Samuel Neaman Institute

FOR ADVANCED STUDIES IN SCIENCE AND TECHNOLOGY

Total Factor Productivity as a Performance Benchmark for Firms: Theory and Evidence

HARIOLF GRUPP • SHLOMO MAITAL

SNI R&D Policy Papers Series

Technion - Israel Institute of Technology

Total Factor Productivity as a Performance Benchmark for Firms: Theory and Evidence

Hariolf Grupp and Shlomo Maital

January 2003

Total Factor Productivity as a Performance Benchmark for Firms: Theory and Evidence

Hariolf Grupp and Shlomo Maital

Abstract

We propose using Solow's macroeconomic approach and the concept of Total Factor Productivity (TFP) as a microeconomic tool for analyzing individual firms. TFP long used in analyzing macroeconomic growth among countries, is a useful strategic performance benchmark for individual firms. TFP calculations permit managers and investors to partition labor productivity growth between two sharply different underlying causes: capital-deepening (higher capital per worker), and exogenous technological change. The TFP benchmark can be computed from readily-available information in financial statements.

The structure of the paper is as follows. Section 2 presents a simple version of Solow's model, suitable for use in individual firms, and provides a numerical example. Section 3 gives detailed total factor productivity calculations for the 20 largest firms in the world. Section 4 provides three case studies of total factor productivity growth, for Intel, YPF (Argentina's largest energy company) and Merck. The final section summarizes and concludes.

Acknowledgements: Research for this paper was supported by a grant from the German-Israel Foundation. This Essay was written while the second author was a Visiting Professor at the MIT - Center for Advanced Educational Services and MIT Sloan School of Management. We also acknowledge partial support from the Technion Vice-President's Fund for Research and from the William Davidson Fund for Management Research, Industrial Engineering & Management Faculty.

* *This paper appeared as Chapter 7 in: H. Grupp, S. Maital, Managing New Product Development and Innovation: A Microeconomic Toolbox. Edward Elgar: Cheltenham, UK: 2001.*

Introduction

It is widely accepted that productivity is a key performance benchmark for firms.[1] Rising productivity is related to increased profitability, lower costs and sustained competitiveness. The most widely-used productivity indicator for firms is labor productivity – units of output, or value added, per employee. However, this measure has serious shortcomings. The main one: It fails to show why labor productivity has risen.

Consider, for instance, productivity among banks. Value added per worker among U.S. banks rose by 3.5 per cent annually, in the 1990's. In contrast, overall labor productivity in the U.S. economy rose by less than half that rate. Why did labor productivity in banks outpace that in the overall economy? Was it because of massive investments in information technology, as some believe? Or because of economies of scale (in part due to mergers, downsizing and improved efficiency). The 3.5 % labor productivity figure itself offers no clue. Clearly, for a particular bank, benchmarking its productivity performance in a way that leads to strategic managerial interventions is vital. Labor productivity is not in itself sufficient.

A possible solution lies in the macroeconomic research of Solow. Solow (1957, 1969) found that a majority of nations' economic growth was attributable to technical change, or "total factor productivity growth", which he proposed measuring as a "residual", based on a so-called "production function approach". This "production function approach" has been extensively used to measure the rate of return to net investment in R&D for firm or line-of-business level data (Mansfield, 1965; Clark and Griliches, 1984; Link, 1981; Griliches, 1986) and industry aggregates (Terleckyj, 1974; Griliches, 1979, 1994; Griliches and Lichtenberg, 1984; Scherer, 1982).

In this paper, we propose using Solow's macroeconomic approach and the concept of total factor productivity as a microeconomic tool for analyzing and partitioning labor productivity change in individual firms. The result is insightful because it shows whether companies' labor productivity gains are driven principally by capital investment, or whether they are driven by technology and knowledge. For outside

1 Prescott (1997) shows that cross-country differences in per capita income are primarily accounted for by differences in total factor productivity and TFP growth rates ("...differences in tangible and intangible capital cannot account for large international differences [in per capita income] ....what is all-important is total factor productivity", p. 1). Differences in earnings per share across firms are similarly accounted for in large measure by TFP differences.

observers and analysts, TFP can be estimated using publicly-available information contained mainly in balance sheets and pro-forma income statements. Within firms, confidential data can be used to build disaggregated measures of total factor productivity and its rate of change, for individual business units or subsidiaries.

We will argue that total factor productivity, a powerful tool in the armoury of macroeconomists, should also be added to the day-to-day toolbox of senior managers and investment analysts, keen to benchmark productivity change within the firm in an operational manner.

Theory

In his classic 1957 paper, Robert Solow showed how technical progress could be measured by using a production function. In his method, the change in labor productivity was caused by two separate factors: a) capital deepening, i.e. a rise in the amount of capital per unit of labor, and b) exogenous "technical change", i.e. improvements in knowledge, methods, etc. While (b) could not be directly measured, it could be inferred as a residual, by subtracting the contribution of "capital deepening" from the overall change in labor productivity. This method was widely applied to analysis of countries and industries.
In this Essay, we argue that Solow's method can be equally useful for benchmarking productivity change within individual firms. For countries, aggregate value added is simply Gross Domestic Product (GDP). For firms, value added is the difference between sales revenue and the cost of material inputs.

Value added per employee for firms, as for countries, grows either because a) capital investment makes workers more productive, or b) better methods, technology, methods, incentives, motivation, etc., makes workers more productive without additional capital investment. It is vitally important for managers, investors and for stockholders to know why labor productivity (value added per employee) has risen, or why it has not.

Solow has shown that countries grew wealthy mainly through factor (b). If this is true, it must therefore be the case that for such wealthy countries, a significant number of the firms in these countries also have significant increases in factor (b).

To adapt Solow's measure of technical progress to the individual firm, define "total factor productivity" as total value added divided by a "representative bundle" of labor and capital – a geometric average of labor and capital, with the exponential weights reflecting the contributions of labor and capital to overall value added:

Terminology

TFP = total factor productivity
VA = value added ($): Sales revenue minus cost of materials
K = capital (generally, shareholders' equity, which is "net assets", or gross assets, taken from the balance sheet)
L = number of employees, or total annual labor hours
α = fraction of value added attributable to labor, equal to [L VMP_L]/VA, where VMP_L is the value of the marginal product of labor
$1 - \alpha$ = fraction of value added attributable to capital, equal to [K VMP_K]/VA, where VMP_K is the value of the marginal product of capital.

Model

$$TFP = VA / [L^{\alpha} K^{1-\alpha}] \quad (1)$$

Equation (1) simply states that total factor productivity is defined as value added per "basket" of labor and capital, where the basket is the geometric mean of Labor (L) and Capital (K), weighted by their respective importance or contribution to output, as measured by α and $1-\alpha$.

Dividing by L yields

$$TFP = [VA/L] / [(K/L)^{1-\alpha}] \quad (2)$$

Total Factor Productivity is now seen as value added per worker, divided by an exponential function of capital per worker. The exponential function in the denominator represents the part of labor productivity (VA/L) generated by capital intensity K/L.[2]

2 To see this: Let VA/L = F[(K/L, A(t)], where A(t) is exogenous technological change, not associated with physical capital K. Assuming certain properties for F( ) permits us to write this expression as: VA/L = A(t) F(K/L). Finally, assuming a Cobb-Douglas (exponential) function form for the production function yields: $VA/L = A(t)\,(K/L)^{1-\alpha}$. It is therefore true that $A(t) = [VA/L] / [(K/L)^{1-\alpha}]$, which is precisely equation [2].

Taking logarithms of both sides provides the form

$$\log TFP = \log [VA/L] - (1-\alpha)\log [K/L] \tag{3}$$

Derivating with respect to time (d/dt) finally gives

$$d\log TFP/dt = d\log [VA/L]/dt - (1-\alpha)\, d\log[K/L]/dt \tag{4}$$

Since 100 dlogx/dt equals 100 [dx/dt]/x, i.e. the % change over time in x, (4) can be expressed as

$$\text{\% change in TFP} = \text{\% change in Value Added per employee} - (1-\alpha)(\text{\% change in capital per employee}). \tag{5}$$

Equation (5) is the key tool for TFP benchmarking. In terms of the Solow (1957) paper, (5) states that whatever part of the change in labor productivity is not attributable to capital deepening (higher capital per employee), must be caused by exogenous non-capital factors like better management, knowledge, motivation, etc. Therefore, the change in Total Factor Productivity, when computed for individual firms, partitions the underlying factors that drive labor productivity between expensive capital-deepening and inexpensive "free lunch" technological change factors. It is of course understood that technological change is often embodied in capital equipment; this fierce debate, about the "embodiedness" of technical change, is the subject of a large number of studies, and will not be addressed here.[3]

Numerical Illustration

Consider two firms. Each has experienced a 20 per cent rise in net after tax profits in 1999 (see Table 1). A deeper analysis is required, to understand why profits rose. Data are collected on operating profits, value added, shareholders' equity (net capital, or assets minus liabilities) and number of employees.

Table 1: *A numerical illustration.*

	Firm 1	Firm 2

3 See Grupp and Schwitalla (1998) for a recent treatment.

	1998	1999	1998	1999
Value Added ($ million)	100	110	100	110
Capital ($ million)	40	45	40	40
Labor (persons)	1,000	1,000	1,000	1,200
NOPAT* ($ million)	10	12	10	12

* NOPAT = net operating profit after tax

Table 2: Partial measures of productivity and profitability.

	Firm 1			Firm 2		
	1998	1999	% change	1998	1999	% change
Economic Value Added*	$2 m.	$3 m.		$2 m.	$4 m.	-
EVA as % of Capital	5 %	6.7 %		5 %	10 %	-
Labor Productivity**($000)	100	110	+10 %	100	92	-8 %
Capital Productivity*** ($)	2.5	2.44	-6.1 %	2.5	2.75	+ 10 %

* Economic Value Added (EVA) = NOPAT minus the opportunity cost of capital. Here, we assume that shareholders can earn 20 % on their investment in equally-risky alternatives; hence EVA = NOPAT - (0.2) (Capital)

** Labor Productivity = Value added per employee

*** Capital Productivity = Value added per dollar of capital

These data permit calculation of standard, partial measures of productivity (see Table 2). Such measures reveal

a) Firm 1 enjoyed a 10 % rise in labor productivity in 1999, while Firm 2 had an 8 per cent *drop* in labor productivity.

b) Firm 1 suffered a 6 % drop in capital productivity, while Firm 2 had a 10 % increase in capital productivity.
Evidently, this results from Firm 1 maintaining its labor force unchanged while increasing capital investment; while Firm 2 kept its capital investment constant, while boosting its labor force by 20 %.

Moreover,

c) Firm 1 increased its economic value added as a % of shareholders' equity from 5 % to 6.7 %, but Firm 2 raised the same measure to 10 %.
While all three of these benchmarking measures have value, what is missing is an overall summary statistic showing what part of labor productivity gains were due to what may be termed an "economic free lunch" (not related to capital investment),

and what part were due to relatively costly (though doubtless necessary) capital investments, i.e. equation (3). This is computed in Table 3.

Table 3: *Per cent change in total factor productivity.*

	Firm 1	Firm 2
% change in value added per employee	+ 10 %	- 8 %
- (0.4) (% change in capital per employee)	- (0.4) (12.5 %)	- (0.4) (-16.67 %)
equals: % change in total factor productivity, 1998 - 1999*	+ 5 %	- 1.67 %

* % change in total factor productivity = % change in value added per worker minus (capital intensity coefficient) (% change in capital per worker). See equation (3).

From Table 3, we learn that Firm 1 experienced a 5 % gain in total factor productivity, while Firm 2 had a 1.67 % decline in this key measure. Thus, even though Firm 2 has managed to boost its economic rent to 10 % of shareholders' equity by avoiding additional investment, its performance in the realm of productivity has been substantially poorer than that of Firm 1. Even though the short-term profit picture may be bright, the TFP numbers raise issues related to management performance.

Economic Value Added (EVA) – return on shareholders' equity after deducting the opportunity cost of capital - has become a widely used measure of firm performance. Strategy experts have criticized this measure, on the grounds that it narrowly measures the productivity of capital alone. The advantage of the TFP measure is that it takes into account both labor and capital in measuring productivity, as well as, of course, sales and output.

A Macro Example

Consider now a real-world example: two "firms" we shall temporarily call HK Ltd. and SG Ltd. (Table 4). Both entities experienced similar, rapid growth in value added per worker over the two decades 1971-1990; in each, labor productivity doubled every decade. But HK Ltd. showed profitability (rates of return on capital) twice that of SG Ltd. Why? SG Ltd. attained growth in labor productivity by massive capital investments. For instance, in 1980, SG Ltd. did not produce any computer components or peripherals whatsoever. By 1983 SG Ltd. was the world's largest producer of disk drives. Such investments were profitable initially, but encountered rapidly diminishing returns. In contrast, HK Ltd. used its high quality human resources and entrepreneurial energy to drive total factor productivity growth with far less capital spending, achieving therefore higher profitability.

HK Ltd. is, of course, Hong Kong. SG Ltd. is Singapore. While Singapore's conservative economic policy has left it relatively unscathed by the Asian financial crisis, nonetheless the concomitance of massive investment, diminishing returns to capital and shrinking profitability, are seen by some as the underlying causes of Asia's 1997-98 financial crisis, in Thailand, Indonesia and Malaysia, anticipated in Young's (1992) paper. Had managers and investors been tracking total factor productivity for firms, as well as for whole countries, the impending crisis might have signalled its coming years before it happened.

Table 4: *HK Ltd. and SG Ltd., 1971-1990.*

	Proportion of Growth in Value Added per Worker Caused by: TFP Growth	Capital Deepening	Real Return on Capital (%)*
Hong Kong	56 per cent	44 per cent	22 % - 24 %
Singapore	- 17 per cent	+ 117 per cent	7 % - 13 %

* HK: 1980-86; Sing.: 1980-89. Source: Young (1992).

Application of TFP analysis to global firms

In this Section, we provide some calculations of TFP growth for a selection of large global firms drawn from the Fortune 1000 list. Data are given in the Appendix 1.

Rates of change in Total Factor Productivity were computed for the largest 20 firms in Fortune magazine's Global 1,000 (see Table 5). They reveal several firms, like GE and WalMart, with large positive TFP gains, and several (mainly Japanese) with large declines in TFP (with Mitsubishi the exception). ATT is also notable for poor TFP performance, as is Mobil.[4]

To determine whether TFP change indeed provides new information about the firm beyond conventional measures – like the change in the price of its shares and the change in profits – we computed the Pearson correlation between % change in TFP and a) % change in stock price during the following year, and b) % change in profits in the same year. None were statistically significant, and in fact none exceeded 0.13. This suggests that TFP change does provide a new dimension of information about firm performance, largely independent of – and behaving differently from – share performance and profit. Of course, because the % change in revenue is a key part of the TFP formula, TFP change is highly correlated with revenue gains. This is not only a statistical artifact but also a management principle – nothing is more helpful to productivity than strong revenue gains, generated with more or less the same capital and labor resources as the year before.

An interesting, marginally-significant relation was found between "rank by firm size" and TFP change. The Pearson correlation of -.390 ($p > 0.089$) was negative, indicating that smaller firms (i.e. higher rank numbers) have smaller rates of growth in TFP.

Table 5: Top 20 firms in the fortune 1000 global list: % change in TFP 1997 vs. 1996.

Company	% change in TFP $1-\alpha = 0.4$	% change in TFP $1-\alpha = 0.3$	Mean % TFP change
GM	2.51	3.33	2.92
Ford	0.98	1.86	1.42
Mitsui	0.57	0.03	0.30
Mitsubishi	12.34	11.25	11.80
Itochu	-6.36	-6.42	-6.39
Royal Dutch Shell	4.80	3.60	4.20
Marubeni	-38	-8.13	-76
Exxon	2.78	2.71	2.74
Sumitomo	-8.94	-10.25	-9.59
Toyota	-10.78	-11.21	-10.99

4 Significantly, Mobil has since been acquired by Exxon.

WalMart	14.68	14.11	14.40
GE	16.04	15.71	15.88
Nissho Iwai	45	6.54	6.99
NTT	-1.55	-1.58	-1.56
IBM	3.37	3.38	3.37
Hitachi	-7.05	-64	-34
ATT	-31.38	-30.66	-31.02
Nippon Life	-161	-16.41	-17.01
Mobil	-14.81	-15.36	-15.08
Daimler Benz	0.27	0.45	0.36

Source: see Appendix.

4 Three case studies: Intel, YPF, Merck

The following three case studies of total factor productivity growth are drawn from publicly-available data in annual financial statements. Use of such public data necessarily requires some assumptions, in order to compute TFP. Of course, when internal company data are available, no such assumptions need to be made.

Intel Ltd.

Table 6 summarizes productivity data for Intel, for 1993 and 1994. They show a decline in labor productivity of 3 %. The TFP equation (5) can help us understand why.

Table 6: Balance sheet data for Intel.

	1994	1993	% change
	- $ billion -		
Net Revenue	$11.5	$8.8	
- Cost of Goods Sold	5.6	3.3	
= Value Added*	5.9	5.5	+ 2 %
Labor (employees)	32,600	29,500	+ 10.5 %
Value Added per Worker	$180,982	$186,440	- 3 %
Capital (Shareholders' Equity)	$9.3 b.	$5 b.	+ 24 %
Capital per Worker	$285,276	$254,237	+ 12 %

Assume value of $(1-\alpha) = 0.4$
Source: Intel Ltd. Annual Financial Statements, 1993, 1994.

* Value added is not technically the difference between net revenue and cost of goods sold (as derived from the income statement), because cost of goods sold includes the cost of labor as well as materials. However, if we assume that the proportion of cost-of-goods-sold comprised of labor costs does not appreciably change in 1994 compared to 1993, then the % change in value added computed by using cost of goods sold will be the same as the value computed by using the technically correct measure of value added (not computable from publicly-known information).

Applying the "Solow equation" (5) yields a % change in TFP = - 8 %.

Intel experienced a decline in labor productivity in 1994, despite a large increase in Intel's capital, owing to "negative technological change". Closer investigation would doubtless reveal Intel's massive shift from 486 microprocessors to the new 586 ("Pentium") microprocessor, and attendant loss of output and production time, as fabrication plants transitioned to new technologies and workers underwent training.

The data indicate the costliness of such transitions, in terms of lost productivity and inefficiency, but further exploration may have led investors to conclude that the productivity decline is likely temporary. Indeed, in following years, Intel's value added per worker grew impressively, driven largely by its technological change, and its stock price rose sharply. Poor TFP numbers do not in themselves prove a bleak outlook, or establish poor managerial performance, for firms. They may be temporary.

YPF Ltd.

YPF is Argentina's leading energy company. In 1991 the company was privatized, and slimmed its employment rolls down from over 50,000 employees to around 6,000 (although many of the 50,000 became private outsourcers for YPF). It provides one of the world's most dramatic examples of efficiency gains through privatization. YPF recorded very large gains in productivity in 1996. Was this due to gains in total factor productivity (higher value added per unit of resources), or capital investment?

Table 7: *Balance sheet data for YPF.*

	1996	1995	
	Billion $	Billion $	Increase
Revenues	5.9	5.0	
Cost of Sales	3.6	3.2	
Value Added	2.3	1.8	27 %
Labor: (employees)	9,700	9,300	4.3 %
Value added per employee	237,000	194,000	22.16 %
Capital	6,734	5,839	15.32 %
Capital per employee	694,000	628,000	10.5 %

Assumption: the contribution of capital to value added (1 - α) is 0.4, typical for a capital-intensive firm. Source: YPF Annual Financial Statements.

Solow's equation provides the answer: The % change in TFP equals 22.2 % - (0.4) (10.5 %) = 18 %.

This tells us that YPF's impressive increase in value added per worker was largely due to improvements in technology, efficiency and knowledge, rather than capital investment. Indeed, the remarkable story of YPF's privatization and resulting dramatic increase in efficiency deserves to be more widely known and studied. As expected, YPF's higher total factor productivity found expression in the higher profitability of its capital.

Merck Ltd.

Merck, an R&D-intensive pharmaceutical company, showed large gains in value added per worker, apparently primarily from increases in knowledge stemming from an aggressive R&D policy. It should be noted that conventional accounting does not treat R&D expenditures as part of a company's "intellectual capital", but rather treats them as current expenditures.

Table 8: *Balance sheet data for Merck.*

	1994	1993	% change
Value Added ($ b.)	$9.0	$8.0	12.5
Employees (L)	47,700	47,100	1.3
Capital (Assets, K)	$21.9	$19.9	10.1

Therefrom, we get a % Change in TFP = 11 % - (0.4)(8.7 %) = 5 %.

Probably, TFP calculations should be accompanied by a recalculation of capital investment, treating R&D spending as investment and amortizing it over 3-5 years to reflect the relative short life of this asset.

From the TFP data, one can deduce that the majority of Merck's labor productivity gain stems from its technological change - probably, its successful investment in R&D for new products.

Conclusion

Analysis of total factor productivity data for countries ultimately led to a new appreciation of the key role of knowledge and technological change as drivers of economic growth in per capita output. Extension of this tool to performance benchmarking for firms has taken a surprisingly long time (Wakelin 1998). By applying TFP to firm data, senior management and external analysts can find answers to the question: why is labor productivity growing (or not growing). Perhaps the key value of such TFP calculations is not that they provide definitive answers, but serve as a stimulus of further analytic questions that help both managers and investors better understand the firm's strengths and weaknesses.

TFP benchmarks for individual firms, or divisions within firms, are best seen as the beginning of an in-depth strategic analysis, rather than the end. A promising extension of TFP analysis for firms might be to apply the so-called "growth accounting" analysis of Denison (1967) – which partitioned TFP growth for countries among a large array of contributing factors – to TFP data for firms, to achieve a similar goal: the answer to the question, how and why did technical change grow (or fail to grow) in the firm?

References

Clark, K. B. and Z. Griliches (1984), Productivity growth and R&D at the business level: results from the PIMS data base. In Z. Griliches, ed., R&D, patents and productivity. Chicago: U. of Chicago Press, 393-416.

Craig, C. E. and R. C. Harris (1973), "Total productivity measurement at the firm level". Sloan Management Review, Spring , pp. 12-29.

Denison, E. (1967), Why Growth Rates Differ. Brookings Institution: Washington, DC.

Griliches, Z. (1986), "Productivity puzzles and R&D: another nonexplanation". Journal of Economic Perspectives. 2 (4), 9-21.

Griliches, Z. (1979), "Issues in assessing the contribution of R&D to productivity growth", The Bell Journal of Economics, 10 (1), 92-116.

Griliches, Z. (1994), "Explanations of productivity growth: Is the glass half-empty?" American Economic Review, 84(1), 1-25.

Griliches, Z. and F. Lichtenberg (1984), "Interindustry technology flows and productivity growth: a re-examination". Review of Economics and Statistics, 66 (2), 325-29.

Grupp, H. and B. Schwitalla (1998), "Embodied and Disembodied Technical Change: A Multi-Factorial Analysis of German firms". *METU Studies in Development*, 25(1), 75-105.

Link, A. N. (1981), "Basic research and productivity increase in manufacturing: additional evidence". American Economic Review, 71, 1111-12.

Mansfield, E. (1965), "Rates of return from industrial R&D", American Economic Review, 55, 863-73.

Prescott, Edward. "Needed: A Theory of Total Factor Productivity". Federal Reserve Bank of Minneapolis: Working Paper, 1997.

Scherer, F. (1982), "Interindustry technology flows and productivity growth". Review of Economics and Statistics. 627-34.

Solow, R. (1957), "Technical progress and the aggregate production function". Review of Economics and Statistics, 39, 312-320.

Solow, R. (1969), Growth Theory: An Exposition. Clarendon Press: Oxford, UK, 1970.

Terleckyj, N. (1974), Effects of R&D on the Productivity Growth of Industries: An Exploratory Study. Washington DC: National Planning Association.

Wakelin, K. (1998), "Productivity growth and R&D expenditure in UK manufacturing firms". Working paper: U. of Nottingham, May.

Young, A. (1992), "A Tale of Two Cities: Factor Accumulation and Technical Change in Hong Kong and Singapore." NBER Macroeconomics Annual, edited by O. J. Blanchard and S. Fischer. MIT Press: Cambridge, MA., 1992, pp. 13-63.

Appendix 1: Data for Top 20 Global Firms (Fortune 1000).

Company	% ch.share price	Assets 96	Employment 96	Assets 97	Employment 97	% change Rev	% change Profits
	5/29/98-5/30/97					1997 vs 1996	1997 vs. 1996
GM	32	222100.00	647.00	225888.00	608.00	5.80	35.00
Ford	107	262900.00	372.00	279097.00	363.00	4.50	55.60
Mitsui	-42	61144.00	42.00	55071.00	40.00	-1.60	-16.50
Mitsubishi	-49	77872.00	35.00	71408.00	36.00	8.00	-1.50
Itochu	-	59179.00	7.00	56308.00	6.70	-6.60	-
Royal Dutch Shell	18	124373.00	101.00	113781.00	105.00	0.00	-12.70
Marubeni	-	60865.00	65.00	55403.00	64.00	-10.40	-21.40
Exxon	19	95527.00	79.00	96064.00	80.00	2.50	12.60
Sumitomo	-32	43506.00	26.00	42866.00	29.50	-14.20	0.00
Toyota	-14	102417.00	150.00	103893.00	159.00	-12.50	8.00
WalMart	85	39501.00	675.00	45525.00	825.00	12.40	15.40
GE	38	272402.00	239.00	304012.00	276.00	14.70	12.70
Nissho Iwai	-	43647.00	150	40799.00	18.00	3.80	-81.90
NTT	-14	115864.00	230.00	113409.00	226.00	-1.70	750
IBM	36	81132.00	268.00	81499.00	269.00	3.40	12.20
Hitachi	-38	80328.00	330.00	75837.00	331.00	-9.40	-96.40
ATT	66	55552.00	130.00	58635.00	128.00	-28.50	-21.50
Nippon Life	-	322759.00	86.70	316530.00	75.90	-12.80	15.30
Mobil	12	46408.00	43.00	43559.00	42.70	-17.00	10.40
Daimler Benz	31	72331.00	290.00	76190.00	300.00	1.00	161.00

Source: Fortune Global 1000: August 4, 1997; August 3, 1998; Share price data is from Business Week: The Global 1000, July 13, 1998.
Capital K is measured by Assets; L Labor is no. of employees; % change in value added is proxied by % change in revenue.