IMES DISCUSSION PAPER SERIES

Generational Accounting in Japan

Noriyuki Takayama
Yukinobu Kitamura
Hiroshi Yoshida

Discussion Paper No. 98-E-1

IMES

INSTITUTE FOR MONETARY AND ECONOMIC STUDIES

BANK OF JAPAN

C.P.O BOX 203 TOKYO
100-8630 JAPAN

IMES Discussion Paper Series 98-E-1
March 1998

Generational Accounting in Japan

Noriyuki Takayama
Hitotsubashi Unibersity

Yukinobu Kitamura
Keio University and Bank of Japan

Hiroshi Yoshida
Tohoku University

ABSTRACT

Although the importance of the concept of generational accounting has been well recognized in Japan as parallel with the rapid aging of the population, there has been no definitive study on the subject. This work intends to rectify this omission by providing the most comprehensive analysis of generational accounting in Japan to date. Given certain conditions such as the prospect of low economic growth and the rapid aging of society which cannot easily be changed, the government has to implement dramatic reform on both the revenue and expenditure side of public finance. Although future prospects with respect to public finance are uncertain and policy objectives to avoid any worsening of the fiscal position are unclear, there is no doubt that the government must reduce the public debt. The base case calculation of the generational imbalance between present and future generations is 169% for Case A (where education expenditures are treated as consumption) and 338% for Case B (where education expenditures are treated as transfers) if the current fiscal policy stance is to be maintained (where the real income growth is 1.5% and the discount rate is 5%). This implies that future generations will have to bear 2.7 to 4.4 times as much the fiscal burden as present generations do, a huge imbalance by international standards.

Key Words: aging, fiscal deficits, fiscal policy, generational accounting
JEL Classification: H1, H3, H6.

This paper is extracted from *Generational Accounting Around The World*, forthcoming, University of Chicago Press. It is also a companion paper to Auerbach, Kotlikoff and Leibfritz "Generational Accounting Around The World" IMES Discussion Paper No. 98-E-2. This research is commissioned by Institute for Monetary and Economic Studies, Bank of Japan. We are grateful for her financial support.

I. Introduction

Although the importance of the concept of generational accounting has been well recognized in Japan as parallel with the rapid aging of the population, there has been no definitive study on the subject. This work intends to rectify this omission by providing the most comprehensive analysis of generational accounting in Japan to date.

Given certain conditions such as the prospect of low economic growth and the rapid aging of society which cannot easily be changed, the government has to implement dramatic reform on both the revenue and expenditure side of public finance. Although future prospects with respect to public finance are uncertain and policy objectives to avoid any worsening of the fiscal position are unclear, there is no doubt that the government must reduce the public debt. In this context, one fiscal measure which is attracting attention among policy makers is the gross public burden ratio (i.e. all taxes and the social security contribution divided by national income). For 1996, the ratio is expected to be 37.2% compared with 25.7% in 1975. As a rule of thumb, the government is expected to maintain this ratio at around 45% at the beginning of the 21st century and below 50% even at the peak of the aging population, say, in 2020.

We should identify some basic principles for future fiscal reform. First, all agents (individuals, firms, and the government) should take full responsibility for their decisions. A simple cost-benefit analysis, such as generational accounting presented here, can be a very useful tool in making individual fiscal positions more transparent. Second, competitive market mechanisms must be utilized to ensure the efficient allocation of government funds, which means institutional and political compromises should be avoided if they do not satisfy competitive market mechanisms. Third, as future generations do not yet have a political voice, if the government does not think of them, they will have to bear a huge debt burden to pay for the benefits accruing to the current generations. In principle, it is the government that adjusts the burdens and benefits of public transfers and objectively decides the fairness of intergenerational burden sharing.

A summary of our main conclusions is as follows:

The base case calculation of the generational imbalance between present and future generations is 169% for Case A (where education expenditures are treated as consumption) and 338% for Case B (where education expenditures are treated as transfers) if the current fiscal policy stance is to be maintained (where the real income growth is 1.5% and the discount rate is 5%). This implies that future generations will have to bear 2.7 to 4.4 times as much the fiscal burden as present generations do, a huge imbalance by international standards.

For the base case, four basic scenarios and two additional scenarios to resolve this generational imbalance are considered. As for the four basic scenarios, government purchases are required to be cut 26-30%, or all taxes need to be raised about 16%, or income tax has to be increased 54%, or transfer payments must be cut by some 25-29%. As for the additional scenarios, both government purchases and transfers are to be cut 14% and if all taxes are reduced by 50%, then both purchases and transfers need to be cut by 57%, that makes the size of government expenditures one-quarter of the current level.

Another simulation indicates that the generational imbalance occurs not from the fiscal debt outstanding *per se* but from changes in demographic structure. Indeed, if demographic structure remains unchanged, the generational imbalance falls substantially. This is probably the main implication of generational accounting, not only in Japan but also in other countries.

We also consider the concept of the fixed life time relative position suggested in Musgrave (1981). This concept differs from the generational imbalance in generational accounting. That is, the fixed life time relative position sets contributions and benefits so as to keep the ratio of per-capita earnings of those in working generations to the per-capita benefits of retirees constant. This concept evaluates the benefits of retirees in terms not of their own net burden but of the earnings of current working generations. In other words, this concept *per se* includes generational interaction. The result shows that a balanced budget will be achieved and the fixed life time relative position maintained constant, if tax is increased 10-15% and transfer benefits are reduced 10-13% . In this case, the generational imbalance remains less than 13% for Case A and 73% for Case B.

II. Brief History of Fiscal Policy and Current Fiscal Debates

A. Brief History of Fiscal Policy in Japan[1]

In 1947, after the Second World War, the government decided to seek a balanced budget, a principle which was applied not only to the general budget but also the special budget and other governmental organizations. Then in 1950, fundamental tax reform, the so-called Shoup mission tax reform, was implemented, which laid the foundation on Japan's tax system on direct taxation with a special emphasis on fairness.

[1] This section is drawn heavily from Tamura (1996, section IV).

A deep economic recession in 1949 suddenly ended when special procurement by the US military due to the Korean War commenced.

During 1951-55, active fiscal policy was implemented from time to time. However, under capital market and foreign exchange controls, the economic boom was suppressed when the balance of payments worsened. For example, fiscal policy was tightened in 1954-55 along with tight monetary policy. This type of stop-and-go policy continued until the mid-1960s.

The high economic growth period started in 1955. The government budget had been increased steadily to finance public investment, social security expenditures among others. Because of the natural increase in tax revenues reflecting high economic growth, the principle of having a balanced general budget was strictly adhered too. Furthermore, a tax reduction was effected almost annually so as to maintain the average ratio of tax revenue to GNP at around 19%. In addition, the government paved the way for the introduction of a comprehensive social security system, namely the public pension and medical insurance system which was intended to cover all citizens in Japan. The fiscal authority in these halcyon days during 1955-64 actually ran fiscal surpluses which fluctuated from year to year and functioned as something of a built-in stabilizer. Looking at the long term, the government invested heavily in fixed public capital formation and tax incentives to encourage personal savings and corporate investment worked well.

In 1965, the economy entered a recession after policy tightening in 1963. Although the budget was balanced in the original plan, tax revenues fell short and the government thus decided to issue government bonds for the first time since the Second World War. In 1966, the government intended only to issue bonds for the purpose of construction investment, but in so doing it obtained a very useful but potentially dangerous free hand in terms of demand management. This is the historical departure from the principle of a balanced budget.

After that first issue of government bonds, the debt dependency ratio increased (see Table 1). In 1968, fiscal discipline was the goal and easy reliance on bond finance halted, as a result, the debt dependency ratio dropped dramatically in 1970.

Table 1 Basic Fiscal Statistics

(100 million yen)

year	General Account			Debt dependency ratio (%)	Tax burden ratio (%)
	Expenditure	Tax revenue	Bond issue		
1960	17431	16183			18.9
1965	37230	30496	1972		18
1970	81877	72958	3472	4.2	18.9
1975	208609	137527	52805	25.3	18.3
1980	434050	268687	141702	32.6	22.2
1985	530045	381988	123080	23.2	24
1990	692687	601059	73120	10.6	27.8
1991	705472	598204	67300	9.5	27.1
1992	704974	544453	95360	13.5	24.9
1993	751025	541262	161740	21.5	24.4
1994	736136	508160	164900	22.4	23.2
1995	780340	537310	125980	28.2	23.3

Source : Ministry of Finance

Note: (1) Debt dependency ratio=bond issue/expenditure.

(2) Tax burden ratio=all tax revenues/national income.

In 1971, the Nixon administration suspended gold convertibility and imposed a 50% import tax as part of new economic policy --- the so called "Nixon shock" which had a serious impact on the Japanese economy. In response, the government adopted expansionary fiscal policies to increase public investment and to reduce taxes during 1971-72, along with an easy monetary policy. In October 1973, the first oil shock pushed inflation to above 20% in 1974. Although dramatic reform of the social security system was implemented in 1973, by which 100% of the medical expenditures of the elderly and 70% of those of non-working spouses and children were covered, the government otherwise maintained a very tight fiscal policy stance and a lot of public investment was suspended or postponed; 1974 saw zero growth in public investment expenditures.

The economy fell into a recession in 1974 and experienced negative growth for the first time since the Second World War. The government could not but implement aggressive fiscal policy to stimulate the economy. As a consequence of the recession, tax revenues fell short and the government thus again turned to rely on bond financing, but this time, it was permitted to issue bonds not for the purpose of public investment.

The debt dependency ratio jumped from 11.3% in 1974 to 25.3% in 1975 and remained high until the late 1980s with a peak of 34.7% in 1979. We consider that 1975 was a second turning point for fiscal policy.

During 1980-84, after the second oil shock in 1979, the government tried to implement substantial fiscal reform to escape from heavy reliance on debt financing. After 1983, the following reforms were adopted: some fiscal expenditures were cut, the public pension and medical insurance system were reformed, local government finances were revamped, subsidies were reduced, food management expenditures revised, and public corporations privatized. As a result, the debt dependency ratio fell to 23.3% in 1985.

From 1985 to 1990, the government continued to pursue various fiscal reform measures. In September 1985, the major OECD economies agreed to adjust exchange rates against the US dollar by international policy coordination (the Plaza Agreement). In order to avoid repercussions of the rapid appreciation of the yen on the Japanese economy, the government took aggressive fiscal policy through an easy monetary policy (i.e. the official discount rate was kept at 2.5% for over two years). These policies stimulated the economy which, in turn, enjoyed a long boom in the latter half of the 1980s. From 1983 to 1987, general government expenditures were cut annually. Thanks to increased tax revenue due to the boom, in 1990 the government succeeded in reducing debt financing by a substantial margin for the first time in 15 years.

In 1991, the economy started contracting as a result of the bursting of the bubble economy and a deep recession ensued. The government implemented extraordinary fiscal policy packages during 1992-95 and the official discount rate was reduced to a record low 0.5% in September 1995. As a consequence, the debt dependency ratio has increased since 1991 (see Table 1). Debt outstanding reached 200 trillion yen at the end of 1994 (the gross debt to GDP ratio in 1994 was 73.2%) and is expected to reach some 240 trillion yen at the end of 1996; if local government debt, i.e. municipal bonds, were included, the figure would be 442 trillion yen (and the gross debt to GDP ratio in 1996 would be 87.4%). In this respect, the fiscal stance of the Japanese government has been going from bad to worse in recent years.

B. Current Fiscal Debates[2]

In reaction to the recent rapid deterioration in the fiscal position and rapidly

[2] This section mainly relies on Ishi (1996, chapter 1).

aging society toward the 21st century, the Japanese government as well as the private sector, including academic economists, have started arguing openly of the urgent need to improve the current fiscal position and for more fundamental structural reform of public finance in general.

To clarify the situation clear, let us first look at the general budget plan for 1996. Of 75.1 trillion yen in expenditures, the social security-related items account for 14.3 trillion yen (19%); public investment for infrastructure (i.e. roads, bridges, housing, etc.), 9.7 trillion yen (13%); educational and science research-related expenditures, 6.2 trillion yen (8%); transfers to municipal governments,13.6 trillion yen (18%); and other small expenditures for defense, official development assistance (ODA), energy-related items, and the promotion of small and medium-sized enterprises. In addition to these expenditures, government bond-related items, i.e. interest payments and the repayment of principal, require 16.4 trillion yen (22%), which is the biggest expenditure item. On the revenue side, income tax provides 19.3 trillion yen; corporate tax,13.5 trillion yen; inheritance tax, 2.6 trillion yen; and consumption tax, 5.9 trillion yen. Together with other tax revenues and stamp duties, tax revenues total 51.3 trillion yen. The gap between expenditures and revenues is mainly filled by public debt, 21 trillion yen (28% of total revenues).

On both the expenditure and revenue side, public debt-related items account for the biggest share, an alarming picture of the fiscal position in Japan. To put it into perspective, let us compare with the statistics of the other major OECD economies (*OECD Economic Outlook*, December 1996, no.60): in Japan, while the gross public debt to GDP ratio increased from 65.1% in 1990 to 80.7% in 1995, in the US, it rose from 55.6% to 64.3%, in the UK, from 39.3% to 60.0%, in Germany, from 45.5% to 61.6%, and in France, from 40.2% to 60.0% respectively. As these statistics show, Japan is in the worst position among major OECD countries.

There are some causes and reasons for the worsening of the fiscal position. First, tax revenue growth remains very low as the economy itself has grown very slowly in recent years. Second, the population is aging at an accelerated tempo (see Table 2). Third, expenditures on institutional arrangements, such as the social security system, have been increasing. Fourth, because of the extraordinary fiscal policy packages in 1992-95 to stimulate the economy amid a deep recession, public debt has increased by 68 trillion yen in the past 5 years.

Table 2 Demographic Projection in Japan

Year	Total Population	Children Age 0-17	Working Age 18-64	Old Age 65 +	Dependancy Ratio (%) Elderly	Children	Total
1995	12557024	24989428	82303927	18276891	22.21	30.36	52.57
2000	12689216	23043161	81978714	21870288	26.68	28.11	54.79
2005	12768376	22050991	80627184	25005587	31.01	27.35	58.36
2010	12762280	21875387	77621677	28125744	36.23	28.18	64.42
2015	12644354	21583315	72977324	31882900	43.69	29.58	73.26
2020	12413316	20709028	70088953	33335184	47.56	29.55	77.11
2025	12091314	19424577	68372447	33116115	48.43	28.41	76.84
2030	11714908	18239653	66141892	32767534	49.54	27.58	77.12
2035	11311406	17436911	62890562	32786592	52.13	27.73	79.86
2040	10896403	16965244	58272787	33726002	57.88	29.11	86.99
2045	10475833	16552487	54708560	33497281	61.23	30.26	91.48
2050	10049630	15954267	52087946	32454089	62.31	30.63	92.94
2055	96188065	15202042	50288102	30697922	61.04	30.23	91.27
2060	91848186	14486333	48858470	28503387	58.34	29.65	87.99
2065	87636413	13964828	47121932	26549657	56.34	29.64	85.98
2070	83773434	13652110	45023103	25098219	55.75	30.32	86.07
2075	80367936	13404853	42899729	24063357	56.09	31.25	87.34
2080	77375135	13106607	41068281	23200243	56.49	31.91	88.41
2085	74639896	12736928	39624936	22278029	56.22	32.14	88.37
2090	72067533	12364880	38445282	21257378	55.29	32.16	87.45
2095	69634513	12073791	37293925	20266797	54.34	32.37	86.72
2100	67365808	11887962	36068378	19409469	53.81	32.96	86.77

Source: The medium variant projection of future population conducted by the Institute of Population Problems, Ministry of Health and Welfare, 1997

Notes: (1) Dependency ratio of the elderly = old population as percent of working population. Dependency ratio of the children = child population as percent of working population. Total dependency ratio = old plus child populations / working age population.

(2) This medium variant projection is based on the following assumptions: (a) the base population distribution was estimated on October 1, 1995; (b) the total fertility rate was 1.42 in 1995, dropped to 1.38 in 2000, and then gradually rose to reach 1.61 in 2030; (c) life expectancy at birth was 76.36 for men and 82.84 for women in 1995, rising to 77.40 and 84.12 in 2000 and 79.43 and 86.47 in 2050 respectively; (d) the net international migration rate remains very small for Japan (a maximum 1.5‰ (permilll) for male immigrants aged 25). Data on net migration is based on five-year average from October 1, 1990 to September 30, 1995 and is assumed constant from October 1, 1995 onwards.

(3) We assume that the population after 2100 will reach a steady-state so that the demographic structure remains the same as in 2100.

(4) In Japan, it is conventional to assume that children are aged 0-14, the working population, 15-64, and the old, above 65. Therefore, officially announced dependency ratios are also different from the above table.

Prospects with respect to the future fiscal position and policy objectives to

avoid a worsening of the fiscal position are still unknown. Without doubt, however, the government must avoid issuing bonds which are not utilized to provide public capital because such bonds are the mere transfer of burden without providing any benefits to future generations. A simulation suggests that the government will have to issue bonds simply for repayment purposes until 2003 even if there is no growth in general expenditures from 1997 onwards (which means 20% lower general expenditures from the natural growth path in 2001). In other words, without any substantial reduction in real terms, government expenditures cannot be maintained, and even if maintained, the government has to issue bonds until 2003.

One fiscal concept which is attracting attention among policy makers is the gross public burden ratio (i.e. all taxes and the social security burden divided by national income, which is a larger concept than the tax burden rate in Table 1). The ratio in 1996 is expected to be 37.2% compared with 25.3% in 1975. As a rule of thumb, the government is expected to maintain this ratio at around 45% at the beginning of the 21st century and below 50% even at the peak of the aging population, say, in 2020. Note that this measure itself does not take into account public debt and the generational distribution of burden. Government expenditures can be increased without raising the gross public burden ratio as long as the gap between expenditures and revenues is financed by public debt. Thus, the usefulness of this concept seems rather limited.

All in all, given certain conditions such as prospects of low economic growth and the rapid aging of society which cannot be easily changed, the government has to implement dramatic reform on both the revenue and expenditure side. Several principles for such reform can be put forward. First, all agents (individuals, firms, and the government) must take full responsibility for their decisions, self-help is a rather old but still valid idea. With respect to the burden and benefits of the social security system, a reasonable balance must be found, i.e. benefits cannot go beyond the means of society. Second, competitive market mechanisms must be used in implementing the efficient allocation of government expenditures. Institutional and political compromises should be avoided if they do not satisfy the market mechanism. Third, the stabilization role of public finance has been weakened, if not abandoned completely, in major OECD countries except Japan. Indeed, stabilization policy has come to be viewed more as one aspect of government intervention to alleviate market failure, and the effectiveness of fiscal stimuli has been very limited as the recent Japanese experience shows. Finally, as future generations do not have political voice at the moment, if the government does not consider them, they will have to bear a huge burden of debt which only benefits current generations. In principle, it is the government that

adjusts the burden and benefit of public transfers and objectively judges the fairness of intergenerational burden sharing.

III. The Data

(1) Government revenues and expenditures are based on *Annual Report on National Accounts*, 1995 (Economic Planing Agency, The Government of Japan). Tax revenue estimates used in the third 1995 supplementary budget shown in *Ministry of Finance Statistics Monthly* (April 1996, vol.528), municipal government revenues and expenditures in the *Municipal Government Finance Plan* for 1995, and income from interest and stock sales in the *National Tax Bureau Annual Report*,1994 (No.120). Government fixed capital formation is obtained from the general account and not the special account.

(2) Consumption and income for each generation are distributed according to age distribution information reported in *National Survey of Family Income and Expenditure*,1994 (Statistics Bureau, Management and Coordination Agency, Government of Japan) by expenditure, savings and loans for two or more member households (issued December 27, 1995), and assets (issued May 25, 1996). As age distribution is reported at five-year intervals from age 20 to age 65, and those aged 70 and above are treated equally, we allocate the same value for those aged from 70 to 95.

(3) Social security transfers in kind (mainly medical transfers) are calculated according to age distribution information in *Survey of Income Redistribution*,1993 (Ministry of Health and Welfare).

(4) Population projections are taken from the medium variant projection of future population conducted by the Institute of Population Problems, Ministry of Health and Welfare, 1997. The base population is the 1995 population census of Japan.

(5) Per capita educational expenditure for each age is allocated from 1993 school expenditure data (excluding donations) in *Ministry of Education Statistics Handbook*,1996.

IV. The Main Findings and Sensitivity Analysis

Table 3 presents the basic results of generational accounting in Japan (1995 base). They are divided into two cases: Case A in which education expenditures are treated as consumption and Case B in which they are treated as transfers. This distinction makes for some differences for generations between age 0 and 24. The percentage imbalance between the newborn and future generations is 169% for Case A

and 338% for Case B, implying that future generations must pay about 2.7 times for Case A and bout 4.4 times for Case B as much tax (net basis) as newborn generations, a huge difference.

Table 3 Generational Accounting: The Base Case

(thousand dollar)

Generation's age in 1995	Case A consumption	Case B Transfer
0	143.4	73.0
5	169.3	90.9
10	200.1	135.4
15	235.9	187.4
20	278.1	257.4
25	295.2	295.2
30	297.8	297.8
35	287.4	287.4
40	263.8	263.8
45	227.7	227.7
50	173.1	173.1
55	99.0	99.0
60	11.9	11.9
65	-47.7	-47.7
70	-44.8	-44.8
75	-36.0	-36.0
80	-26.7	-26.7
85	-18.2	-18.2
90	-9.7	-9.7
Future generations	386.2	319.4
Generational Imbalance (%)	169.3	337.8

Note: $1=¥93.37(1995 average); the real income growth,1.5%;
the discount rate,5.0%.
Case A: Education expenditures treated as consumption.
Case B: Education expenditures treated as transfers.

Note, however, that such a large generational imbalance does not immediately imply a heavy burden or a pain for future generations. That is to say, if the net present value of payments as a proportion of life-time income for future generations is reasonably small, this large imbalance might not induce a burden for future generations which is 2.7 to 4.4 times as much as that on newborn generations. In other words, an absolute value comparison of net payment makes sense as far as the generational imbalance is concerned. The net present value of net payments as a proportion of life-time income for future generations (i.e. the relative burden of future generations), however, cannot be identified solely by the absolute value of net payments as life-time income differs substantially.

In the following, we calculate the net present value of payments as a percentage of life-time income. Taking the working generations as those aged between 0 and 64, the present value of average life-time income for employees (evaluated at age 0) is approximately 478.6 thousand dollar (in the case of 1.5% growth with a 5.0% discount rate). According to Table 3, Case A, the net present value of payments for the present generation is 143.4 thousand dollars, implying that the life-time net tax rate is 30%. It is 81% for future generations. Even if we take into consideration pension benefits, net tax payments of over 80% of the life-time income would be a heavy burden.

However, it is noteworthy that, as future generations will benefit from government consumption, some 80% of life-time income is not meant to be collected for nothing. In fact, the net tax payments of each generation will be used as government consumption, mostly for one's own generation and the rest for future generations. Government consumption used for future generations can be interpreted as a net burden for the current generation because it is a form of intergenerational transfer *via* the government.

On the other hand, in Case B (where education expenditures are treated as transfers), the life-time net tax rate is 15% for present generations and 67% for future generations.

Table 4 Sensitivity Analysis of Generational Imbalance

Case A thousands of dollars

Real Income Growth Rate (%)	1				1.5				2.0				3.0			
Discount Rate (%)	2.0	3.0	5.0	7.0	2.0	3.0	5.0	7.0	2.0	3.0	5.0	7.0	2.0	3.0	5.0	7.0
Present generations	348.6	242.1	120.1	62.4	419.5	291.0	143.4	73.8	NA	349.8	171.4	87.4	NA	NA	245.6	123.3
Future generations	595.2	510.6	356.5	283.3	730.7	571.5	386.2	297.6	NA	644.3	421.6	314.9	NA	NA	514.7	360.6
Generational imbalance (%)	70.7	110.9	196.9	354.3	74.2	96.4	169.3	303.5	NA	84.2	146.0	260.3	NA	NA	109.6	192.5

Notes:(1) $1=¥93.37(1995 average).

(2) Situation where the real growth rate and discount rate are identical is not available.

Case A: Education expenditures treated as consumption.

Case B thousands of dollars

Real Income Growth Rate (%)	1				1.5				2.0				3.0			
Discount Rate (%)	2.0	3.0	5.0	7.0	2.0	3.0	5.0	7.0	2.0	3.0	5.0	7.0	2.0	3.0	5.0	7.0
Present generations	256.3	159.7	53.3	7.4	321.7	203.8	73.0	16.0	NA	257.5	97.1	26.7	NA	NA	162.7	56.0
Future generations	553.3	431.3	293.6	232.5	635.3	487.2	319.4	243.9	NA	554.7	350.9	258.1	NA	NA	435.0	297.1
Generational imbalance (%)	115.9	170.1	450.7	3038.4	97.5	139.0	337.8	1424.3	NA	115.4	261.4	868.5	NA	NA	167.3	430.6

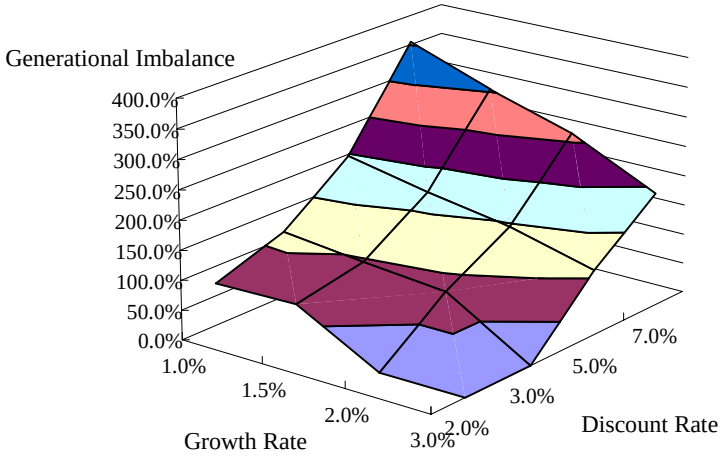
Notes:(1) $1=¥93.37(1995 average).

(2) Situation where the real growth rate and discount rate are identical is not available.

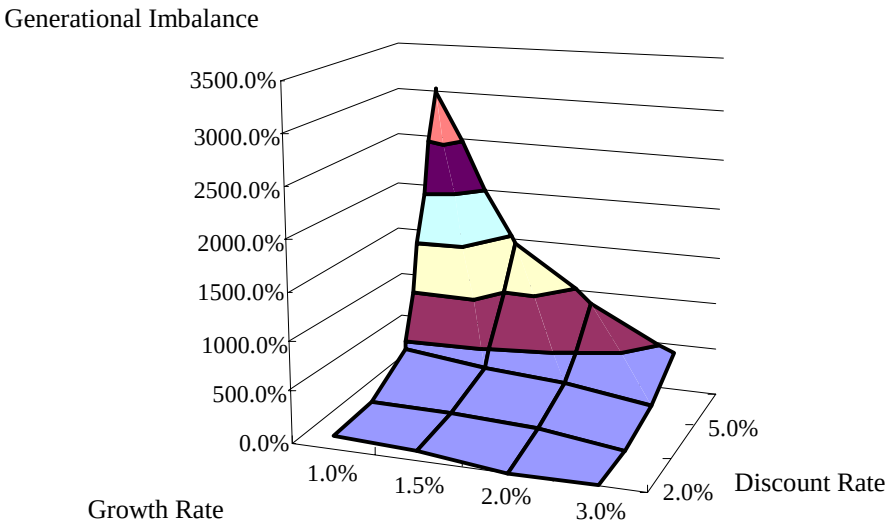
Case B: Education expenditures treated as transfers.

Graph 1 Sensitivity of Generational Imbalance

Case A



Case B



In addition to base case real income growth of 1.5% and a 5.0% discount rate, Table 4 gives various combinations. In particular, we include the case of a 2.0% discount rate because the standard discount rates in this volume seem rather high (i.e. 3%, 5%, 7%) by Japanese standards, while real growth rates are assumed low (i.e. 1%, 1.5%, 2%, 3%).

Given the same fiscal policy, the generational imbalance is very sensitive to real income growth and discount rate assumptions. According to demographic projections, the aging process will reach a peak in 2050, after which society will get younger. The fiscal position is also expected to ease after 2050. The higher real income growth rate reduces the burden of future generations because of a bigger improvement in fiscal position after 2050. On the other hand, the higher discount rate increases the burden of future generations because the fiscal position is heavily discounted.

As the demographic projection includes a lot of uncertainty, nothing can be said for sure. But, if the demographic structure remains stationary after the aging process reaches its peak, then effects of real income growth and the discount rate work in the opposite direction. A reasonable scenario would be a real income growth rate of 1.5% and discount rate of 3.0%. In this case, the generational imbalance is 96.4% for Case A and 139% for Case B. It is much smaller than that in the base case (i.e. a real income growth rate of 1.5% and the discount rate of 5%).

If we are concerned only with the net present values of payments after 1995, Table 3 indicates that they are positive for generations aged 64 and younger and negative for generations aged 65 and older. This is partly due to the fact that tax payments and social security contributions of the old generations made when they were young are ignored in this calculation and also partly due to large intergenerational transfers from young to old generations *via* fiscal policy. If redistribution policy is biased toward old generations, the fiscal burden of future generations will increase more as the aging process advances. Table 5 eloquently indicates this.

Table 5 Decomposition of Generational Imbalance

	Base case	No demographic change	Zero debt
Case A	169.3%	42.19%	154.50%
Case B	337.8%	77.21%	308.64%

Notes: Assumed real income growth of 1.5 %; discount rate of 5%.
Case A: Education expenditures treated as consumption.
Case B: Education expenditures treated as transfers.

Table 5 decomposes the generational imbalance into two factors; demographic change and fiscal debt position. Even if we assume no debt outstanding (zero debt) in 1995, there will remain the generational imbalance of 155% for Case A and 309% for Case B. Hence, current debt outstanding *per se* is not the main reason for the generational imbalance. On the other hand, if we assume no demographic change after 1995, the generational imbalance will shrink substantially to 42% for Case A and 77% for Case B. This implies that in Japan the generational imbalance is largely due to the aging of the demographic structure and intergenerational transfers *via* fiscal policy.

An important aspect of generational accounting in Japan is the role of the government's fixed capital formation. So far, future generations seem to be forced to bear an unjustifiably huge fiscal burden for financing current and future old generations. However, at the same time, future generations will enjoy benefits of public capital accumulated by the previous (old) generations without explicit repayment. In order to make a fair judgment for intergenerational income redistribution, it is necessary to evaluate imputed benefits from public capital inherited from the previous (old) generations (on this, see Appendix I). As for the private sector, young generations either buy private capital or borrow it (paying rent) from old generations. As for the household sector, bequest and gift transfers from old to young generations are made without repayment except taxes.

Table 6 shows the percentage share of public capital formation to total gross domestic fixed capital formation. As is evident, the Japanese government has been investing heavily in public capital formation, probably one of the heaviest among OECD countries. In fact, we can say that the government transfers its gross fixed capital formation to future generations *via* public capital investment financed by current taxes. We think it is fair to discount the burden of future generations as they enjoy benefits from public capital. Unfortunately, the framework we use here makes no distinction between government consumption and investment for public capital formation which will benefit future generations.

Table 6 Gross Domestic Fixed Capital Formation in Major OECD Countries

1995	A Gross domestic fixed capital formation	B Private sector investment	C Public sector investment (A-C)	D Share of public sector investment C/A	unit
Japan	136,695	95,054	41,641	30.5%	Yen billion
UK	104,024	87,283	16,741	16.1%	Pounds million
Germany	7,534	6,674	860	11.4%	Marks million
France	13,807	11,403	2,404	17.4%	Francs100million
Italy	301,039	261,083	39,956	13.3%	Lira billion

Source: Comparative Economic and Financial Statistics, Japan and Other Major Countries 1996, Bank of Japan.
Note: Because of NIPA basis, US data is not shown.

In the following section, we will discuss the impact of alternative policies and the fairness of intergenerational transfers.

V. The Generational Impact of Alternative Policies

A. Six Different Policy Simulations

This section conducts six different policy simulations and an "alternative fairness" exercise of intergenerational transfers.

The six different policy simulations are based on the following assumptions to achieve generational balance: a) an immediate and permanent cut in government purchases, b) an immediate and permanent increase in all tax revenues, c) an immediate increase in income tax revenues, d) an immediate and permanent cut in transfer payments, e) an immediate and permanent cut in both purchases and transfers, and f) an immediate and permanent 50% cut in all taxes and reduction in both purchases and transfers. The results are reported in Table 7 under both Case A and Case B. Let us first look at the base case, real growth of 1.5% and discount rate of 5.0%.

Table 7 Generational Impact of Alternative Policies

The Base Case (Real income growth of 1.5%; discount rate of 5.0%)

Case A

Policy	Change	Results
a) Cut in government purchases	26.0% cut	74.0%
b) Increase in all taxes	15.5% up	115.5%
c) Increase in income tax	53.6% up	153.6%
d) Cut in transfer payments	28.6% cut	71.4%
e) Cut in both purchases and transfers	13.6% cut	86.4%
f) All taxes cut by half and both purchases and transfers reduced	57.4% cut	42.6%

Case A: Education expenditures treated as consumption.
Note: For both b) and e), local tax and social insurance contribution (the Japanese counterpart of the social security tax) are included in taxes.

Case B

Policy	Change	Results
a) Cut in government purchase	29.5% cut	70.5%
b) Increase in all taxes	15.5% up	115.5%
c) Increase in income tax	53.6% up	153.6%
d) Cut in transfer payments	25.3% cut	74.7%
e) Cut in both purchases and transfers	13.6% cut	86.4%
f) All taxes cut by half and both purchases and transfers reduced	57.4% cut	42.6%

Case B: Education expenditures treated as transfers.
Note: For both b) and e), local tax and social insurance contribution (the Japanese counterpart of the social security tax) are included in taxes.

Alternative Case (Real income growth of 1.5%; discount rate of 3.0%)

Case A

Policy	Change	Results
a) Cut in government purchases	29.7% cut	70.3%
b) Increase in all taxes	17.8% up	117.8%
c) Increase in income tax	60.8% up	160.8%
d) Cut in transfer payments	31.3% cut	68.7%
e) Cut in both purchases and transfers	15.2% cut	84.8%
f) All taxes cut by half and both purchases and transfers reduced	57.9% cut	42.1%

Case A: Education expenditures treated as consumption.
Note: For both b) and e), local tax and social insurance contribution (the Japanese counterpart of the social security tax) are included in taxes.

Case B

Policy	Change	Results
a) Cut in government purchase	33.5% cut	66.5%
b) Increase in all taxes	17.8% up	117.8%
c) Increase in income tax	60.8% up	160.8%
d) Cut in transfer payments	28.0% cut	72.0%
e) Cut in both purchases and transfers	15.2% cut	84.8%
f) All taxes cut by half and both purchases and transfers reduced	57.9% cut	42.1%

Case B: Education expenditures treated as transfers.
Note: For both b) and e), local tax and social insurance contribution (the Japanese counterpart of the social security tax) are included in taxes.

First, the case in a) implies that government purchases and fixed capital investment must be cut by about 26-30% to achieve generational balance. As the ratio between private and public demand with respect to gross domestic expenditures is about 4:1, an immediate cut in government purchases of 26-30% implies a reduction in gross domestic expenditure of 5-6%, which would have a big macroeconomic impact.

Second, the case in b) means an approximate 16% increase in tax payments. Tax payments and social security contributions as a percentage of national income (the so- called gross public burden ratio) in 1995 were 36.8%. If scenario b) is selected, the gross public burden ratio will jump to 41%. If this scenario is not selected, the net tax payment of future generations will be 2.7 to 4.4 as much as that of present generations, as seen in Table 3. In such a case, the gross public burden ratio would certainly exceed 50%. Therefore, this scenario, with a gross public burden ratio of around 40%, could be accepted by the public, as long as it is sustainable.

Third, the case in c) implies a 54% increase in income tax. Compared with the case in b), it is rather high. Give the percentage share of income tax in total government tax revenue as 35.5% in 1995, simple arithmetic implies that c) requires three times as much of an increase as in case b). Case c) affects mostly current working generations. As the income tax rate is already rather high, it would be very difficult to raise income tax further.

Fourth, case d) requires 29% cut in transfer payments for Case A and 25% for Case B. The ratio of social security transfers to national income was 17.5% in 1995. A slightly less than 30% cut in transfer payments implies a 5% decrease in the national income ratio.

We consider two additional scenarios of which seek "small government".

Fifth, case e) is concerned with an immediate cut in both purchases and transfers to achieve generational balance. Here, a 13.6% cut in gross government expenditures is needed. This scenario seems to be reasonable and acceptable.

Sixth, case f) is an immediate 50% cut in all taxes and a reduction in both purchases and transfers. Gross government expenditures must be cut by 57.4%. This implies the size of government in terms of expenditure shrinks to one-quarter of the current level.

Now look at an alternative case, real income growth of 1.5% and discount rate of 3.0%. This case is considered because, as shown in Table 4, it reduces the generational imbalance by half from that of the base case. In general, with a lower discount rate, generational impact of alternative policies becomes larger (i.e. larger cut in purchase and transfers and larger increase in taxes). But a difference between the base case and the alternative case is not so larger as we expect. In other words, generational impact of alternative policies remains robust.

Table 8 Generational Impact of Alternative Policies After Maintaining Current Policy for Ten Years

The Base Case (Real income growth of 1.5%; discount rate of 5.0%)

Case A

Policy	Change	Results
a) Cut in government purchases	37.8% cut	62.2%
b) Increase in all taxes	22.5% up	122.5%
c) Increase in income tax	76.6% up	176.6%
d) Cut in transfer payments	39.3% cut	60.7%
e) Cut in both purchases and transfers	19.3% cut	80.7%
f) All taxes cut by half and both purchases and transfers reduced	62.0% cut	38.0%

Case A: Education expenditures treated as consumption.
Note: For both b) and e), local tax and social insurance contribution (the Japanese counterpart of the social security tax) are included in taxes.

Case B

Policy	Change	Results
a) Cut in government purchase	42.5% cut	57.5%
b) Increase in all taxes	22.5% up	122.5%
c) Increase in income tax	76.6% up	176.6%
d) Cut in transfer payments	35.2% cut	64.8%
e) Cut in both purchases and transfers	19.3% cut	80.7%
f) All taxes cut by half and both purchases and transfers reduced	62.0% cut	38.0%

Case B: Education expenditures treated as transfers.
Note: For both b) and e), local tax and social insurance contribution (the Japanese counterpart of the social security tax) are included in taxes.

Alternative Case (Real income growth of 1.5%; discount rate of 3.0%)

Case A

Policy	Change	Results
a) Cut in government purchases	35.6% cut	64.4%
b) Increase in all taxes	21.4% up	121.4%
c) Increase in income tax	72.4% up	172.4%
d) Cut in transfer payments	36.5% cut	63.5%
e) Cut in both purchases and transfers	18.0% cut	82.0%
f) All taxes cut by half and both purchases and transfers reduced	60.0% cut	40.0%

Case A: Education expenditures treated as consumption.
Note: For both b) and e), local tax and social insurance contribution (the Japanese counterpart of the social security tax) are included in taxes.

Case B

Policy	Change	Results
a) Cut in government purchase	40.0% cut	60.0%
b) Increase in all taxes	21.4% up	121.4%
c) Increase in income tax	72.4% up	172.4%
d) Cut in transfer payments	32.7% cut	67.3%
e) Cut in both purchases and transfers	18.0% cut	82.0%
f) All taxes cut by half and both purchases and transfers reduced	60.0% cut	40.0%

Case B: Education expenditures treated as transfers.
Note: For both b) and e), local tax and social insurance contribution (the Japanese counterpart of the social security tax) are included in taxes.

Table 8 presents results of the same policy simulations as in Table 7 with an additional assumption that the current policy will be kept for ten years (i.e. until 2005) and then the listed policy action will be implemented afterwards. Underlying assumption is that the government may not be able to implement the policy action immediately to achieve generational imbalance. It is worthwhile examining how generational impact of alternative policies would change if the government fails to conduct a prompt policy action. As expected, the generational impact becomes larger for all cases. It implies that the sooner the policy action is implemented, the easier the generational balance is maintained. In contrast with the results in Table 7, this exercise shows that the alternative case with a lower discount rate makes generational impact slightly smaller than the base case.

B. Alternative Measure of Intergenerational Transfers: The Musgrave Criterion

So far we have examined generational accounting in terms of absolute generational imbalance between present and future generations. In this section, we propose an alternative criterion to measure the fairness of intergenerational transfers, i.e. a concept of intergenerational social contract upon which a social security system may be designed. Richard Musgrave (1981, p.97) considers six alternative contracts:

(1) *Intergenerational Neutrality*: Each generation finances its own retirement, without claims on following generations or obligations to preceding generations.

(2) *Ad Hoc Provision*: The agreement may be a very loose one, allowing the voters of each period to decide the level of support.

(3) *Fixed Replacement Rate* (*FRR*): Retirees are entitled to receive a given fraction of their gross earnings in the form of benefits. With the replacement rate fixed, the working generation must adjust its contribution rate accordingly. Thus, the tax rate changes.

(4) *Fixed Replacement Rate, Adjusted* (*FRRA*): The replacement rate is fixed, as under FRR, but the earning base of retirees to which this rate is applied is adjusted upward to allow for the productivity gains and higher wage rates enjoyed by subsequent working generations.

(5) *Fixed Contribution Rate* (*FCR*): The working population is required to contribute a given fraction of its gross earnings for the support of retirees. With the contribution rate thus fixed over generations, the replacement rate has to be changed. However, (a) it seems impossible to maintain a fixed contribution rate throughout the aging process and (b) the contribution rate has been changed frequently (in an intergenerationally

redistributive way) and it would be very costly to maintain.
(6) *Fixed Relative Position* (*FRP*): Contributions and benefits are set so as to hold constant the ratio of per-capita earnings of those in working generations (net of contribution) to the per-capita benefits of retirees.

In the following, we will consider the concept of fixed relative position (FRP) in detail. This means that government transfers to old generation as a percentage of disposable income of young generation is fixed. This resembles the concept of "net income indexation" in the case of public pension transfers[3].

Defining transfer benefits to old generation as *Bo*, gross wage income of working generation as *Wy*, and social security tax, pension contributions, and all other taxes of working generation as *Ty*, the fixed relative position k can be expressed as,

$$k=Bo / (Wy-Ty) \quad (1)$$

As long as *k* remains constant, transfer benefits to old generation will not increase even if the aging process advances. This is because disposable income of working generation binds transfers as the above equation (1) shows.

Now, let us define a number of old generation as *No* and that of working generation as *Ny*. Under the fully pay-as-you-go social security system,

$$Bo\ No=NyTy \quad \text{or} \quad Ty=Bo(No/Ny) \quad (2)$$

Substituting (2) into (1) yields,

$$k = Bo/(Wy-Bo(No/Ny))=Bo/(Wy-Bo \cdot a) \quad (3)$$

where $a=No/Ny$=the ratio of old generation to working generation

Solving for *Bo*, we obtain

$$Bo=kWy / (1+a\ k). \quad (4)$$

[3] Net income indexation is a concept in which pension benefits for pensioners are a given fraction of the disposable income of pension contributors, the working generation. This concept has been adopted in Germany and Japan.

Given k is constant, transfer benefits to old generation increase as gross wage income increases and decrease as the ratio of old generation to working generation increases.

The main characteristics of this fixed relative position can be summarized as follows. First, it includes interaction with other generations within society, while the concept of net present value of payments for each generation as discussed in section IV and V.A is an individualistic one, meaning that it is a closed accounting system within a generation. Fixed relative position is suitable for the current social security system which is virtually a pay-as-you-go system. Furthermore, at the end of section IV, we pointed out that intergenerational transfers of fixed public capital to future generations are prevalent and, therefore, that it is important to take account of a productivity increase due to public capital which, in turn, is reflected in the income of working generation. The fixed relative position takes income changes of working generation into full account.

Second, the concept of fixed relative position allows for policy changes such as reductions in transfer payments and tax cuts, as long as k remains constant. On the other hand, the generational accounting of the net present value of payments assumes once-for-all policy changes and a balanced budget in the infinite future. In practice, political pressure increasingly imposes heavy restrictions on annual budget deficits and allows frequent changes in policy stance. The concept of fixed relative position can be used as an alternative to (or a complement of) the generational accounting of the net present value of payments. Note also that fixed relative position is not a discretionary policy but a rule with some intrinsic flexibility.

Third, the policy authority can manage this policy rule of fixed relative position easily because it only needs to pay attention to the relative relationship between old and working generations on an annual basis. In addition, this rule may be politically acceptable as it avoids direct generational conflict as to who bears the fiscal burden of the aging process.

In order to calculate fixed relative position in Japan, we extend this concept over life. The working period is defined as from age 0 to 64 and the old period as age 65 and above. We then calculate disposable income (gross earnings minus net tax burden) of the working period and transfer benefits for the old period. Our fixed life-time relative position is defined as

$$k(1995) = \sum_{t=65}^{99} Bot \,/\, \sum_{t=0}^{64} (Wyt - Tyt) \qquad (5)$$

As Table 9 shows, the fixed life-time relative position in 1995 is 0.699. Suppose the policy stance in 1995 is kept for the future, then the fixed life-time relative position will be high at 0.88 when the aging process approaches its peak in 2045. Note that *Ty* includes taxes other than income tax (e.g. corporate tax) so that the high value of fixed life-time relative position, *k*, does not necessarily imply a very small life-time disposable income.

Table 9 Fixed Life-Time Relative Position: Simulation

Case A

Year	a	b	g	h(1)	h(2)	i(n)
1995	17.0%	Start	0.699	Start	Start	Start
2020	36.7%	16.3% up	0.816	9.6% cut	10.9% up	5.4%
2045	47.7%	23.4% up	0.880	13.3% cut	15.1% up	13.0%
2070	42.8%	21.3% up	0.860	12.2% cut	13.9% up	10.8%

Case B

Year	a	b	g	h(1)	h(2)	i(n)
1995	17.0%	Start	0.699	Start	Start	Start
2020	36.7%	16.3% up	0.816	9.2% cut	10.5% up	52.3%
2045	47.7%	23.4% up	0.880	12.8% cut	14.6% up	72.8%
2070	42.8%	21.3% up	0.860	11.8% cut	13.4% up	66.9%

Notes: (1) Assumed real income growth of 1.5%; discount rate of 5%.
(2) "Up" and "cut" imply percentage changes from the base year, 1995.
(3) Definitions of simulation;
a = ratio of older generation to working generation.
b = an increase in tax from the 1995 level to achieve a balanced budget.
g = value of fixed relative position *k* under b.
h(1) = cut in transfer benefits to maintain *k* (=0.699).
h(2) = increase in tax from the 1995 level under h(1) and constant *k* (=0.699).
i(n) = generational imbalance to maintain *k* (=0.699), where it is defined as life-time net tax of the future generation born in year n divided by that of the 1995 generation.

We have conducted two additional policy simulations: g) an increase in tax and reduction in transfer benefits to achieve a balanced budget every year from now on, and h) a reduction in transfer benefits (h(1)) and an increase in tax (h(2)) in order to

maintain the level of the fixed life-time relative position in 1995 (= 0.699). Table 9 shows that a balanced budget will be achieved and that the fixed life-time relative position will be maintained constant, if transfer benefits are reduced 9-13% and tax is increased by some 10-15%. These policy simulation results appear politically acceptable as they satisfy the political trade off between some transfer benefit reductions (i.e. a cut in the size of the government) and tax increases (i.e. to sustain decent economic policy in an aging society). To put it differently, if the fixed life-time relative position is kept constant at $k = 0.699$, then the generational imbalance[4] would be less than 13% for Case A and 73% for Case B, even at the peak of the aging population.

Nevertheless, some problems remain. First, it is difficult to determine the base year value *k*, the fixed life-time relative position. Second, it may not be politically easy to change policies such as reductions in transfer payments, given an arbitrary value of *k*.

VI. Brief Summary and Conclusion

This study has presented the most comprehensive picture of generational accounting in Japan to date. The main results are summarized as follows:

The base case calculation of the generational imbalance between present and future generations is 69% for Case A and 338% for Case B if the current fiscal policy stance is to be maintained (real income growth of 1.5% and discount rate of 5%). It implies that future generations have to bear 2.7 to 4.4 times as much the fiscal burden as present generations over life. This imbalance is very large by international standards.

For the base case, four basic scenarios and two additional scenarios to resolve such a generational imbalance are considered. As for the four basic scenarios, government purchases have to be cut 26-30%, or all taxes have to be raised about 16%, or income tax has to be increased 54%, or transfer payments must be reduced 25-29%. As for the additional scenarios, both government purchases and transfers have to be reduced 14% ; if all taxes are cut by 50%, then both purchases and transfers have to be

[4] In this exercise, the generational imbalance is defined as life-time net tax of the generation born in year *n* divided by that of the generation born in 1995.

cut by 57%, shrinking government expenditures to one-quarter of the current level.

Another simulation indicates that the generational imbalance occurs not from fiscal debt outstanding *per se* but from change in demographic structure. Indeed, if demographic structure does not change, the generational imbalance falls substantially. This is probably the main implication from the study of generational accounting not only in Japan but also other countries.

Because of the relatively low stock of public capital, the Japanese government has been investing heavily. In flow statistics, the share of government investment in total gross domestic fixed capital formation has been much higher than in other OECD economies. And a portion of present government expenditure is used to accumulate public capital which will benefit future generations without repayment. In this respect, present generation transfers benefit, *via* government, to future generations.

To take this aspect of public capital accruing to future generations, we consider the concept of the fixed life-time relative position. The result shows that balanced budgets will be achieved annually and that the fixed life-time relative position will remain constant, if tax is increased by 10-15% and transfer benefits are reduced by 10-13%. In this case, the generational imbalance remains less than 13% for Case A and 73% for Case B.

Remaining problems and future research:

First, generational accounting in general, and the generational imbalance in particular, are very sensitive to real interest rate and income growth assumptions. It is very difficult to set reasonable assumptions for these parameters over a long period. It may be interesting to estimate alternatively a required real income growth rate to minimize the generational imbalance for a given discount rate.

Second, which is somehow related to the first point, generational accounting is based on a comparative static framework. It would be much more realistic to formulate a dynamic general equilibrium framework in which economic growth and interest rate are determined endogenously, as discussed in Auerbach and Kotlikoff (1987).

Third, the standard framework of generational accounting ignores benefits from government consumption. Suppose a cut in government purchases is made to achieve generational balance, future generations may not enjoy this situation because of reduced benefits from government consumption. The same argument can be applied to government investment and public capital, as has been discussed elsewhere in this study.

Fourth, the demographic projection we use in this study expects a gradual increase in the fertility rate in the mid- 21st century. But, in fact, there is no guarantee

of this happening. If the demographic structure in 2050 remains as it is, the intergenerational imbalance will be larger.

Appendix I Evaluation of Imputed Benefits from Public Capital

There are at least three approaches for evaluating the imputed benefits stemming from public capital inherited from previous (old) generations.

(1) Simple distribution of public capital among current generations

The simplest approach is to estimate the monetary value of public capital. According to our calculation, per capita public capital in 1954 was 99.8 thousand dollars (1993 value) and in 1993 it was 610.4 thousand dollars (1993 value). This significant increase may indicate that intergenerational transfers in the form of public capital are rather huge. This approach, however, has two drawbacks. First, a large portion of public capital inherited from previous generations such as roads, public buildings, and sewerage systems cannot be disposed of by individuals or a generation but simply handed over to future generations. Second, the value of public capital stock may not necessarily correspond to the benefits of current generations.

(2) Evaluation of imputed benefits from public capital

The second drawback we raised in (1) above can be avoided by estimating imputed benefits which can be obtained by multiplying public capital stock by its annual return. However, this approach does not solve how imputed benefits are distributed among generations (for example, through consumption, income, or assets).

(3) Evaluation of public capital in terms of wage rate

This approach evaluates benefits stemming from public capital in terms of labor productivity, i.e. young generations enjoy marginally higher production levels because of inherited public capital from previous (old) generations. This fact must be reflected in the wage rate. Suppose a production function such that,

$$Y = F(G, K, L) \tag{A1}$$

where G is public capital, K is private capital and L is labor input.

Differentiate Y with respect to L and it must be equal to wage rate W.

$$W = \frac{\partial Y}{\partial L} = \frac{\partial F(G, K, L)}{\partial L} = H(G) \tag{A2}$$

Now the wage rate becomes a function of public capital G. The sign condition of G on W is positive. With this approach, we can evaluate the net present value of payments for each generation in comparison with the life-time income of each generation which includes benefits stemming from public capital.

References

Auerbach,A.J. and Kotlikoff,L.J.(1987) *Dynamic Fiscal Policy*, Cambridge: Cambridge University Press.

Auerbach,A.J., Gokhale,J. and Kotlikoff,L.J.(1991) "Generational Accounts: A Meaningful Alternative to Deficit Accounting", *NBER Tax Policy and the Economy*, vol.5, 55-110.

Auerbach,A.J., Gokhale,J. and Kotlikoff,L.J.(1994) "Generational Accounting: A Meaningful Way to Evaluate Fiscal Policy", *Journal of Economic Perspectives*, 8(1),73-94.

Diamond, P.(1996) "Generational Accounts and Generational Balance: An Assessment ", *National Tax Journal*, vol.49(4), 597-607.

Fehr H. and Kotlikoff, L.F.(1995) "Generational Accounting in General Equilibrium", NBER working paper No.5090.

Ishi,H.(1991) *The Japanese Tax System*, Oxford: Oxford University Press.

Ishi,H.(ed) (1996) *White Paper on Structural Reform of Public Finance*, Tokyo: Toyokeizai (in Japanese).

Kotlikoff, L.F.(1992) *Generational Accounting*, New York: The Free Press

Leibfritz,W.(1996) "Generational Accounting: An International Comparison", *Intereconomics*, vol.31, March/April, 55-61.

Musgrave, R.(1981) "A Reappraisal of Social Security Financing", in Skidmore,F.(ed) *Social Security Financing*, Cambridge: The MIT Press

Takayama, N. (1994) "Intergenerational Distribution of Disposable Income" *Keizai Kenkyu* (Economic Studies), 46(1), 1-16 (in Japanese).

Tamura, Y.(ed)(1996) *Public Finance in Japan*, Tokyo: Toyokeizai (in Japanese).