

Public Capital Stocks for Improving Farmland Quality in Japan: Comparison Between the Less-Favored Area and the Flat-Farming Area

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Key words: Public capital stocks, Private capital stocks, Irrigation and drainage capital, Farmland consolidation capital, Agricultural machinery

SUMMARY

The capital stocks, including public and private capital stocks, play an important role in agriculture for complementing decreased labor and dissolving per-capita income gaps between agriculture and manufacture. However, there were few previous studies with consideration of public capital stocks, because no data on agricultural public capital stocks were available for econometric analysis. This study aims to estimate chronological private and public capital stocks and to explain chronological changes of farmland quality. The public capital stocks are classified as irrigation and drainage capital for paddy fields or for dry fields, farmland consolidated capital for paddy-fields or dry fields, agricultural road capital and farm village life base capital. Also, the public capital stocks were estimated by each town, 3247 towns, from 1982 to 2004. Results demonstrate that there were great difference in the chronological and regional tendency of the private capital stocks as well as the public one, and such tendency was greatly different even in the public capital stocks by kinds. Second, the agricultural public capital stocks are recently accumulated in the flat farming areas where most of the farmland exists. However, public capital stocks were rapidly consolidated in the hilly and mountainous areas. Third, the public capital stocks, such as farmland consolidated capital for paddy-fields and dry-fields.

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1. INTRODUCTION

Agricultural development has heavily depended on improvement in the labor productivity caused by the large-scale mechanization. At the early stage of development, agriculture was labor intensive with using an excess labor in the society, but after development, capital stocks play an important role in agriculture for complementing decreased labor and dissolving per-capita income gaps between agriculture and manufacture.

Generally, capital stocks consist of two kinds. One is a private capital such as agricultural machinery and buildings, and another is a public capital such as irrigation and drainage facilities, farmland consolidated facilities, and agricultural roads. The irrigation and drainage facilities provide irrigation water and drain excess water from farmland. Farmland consolidation is conducted by enlarging and formulating each plot of farmland with constructing small irrigation and drainage canals and farm roads. Agricultural roads are constructed for improving access conditions of agricultural products to the market. Irrigation and drainage capital stocks have the character of the club goods with non-exclusion feature, although a non-rivalry is poor. On the other hand, farmland consolidation capital stocks can directly stimulate the farmland quality via the shape of each farmland parcel and small canals. Therefore, these capital stocks have non-exclusion and the non-rivalry features and are relatively similar to the private capital stocks.

In other words, these public capital stocks can improve farmland quality by improving agricultural productivity. Therefore, how farmland maintenance can be sustainable depends on the chronological tendency of private capital formation as well as public capital formation.

Previous studies analyzed effects of private capital stocks by estimating production functions in Japanese agriculture (Godo, 1993; Ito, 1993). However, there were few previous studies with consideration of public capital stocks, except for Nakashima (1989). One of the reasons was less availability of data on agricultural public capital stocks for econometric analysis. Especially, agricultural public capital stocks have different effects on production by kinds, but no statistical data were published about public capital stocks in each region and each kind.

In 1990's, Economic and Social Research Institute (ESRI) of the cabinet office in Japan published the data on public capital stocks (ESRI, 2007). In this publication, whole public capital stocks in the agricultural sector appeared with chronological values, but there were no detail capital stock data classified as above.

This study aims to estimate chronological private and public capital stocks and to explain chronological changes of farmland quality. The public capital stocks are classified as "irrigation and drainage capital for paddy fields (IDC-PF)," "irrigation and drainage capital for dry fields (IDC-DF)," "farmland consolidated capital for paddy-fields (FCC-PF)," "farmland consolidated capital for dry fields (FCC-DF)," "agricultural road capital (ARC)," and "farm village life base capital (FVLBC)." Also, the public capital stocks were estimated by each town, 3247 towns, from 1982 to 2004.

2. METHOD

2.1 Previous studies

The ESRI (2007) and Central Research Institute of Electric Power Industries (CRIEPI, Hamagata and Hitomi, 2009) estimated and published the chronological data on public capital stocks. These institutes used the perpetual inventory method for estimation of public capital stocks in whole Japan, and then used the bench mark year method for prefectural capital stocks. The equations used here were as follows.

(Public capital stocks in whole country)

$$KG(t) = \sum_{i=t-N}^t IG(t) \quad (1).$$

(Public capital stocks by prefectures)

$$KG(p, t) = KG(p, 1940) + \sum_{i=1941}^t IG(t) - \sum_{i=1941}^t D(t) \quad (2).$$

Here, p and t show prefecture and year respectively. KG is public capital, IG is public investment, and D is depreciation value of the capital stocks. The year, 1940, is the benchmark year and N is the comprehensive life span for the capital stocks.

The difference between estimations of two institutes exists in $IG(p, t)$ in eq. (2). The IG of the ESRI included the land costs and the IG of the CRIEPI excluded it. Also, the ESRI estimated capital stocks classified as agricultural base, forestry base and fishery base, but the CRIEPI estimated for the total of these sectors.

Both estimations calculated the shares of prefectural capital in eq. (2) and then modified the prefectural capital stocks by multiplying these shares to the capital stocks of whole country. Since agricultural public investment includes little land costs and the portions of forestry and fishery are not so big, the chronological tendencies of these two estimations were almost the same in the case of the agricultural sector.

2.2 Estimations of the agricultural public capital stocks by kinds and by prefectures

After considering detail classifications, this study used the estimations of the ESRI and estimated the agricultural public capital stocks by kinds and by prefectures as follows.

(Public capital stocks at the starting year)

$$K(p, k, t_0) = K(p, t_0) * S_TG(p, k, t_0) \quad (3).$$

(Public capital stocks at the year t)

$$KG(p, k, t) = KG(p, t-1) + \{KG(p, t) - KG(p, t-1)\} * S_G(p, k, t) \quad (4).$$

Here, p shows prefecture and k shows kinds of capital stocks such as "irrigation and drainage capital for paddy fields (IDC-PF)," "irrigation and drainage capital for dry fields (IDC-DF)," "farmland consolidated capital for paddy-fields (FCC-PF)," "farmland consolidated capital for dry fields (FCC-DF)," "agricultural road capital (ARC)," and "farm village life base capital (FVLBC)." t_0 is the starting year, 1977, for the calculation. $KG(p, t)$ is the whole capital stocks of agriculture in the p -th prefecture at year t , published by ESRI. $KG(p, k, t)$ is the capital stocks of the k -th kind in the p -th prefecture at year t .

$S_G(p, k, t)$ is the share of the k -th G among the total, and $S_TG(p, k, t)$ is the share of the k -th TG among the total, calculated by;

$$S_TG(p, k, t_0) = TG(p, k, t_0) / \sum_{k=1}^K TG(p, k, t_0) \quad (5).$$

$$S_G(p, k, t) = G(p, k, t) / \sum_{k=1}^K G(p, k, t) \quad (6).$$

Here, G and TG are respectively the annual expenditure and the total real expenditure of the public projects at year 2000\.

2.3 Estimations of the agricultural public capital stocks by kinds and by towns

Agricultural capital stocks by kinds and by towns were estimated from the expenditure of each project mentioned by each town. Such statistics were available since 1983, so the estimations of capital stocks were limited from 1983 to 2004. The k -th capital stock at the c -th town in year t is;

$$KG(k, c, t) = KG(k, c, t-1) + [KG(k, p_0, t) - KG(k, p_0, t-1)] \times \frac{G(k, c, t)}{G(k, p_0, t)} \quad (7).$$

Here, c and p_0 respectively show towns and each prefecture where the noticed town is located. KG and G are the capital stocks and expenditure of the public project, respectively.

The initial value in the above equation as 1982 is estimated by using the unit price of KG in each prefecture where the noticed towns are located. That is;

$$KG(k, c, 1982) = A(k, c, 1982) \times PG(k, p, 1982) \text{ and,} \\ PG(k, p, 1982) = KG(k, p, 1982) / A(k, p, 1982) \quad (7).$$

Here, $KG(k, c, 1982)$ shows the k -th capital stocks at the c -th town in 1982. PG is the unit price of construction for KG , and A is the beneficial areas of KG .

2.4 Statistical Data

The values of $KG(p, t)$ in eqs. (3) and (4) were mentioned in the book of ESRI (2007) until 2003, and the value in 2004 was estimated by using investment values in 2004 according to the estimation method used in this book. The annual expenditure of the public projects by kinds, $G(p, k, t)$, was gotten from the "Statistics on Farmland Consolidation Projects," (Ministry of Agriculture, Forestry and Fishery; MAFF).

In terms of beneficial areas in eq. (7), A, the following data were used. First, the beneficial areas of ID-PF and IDC-DF, respectively, adopted the paddy-field areas and dry-field areas equipped with the final irrigation facilities, and these statistics were in "The report of the Basic Survey about the Consolidated Farmland," (MAFF). The beneficial areas of the FCC-PF and FCC-DF were also on the same statistics. There were no data on ARC and FVLBC, so the share rates of expenditure for the public projects in each town among prefectural total in 1983 was used as the initial value in eq. (7).

3. ESTIMATION RESULTS

3.1 Changes in the agricultural public capital stocks by kinds

Figure 1 shows chronological trend of each public capital. The FCC-PF stocks were the biggest and then IDC-PF stocks were the second. Hence, the capital stocks concerned with paddy fields accounted for the large portion of the agricultural public capital stocks. However, these capital stocks show the decreasing trend whereas the FVLBC stocks were on the increasing trend.

If the public capital stocks and private capital stocks are compared, the growth rate of the private one is much lower than the public one, showing the farmland quality depends more on the public capital stocks in recent years.

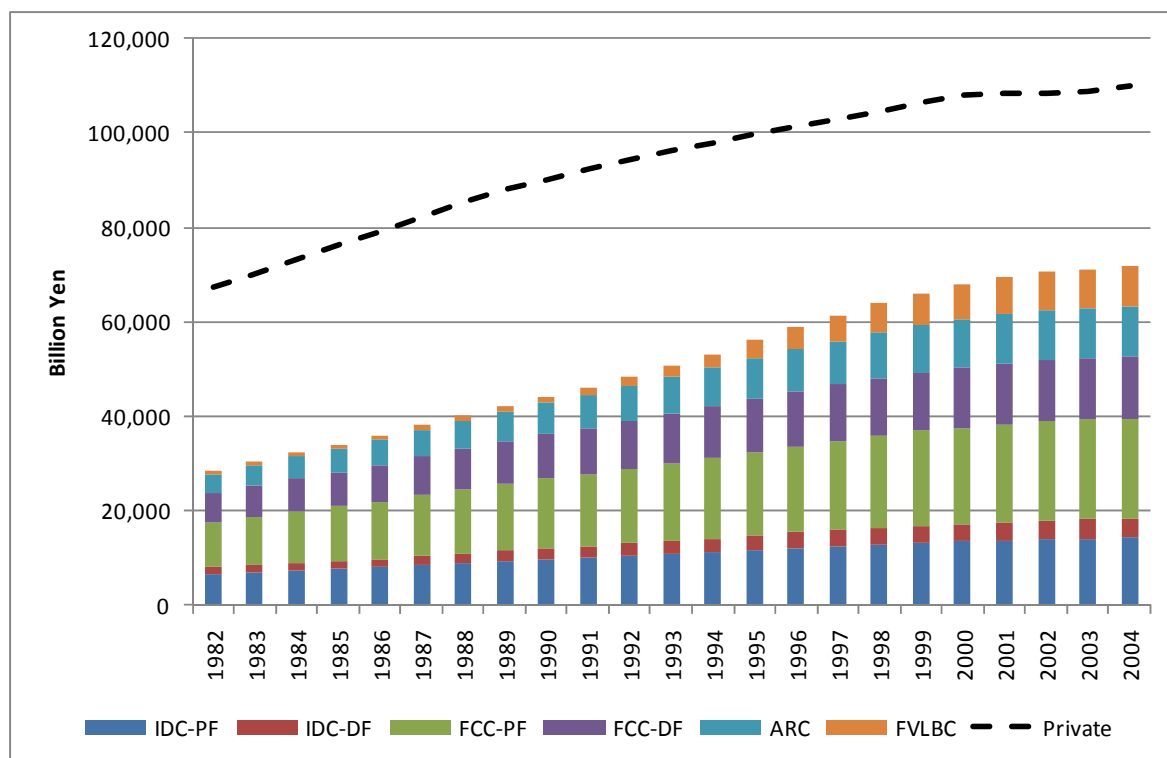


Fig. 1 Changes in the agricultural capital stocks by kinds

Figure 2 is the comparison of the public capital stocks by kinds and by prefectures. Hokkaido, where agricultural production is the highest in Japan, marked the highest level among prefectures. Then, Niigata, Aomori, Akita, Iwate, Miyagi, Yamagata, Fukushima, Aichi and Kagoshima prefecture followed. Rice production is prosperous in these prefectures except for Kagoshima, so public capital stocks for paddy-fields account for the great portion in these prefectures and also in whole Japan.

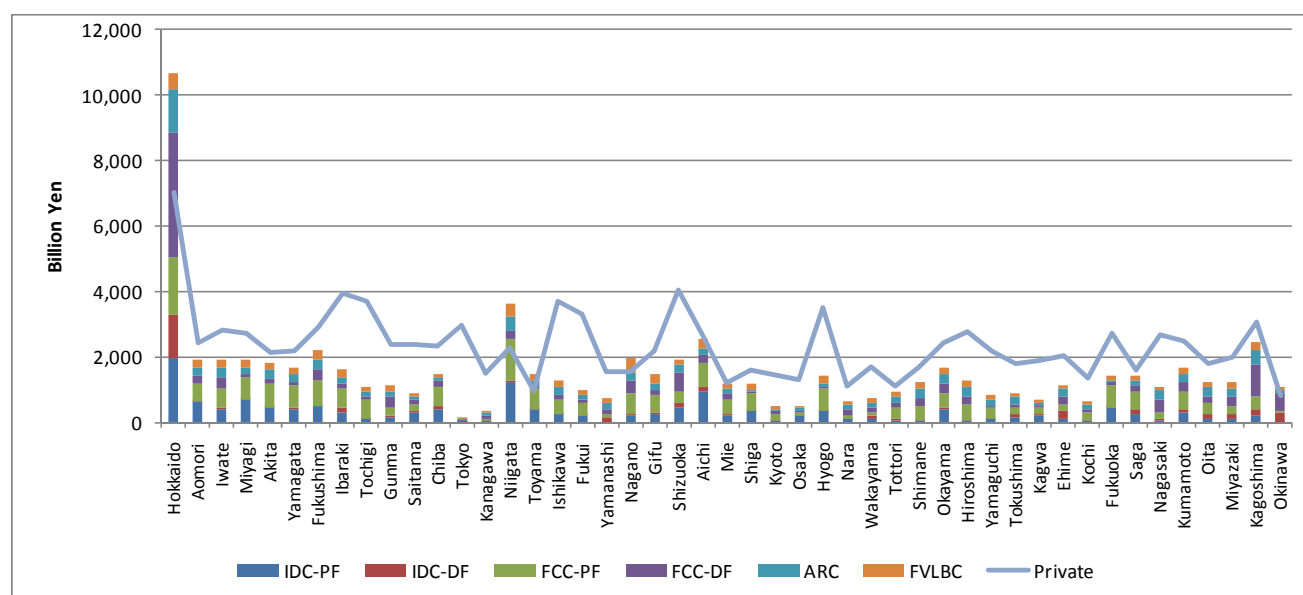


Fig. 2 The comparison of the public capital stocks by kinds and by prefectures

3.2 The public capital stocks by the geographical classification

Table 1 shows the agricultural public capital stocks of the unit areas by the geographical classification. The geographical classification was consisted by "Sub-urban areas," "Flat farming areas," "Hilly areas," and "Mountainous areas," which were classified by the Agricultural census of MAFF. This table shows following features.

First, the agricultural public capital stocks of the unit area were the highest in all the kinds in the flat farming areas where most paddy-fields exist. This regional tendency was along with the aim of the agricultural public capital with being carried out to promote an agricultural production.

Second, the amount of public capital stocks in hilly and mountainous areas was relatively low. However, as for public capital stocks relating to dry fields, the difference in capital stocks between hilly and mountainous areas and flat farming areas was not so large as compared to the capital stocks relating to paddy-fields.

Third, the public capital stocks of FCC and ARC are on the increase in the hilly and mountainous areas from 1984 to 2004 remarkably. Whereas, the capital stocks of IDC grew at the low rate during these years, and growth rate in the flat farming areas where the capital stocks per areas were the highest was also the highest.

Fourth, the private capital stocks were the highest in the sub-urban areas. Interestingly, difference in the private capital stocks between the flat farming areas, the hilly areas, and mountainous areas was not so large, showing that farmers even in the mountainous areas invest their money to the agricultural machine.

Table 2 shows the per-capita capital stocks by the geographical classification. The following features are shown in this table. First, the capital stocks of IDC, FCC and ARC are high in the flat-farming areas. The capital stocks of FVLBC are higher in the mountainous areas, where population is relatively few, than sub-urban and flat farming areas. Second, the public capital stocks were accumulated in the hilly and mountainous areas at the faster growth rate during these 20 years.

Table 1 The agricultural capital stocks of the unit areas by the geographical classification

Items		IDC-PF	IDC-DF	FCC-PF	FCC-DF	ARC	FVLBC	Private
2004	SubUrban	1.32	0.25	1.57	0.73	0.68	0.59	10.06
	FlatFarm inc	1.62	0.53	2.33	1.56	0.76	0.68	8.49
	Hilly	0.96	0.35	1.73	1.21	1.13	0.77	9.02
	Mountainous	0.55	0.22	1.34	1.03	0.98	0.83	7.18
	Total	1.18	0.33	1.75	1.09	0.87	0.69	9.07
	Max-Min	1.1	0.3	1.0	0.8	0.5	0.2	2.9
2004/1984	SubUrban	1.2	2.7	2.0	1.8	1.9	11.6	1.5
	FlatFarm inc	1.9	2.8	1.7	1.8	2.3	9.3	1.4
	Hilly	1.9	2.3	2.0	1.9	2.4	10.8	1.5
	Mountainous	1.5	2.4	2.1	2.0	2.4	9.9	1.6

Table 2 The per-capita capital stocks by the geographical classification

Items		IDC-PF	IDC-DF	FCC-PF	FCC-DF	ARC	FVLBC	Private
2004	SubUrban	58	11	69	32	30	26	441
	FlatFarm inc	479	159	692	463	227	202	2517
	Hilly	265	96	478	333	311	211	2486
	Mountainous	194	79	472	362	346	294	2530
	Total	112	32	167	104	83	66	866
	Max-Min	421	148	623	431	316	268	2089
2004/1984	SubUrban	1.9	2.5	1.8	1.7	1.8	10.9	1.4
	FlatFarm inc	1.9	2.8	1.7	1.8	2.3	9.3	1.4
	Hilly	2.0	2.5	2.1	2.1	2.6	11.7	1.6
	Mountainous	1.8	2.9	2.6	2.5	2.9	11.9	1.9

4. SUMMARY AND CONCLUSION

This study analyzed the accumulated conditions of the agricultural public capital stocks, which enhance the operation and maintenance of farmland, and agricultural private capital stocks such as the farm machinery and buildings which contribute to the agricultural productivity. The results can be summarized as follows.

First, in the agricultural sector, there were great difference in the chronological and regional tendency of the private capital stocks as well as the public one, and such tendency was greatly different even in the public capital stocks by kinds. Second, the agricultural public capital stocks are recently accumulated in the flat farming areas where most of the farmland exists. However, public capital stocks were rapidly consolidated in the hilly and mountainous areas. Third, the farmland consolidated capital stocks for paddy-fields and dry-fields, which are close to the private capital stocks in their characteristics, increased rapidly. Whereas, the increase rate of the irrigation and drainage capital stocks, which have the characteristics of the

club goods, is comparatively low. Therefore, we can see the shift of the public capital stocks from the semi-public one to the semi-private one in the agricultural sector.

As a conclusion, measuring these agricultural private and public capital stocks by kinds and by towns chronologically makes clear the changes in farmland quality. Also, it becomes possible that the degree of contribution of the capital stocks against agricultural production is measured precisely by using these data.

Of course, there are many remained subjects, such as an extension of the estimation periods which are until 2004 under the present condition, a comparison with other public capitals like general roads and flood protection facilities, and an evaluation on the contribution degree of the agricultural public capital stocks to the production by estimating production function.

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BIOGRAPHICAL NOTES

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- Ph.D. in Agricultural Economics, Chiba University, 1994
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- B.A. in Agricultural Engineering, Okayama University, 1981

Career:

- 1981: Japanese Ministry of Agriculture, Forestry and Fishery (MAFF)
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