Statistical Analysis of Debt-Equity in Japanese Manufacturing Industry 1988–2003

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1. Introduction

There are three aims of this paper. The first is to measure the relation between Japanese manufacturing companies' levels of borrowings and the condition of its financial nature. In particular I will measure the relationship between the companies' borrowings and the: 1) Sales, 2) Earnings per Share, 3) Dividend per Share, 4) Total Assets, 5) level of Shareholders' Equity, 6) Return on Assets 7) number of Employees and 8) Research and Development Expenditures. The second aim is to investigate whether there are any similarities among main Japanese manufacture industry branches considering above factors. Partial attention is also focused on correlations between so-called sun-rising and sun-setting industries.[1)] Finally, I will try to extract and, if possible, evaluate the differences in results for those two groups of samples.

Data description

The materials used in this study are derived from two volumes of Japan Company Handbook: summer 1989 first section and summer 2003 first section published by Toyo Keizai Inc. Although there exist other reliable sources of data such as Ministry of Finance I have decided to use Toyo Keizai Japan Company Handbook because the data were easily accessible and mostly complete.

I have chosen for each year the group of thirteen main manufacturing industry branches

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1) So called sun-setting industries are the branches of industry which are gradually less and less important for Japanese economy. As the sample of sun-setting industry I have chosen a group of three industries: metal, steel and oil and coal industry. On the other hand, the role of so called sun-rising industries is growing and the examples of such industries in this paper are precision instruments, pharmaceuticals and part of electrical machinery industry producing semi-coductors, mobile phones, personal computers, liquid crystal screens. The last branch of sun-rising industry is called in this paper electrical machinery new.

and for each industry a sample of ten of the biggest companies in terms of sales. The income data such as 'Sales', 'Earnings per Share — EPS' and 'Dividend per Share — DPS' were extracted from the company's financial statements. 'EPS' was obtained by dividing net profit by the total number of issued shares at the close of the settlement term. 'DPS' was treated as the total of the mid-term and term-end dividends. Ordinary dividends were most common, however, there are also special dividends, commemorative dividends and stock dividends regarded here. 'Total Assets' included all assets possessed by the company and is composed of total of current assets, fixed assets, and deferred assets. The figure of 'Total Assets' is equal to the total of liabilities and capital. 'Shareholders' Equity' was extracted from the capital part of the balance sheet and was obtained by adding surplus to capital stock and legal reserves. 'Borrowings' showed so-called interest-bearing liabilities, namely the total of short and long–term borrowings (including commercial papers), short-term bonds, convertible bonds and warrant bonds.[2)] 'Return on Assets — ROA' was calculated as net profit after taxes/Total assets. 'Employees' indicate the number of regular full-time employees of the parent firm, excluding temporary employees, outside workers, and members of the board of directors in principle. Symbol r(B, *variable*) means coeflicient of correlation: Borrowings/*respective variable*.

2. Statistical Analysis of Debt-Equity in Japanese Manufacturing Industry 1988/2003

In table 1, the companies in 2003 are characterized by higher values of positive correlation between borrowing and sales with average rise of fluctuations of correlation by 0.21 comparing companies in 1988. In contrary to general outlook, the individual industries show wide range of results of correlations regarding the change of correlation in time. The extreme change of correlations in time can be observed in glass & ceramics industry where the correlation rose from negative – 0.0442 to strong positive 0.8912. Similarly, many industries have reached

2) Considering the level of borrowings in case of companies from 1988 the data do not include corporate bonds, convertible bonds and warrants as in case of the data from 2003. The reason of not including them in the sample from 1988 was the low level of corporate bond and warrant markets, its small influence on company financial behavior and the lack of such data. The level of borrowings in 1988 is therefore the amount of bank borrowings. It may result in little differences when making comparison with sample from 2003 but has no influence on the results of study within the 1988 sample.

Table 1 Coefficients of Correlation: Borrowing/Sales for Japanese Manufacturing Industry 1988/2003

INDUSTRY	r(B,Sales)1988	r(B,Sales)2003	r2003 – r1988
textile & apparel	0.5076	0.9014	0.3938
pulp & paper	0.8532	0.9729	0.1197
chemicals	–0.3579	0.3018	0.6597
pharmaceuticals	0.3999	–0.2746	–0.6745
oil&coal industry	0.6992	0.8396	0.1404
rubber industry	0.9674	0.9535	–0.0139
glass & ceramics	–0.0442	0.8912	0.9354
steel industry	0.8920	0.9714	0.0794
metal industry	0.7527	0.4786	–0.2741
machinery	0.7896	0.9623	0.1727
electrical machinery	0.3790	0.6394	0.2604
transport equipment	0.3103	0.8884	0.5781
precision instruments	0.3965	0.7623	0.3658
average	**0.5035**	**0.7145**	**0.2110**

Source: Calculations based on data from Japan Company Handbook: summer 1989 first section and summer 2003 first section Toyo Keizai Inc.

very high values of correlation in 2003 (above 0.9, especially for textile and apparel, pulp and paper, rubber industry, steel industry, machinery). Other industries, although have not reached as high values in 2003, often displayed big changes when compared with correlation values for 1988, which is the case of chemicals, electrical machinery, transport equipment and precision instruments. There are only three other cases where changes were negative with virtually only one industry having noted strong negative trend. The case is pharmaceuticals with drop by 0.68 from 0.4 in 1988 to – 0.28 in 2003. It is also the only example of industry characterized by negative coefficient of correlation in 2003.

As we can see (table 2) there was no significant change in time in average correlations between borrowings and earnings per share for the sample of all analyzed companies in period 1988–2003. When comparing individual industries, however, four of them have strong positive correlation with extreme cases of steel industry and glass and ceramics where the coefficients of correlation differed (respectively, 0.795 and 0.714). The other two industries are machinery and transport equipment where coefficients of correlation changed respectively by 0.5636 and 0.5212. On the other hand, metal industry, has displayed opposite trends to steel industry, glass and ceramics with correlation coefficient dropping by 0.833 from positive 0.418 in 1988 to negative – 0.414 in 2003. Out of eight remaining industries seven are characterized by slightly negative values.

Table 2 Coefficients of Correlation: Borrowing/Earnings per Share for Japanese Manufacturing Industry 1988/2003

INDUSTRY	r(B,EPS)1988	r(B,EPS)2003	r2003 – r1988
textile & apparel	– 0.3371	– 0.5507	– 0.2136
pulp & paper	– 0.0525	– 0.1718	– 0.1193
chemicals	– 0.3738	– 0.5381	– 0.1643
pharmaceuticals	– 0.5216	– 0.5559	– 0.0343
oil&coal industry	– 0.1786	– 0.0142	0.1644
rubber industry	0.9715	0.7803	– 0.1912
glass & ceramics	– 0.6315	0.0823	0.7138
steel industry	– 0.5075	0.2877	0.7952
metal industry	0.4181	– 0.4143	– 0.8324
machinery	– 0.6243	– 0.0607	0.5636
electrical machinery	– 0.4432	– 0.6065	– 0.1633
transport equipment	– 0.1672	0.354	0.5212
precision instruments	0.0328	– 0.3658	– 0.3986
average	**– 0.1858**	**– 0.1364**	**0.0493**

Source: Calculations based on data from Japan Company Handbook: summer 1989 first section and summer 2003 first section Toyo Keizai Inc.

When comparing the values of correlation coefficient among industries in 2003, it is only rubber industry that displays relatively strong positive correlation between borrowings and earnings per share (0.78). Correlations of other industries are either close to zero or are characterized by average negative correlation. The latter is case of electrical machinery, textile and apparel, pharmaceuticals, chemicals and metal industry (respectively – 0.6065, – 0.5559, – 0.5507, – 0.5381, – 0.4143.

In general, there is little correlation between the level of borrowings and earnings per share: – 0.1858 and – 0.1364, respectively for year 1988 and 2003.

Similarly to the case of average correlations between borrowings and earnings per share, Japanese manufacturing industry in both years, 1988 and 2003 has been characterized by similar, weak negative coefficient of correlation of borrowings and dividend per share (– 0.2 see table 3, diagram 3) displaying in average almost no change.

Looking at the data of single industries we can observe that they display different values of correlation for two compared periods and also wide range of change between those two periods. The extreme change in years 1988 and 2003 has been in precision instrument industry where coefficients of correlation dropped from positive 0.7710 in 1988 to negative – 0.3998 in 2003 (change of – 1.1708 in correlation coefficient). In contrast, three other industries: glass and ceramic, machinery, transport equipment, show, interestingly, positive

Table 3 Coefficients of Correlation: Borrowing/Dividends per Share for Japanese Manufacturing Industry 1988/2003

INDUSTRY	r(B,DPS)1988	r(B,DPS)2003	r2003 – r1988
textile & apparel	–0.2446	–0.5606	–0.3160
pulp & paper	–0.0380	–0.0853	–0.0473
chemicals	–0.6589	–0.6601	–0.0012
pharmaceuticals	–0.5552	–0.6917	–0.1365
oil&coal industry	–0.3088	–0.3457	–0.0369
rubber industry	0.6895	0.7908	0.1013
glass & ceramics	–0.8606	–0.4075	0.4531
steel industry	–0.6653	–0.4019	0.2634
metal industry	–0.2265	0.0751	0.3016
machinery	–0.6119	–0.0968	0.5151
electrical machinery	–0.3063	–0.6355	–0.3292
transport equipment	0.3097	0.8105	0.5008
precision instruments	0.7710	–0.3998	–1.1708
average	**–0.2081**	**–0.2007**	**0.0075**

Source: Calculations based on data from Japan Company Handbook: summer 1989 first section and summer 2003 first section Toyo Keizai Inc.

trend (difference between periods was around 0.5) although the values of correlations were different (respectively in 1988: –0.8606, –0.6119, 0.3097, in 2003: –0.4075, –0.0986, 0.8105). Moreover, these three industries, together with precision instrument industry, represent extreme values of correlation coefficient for both, year 1988 and 2003.

Similarly to the case of correlations between borrowings and sales and in contrast to correlations between borrowings and earnings per share (and also borrowings and dividend per share) Japanese manufacturing industry in both years, 1988 and 2003, has been characterized by moderate positive coefficient of correlation between level of borrowings and total assets (0.6010 and 0.7219 respectively in 1988 and 2003, see table 4).

The industries analyzed in this study have not displayed significant changes in coefficients of correlation in 1988 and 2003. The only extreme examples were observed in pharmaceuticals, and glass and ceramics industry (respectively, –0.6961, 0.5453). It is important, however, that most of these industries have displayed very high positive values of correlations close to 1, in both periods; in 1988: steel industry, rubber industry and pulp and paper (respectively, 0.9778, 0.9539 0.8847) and in year 2003: transport equipment, pulp and paper, steel industry, rubber industry, machinery, oil and coal industry and glass and ceramics (respectively, 0.9947, 0.9895, 0.9894, 0.9612, 0.9527, 0.9173, 0.9135). The only negative correlations were observed in chemical industry in 1988 (–0.0139) and pharmaceuticals in 2003 (–0.3732).

Table 4 Coefficients of Correlation: Borrowing/Total assets for Japanese Manufacturing Industry 1988/2003

INDUSTRY	r(B,Assets)1988	r(B,Assets)2003	r2003 – r1988
textile & apparel	0.6705	0.929	0.2585
pulp & paper	0.8847	0.9895	0.1048
chemicals	–0.0139	0.2798	0.2937
pharmaceuticals	0.3229	–0.3732	–0.6961
oil&coal industry	0.6110	0.9173	0.3063
rubber industry	0.9539	0.9612	0.0073
glass & ceramics	0.3682	0.9135	0.5453
steel industry	0.9778	0.9894	0.0116
metal industry	0.7769	0.4439	–0.3330
machinery	0.8454	0.9527	0.1073
electrical machinery	0.2314	0.6076	0.3762
transport equipment	0.4787	0.9947	0.5160
precision instruments	0.7060	0.7789	0.0729
average	**0.6010**	**0.7219**	**0.1208**

Source: Calculations based on data from Japan Company Handbook: summer 1989 first section and summer 2003 first section Toyo Keizai Inc.

Table 5 Coefficients of Correlation: Borrowing/Shareholders equity for Japanese Manufacturing Industry 1988/2003

INDUSTRY	r(B,Shareh)1988	r(B,Shareh)2003	r2003 – r1988
textile & apparel	0.0945	0.4347	0.3402
pulp & paper	0.1654	0.9307	0.7653
chemicals	–0.3628	–0.2994	0.0634
pharmaceuticals	0.2190	–0.4193	–0.6383
oil&coal industry	–0.0463	0.7942	0.8405
rubber industry	0.8499	0.919	0.0691
glass & ceramics	–0.0509	0.5826	0.6335
steel industry	0.7851	0.9026	0.1175
metal industry	0.6493	0.2961	–0.3532
machinery	0.5046	0.8151	0.3105
electrical machinery	–0.0923	–0.1702	–0.0779
transport equipment	0.1898	0.9743	0.7845
precision instruments	0.4433	0.1005	–0.3428
average	**0.2576**	**0.4508**	**0.1933**

Source: Calculations based on data from Japan Company Handbook: summer 1989 first section and summer 2003 first section Toyo Keizai Inc.

Although the average values of coefficient of correlation: borrowings/shareholders equity (0.2576, 0.4508, 0.1933 for respectively 1988, 2003 and change, see table 5, diagram 5) may suggest that individual industries have not displayed high values or strong trends — that is not

the case. In both years the values show strong dispersion, especially for industries in 2003. Although in 1988 four industries show negative values, three of these coefficients are very close to zero and only chemical industry shows moderate negative correlation (– 0.3628). There are more examples of moderate and strong correlations (rubber industry 0.8499, steel industry 0.7851, metal industry 0.6493). Over a half of industries in 1988 have displayed values close to zero.

However, in 2003, the coefficients of correlations are more polarized among industries. There are more of them displaying moderate or weak negative values (pharmaceuticals –0.4193, chemicals – 0.2994, electrical industry – 0.1702) and six of them displaying strong positive correlations (transport equipment 0.9743, pulp and paper 0.9397, rubber industry 0.919, steel industry 0.9026, machinery 0.8151, oil and coal industry 0.7942).

In addition, the strongest negative trends in coefficients of correlation have been exhibited by pharmaceutical industry (change between 1988 and 2003 was – 0.6383). Strong positive trends in coefficients of correlation characterized oil and coal industry (0.8405), transport equipment (0.7845) and pulp and paper industry (0.7653).

Almost all industries in 1988 have displayed moderate negative correlations between the level of borrowings and return on assets (see table 6). The strongest negative correlations were observed in case of glass and ceramics (– 0.6643), pharmaceuticals (– 0.6605) and

Table 6 Coefficients of Correlation: Borrowing/Return on Assets for Japanese Manufacturing Industry 1988/2003

INDUSTRY	r(B,ROA)1988	r(B,ROA)2003	r2003 – r1988
textile & apparel	– 0.3974	– 0.6662	– 0.2688
pulp & paper	– 0.5490	– 0.1211	0.4279
chemicals	– 0.5311	– 0.4031	0.1280
pharmaceuticals	– 0.6605	– 0.5174	0.1431
oil&coal industry	– 0.4492	– 0.4495	– 0.0003
rubber industry	0.2559	0.3968	0.1409
glass & ceramics	– 0.6643	0.133	0.7973
steel industry	– 0.5155	0.2548	0.7703
metal industry	– 0.2495	– 0.5055	– 0.2560
machinery	– 0.6146	– 0.0539	0.5607
electrical machinery	– 0.5972	– 0.604	– 0.0068
transport equipment	– 0.3189	0.3629	0.6818
precision instruments	– 0.4910	– 0.4411	0.0499
average	**– 0.4448**	**– 0.2011**	**0.2437**

Source: Calculations based on data from Japan Company Handbook: summer 1989 first section and summer 2003 first section Toyo Keizai Inc.

machinery (0.6146). The only industry that displayed positive correlation was rubber industry (0.2559). For almost all other industries there were only slight or moderate differences (in average 0.2437) towards weakening negative correlations. The biggest change in 2003 was noted in cases of glass and ceramics, steel industry and transport equipment (comparing correlations from 1988 the change was respectively 0.7973, 0.7703 and 0.6818). In contrast, textiles and metal industry were characterized by weak negative change (– 0.2688 and – 0.256). All other industries have displayed little or almost no change.

There was no big dispersion of correlation coefficient neither in 1988 nor in 2003. Industries in 2003 displayed, however, more positive correlations (rubber industry 0.3968, transport equipment 0.3629, steel industry 0.2548 and glass and ceramics 0.133) causing the average coefficient of correlation rise from – 0.4448 in 1988 to – 0.2011 in 2003.

Regarding the correlation between the level of borrowings and the number of employees there was a little change (– 0.1241) between two periods (see table 7, diagram 7). In average, the correlation coefficient dropped from moderate 0.5448 to 0.4207.

Table 7 Coefficients of Correlation: Borrowing/Employees for Japanese Manufacturing Industry 1988/2003

INDUSTRY	r(B/Empl)1988	r(B/Empl)2003	r2003 – r1988
textile & apparel	0.4267	0.4154	– 0.0113
pulp & paper	0.8844	0.4481	– 0.4363
chemicals	0.3812	0.0027	– 0.3785
pharmaceuticals	0.4751	0.2015	– 0.2736
oil&coal industry	0.7480	0.4836	– 0.2644
rubber industry	0.9360	0.9854	0.0494
glass & ceramics	– 0.6361	0.138	0.7741
steel industry	0.8466	0.4735	– 0.3731
metal industry	0.6230	– 0.149	– 0.7720
machinery	0.7862	0.9067	0.1205
electrical machinery	0.5459	0.1624	– 0.3835
transport equipment	0.4813	0.9892	0.5079
precision instruments	0.5840	0.411	– 0.1730
average	**0.5448**	**0.4207**	**– 0.1241**

Source: Calculations based on data from Japan Company Handbook: summer 1989 first section and summer 2003 first section Toyo Keizai Inc.

We can also observe that in period 1988 – 2003 almost all industries have displayed moderate or strong positive correlations. In particular, in 1988 the most extreme positive values characterized rubber industry (0.9360), pulp and paper (0.8844) and steel industry

Table 8 Coefficients of Correlation: Borrowing/Research and Development Expenditures for Japanese Manufacturing Industry 1988/2003

INDUSTRY	r(B,R&D)1988	r(B,R&D)2003	r2003–r1988
textile & apparel	0.3387	0.8654	0.5267
pulp & paper	–0.0953	0.8745	0.9698
chemicals	0.0517	0.1616	0.1099
pharmaceuticals	0.2478	–0.3327	–0.5805
oil&coal industry	0.4521	0.9745	0.5224
rubber industry	0.9420	0.9776	0.0356
glass & ceramics	–0.5731	0.3721	0.9452
steel industry	0.8997	0.9483	0.0486
metal industry	0.3148	0.2513	–0.0635
machinery	0.7915	0.9081	0.1166
electrical machinery	0.3959	0.2764	–0.1195
transport equipment	0.3865	0.9577	0.5712
precision instruments	0.8782	0.6955	–0.1827
average	**0.3870**	**0.6100**	**0.2231**

Source: Calculations based on data from Japan Company Handbook: summer 1989 first section and summer 2003 first section Toyo Keizai Inc.

(0.8466), whereas in 2003 strongest correlations were in transport equipment (0.9892), rubber industry (0.9854) and machinery (0.9067).

In addition, glass and ceramics and transport equipment industry show also the strongest positive correlations (respectively, 0.7741 and 0.5079). Interestingly, the former one was the only industry that displayed negative coefficient of correlation in 1988. Very opposite case was metal industry, which displayed negative correlation in 2003 (with extreme negative value of –0.7741.

Finally, the results of study on correlations between the level of borrowings and research and development expenditures for Japanese manufacturing industries in 1988 and 2003 are presented in table 8. Here we can observe that the glass and ceramic industry in 1988 displayed moderate negative correlation (– 0.5731) and that rubber and steel industries displayed strong positive correlations (0.942 and 0.8997).

In contrast, pharmaceutical industry is the only industry showing negative correlation in 2003 (– 0.3327). All other industries display weak, moderate and strong correlations with extreme values in rubber industry (0.9776), oil and coal industry (0.9745) and transport equipment (0.9577).

In average, the coefficient of correlation for Japanese manufacturing industries in 1988

and 2003 rose by 0.2231 from 0.387 in 1988 to 0.61 in 2003. Here the individual industries show wide range of amplitude of values in both periods. The biggest change was in pulp and paper industry and glass and ceramic industry (respectively, 0.9698 and 0.9452). In contrast, negative trend in coefficients of correlations between the level of borrowings and research and development expenditures characterized pharmaceutical industry (– 0.5805).

From table 9 and 10 we can conclude that for Japanese sun-rising and sun-setting industries there are no clear trends in coefficients of correlation between borrowings and six examined variables (Sales, Earnings per Share, Dividend per Share, Total Assets, level of Shareholders' Equity, Return on Assets, number of Employees and Research and Development Expenditures). Looking at averages for two groups of industries we can see that most correlations are stronger for sun-setting industries; (for correlations between borrowings and sales, earnings per share, dividend per share, total assets, shareholders equity, return on assets,

Table 9 Coefficients of Correlation: Japanese Sun Rising Manufacturing Industry 2003

r(B,y)	pharmaceuticals	electrical machinery new	precision instruments	average
r(B,Sales)	–0.2746	0.989	0.7623	0.4923
r(B,EPS)	–0.5559	–0.71	–0.3658	–0.5441
r(B,DPS)	–0.6917	–0.58	–0.3998	–0.5568
r(B,Assets)	–0.3732	0.961	0.7789	0.4554
r(B,Shareholders equity)	–0.4193	–0.14	0.1005	–0.1518
r(B,ROA)	–0.5174	–0.82	–0.4411	–0.5921
r(B/Employees)	0.2015	0.933	0.411	0.5151
r(B,R&D)	–0.3327	0.972	0.6955	0.445

Source: Calculations based on data from Japan Company Handbook: summer 2003 first section Toyo Keizai Inc.

Table 10 Coefficients of Correlation: Japanese Sun Setting Manufacturing Industry 2003

r(B,y)	oil & coal industry	steel industry	metal industry	average
r(B,Sales)	0.8396	0.971	0.4786	0.7632
r(B,EPS)	–0.0142	0.288	–0.4143	–0.0469
r(B,DPS)	–0.3457	–0.4	0.0751	–0.2241
r(B,Assets)	0.9173	0.989	0.4439	0.7835
r(B,Shareholders equity)	0.7942	0.903	0.2961	0.6643
r(B,ROA)	–0.4495	0.255	–0.5055	–0.2334
r(B/Employees)	0.4836	0.474	–0.149	0.2693
r(B,R&D)	0.9745	0.948	0.2513	0.7247

Source: Calculations based on data from Japan Company Handbook: summer 1989 first section and summer 2003 first section Toyo Keizai Inc.

research and development expenditures). The only stronger correlation in sun-rising industries exisits for borrowings and emplyoees.

In case of correlations between borrowings and sales both groups of industries display moderate/strong positive correlations (with average for sun rising and sun setting industries respectively 0.4923 and 0.7632). The difference is significant because pharmaceutical industry, as the only in the sample, displayed negative correlation – 0.2746. Maximum level of correlations for both groups were reached by electrical machinery industry — companies producing mobile phones, computers, semi-coductors, liquid crystal screens (correlation 0.9893). Sun-setting industries display even higher average correlation (with the higest for steel industry 0.9714).

With regard to relationship between borrowings and earnings per share there are differences in the examined sample. All-sun rising industries display moderate negative correlations (with average – 0.5441) and strongest negative correlations for electrical machinery (– 0.7108) wheras average correlation for sun-setting industries is weak (– 0.0469). This is due to the weak correlation for oil and coal industry (– 0.0142) and positive correlation of 0.2877 for steel industry, the only industry in this group diplaying positive correlation.

Similar trends can be observed in the correlation between level of borrowings and dividend per share. Here, sun-rising industries displayed lower, moderate negative correlations with average – 0.5568 (lowest in case of pharmaceuticals – 0.6917) wheras sun-setting industries displayed weak negative correlation with average – 0.2241. Only one sun-setting industry displayed positive correlation here (metal industry 0.0751).

The results for correlations between borrowings and total assets are similar. Average correlations for sun-rising industry and sun-setting industry were respectively, 0.4554 and 0.7835, wheras only pharmaceutical industry displayed negative correlation (– 0.3732). Also maximum levels of correlation for both groups are very similar as in case of correlation between borrowings an sales. For sun-rising industries the strongest correlation is in electrical machinery (0.9607) and for sun-setting industries is in steel industry (0.9894).

Regarding the correlations between borrowings and shareholders equity, sun-rising industries display (in average) negative correlations (– 0.1518, with lowest – 0.4193 for pharmaceuticals), wheras all sun-setting industries displayed moderate and strong positive correaltions (with average 0.6643 and the strongest for steel industry 0.9026).

Correlations between borrowings and return on assets are very similar to borrowings and earnings per share. Here the average for sun-rising industries is – 0.5921 and for sun setting

industries – 0.2334. Correlations for sun-rising industries display similar values as in the case of earnings per share; the lowest value of correaltion was reached, again, by electrical machinery (– 0.818). Again, it is metal industry that displays the highest, positive correaltion of 0.2548. It is the only industry in the analyzed sample which shows positive correlation.

The only correlation which displays higher values for sun-rising industries is for borrowings and emplyoees. Here, the average for sun-rising industry is moderate (0.5151) wheras for sun-setting industry is weak (0.2693). The highest, and only one strong positive correlation in whole sample was displayed by electrical machinery (0.933), wheras the only negative correlation was in metal industry (– 0.149).

The analysis of research and development expenditures, shows very similar results to the two previous variables; sales and total assets. The average for sun-rising industry is 0.445 and

Table 11 Coefficient of Correlation for Japanese Manufacturing Industry 1988/2003; synthetic data

INDUSTRY 1988 & 2003	r(B,Sales)	r(B,EPS)	r(B,DPS)	r(B,Assets)	r(B,Shld)	r(B,ROA)	r(B/Empl)	r(B,R&D)	average
textile & apparel	0.5076	–0.3371	–0.2446	0.6705	0.0945	–0.3974	0.4267	0.3387	0.1324
pulp & paper	0.8532	–0.0525	–0.038	0.8847	0.1654	–0.549	0.8844	–0.0953	0.2566
chemicals	–0.3579	–0.3738	–0.6589	–0.0139	–0.3628	–0.5311	0.3812	0.0517	–0.2332
pharmaceuticals	0.3999	–0.5216	–0.5552	0.3229	0.219	–0.6605	0.4751	0.2478	–0.0091
oil&coal industry	0.6992	–0.1786	–0.3088	0.611	–0.0463	–0.4492	0.748	0.4521	0.1909
rubber industry	0.9674	0.9715	0.6895	0.9539	0.8499	0.2559	0.936	0.942	0.8208
glass & ceramics	–0.0442	–0.6315	–0.8606	0.3682	–0.0509	–0.6643	–0.6361	–0.5731	–0.3866
steel industry	0.892	–0.5075	–0.6653	0.9778	0.7851	–0.5155	0.8466	0.8997	0.3391
metal industry	0.7527	0.4181	–0.2265	0.7769	0.6493	–0.2495	0.623	0.3148	0.3824
machinery	0.7896	–0.6243	–0.6119	0.8454	0.5046	–0.6146	0.7862	0.7915	0.2333
electrical machinery	0.379	–0.4432	–0.3063	0.2314	–0.0923	–0.5972	0.5459	0.3959	0.0142
transport equipment	0.3103	–0.1672	0.3097	0.4787	0.1898	–0.3189	0.4813	0.3865	0.2088
precision instruments	0.3965	0.0328	0.771	0.706	0.4433	–0.491	0.584	0.8782	0.4151
average 1988	**0.5035**	**–0.186**	**–0.208**	**0.601**	**0.2576**	**–0.445**	**0.5448**	**0.387**	**0.1819**
textile & apparel	0.9014	–0.5507	–0.5606	0.929	0.4347	–0.6662	0.4154	0.8654	0.2211
pulp & paper	0.9729	–0.1718	–0.0853	0.9895	0.9307	–0.1211	0.4481	0.8745	0.4797
chemicals	0.3018	–0.5381	–0.6601	0.2798	–0.2994	–0.4031	0.0027	0.1616	–0.1444
pharmaceuticals	–0.2746	–0.5559	–0.6917	–0.3732	–0.4193	–0.5174	0.2015	–0.3327	–0.3704
oli&coal industry	0.8396	–0.0142	–0.3457	0.9173	0.7942	–0.4495	0.4836	0.9745	0.4000
rubber industry	0.9535	0.7803	0.7908	0.9612	0.919	0.3968	0.9854	0.9776	0.8456
glass & ceramics	0.8912	0.0823	–0.4075	0.9135	0.5826	0.133	0.138	0.3721	0.3382
steel industry	0.9714	0.2877	–0.4019	0.9894	0.9026	0.2548	0.4735	0.9483	0.5532
metal industry	0.4786	–0.4143	0.0751	0.4439	0.2961	–0.5055	–0.149	0.2513	0.0595
machinery	0.9623	–0.0607	–0.0968	0.9527	0.8151	–0.0539	0.9067	0.9081	0.5417
electrical machinery	0.6394	–0.6065	–0.6355	0.6076	–0.1702	–0.604	0.1624	0.2764	–0.0413
transport equipment	0.8884	0.354	0.8105	0.9947	0.9743	0.3629	0.9892	0.9577	0.7915
precision instruments	0.7623	–0.3658	–0.3998	0.7789	0.1005	–0.4411	0.411	0.6955	0.1927
average 2003	**0.7145**	**–0.136**	**–0.201**	**0.7219**	**0.4508**	**–0.201**	**0.4207**	**0.61**	**0.2975**

Source: Calculations based on data from Japan Company Handbook: summer 1989 first section and summer 2003 first section Toyo Keizai Inc.

for sun-setting industry is 0.7247. It is again pharmaceutical industry which displays the only negative correlation in whole set of industries (– 0.3327). The higest correlation for sun-rising industry is again in electrical machinery (0.9722) and for sun-setting industry in oil and coal industry 0.9745.

From table 11 we can conclude that in 1988 the highest, positive average values of correlations were observed for borrowing and total assets (0.601) and borrowings and employees (0.5448). In 2003 the strongest correlations existed between borrowings and total assets (0.7219) and borrowing and sales (0.7145). In contrast, the average, negative correlations in 1988 were observed between borrowings and return on assets (– 0.4448) and borrowings and dividend per share (– 0.2081). In 2003 the average, negative correlations were observed, similarly, between borrowings and return on assets and borrowings and dividend per share (respectively, – 0.2011 and – 0.2007).

Companies‘ borrowings, in 2003, were more correlated with almost all examined factors compared with 1988, (the differences were significant especially in research and development expenditures, sales, shareholders equity and total assets, respectively, 0.2230, 0.2110, 0.1932 and 0.1209). There was also a difference (0.2437) between two periods regarding negative correlations between borrowings and return on assets, whereas companies in 1988 displayed, in

Table 12 Trends of individual Japanese Manufacturing Industry in period 1988 – 2003

INDUSTRY	1988	2003	change
textile & apparel	0.1324	0.2211	0.0887
pulp & paper	0.2566	0.4797	0.2231
chemicals	– 0.2332	– 0.1444	0.0888
pharmaceuticals	– 0.0091	– 0.3704	– 0.3613
oil&coal industry	0.1909	0.4	0.2091
rubber industry	0.8208	0.8456	0.0248
glass & ceramics	– 0.3866	0.3382	0.7247
steel industry	0.3391	0.5532	0.2141
metal industry	0.3824	0.0595	– 0.3228
machinery	0.2333	0.5417	0.3084
electrical machinery	0.0142	– 0.0413	– 0.0555
transport equipment	0.2088	0.7915	0.5827
precision instruments	0.4151	0.1927	– 0.2224

Source: Calculations based on data from Japan Company Handbook: summer 1989 first section and summer 2003 first section Toyo Keizai Inc.

average, stronger negative correlations for those values. There was almost no difference between the year 2003 and 1988 for correlations between borrowings and earnings per share and dividend per share. In 1988, the only factor significantly correlated with borrowings was number of employees (where difference with average values of correlations with companies from 2003 was 0.1241).

As for individual industries, the highest correlations in 1988 were observed in rubber industry (strong positive correlation 0.8208 (see table 12)), precision instruments (0.4151) and metal industry (0.3391) whereas in 2003 rubber industry, (0.8456) transport equipment (0.7915), steel industry (0.5532) and machinery (0.5417). In contrast, the strongest negative correlations were in glass and ceramics (in average -0.3866 in 1988) and pharmaceuticals (in average – 0.3704 in 2003).

Looking at the average trend for industries the biggest positive changes in average coefficient of correlation were observed in glass and ceramic industry where the average correlation rose by 0.7247 (from – 0.3866 in 1988 to 0.3382 in 2003) and in transport equipment (change by 0.5827 from 0.2088 to 0.7915). In contrast, negative trend was observed in case of pharmaceuticals (– 0.3613) and metal industry (– 0.3228).

3. Conclusion

The results of this study show that the companies‘ borrowings, in 2003, were more correlated with almost all examined variables compared with 1988, (the differences were significant especially in research and development expenditures, sales, shareholders equity and total assets). Companies in 1988 displayed also stronger negative correlations between borrowings and return on assets comparing companies from 2003. With regard to relationship between borrowings and earnings per share and dividend per share there was almost no difference between two periods. In 1988, the only factor significantly correlated with borrowings, comparing companies from 2003 was number of employees.

We can conclude, that in 1988 the highest, positive correlations were observed for borrowing and total assets and borrowings and employees. In 2003 the strongest correlations existed between borrowings and total assets and borrowing and sales. In contrast, negative correlations in 1988 were observed between borrowings and return on assets and borrowings and dividend per share. In 2003 negative correlations were observed, similarly, between borrowings and return on assets and borrowings and dividend per share.

As for individual industries, the highest correlations in 1988 were observed in rubber industry, precision instruments and metal industry whereas in 2003 rubber industry, transport equipment, steel industry and machinery. It was rubber industry that displayed the highest values of correlation with regard to the whole set of variables except total assets (where the highest value of correlation was displayed by steel industry). In 2003 rubber industry displayed the highest correlations for only three variables (earnings per share, return on assets and research and development expenditures). Pulp and paper industry reached the highest value of correlation between borrowings and sales. The highest values of correlation for all four remaining variables were displayed by transport equipment industry.

In contrast, the strongest negative correlations for companies in 1988 were in glass and ceramics industry and chemical industry whereas in 2003 in pharmaceutical industry. In 1988 glass and ceramics displayed the lowest values of correlation for five variables and the lowest values of remaining three variables (sales, total assets and shareholders equity) were displayed by chemical industry. From the other hand, in 2003, the lowest values of correlations for eight examined variables were displayed by: electrical machinery (earnings per share), textile and apparel (return on assets), metal products (number of employees) and pharmaceuticals (all remaining variables).

Looking at the average trend for Japanese manufacturing industries in years 1988-2003 the biggest positive changes in average coefficient of correlation were observed in glass and ceramic industry and in transport equipment. In contrast, negative trend was observed in case of pharmaceuticals and metal industry.

Regarding Japanese sun-rising and sun-setting industries we can conclude that there are no clear trends in coefficients of correlation between borrowings and eight examined variables (Sales, Earnings per Share, Dividend per Share, Total Assets, level of Shareholders' Equity, Return on Assets, number of Employees and Research and Development Expenditures). Looking at averages for two groups of industries we can see that most correlations are stronger for sun-setting industries. The only stronger correlation in sun-rising industries exisits for borrowings and emplyoees.

Appendix Japanese multinational corporations in this project

name of the company 1988	Sales	Borrowings	name of the company 2003	Sales	Borrowings	rank
textile & apparel						
Asahi Chemical Industry	765,483	211,143	Toray Industries	1,032,991	530,374	1
Toray Industries	541,511	209,370	Teijin	890,433	427,703	2
Kanebo	381,819	405,664	Toyobo	376,377	269,098	3
Teijin	309,666	261,818	Kuraray	322,523	20,637	4
Toyobo	298,378	168,961	Mitsubishi Rayon	300,641	82,502	5
Unitika	248,183	188,726	Onward Kashiyama	263,398	20,197	6
Kuraray	198,795	85,110	Unitika	233,725	238,243	7
Mitsubishi Rayon	193,973	118,761	World	232,819	13,123	8
Nisshibo Industries	186,790	46,931	Nisshinbo Industries	231,194	44,072	9
Nitto Boseki	121,547	35,111	Wacoal	163,709	6,161	10
pulp & paper						
Oji Paper	387,758	177,661	Oji Paper	1213173	786,329	1
Honshu Paper	366,974	340,307	Nippon Unipack Holding	1165450	867,978	2
Jujo Paper	342,619	207,223	Daio Paper	385845	448,812	3
Daishowa Paper Mfg.	313,026	289,969	Rengo	364300	211,326	4
Sanyo-Kokusaku Pulp	279,701	145,315	Mitsubishi Paper Mills	236403	209,966	5
Taio Paper Mfg.	210,903	121,463	Hokuetsu Paper Mills	142156	87,567	6
Rengo	201,337	41,814	Tomoku	136747	44,614	7
Mitsubishi Paper Mills	170,712	49,915	Chuetsu Pulp&Paper	109800	19,632	8
Kanazaki Paper Mfg.	138,056	24,378	The Pack	70001	2,660	9
Chuetsu Pulp Industry	93,167	29,942	Kishu Paper	56300	11,563	10
chemicals						
Fuji Photo Film	739,906	85,097	Fuji Photo Film	2505703	291,220	1
Sumitomo Chemical	556,113	341,451	Mitsubishi Chemical	1887493	911,181	2
Kao	490,019	4,546	Asahi Kasei	1193614	322,895	3
Showa Denko	471,288	267,732	Sumitomo Chemical	1111128	504,857	4
Sekisui Chemical	441,488	62,162	Mitsui Chemical	1053182	491,941	5
Mitsubishi Kasei	439,258	69,922	Dainippon Ink And Chemicals	961998	558,310	6
Dainippon Ink&Chemicals	417,697	199,785	Kao	865247	53,826	7
Ube Industries	364,989	550,180	Sekisui Chemical	799709	167,043	8
Mitsui Toatsu Chemicals	363,338	393,365	Shin-Etsu Chemical	797523	148,987	9
Mitsubishi Petrochemical	340,346	158,062	Showa Denko	689366	527,388	10
pharmaceuticals						
Takeda Chemical Industries	539,754	12,902	Takeda Chemical Industries	1046081	7,563	1
Sankyo	291,724	25,548	Sankyo	569927	16,858	2
Shionogi	206,118	13,637	Yamanouchi Pharmaceutical	506602	9,147	3
Fujisawa Pharmaceutical	190,293	14,712	Eisai	466613	313	4
Yamanouchi Pharmaceutical	185,082	895	Fujisawa Pharmaceuticals	382079	22,900	5
Tanabe Seiyaku	167,231	15,458	Kyowa Hakko Kogyo	359284	47,636	6
Eisai	167,063	100	Daiichi Pharmaceutical	322011	51	7
Daiichi Seiyaku	147,450	13,350	Shionogi	285231	28,293	8
Chugai Pharmaceutical	124,492	2,535	Mitsubishi Pharma	280780	36,089	9
Taisho Pharmaceutical	123,781	0	Taisho Pharmaceutical	274077	305	10
oli&coal industry						
Nippon Oli	1,725,814	206,600	Nippon Oli	4187392	1,049,620	1

Cosmo Oil	1,297,593	700,060	Nippon Minning Holdings	2163088	853,429	2
Showa Shell Sekiyu	1,231,063	434,040	TonenGeneral Sekiyu	2135289	104,578	3
Mitsubishi Oil	671,719	271,233	Cosmo Oil	1902767	573,241	4
Toa Nenryo Kogyo	457,572	127,803	Showa Shell Sekiyu	1726917	120,950	5
General Sekiyu	446,018	77,235	AOC Holdings	113038	115,468	6
Koa Oil	183,335	121,264	Fuji Kosan	81588	12,164	7
Fuji Kosan	127,765	39,326	Nichireki	42105	1,314	8
Nichireki Chemical Industry	15,017	417	Petrolub International	11050	0	9
n/a	n/a	10				
rubber industry						
Bridgestone	621,416	322,061	Bridgestone	2303917	487,237	1
Yokohama Rubber	245,364	113,056	Sumitomo Rubber Industries	450490	210,679	2
Sumitomo Rubber Industries	220,083	181,297	Yokohama Rubber	400448	177,008	3
Toyo Tire&Rubber	180,832	74,927	Toyo Tire&Rubber	255157	94,111	4
Okamoto Industries	66,775	135	Tokai Rubber Industries	182397	20,618	5
Mitsuboshi Belting	64,540	8,451	Achilles	101083	12,565	6
Kinugawa Rubber Industrial	53,625	9,826	Bando Chemical Industries	66885	11,151	7
Bando Chemical Industries	50,306	6,385	Mitsuboshi Belting	65227	11,139	8
Achilles	37,363	2,871	Okamoto Industries	60520	5,033	9
Sekaicho Rubber	14,798	6,375	Kinugawa Rubber Industrial	53521	18,066	10
glass & ceramics						
Asahi Glass	834,421	105,530	Asahi Glass	1242956	574,266	1
Toto	293,099	1,414	Taiheiyo Cement	927956	799,313	2
Nippon Sheet Glass	203,918	55,602	Toto	439683	100,742	3
Inax	193,964	0	Nippon Electric Glass	328803	161,051	4
Onoda Cement	186,887	207,908	NGK Insulators	301750	60,377	5
Mitsubishi Mining&Cement	173,406	153,833	Nippon Sheet Glass	280100	164,463	6
Ngk Insulators	171,514	6,660	NGK Spark Plug	228928	51,927	7
Nippon Electric Glass	169,005	60,620	Sumitomo Osaka Cement	194679	137,532	8
Nihon Cement	155,138	182,394	Nitto Boseki	127950	47,946	9
Sumitomo Cement	135,589	143,764	Noritake	110857	25,980	10
steel industry						
Nippon Steel	2,147,038	1,424,817	Nippon Steel	2749306	1,832,053	1
Nkk	1,050,325	1,450,215	JFE Holdings	2426886	1,995,454	2
Kobe Steel	975,932	1,052,809	Sumitomo Metal Industries	1224633	1,342,608	3
Kawasaki Steel	936,372	746,374	Kobe Steel	1204749	943,480	4
Sumitomo Metal Industries	909,271	996,574	Nisshin Steel	412411	226,098	5
Nisshin Steel	363,555	157,821	Hitachi Metals	408658	150,885	6
Hitachi Metals	251,720	67,857	Daido Steel	344456	153,590	7
Daido Steel	193,682	145,281	Aichi Steel	152017	23,326	8
Tokyo Steel Mfg.	162,067	0	Yodogawa Steel Works	147123	8,725	9
Yodogawa Steel Works	147,114	7,096	Nippon Yakin Kogyo	134016	95,508	10
metal industry						
Toyo Seikan	437,690	44,324	Tostem Inax Holding	942773	101,540	1
Toyo Sash	302,561	53,506	Toyo Seikan	696361	38,356	2
Sankyo Aluminium Industry	201,109	42,553	NHK Spring	249855	77,698	3
Nhk Spring	117,158	18,596	Sanwa Shutter	242468	94,895	4
Rinnai	89,470	2,618	Rinnai	189685	15,540	5
Noritz	80,003	0	Noritz	170079	1,959	6

Sanwa Shutter	79,858	4,693	Hokkai Can	145932	86,072	7
Hokkai Can	66,670	12,084	Kawada Industries	112912	39,180	8
Bunka Shutter	56,180	3,764	Bunka Shutter	109497	3,903	9
Tokyo Rope Mfg.	55,644	35,378	Yokogawa Bridge	78975	0	10
machinery						
Mitsubishi Heavy Industries	1,708,256	489,433	Mitsubishi Heavy Industries	2593894	1,095,222	1
Ishikawajima-Harima Heavy Industries	714,714	415,899	Komatsu	1089804	487,469	2
Kawasaki Heavy Industries	579,731	388,005	Ishikawa-Harima Heavy Industries	1019061	447,824	3
Kubota	557,979	82,321	Toyota Industries	1069218	360,079	4
Toyota Automatic Loom Works	367,828	3,000	Kubota	926145	278,888	5
Nippon Seiko	265,225	50,801	Daikin Industries	572413	153,480	6
Ntn Toyo Bearing	225,745	86,424	Calsonic Kansei	545000	46,675	7
Aichi Machine Industry	223,078	10,910	Nsk	522820	262,857	8
Diesel Kiki	214,925	32,237	Ebara	517981	231,911	9
Sumitomo Heavy Industries	200,026	164,755	Sumitomo Heavy Industries	481289	247,070	10
electrical machinery						
Matsushita Electric Industrial	3,277,613	149,570	Hitachi	8191752	2,702,617	1
Hitachi	2,919,539	785,565	Sony	7473633	1,159,399	2
Toshiba	2,682,781	849,457	Matsushita Electric Industrial	7401714	864,492	3
Nec	2,304,392	845,098	Toshiba	5665778	1,641,559	4
Mitsubishi Electric	1,954,187	601,411	Nec	4695035	1,382,838	5
Fujitsu	1,714,424	437,207	Fujitsu	4617580	1,476,668	6
Nippondenso	1,115,748	6,733	Mitsubishi Electric	3639071	996,029	7
Sony	1,029,891	326,192	Canon	3198072	98,396	8
Sanyo Electric	987,539	377,625	Denso	2332760	143,761	9
Sharp	872,707	518,939	Sanyo Electric	2273875	1,103,084	10
transport equipment						
Toyota Motor	6,691,299	179,207	Toyota Motor	16054290	7,243,554	1
Nissan Motor	3,418,671	1,262,062	Honda Motor	7971499	2,492,137	2
Mazda Motor	1,844,319	378,037	Nissan Motor	6828588	2,997,253	3
Mitsubishi Motors	1,752,697	664,291	Mitsubishi Motors	3884874	1,141,278	4
Honda Motor	1,249,737	180,617	Mazda Motor	2364512	687,008	5
Isuzu Motors	1,023,300	347,462	Suzuki Motor	7971499	159,135	6
Suzuki Motor	759,550	113,907	Fuji Heavy Industry	1372337	396,608	7
Fuji Heavy Industries	686,238	56,786	Isuzu Motors	1349449	455,426	8
Hino Motors	448,412	32,139	Kawasaki Heavy Industries	1239598	434,886	9
Daihatsu Motor	445,665	129,174	Yamaha Motor	1013155	165,906	10
precision instruments						
Dai Nippon Printing	680,849	3,718	Olympus	564343	229,177	1
Canon	672,227	259,880	Nikon	468958	227,737	2
Ricoh	560,017	59,240	Citizen Watch	333988	35,298	3
Toppan Printing	557,026	17,651	Hoya	246293	2,200	4
Minolta Camera	196,939	107,172	Seiko	226734	144,509	5
Nikon	170,347	47,486	Shimadzu	204282	86,717	6
Citizen Watch	162,123	56,421	Terumo	200625	28,511	7
Yokogawa Electric	161,777	8,531	Nipro	180369	127,812	8
Shimadzu	133,453	9,315	Pentax	108189	35,040	9
Yamatake-Honeywell	95	5,379	Noritsu Koki	78602	3,468	10

	Toshiba	5665778	1,641,559	1
	Nec	4695035	1,382,838	2
	Fujitsu	4617580	1,476,668	3
	Sharp	2003210	436,794	4
	Seiko Epson	1322452	548,929	5
	Kyocera	1069770	197,783	6
	Nec Electronics	725093	118,957	7
	Alps Electronic	601816	140,510	8
	Murata MFG	394955	4,547	9
	Rohm	350281	0	10

Source: Calculations based on data from Japan Company Handbook: summer 1989 first section and summer 2003 first section Toyo Keizai Inc.