TFP and production factors over the post-war period in Japan's macro economy*

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Abstract

This paper analyzes factors in the transition of production and the situation of productivity including (Total Factor Productivity) TFP using Japanese macro time series economic data from 1955 to 2000.

Labor productivity in the overall Japanese economy slowly declined during the 1990s, yet TFP did not decline during the same period. These changes were measured using both the Total Cost approach and Solow's residuals, adjusted by the operating ratio of equipment.

We found that the real reasons for Japan's slower growth rate during the 1990s were negative growth of capital and labor. The primary cause was a decline in the distribution of capital, which negatively affected the operating ratio and the growth rate of capital stock on the capital side, while also decreasing both labor hours and employees on the labor side. This corresponds with declining investment on the demand side as a factor in recession.

Keywords : Macro economy, capital stock, productivity, TFP, Solow's residuals

1 Introduction

This paper analyzes factors in the transition of production and overall productivity including TFP using Japanese time series macroeconomic data from 1955 to 2000. There are several perspectives regarding Japan's long recession. The first states that supply side changes caused the long recession. Continued low productivity during the 1990s could not support Japanese economic growth. Representative of this view is Hayashi and Prescott (2002). Another perspective is that a shortage of demand within the business cycle actually caused the recession, as cited by Iwata and Miyakawa (2003). Other perspectives on the long Japanese recession are available from Hamada and Horiuchi (2004), Kobayashi and Kato (2001), and Noguchi and Tanaka (2001).

In Japan, collusion in the construction industry, large bankruptcies in the field of distribution, and bad-debt disposal in monetary institutions had the most adverse effect on investment. It is logical to focus next on the problem of productivity and effectiveness in those sectors because declining investment there may be structural and therefore, not suitable to updated change. Consequently, we would also like to analyze the supply side situation in Japan through the analysis of productivity.

* I'd like to appreciate anonymous comments of this journal. Mistakes still remained are all owed to me, of course.
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TFP (Total Factor Productivity) is crucial in this analysis. Previous research on Japanese TFP noted declines during the 1990s (Kawai and Inui (2003)), Hayashi and Prescott (2002), and Iwata and Miyakawa (2003). Recently, Morana (2004) supported supply side reform by using VECM, noting common trends in productivity and labor supply. Also, Miyao (2004), along with Hamada and Horiuchi (2004), pointed out the tendency for decline in productivity by TFP when excluding linear trends on the monetary side.

Shinozaki (2003) indicated TFP was in a slight decline during the 1990s in an analysis on information-related industries in Japan.

In contrast, Kamada and Masuda (2001) and Kawai and Inui (2003) have found different TFP results. This can be explained by a kind of *residuals of measurement* due to the quality of the economic data. Results depend on the quality and type of statistics, the adjustment of the operating ratio of production equipment, and the changing quality of labor.

Kawamoto (2004) and others reported that *the true* TFP or progress rate of technology was not declining during the 1990s after adjustment of the operating ratio and the quality of labor. Going even further, Inui and Kwon (2004) said TFP in services was rising rather than declining.

The following problems still exist though the different result of TFP variation is reported in the previous research above.

First, the measurement period is not consistent. Some measurements are used ones from middle in 1970s as 70s TFP and other is used one from middle in 80s as 80s TFP. It can be said that it is a rough estimate that assumes the mean value of a decade except some specific years. Secondarily, some measurements are not modified capital contribution with operating ratio. However, capital contribution must be overestimate without modification by business cycle index during recession period. Thirdly, there is not much research of examining how influent the change of the distribution rate gives TFP.

This paper is going to contribute to some points as follows;

First, we analyzed the productivity change during 46 years in postwar period constantly by unified data from 1946 to 2000.

Secondarily, we examined to include the change in the capital operating and the distribution rate for estimation of the change of TFP.

Thirdly, we tried to use and examine net fixed assets as capital in macro not so used by the previous research.

The second section discusses the transition of labor productivity and capital

stock. This includes a discussion of problems in capital stock data. In the third section we will see the measurement result of TFP and the components and tendencies of individual TFP. We will follow these discussions with brief concluding remarks.

2 Changes in Labor Productivity and Capital stock

First, let us examine the characteristics of real production per capita, that is productivity, $y_i = \frac{Y_i}{L_i}, i = 1,2,\cdots,46$ during the past 46 years in postwar Japan[1]. References are Table1 and Table2.

Briefly, these tables indicate the following: Real estate, petroleum, coal products, electricity, and private gas and water supply maintained high labor productivity through the 46 postwar years. Electrical machinery, equipment, and supplies rapidly rose in labor productivity since the middle 1980s.

Real GDP per capita appeared to decline slowly. In contrast, labor productivity in manufacturing tended to rise slowly. Textiles, however, declined since the 1980s. Agriculture, forestry and fishing have had lower labor productivity throughout the postwar period[2]. Labor productivity in government services is declining slowly[3]. It is obvious that the productivity of service activities and construction has tended to decline. In addition, wholesale and retail trade remains at lower labor productivity.

In the end, labor productivity in manufacturing remains high except for a few sectors, and service-related sectors are generally low in productivity in Japan. Specifically, wholesale and retail trade, service activities, and construction employ large numbers of workers, but have lower productivity. Achieving greater productivity in

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[1] The data used in this paper is basically all the NEEDS database that the Nikkei Media Marketing is editing and publishing.

However, because the publishing period of data is different in each data, 68 SNA is connected directly with 93 SNA at the time of 1990 in this paper. When other data is used, we'll describe about data source clearly in every case.

Twenty-six industrial sectors are accepted and those sectors are agriculture, forestry and fishing, and mining, thirteen sectors related to manufacturing, construction, electricity, gas and water supply (all private), and other sectors including wholesale and retail trade, finance and insurance, real estate, transport and communications, service activities electricity, gas and water supply (public), education, medical services and research, public administration, and private nonprofit services. In addition, we treated the economy as the entire country and all manufacturing industries as total manufacturing.

[2] Agriculture, forestry and fishing, and textiles are also simultaneously cutting the number of workers. Hence, those sectors are considered to be declining in Japan.

[3] In these tables, although the productivity of public electricity, gas and water supply tends to rise, education, medical services and research, and public administration decrease overall productivity.

those sectors may be an ongoing problem in Japan since they usually have lower productivity due to large numbers of workers.

Table 1: Labor Productivity (real production per capita at price of 1990) 1: Billion Yen

Labor Productivity(Billion Yen/person)

1980		1985		1990	
Petroleum and coal products	609.097	Petroleum and coal products	1124.771	Petroleum and coal products	963.023
Real estate	533.152	Real estate	514.132	Real estate	499.104
Electricity, gas and water supply(Private)	217.205	Electricity, gas and water supply(Private)	263.982	Electricity, gas and water supply(Private)	279.403
Iron and steel	143.554	Chemicals	121.380	Electricity, gas and water supply(Public)	223.386
Mining	90.154	Iron and steel	120.771	Chemicals	193.025
Food products and beverages	79.028	Electricity, gas and water supply(Public)	89.102	Iron and steel	152.383
Public administration	72.833	Mining	88.549	Finance and insurance	116.012
Chemicals	72.098	Public administration	81.748	Mining	110.990
Producers of government services	72.000	Finance and insurance	80.541	Transport equipment	102.058
Education, medical services and research	71.017	Producers of government services	80.093	Public administration	96.075
Electricity, gas and water supply(Public)	70.327	Education, medical services and research	77.284	Producers of government services	94.342
Finance and insurance	62.238	Food products and beverages	75.316	Pulp, paper and paper products	90.946
Pulp, paper and paper products	60.865	Pulp, paper and paper products	74.731	Electrical machinery, equipment and supplies	82.590
Tranport and communications	54.615	Machinery	73.238	Education, medical services and research	80.113
Construction	52.671	Tranport and communications	66.887	Machinery	80.061
Manufacturing	52.127	Manufacturing	63.689	Tranport and communications	80.028
Transport equipment	51.518	Transport equipment	59.945	Manufacturing	79.575
Machinery	50.670	Precision instruments	59.739	Food products and beverages	73.668
Private non-profit services	50.533	Non-metallic mineral products	59.093	Non-metallic mineral products	72.517
Whole country	49.593	Whole country	56.190	Construction	70.010
Service activities	43.462	Construction	54.627	Whole country	66.911
Non-metallic mineral products	40.155	Private non-profit services	54.397	Precision instruments	65.868
Others	38.799	Fabricated metal products	49.924	Fabricated metal products	60.894
Precision instruments	38.129	Service activities	48.158	Private non-profit services	56.310
Wholesale and retail trade	36.007	Others	47.459	Wholesale and retail trade	52.825
Fabricated metal products	33.117	Electrical machinery, equipment and supplies	45.177	Others	50.687
Electrical machinery, equipment and supplies	26.950	Wholesale and retail trade	38.439	Service activities	48.867
Textiles	26.042	Textiles	24.521	Textiles	28.744
Agriculture,forestry and fishing	12.263	Agriculture,forestry and fishing	15.743	Agriculture,forestry and fishing	19.389

1995		2000	
Petroleum and coal products	1055.371	Petroleum and coal products	1265.530
Real estate	533.763	Real estate	593.805
Electricity, gas and water supply(Private)	270.703	Electricity, gas and water supply(Public)	350.110
Electricity, gas and water supply(Public)	264.714	Electricity, gas and water supply(Private)	319.086
Chemicals	221.894	Chemicals	234.980
Iron and steel	155.721	Electrical machinery, equipment and supplies	232.391
Finance and insurance	141.619	Iron and steel	178.218
Electrical machinery, equipment and supplies	125.138	Finance and insurance	163.362
Transport equipment	107.988	Transport equipment	126.624
Public administration	102.693	Manufacturing	116.758
Producers of government services	102.476	Producers of government services	116.351
Manufacturing	89.912	Public administration	114.017
Education, medical services and research	86.773	Mining	98.837
Tranport and communications	85.710	Education, medical services and research	97.180
Pulp, paper and paper products	85.398	Pulp, paper and paper products	92.444
Mining	81.035	Tranport and communications	90.232
Non-metallic mineral products	78.830	Non-metallic mineral products	81.726
Food products and beverages	78.761	Private non-profit services	78.289
Machinery	75.310	Precision instruments	75.284
Whole country	69.153	Machinery	74.636
Fabricated metal products	65.562	Food products and beverages	73.702
Wholesale and retail trade	65.408	Whole country	73.022
Precision instruments	65.359	Others	72.558
Private non-profit services	59.484	Fabricated metal products	65.499
Construction	53.010	Wholesale and retail trade	61.376
Others	51.758	Construction	49.821
Service activities	46.854	Service activities	49.605
Textiles	38.047	Textiles	38.060
Agriculture,forestry and fishing	18.222	Agriculture,forestry and fishing	18.370

Note:Data source is NEEDS Database in 2002.

Next we will consider capital with fixed assets on balance sheets since we can view assets and liabilities by using stock tables in SNA.

Please note that market price data is based directly on B/S due to the lack of an adequate deflator for each asset[4].

Theoretically, an increase in capital stock must correspond with investment in that period $I_t = \Delta K_t = K_t - K_{t-1}$, so the amounts of net fixed capital formation (gross fixed capital formation - consumption) in the *Integrated account* (Flow table) equals the

[4] It is possible to deflate only net fixed assets by the deflator of private capital formation, as we shall see later.

net fixed capital formation in the *Capital Finance Account* (Stock table)[5].

Also, changes in financial assets in the Capital Finance Account in the Stock table are consistent with Financial transactions in Capital Finance Accounts by institutional sector in the Flow tables[6].

We used five asset items here: net fixed assets, inventories, tangible non-produced assets[7], financial assets, and corporate shares[8] and three types of liabilities--liabilities, corporate shares, and net worth (national wealth)[9].

Calculating a correlation coefficient matrix between assets and liabilities with the data above, significant relationships were shown in net worth and tangible non-producible assets, financial assets and liabilities except shares, and corporate shares and shares in liabilities. The result is shown in Table 3.

All coefficients were recorded at over 0.99. This result means that net worth or national wealth mainly affects tangible non-producible fixed assets such as land, forests and fisheries. In other words, non-reproducible tangible assets have a greater effect on net worth than on net fixed assets and inventories. We can see that not only financial assets affect liabilities except corporate shares, and also corporate shares affect equity financing. These results are reasonable because credit and debt in the entire country correspond with one another.

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[5] However, there are some differences in definitions between 68SNA and 93SNA. For example, liabilities in 93SNA include shares in both closing liabilities and financial assets, but liabilities in 68SNA exclude shares in both.

Other incongruities between 68SNA and 93SNA are notable. *Tangible fixed assets* and *intangible fixed assets* in 93SNA, which are net-based concepts, correspond with *net fixed assets* in 68SNA. Also, (*financial assets - of which shares*) and *of which shares* corresponds with *financial assets except corporate shares* and *corporate shares* in 68SNA. *Net worth* in 93SNA is equivalent with *Net worth (national wealth)* of *Corporate shares and net worth* in 68SNA.

We maintained the corresponding relations of the above-mentioned concepts and decided the items.

[6] As for the debt items, it is similar. Changes of debt in the Capital Finance Account in the Stock table are consistent with the debt totals less financial surplus or deficit in Capital Finance Accounts classified by institutional sector in the Flow tables. Moreover, saving, capital transfers and statistical discrepancy are also consistent with the corresponding items in Integrated Accounts.

[7] Tangible non-produced assets mean tangible assets that are not a direct outcome of production such as land, forest, fishery and subsoil resources. These were called non-reproducible tangible assets in 68SNA. Tangible non-produced assets include accumulation and improvement of land, and developing fisheries for an increase of value.

[8] Corporate shares in liabilities are the same as equity financing in the balance sheet.

[9] Net worth is a peculiar stock concept in SNA and means net worth of a whole country = real assets + external assets.

Table 2: Labor Productivity (real production per capita at price of 1990) 2: Billion Yen

Labor Productivity(Billion Yen/person)

1955		1960		1965	
Real estate	1185.620	Real estate	1000.000	Real estate	608.976
Electricity, gas and water supply(Public)	82.919	Petroleum and coal products	141.919	Petroleum and coal products	333.597
Petroleum and coal products	59.974	Electricity, gas and water supply(Private)	67.997	Electricity, gas and water supply(Private)	96.459
Public administration	58.413	Electricity, gas and water supply(Public)	66.890	Education, medical services and research	55.208
Producers of government services	53.181	Public administration	53.977	Producers of government services	53.417
Education, medical services and research	46.628	Producers of government services	51.927	Public administration	52.165
Private non-profit services	44.238	Education, medical services and research	49.902	Electricity, gas and water supply(Public)	51.411
Electricity, gas and water supply(Private)	42.918	Private non-profit services	43.975	Private non-profit services	46.847
Food products and beverages	24.759	Service activities	29.537	Construction	32.121
Service activities	23.224	Construction	26.694	Food products and beverages	31.966
Construction	20.709	Food products and beverages	24.981	Service activities	30.232
Iron and steel	15.491	Tranport and communications	20.580	Iron and steel	27.102
Tranport and communications	13.578	Iron and steel	18.256	Tranport and communications	26.897
Finance and insurance	12.937	Whole country	15.913	Finance and insurance	25.518
Whole country	11.715	Finance and insurance	14.236	Whole country	22.500
Others	10.123	Others	13.998	Mining	21.930
Manufacturing	9.093	Manufacturing	11.829	Others	20.034
Mining	7.065	Mining	11.403	Pulp, paper and paper products	19.458
Non-metallic mineral products	6.069	Pulp, paper and paper products	10.615	Non-metallic mineral products	19.067
Agriculture,forestry and fishing	5.219	Non-metallic mineral products	10.374	Manufacturing	18.024
Textiles	4.795	Transport equipment	7.847	Fabricated metal products	14.522
Fabricated metal products	4.337	Agriculture,forestry and fishing	6.827	Transport equipment	13.819
Pulp, paper and paper products	4.121	Machinery	6.823	Machinery	11.214
Wholesale and retail trade	3.841	Fabricated metal products	6.772	Wholesale and retail trade	10.946
Transport equipment	3.492	Textiles	6.428	Textiles	9.614
Machinery	2.994	Wholesale and retail trade	6.041	Chemicals	8.731
Chemicals	1.972	Chemicals	4.012	Agriculture,forestry and fishing	8.360
Precision instruments	1.913	Precision instruments	3.085	Precision instruments	6.285
Electrical machinery, equipment and supplies	0.635	Electrical machinery, equipment and supplies	1.274	Electrical machinery, equipment and supplies	2.479

1970		1975	
Petroleum and coal products	612.668	Petroleum and coal products	765.248
Real estate	497.177	Real estate	532.081
Electricity, gas and water supply(Private)	170.600	Electricity, gas and water supply(Private)	187.091
Iron and steel	71.105	Iron and steel	82.635
Education, medical services and research	63.312	Food products and beverages	76.591
Producers of government services	60.206	Mining	66.906
Public administration	58.412	Education, medical services and research	66.290
Food products and beverages	56.974	Producers of government services	63.841
Construction	53.376	Public administration	62.545
Electricity, gas and water supply(Public)	53.302	Electricity, gas and water supply(Public)	55.474
Tranport and communications	48.896	Tranport and communications	55.301
Mining	48.790	Construction	55.284
Private non-profit services	45.003	Finance and insurance	50.933
Service activities	40.464	Pulp, paper and paper products	49.392
Non-metallic mineral products	39.036	Private non-profit services	49.294
Pulp, paper and paper products	35.529	Whole country	41.972
Whole country	34.677	Service activities	40.786
Finance and insurance	34.026	Manufacturing	39.046
Manufacturing	31.907	Transport equipment	38.881
Transport equipment	31.708	Non-metallic mineral products	36.972
Others	31.069	Others	31.779
Fabricated metal products	24.989	Chemicals	29.297
Machinery	24.830	Machinery	27.537
Chemicals	21.499	Wholesale and retail trade	25.210
Wholesale and retail trade	18.915	Fabricated metal products	24.781
Textiles	14.839	Textiles	21.984
Precision instruments	11.593	Precision instruments	17.630
Agriculture,forestry and fishing	9.084	Agriculture,forestry and fishing	12.711
Electrical machinery, equipment and supplies	2.507	Electrical machinery, equipment and supplies	9.567

Note:Data source is NEEDS Database in 2002.

Table 3: correlation between Assets and Liabilities

	Net fixed assets	Inventories	Tangible non-produced assets	Financial assets	Shares
Liabilities	0.9764	0.9275	0.9139	**0.9999**	0.8187
Shares	0.8748	0.8172	0.9421	0.8435	**0.9978**
Net worth(national wealth)	0.9802	0.9634	**0.9903**	0.9521	0.9154

Note:Data souce is NEEDS Database in 2002. Net fixed assets in Closing balance sheet account.

Next, we would like to break down the growth rate of the stock data above by the degree of contribution. The growth rate of aggregation of Y_t, closing assets, can be expressed as a weighted summation of the growth rate of the components X_{it}. The result of the breakdown of the growth rate of stock (1) is seen on Table 4.

$$\hat{Y}_t = \sum_{i=1}^{n} w_{it-1}\hat{X}_{it}, \qquad t = 1,2,\cdots,T \qquad (1)$$

Table 4: Decomposition of growth rate of capital stock by Contribution degree

	Net fixed assets	Inventories	Tangible non-produced assets	Financial assets	Shares	Closing assets	Liabilities	Shares	Net worth(national wealth)	Closing liabilities plus net worth
1956	3.298%	1.388%	4.327%	7.592%	0.700%	17.305%	8.088%	0.669%	8.553%	17.309%
1957	0.917%	1.051%	3.987%	6.543%	0.637%	13.135%	6.891%	0.640%	5.600%	13.131%
1958	0.169%	0.205%	4.249%	6.515%	0.510%	11.648%	6.399%	0.456%	4.793%	11.648%
1959	1.801%	0.925%	4.741%	8.993%	0.522%	16.982%	8.859%	0.467%	7.655%	16.982%
1960	2.331%	0.844%	8.203%	8.814%	0.795%	20.988%	8.806%	0.700%	11.483%	20.989%
1961	4.148%	1.200%	6.546%	10.639%	1.062%	23.594%	11.123%	0.901%	11.570%	23.594%
1962	2.222%	0.482%	5.782%	8.145%	0.681%	17.312%	8.321%	0.615%	8.376%	17.312%
1963	2.586%	0.641%	3.032%	10.466%	0.487%	17.212%	10.723%	0.437%	6.052%	17.212%
1964	2.699%	0.640%	4.612%	8.215%	0.530%	16.696%	8.325%	0.531%	7.840%	16.697%
1965	1.956%	0.506%	2.451%	7.952%	0.087%	12.952%	7.785%	0.147%	5.019%	12.952%
1966	2.783%	0.588%	4.416%	8.225%	0.165%	16.177%	8.046%	0.190%	7.941%	16.177%
1967	3.064%	0.764%	5.666%	9.282%	0.125%	18.901%	9.271%	0.142%	9.489%	18.901%
1968	2.666%	0.717%	6.626%	8.025%	0.207%	18.242%	7.945%	0.159%	10.138%	18.242%
1969	3.437%	0.746%	6.834%	9.745%	5.809%	26.571%	9.289%	6.128%	11.155%	26.572%
1970	4.034%	0.553%	6.173%	8.329%	−0.835%	18.255%	8.156%	−0.871%	10.970%	18.254%
1971	3.139%	0.142%	6.043%	8.546%	1.073%	18.943%	8.261%	1.133%	9.549%	18.943%
1972	4.626%	0.367%	11.985%	10.765%	5.052%	32.795%	10.444%	5.193%	17.157%	32.795%
1973	6.356%	0.928%	8.899%	9.709%	0.420%	26.312%	9.804%	0.354%	16.155%	26.312%
1974	4.492%	0.736%	0.111%	5.956%	−0.886%	10.409%	6.109%	−0.932%	5.232%	10.410%
1975	2.009%	0.110%	2.067%	6.540%	−0.126%	10.600%	6.553%	−0.093%	4.140%	10.600%
1976	3.035%	0.248%	1.897%	6.719%	1.246%	13.145%	6.634%	1.276%	5.235%	13.145%
1977	2.037%	0.049%	1.894%	5.517%	−0.038%	9.459%	5.318%	−0.073%	4.214%	9.459%
1978	2.249%	0.022%	3.571%	6.522%	1.666%	14.029%	6.412%	1.680%	5.937%	14.029%
1979	3.251%	0.444%	5.129%	5.538%	0.577%	14.940%	5.658%	0.583%	8.699%	14.940%
1980	2.409%	0.288%	4.869%	5.475%	0.092%	13.134%	5.522%	0.179%	7.432%	13.134%
1981	1.433%	0.069%	3.674%	4.843%	0.434%	10.453%	4.766%	0.529%	5.157%	10.452%
1982	1.117%	0.052%	1.982%	4.286%	−0.155%	7.282%	4.132%	−0.120%	3.269%	7.282%
1983	0.778%	−0.037%	1.106%	4.350%	1.020%	7.217%	4.114%	1.157%	1.946%	7.217%
1984	1.047%	0.036%	1.121%	4.282%	1.264%	7.751%	4.041%	1.256%	2.453%	7.751%
1985	0.855%	−0.019%	2.128%	4.792%	1.067%	8.822%	4.344%	1.077%	3.401%	8.822%
1986	0.639%	−0.103%	6.489%	4.786%	3.375%	15.186%	4.695%	3.456%	7.035%	15.186%
1987	0.966%	−0.005%	9.164%	5.472%	2.165%	17.762%	5.486%	2.085%	10.191%	17.762%
1988	0.952%	0.037%	3.188%	4.418%	3.673%	12.268%	4.429%	3.648%	4.190%	12.268%
1989	1.408%	0.089%	4.991%	4.240%	3.685%	14.414%	4.043%	3.865%	6.506%	14.414%
1990	0.652%	0.545%	3.903%	16.330%	−5.371%	16.058%	16.169%	−5.391%	5.280%	16.058%
1991	0.896%	0.012%	−2.258%	2.509%	−0.170%	0.990%	2.406%	−0.117%	−1.299%	0.990%
1992	0.537%	−0.011%	−2.634%	1.477%	−1.725%	−2.355%	1.297%	−1.772%	−1.880%	−2.355%
1993	0.363%	−0.068%	−1.154%	1.735%	0.355%	1.231%	1.590%	0.437%	−0.796%	1.231%
1994	0.293%	−0.039%	−0.735%	1.587%	0.954%	2.060%	1.516%	1.019%	−0.475%	2.060%
1995	0.129%	−0.004%	−1.027%	2.136%	−0.067%	1.166%	1.961%	0.036%	−0.831%	1.166%
1996	0.437%	0.029%	−0.419%	1.472%	−0.501%	1.018%	1.195%	−0.459%	0.282%	1.018%
1997	0.443%	0.015%	−0.474%	2.443%	−0.728%	1.699%	2.249%	−0.791%	0.241%	1.699%
1998	−0.046%	−0.064%	−0.859%	0.881%	−0.713%	−0.800%	0.799%	−0.734%	−0.866%	−0.800%
1999	−0.025%	−0.046%	−0.890%	0.955%	2.495%	2.488%	0.826%	3.204%	−1.542%	2.488%
2000	0.145%	−0.021%	−0.787%	0.623%	−1.073%	−1.113%	0.374%	−1.388%	−0.099%	−1.113%
2001	−0.110%	−0.057%	−1.043%	−0.053%	−1.070%	−2.331%	−0.441%	−1.227%	−0.664%	−2.331%

Note: Data souce is NEEDS Database in 2002. Net fixed assets in Closing balance sheet account.

Here, $\hat{Y}_t, \hat{X}_{it}$ are growth rate individually. $\hat{Y}_t := \Delta Y_t / Y_{t-1}, \hat{X}_{it} := \Delta X_{it} / X_{it-1}$. w_{it-1} is weight of X_{it-1} on Y_{t-1} and then $w_{it-1} := X_{it-1} / Y_{t-1}$.

This table has the following features: First, the growth rate of closing assets was very high during the rapid growth period prior to the oil crisis in 1973. Second, net fixed assets did not contribute significantly. Third, corporate shares as assets and inventories have consistently made small contributions. Fourth, the growth rate of closing assets in the 1990s enters into a low growth rate period due to falling tangible non-producible assets. In contrast, financial assets except shares were up in the 1990s, with total corporate shares rising in late 1990s. Fifth, net fixed assets, inventories, and shares as assets did not significantly contribute to the growth rate of closing assets in the 1990s. Sixth, net worth and liabilities in closing liabilities plus net worth were high until the 1990s. Seventh, the low growth rate of closing liabilities in the 1990s was affected by the contribution of liabilities but the negative contribution of net worth in the early 1990s. Also, the contribution of corporate shares as equity finance affected the growth rate negatively in the late 1990s.

Traditionally, the role of assets in the Japanese economy has been mainly affected by tangible non-producible assets and financial assets, but lately the role of corporate shares has become more important. This tendency began with the boom

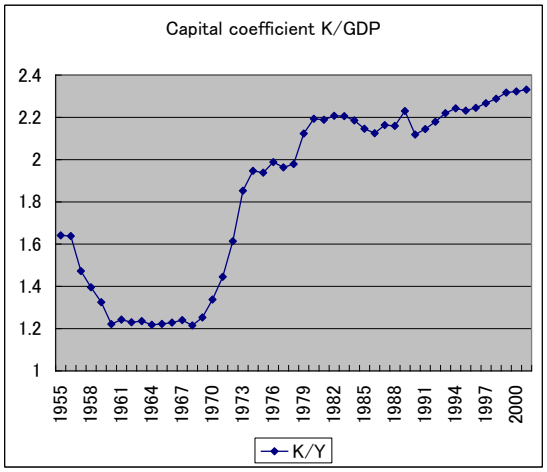
period of the late 1980s, called *Bubble economy* but it later became a permanent feature of Japanese assets. As a result, the weight of indirect financing such as loans from banks backed by land mortgages will decline. Direct financing by holding shares and their operations will increase in Japan. We can see similarities in some institutional financial reforms from the late 1990s, particularly the easing of restrictions on securities transactions on the Internet, a liberalization of financing that increased the total number of investors.

Now we will examine the change in the capital coefficient K_t / Y_t by using net fixed assets and nominal GDP. That is Figure 1. The capital coefficient tended to decline until the late 1960s, but then grew rapidly from 1969 onward. It stabilized in the 1980s and since the 1990s, increased slowly. This means that although productivity of capital fell in the 1990s, the magnitude of the decline was not serious. This also parallels the slow decline of labor productivity across the country and mirrors the low growth rate of GDP above.

Comparison of the ratio of gross fixed capital[10] over GDP by flow data is visible in Figure 2. This figure shows how the fluctuating ratio had increased until 1975 but then turned down slowly from then. The ratio increased again in the bubble economy, but finally declined in the 1990s.

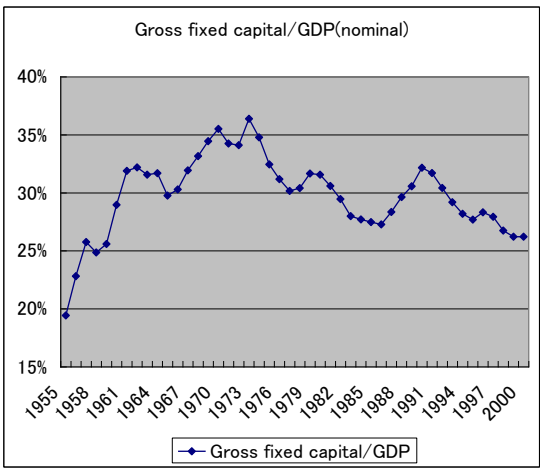
Here, the tendency of the ratio of gross fixed capital to decline during the 1990s indicated that a decrease in demand of investment does not necessarily fit with an increasing of capital coefficient on Figure 1. However, this result could be theoretically true if marginal investment were diminishing.

Figure 1:Transition of Capital coefficient



Note:Data source is NEEDS Database in 2002. Net fixed assets in Closing balance sheet account and GDP in SNA.

Figure 2: Ratio of Gross fixed capital over GDP

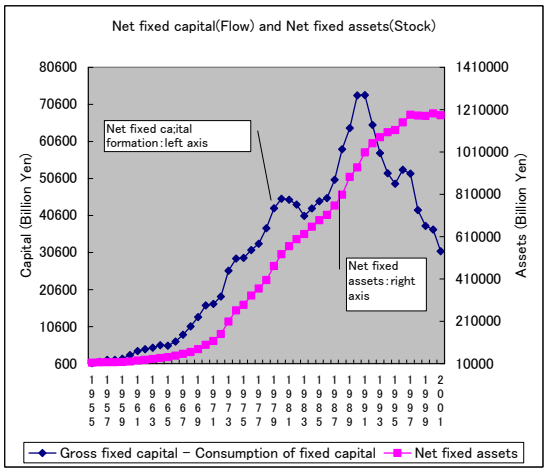


Note:Data source is NEEDS Database in 2002. Gross domestic fixed capital formation in private and public sectors and GDP in SNA.

[10] This data corresponds with domestic gross fixed capital in the formation of the Capital Finance Account in the Integrated Account, which includes depreciation of capital.

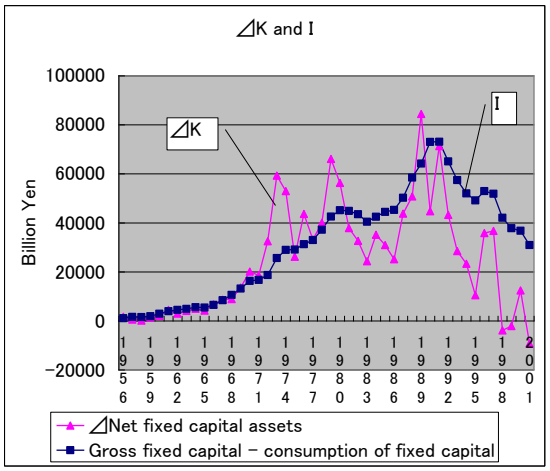
However, there is a more serious problem with the data we used than with the theory. K (fixed assets) from stock data and I (fixed capital formation) from flow data must correspond as $\Delta K = I$, but the actual statistics differ. Figure 3 indicates net fixed capital formation (gross fixed capital formation - its consumption) by flow data, and net fixed assets (so called capital stock) by stock data. The increase of the latter (ΔK) and the former are apparent in Figure 4. This tendency is especially obvious after the 1970s, when the largest difference between ΔK and I occurs. The changes discussed are both caused by the Reconciliation Accounts for capital stock in Japanese SNA.

Figure 3: Transition of Net fixed capital formation and Capital stock



Note : Data source is NEEDS Database in 2002. Net fixed assets in Closing balance sheet account and Gross domestic fixed capital formation in private and public sectors.

Figure 4: Net fixed capital formation and Increases of capital stock

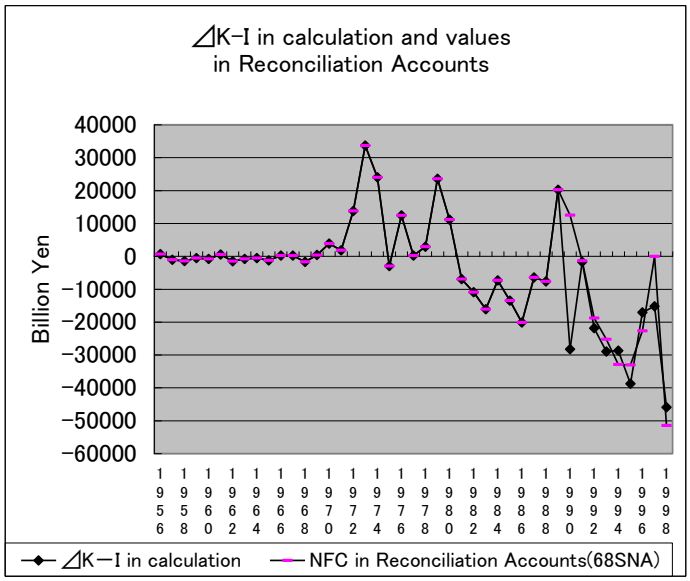


Note : Data source is NEEDS Database in 2002. Net fixed assets in Closing balance sheet account and Gross domestic fixed capital formation in private and public sectors.

To further clarify, we plot the difference of I and ΔK on Figure 4 and the amount of net fixed assets from the Reconciliation Account in 68SNA, as seen in Figure 5. The values of the Reconciliation Account in 68SNA exist only until 1998, but these very nearly correspond to $\Delta K - I$ that we measured.

We have covered both flow data for investment and capital stock data as published *right*. However, stock data is adjusted largely by Reconciliation Accounts, creating the most serious problem in Japanese SNA when using capital stock data. Seen from this perspective, we can see that capital stock during the 1990s era Japan simultaneously faced both a shortage of demand by declining investment and a decrease in capital productivity.

Figure 5: ⊿*K-I* and Net fixed assets in Reconciliation Account



Note:Data source is NEEDS Database in 2002. Reconciliation Accounts.

3 Measurement of TFP

Now, we will outline technical progress in the recession of the 1990s by measuring TFP[11]. Extensive research exists on the measurement of TFP in Japan[12]. Studies range from the construction of databases to measurement methods. Taken together, these studies offer certain conclusions. Most obvious is that Japanese TFP in the 1990s has been declining. In addition, the magnitude of the TFP drop is not significant when considering operating ratio from the demand side and the quality of labor[13].

We believe that our research leads to an easier and more accurate method of calculation. We first connected annual data between 68SNA and 93SNA at 1990, creating a long time series of over 40 years of data[14]. Next, we used Net Fixed Assets from the National Balance Sheet in SNA as capital stock and then deflated it by the Private Capital Formation Deflator. Lastly, we transformed quarterly and monthly data into annual data for annual comparison with other annual indexes.

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[11] Refer to Nakajima (2001) for comprehensive Japanese TFP explanation.
[12] See Miyagawa (2006) and Inui and Kwon (2005) for a detailed survey concerning the comparison of Japanese TFP in the 1990s.
[13] Besides, a bias upward in TFP could be caused by economies of scale and by mark-up ratio. Refer to Inui and Kwon (2005).
[14] The unit root test and the structural change test for these dates were done in Ichihashi (2006). The result showed that real GDP was *I(1)* and there was no significant structural change except during the 1974 oil shock.

Contrary to previously published research, we did not use *Gross Capital Stock of Private Enterprises*. The reason we employed net fixed assets as capital stock was to include and cover all fixed assets of all institutional sectors in the macro economy. Keep in mind, however, that gross capital stock of private enterprise does not include the stock of public sectors such as social stock. Our estimation of TFP in the macro economy is by an aggregate production function, so our production function should cover the stock of public, private, and nonprofit organizations. A price adjustment is required to employ net fixed assets of SNA. We deflated it with the Private Capital Formation Deflator of 1990.

The method of depreciation is also different between gross capital stock of private enterprise and net fixed assets of SNA. Gross capital stock of private enterprise includes the estimated gross assets value before depreciation. This method is best for evaluating the real ability to produce. The method of estimation is the two points benchmark year method based on national wealth statistics in 1955 and 1970. Investment and deduction of assets of each year are added and subtracted from the bench mark[15].

In contrast, tangible fixed assets (net fixed assets) from the National Balance Sheet in SNA are evaluated by the replacement cost after depreciation. Depreciation is based on the fixed rate method as the 10¥% redemption rate to the residual value. *Depreciation of social capital* is estimated by the fixed amount method. Here, the method of estimation is the Bench Mark Year method based on National Wealth Statistics in 1970.

Evaluating the ability to produce, which will also depreciate, depends on whether we focus on economic depreciation or the real abilities of the materials. In this case, we assume that economic depreciation is more important[16].

Total number of workers of SNA is used for the number of labor hours and the average total hours are used for labor hours, which those are worked per regular employee in manufacturing operations of 30 or more employees in *Final report of monthly Labor Survey* of Ministry of Health, Labor and Welfare.

The operating ratio we use is derived from the operating ratio of the original index in manufacturing *Indices of operating ratio and production Capacity* from the Ministry of Economy, Trade and Industry. The rest of our data is supplemented from the

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[15] This deduction is estimated by the ratio of deduction from *Financial statements statistics of corporations by industry, quarterly*.

[16] We found a similar result for TFP by gross capital stock of private enterprise data, though we report the result of TFP by real net fixed assets.

Connected Indices of Industrial Production (Jan. 1978 to Dec. 2002) on HP[17] of METI, because time series data of operating ratio with MT code exists only from 1968 to 1998. We transformed monthly data into annual data using the averaging method of calculation.

Total input originates from the annual series of intermediate inputs (nominal) by economic activities in SNA. We made real intermediate inputs by adjusting for deflation with the subtotal of economic activity. In the calculation, since we could not find a significant difference between the nominal and real result, we show the result with real values.

We used two models, one being TFP for total outputs divided by total inputs, and the other TFP by Solow's residuals with Cobb-Douglas production function adjusted by operating ratio of capital.

The definitions of both are as follows;

$$TFP = \frac{Y}{X} \qquad (2)$$

$$Y = A(\rho K)^{\alpha}(LH)^{\beta} \qquad (3)$$

Here, X is total inputs in the equation (2). A in equation (3) is seen as Solow's residuals, the technical progress term and another definition of TFP. However, it is accepted knowledge that the two types of TFP are equivalent from an accounting balance if total inputs is defined as costs and the production function is transformed to include three factors of production: capital, labor and intermediate inputs[18]. K is fixed capital stock (Net fixed capital), ρ is operating ratio. LH is labor hours (total number of workers×hours).

It is commonly understood that Solow's residual as a term of technical progress differs from real technical progress if imperfect competition (or mark-up ratio) and economies of scale exist[19]. However, for simplicity's sake we assume the existence of neither.

Model (2) is very easy to measure. Especially, when TFP according to industry is measured, the acquisition of data is easy. On the other hand, model (3) is a typical expression of Solow's residual and it is convenient that the contribution of the capital and labor can be specified. However, it has the difficulty obtaining data by each industry. We used both models together here because there are both merit and demerit in those.

If we assume the proposition of marginal productivity in equation (3), α and

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[17] See http://www.meti.go.jp/statistics/index.html.
[18] See Kawai and Inui (2003). Of course, actual measurement of TFP depends on how capital and labor are evaluated and on how operating ratio is considered.
[19] See Inui and Kwon (2004).

β (indices of elasticity) correspond to the distribution rate of capital and labor, respectively, we can use the value of each parameter when calculated in advance. However, we do not assume unrealistic constant returns to scale, $\alpha+\beta=1$ or $\alpha+\beta=const.$ have been constant for 46 years, rather, we use each annual distribution ratio[20].

A share of operating surplus to value-added is used as the distribution ratio of capital[21] and a share of employee compensation is partially used as the distribution ratio of labor. Adding both is still less than the total because it does not include consumption of fixed capital and taxes less subsidies.

We calculated individual distribution ratio with real value added, which was derived from *value-added economic activities* we calculated. Individual value added is adjusted for deflation and summarized by real value added and the individual distribution ratio[22]. Of course, it is possible to calculate distribution ratios of capital and labor with nominal value added, but this tends to be lower than ratios with real value due to variation of price[23]. If we were to use the nominal distribution ratio, the result regarding TFP could have an upward bias.

Moreover, aggregation of nominal operating surplus does not usually include imputed interests according to the definition in SNA. Nevertheless, imputed interests should be included in the distribution of capital of industries such as finance and insurance. Therefore, we included real imputed interests in each real operating surplus. We calculated with logarithm conversion of equation (3).

$$\ln Y_t = \ln A_t + \alpha_t \ln(\rho K)_t + \beta_t \ln(LH)_t, \qquad t = 1,2,\cdots,46 \tag{4}$$

Figure 6 and Figure 7 show results of the macro economy with equation (2) and (4)[24]. According to our results, TFP level in 1990s Japan does not decline. This is similar to the result of Kawamoto (2004).

Both figures show that TFP tended to increase in the 1990s despite variations

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[20] In the point to loosen assumption that the total of elasticity is one, our model (3) is not Cobb-Douglas type in a strict meaning. The theory of trans-log function and Divisia index also supports the idea that distribution ratio can be changeable. See Nakajima (2001).

[21] Here, distribution ratio of *gross* capital must include depreciation costs of fixed capital but one of *net* capital does not include depreciation costs.

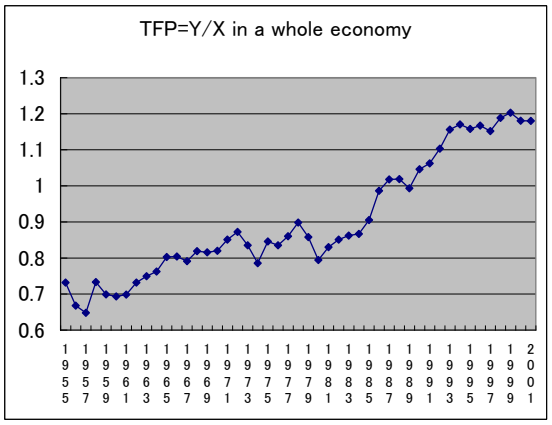
[22] See Ichihashi (2006) about the method of deriving real value added according to the characteristics of the data.

[23] The reasons are as follows: Nominal share of taxes less subsidies tends to be higher, and secondly, nominal imputed interests, which are deducted from operating surplus, similarly tend to be evaluated higher.

[24] There is a peak at 1990 in Solow's residuals on Figure 7, but this is due to a difference in level when combining data.

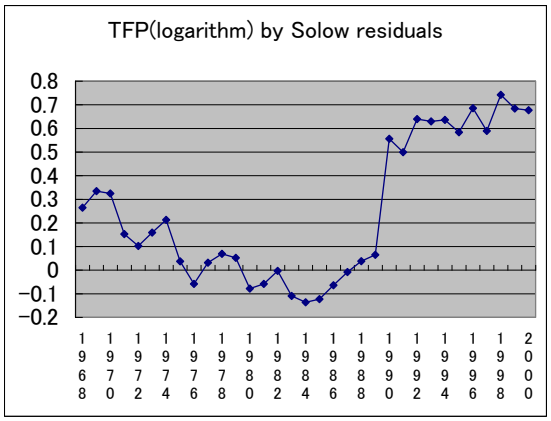
in TFP within these figures until the late 1980s. The variance is due to different methods of measuring TFP. As mentioned above, TFP with equation (2) uses total costs while TFP with equation (3) uses stock data. The latter has the tendency to lower TFP when distribution rate (α, β) and operating ratio (ρ) are relatively larger.

Figure 6: Transition of TFP=Y/X



Note:Data source is NEEDS Database in 2002.

Figure 7: Solow's residuals adjusted by operating ratio



Note:Data source is NEEDS Database in 2002.

Actually, the capital distribution rate has been changing about 0.31 % since the late 1980s and the operating ratio has been about 96 %, as we will see later. Since those percentages are significant, we can surmise that they raised the distribution of capital and then lowered TFP.

The calculation of average growth rates of Solow's residual and TFP by total inputs is seen in Table 5. Both growth rates have similar tendencies, but some characteristics compare with prior studies (Table 7). The average growth rate of TFP in the 1990s dropped since the 1980s as verified in previous research, declining around 1.0%～1.3%. Contrary to previous research, we found a smaller drop of TFP in the 1990s.

Table 5: Average growth rates of Output/Input and Solow's residual

	Solow	Y/X
60s	−	2.410%
70s	1.190%	−0.492%
80s	2.285%	2.476%
90s	1.248%	1.207%
90s−80s	−1.038%	−1.269%

Table 6: Modified Solow's residual

	(1)M. C. S	(2)M. D. R
70s	1.317%	−0.386%
80s	2.131%	1.480%
90s	1.284%	0.216%
90s−80s	−0.847%	−1.265%

Note:(1) M.C.S means Modified capital stock.

(2) M.D.R means Modified distribution ratio.

One reason for the differing results is the source of capital stock data. The value of the reconciliation account in 93SNA had been increasing each year, resulting in less consideration for the impact of capital. As a test, let us calculate Solow's residual again with other capital stock data. We totaled new net fixed assets again by adding *net capital formation* in the integrated account in each year to the net fixed asset on the 1955 Closing Balance Sheet. This asset is capital stock for a modified Solow's residual. Here, the net fixed formation results from the consumption of capital (depreciation costs) in Value Added subtracted from gross capital formation. This modified Solow's residual is shown on the left side column (1) of Table 6. In this table, Solow's residual dropped in the 1980s as compared with Table 5, and by contrast, it rose somewhat in the 1970s. Also, it rose in the 1990s because of new capital stock affecting TFP. As a result, the difference in TFP growth between the 1980s and 1990s is less.

Another reason that we believe TFP has not dropped as much as previously thought is inaccurate calculation of the distribution ratio. We did not include depreciation costs in the ratio of capital, but had they been included, Solow's residual would have decreased due to extra impact of capital. The column on the right (2) in Table 6 indicates TFP changes due to capital stock when including depreciation costs. Clearly, residuals in all periods decreased more quickly when compared with Table 5. These results are caused by substantial depreciation in each period, which we interpret as the result of solid renewal or accumulation of capital during those decades[25].

If you would consider that productive ability was a key in manufacturing sectors and depreciation costs should've been included in capital factor like *Gross Capital Stock of Private Enterprises*, TFP would be decreased because of the greater evaluation of capital contribution. In contrast, if you would use the concept of net fixed capital excluded depreciation costs and then TFP would be increased because the contribution of capital would be small. That is the second point that our result is different from the results of previous studies.

Another difference resulting in falling TFP involves consideration of the adjustment of capital by the operating ratio. If the ratio were not considered when calculating TFP growth, Solow's residual in a recession period would be smaller because total operating capital is assumed. Although the majority of previous research reported declining TFP, those studies did not consider adjustment by operating ratio (See Table 7). Kawamoto (2004), however, found that when considering operating ratio, TFP in the 1990s did not decline.

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[25] Average growth rates of real depreciation and investment in 70's were 4.3% and 2.9%, and those in 80's were 6.7% and 7.4%. Those in the 1990's were 3.7% and -0.1%.

Table 7: Comparison table of TFP growth rates in previous research

TFP growth rate comparison table in other research

	Fukao et al.(a)	Jorgenson & Motohashi(b)	Hayashi & Nomura(c)	Hayashi & Prescott(d)	Cabinet Office(e)	Yoshikawa & Matsumoto(f)	Nakajima et al.(g)	Kawamoto(h)
1970s	1.55%	1.57%	0.00%	0.52%				
1980s	1.29%	1.25%	0.70%	2.36%	1.60%	1.20%	−1.55%	1.90%
1990s	0.58%	0.58%	−0.20%	0.18%	0.20%	−0.90%	−0.41%	1.90%
90s−80s	−0.71%	−0.67%	−0.90%	−2.18%	−1.40%	−2.10%	1.14%	0.00%

(a)70s' average=1970−1980, 80s'=1980−1990, 90s'=1990−2002. Operating ration is not adjusted.
(b)70s' average=1975−1980, 80s'=1980−1990, 90s'=1990−2003. Operating ration is not adjusted.
(c)70s' average=1973−1984, 80s'=1984−1990, 90s'=1990−2000. Operating ration is not adjusted.
(d)70s' average=1973−1983, 80s'=1983−1991, 90s'=1991−1998. Operating ration is not adjusted.
(e)80s' average=1981−1990, 90s'=1991−2000.
(f)80s' average=1987−1993, 90s'=1994−1997.
(g)80s' average=1985−1989, 90s'=1990−1999.
(h)80s' average=1980−1990, 90s'=1990−1998.
This table is retouched based on Miyakawa (2006) and Inui and Keng(2005).

As a caveat, our results are based on a single industry－manufacturing. We calculated Solow's residual using the operating ratio of manufacturing for the purpose of TFP for the entire macro economy. Needless to say, individual operating ratios are different in each industry. We could have found different results using other operating ratios related to individual capital by industry. This is an area open to future study.

Naturally, it is quite possible to arrive at different results when measuring Solow's residuals as TFP using different data and various methods of calculation. This underlies the differing results of previous studies. In any case, our result indicates that TFP in the 1990s did not decline seriously despite being somewhat lower than it was in the 1980s. Therefore, we believe that Japan's long recession was not caused by the decline of TFP in the 1990s.

The question is what did cause the long recession of the 1990s if TFP was not falling? Let us begin by breaking down the growth rate of the macro economy into the TFP components of capital, labor and technology. We can view the growth rate of real GDP to growth rate of each factor in the next equation.

$$\begin{aligned}\Delta \ln Y_t &= \Delta \ln A_t + \Delta \alpha_t \ln(\rho K)_t + \Delta \beta_t \ln(LH)_t \\ &= \Delta \ln A_t + [\Delta \alpha_t \{\ln \rho_t + \ln K_t\} + \alpha_t \Delta \ln \rho_t + \alpha_t \Delta \ln K_t] \\ &\quad + [\Delta \beta_t \{\ln L_t + \ln H_t\} + \beta_t \Delta \ln L_t + \beta_t \Delta \ln H_t] \\ &\quad t = 2,3,\cdots,46 \qquad (5)\end{aligned}$$

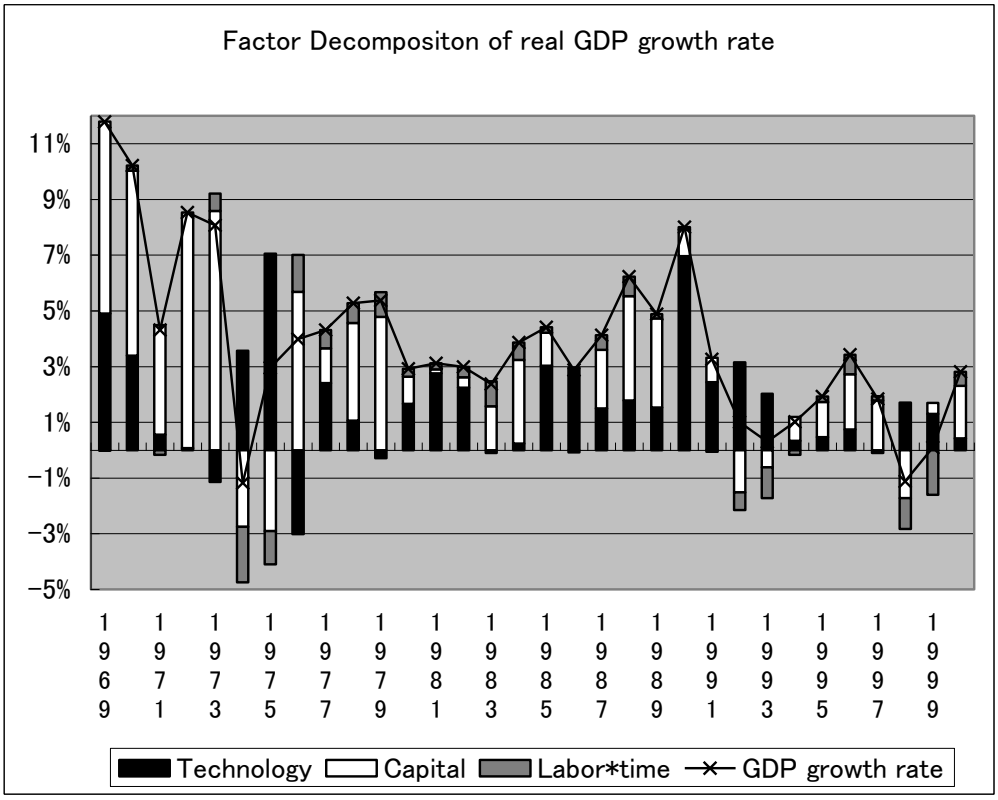
We can see the result on Figure 8.

This figure shows that the main causes for slowed economic growth in the 1990s were related capital and labor. The growth rates of capital were negative in the three years of 1992, 1993 and 1998. The growth rates of labor were negative in six different years ranging from 1991 to 1994 and 1998 to 1999.

Growth rates less than -1.0 % occurred for capital in 1992 and 1998, and the same held true for labor in 1993, 1998 and 1999. Taken together, these years had a significant effect on the decade's economic growth. In contrast, the growth rates of TFP

were positive during the 1990s with the exception of 1997. That means declining capital and labor growth at that time weakened the entire economy. Therefore, it does not appear that the TFP factor on the supply side seriously damaged the economy.

Figure 8: Factor Decomposition of growth rate of real GDP with TFP components



Note : Data source is NEEDS Database in 2002.

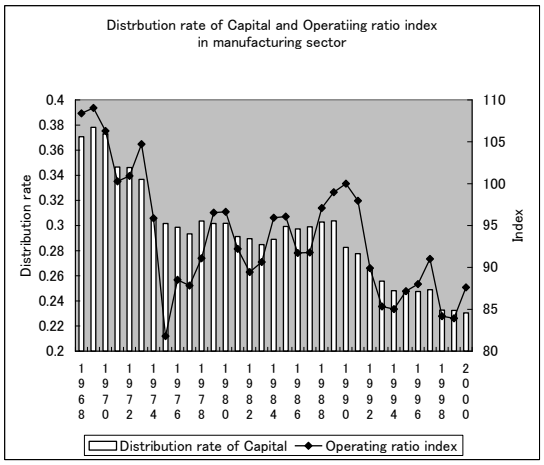
What then caused negative growth of capital and labor? Figure 9 shows the distribution rate and operating ratio of capital. As you can see, both fall sharply in the 1990s. One reason that capital declined was a decrease in both the distribution rate of capital and the operating ratio.

Another reason relates to labor. Figure 10 shows the growth rate of capital stock, total employees, and hours worked. Capital stock recorded serious negative growth in 1992, 1993 and 1998, the worst decline since the 1974 and 1975 oil shock. Moreover, on the labor side, continuous shortening of labor hours in the 1990s surpassed the growth of employees. The growth rate of employees was also negative in the late 1990's. Taken together, these factors led to negative overall labor growth in the six years in Figure 8 above.

Three indices of the economy declined in the 1990s-distribution rate, operating

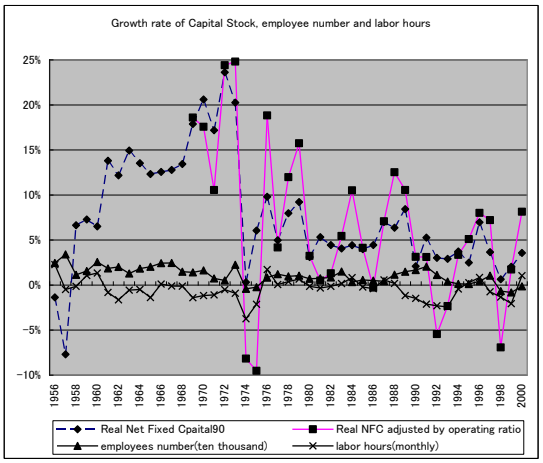
ratio and growth rate of capital stock, together leading to negative growth of capital. In addition, shortened labor hours and fewer employees caused negative growth of labor. Therefore, we can infer that the combination of these caused a slowdown in macroeconomic growth in the 1990s. This result is also compatible with the theory that declining investment (lack of effective demand) was the main factor in Japan's long recession.

Figure 9: Distribution rate and Operating ratio of capital



Note: Operating ratio index is from Ministry of Economy, Trade and Industry. Distribution rate is calculated with NEEDS database.

Figure 10: Growth rate of capital stock, employee number and working hours



Note: Number of employees and labor hours are from Health, Labor and Welfare. Others are calculated with NEEDS database.

Finally, we look at the transition of TFP with regard to individual industries. Due to the difficulty of collecting capital stock data for individual industries, we calculated individual TFP by means of the total cost approach for 26 industries (equation (2)) and created an individual index based on the year 1990. Those results are displayed in Table 8.

Let's call *TFP increasing industries* if the index exceeds 100 in the year 2000. Eleven industries showed a rising TFP: petroleum and coal products, and manufacturing-related industries such as textiles and food products and beverages. Also, the three non-manufacturing-related industries, including service activities and wholesale and retail trade tended to increase TFP[26].

Textiles, wholesale and retail trade, and service activities declined in labor productivity as mentioned above, while increasing in TFP. This could indicate either technical progress or efficiency of production in these industries.

In contrast, *TFP decreasing industries*, even more industries did not exceed 100 in the 2000 TFP index. These include three manufacturing industries, such as the

[26] This table shows only a part of 26 industries.

electrical machinery, equipment and supplies industry, and nine non-manufacturing related industries, including transport and communications, agriculture, forestry and fishing, finance and insurance, construction, education, medical services and research, real estate, and public administration.

Table 8: Individual TFP index by Industries (based on '90)

	1	2	3	4	5	6	7		19	20	21	22	23	24	25	26
	PET	TEX	SER	FOO	IRN	TRD	PUL	Whole economy	EST	EMR	CON	MAC	MIN	FIN	AGR	TRC
1955	100.50	60.48	100.23	104.45	55.73	44.71	66.25	68.23	46.11	73.99	47.59	66.39	147.76	74.41	94.43	83.14
1956	83.75	58.53	86.97	107.08	71.13	48.02	69.56	62.87	52.72	74.15	39.02	51.66	154.20	71.91	87.55	83.46
1957	100.01	57.82	77.22	100.06	79.60	48.51	65.48	60.84	61.97	71.53	37.18	54.90	168.06	71.78	86.31	83.50
1958	127.40	56.53	75.58	108.17	55.35	52.07	67.90	68.59	65.08	67.50	49.29	78.57	189.53	68.13	93.33	96.46
1959	161.57	58.40	63.97	107.30	58.68	52.14	68.82	65.46	65.25	66.75	42.32	76.48	165.06	57.33	98.24	99.52
1960	168.09	63.33	54.91	99.18	63.41	63.04	67.04	66.16	91.54	68.53	45.00	76.31	170.97	48.44	99.89	97.76
1961	157.42	62.52	56.55	98.54	65.49	70.08	69.33	67.70	99.08	66.97	42.49	78.15	143.88	48.26	100.22	104.29
1962	174.74	62.13	57.58	97.42	55.66	71.51	66.35	71.70	87.88	59.27	47.96	89.94	150.92	52.15	103.60	103.68
1963	178.51	66.34	59.48	97.53	53.43	69.66	70.04	74.73	82.22	63.24	50.21	89.79	145.31	56.41	110.59	111.83
1964	193.67	70.26	62.71	91.24	65.42	73.46	72.13	76.41	65.40	65.31	48.39	91.20	166.31	62.12	101.97	105.71
1965	183.75	70.41	66.60	97.55	60.27	76.64	74.77	80.68	72.62	66.46	54.16	96.51	177.16	66.40	110.05	107.47
1966	183.46	74.36	68.32	93.80	59.88	82.38	70.13	81.22	74.55	64.85	50.25	86.65	202.28	66.18	112.06	108.86
1967	186.85	74.75	74.11	93.61	57.51	82.96	66.52	80.76	72.16	60.33	45.37	88.97	169.73	71.85	115.46	110.03
1968	181.28	83.64	81.21	101.29	59.98	92.70	70.85	84.00	57.75	59.15	47.90	87.29	159.27	81.46	111.08	112.51
1969	155.51	84.34	86.06	103.98	64.63	90.14	68.67	83.63	66.81	61.29	51.77	85.73	173.63	80.58	107.83	118.14
1970	156.41	90.17	86.30	104.47	74.49	95.47	73.79	83.74	65.52	64.09	59.68	82.70	165.92	78.23	103.32	115.95
1971	142.48	91.89	84.50	105.00	79.80	97.94	78.58	86.12	68.66	66.46	65.93	90.05	158.72	76.69	95.30	105.51
1972	142.94	86.11	90.60	97.12	89.00	97.48	80.44	88.07	68.94	67.92	66.37	89.00	151.34	80.92	111.88	103.25
1973	132.50	93.18	85.92	90.03	86.37	106.36	78.25	85.33	69.85	70.41	61.38	74.19	145.82	78.05	128.07	105.20
1974	16.02	101.90	86.35	80.84	75.68	104.99	85.84	79.81	70.58	75.62	63.63	73.78	118.86	80.40	111.49	87.92
1975	34.63	90.27	86.56	77.38	70.58	105.36	81.47	85.70	65.35	79.56	76.93	86.96	110.67	76.87	113.03	90.38
1976	41.64	78.65	86.17	83.49	68.84	105.28	77.17	84.67	71.69	76.30	72.71	75.92	112.32	71.94	111.09	90.23
1977	50.18	80.36	90.08	94.58	63.76	101.15	75.38	86.92	74.29	73.83	69.99	74.30	108.52	69.95	108.82	102.09
1978	80.90	88.12	90.43	91.77	80.37	101.17	79.17	91.03	73.80	70.48	74.88	69.69	111.03	74.47	107.23	97.56
1979	35.35	87.47	93.48	97.29	86.04	100.38	70.84	86.11	73.19	66.39	74.87	69.04	104.98	77.00	100.84	87.45
1980	29.43	88.22	94.21	94.60	75.34	96.73	66.20	78.70	72.33	62.67	72.88	70.70	100.90	79.66	81.09	71.81
1981	33.33	90.45	97.94	95.85	71.25	97.54	75.43	81.40	72.93	60.66	81.18	75.59	94.77	67.21	81.57	75.22
1982	38.34	92.72	96.82	100.91	69.32	98.37	73.46	83.93	63.83	59.04	82.04	81.67	95.71	71.16	82.23	76.59
1983	45.56	97.44	97.87	104.51	58.72	94.78	75.78	84.57	64.39	58.71	77.37	82.71	95.18	70.77	83.54	78.77
1984	47.74	97.42	98.80	99.72	75.26	90.36	75.94	84.17	72.90	57.80	78.92	83.10	92.49	64.15	83.60	82.63
1985	53.98	100.62	109.10	100.97	78.70	90.85	78.89	87.19	78.80	57.41	83.16	92.03	91.32	61.24	86.49	84.70
1986	92.83	107.86	108.22	108.15	86.72	93.21	92.49	95.69	92.07	57.92	85.78	92.56	96.86	60.01	88.77	98.12
1987	116.93	117.55	103.71	111.14	96.70	95.95	98.10	98.22	98.46	56.20	90.12	93.84	92.32	59.83	97.57	104.62
1988	121.27	118.42	100.87	107.03	105.61	96.47	100.87	97.97	111.26	55.61	94.27	94.64	92.56	66.36	98.26	106.50
1989	120.24	100.90	101.22	104.26	106.64	97.12	105.56	95.34	102.96	55.27	96.40	93.75	79.00	59.16	98.95	108.64
1990	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00	100.00
1991	119.01	101.69	102.62	101.53	103.04	103.76	101.38	101.54	91.63	98.99	96.46	101.82	100.72	119.72	98.22	100.40
1992	142.98	124.88	108.62	109.81	114.24	108.05	104.11	105.52	94.31	97.80	97.29	107.65	99.66	82.37	100.72	101.90
1993	155.65	155.20	117.02	113.21	111.29	114.89	113.23	110.67	104.97	99.17	99.56	106.80	98.36	88.39	97.89	100.85
1994	181.17	148.39	115.44	113.84	113.71	118.74	111.42	112.05	104.66	99.21	94.57	98.46	95.44	83.42	99.77	97.72
1995	172.62	140.48	117.73	116.12	117.06	118.10	111.17	110.82	102.99	99.45	90.80	96.80	100.61	74.38	92.76	97.77
1996	162.51	138.89	119.71	113.10	120.24	116.23	113.80	111.79	103.57	97.24	88.47	97.17	98.11	73.67	98.75	97.65
1997	158.97	140.16	122.60	112.73	114.27	118.81	109.28	110.21	101.70	96.66	88.32	96.51	96.84	74.35	84.16	93.35
1998	174.14	137.40	125.98	112.21	108.36	118.13	112.07	113.59	91.83	99.53	91.33	94.30	100.72	71.19	87.67	89.36
1999	180.55	133.89	125.63	118.17	115.35	117.91	111.88	114.87	90.84	95.59	91.75	93.10	88.28	75.91	82.39	79.85
2000	144.07	143.64	123.28	119.81	117.13	116.56	116.13	112.49	94.65	92.97	90.82	88.05	86.47	78.89	77.91	73.31

Note: Data source is NEEDS Database in 2002. Intermediate Consumption and GDP in SNA

Sector

PET Petroleum and coal products
TEX Textiles
SER Service activities
FOO Food products and beverages
IRN Iron and steel
TRD Wholesale and retail trade
PUL Pulp, paper and paper products
EST Real estate
EMR Education, medical services and research
CON Construction
MAC Machinery
MIN Mining
FIN Finance and insurance
AGR Agriculture,forestry and fishing
TRC Tranport and communications

Although electrical machinery, equipment and supplies, real estate, electricity, and gas and water supply all had high labor productivity as mentioned above, their TFPs tended to decrease. This could indicate an inefficiency of capital in these industries.

Note that both labor productivity and TFP in construction, agriculture, and forestry and fishing are low. This is indicative of structurally low productivity sectors, calling for reforms in efficiency.

Declines in TFP for numerous non-manufacturing industries concur with previous studies such as Kawai and Inui (2003). It is particularly interesting that declines in TFP during the 1990s occurred in several industries for different problems. For example, finance, insurance and real estate had been holding bad debts. Agriculture, public administration and education had low productivity. Communication, electricity, and gas and water supply had been criticized as monopolies or oligopolies. These non-manufacturing industries should make efficiency in production a priority. In the final analysis, improving productivity in the non-manufacturing sectors of Japan's economy is the key to overcoming a long recession.

4 Concluding Remarks

This paper analyzed production factors using annual macroeconomic data over the 46 post-war years in determining the causes behind Japan's long recession of the 1990s. In conclusion, TFP of the entire Japanese economy did not have a tendency to decrease despite slowly decreasing labor productivity in the 1990s. Factors relating to capital caused negative macroeconomic growth in the 1990s. The distribution rate, operating ratio and growth rate of capital stock all tended to decline in the 1990s, leading to negative overall growth. Worsening the situation, shortened labor hours and a decrease in employees caused negative growth in labor. The combination of these slowed economic growth in the 1990s, despite the apparently positive growth rates of TFP through most of the 1990s.

We have considered the serious problem of capital stock data. When compared with flow data, a substantial discrepancy results, making reconciliation difficult. This point must be kept in mind throughout all studies on this topic.

We analyzed TFP by individual industry, and found interesting results. Eleven manufacturing-related industries and three non-manufacturing industries showed a tendency to increase TFP. However, nine non-manufacturing related industries actually indicated decreasing TFP. On the whole, we can say that Japanese industries have problems in efficiency, mainly in the non-manufacturing sectors.

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