A Commodity Flow Estimate of Capital Formation in Korea and Taiwan under Japanese Rule

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I. Introduction(1)

The purpose of this paper is to estimate, by the commodity flow method, the capital formation in Korea and Taiwan under Japanese rule, and this is a part of works to make an index of real GNE in these area before the Second World War (hereafter we use the word of war as the Second World War). Though it is very difficult to estimate directly the real personal consumption the index of real wages can be used as proxy.(2) Because the data on governments' expenditures are abundant, we can get the figures on government consumption.(3) Therefore, the bottleneck is how to calculate the real investments.

As is well known, two kinds of approaches can be considered on the estimate of capital formation. One is called as the expenditure approach and uses data on expenditures by institutes. Emi tried to get the figures on the capital formation by the Government General of Taiwan.(4) Yun Keun

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(1) The writer expresses his gratitude for Professors of Miyohei Shinohara and Konosuke Odaka who permit him to use their unpublished work sheets. This paper owes very much to general suggestions by Professor Koichi Emi.

(2) The estimate of real wages was published in T. Mizoguchi, "Consumer Prices and Real Wages in Taiwan and Korea under Japanese Rule," *Hitotsubashi Journal of Economics*, Vol. 13, No.1, 1972.

(3) The results will be published in *Hitotsubashi Review*, in June 1974 in Japanese.

(4) Koichi Emi, "Capital Formation in Taiwan," in M. Shinohara and S. Ishikawa(ed.), *Economic Growth of Taiwan* (Taiwan no Keizai Seicho), Institute of Developing Economies, 1972 (in Japanese).

Lee's work on Korean capital formation seems to belong to this category.[5] This approach is efficient to get figures on the governments' investments, but there are many difficulties to apply for investments by the private sector though Yamamoto tries to get figures by using expenditure data of Japanese companies.[6]

The second type approach, called the commodity flow method, has advantage in this respect for the first. Strictly speaking, we cannot find the information enough to get the reliable estimates by this method regarding Korea and Taiwan under Japanese rule. But we can increase of the coverage of our estimates by using this method, though the results would include some margins of errors. Our estimate could be used, however, to study the trend or major cycles on the real capital formation.

According to the classification adopted in U.N.'s *Yearbook of National Accounts Statistics*, the capital formation is composed of four item; *i.e.*,

(A) investments for machinery and equipments,

(B) investments for construction,

(C) increases of inventories, and

(D) increases of foreign balances.

We have already discussed about the item (D).[7] Unfortunately, we cannot find the information for the item (C). Regarding the items (A) and (B), let us try to estimate the *gross* capital formation, because we have not obtained the amounts of fixed capital which is necessary to calculate depreciations.

II. Data and Method of Estimation

In order to get figures on capital formation, we need to pass, at least,

(5) Dr. Hakchung Choo suggested the writer that there are works on Korean capital formation by Lee, but the writer has not obtained his reprints.

(6) Yuzo Yamamoto, "Colonial Investments of Japan," *Shakai Keizaigakushi*, Vol. 38, No. 5, 1973(in Japanese).

(7) Toshiyuki Mizoguchi, "Foreign Trade in Taiwan and Korea under Japanese Rule," *Hitotsubashi Journal of Economics*, Vol. 14, No. 1, 1974. See also Yuzo Yamamoto, "Balance of Payments of Chosen under the Reign of Japan," *Jimmon Gakuho*, XXV, 1972 (in Japanese).

following four steps.

(1) To calculate amounts of production and net imports (imports minus exports by commodities),

(2) to decide the percentage of production plus net imports occupied by expenditures for capital formation (let us call this ratio as the distribution ratio),

(3) to revaluate amounts of (2) by adding up the margines of merchants or construction companies, and

(4) to sum the added values by labor inputs, if necessary. Regarding the step (1), we have relatively good statistics. Data for production are shown in

Government General of Taiwan, *Taiwanese Commerce and Industry Statistics (Taiwan Shoko Tokei)*, Annual (in Japanese), and

Government General of Korea, *Statistical Yearbook of Government General of Korea(Chosen Sotokufu Tokei Nempo)*, Annual (in Japanese).

These data supply us not only amounts of production by groups of commodities but also by major commodities. The former figures should be used, however, with great cares because the coverage of production statistics has gradually enlarged. Two papers have been published with these consideration in mind.(8) The work sheets of these papers are used for our study.

The foreign trade statistics are also abundant and can be found in

Government General of Taiwan, *Annual Report on Taiwanese Trade (Taiwan Boeki Nempyo)*, Annual (in Japanese) and,

Government General of Korea, *Annual Report on Korean Trade (Chosen Boeki Nempyo)*, Annual (in Japanese).

We can get relatively reliable estimates on the production and net imports

(8) Miyohei Shinohara, "Industrization and Trade," in Shinohara and Ishikawa (ed.), *Taiwanese Economic Grovth, op. cit.* and T. Mizoguchi, "Production Index of Industry and Mining in Korea," *Keizai Kenkyu*, Vol. 24 No. 4. The pioneer work on the estimates of production of industry and mining can be found in Yun Keun Lee's GNP estimates. See Lee et al., *History of People's Livings under Rule of Japanese Empire*(日帝下의 民族生活史), 民衆書館, 1971(in Korean).

from 1912 to 1938. Before 1911, the coverage of production statistics is narrow, and we are forced to depend only on the net imports. This restriction is very unfavorable for Taiwanese estimates. Though we try to extrapolate our figures before 1911, the results are less reliable than the figures after 1912.

We have not data on the step (2) for Korea and Taiwan before the war. However, we have detailed information on the distribution ratio in recent Japan.[9] We use the figures with some adjustments for our works. The distribution ratio is relatively easily determined for investments for machinery and equipments. The ratio is 100% for industry machines. When data are classified in such a title as "engines and their parts", the ratio should be lower than 100% because the parts are used for small scaled repairs. We decide the ratio by referring the postwar figures for Japan. There are some machines which can be used for both investments and consumption. The ratios for such machines would be different between pre-war and post-war period. However, the shares of these machines are very low in pre-war Korea and Taiwan, so the errors are negligible if we use the post-war ratios without adjustments.

The estimates of construction investments are more difficult than those for machinery and equipments. We can know the production and net imports on the major commodities for construction and can decide the distribution ratio for these commodities by referring post-war information. The problem is that these major commodities do not cover all materials for construction. For instance, we cannot get statistics on amounts of gravel used. Our production data on wooden products seem to cover only a part of wood for construction. To overcome partially these difficulties, we make the following devices. First, the materials are classified into four categories; *i.e.*, (1) metal

(9) Economic Planning Agency, Government of Japan, *Revised National Income Statistics based on* 1965 *Standard* (*Showa* 40 *nen Kijun Kaitei Kokumin Shotoku Tokei... Shiryohen*), The Agency, 1970.

products, (2) pottery products, (3) wooden products and (4) combined products for construction (for example, figures titled as the materials for bridge construction). Second, amounts of investments by commodities used in our estimates are added up by these groups. Third, in order to adjust underestimates, we refer again the post-war data in Japan, and calculate the ratio of commodities covered by commodities adopted in our estimates to those uncovered. The ratio is used to magnify our figures in the second. Though this work can adjust our estimates, it is possible that our estimates have down-ward biases regarding the construction of residencial houses, which are closely related to the weakness of wooden production data. This is especially true for the period before 1911.

We assume that the margine rate is about 15%. Concerning the final step, the labour inputs can be neglected for the investments for machinery and equipments. Regarding the construction investments, we cannot, of course, escape from the estimates on labor inputs. Though nominal wages of construction workers are made by Odaka,(10) there are few amounts of information on annual changes of employments by construction industry. In these circumstances, figures shown in the population census in 1930 are very precious.(11) We then try to estimate the time-series of these employments on the assumption that the number of workers is proportional to the real inputs of construction materials. This assumption is very broad and should be re-examined in the future.(12)

(10) Konosuke Odaka, "Employments and Wages in Taiwan under Japanese Rule," in Shinohara and Ishikawa (ed.), *Economic Growth of Taiwan, op. cit.* (in Japanese) and "Employments and Wages in Korea under Japanese Rule," (Nihon Tochika niokeru Chosen no Koyo to Chingin), 1971(mimeographed, in Japanese).

(11) Government General of Taiwan, *Population Census... Whole Taiwan*, 1930(*Showa 5-nen Kokusei Chosa Hokoku*), 1934 (in Japanese), and Government General of Korea, *Korea Population Census*(*Chosen Kokusei Chosa Hokoku*), 1935 (in Japanese). We have also population census in 1920 for Taiwan, but the results are not much different according to the census used.

(12) One of devices to solve this difficulty is to use data on death by occupations. Such an interesting attempt was done by using Japanese data. See Mataji Umemura, "Changes of Gainful Workers, 1880-1940," *Keizai Kenkyu*, Vol.24, No.2, 1973 (in Japanese).

The next work is to make the deflator for capital formation. Concerning the investments for machinery and equipments, price data are taken from Japanese historical statistics.(13) This can be justified because most of machines are imported from Japan in pre-war Korea and Taiwan. After our period are divided into three for Taiwan and into two for Korea, we calculate the Laspyres type indices.(14) These indices are linked by countries and divided by the average values from 1934 to 1936.(15) Regarding the capital formation by construction, Korean prices indices can be found in *Report of First Wealth Survey.*(16) Since we cannot find the data in same characters in Taiwan, we make our indices by referring the production prices and the import prices. The deflators for labour inputs are Odaka's indices of nominal wages. These indices are aggregated by the method of implicit deflator: *i.e.*, the harmonic average by using the nominal inputs on investments as the weights.

III. Results of Estimates

Our estimates are shown in Table 1. Though we tried to exclude irregular fluctuations caused by the deficits of original data, there remained some minor variations in our time-series. It is not necessarily appropriate to discuss about minor changes found in the table because they may have their origin on unadjusted original errors. But our results can be used for the studies on the trend or major cycles of capital formation.

Our nominal figures can be compared with previous estimates. Regarding Taiwanese, the results are generally consistent with Emi's. Though our

(13) Kazushi Ohkawa and et. al., *Prices* (*Bukka*), Toyo Keizai Shimposha, 1967(in Japanese).

(14) Our division of period is as follows. Taiwan, (i) 1896-1915, (ii) 1915-1925, and (iii) 1925-1938, and Korea, (i) 1910-1925 and (ii) 1925-1938. Years are overlapped in order to link indices.

(15) The base years are decided to compare Japanese historical statistics. Though the individual indices are 100 in the average of base years, the aggregated indices do not necessarily satisfy this condition.

(16) Economic Planning Board, Government of Korea, *First Report on National Wealth Survey.* The writer expresses his gratitude for Dr. Choo who kindly supply the report.

figures are larger than Emi's which covers only the capital formation by the Government General of Taiwan, the major cycles are very similar with each other. The ratio of our figures to Emi's has an upward trend. This can be explained by the rises of capital formation by Japanese private

Table 1 Capital Formation in Korea and Taiwan under Japanese Rule

(A) Korea (Thousands Yen)

Year	Nominal		Real		
	Machinery and equip.	Construction	Machinery and equip.	Construction	Deflator
1911	4,101	15,633	6,729	28,886	55.4
1912	5,224	18,813	7,643	33,509	58.4
1913	5,596	15,609	7,338	27,469	60.8
1914	4,419	15,503	6,894	29,402	54.8
1915	3,418	13,349	4,486	26,217	54.6
1916	4,419	15,110	4,617	28,371	45.8
1917	9,575	23,281	7,514	33,640	79.8
1918	23,126	35,215	16,095	37,971	107.9
1919	26,272	40,173	20,201	30,412	131.3
1920	21,235	38,664	15,077	23,946	153.5
1921	18,642	44,861	14,922	32,570	133.7
1922	19,181	52,807	16,261	39,509	129.1
1923	17,832	51,216	15,689	40,856	122.1
1924	20,226	37,517	17,309	29,062	124.6
1925	17,832	54,060	14,850	26,042	126.6
1926	21,120	48,641	20,223	38,796	118.2
1927	22,687	71,337	21,860	58,671	116.8
1928	28,670	81,467	27,830	66,452	116.8
1929	32,150	85,601	31,274	71,444	114.6
1930	26,570	75,698	29,542	72,002	100.7
1931	17,357	59,468	21,026	65,590	88.7
1932	21,160	67,728	23,556	78,421	87.2
1933	28,107	72,164	27,783	82,278	91.1
1934	37,783	95,766	37,308	106,713	92.7
1935	56,338	133,321	57,806	132,357	99.7
1936	81,120	187,568	80,619	171,237	106.7
1937	87,182	99,857	62,138	82,340	126.0
1938	119,954	100,245	83,107	73,167	140.9

(B) Taiwan

Year	Nominal		Real		
	Machinery and equip.	Construction	Machinery and equip.	Construction	Deflator
1896	366	254	719	654	45.1
1897	564	386	1,038	824	51.0
1898	592	604	1,045	1,186	52.2
1899	676	1,324	1,098	2,796	51.4
1900	1,242	2,566	1,992	4,664	57.1
1901	2,764	3,354	4,610	6,380	57.5
1902	1,863	2,800	3,357	3,150	71.7
1903	1,142	3,490	1,943	7,766	47.7
1904	1,176	3,638	1,845	8,168	46.5
1905	1,764	3,280	2,593	6.996	52.6
1906	1,205	4,558	1,750	9,020	53.5
1907	3,904	9,864	5,283	14,802	68.5
1908	8.839	10,461	13,024	15,585	66.1
1909	3,988	8,900	6,820	17,064	54.0
1910	8,190	10,877	13,024	15,196	67.6
1911	8,623	13,117	14,062	21,436	61.2
1912	4,650	17,404	6,569	27,095	65.5
1913	2,451	15,736	3,583	23,386	67.4
1914	2,017	11,856	3,039	19,389	61.9
1915	2,323	11,226	3,019	15,629	72.7
1916	2,854	15,731	2,946	15,898	99.2
1917	5,511	35,293	4,312	28,683	123.6
1918	9,281	51,016	6,229	21,505	218.4
1919	12,959	63,277	9,269	32,592	182.1
1920	16,835	127,778	11,284	50,836	232.7
1921	14,370	86,657	11,294	46,454	214.8
1922	7,774	55,667	6,584	39,107	138.8
1923	8,440	54,983	8,015	38,510	133.4
1924	6,916	47,983	5,889	31,716	145.7
1925	8,505	62,496	7,104	44,433	137.7
1926	9,703	58,923	9,272	43,692	129.8
1927	11,326	69,788	10,784	51,904	129.8
1928	14,834	83,649	14,243	62,110	128.9
1929	15,103	92,047	14,547	65,967	133.0
1930	15,302	71,264	16,648	57,485	116.7

1931	11,248	61,995	13,279	56,837	104.5
1932	10,510	73,496	11,531	71,884	100.8
1933	13,160	81,114	12,879	79,394	102.2
1934	19,004	89,186	18,677	85,674	103.7
1935	24,106	113,606	24,700	109,553	102.6
1936	23,096	110,648	23,235	120,009	95.0
1937	31,030	105,783	22,324	91,921	119.5
1938	40,879	128,403	28,607	97,801	133.9

companies and local governments. One of difficulties is the fact that the ratio is very close to one from 1896 to 1900. We admit that the major investor in the period is the Government General, but it is possible that this may have its origin on the underestimates of residencial construction mentioned above. According to Emi's experience of Japanese estimates, the investments on residencial houses tend to have a downward bias when we follows the method used here. These checks should be re-examined in the future by supplementing the additional information.

Korean figures are also consistent with the writer's unpublished estimates of the capital formation by the Government General of Korea. Though the ratio is generally lower than Taiwanese, it has also an-up-ward trend. Our nominal figures can be compared with Yun Keun Lee's production estimates on construction industry and the results show that they are consistent with each other.[17]

Implicit deflators on capital formation are very similar with those for Japan by Nobukiyo Takamatsu.[18] This is natural because most of investment goods are imported from Japan. The major causes of differences among three regions can be found in the wage indices of construction workers which are one of components of construction investments. Though Korean

(17) Rigidly speaking, Lee's coverage of construction production seems to be narrower than ours. In fact Lee's figures are nearly 80% of ours and the ratio is nearly constant from 1927 to 1934. Lee's figures are higher in 1926 and lower in 1935 than ours, but these differences are not too important.

(18) Ohkawa, et al., *Prices, op. cit.*

deflator is very similar to Japanese, Taiwanese fluctuates a little violently from 1917 to 1925. This can be explained by the violent rises of prices of construction materials as well as the rise of wages.

Now, let us study the trend and cycles of real capital formation. In Table 2, the growth rates are compared with the non-military capital formation in Japan calculated by Emi.[19] The growth rate is calculated by applying the least-squares method for

$$\log_e X(t) = a + bt \qquad (1)$$

where X is the capital formation and t is the time variable. The rate is surprisingly high in Taiwan before 1910. This may have its partial origin in the down-ward biases on the figures for the residencial construction. But it is more important to note that the investments by the Government General and Japaneses private companies rose remarkably in the 1900's. They expended much money on the building for their administration, equipments for transportation and communication, and machines for sugar production. However, as the increases of investments for Korea Taiwanese

Table 2 Growth Rate of Capital Formation unit:(%)

	1911-1938			1876-1910		1896-1936	
	Japan	Taiwan	Korea	Japan	Taiwan	Japan	Taiwan
Construction	6.72	6.41	8.90	2.85	17.31	7.21	6.53
Machinery & equip.	4.09	6.69	5.80	3.36	22.45	4.50	9.64
Total	5.39	6.55	5.39	3.11	20.52	5.69	8.70

growth rate of capital formation slowed down. Yamamoto pointed out that the early 19-th century Japan was in the scarcity of capital economy, and the investments in the late period of Japanese rule were supplied by the profits of Japanese companied in Taiwan and Korea.[20] Our finding is consistent with Yamamoto's suggestion. Taiwanese growth rate of construction investments is higher than those for machinery and equipments. Before

(19) Koichi Emi, *Capital Formation* (*Shihon Keisei*), Toyo Keizai Shimposha, 1971.
(20) Yamamoto, "Colonial Investments of Japan," *op. cit.*

the war, Taiwanese economy depended on agriculture and the industry was restricted for sugar indusry. The high growth of construction investments seems to correspond to the large scaled construction for agriculture.

Korean growth rate of capital formation is lower than Taiwanese. Especially, the rate is low for construction investments. Regarding the capital formation for machinery and equipments, the rate is relatively high, especially, in the 1930's. This can be related to the development of heavy industry and minings in the 1930's. The growth rate of real production is 21.8% in chemical, 19.7% in minings and 12.0% in machinery industry in the 1930's. It should be noted that the growth rate is higher in North Korea than South Korea.(21) It is an interesting topic to study the flow of fund for these capital formation, but this is left as the future study.

The another interesting topic is to investigate the ratio of capital formation to GNP. This is important to know the efficiency of capital in our time-series analysis. Since we have not obtained the time-series data on GNP covering the whole period of our study in Taiwan and Korea, we use the sum of amounts of production in agriculture and industry including minings as proxy of GNP. According to Figure 1, Korean capital formation is small

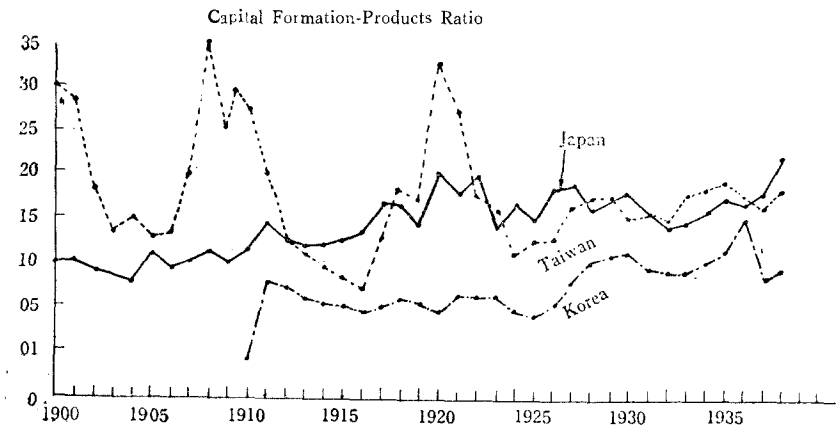

Figure 1

(21) See T. Mizoguchi, "Production Index of Industry and Mining in Korea," *op. cit.*

as comapred with her income. However, it is interesting that there is an up-ward trend in this ratio as Japanese case. Taiwanese ratio is very high in the earlier period of Japanese rule and as high as Japanese level afterward. Because there is the possibility that our figures have down-ward biases we cannot get final conclusions. But the Figure 1 seems to show that our estimates are not too singular.

It is also interesting to compare the cyclical changes of capital formation. In order to obtain the cycles, we used the residuals of regression of the equation (1) though the writer understood that this method might be criticized by statisticians. According to Figure 2, the cycles for investments for

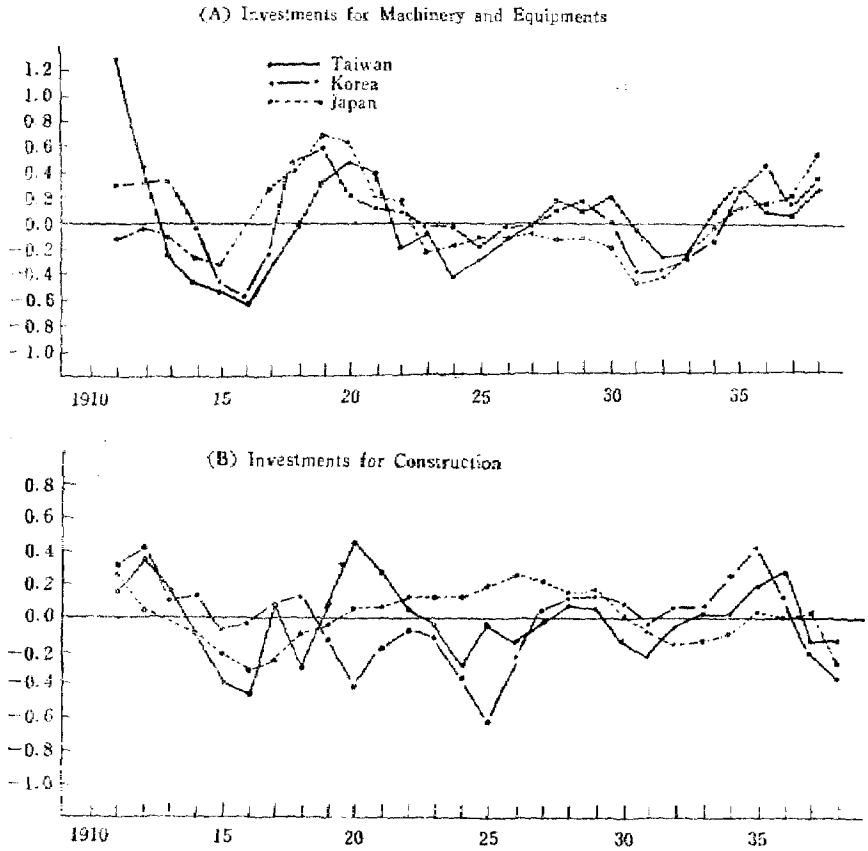

Figure 2

machinery and equipments are similar in these three regions. But the construction investments show different pattern by regions. It is very interesting that the inverse cycles can be found between Japan and these two regions. This may be partially related to Yamamoto's suggestions mentioned above, but the detailed studies are necessary to get the final conclusions.

IV. Final Remark

In this paper, we have shown the broad tendency of gross capital formation in Taiwan and Korea. Because we use only the relatively well known data there remain area to be improved by using the other information. Especially data for residencial construction may be useful to revise our estimates. It is more important to get the comments from historians who know historical background in the period.

However, we need to add some words for anticipated comments. There would arise comments that our estimates are too macro. For instance, we have not discussed the problems how many shares of capital formation belong to Taiwanese or Korean people. This writer thinks that these micro-type studies are very important to evaluate the colonial policies. But he does not think that the relation between macro and micro type studies are substitutional but he believe that it should be complemental. Especially our deflators can be used for some micro-type studies.