth for military reasons. Furthermore, the textiles sector played an overwhelmingly important role for a long period in Japan because it continuously reorganized itself to become decentralized and flexible to accommodate global changes (Fruin, 1992). Overall, OIs played an important role, especially in the leading sectors of textiles initially and those of machinery and metals at a later stage. The concurrent combination of the *zaibatsu* conglomerates, a proliferation of rather small focal factories, the strong intervention of governmental policies, and the existence of leading sectors, all created a process of embeddedness for corporate strategy, governance, and leadership according to Chandler's (1962) thesis. Other studies are needed to determine more precisely this process.

CONCLUSION

In this paper computations of TFP and real output growth during 1899-1914 and 1915-1929 in the USA has revealed which sectors led the American economy during these periods. The appearance of major OIs at the same time as the existence of leading sectors created a process of embeddedness for corporate strategy, governance and leadership. A parallel exploration of Japanese leading sectors and OIs also created a similar process of embeddedness in Japan. Only a brief description of this three-layer relationship between leading sectors, OIs and the concept of embeddedness is presented in this paper. More evidence is needed to confirm the relevant conclusions.

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