Valuation of Public Capital Stock
Using Productive Effect on Public Capital

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1. Introduction

Since the late 1990s, as sudden increase in government debt and expansion of the fiscal deficit have been addressed as serious issues, administrative and financial reforms have been pursued to improve the government sector's inefficiency. These reforms also involve diminishing public investments. With regard to discussions on the efficiency of public investments in the macroeconomic level, there are numerous studies using productivity effect of public capital. Some researchers believe that public investment after the first oil shock played the role of interregional income redistribution (Higuchi et al., 2003). This indicates an undesirable consequence from the efficiency. Therefore, the portion of public investments in the national economy has significantly decreased recently. More specifically, according to the Annual Report on National Accounts, the ratio of the general government's gross fixed capital formation to GDP posted a sharp decrease, from 6.3% in 1996 to 3.7% in 2005.

The inefficiency of the productivity of public capital signifies that there exists public capital which is either not used at all or, even if used, not used up completely. This does not mean that public capital services have been denied as a factor of production. However, because the contribution of public capital services as a factor of production activities cannot be evaluated in terms of market mechanism, it is difficult to quantitatively assess it.

Meanwhile, public investments can be financed by issuance of government bonds in order to balance between benefits and burdens by giving benefits over a long period of time as public capital. Today, a high outstanding government bonds causes adverse effects on the Japanese economy. However, there is in principle absolutely no problem as long as the values of the public capital are high enough, regardless of the amount of outstanding government bonds. Therefore, the adequacy of the current amount of outstanding government bonds can be examined by evaluating the asset values of the public capital.

The purpose of this paper is to examine the adequacy of the current outstanding government bonds in Japan

by estimating the asset values of the public capital at the end of 2003 using productivity effect of public capital, and by comparing them with the government sector's outstanding government bonds at the end of 2003. This analysis shall not only quantitatively clarify the public capital's contributions to the Japanese economy; it is also expected to become a new valuation method for public investment policies from the perspective of macro economy.

The structure of this paper is as follows. In Section 2, I will examine the model of previous studies on public capital asset valuation. In Section 3, I will present the concept and assumptions regarding the estimation model and valuation method proposed in this paper. Then in Section 4, I will estimate the asset values of the public capital in Japan, that is, the net public capital stock, which is based on the valuation method proposed in the preceding section, and valuate them. Section 5 will present the conclusion and remaining issues.

This paper can draw the following conclusion. The public capital asset values at the end of 2003 were higher than the outstanding government construction bonds. This indicates that there was no problem in terms of the balance between benefits and burdens of the public capital services. Meanwhile, we compared the outstanding government bonds to the public capital asset values at the end of 2003 in order to examine the possibility that burdens are comprehensively transferred to future generations. We showed that the outstanding government bonds were higher than the public capital asset values. This clarifies, all things considered, to be a burden on future generations.

2. Previous Studies Related to Public Capital Asset Values

The economic effect of the public capital brought to light by its productivity effect is often recognized as reflecting a small portion of economic activities. However, the GDP includes not only the economic activities involving the usual market transactions but also the imputed transactions such as the services of owner-occupied housing and in-house production by farmers. Therefore, we can recognize that productivity effect of public capital includes a more extensive range of effects compared to the production activities normally considered.[1]

Also, just like balance sheets and income statements use asset valuation to check management efficiency in business administration, the asset valuation in the government sector is performed, as in the same manner, to examine the efficiency of the government sector management. Indeed, the Ministry of Finance has been releasing the "National Balance Sheet" since 2000. Akai et al. (2002) have also prepared balance sheets targeting not only the central government but the overall government sector. Furthermore, public companies that receive fiscal investment and loans must now publicly release their policy cost analysis, thus they are disclosing the present discounted value of the total amount of subsidies that will be put into public companies in the future, in other words, the amount of net liabilities. Additionally, even in Japan's System of National Accounts (SNA), consumption of fixed capital regarding public capital is now taken into consideration due to a shift to 93SNA. According to the definition of SNA, the consumption of fixed capital reflects not only physical consumption but also diminution in value, and is thus an important indicator when measuring net capital stock. Today, because the method of estimation of the SNA in Japan has shifted to 93SNA, the public capital's consumption of fixed capital is included in the GDP and estimation of the net capital stock is in

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[1] If the range of production activities were extended to the range defined by Hill criterion, which is also called the outsider criterion, most economic activities would be regarded as activities yielding value added, and then the productivity effect of public capital would include the effect of most economic activities. Furthermore, there is some case where the classification of some goods and service would be changed: the goods and services regarded as consumption, for example, would change to those regarded as investment.

principle easy. Furthermore, in the Director General for Policy Planning, Cabinet Office Edition (2007), not only the gross public capital stock but also the net concept have been provisionally calculated and further progress is anticipated.

However, these public capital asset valuations are not sufficient by themselves. In the National Balance Sheet of the Ministry of Finance, the public capital includes only assets available for sale. Akai et al. (2001) performed asset valuations based on historical costs. In fact, the reason why pricing has not been set can be explained as follows: Because a major part of public capital services are defined as public property, issues arise such as technical difficulties in charging fees and costs to add users are significantly low, thus it is more efficient to provide the services free of charge. Therefore, deciding whether to include asset values according to marketability is believed to cause many problems. In addition, the Director General for Policy Planning, Cabinet Office Edition (2007) uses a direct method whereby estimated figure of the consumption of fixed capital is excluded, for public capital asset valuation (net capital stock). However, as the consumption of fixed capital remains at this stage a simple estimate, it is anticipated to be improved in the future as a result of further studies regarding public capital asset valuation.

Asako and Noguchi (2002) have evaluated the value of public capital assets, which had caused problems in the preparation of financial statements in the government sector, by Tobin's q theory. Asako and Noguchi (2002) used the productivity effect of public capital to compute the Tobin's q, and assets were valued using an approach similar to the one analyzed in this paper. It has shown that there were values that exceeded the replacement cost. This can be considered an original study in the sense that it uses productivity effect of public capital to valuate the public capital's contribution as an asset value.

This paper estimates the public capital's asset values from productivity effect of public capital like Asako and Noguchi (2002) and evaluates them by comparing them with the outstanding government bonds. As compared with the study by Asako and Noguchi (2002), this paper is characterized by the fact that it processed data as consistent as possible with the SNA, and evaluated them through comparison with the outstanding government bonds. In particular, with regard to the former, certain adjustments were made in this paper such as adding housing capital to which the imputation procedure was applied to private capital in the SNA. For the method of data creation, please see the addendum.

3. Estimation Model for Asset Valuation of Public Capital

This section will provide a specific explanation on the method used for the asset valuation of public capital. First, I will present the production function assumptions required to estimate the productivity effect of public capital used in the asset valuation. Then I will describe the estimation method of the capital utilization rate and the asset valuation method from marginal productivity.

3.1. Production Function Assumptions in the Asset Valuation of Public Capital

Here I will study the relationship between the production function required to estimate the productivity effect of public capital and factor payments in terms of returns to scale of the production function.

When analyzing the productivity effect of public capital, the extent of returns to scale is sometimes discussed. However, when the presence of productivity effect of public capital is evaluated, the extent of returns to scale

is not in itself emphasized. For example, Yoshino and Nakajima ed. (1999) performed simultaneous estimation of the translog production function and the share function only to stabilize the estimates of the production functions' parameters. Of the factors of production, value added was assumed in their study to be completely distributed to capital and labor, and that it presented increasing returns to scale with respect to all factors of production including the public capital. This was the result of various estimations and of having chosen something for which the estimates of the coefficient parameters were believed to be appropriate both statistically and based on economic theories, but the significance of this result has not been studied.

Suppose that the technical condition on production is increasing return to scale with respect to all factors of production, and that the income distribution bases on marginal productivity under the market mechanism, as is known in the context of market failure, a producer who selects optimal factor inputs to conduct production activities to ensure profit maximization will fall into the red, and will prevent production activities from being performed. Furthermore, if compensation for public capital is not paid despite there being contribution to public capital under increasing returns to scale, it means that such compensation is included in private capital or labor. Of course, factors such as cost reduction due to sharing of information or business could lead to increasing returns to scale. However, compensation for public capital services is in principle collectable when technical conditions are met. Further, if it is indeed collected, even if public capital services have the nature of public goods, such compensation becoming increasing returns to scale through cost reduction is rather inconceivable in a national level. Therefore, unlike the results obtained in many of the previous studies, this paper will assume constant returns to scale with respect to factors of production that include public capital.

Next, I will examine whether the public capital contribution is included in private capital or in labor. Asako and Noguchi (2002) opted for constant returns to scale, and based on the income distribution from coefficient parameters estimated theoretically their study suggests that public capital contribution is included in labor income. This can be interpreted that the benefits of public capital are capitalized into wage rates because from a national perspective, the labor force population is fixed.[2]

Due to the above, I assume in this paper that the production function is characterized by constant returns to scale for factors of production that include public capital, while public capital is assumed to be included in part of labor distribution.

3.2. Estimation of Capital Utilization Rate

If public capital services are used as one of the factors of production, the value of services from unused public capital is zero. Particularly in the early 1990's when the bubble economy burst, public capital development may have been inefficient because an aggressive fiscal policy consisting mainly of public investments was carried out as an economic measure. With such reasons, the utilization rate of public capital is introduced in order to differentiate the public capital used as public capital services and the unused public capital.

Studies that have explicitly discussed the utilization rate of public capital are presented by Takahashi (1996) and Hayashi (2004). Takahashi (1996) assumes that the utilization rate of public capital stock is identical to that of the private capital stock. However, this does not mean the relationship between utilization and stock is the same as that for

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[2] In present days when international relations become close, labor is considered more variable in cost compared with land even from national perspective. In such situation, benefits of public capital may not be completely included in labor.

private capital stock, and there is no validity of using an identical relationship. In particular, if the aspect of income redistributing effects of public investments after the first oil shock is to be stressed, the variations of the private capital stock and of the public capital stock are not necessarily identical, and the public capital utilization rate may in the end be different. In addition, the public investment policies after the 1990's have increased the public capital accumulation rapidly. Therefore, rates of private capital utilization and public capital utilization cannot be considered identical. Hayashi (2004) estimated the road capital utilization rate using indexes reflecting the extent of road utilization. Although the proxy for the use of roads is clear, in terms of public capital in general, considering indexes reflecting such use is difficult.

Under such constraints, the public capital utilization rate is estimated using the capital coefficient, the ratio of capital to production, used in the estimation method of the private capital utilization rate. More specifically, I assumed that the long-run changes in capital coefficient become linear over time.

$$\left[\frac{Kg}{Y}\right]_t = \emptyset_0 + \emptyset_1 t + u_t \tag{1}$$

, where u_t represents the error term. In addition, during the sample periods used in the estimation, when the value of capital coefficient is relatively low, it means that a utilization rate is relatively high. Therefore I determine the years when capital stock was 100% utilized, and the long-run changes in capital coefficient are estimated by only the values of those years.[3] I assumed that the years when private capital stock was 100% utilized were 1980, 1988, 1989 and 1990, and the years when public capital stock was 100% utilized were 1980 and 1991. After obtaining the result of equation (1) using the 100% utilization data, if the capital coefficient estimate of period t is $(Kg/Y)_t^*$ and the actual capital coefficient is $(Kg/Y)_t$, the public capital utilization rate $cu_{G,t}$ can be estimated using the following equation.

$$cu_{G,t} = \frac{(Kg/Y)_t^*}{(Kg/Y)_t}\left[=\frac{Kg^*}{Kg}\right] \tag{2}$$

Figure 1 shows the estimates of the utilization rate. Around the collapse of bubble economy in the early 1990's, there is a slight gap in the changes of the utilization rate. This is due to the fact that the years where capital stock was assumed to be 100% utilized are different between private capital and public capital.

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[3] The 100% utilization defined in this paper does not necessarily indicate that capital stock is really 100% utilized. This shows that merely relative degree of utilization is higher than the other years in the sample period. However, when the absolute degree of the utilization rate is low even if relative degree of utilization is high, marginal productivity of public capital will be evaluated as being lower. From this, the evaluation of relative utilization is all needed.

Figure 1. Utilization Rate of Private Capital and Public Capital

Utilization rate (100% = 1)
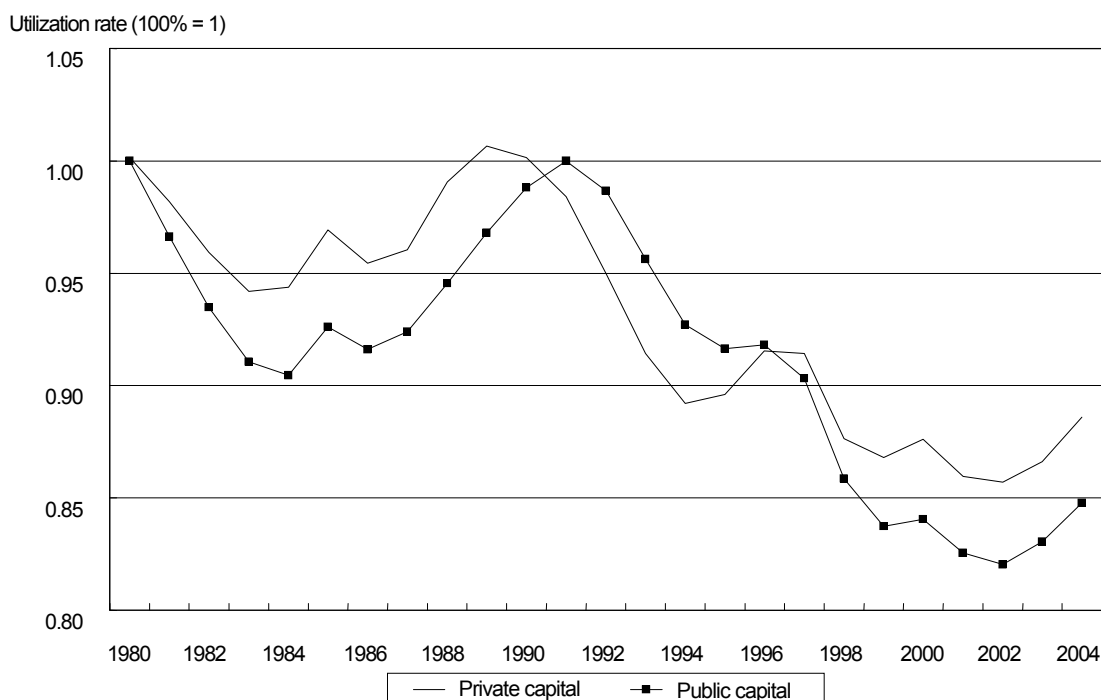
3.3. Asset Valuation Method Using Marginal Productivity

Normally, gross value added generated from private capital stock, as contribution of private capital, results in consumption of fixed capital representing capital depreciation and distribution to economic entities that provided capital. Thus including the fixed capital consumption on public capital is more preferable than estimation based on 68SNA (new SNA) in terms of consistency with the capital stock (capital services) of gross value added.

The asset values of capital are believed to be theoretically determined mainly from the following three factors: (1) the production volume generated from the existing capital and the production price, (2) the expected lifetime during which the existing capital contributes to production activities, and (3) the discount rate when assessing the current value. Additionally, (2) varies depending on whether contribution is considered constant or it decreases during the expected lifetime. Furthermore, in addition to the above classification, there is a need for classification whether the information for the estimation of the asset value is collectable at the time of assessment. Of the above three factors, the only information that can be collected at the time of assessment is the production volume generated from the existing capital. The rest depends entirely on prediction. In other words, most of the factors that determine asset values have no choice but to be based on prediction of the future, which can greatly affect the outcome.

Thus this paper does not make assumptions for every predicted value of the factors determining the asset values; instead, the asset values of public capital is estimated by multiplying the value added generated from public capital by the ratio of the amount of private capital stock to the value added generated from private capital.

Of course, considering the asset values of private capital and those of public capital with identical ratios is not particularly desirable. The reason for this is that, among the factors that determine the asset values of public capital, expected life and discount rates other than the product prices are believed to be different if the types of assets are different. For example, expected life can be considered on average to be longer for public capital, and the discount rate

in the assessment of public capital may be lower than that of private capital if we also consider the differences in risks taken in the private and public sectors. However, it is far more difficult than one might imagine to determine how different the expected lives are between the different types of capital and to numerically express how low the discount rates are.

Therefore, because making detailed assumptions of the predicted values of the factors determining the entire asset values would be ridiculously time-consuming, this paper estimates the public capital asset values with the assumption that the asset value ratio to the value added of private capital can also be applied to public capital.

4. Estimation of the Public Capital Asset Values

4.1 Estimation of the Productivity Effect of Public Capital

This paper assumes constant returns to scales with respect to all factor inputs including public capital, and the contribution of public capital is assumed to be included in the value of labor input when viewed from a national perspective. In addition, it assumes the Cobb-Douglas production function, that income is completely allocated to private capital and labor input, and that distribution to labor includes contribution of public capital.

First, with regard to the Cobb-Douglas production function, if the production of period t is Y_t, labor input is L_t, the private capital stock at the beginning of period t is Kp_t, and public capital stock is Kg_t, the following equation applies:

$$\ln Y_t = \alpha_0 + \alpha_K \ln Kp_t + \alpha_L \ln L_t + \alpha_G \ln Kg_t \tag{3}$$

Here, constant returns to scale with respect to all factors of production could be represented as follows:

$$\alpha_K + \alpha_L + \alpha_G = 1 \tag{4}$$

In order to differentiate contribution to labor between contribution of public capital and that of labor input, capital share is calculated based on the Annual Report on National Accounts, which is excluded in advance.[4] Here, if the capital share during period t is $\tilde{\alpha}_{K,t}$, equation (4) would be as follows:

$$\alpha_L + \alpha_G = 1 - \tilde{\alpha}_{K,t} \tag{5}$$

Also, because the capital share $\tilde{\alpha}_{K,t}$ is previously given, if we pay attention to the fact that the right hand side of equation (5) is a numerical value, we can remove α_L from equation (5). Thus the actual estimation model becomes as follows:

$$\ln Y_t - \ln L_t - \tilde{\alpha}_{K,t}(\ln Kp_t - \ln L_t) = \alpha_0 + \alpha_G(\ln Kg_t - \ln L_t) + \varepsilon_t \tag{6}$$

Table 1 shows the results obtained from equation (6). According to these estimation results, the coefficient of public capital is estimated to be 0.255, showing that this is significantly positive. The estimated values are higher than those obtained in the numerous preceding studies. That is because this analysis included the public capital utilization rate, which was not expressly dealt with in the preceding studies.

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[4] Regarding practical calculation, see the Addendum.

Table 1. Estimation Results of the Productivity Effect of Public Capital

Coefficient	Estimate	*t* value
α_0	- 1.600	- 23.214
α_G	0.255	13.719

(Estimation period: Between 1980 and 2003)

$$\overline{R}^2 = 0.886, \ D.W. = 0.366$$

4.2. Estimation of the Public Capital Asset Values

Now I estimate the public capital asset values, using the estimation results of equation (6). In this paper, as mentioned earlier, I obtained the asset values of public capital by multiplying the value added of public capital by the ratio of the amount of private capital stock to the value added generated from private capital.

The parameter of the above-mentioned Cobb-Douglass production function is the extent of contribution to each factor of production, that is, the factor share. Therefore, if the estimate of parameter α_G obtained from equation (6) is $\widehat{\alpha}_G$, the contribution from the generated value added of private capital, labor input and public capital can be assumed to be $\widetilde{\alpha}_{K,t}Y_t$, $(1-\widetilde{\alpha}_{K,t}-\widehat{\alpha}_G)Y_t$ and $\widehat{\alpha}_G Y_t$, respectively. Perhaps we can say that the asset values generated from the amount of capital stock that existed at the beginning of the period was obtained by multiplication based on the observed values of value added achieved by investing the capital stock at the end of the preceding period.

Therefore, $V_{G,t}$, which is the public capital asset values at the beginning of period t, can be estimated by multiplying the ratio of the value added generated from private capital $(\widetilde{\alpha}_K Y_t)$ to the asset value of private capital $(V_{K,t})$ by the value added generated using the public capital existing at the beginning of term t $(\widehat{\alpha}_G Y_t)$:

$$V_{G,t} = \frac{V_{K,t}}{\widetilde{\alpha}_{K,t}Y_t} \times \widehat{\alpha}_G Y_t \tag{7}$$

Now I estimate the asset values at the end of 2003. More specifically, the gross capital stock at the end of 2003 is obtained using equation (7), based on the assumption that I am obtaining the productive value added of 2004, that is, the total for industries covered in the GDP by kind of activity.[5]

First, the value added generated from the gross private capital stock, from the gross public capital stock at the end of 2003, and from the actual labor input for 2004 are estimated in nominal terms. The labor share was about 0.333, which derives from the private capital share being about 0.412 and the public capital share calculated using the model of equation (7) being about 0.255. In addition, the total for "industries" in the GDP by kind of activity for 2004 was about 460.3 trillion yen. As a result, in 2004, the contributions by the private capital, the labor, and the public capital were about 189.7 trillion yen, 153.4 trillion yen, and 117.1 trillion yen, respectively.

Next, the ratio of the value of the private capital to the value added from the private capital is calculated using the private capital share from the total for "industries" in the GDP by kind of activity for 2004 and the value of private capital at the end of 2003. The asset value of private capital is 781.8 trillion yen, obtained by adding the fixed assets of the periodic balance sheet account of each institutional sector excluding general government and non-profit

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[5] This assumption indicates that the value added of 2004 is known in the end of 2003. Therefore, this assumption is not desirable in the strict sense.

organizations. As a result, the ratio was about 4.121 fold.

From there, the asset value of public capital estimated using the ratio of the asset value of private capital to the value added generated from the private capital was about 491.9 trillion yen. Incidentally, this estimate shows it is much larger compared to the asset value of general government listed in the periodic balance sheet account of the Annual Report on National Accounts at the end of 2003, which amounts for 324.1 trillion yen.

4.3. Assessment of Outstanding Government Bonds from the Perspective of Asset Values of the Public Capital

Finally, I will assess the adequacy of the amount of outstanding government bonds from the perspective of debt-asset balance, based on the estimated asset values of public capital.

First, I will compare the outstanding government construction bonds and public capital asset values. Public investments offer benefits over the long term as capital services. In terms of beneficiary liability, burdens at a specific point in time in exchange for long-term benefits are not desirable, and thereby financing with government bonds becomes justified. If the asset value of public capital is higher than the outstanding government construction bonds, the outstanding government bonds would by no means be a problem even if there is financing with government bonds.

Here, I compare between the outstanding government construction bonds and public capital asset values at the end of 2003. The reason why the comparison is restricted to the outstanding government construction bonds is because the capital stock of public companies is not included in the public capital in this paper. The outstanding government construction bond at the end of 2003 was 288.1 trillion yen. More specifically, central government construction bonds was 226.4 trillion yen, and local government construction bonds was 61.7 trillion yen, which is the total of bonds including bonds for municipal public works without state subsidy, compulsory education facilities improvement bonds, bonds for municipal public works with state subsidy, and public welfare facilities improvement bonds which is a part of the 134.1 trillion yen of the outstanding local government bonds. Compared to the previously estimated public capital asset values of 491.9 trillion yen, this shows excess assets. In terms of the balance between benefits and burdens of the public capital, we can see that there is no problem with the outstanding government construction bonds at the end of 2003.[6]

Next, the outstanding government bond including special government bonds is compared with the public capital asset values. This is a comparison between liabilities and assets in terms of the government's real assets, allowing us to see whether burdens will be shifted to future generations. Regardless of what the purpose of financing through the issuance of government bonds, if the benefits of public capital which future generations will receive can offset the current outstanding government bonds, this would mean that all things considered, future generations will be receiving benefits and that burdens will not be shifted to them.

Here as well, the outstanding liabilities of the general government and the public capital asset values at the end of 2003 are compared. The outstanding liabilities of the general government are considered without fiscal loan fund special account bonds, which are debts of public companies. The total amount of outstanding liability is about 620.0 trillion yen: More specifically, these refer to the 457.0 trillion yen of ordinary central government bonds, 5.6 trillion yen of special tax reduction bonds, 15.9 trillion yen of refunding government bonds converted from the debts of Japanese

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[6] It is greater than the value of fixed assets of general government in the Annual Report on National Accounts.

National Railways Settlement Corporation, 2.8 trillion yen of refunding government bonds converted from the debts of National Forest Service, 0.5 trillion yen of refunding government bonds converted from the central government debt in the account for local allocation tax grants, and 138.1 trillion yen of outstanding local government bonds. This exceeds the public capital asset value of 491.9 trillion yen. This estimated result suggests that, despite the existence of value generated from public capital, it cannot compensate for the outstanding liabilities, and therefore burdens will be transferred to future generations.

5. Conclusion

In a situation where government debts are believed to have reached a critical level, I estimated public capital asset values using the productivity effect of public capital, and evaluated the validity of these government debts. I compared the public capital asset values to the outstanding government construction bonds, and it showed that the public capital asset values at the end of 2003 exceeded the outstanding government construction bonds. Therefore, there was no problem in terms of the balance between benefits and burdens of the public capital services. However, when I examined the possibility of overall transfer of burdens to future generations beyond the balance between benefits and burdens of public capital alone, the current outstanding of government bonds is higher than the value generated from public capital, which showed that burdens would indeed be shifted to future generations.

Remaining issues are as follows. The first issue consists of refining data, allowing for more reliable estimates. The second issue involves the extent of returns to scale that include public capital in the production function. The results of previous studies on the productivity effect of public capital are different from the assumptions in this paper. Particularly in terms of asset valuation, this paper assumed constant returns to scale including public capital, but the results of statistical analyses in preceding studies refer to increasing returns to scale. Although the relationship with the extent of returns to scale is believed to be an important analytical issue from the perspective of asset valuation of public capital, I was not able to study sufficiently this aspect in depth in this paper.

Addendum

A. Data Generation Method

Here is a brief explanation on the data's estimation method.

A.1 Public Capital Stock and Private Capital Stock

Because the range of production activities in this paper consists of industries listed in the classification of economic activities of the System of National Accounts (SNA), changes were made to the classification of public capital stock and private capital stock in order to conform to the SNA.

The private capital stock was based on the "Statistics on Capital Stock in Private Enterprises" of the Economic and Public Research Institute (ESRI) of the Cabinet Office. The stock series became discontinuous following the privatization of companies such as each of the JR group companies, Electric Power Development, JT,

and NTT. Therefore, this paper used the figures of the "Statistics on Capital Stock in Private Enterprises" added following privatization as a benchmark, to which I added the amended estimated figures of the Director General for Policy Planning, Cabinet Office Edition (2007)[7]. In addition, regarding housing subject to imputation in the SNA (private housing and public rental housing in this paper's estimated figures), the estimated figures of the Director General for Policy Planning, Cabinet Office Edition (2007) have directly been added to private capital stock.

Many of the public companies belong to "industries" in the classification of economic activities. Hence from the sector-based estimations of the Director General for Policy Planning, Cabinet Office Edition (2007), toll roads were added to private capital after classifying roads into toll roads and general roads. Moreover, water works, national forests, and industrial water works were added to private capital stock. All the rest was considered to be public capital.

A.2 Other Data

I used value added obtained by excluding "taxes (deduction) and subsidies on production and imports", which are the adjustment portion of indirect taxes and subsidies, from the "industries" in the GDP by kind of activity of the Annual Report on National Accounts[8]. Real value added was estimated by dividing the nominal value added by the GDP deflator in the fixed-base year method. That is because the private and public capital used the fixed-base year method with the year 2000 as the base period from the Statistics on Capital Stock in Private Enterprises and by the Director General for Policy Planning, Cabinet Office Edition (2007).

By assuming complete allocation of capital and labor, capital share can be estimated with the labor share. The labor share derived from the ratio of the worker's income estimated from the employer's compensation to the value added computed in this paper. However, there were possible major gaps in labor costs due to differences in employment position especially in the agriculture, forestry and fisheries industry. Therefore, when I estimated the income of workers in the agriculture, forestry and fisheries industry, I must take the differences in compensation per unit between employer and persons other than the employer (self-employed, family workers) into account. More specifically, I referred to the Labor Force Survey of the Statistics Bureau of the Ministry of Internal Affairs and Communications, the Economic Calculation on Agricultural and Food-Related Industries of the Ministry of Agriculture, Forestry and Fisheries, and Annual Report on National Accounts. For other industries, I have computed the estimates under the assumption that there were no differences in compensation per unit attributed to employment position.

Labor input was obtained by multiplying the number of employed workers by the working hours. For the number of employed workers, the figures in Annual Report on National Accounts were used. Meanwhile, with regard to the number of working hours, under normal circumstances, the data listed in the Annual Report on National Accounts are used. However, in the number of working hours there were conceptual differences between the 2003 and 2005 versions. Therefore, the author's own estimates based on the Labor Force Survey were used for the agriculture, forestry and fisheries industry, the service industry, and the electricity, gas, heat and water supply industry.

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[7] The amount of the capital stock of Japan Tobacco Inc. is estimated by author.
[8] To grasp value added of producer from the viewpoint of costs which the producer faces, the value added used in this paper is adjusted by taxes and subsidies on production/imports.

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