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Korea's first industrial revolution, 1911–1940[☆]

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ABSTRACT

We estimate output and population of colonial Korea to show that per capita output grew 2.3% with population expanding 1.3% per year from 1911 to 1940. Growth accounting indicated that productivity advance accounted for roughly one half of the per capita output growth. Primary production as a share of GDP fell from 69% to 42% during the period. Rapid productivity improvement caused nontradable sectors to become increasingly important, while capital accumulation drove industrialization. Demographic expansion, per capita output growth, and structural change occurred at considerably faster rates in northern than in southern provinces.

1. Introduction

The economic history of modern Korea offers a series of interesting natural experiments for growth economists. Having forced Korea to be open to international trade in 1876, Japan annexed the country in 1910, replacing the decrepit government of the Yi dynasty with an efficient, if not democratic, colonial state. Thirty five years later, Korea regained independence, but was split into two separate regimes, one adopting a market system and the other a command economy. Growth performance differed radically under the four different policy regimes — a pattern of laboratory outcome that seems likely to help one to assess the importance of different growth-affecting shocks and institutions.

However, the amount of information available on growth-affecting variables under each of the four regimes varies widely, which limit the kinds of comparison that can be made across the growth episodes. One major objective of this article is to allow more interesting questions to be asked on the causes of Korea's economic growth by estimating the country's aggregate output and population during the colonial era. Not being the first to try to estimate the national accounts of colonial Korea, we begin in the second section by explaining why the calculation is well worth carrying out all over again and how we did it. Population growth before the first census in 1925 has so far been extrapolated from demographic trends observed during the post-census decades. In the third section of this article, we present the first estimate of pre-census population growth based upon direct observation, which is vital data collected from genealogies. As the outcome of these two sections indicates, per capita output grew 2.3% with population expanding 1.3% per year, and primary production as a share of GDP fell from 69% to 42% from 1911/3 to 1938/40. In the fourth section, we carry out growth accounting in the aggregate, as well as by sector, which allows us to assess the role of productivity advance and capital accumulation in the colonial growth and structural change. The fifth section discusses the implications of our estimate for the economic history of colonial Korea and the impact of colonialism on growth. The final section summarizes and concludes.

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2. Gross domestic expenditure and product, 1911–1940

Statistical legacy of Japanese rule has so far prompted three separate attempts to estimate the size and structure of colonial Korea's aggregate output, which generated outcomes that are inadequate in varying degrees. Lee (1971) was the first to calculate the aggregate output of colonial Korea, but his estimation dealt only with the decade from 1926 to 1936. Suh (1978) then estimated gross and value-added output from 1910 to 1940 for agriculture and manufacturing, leaving out service production. Finally, Mizoguchi and Umemura (1988) published the national accounts of Korea from 1911 to 1938, which represented the first ever calculation covering the whole economy and the best part of the colonial period.

Undoubtedly a significant advance made on the shoulder of earlier efforts, Mizoguchi and Umemura (1988) left ample room for improvement. First, Mizoguchi and Umemura (1988) calculated nontradable output (including construction, public utilities and service) by first deriving underestimates using a fraction of available information and then blowing them up with multipliers lacking empirical basis (Mizoguchi and Nojima (1988, p. 141)). Second, drawing primarily on *Chōsen sōtokufu tōkei nenpō* (Statistical Yearbook of Colonial Korea, Statistical Yearbook hereafter) to estimate manufacturing output, Mizoguchi and Umemura (1988) replaced missing observations with values obtained by interpolation and extrapolation, although the holes could have been filled with direct observations available from other sources than the Statistical Yearbook. Third, the Mizoguchi and Umemura (1988) dataset includes component series that are mutually inconsistent: for instance, fixed capital consumption exceeds gross fixed capital formation until as late as 1934, while the capital stock estimate follows an uninterrupted growth path.[1] Fourth, the dataset uses imprecise and non-standard definitions, one important example being the current account that excludes bullion and service trade. Finally, Mizoguchi and Umemura (1988)'s procedure does not conform either to the 1968 System of National Accounts (SNA 68) or SNA 93 developed by the United Nations, which makes it difficult to link the colonial with South Korean macroeconomic time series.

This section presents a fresh estimate of the national accounts of Korea from 1911 to 1940 that incorporate major improvements in at least four areas. First, we sought to avoid the use of multipliers with little empirical basis by broadening data base, which improved the reliability of estimate of public spending and service output, among others. Second, service output also benefited from superior method of evaluation: in particular, to estimate output from trade and transportation sectors we used information on markup ratios. Third, rather than drawing primarily on the Statistical Yearbook, we compared multiple data sources to enhance the accuracy and consistency of underlying data, which resulted in considerably more reliable estimates of manufacturing output and overseas trade. Finally, we estimated both gross domestic product and expenditure (GDP and GDE, respectively, hereafter) in a consistent framework, SNA 93, thereby reducing the discrepancy between the two measures of the aggregate economic activity substantially. We have prepared a Technical Note, which is available upon request, to explain these issues in detail.

We derived GDP by summing up gross value-added output from fifteen different branches of economic activity. For sectors other than agriculture, construction, and the government, value-added output was obtained by multiplying sectoral gross output with sectoral value-added ratios.[2] While both Suh (1978) and Mizoguchi and Umemura (1988) borrowed the Japanese value-added ratios in 1930, we chose to use the value-added ratios for South Korea in 1966, for colonial Korea looked far closer to South Korea in the mid-1960s than Japan in 1930 in terms of living standards and economic structure.[3] Value-added output for agriculture was set equal to the difference between estimated gross output and the sum of intermediate input use. Gross and value-added output of construction was derived by combining information on wage payments and intermediate input with assumptions on profit. Value-added output of the public sector equals the sum of wages paid to public servants and capital consumption, which amounts to assuming that the operating profits and indirect tax payments are zero.[4]

GDE includes public and private consumption, investment and net exports. Value of exports and imports are readily available from official statistics, which we adjusted for omission and inconsistency.[5] As the SNA 93 stipulates, public consumption was set equal to gross government service output, which can be derived by adding intermediate input use to the estimated valued-added output of the public sector.[6] We derived investment and private consumption by applying investment and consumption ratios, respectively, to domestic supply – the sum of gross output and net imports – by sector. For most of goods and services, we applied sectoral consumption and investment ratios as read off the 1966 input–output table for South Korea. Exceptions to this procedure include construction investment and consumption ratios for primary products, rubber goods, and electricity, which were derived using relevant information based on direct observation.[7]

To convert values into volumes, we used the geometric mean of chained Laspeyres and Paasche price index, a deflator known as the chained Fisher index. The United Nations recommends the use of this deflator, both because its growth rate (i.e. rate of inflation) is not susceptible to base year shifts, and because the index can readily incorporate the impact of entry and exit of goods. Our GDP deflator follows a familiar pattern of fluctuations, which includes inflation during the First World War, the

[1] The origin of this inconsistency is to be found in Mizoguchi and Umemura's (1988) use of Japanese depreciation rates in deriving capital stock from his capital formation estimate for colonial Korea. As explained in the fourth section, we could avoid this incongruity by letting the depreciation rate be determined endogenously by the estimated amount of capital consumption. It should also be noted that agricultural capital stock, a component of Mizoguchi and Umemura's (1988) capital stock estimate, refers to agricultural capital stock in southern Korea, which was estimated by Ban (1979).

[2] The first section of Technical Note explains the procedure followed to estimate sectoral gross output.

[3] See page 12 of Technical Note for empirical basis for this claim.

[4] Pages 5, 6, 9, and 10 of Technical Note describe the procedure followed to calculate value-added output of construction and the public sector.

[5] See pages 14 and 15 of Technical Note for details on trade statistics.

[6] Some government services (e.g. public education) are sold on the market (frequently at heavily subsidized prices), which was subtracted from government to be attributed to private consumption.

[7] Page 13 of Technical Note takes the case of rice consumption to illustrate this procedure.

Table 1
Gross domestic product and expenditure of Korea, 1911–1940.

	Agriculture, forestry and fishing	Mining and manufacturing	Electricity, gas and water supply	Construction	Services	Gross value added at basic price (1)	Taxes less subsidies on products (2)	Gross domestic product at market price (3) = (1) + (2)	Net factor income from the rest of the world (4)	Gross national income (5) = (3) + (4)
A. Gross domestic product by kind of economic activity and gross national income (at current prices, unit: million yen)										
1911	347.5	25.7	0.4	8.3	130.5	512.4	2.8	515.2	−2.4	512.8
1912	430.5	29.2	0.5	9.0	156.7	625.9	3.9	629.9	−3.7	626.2
1913	484.0	33.2	1.1	9.3	167.9	695.5	4.4	699.9	−5.0	695.0
1914	418.0	36.0	1.3	9.4	162.0	626.8	4.2	631.0	−5.6	625.3
1915	353.5	41.3	1.5	8.9	160.3	565.6	5.1	570.7	−6.3	564.4
1916	421.6	46.3	3.1	9.6	178.7	659.3	6.4	665.7	−6.4	659.3
1917	587.2	60.5	2.7	12.2	227.5	890.2	10.2	900.4	−7.1	893.3
1918	947.3	90.8	12.8	19.1	335.0	1404.9	15.3	1420.2	−10.0	1410.2
1919	1148.4	130.7	11.7	31.6	491.0	1813.4	25.9	1839.3	−14.0	1825.4
1920	1277.2	109.6	9.0	38.6	511.9	1946.3	20.0	1966.3	−20.8	1945.5
1921	915.7	109.0	8.6	48.1	477.7	1559.0	24.9	1583.9	−24.3	1559.6
1922	1028.5	107.4	8.8	52.3	503.3	1700.3	28.4	1728.7	−27.9	1700.8
1923	1004.1	120.2	8.9	46.2	512.5	1691.9	18.5	1710.3	−33.2	1677.1
1924	1084.8	127.9	8.6	38.5	532.2	1792.0	22.2	1814.2	−35.3	1778.9
1925	1140.2	130.1	11.9	38.9	546.0	1867.0	25.0	1892.0	−41.1	1850.9
1926	1060.4	136.8	11.2	40.1	555.1	1803.6	30.7	1834.3	−33.3	1800.9
1927	1059.6	133.2	13.4	48.0	575.4	1829.6	30.8	1860.4	−39.2	1821.2
1928	932.9	138.6	14.4	55.1	595.1	1736.1	31.0	1767.0	−44.6	1722.5
1929	875.0	133.6	11.8	59.2	597.3	1676.9	33.8	1710.8	−52.3	1658.5
1930	656.9	103.4	44.2	52.8	528.0	1385.3	32.9	1418.3	−43.9	1374.3
1931	633.9	87.2	70.0	44.7	493.6	1329.4	36.7	1366.1	−49.6	1316.5
1932	740.1	112.7	64.4	44.6	519.0	1480.7	31.7	1512.5	−56.5	1455.9
1933	795.4	140.6	68.3	45.2	560.1	1609.5	38.3	1647.9	−44.2	1603.7
1934	902.0	170.8	55.3	52.7	623.7	1804.6	38.9	1843.5	−48.7	1794.8
1935	1098.6	232.1	55.9	73.7	720.9	2181.3	48.3	2229.6	−74.3	2155.2
1936	1034.0	282.4	98.4	97.6	789.9	2302.3	59.4	2361.7	−73.6	2288.0
1937	1405.1	365.0	148.5	109.4	923.0	2951.0	64.8	3015.8	−82.8	2933.0
1938	1376.4	468.8	183.9	127.1	1036.2	3192.4	78.4	3270.8	−78.7	3192.0
1939	1455.0	621.7	161.9	168.8	1220.5	3627.9	88.3	3716.2	−99.3	3616.9
1940	1893.3	788.2	170.4	213.2	1444.2	4509.3	78.5	4587.8	−82.4	4505.4

	Agriculture, forestry and fishing	Mining and manufacturing	Electricity, gas and water supply	Construction	Services	Gross value added at basic price	Taxes less subsidies on products	Gross domestic product at market price	Trading gains and losses from change in the terms of trade	Gross domestic income	Net factor income from the rest of the world	Gross national income
B. Gross domestic product by kind of economic activity and gross national income (at 1935 prices, unit: million yen)												
1911	637.9	38.5	0.2	12.8	236.9	878.3	4.5	970.6	−3.8	966.8	−4.3	962.5
1912	657.3	42.8	0.2	12.4	253.5	916.4	6.1	1007.0	2.9	1009.8	−5.8	1004.1
1913	716.9	48.5	0.4	13.1	266.7	992.7	6.6	1087.3	7.2	1094.5	−7.5	1087.0
1914	746.4	54.1	0.5	14.5	289.8	1049.7	6.6	1156.8	−2.9	1154.0	−9.9	1144.1
1915	746.4	65.0	0.6	14.9	317.3	1089.8	8.4	1201.3	−16.7	1184.6	−12.6	1172.0
1916	790.9	68.6	1.3	15.7	329.0	1150.1	8.8	1278.5	−25.9	1252.5	−11.6	1241.0
1917	800.0	73.9	1.1	15.3	333.2	1167.5	10.8	1296.1	−37.1	1259.0	−9.5	1249.4
1918	866.0	81.2	3.3	17.5	342.5	1257.1	11.8	1370.8	−41.5	1329.3	−9.0	1320.3
1919	723.6	90.9	2.8	22.8	352.0	1138.1	16.3	1246.6	−48.4	1198.2	−8.9	1189.3

1920	864.9	86.0	1.8	23.9	355.7	1273.6	12.9	1424.5	−59.5	1365.0	−13.9	1351.1
1921	855.7	91.4	1.8	38.5	407.1	1335.3	19.0	1457.0	−67.0	1390.0	−20.7	1369.3
1922	867.5	92.5	2.1	41.4	413.9	1358.4	22.4	1480.3	−43.3	1437.0	−22.5	1414.5
1923	863.8	105.3	2.5	37.6	430.3	1380.3	14.5	1508.4	−58.6	1449.8	−27.4	1422.4
1924	824.9	109.7	2.8	29.6	424.9	1334.5	16.6	1447.1	−54.9	1392.2	−26.6	1365.6
1925	870.6	112.1	4.3	31.0	431.5	1391.9	18.6	1499.4	−47.3	1452.0	−31.0	1421.1
1926	890.1	124.2	4.1	32.4	470.0	1458.9	24.6	1576.9	−51.9	1525.1	−27.3	1497.8
1927	972.0	123.2	5.3	40.2	510.8	1586.1	25.9	1706.8	−61.4	1645.4	−34.2	1611.2
1928	845.8	128.6	4.3	48.0	523.7	1489.9	26.4	1636.7	−85.1	1551.6	−38.9	1512.7
1929	858.6	129.2	3.5	54.2	548.1	1530.2	30.3	1677.3	−75.4	1601.9	−48.5	1553.4
1930	947.2	121.3	15.0	54.3	607.0	1700.2	36.5	1855.8	−86.6	1769.2	−53.8	1715.4
1931	917.5	113.8	25.2	50.5	606.3	1698.1	46.5	1916.6	−125.7	1790.9	−64.6	1726.3
1932	998.5	134.0	24.8	51.3	609.7	1793.3	37.6	1951.8	−67.5	1884.3	−69.6	1814.7
1933	1011.5	155.1	27.4	47.9	633.1	1854.7	41.5	2034.8	−89.8	1945.0	−51.5	1893.5
1934	990.9	182.0	39.6	53.4	666.2	1928.8	41.3	2040.7	−74.5	1966.2	−51.8	1914.4
1935	1098.6	232.1	55.9	73.7	720.9	2181.3	48.3	2229.6	–	2229.6	−74.3	2155.2
1936	976.7	261.0	62.9	94.1	763.2	2159.6	56.2	2256.8	−4.9	2252.0	−70.2	2181.7
1937	1275.9	302.1	73.1	90.1	823.0	2563.4	53.6	2688.6	−56.7	2631.9	−72.0	2559.9
1938	1131.7	361.1	80.1	89.0	866.1	2541.0	59.5	2703.3	−115.0	2588.2	−62.3	2525.9
1939	866.5	424.0	104.3	103.7	838.1	2356.8	57.7	2445.9	−104.3	2341.6	−62.9	2278.6
1940	1045.3	483.8	114.1	118.5	940.2	2730.7	45.5	2843.1	−63.4	2779.7	−49.5	2730.2

	Private consumption expenditure	Government consumption expenditure	Gross fixed capital formation	Changes in inventories	Exports of goods and services	(less) Imports of goods and services	Statistical discrepancy	Expenditure of GDP
C. Expenditure on gross domestic product (at current prices, unit: million yen)								
1911	471.9	29.4	24.9	11.8	34.1	67.7	10.8	515.2
1912	592.6	31.5	28.7	−5.4	34.5	76.0	24.0	629.9
1913	640.8	32.0	29.1	9.3	44.7	77.9	21.9	699.9
1914	561.9	32.6	27.4	7.4	48.1	67.8	21.4	631.0
1915	522.4	33.3	25.5	−13.8	65.7	65.5	3.2	570.7
1916	579.0	35.1	28.6	14.9	76.4	84.3	15.9	665.7
1917	792.7	35.8	43.7	−3.3	97.6	114.9	48.8	900.4
1918	1220.2	40.5	77.5	25.1	171.4	172.3	57.7	1420.2
1919	1785.9	65.6	97.5	−131.4	234.7	292.9	79.9	1839.3
1920	1599.0	97.2	105.6	121.7	214.4	262.8	91.3	1966.3
1921	1405.6	106.4	109.1	−30.3	210.1	222.4	5.4	1583.9
1922	1488.6	110.2	122.4	14.5	203.6	239.5	28.9	1728.7
1923	1503.1	105.9	105.2	−4.3	251.3	240.5	−10.4	1710.3
1924	1697.0	101.3	94.0	−70.8	339.6	308.9	−37.9	1814.2
1925	1687.4	93.9	92.7	54.3	347.0	339.1	−44.1	1892.0
1926	1710.5	99.3	102.1	−5.1	362.7	360.0	−75.2	1834.3
1927	1691.5	102.0	118.0	35.8	368.0	404.6	−50.3	1860.4
1928	1688.2	105.9	133.5	−85.2	372.0	421.3	−26.1	1767.0
1929	1540.6	113.7	142.9	27.8	338.0	411.7	−40.6	1710.8
1930	1233.3	111.2	130.6	67.0	280.1	369.2	−35.0	1418.3
1931	1242.9	100.0	104.4	−87.0	304.3	288.1	−10.4	1366.1
1932	1252.4	103.1	105.9	35.4	336.7	330.7	9.7	1512.5
1933	1387.5	112.4	120.3	21.3	376.9	396.5	25.9	1647.9
1934	1628.8	111.0	152.3	−65.8	496.4	511.7	32.7	1843.5
1935	1829.8	121.2	209.4	61.0	737.6	704.4	−25.1	2229.6
1936	2061.4	130.0	265.9	−52.6	638.8	746.8	65.0	2361.7

(continued on next page)

Table 1 (*continued*)

	Private consumption expenditure	Government consumption expenditure	Gross fixed capital formation	Changes in inventories	Exports of goods and services	(less) Imports of goods and services	Statistical discrepancy	Expenditure of GDP
C. Expenditure on gross domestic product (at current prices, unit: million yen)								
1937	2290.9	174.8	315.5	182.1	734.7	825.6	143.4	3015.8
1938	2689.3	193.2	391.0	−115.7	942.1	1009.0	179.8	3270.8
1939	3230.0	201.4	539.9	−187.2	1032.1	1284.9	184.9	3716.2
1940	3560.0	254.5	723.6	318.9	1058.9	1520.0	191.9	4587.8
D. Expenditure on gross domestic product (at 1935 prices, unit: million yen)								
1911	854.6	59.3	36.6	23.3	59.1	112.1	20.3	970.6
1912	911.8	62.5	38.2	−8.6	52.5	119.6	38.4	1007.0
1913	957.9	62.3	39.3	14.0	62.5	118.1	34.1	1087.3
1914	988.8	65.4	39.8	14.2	78.4	107.3	39.3	1156.8
1915	1053.5	66.4	38.9	−31.3	121.5	104.6	6.7	1201.3
1916	1050.1	66.3	41.7	28.9	125.4	110.9	30.5	1278.5
1917	1055.3	59.0	49.5	−4.6	130.5	113.0	70.3	1296.1
1918	1081.1	52.4	66.4	23.9	170.8	130.2	55.7	1370.8
1919	1102.1	66.8	71.2	−84.8	195.2	189.0	54.2	1246.6
1920	1060.6	75.2	67.5	88.7	174.2	146.9	66.1	1424.5
1921	1204.1	90.6	86.9	−31.7	225.9	169.8	4.9	1457.0
1922	1194.7	95.6	97.8	13.4	201.5	189.8	24.7	1480.3
1923	1233.2	93.7	87.8	−4.0	255.8	187.6	−9.2	1508.4
1924	1261.5	90.2	73.6	−54.8	307.3	227.4	−30.3	1447.1
1925	1251.7	80.9	76.5	43.6	294.9	241.5	−35.0	1499.4
1926	1388.5	88.7	85.3	−4.5	337.6	283.5	−64.6	1576.9
1927	1474.3	91.4	101.3	35.0	377.4	350.3	−46.1	1706.8
1928	1468.2	95.3	118.6	−82.4	409.3	372.6	−24.2	1636.7
1929	1430.5	104.4	130.7	30.0	380.4	379.6	−39.8	1677.3
1930	1556.3	112.5	134.9	117.9	377.5	397.6	−45.7	1855.8
1931	1661.4	108.1	119.2	−140.2	527.6	377.7	−14.6	1916.6
1932	1571.5	109.7	121.1	49.9	474.8	399.5	12.5	1951.8
1933	1646.5	117.9	126.0	29.3	482.6	415.3	32.0	2034.8
1934	1745.9	115.2	152.6	−72.8	589.2	531.7	36.2	2040.7
1935	1829.8	121.2	209.4	61.0	737.6	704.4	−25.1	2229.6
1936	1959.3	125.3	259.9	−50.2	649.9	754.6	62.1	2256.8
1937	2007.2	157.2	256.1	171.2	687.6	712.5	127.8	2688.6
1938	2156.0	160.5	276.4	−98.4	832.3	772.1	148.6	2703.3
1939	2015.4	147.1	350.0	−115.7	749.7	816.8	121.7	2445.9
1940	2125.0	174.2	429.0	192.8	652.0	860.7	118.9	2843.1

Note: Total does not equal to the sum of their components, since additivity does not hold for volume series obtained using Fisher's chain index.

post-war collapse (1919–1921), deflation in the late 1920s and the early 1930s, finally reflation during the world recovery from the Great Depression.

The average annual ratio of absolute value of discrepancy between GDP and GDE to GDP equaled 2.7% of GDP, while the corresponding figure for Mizoguchi and Umemura (1988)'s estimate is 6.04%. Maximum, minimum, and average annual ratio of the discrepancy to GDP are 5.4%, −4.1%, and 1.4%, respectively. Corresponding values for Mizoguchi and Umemura (1988)'s estimate are 14.7%, −7.3%, and 2.6%, respectively. Also one finds more pronounced growth slowdown in the 1920s in Mizoguchi and Umemura (1988)'s output series than in our estimate.

Gross domestic product and expenditure of colonial Korea and their components estimated are presented as Table 1. The aggregate output of Korea measured at 1935 prices grew 3.6% per year from 1911/3 to 1938/40. In the course of the economic growth, the structure of the gross domestic product shifted: the share of agriculture, fishery, and forestry within the aggregate output fell from 68.7% to 41.7%, while the proportion of manufacturing (including mining) and nontradables rose from 4.8% to 16.4% and from 26.4% to 41.9%, respectively. The composition of gross domestic expenditure also changed with investment rate rising from 4.5% to 14.1%, exports' share from 6.2% to 26.6%, and private consumption rate falling from 92.3% to 82.3%.

Korea having been divided into North and South Korea with the end of Japanese rule, it would be useful to have separate output estimates for the northern and southern halves of colonial Korea. To obtain separate GDP estimates for the two regions corresponding to the present-day South and North Korea, we calculated gross regional domestic product (GRDP) for agriculture, fishery, forestry, manufacturing, mining, and electricity for each of the thirteen provinces of colonial Korea using provincial production data as published in the Statistical Yearbook. Provincial data being either unavailable or incomplete for sectors other than these, service in particular, we drew on a variety of relevant information, including business tax payments, order books of construction companies, and distribution of public servants among different locations.

Of the thirteen provinces of colonial Korea, five northern provinces belong to North Korea, and six southern provinces form parts of South Korea, with the remaining two – Kyŏnggi and Kangwon – lying on the border separating the two Koreas. To divide the output of each of these provinces into two parts attributable to South and North Korea, we used population shares as derived in Section 3. Table 2 presents GDP for southern Korea thus obtained: GDP table for northern Korea may be derived by subtracting Table 2 from Table 1.

Switching from SNA 68 to SNA 93 in 2004, the Bank of Korea converted the national accounts from 1970 to 2003, originally calculated in SNA 68, into the new format.[8] Therefore, nominal series in Table 1 can be linked with the South Korean national accounts from 1970 after making adjustment for changes in currency unit, i.e. dividing colonial amounts expressed in the *yen* with 1000 to obtain post-colonial *won* figures. Joining colonial and South Korean series in constant prices requires GDP deflator spanning the pre- and post-1945 decades, which however is as yet unavailable, Kim and Park's (2007) consumer price index from 1936 to 1956 being the only available price index bridging colonial and postcolonial decades. Bank of Korea's national accounts from 1953 to 69 remain in SNA 53 and cannot readily be converted into SNA 93.

3. Population, 1911–1940

In 1925 the colonial government carried out the first ever modern census in Korea, which was followed by four more colonial censuses in 1930, 1935, 1940 and 1944. The reports published following these censuses indicated, among others, that mortality fell consistently causing the Korean population to grow 1.4% per year from 1925 to 1940, although out-migration occurred on a substantial scale (Kwon and Kim (2002, pp. 249–50)). For the pre-census period, i.e. 1910–1924, the Statistical Yearbook provides the number of Korean residents, which increased at the rate of 1.7% per year during the pre-census period. Demographers believe the growth rate to be an overestimate, because the number of residents at the beginning of colonial rule is an underestimate (Ishi (1972, p. 60); Kwon (1977, p. 21)). One of the most convincing pieces of evidence for underestimation is provided by Park (2008), who found that the pre-1925 number of Korean residents was exceeded by the lower bound measure of population he calculated. Park's (2008) criterion refers to the sum of population by age, which was derived by applying the following formula to the Korean population by age in 1925 backwards and recursively:

$$ {}_xN_{t-1} = {}_{x+1}N_t + {}_xD_t + {}_xM_t, \tag{1} $$

where ${}_xN_t$, ${}_xD_t$, and ${}_xM_t$ refer to the number of population at age x at the end of year t, incidence of death and net-migration at age x during year t, respectively. Eq. (1) yields lower boundary for pre-1925 population, because, as Park (2008) estimated, information on ${}_xD_t$ (also available from the Statistical Yearbook) left out at least 29.5% and 20.1% of male and female deaths, respectively.

Ishi (1972) estimated population in 1920, 1915, and 1910 by applying pre-1925 age specific survival ratios (ASSR or ${}_xp_5$, hereafter) – a measure of mortality showing the probability of surviving from age x to age x + 5 – as extrapolated from linear trends fitted to ASSR's in 1925, 1930, 1935, 1940, and 1944. One difficulty with this approach is that the assumption of ${}_xp_5$s following linear trends throughout the colonial decades has little empirical basis. More problematic is that the post-1924 trends in ${}_xp_5$s as estimated by Ishi (1972) are upward for some age groups and downward for others, although mortality transition normally entails improvement in survival probability for all age groups.[9] Finally, Ishi (1972)'s estimate of pre-1925 population remains below Park's (2008) lower boundary.

[8] Adopting chained price indices in 2009, the Bank of Korea further revised post-1970 national accounts and made the results available on its website.

[9] Ishi's (1972) ${}_xp_5$s trend in different directions, probably because he did not take out-migration into account, which occurred on an extensive scale and at different rates for different age groups.

Table 2
Gross domestic product of South Korea, 1911–1940.

	Agriculture, forestry and fishing	Mining and manufacturing	Electricity, gas and water supply	Construction	Services	Gross value added at basic price	Taxes less subsidies on products	Gross domestic product at market price
A. Gross domestic product by kind of economic activity of South Korea, 1911–1940 (at current prices, unit: million yen)								
1911	231.3	15.7	0.3	4.9	91.1	343.3	1.8	345.1
1912	271.6	17.4	0.4	5.3	107.9	402.7	2.4	405.1
1913	307.8	19.8	0.6	5.5	116.6	450.3	2.7	453.0
1914	274.2	21.5	0.8	5.6	111.7	413.8	2.7	416.5
1915	226.4	24.6	0.9	5.2	110.4	367.6	3.2	370.8
1916	268.0	26.3	1.5	5.7	122.6	424.3	4.0	428.3
1917	391.6	35.3	1.5	7.3	155.2	590.9	6.7	597.6
1918	627.5	54.9	4.6	11.5	227.7	926.2	10.0	936.2
1919	829.3	81.3	4.5	21.7	333.3	1270.2	18.0	1288.2
1920	836.3	67.1	5.4	25.8	348.3	1282.9	13.3	1296.2
1921	611.7	69.6	4.3	29.1	324.2	1039.0	16.7	1055.7
1922	691.3	67.5	4.6	29.3	340.5	1133.2	18.8	1152.1
1923	670.1	75.8	4.8	27.3	347.7	1125.7	12.2	1137.9
1924	717.5	79.5	4.9	24.3	358.6	1184.7	14.6	1199.3
1925	762.5	80.2	5.0	23.7	369.6	1241.0	16.4	1257.4
1926	714.1	85.2	5.3	22.3	375.6	1202.5	20.4	1222.8
1927	703.4	82.0	6.0	22.2	389.5	1203.0	20.2	1223.2
1928	598.3	82.8	6.6	28.3	402.5	1118.5	19.7	1138.2
1929	549.8	77.3	6.8	35.0	401.1	1070.0	21.0	1091.0
1930	429.0	61.6	7.7	33.4	354.4	886.0	21.3	907.3
1931	414.1	48.7	8.2	26.0	331.7	828.8	22.6	851.4
1932	476.0	62.1	8.5	24.8	349.1	920.4	19.1	939.5
1933	512.5	74.4	8.7	24.3	375.7	995.7	22.3	1018.0
1934	595.4	91.4	10.5	29.4	416.9	1143.6	22.7	1166.3
1935	702.0	115.0	12.5	41.2	481.9	1352.5	26.7	1379.2
1936	639.4	131.6	15.9	54.2	538.0	1379.0	31.0	1410.0
1937	906.8	160.9	20.6	59.1	626.4	1773.8	31.6	1805.5
1938	877.3	197.5	25.5	65.2	696.3	1861.7	37.4	1899.1
1939	793.8	250.8	29.0	75.3	809.1	1957.9	39.7	1997.6
1940	1160.2	315.9	33.2	107.5	946.9	2563.7	36.1	2599.8

B. Gross domestic product by kind of economic activity of South Korea, 1911–1940 (at 1935 prices, unit: million yen)

1911	424.6	23.5	0.1	7.6	165.3	588.4	2.9	650.1
1912	414.7	25.6	0.2	7.4	174.6	589.6	3.8	647.7
1913	455.9	28.9	0.2	7.7	185.2	642.7	4.1	703.7
1914	489.6	32.4	0.3	8.5	199.9	693.1	4.2	763.6
1915	478.0	38.8	0.4	8.8	218.5	708.3	5.3	780.5
1916	502.8	39.0	0.6	9.3	225.8	740.1	5.5	822.5
1917	533.5	43.0	0.6	9.1	227.3	774.9	7.0	860.1
1918	573.6	49.1	1.2	10.6	232.9	828.8	7.7	903.6
1919	522.5	56.6	1.1	15.7	239.0	797.2	11.3	873.1
1920	566.3	52.6	1.1	16.0	242.1	839.5	8.6	939.0
1921	571.7	58.4	0.9	23.3	276.3	889.9	12.8	971.1
1922	583.1	58.1	1.1	23.2	280.0	905.4	14.8	986.5
1923	576.5	66.4	1.4	22.2	291.9	918.4	9.6	1003.5
1924	545.6	68.1	1.6	18.7	286.3	882.3	10.9	956.7
1925	582.2	69.1	1.8	19.0	292.1	925.2	12.2	996.5
1926	599.4	77.3	2.0	18.0	318.0	972.7	16.3	1051.2
1927	645.2	75.8	2.4	18.5	345.8	1042.9	17.0	1122.3
1928	542.4	76.8	2.0	24.6	354.3	959.9	16.8	1054.2
1929	539.4	74.7	2.0	32.1	368.1	976.3	18.9	1069.6
1930	618.5	72.3	2.6	34.3	407.4	1087.3	23.6	1187.1
1931	599.4	63.6	3.0	29.4	407.5	1058.7	28.7	1194.6
1932	642.2	73.8	3.3	28.5	410.1	1114.7	22.7	1212.4
1933	651.8	82.1	3.5	25.7	424.6	1147.4	24.2	1257.0
1934	654.1	97.3	7.5	29.8	445.2	1222.3	24.1	1291.0
1935	702.0	115.0	12.5	41.2	481.9	1352.5	26.8	1379.2
1936	603.9	121.6	10.2	52.3	519.8	1293.6	29.4	1347.4
1937	823.4	133.2	10.1	48.7	558.6	1540.9	26.2	1609.6
1938	721.4	152.1	11.1	45.7	582.0	1481.8	28.3	1569.6
1939	472.7	171.0	18.7	46.2	555.6	1271.9	25.9	1314.8
1940	640.5	193.9	22.3	59.8	616.4	1552.5	20.8	1611.1

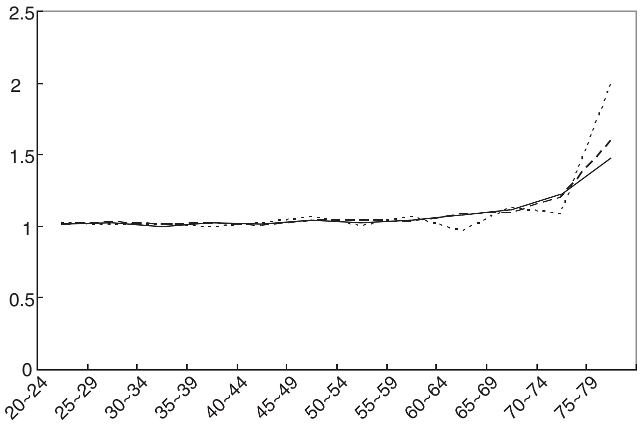

Fig. 1. Age-specific survival ratio of *Yangban* males/age-specific survival ratio of all males, 1925–1940. *Note*: solid, broken, and dotted lines refer to 1925/30, 1930/35, and 1935/40, respectively. *Source*: genealogies of four *yangban* clans; census reports of 1925, 1930, 1935, and 1940.

In this section, we estimate pre-census population of Korea combining mortality information provided by census results and genealogies, the latter being one of the key sources of demographic information for the pre-census years. Korean genealogies typically provide vital data only for those fortunate enough to be males born into a privileged class (known as *yangban*) and surviving into adult life. Therefore, age specific survival ratio of *yangban* males can be estimated only for age groups older than nineteen. In the following, we explain the procedures followed 1) to convert the estimated ASSR for adult *yangban* males into that pertaining to all adult males, 2) to infer the ASSR of male infants and children from the estimated ASSR for adult males, and finally 3) to derive female ASSR from the estimated male ASSR.

ASSR was estimated by five year period from 1910 to 1940 for *yangban* males in age groups 20–24 and older using vital records found in the genealogies of four different clans: Muan Lee, Changch'on Lee, Kangnŭng Kim, and Hamyang Pak. As of 1925, the number of adult males in the four clans was 3817, which accounted for 0.08% of the Korean male population older than nineteen years in that year.[10] The four clans were based in different parts of Korea and represented different strata of *yangban* status: while Muan Lee was a branch of royal lineage producing a significant number of holders of high-ranking offices, the members of Hamyang Pak spent their lives mostly in rural areas in southeastern Korea, achieving limited success in state examinations. The shift from dynastic to colonial Korea certainly had a major impact on the fortunes of *yangban*s, because Japanese rulers repealed state examinations, bringing *yangban*s' monopolistic access to rent-seeking to an end. Nevertheless, *yangban*s survived the regime change as land-holding class: as Gragert (1994) found out, the Cadastral Survey (1910–1918) had little impact on traditional inequality in landownership. As a consequence, the landlordism continued to prevail as one of key institutions of the colonial economy until it was abolished by postcolonial land reforms.

To convert the estimated ASSR for adult *yangban* males from 1910 to 1925 into that pertaining to the whole adult male population, we calculated the ratio of *yangban* male ASSR (estimated from genealogies) from 1925 to 1940 to the that pertaining to the whole male population (estimated by Kwon (1977) using census results) in the same period. As seen in Fig. 1, the ratio exceeded one for all age groups in 1925/1930, in 1930/35, and in 1935/40, confirming higher living standards enjoyed by *yangban* males. Tending to be higher for older ages groups, the relative changed little over the three 5-year periods in terms of either level or age-profile. We obtained the average of the ratios over the three periods, which was then used to convert the estimated *yangban* male ASSR in 1920/25, 1915/20 and 1910/15 into that pertaining to the whole male population.

As Kwon (1977) found, chances of survival improved for all age groups from 1925 to 1940, but the extent of the enhancement differed not only between age groups, but also between 5-year periods, i.e. between 1925/30 and 1930/35, between 1930/35 and 1935/40, and between 1935/40 and 1940/44. However, the age profile of increment in ASSR as a proportion to the weighted average of increase in survival chances for *all* age groups remained remarkably stable from 1925 to 1944, with the ratio being much higher for male infants and elderly males.[11] Fig. 2 shows that the age pattern of increments in ASSR as a proportion to the weighted average of increase in survival chances for age groups *older than nineteen* also barely changed in the two decades following the first census.

We calculated the average of the ratios in Fig. 2 over periods, which was then multiplied with the weighted average of estimated increments in survival ratio for age groups older than nineteen, say, from 1920/25 to 1925/30, to arrive at increase in survival ratio for all age groups between the two 5-year periods. The extent of improvement in survival ratio for all age groups from 1915/20 to 1920/25, and from 1910/15 to 1915/20 was estimated in the same manner. Deducting from male ASSR in 1925/30 the

[10] Compare this with 0.66%, the number of living individuals in families reconstituted as a share of the English population in 1801. Wrigley, et al. (1997: 20).

[11] Population shares of different age groups were used as weigh-share indices in calculating the weighted average. Infants and children benefitted from a larger decline in mortality than older age groups in mortality transitions occurring in colonial Taiwan, in pre-1900 Sweden, and in Chicago in the late nineteenth to early twentieth centuries. See Barclay (1954: 154, Table 37), Johansson (2004), and Ferrie and Toresken (2005).

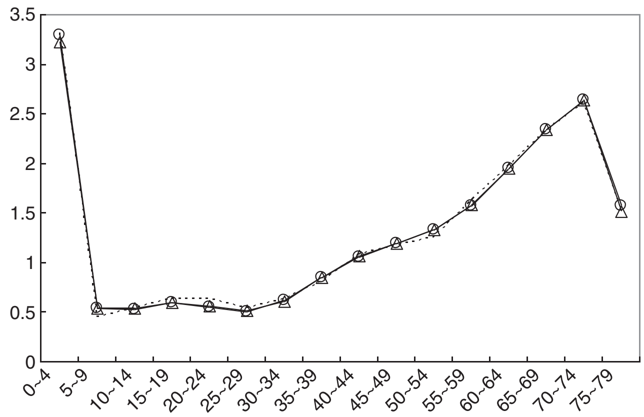

Fig. 2. Increase in male age-specific survival ratio as a proportion to the weighted average of increase in male age-specific survival ratio of age groups older than nineteen. *Note*: triangles, dots, and circles refer to increase in male ASSR from 1925/30 to 1930/35, from 1930/35 to 1935/40, and from 1935/40 to 1940/44, respectively. Source: Kwon (1977).

Table 3
Population of Korea, 1910–1940 (persons).
Sources: prior to 1925, see text; from 1925 on, census reports.

	Korea			Southern Korea
	Korean	Non-Korean	Total	
1910	16,272,203	195,407	16,467,610	10,912,924
1915	17,566,226	339,057	17,905,283	11,713,233
1920	18,296,410	395,032	18,691,443	12,439,569
1925	19,020,030	502,915	19,522,945	12,831,402
1930	20,438,108	620,197	21,058,305	13,724,203
1935	22,208,102	690,936	22,899,038	14,835,769
1940	23,547,465	778,862	24,326,327	15,438,681

Table 4
Growth accounting for Korea, 1911–1940.
Sources: see text.

$\Delta Y/Y$	$\alpha \cdot \Delta N/N$	$\beta \cdot \Delta K/K$	$(1\text{-}\alpha\text{-}\beta) \cdot \Delta T/T$	$\Delta A/A$
3.6%	0.6%	1.7%	0.1%	1.3%

Table 5
Sectoral growth accounting, 1911–1940.

	Agriculture	Mining	Manufacturing	Nontradables
TFP growth	−0.03%	−1.2%	0.6%	1.3%
Output growth	1.5%	11.4%	8.3%	5.7%
Contribution	−0.02%	−0.02%	0.1%	0.4%

Notes: Agriculture includes fishery and forestry as well; “Contribution” refers to sectoral productivity growth rate multiplied by the sector's share in GDP.

estimated increase in male ASSR from 1920/25 to 1925/30 gives male ASSR in 1920/25, from which the estimated increases in male ASSR from 1915/20 to 1920/25 may be subtracted to arrive at male ASSR in 1915/25, and so on.

Finally, Kwon (1977: 91) observed that “mortality decline appears to have been larger for females than for males during the four decades between 1925 and 1965.” We assumed and estimated a linear relation between Kwon's (1977) estimate of female and male ASSR for 1925–1944, which was used to derive female ASSR from the estimated male ASSR for 1910–1925.

Having obtained pre-census ASSR for males and females in all age groups, we estimate pre-1925 Korean population following “the method of reverse survival ratio,” which refers to deriving population in year *t-5* by dividing the population in year *t* with the

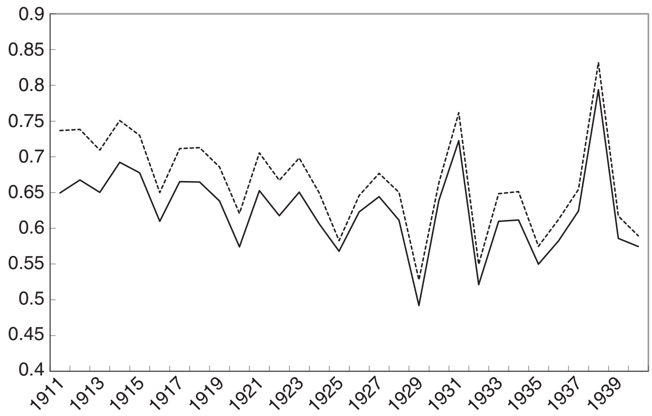

Fig. 3. Per capita rice availability in Korea (*sok* of polished rice). *Note*: solid and dotted lines represent, respectively, per capita rice availability as calculated using population estimate presented in this article and population figures available from the *Statistical Yearbook of Korea*.
Sources: *Statistical Yearbook of Colonial Korea*, various years and see text.

ASSR pertaining to the period from *t-5* to *t*. Prior to applying this method, we added net out-migration occurring from 1910 to 1925 to the number of Korean residents in 1925 to arrive at the number of Koreans by sex and age group who would have remained in Korea in 1925 had there been no migration.[12] Then, we divided the hypothetical population by sex and age group with corresponding $_xp_5$s for 1920–1925 to derive the number of Koreans by sex and by age group who would be residing in Korea in 1920 in the absence of migration from 1910 to 1920.[13] From the hypothetical population by sex and age group in 1920 we subtracted net out-migration from 1910 to 1920 to derive actual population by sex and by age group in 1920.[14] Recursive application of this procedure backwards yields the number of Korean residents by sex and age group in 1915 and 1910.

Comparison of the non-Korean population figures as recorded in census reports with those found in the Statistical Yearbook suggested that the latter are underestimates. Hence, we calculated the ratio of the non-Korean population as given in census report to the non-Korean residents as recorded in the Statistical Yearbook in 1925, which was used to inflate pre-1925 non-Korean residents as available from the Statistical Yearbook.

The population estimate thus derived is presented in Table 3. Korean and non-Korean population increased 1.3% per year from 1911 to 1940, which together with the aggregate output expanding 3.6% per year imply per capita output growing 2.3% per year during the three decades.

We estimate the population of southern Korea using the number of Korean and non-Korean residents by province as available from the Statistical Yearbook. Although these numbers are almost certainly underestimates, we assumed that they can be used to derive provincial population shares, which were then multiplied with the population total as estimated above to arrive at provincial population. To divide the population of two provinces lying across the border separating North and South Korea, Kyŏnggi and Kangwon, we followed Moon's (2006) procedure, which draws on the number of population by county (*kun*) and township (*myŏn*) as published in the Statistical Yearbook. The rightmost column of Table 3 presents the population of southern Korea thus derived.

4. Capital accumulation vs. productivity advance

Was the colonial growth driven primarily by capital accumulation or by improvement in productivity? We shall begin by estimating the rate of TFP growth using the primal approach to growth accounting and then compare the outcome with a TFP growth estimate obtained by dual approach.

Land and labor input growth rates are either readily available or calculable. Park (2006, pp. 29–33, 409) estimated the rate of acreage expansion to be 0.2% per year. We set labor input growth as equal to the growth rates of Koreans aged from 15 to 64, which was 1.1% per year. As the colonial government never carried out a national wealth survey, we drew on the perpetual inventory method to derive capital stock from capital formation and depreciation data. Assuming gross investment to have grown at a constant rate (g) from the distant past up to 1911, capital stock total for 1911 may be obtained by dividing gross investment in 1911 with the sum of g and depreciation rate (δ) (Young (1995, p. 652)). As Young (1995) did to estimate South Korean capital stock series, we set g equal to the growth rate in the first five years of our estimate of gross investment. While Young (1995) borrowed U.S. depreciation rates, we chose to allow δ to be determined internally by our estimate of capital consumption.[15] The Korean capital stock thus estimated grew 6.6% per year from 1911 to 1940.

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[12] In doing so, we assumed that migration started from 1910. Net out-migration by sex and by age interval is available from Kwon (1977, pp. 356–61).

[13] For instance, dividing the male population between age 20 and 24 in 1925 by male $_{15}p_5$ for 1920–1925 gives the number of males aged between 15 and 19 in 1920 who would have been in Korea in the absence of migration from 1910–1920.

[14] To derive pre-1925 out-migration by sex and by age, we first added up Chaeil Pak's estimate of pre-1925 migration to Japan and Doosub Kim's estimate of pre-1925 migration to Manchuria, which are available from Kwon and Kim (2002: 251). The migration total was then multiplied with age distribution of out-migration from 1925 to 1940 by sex, which was calculated from Kwon (1977, pp. 356–61).

[15] The depreciation rate turned out to be 7.9%.

We derived aggregate factor shares as weighted averages of sectoral factor shares, using sectoral shares in GDP as share-weight indices. For agriculture, we calculated factor shares in value-added output from Ban's (1973, p. 187) estimate of the composition of gross agricultural output in 1933. For manufacturing, mining, construction, public utilities, and service, we chose to use Young's (1995, p. 660) factor share estimates for South Korea in the early 1960s, rather than try to estimate factor shares in these sectors by combining inadequate data and unsubstantiated assumptions. Again we justify this practice by referring to the fact that colonial and early post-colonial Korea were similar in terms of living standards and economic structure.[16] The aggregate factor shares thus derived are 0.51 for labor, 0.26 for capital and 0.23 for land, and the growth accounting results obtained using these numbers are presented in Table 4.

The primal estimate of TFP growth (1.3%) turns out to account for more than one third of output growth (3.6%) and more than one half of per capita output growth (2.3%). This is likely to be an upper bound measure, since the input growth rates used in the calculation do not take quality improvement into account: in particular, in our labor input series is not incorporated the effect of rising educational attainment during the colonial period.

Hence, it would be useful to compare the primal with a dual estimate derived as a weighted sum of factor price growth rates. Weighted average of Cha and Lee's (2007) estimate of unskilled and skilled real wage, calculated using the share of skilled and unskilled workers in the work force as weights, increased 1.2% per year from 1910 to 1942. We calculated the rental rate of capital following the standard Hall and Jorgenson (1967) formula to find that it neither rose nor fell as a matter of trend.[17] Given that landlords normally took a fixed share of gross farm output in colonial Korea, we derived a growth rate of rent per acre by subtracting the rate of acreage expansion (0.2%) from the rate of agricultural gross output growth (1.9%). These factor price growth rates together with the factor shares used for the primal approach imply total factor productivity improving 1.0% per year from 1911 to 1940, a growth rate slower than the primal estimate. A similar gap exists between primal and dual estimates of TFP growth in South Korea: Young's (1995, p. 660) "raw" labor and capital input growth rates give a total factor productivity growth of 2.7% per year from 1966 to 1990, while Hsieh's (2002, p. 509) estimates based upon factor prices is 1.9%.[18]

Although the primal approach may overstate the pace of productivity growth in the absence of input data accurately reflecting both quantity and quality changes, it can be used to compare rates of technological progress across sectors. Manufacturing vis-à-vis agricultural prices and nontradable vis-à-vis tradable prices fell as a matter of trend in colonial Korea, which indicates that the rise of manufacturing and nontradables at the expense of agriculture was attributable primarily to supply shocks. Therefore, sectoral TFP growth estimates in combination with information on sectoral factor intensity may shed light on the causes driving the structural shifts in colonial Korea.

The first row of Table 5 presents primal estimates of TFP growth in agriculture, mining, manufacturing, and nontradables.[19] The rates of total factor productivity growth in agriculture and mining were negative, while manufacturing and nontradables (including construction, gas, electricity, water, and service) registered positive TFP growth.[20] Agriculture's share in the aggregate output fell rapidly, not only because manufacturing and nontradables achieved productivity growth, but also because capital accumulation and the consequent rise in capital/labor ratio discouraged the growth of agriculture, a relatively labor intensive sector. In contrast, mining managed to increase its share in the aggregate output despite negative productivity growth, because the rising capital/labor ratio favored the development of the capital intensive sector. TFP growth was significantly higher in nontradables than in manufacturing, which is consistent with the expanding share of nontradable sectors in the aggregate output at the expense of tradable sectors (including agriculture and manufacturing): given the rising capital/labor ratio in colonial Korea and the higher capital intensity of tradable vis-à-vis nontradable sectors, nontradable output as a share of GDP would have contracted, had technological progress in nontradable sectors been slower than or similar to that in manufacturing.[21] In sum, the sectoral growth accounting indicates that colonial industrialization was driven by both capital accumulation and faster productivity advance in manufacturing, while even faster productivity growth propelled the rise of nontradable sectors, including public utilities, construction, and service.

[16] Direct observations in 1933 and in the early 1960s confirm that agricultural factor shares hardly shifted in the intervening three decades. See Ban (1973, p.187).

[17] We tried three different rental rates of capital using the moneylender rate, bank loans rate, and the deposit rate, none of which was found to contain a time trend.

[18] 1.9% is the average of Hsieh's (2002)'s three different TFP growth estimates, which is comparable to 1.7%, Young's (1995) estimate of productivity growth using "weighted" labor and capital input growth rates.

[19] We derived sectoral capital stock by the perpetual inventory method, setting rate of depreciation in all sectors equal to the average depreciation rate (7.9%) and the investment growth rate up to 1911 equal to the investment growth rate in each sector from 1911 to 1916. Our estimate of sectoral labor input is based on the sectoral population data available from the Statistical Yearbook, sum of which is substantially smaller than our population estimate. Therefore, these figures were used to calculate sectoral population shares, which were multiplied with our population estimate to obtain sectoral population. Multiplying the sectoral population with the share of persons aged from 15 to 64 yielded sectoral labor force. This procedure produced numbers for the mining and manufacturing work force combined, from which we subtracted the number of mining workers (available from *Chōsen kōgyō no sūsei*) to derive the number of manufacturing workers.

[20] Ban's (1973) growth accounting for gross agricultural output indicated that total factor productivity grew −0.01% p.a. from 1920 to 1939. Given that irrigation facilities were being expanded and improved rapidly in the 1920s under the Rice Production Development Program, it would seem worthwhile to compare the result of agricultural growth accounting result between the 1920s and 1930s. While agricultural capital stock grew at a significantly faster rate in the 1920s than in the following decade (14.01% from 1919/21 to 1929/31 vs. 2.01% from 1929/31 to 1938/40), value-added agricultural output grew somewhat more rapidly in the 1930s than in the preceding decade (1.13% from 1919/21 to 1929/31 vs. 1.36% from 1929/31 to 1938/40). The implied total factor productivity growth rates are − 1.10% from 1919/21 to 1929/31 and 0.81% from 1929/31 to 1938/40, which together with the decadal output growth rate, suggest that it took time for irrigation facilities to be built or to have positive impact on agricultural production or both.

[21] Productivity advance was faster in nontradable sectors than in manufacturing in late nineteenth century Germany and post-WWII OECD countries as well. See Bernard and Jones (1996) and Broadberry (1998).

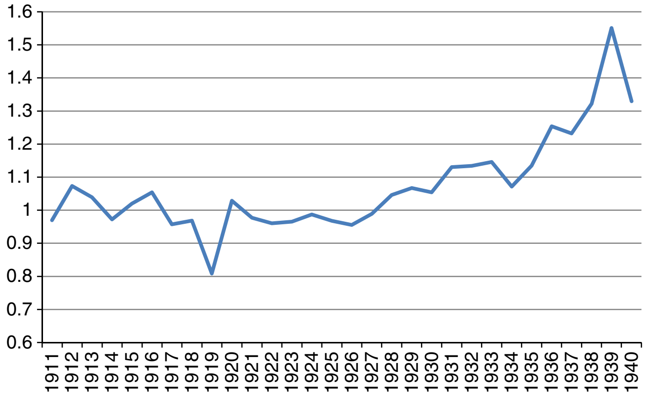

Fig. 4. Northern/Southern per capita GDP.
Source: see text.

The bottom row of Table 5 shows the contribution to overall TFP growth made by individual sectors, which was obtained by multiplying sectoral TFP growth with sectoral share in GDP. Nontradables played a prominent role in technological progress in colonial Korea, leaving manufacturing a distant second. Sectoral contributions add up to 0.5%, about one third of the primal estimate of TFP growth of the aggregate economy. The remaining two thirds are to be attributed to productivity growth due to reallocation of resources from less to more productive sectors as well as to productivity growth in non-market sectors, including public service and education.

5. Implications of the new estimate

Pessimism prevails in well-known accounts of the economic history of colonial Korea, one of important pieces of supporting evidence being the apparently downward trend found in the amount of rice available per Korean as derived by dividing domestic rice supply (=rice output plus net rice imports) with Korean population.[22]

In Fig. 3 two distinct estimates of rice availability per Korean are shown, one obtained by dividing domestic rice supply with the number of Korean residents given in the *Statistical Yearbook* (dotted line) and the other with Korean population as estimated in Section 3 (solid line). The dotted line contains a negative time trend statistically significant at 5% level, which is absent in the solid line, which indicates that the traditional narrative of starvation suffered under colonial rule is an artifact of overestimated population growth, resulting from underestimation of population at the beginning of the colonial period. Moreover, as indicated by our estimate of the national account, per capita food consumption increased 1.4% per year from 1911/3 to 1938/40. This is in line with upward trends found in other indices of living standards, including real wages of unskilled workers and male stature (Cha and Lee (2007); Choi and Schwekendiek (2009)).

Spending on food items as a proportion of total consumption – Engel coefficient – is known to be inversely correlated with living standards. Our estimate of Korean national accounts indicates that Engel's coefficient fell consistently from 74.6% in 1911/3 to 63.4% in 1938/40 in Korea, remaining higher than in Taiwan, where people appeared to enjoy higher living standards. In contrast, Engel coefficient as implied by Mizoguchi and Umemura (1988: 279)'s estimate of the national account of Korea is exceeded by that calculated for colonial Taiwan.

Mizoguchi and Umemura's (1988, p. 238) estimate of the aggregate output grows more rapidly than our estimate, i.e. 4.0% vs. 3.7% per year from 1911/3 to 1936/8, implying a correspondingly faster growth in per capita output, i.e. 2.7% vs. 2.4%. Steckel (1995: 1914) estimated that one per cent growth in per capita output results in an increase of 0.0397 cm in adult height, which implies that the average adult height in colonial Korea would have risen either by 2.7 (=0.0397*2.7*25) cm (according to Mizoguchi and Umemura (1988)'s estimate) or by 2.4 (=0.0397*2.4*25) cm (according to our estimate) from 1911/3 to 1936/8. This prediction may be compared with two existing estimates of height increase in colonial Korea. Analyzing height data generated from police examination of bodies of persons dying unidentified on the road, Kim and Park (2008:10) concluded that their stature increased by 2.4 cm from 1914 to 1944. And Choi and Schwekendiek (2009) pooled and analyzed four different sets of height data to find that adult height increased by 2 cm from 1910 to 1945. This suggests that Mizoguchi and Umemura (1988) may have overestimated output growth.

Maddison (1995: 2003) divided the aggregate output of colonial Korea by applying to the Mizoguchi and Umemura's (1988) output estimate southern Korea's share in 1940 as derived by Kim and Roemer (1979: 23). The underlying assumption of the aggregate output in northern and southern Korea growing at the same rate not only remains unsubstantiated, but also contradicts narrative accounts saying that the north was being industrialized more rapidly than the south. Our estimate confirms that the

[22] Notable examples include, among others, Tōhata and Ōkawa (1935), Grajdanzev (1944), and Suh (1978: 86). Prominent agricultural economists of Japan, Tōhata and Ōkawa (1935) left a lasting influence on historiography of the economic development of colonial Korea.

north achieved substantially faster growth in manufacturing, mining, and electricity output, which resulted in the decline of southern share in GDP from 65% in 1911/3 to 56% in 1938/40.

To derive per capita output of southern Korea, Maddison (1995; 2003) used Suh's (1978) estimate of population for southern Korea, which includes Koreans only and excludes Japanese and other foreign residents in Korea. Moreover, it was derived by assuming population growth in southern Korea from 1910 to 1925 being the same as that for the whole Korea from 1925 to 1940, which lacks empirical basis. In fact, as revealed by our estimate, the pace of demographic expansion in the two halves of colonial Korea differed significantly, with population growing 1.2% and 1.5% per year from 1911/3 to 1938/40 in the south and north, respectively. Given that GDP expanded 3.0% and 4.5% per year in the two regions from 1911/3 to 1938/40, the south and north saw per capita output growing 1.8% and 3.0% per year, respectively. These growth rates are consistent with findings that workers in southern Korea migrated to the north, where wages were rising faster (Park (2000); Cha and Lee (2007)). In addition, Pak et al. (2009) found that Koreans born in the 1930s in the north were taller than those born in the south.

As the north/south per capita output ratio (Fig. 4) indicates, per capita output in the north tended to be lower than that in the south in early colonial years, but by 1940 the northern per capita output was more than one third higher than that in the south. While interregional convergence probably is a part of the explanation of the shift in the north/south output gap, the rapid rise in the north/south ratio from around 1930 indicates the north's catching up with and forging ahead of the south was primarily a consequence of the industrialization in the 1930s, which was in large part driven by inflows of Japanese capital attracted by iron ore, coal, and water power located in the north.

Per capita output growth in colonial Korea, 2.3% p.a. from 1911 to 1940, was considerably slower than that occurring in South Korea, 7.9% p.a. from 1960 to 1990. Nevertheless, colonial Korea surpassed the rest of the world in growth performance as did South Korea: Angus Maddison's estimated that the world average per capita output grew 0.93% per year during 1913–1940 and 2.3% per year 1950–1990.[23] In contrast, not only did growth ground to a halt in North Korea, but also the country began to suffer worsening living standards from around 1990, repeating the performance as delivered by late dynastic Korea. The superior performance of northern relatively to southern Korea under Japanese rule indicates that North Korea has only itself to blame for its economic failure.

One policy choice to reverse the fortunes of the two Koreas appeared to concern whether colonial system was allowed to continue to function. Colonial institutions were designed to stimulate investment, rather than to facilitate extraction, the most important example being well-defined land property as introduced by the Cadastral Survey.[24] Replacing such useful institutions with a system of command in North Korea had disastrous consequences, while in the absence of a regime shift South Korea was able to continue to achieve high growth, as Taiwan and Japan were.[25]

6. Conclusions

In this article, we presented a fresh set of output and population estimates for colonial Korea. While existing population figures for pre-census decades reflect either the growth of the colonial police or post-census trends in mortality, we used direct observation on mortality to estimate population from 1910 to 1925. And the new estimate output represent improvement over existing figures in terms of both the amount of information used and the consistency and rigor of procedures followed. Measured in the framework of SNA 93, the new set of figures on output and expenditure facilitates comparison of colonial and South Korean growth.

Nevertheless, it is important to draw attention to shortcomings we were unable to overcome with currently available information. In deriving the population estimate, we assumed that the structure of differential mortality between different social classes did not shift during the colonial period, which we tried to justify by showing that mortality differential between privileged class and ordinary peasants remained stable from 1925 to 1940. Either data unavailability or limited coverage of official statistics compelled us to draw on extrapolation to estimated acreage, land productivity, and output of several manufacturing items in the 1910s.

Despite these limitations, there are reasons to regard our figures as being more accurate than existing estimates. One is that the new population estimate passes Park's (2008) lower bound test, where both official enumeration and Ishi (1972)'s estimate failed. Second, Mizoguchi and Umemura's (1988) GDE figures indicate that despite living standards remaining lower in colonial Korea, a lower Engel coefficient continued to prevail than in colonial Taiwan, an anomaly not found in our estimate. Finally, per capita output growth as implied by evidence of stature growth is closer to our estimate than Mizoguchi and Umemura (1988)'s.

The revised estimates as reported in the article indicated that per capita output grew 2.3% p.a. from 1911 to 1940, which contradicts pessimistic assessment of the colonial economy as told by well-known narrative accounts, but confirms emerging evidence of improvement in living standards. Contrary to the assumptions adopted by Angus Maddison, per capita output, as well as population, expanded substantially more rapidly in the north than in the south, indicating that the origins of the economic disaster currently faced by North Korea cannot be traced to the colonial period. On the contrary, the reversal of fortune between

[23] These growth rates were calculated using figures available from http://www.ggdc.net/MADDISON/oriindex.htm.

[24] As Yoo and Steckel (2010) show, legalized property rights allowed farmers to obtain loans from banks, hence encouraged investment in irrigation and financial development.

[25] Why did then Japanese set up institutions encouraging investment, rather than extraction, in Korea? Acemoglu et al. (2001) suggests that low mortality of Japanese settlers in Korea may be an answer, as indicated by their crude death rate never exceeding 24 per thousand.

the two Koreas confirms that North Korea inflicted a grave wound on itself by taking apart the institutional legacy of Japanese colonialism, which, as the high-growth of South Korea, Japan, and Taiwan throughout the twentieth century suggests, had helped growth.

Appendix A. Technical note

Technical note to this article can be found online at doi:10.1016/j.eeh.2011.09.003.

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