Interwar U.S. and Japanese National Product and Defense Expenditure

William D. O'Neil

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William D. O'Neil
Vice President and Chief Scientist
Contact: oneilw@cna.org

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Contents

Background

This memorandum documents the derivation of estimates of Japanese and U.S. economic resources and of their application to military purposes between the two world wars.

Data sources

Japan and its colonies

As the first extra-Western economy to match Western standards of performance, Japan has come in for special scrutiny from economists and economic historians. While much of this work has been done by Japanese economists and published in Japanese, the material available in English is extensive and adequate for the purposes of this effort.

As the concepts and procedures of national income accounting developed in the 1930s and 1940s, various efforts were made to apply them to Japan. These are summarized in a study of the Japanese economy published following the war by Jerome Cohen, an economist associated with the United States Strategic Bombing Survey (USSBS). [1] The USSBS itself studied the Japanese economy in the wartime years and published estimates of wartime national product. [2]

The USSBS efforts were bedeviled by inadequacies in the source records, wide scale destruction of records in the war and immediately following it, and Japanese official secrecy. While these obstacles have not been altogether eliminated, subsequent research has done much to minimize their effect.

Beginning in the 1960s, a major effort by Japanese economists led to the publication of a comprehensive 14-volume series covering all

aspects of Japanese historical statistics. This was published in Japanese, but has English summaries and table headings and is usually cited as LTES (*Estimates of Long-Term Economic Statistics of Japan*). [3] A further volume published in English by the same group, *Patterns of Japanese Economic Development* (PJED), summarizes the results and in a few cases revises them somewhat. [4] More recently, Toshiyuki Mizoguchi and Noriyuki Nojima have published revised estimates for pre-war Japan and its colonies.[1] [5] The same authors have also published estimates for the war years separately. [6] I have relied primarily on data from Mizoguchi and Nojima.

Fortunately for our purposes, economists studying Japan have seen military expenditure as an important part of the picture. Naturally, these efforts have been especially affected by records destruction and official secrecy, but a reasonably satisfactory picture has emerged, at least for the years prior to World War II.

In an early study of Japanese capital formation, Henry Rosovsky paid careful attention to Japan's investments in military capital, arguing that this served both statistical clarity and history. [7] Koichi Emi, who had collaborated with Rosovsky, revised the earlier study's estimates for his volume on capital formation in the LTES series. [8] As Emi does not include as much detail on the composition of military capital, however, I have drawn on Rosovsky's work as well as his. LTES and PJED provide data on total defense expenditures.

Takafusa Nakamura, in his study of economic development before World War II, includes statistics from a variety of Japanese-language studies which have been useful in filling in certain parts of the picture. [9]

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[1] All author names in this report have been rendered in the usual Western order with surname last.

Manchuria

Manchuria, meaning the far north-eastern provinces of China, also played a role in the Japanese economy. Japan had gained economic concessions in Manchuria in the wake of the Russo-Japanese War of 1904-05, and rights to station troops in the region to guard these interests. For most of the long civil war that followed the Chinese Revolution of 1911, Manchuria was controlled by a local warlord who did not answer to the authority of the nominal central government. Expansionist-minded Japanese army officers convinced themselves that control of Manchuria was essential to Japan's security and that its resources were a key to Japan's economic well-being. In 1931-32, they initiated a military takeover of the region. Ostensibly this was a "liberation" which resulted in the establishment of an "independent" "Empire of Manchukuo." In fact, "Manchukuo" was a de-facto Japanese colony whose economy was integrated with that of Japan.

There have been several studies of the Manchurian economy in this period. [10] Of these, Kang Chao's 1983 study provides the most comprehensive and systematic estimates of population and economic product, and these have been used here.

United States

American economist Simon Kuznets pioneered national income accounting, thus ensuring that the U.S. economy would the be the first and among the most intensively analyzed. The federal government's Bureau of Economic Affairs (BEA) includes data back to 1929 in its National Income and Product Accounts (NIPA) series, and revises the entire series as necessary in light of any new evidence. [11] For periods prior to 1929, an earlier study by John Kendrick was long the standard reference. [12] More recently, Nathan S. Balke & Robert J. Gordon, have revised these estimates. [13]

The BEA also provides data on fixed assets, including military equipment and structures. [14] Among these is a series showing

government acquisitions of fixed assets extending over the past century. [15] The NIPA provides data on defense expenditure back to 1929. The Office of Management and Budget (OMB) kept a series on national security expenditure which has been compiled and published. [16] For the period of interest, the OMB series is essentially identical with that carefully compiled and fully documented by M. Slade Kendrick. [17]

The United States of course also had colonial possessions, but these played so small a role in its economic and manpower resources that I have felt justified in neglecting them.

International and comparative

In the period between the wars, the League of Nations published voluminous yearbooks of economic and military data. [18] For the most part, the data from these are too limited in scope and concept to be of much value for this purpose, but certain data have been of help, particularly those on population, production of specific materials, and dollar-yen exchange rates.

Angus Maddison has undertaken a series of efforts in comparing economic performance of virtually all of the world's nations over time, culminating in two works that I have drawn upon for this effort. [19]

Data and estimates

Broad comparisons: GDP at PPP and life expectancy

The key issues in this study are finding the necessary data and comparing them over space and time. One framework for this is provided by the work of Maddison, who deals with the international values problem by valuing economic outputs according to *purchasing power parity* (PPP). For intertemporal comparisons he relies on price series for like goods within each economy to estimate overall price changes and uses these to deflate data to constant price levels. His standard of value is a *1990 international dollar* which in principle has the same purchasing power at all places and times as did a U.S. dollar in the domestic economy in 1990. [20]

This is a rather breathtaking program, especially as extended back over 1,000 years. While it has not won universal acceptance, it is generally admired. It is important, however, to understand certain inherent limitations.

PPP is generally different from market exchange rate, often very different. Maddison has two main reasons for choosing to use PPPs over exchange rates. For one thing, exchange rates fluctuate a good deal, especially under the influence of capital flows and government actions. And to the extent that exchange rates do reflect market prices of goods and services, these are only the goods and services that enter into international trade. Even today the things that people need and use in their everyday lives are for the most part produced locally with local inputs, and have no close economic ties to international trade. In poor countries these local goods and services are priced very low relative to manufactures, making the cost of living, or at least of subsistence, extremely low in exchange-rate terms. Anyone who has had his hair cut for a quarter in some far-off place or bought a simple but good meal for half a

dollar will understand this clearly. Thus a comparison at PPP may provide a better picture of how much value the economy truly produces, as perceived by those who live in it. A simple comparison to illustrate this point is presented in Appendix A.

I have drawn on Maddison's data for a broad comparison of the U.S. and Japanese economies over the first half of the 20th century, showing data not only for Japan proper but for the countries and regions which constituted its external empire—Taiwan from 1895 to 1945, Korea from 1911 to 1945, and the Manchurian provinces of China (effectively) from 1932 to 1945, as well as certain economically minor dependencies.

The data I have used for Japan and its empire as well as for the U.S., based on Maddison's, are shown in Table 1.

Table 1. Gross domestic product of U.S., Japan, and the Japanese external empire, at purchasing power parity, in billions of 1990 international dollars.

Year	United States	Japan proper	Empire + "Manchukuo"
1900	313	52	55
1901	348	54	57
1902	352	51	54
1903	369	55	58
1904	364	55	60
1905	391	54	62
1906	436	61	66
1907	443	63	66
1908	407	64	67
1909	456	64	68
1910	461	65	68
1911	476	68	80
1912	498	71	83
1913	518	72	85
1914	478	70	83
1915	492	76	91
1916	559	88	103
1917	545	91	106
1918	595	92	107
1919	600	101	120
1920	594	95	111

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1921	581	105	124
1922	613	105	127
1923	694	105	131
1924	715	108	127
1925	731	112	137
1926	779	113	141
1927	787	115	143
1928	796	124	152
1929	844	128	156
1930	769	119	143
1931	710	120	148
1932	616	130	178
1933	603	143	192
1934	650	143	191
1935	700	147	194
1936	799	157	214
1937	833	165	228
1938	800	176	255
1939	864	204	294
1940	931	210	302
1941	1,100	214	311
1942	1,320	215	311
1943	1,583	211	307
1944	1,716	207	301
1945	1,647	157	208
1946	1,307	120	
1947	1,287	125	
1948	1,336	135	
1949	1,341	139	
1950	1,458	161	

These data are obtained as follows:

- **United States:** Taken directly from Maddison 1995, Table C-16a, pages 182-183.

- **Japan:** Taken directly from Maddison 2001, Table A-j, page 206.

- **Japan's empire and "Manchukuo":** Maddison reports his data in terms of today's political boundaries and hence has no information directly applicable to Japan's external empire or to

Manchuria under Japanese de facto rule as "Manchukuo". Thus I have assumed that the GDPs of these areas expressed in Maddison's terms bear the same proportionate relation to that of Japan proper as they do expressed in GNP terms in constant 1934-36 yen, as shown in Table 2.

The data are plotted in Figure 1.

Figure 1. GDP comparisons. Amounts for Japan and its dependencies are cumulative.
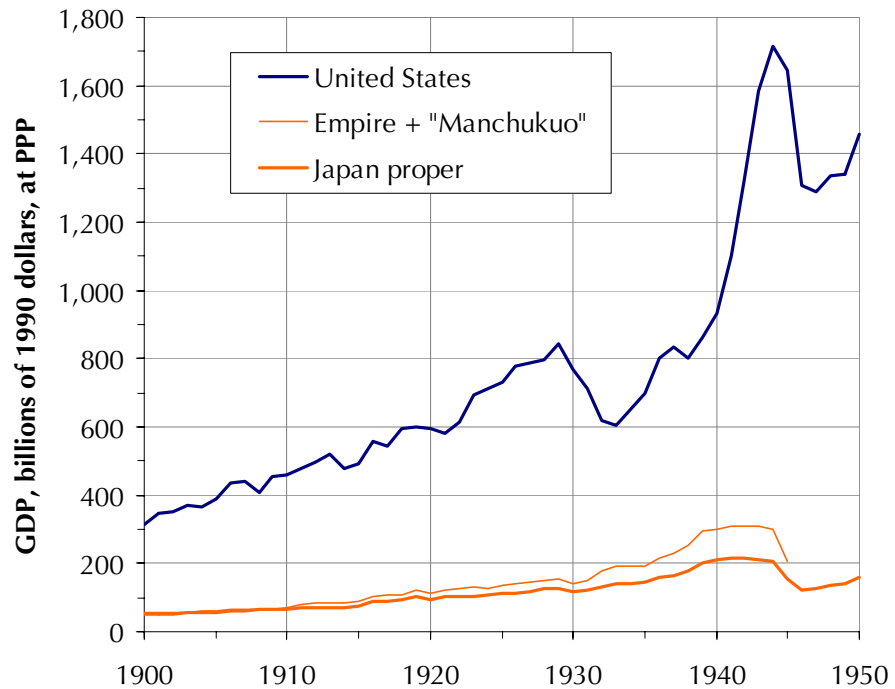
Another broad measure of welfare and overall economic strength is life expectancy. In 1935-36 the life expectancy at birth in Japan was 46.9 years for males and 49.6 years for females. In the U.S., 1930-39 overall averages were 60.6 years for white males and 64.5 years for white females. For people in the U.S. who were categorized as "colored", the figures were 50.1 years for males and 52.6 years for females. [21]

Comparison of GNP at exchange rate

Exchange rates

The data of Table 1 imply that a yen in the early 1930s was worth about $1.25. This is far from the rates as which yen and dollars changed hands in this period, as shown in Figure 2.

Figure 2. Exchange rate.
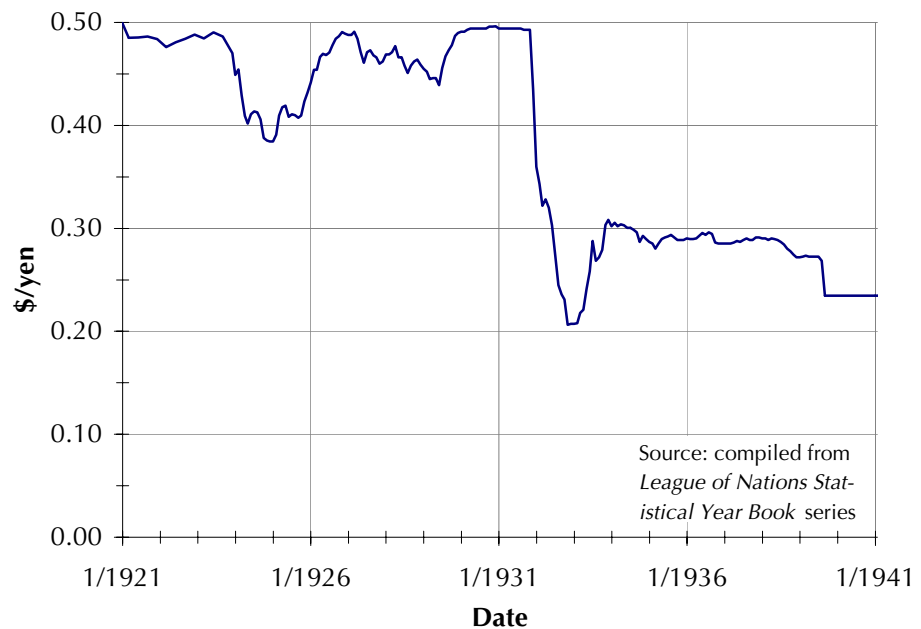
This of course reflects the discrepancies between local prices and those in international trade earlier mentioned. The goods needed in war, however, are predominantly the manufactures and industrial raw materials that figure so largely in international trade rather than the local labor and products that dominate in PPP. That is, exchange rates are in principle a better standard for comparing economies for the purpose of revealing their war-making potential.

As will be seen from Figure 2, however, the value of the yen in terms of dollars varied from a high of nearly $0.50 to a low of nearly $0.20 during this period. Did the economic value of the yen truly vary by that much? An important clue is given by Figure 3,

showing the ratio of price-level movements in the two nations, taking 1929 as the reference point. [22]

Figure 3. Ratio of price levels.[2]
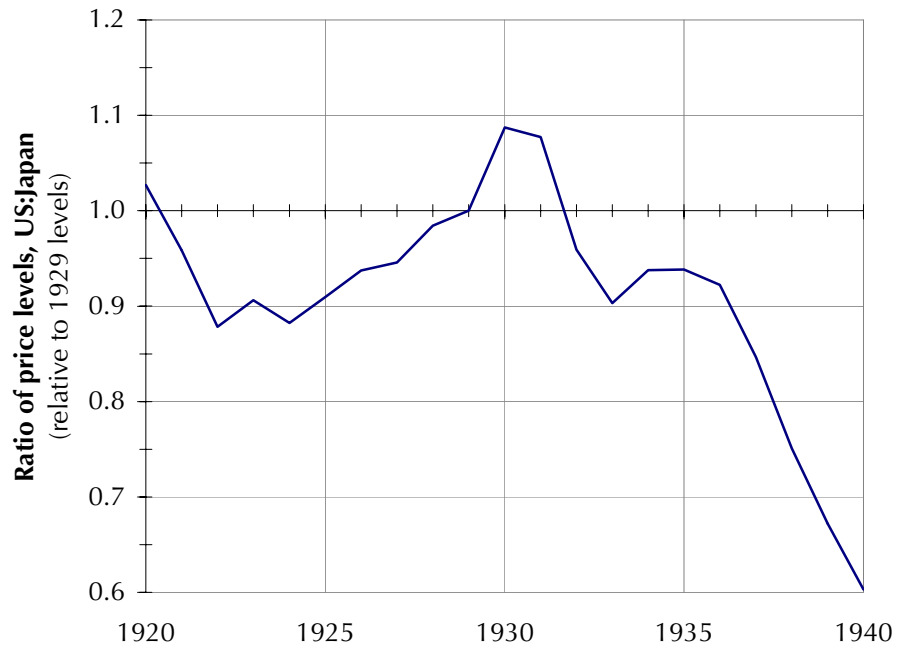
We see that prices in the two economies moved generally in parallel until the start of Japan's war with China in 1937. Thus, on a pure trade basis we would have expected exchange rates to have remained fairly stable until 1937 and then have sunk by about 40% to 1940. The explanation for this discrepancy between ideal and actual exchange rates lies in the extraordinary economic circumstances of this period.

For nearly a century prior to World War I, the international economic system had been founded on the gold-exchange standard. [23] Following the war, most major nations found themselves in very changed economic circumstances, with greatly altered economic strengths, one relative to another. It was thought essential to return to the gold standard which most had abandoned as an emergency measure during the conflict. For a variety of reasons, of

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[2] Ratio of GNP deflators.

which prestige was not the least, most strove to return to the standard at pre-war parity to gold, regardless of intervening economic trends. In many cases, this meant that the inflation of the war years had at least in part to be reversed with deflation. [24]

Japan struggled throughout the 1920s to stabilize its exchange near the pre-war parity of 0.024115 ounces of fine gold per yen, equivalent to 49.846 U.S. cents per yen. But the government faced urgent domestic needs and demands and could not afford to constrain domestic demand enough to close the balance of payments gap. Finally, based more in hope than in calculation, Japan returned to the gold standard at pre-war parity in January 1930. This was of course just as the Great Depression took hold. Japan's largest trading partner was the U.S. and with its economy collapsing the prices that Japan could get for its exports of silk fell dramatically. [25] Raw silk which had generally sold at prices near $5 per pound on the New York market through 1929 plunged to half that level by the closing months of 1930, reaching lows near $1.25 per pound 18 months later. [26]

After domestic unrest leading to a change of government, and following Britain's lead, Japan went off the gold standard forever in December of 1931. Under new finance minister Korekiyo Takahashi, Japan pioneered the closed-economy reflationary policies of a kind that most nations eventually adopted in an effort to deal with the effects of the Depression. Among other things, this involved acceptance of a sharp fall in the exchange rate as the price for loosening domestic monetary and fiscal policy, managing the resulting pressures on the payments balance through exchange and capital controls. [27]

From this perspective, the fluctuations seen in Figure 2 and their departure from the behavior of prices shown in Figure 3 become more understandable. I conclude that the true underlying trade value of the yen was close to $0.45/¥ throughout the late 1920s and early 1930s and have used this as the basis for converting yen to dollar amounts for purposes of comparing material defense potential and investment – but not for personnel-related purposes.

Japanese and U.S. GNPs

In comparing peacetime potential for defense purposes it is better (slightly) to use *national* rather than *domestic* product as the basis[3]. The estimates of Japan's gross national product (GNP) that I have used for this period are those of Mizoguchi and Nojima. In principle, GNP may be measured in any of three ways, which ought to produce identical results: one can sum final physical production and value it at market prices, sum expenditures for final products, or sum incomes earned by the productive factors. In practice, questions of data availability may make one measure or another better, particularly for periods in the past when systematic data were not collected. Generally, the Japanese economists have taken gross national expenditure (GNE) as the best estimate of their nation's GNP in the period prior to 1945. Most recent studies have taken the years 1934-1936 as the benchmark for comparisons, judging that this is a "normal" period in which economic distortions were at a minimum. Thus the data I use are those for GNE valued at 1934-36 yen prices[4].

Mizoguchi and Nojima provide no data on Manchuria. I have used those from Chao, interpolating and extrapolating to fill in amounts

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[3] National product is calculated on the basis of the ownership of the factors used in production while domestic product reflects the physical location of the factors. For large economies such as those of the U.S. and Japan the differences are usually no more than 1%. Estimation of economic resources during wartime presents special problems not addressed here.

[4] For 1903-1938 Mizoguchi and Nojima provide GDE, but also give the figures necessary to convert this to GNE. For 1940-45 only GDP is available from them, but any discrepancy between GNP and GDP is bound to be quite small relative to the uncertainties in the estimates for this turbulent period. For 1939, which falls in a gap between their two series, I have interpolated. Their data for 1940-45, which are stated in 1958 prices, have been adjusted to a 1934-36 basis by assuming that their 1940 figure is identical to that stated in PJED. As they provide no data on the empire outside of Japan proper after 1938, I have assumed that the rest of the empire added 25% to Japanese output up to its end. For 1945, only 5/8 of the output of the empire and Manchukuo has been counted, reflecting the end of the empire with war's end in August.

in the years other than those they tabulate (1934, 1936, 1939, and 1941). [28] These data are in GDP rather than GNP, but the difference is almost surely small enough to be neglected for these purposes. I have assumed that the "Manchukuo" yuan was at parity with the yen throughout this period; this was not precisely so but again the differences are small.

The resulting estimates are tabulated in Table 2 and plotted in Figure 4. The use of the term "Manchukuo" is intended not to lend any legitimacy to the fiction of this puppet state but merely to denote that I include Manchuria's product only for the period when it was under Japanese control.

Table 2. Japan's GNP, 1920-1945, at 1934-36 prices, in billions of yen.

	Japan proper	Other Empire	"Manchukuo"
1920	10.92	1.85	
1921	11.61	2.07	
1922	10.64	2.26	
1923	9.94	2.46	
1924	12.28	2.21	
1925	11.36	2.50	
1926	11.20	2.73	
1927	11.46	2.85	
1928	12.55	2.79	
1929	12.73	2.73	
1930	13.13	2.63	
1931	12.86	2.99	
1932	13.94	3.06	2.06
1933	15.72	3.10	2.36
1934	17.40	3.15	2.66
1935	18.73	3.02	2.96
1936	18.94	3.49	3.26
1937	19.63	3.91	3.56
1938	19.99	5.15	3.85
1939	21.60	5.40	4.15
1940	23.21	5.80	4.44
1941	23.72	5.93	4.73
1942	23.78	5.94	4.73
1943	23.40	5.85	4.73
1944	22.88	5.72	4.73
1945	17.35	2.71	2.96

Figure 4. Japan's GNP at constant prices. Amounts are cumulative over categories.
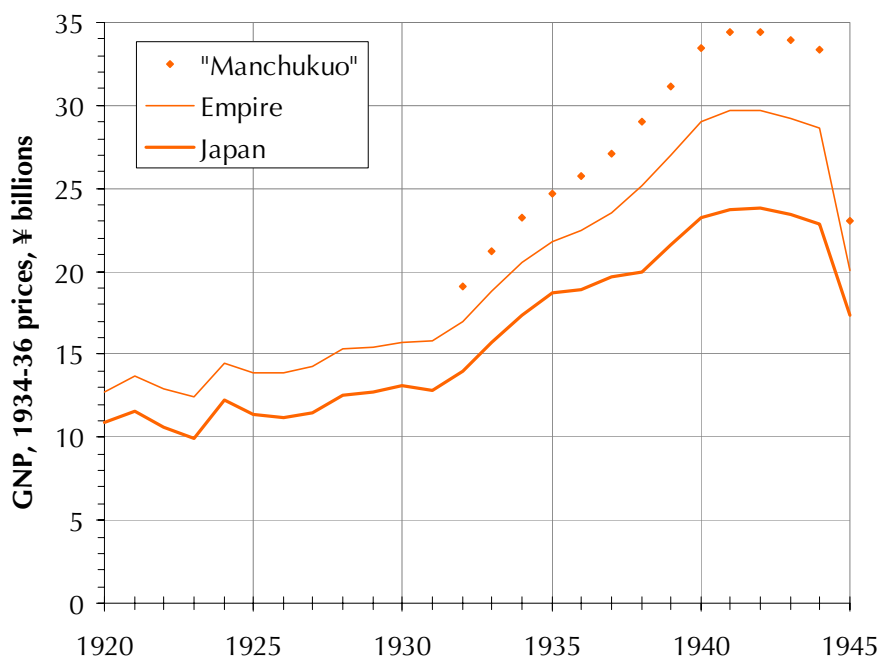
In the U.S., the BEA takes 1937 as its corresponding benchmark year. For the years 1929-1940 they give a series of GDP valued at 1937 dollar prices, but not of GNP. [29] To obtain an estimate of GNP valued at 1937 prices I have applied the implicit deflators for GDP to the data for GNP expressed in current dollars[5]. [30] The results thus obtained are not quite correct, as in general the GNP deflator will differ slightly from that for the GDP, but the error thus introduced is small compared to other approximations and uncertainties in this overall comparison.

For years up to 1929, GNP in constant 1929 dollars from Balke and Gordon has been used. [31] In calculating their series, the authors

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[5] The *implicit deflator* for each year in a composite series such as GNP or GDP is the current-value figure divided by the constant-value figure. Thus it is a composite measure of overall price changes between the base year and current year. It is usually multiplied by 100 in tables.

spliced it to the NIPA by matching values for 1929. The NIPA estimates for 1929 have since been revised slightly and I have re-matched the series to conform.

If I were to take the value of the yen in 1929 as \$0.45/¥ and multiply this figure by the ratio of the deflator of the Japanese GNP for 1934-36 to that of the U.S. GNP for 1937 dollars, I would obtain a value of \$0.443/¥. As this change is insignificant compared to the uncertainties about the value for 1929 or any other year, I have simply used a price of $\$_{1937}0.45/¥_{1934-36}$ to convert the 1934-36 yen values to 1937 dollar values.

The resulting series are tabulated in Table 3 and plotted in Figure 5.

Table 3. GNP at 1937 U.S. dollar prices, in billions.

	U.S.	Japan proper	Other Empire	"Manchukuo"
1920	61.46	4.91	0.83	
1921	59.29	5.23	0.93	
1922	63.55	4.79	1.02	
1923	72.44	4.47	1.11	
1924	74.36	5.53	1.00	
1925	76.05	5.11	1.13	
1926	80.62	5.04	1.23	
1927	81.06	5.16	1.28	
1928	82.56	5.65	1.26	
1929	87.87	5.73	1.23	
1930	80.31	5.91	1.18	
1931	75.19	5.79	1.35	
1932	65.34	6.27	1.38	0.94
1933	64.34	7.07	1.39	1.06
1934	71.22	7.83	1.42	1.17
1935	77.72	8.43	1.36	1.26
1936	87.61	8.52	1.57	1.28
1937	92.30	8.83	1.76	1.33
1938	89.11	9.00	2.32	1.35
1939	96.42	9.72	2.43	1.46
1940	104.51	10.44	2.61	1.57
1941	122.38	10.68	2.67	1.60
1942	144.66	10.70	2.67	1.60
1943	168.44	10.53	2.63	1.58

| 1944 | 182.23 | 10.30 | 2.57 | 1.54 |
| 1945 | 180.02 | 7.81 | 1.22 | 0.73 |

Figure 5. GNP comparison, 1920-45. Amounts for Japan and dependencies are cumulative.
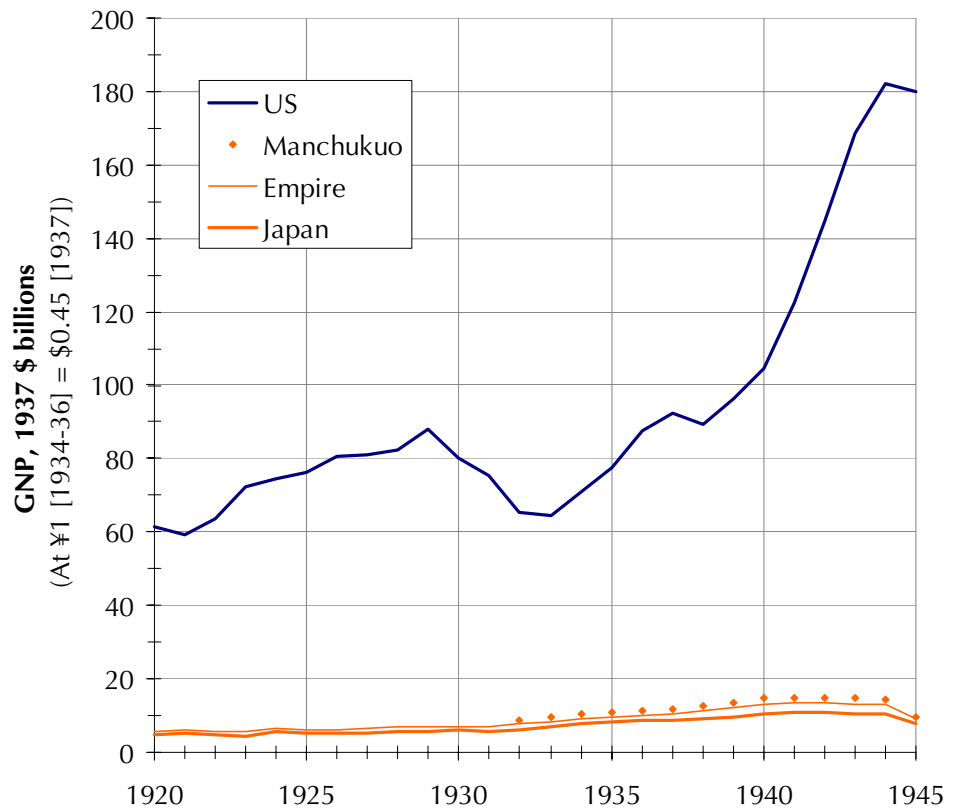
Japanese military expenditures

In current yen

A series on Japanese total military expenditure up through 1945 is presented by Koichi Emi and Yuichi Shionoya in their volume on government expenditure in LTES. [32] The authors express strong reservations about the figures for the wartime period, however. Revised figures are given in PJED, although extending only through

1940. [33] These are used here, but I have included the Emi-Shionoya wartime data to give a rough idea of spending for this period.

PJED also gives series for military "producers' durables" and non-residential construction. [34] These derive ultimately from Rosovsky's figures, but have been revised. Rosovsky's figures have the advantage of greater detail concerning the objects of investment, however. [35] I have used the proportions from Rosovsky to allocate PJED's figures for durables. It is clear from his descriptions that Rosovsky's labels for his categories are a bit misleading. Accordingly, I have relabeled his "ordnance" category as "Army equipment and aircraft" and his "ships" category as "Naval equipment and aircraft." I have lumped the category of "furniture" in current operations as irrelevant to war preparations. Construction has been increased by 5% to account for military residential structures.

It is not clear whether the figures from which Rosovsky worked recorded capital goods expenditures as of the time of order or time of payment. In any event, he endeavored in the case of ships to spread the expenditures over the period of construction, although his method for so doing was relatively naïve. [36] PJED and LTES are not specific on this matter, but it seems not unlikely that they followed him. Thus it is possible that the figures for total defense expenditure and those for capital items are stated on a somewhat different accounting basis. Nevertheless, I have treated them as comparable.

The resulting estimates are tabulated in Table 4.

Table 4. Japanese defense expenditure in millions of current yen

	Defense total	Investment total	Machinery & Tools	Army equipment & aircraft	Naval equipment & aircraft	Construc-tion	Current expense
1920	994	376	20	42	276	38	618
1921	924	429	52	30	314	34	495
1922	791	346	42	30	254	20	445
1923	618	232	40	14	162	16	386
1924	579	188	30	14	132	12	391

1925	552	240	20	13	199	8	312
1926	535	198	25	18	146	9	337
1927	581	200	27	18	138	17	381
1928	615	219	41	22	138	18	396
1929	621	202	21	16	149	16	420
1930	561	172	20	23	118	12	389
1931	563	174	18	33	113	9	389
1932	751	307	60	74	160	13	444
1933	950	342	36	83	202	21	608
1934	1,047	413	42	69	269	33	634
1935	1,134	460	26	77	327	30	674
1936	1,197	492	37	95	321	39	705
1937	2,606	1,586	38	972	526	49	1,020
1938	4,180	3,131	66	2,181	812	74	1,049
1939	5,290	3,572	93	2,133	1,242	104	1,718
1940	6,634	4,140	129	2,105	1,517	390	2,494

The figures for total military expenditure for the years 1941 through 1945 given by Emi and Shionoya are (in millions of current yen) ¥9,838M, ¥14,483M, ¥21,395M, ¥33,260M, and ¥38,708M. [37]

In constant yen

One advantage of categorizing the investment expenses is that different deflators may be applied to the various categories. I examined a wide variety of price indexes from the price volume of LTES. [38] The three that seem most directly relevant are plotted in Figure 6, together with the index for producer durables generally. [39]

Figure 6. Selected investment price indexes for Japan.
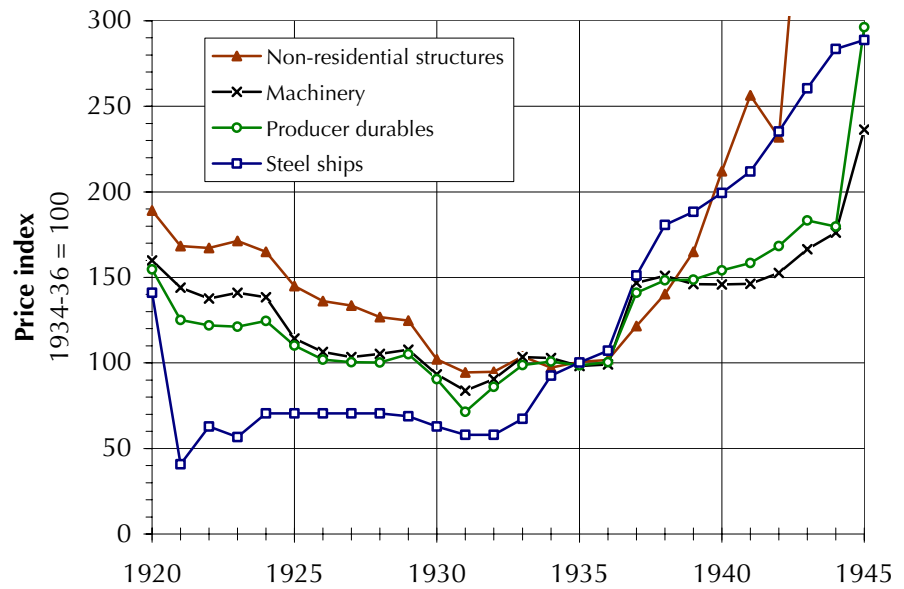
The index for non-residential structures has been used for military construction. For naval equipment and aircraft I have taken the mean of the machinery and steel ships indexes. The machinery index has been used for the other investment items, while the overall GNP deflator has been applied to the operating items. Application of these result in the constant-price series shown in Figure 7 and Table 5. Figure 8 shows the investment item detail.

Figure 7. Japanese defense expenditure in constant yen terms. Amounts are cumulative over categories.
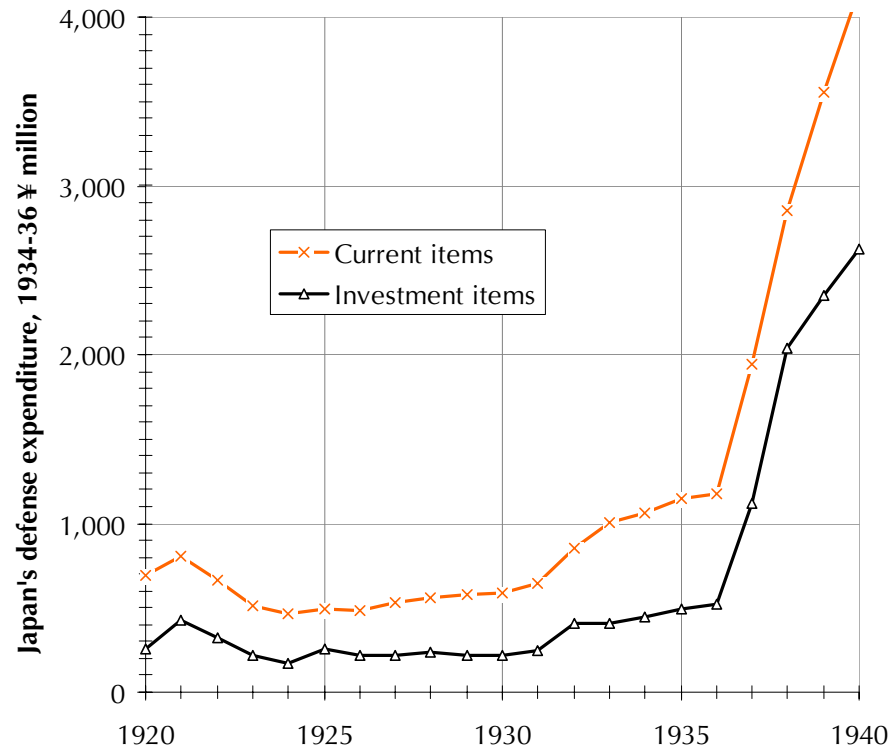
Table 5. Japanese defense expenditure in millions of 1934-36 yen

	Defense total	Investment total	Machinery & Tools	Army equipment & aircraft	Naval equipment & aircraft	Construc-tion	Current expense
1920	689	242	13	26	183	20	447
1921	808	416	36	21	339	20	392
1922	660	318	30	22	254	12	342
1923	509	211	28	10	164	9	298
1924	463	165	22	10	127	7	297
1925	490	250	18	11	215	6	240
1926	478	212	23	17	165	7	266
1927	526	215	26	17	159	13	311
1928	563	231	39	21	157	14	332
1929	574	216	19	15	168	13	358
1930	583	208	21	25	151	11	374
1931	646	231	22	39	160	10	415
1932	854	377	67	82	215	13	478

1933	1,004	372	34	81	237	20	632
1934	1,065	417	41	67	275	33	648
1935	1,142	465	27	78	330	30	677
1936	1,171	483	37	96	312	38	689
1937	1,958	1,081	26	662	353	41	877
1938	2,854	2,031	44	1,445	490	52	824
1939	3,555	2,329	63	1,460	743	63	1,225
1940	4,163	2,595	89	1,443	879	184	1,569
	24,757	13,065	725	5,648	6,076	616	11,692

Figure 8. Japanese defense investment in constant yen terms. Amounts are cumulative over categories.
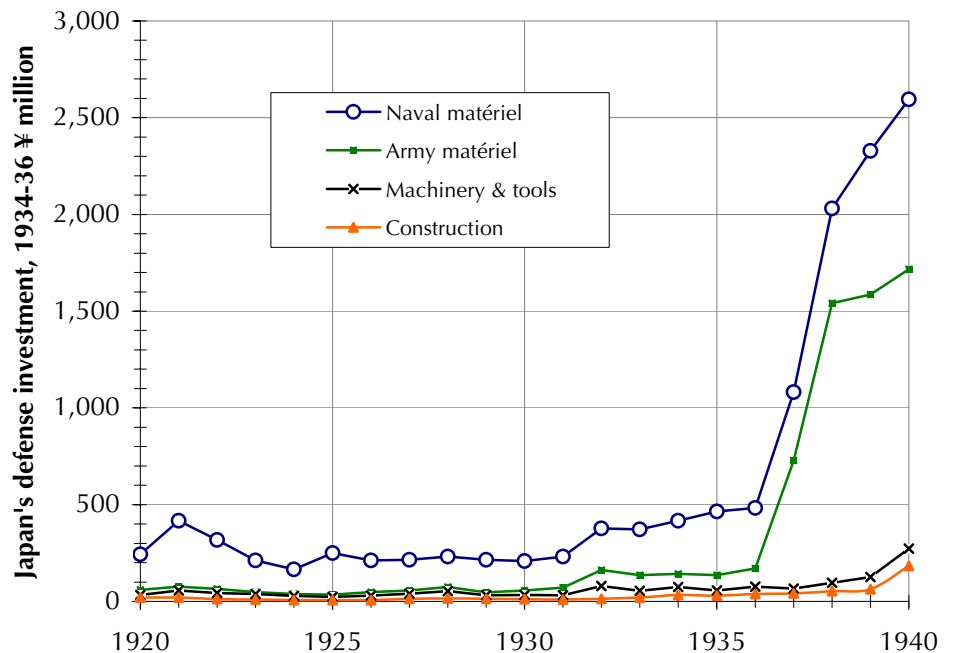
In constant 1937 dollars

Any attempt to express these figures in dollar terms is bound to involve very broad approximations. In line with the arguments advanced earlier under the heading of "Exchange rates" I conclude that the best choice for the investment items is $\$_{1937[invest]}0.45/¥_{1934\text{-}36[invest]}$. Figure 9 shows the results of converting the investment items into dollar terms at this rate.

Figure 9. Japanese defense investment in 1937 dollar terms. Amounts are cumulative over categories.
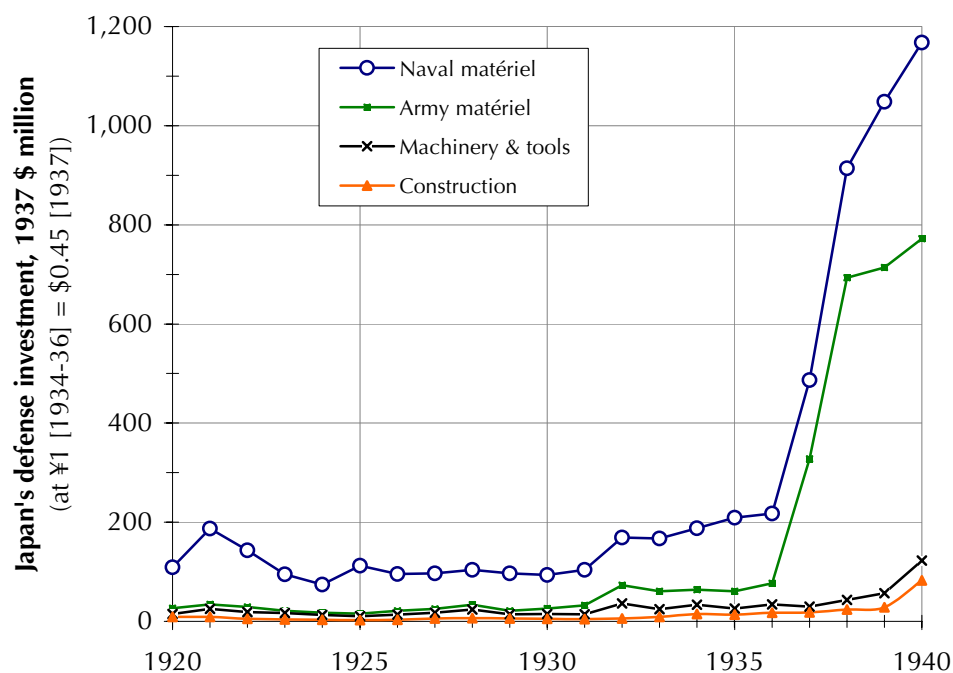
Military operating expense, on the other hand, may offer more opportunities for local resources and manpower to be effective. While the amply equipped construction engineers in the U.S. forces, may have been a good deal more productive than their undercapitalized Japanese counterparts, this probably does not apply with nearly the same force to infantry. Nor does it appear that Japanese warships or aircraft required crews that were significantly larger than those of comparable U.S. units. Rough comparisons of civilian wages and military manpower costs, reported in Appendix A and Appendix B, suggests that the yen was worth substantially more than the dollar in terms of buying both. In consideration of this I have adopted a conversion of $\$_{1937[operating]}1.25/¥_{1934\text{-}36[operating]}$ for operating expenses, which is to say equal to Maddison's purchasing power parity of $1.25.

Overall Japanese defense spending, calculated on this basis, is displayed in Figure 10. The data are tabulated in Table 6. Again, I emphasize the very broad approximations that lie behind these seemingly precise figures.

Figure 10. Japanese defense expenditure in 1937 dollar terms. Amounts are cumulative over categories.
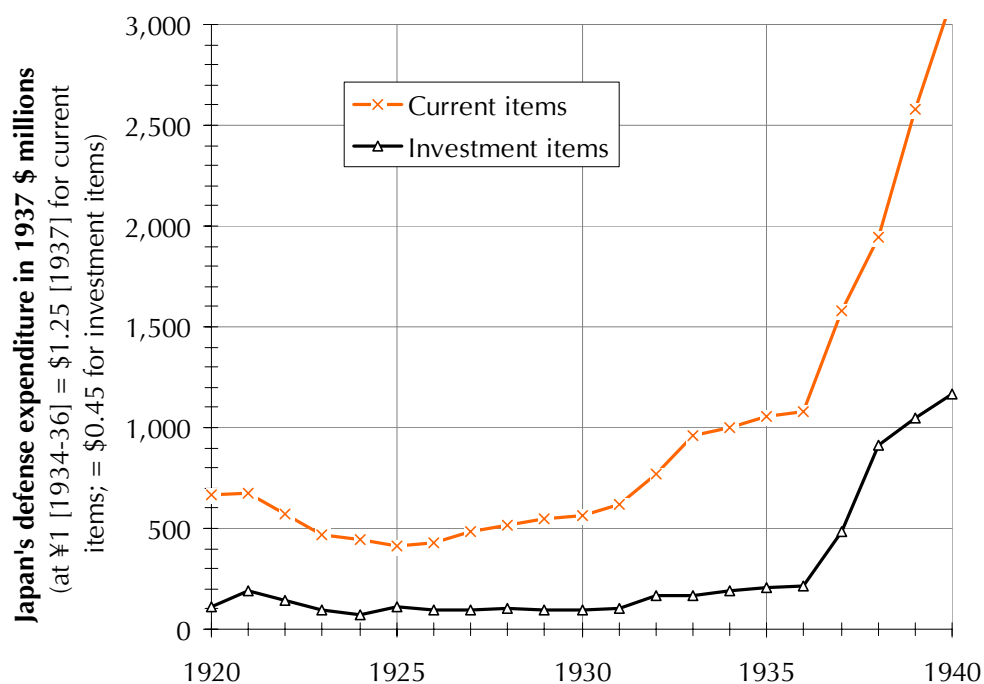

Table 6. Japanese defense expenditure in millions of 1937 dollars.

	Defense total	Investment total	Machinery & Tools	Army equipment & aircraft	Naval equipment & aircraft	Construc-tion	Current expense
1920	668	109	6	12	82	9	559
1921	678	187	16	9	153	9	491
1922	570	143	14	10	114	5	427
1923	467	95	13	4	74	4	372
1924	446	74	10	4	57	3	372
1925	412	113	8	5	97	3	300
1926	428	95	10	8	74	3	333
1927	485	97	12	8	72	6	388
1928	519	104	18	9	71	6	415
1929	545	97	9	7	76	6	448
1930	562	94	9	11	68	5	468
1931	622	104	10	18	72	5	518
1932	767	169	30	37	97	6	597
1933	958	167	15	36	107	9	790
1934	998	188	18	30	124	15	810

1935	1,055	209	12	35	148	14	846
1936	1,078	217	17	43	140	17	861
1937	1,582	487	12	298	159	18	1,096
1938	1,943	914	20	650	220	24	1,030
1939	2,580	1,048	29	657	334	28	1,532
1940	3,128	1,168	40	650	395	83	1,961
	20,494	5,879	326	2,542	2,734	277	14,614

U.S. military expenditures

The NIPA tabulations of defense expenditures are of little use for the 1930s because they are expressed only to the nearest $100 million, a large figure relative to the expenditures of that era. However, the quantity and price indexes are expressed with sufficient precision to permit reconstruction of more precise expenditure data[6]. The product of the quantity index and price index for the year of interest with base-year (1996) expenditure yields target-year expenditure. [40] For purposes of national product accounting, the BEA includes a figure for consumption of capital in the current expenses of national defense, but I have subtracted this from my figures as it is not consistent with the figures for Japan.

For investment items, precise data extending back to 1914 are available in the BEA Fixed Asset tables. [41] It should be noted that these are presented on the basis of when an item was delivered, which may come significantly later than the actual expenditure. This effect is reduced, however, in that in this period the government generally paid private firms on delivery and did not provide advance or progress payments.

Inquiry to the BEA has confirmed that they have no expenditure data for non-investment items covering years prior to 1929. Data on the expenditures of the Departments of War and the Navy for this

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[6] I am indebted to Ms. Pamela Kelly of the BEA for this suggestion.

period are readily available[7]. These are not altogether satisfactory as a record of defense expenditure, however, as both departments had some civil functions in their budgets, while some defense functions were carried in other budgets.

M. Slade Kendrick analyzed federal expenditures in depth and carefully categorized military expenditures with full documentation of his procedures. [42] The OMB series "Major National Security" is essentially identical for the period up to 1940. The Kendrick-OMB series is not entirely identical with the BEA "National Defense" expenditure total due to divergences in coverage and accounting basis, as shown in Figure 11 and, in greater detail for 1920-1940, in Figure 12. In particular, the Kendrick-OMB figures record expenditures when checks are paid whereas those used by the BEA record them when the item is delivered. This is less significant for the 1920s, both because procurements were small in this period and because at that time no advance payments were made to outside contractors. Thus I have used the Kendrick-OMB series for 1920-1929.

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[7] Prior to the establishment of the Department of Defense in 1947 there were two cabinet-level military departments, those of War and the Navy.

Figure 11. Comparison of NIPA, M.S. Kendrick, and OMB series for total defense expenditure.
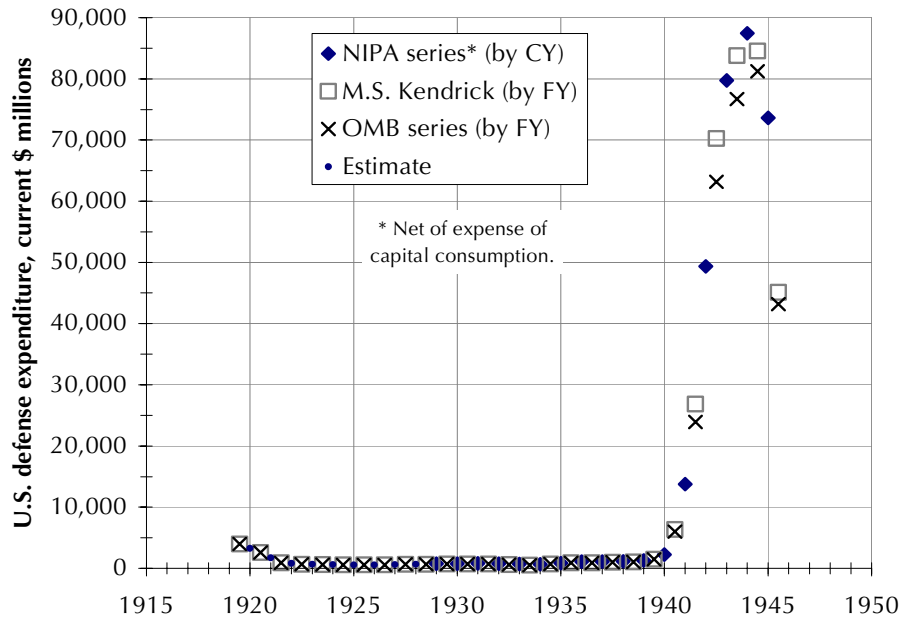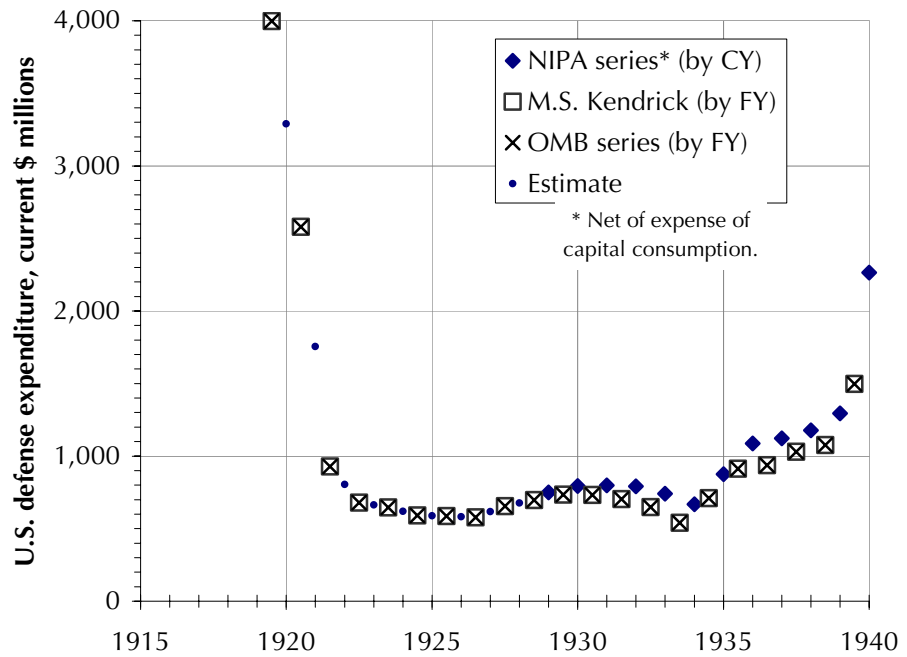

Figure 12. Comparison of NIPA and OMB series showing greater detail.

The resulting expenditure data, in current-year prices, are shown in Table 7.

Table 7. U.S. defense expenditures in millions of current dollars.

	Defense total	Investment total	Equipment	Construc-tion total	(Residential)	(Industrial)	(Military facilities)	Current items
1920	3,289	236	75	161				3,053
1921	1,755	64	15	49				1,691
1922	805	50	25	25				755
1923	664	32	16	16				632
1924	619	19	10	9				600
1925	589	25	17	8				564
1926	582	31	20	11				551
1927	617	39	27	12				578
1928	676	48	33	15				628
1929	749	36	12	24				712
1930	794	60	23	37				737
1931	798	84	33	51				712
1932	792	67	24	43				724
1933	741	89	42	47		2	45	654
1934	669	113	41	72	1	11	60	558
1935	876	103	42	61	9	4	48	773
1936	1,088	259	80	179	64	42	73	829
1937	1,122	324	92	232	98	45	89	798
1938	1,176	318	115	203	34	52	118	859
1939	1,294	325	151	174	4	17	154	972
1940	2,264	803	201	602	4	133	465	1,462

To convert the current-price figures to a constant-price basis is straightforward for the period since 1929, given the NIPA price index series. For earlier years, however, these are not available. Figure 13 plots the main NIPA indexes for 1929-1945 together with three series that extend back to 1920. The GNP deflator series here is that for the GNP series described earlier; in essence these are the deflators developed by Balke and Gordon. [43] The wholesale price index is that of the Bureau of Labor Statistics (BLS). [44] Kendrick gives a series for "National Security Outlays" (which does not track very well with either the NIPA or OMB series) in both

current and constant terms and I have plotted the implicit deflator for this as well in Figure 13.

Note first how little the NIPA series for consumption (current items) varies over the years. This is because current expense for defense is largely dominated by military pay, which varied little. The dip in the early 1930s largely reflects a 15% cut in pay for the military made as part of misguided responses to the fiscal crisis accompanying the onset of the Great Depression. In light of this, I conclude that the best overall estimate of the deflator for this series is that it was flat for the period from 1920 to 1929.

Equipment prices showed considerably more variation. In the 1930s they tracked the trend of prices in the economy as a whole, as measured by wholesale prices and the GNP deflator. With the coming of large orders for new equipment at the outset of World War II they initially rose, then fell sharply, reflecting economies of scale. As prices generally fell sharply in the post-World War I deflation and then were flat through the 1920s, I have represented the deflators for this series in the same general way, with some downward adjustment for 1920 to reflect scale economies.

Figure 13. Potential deflators.
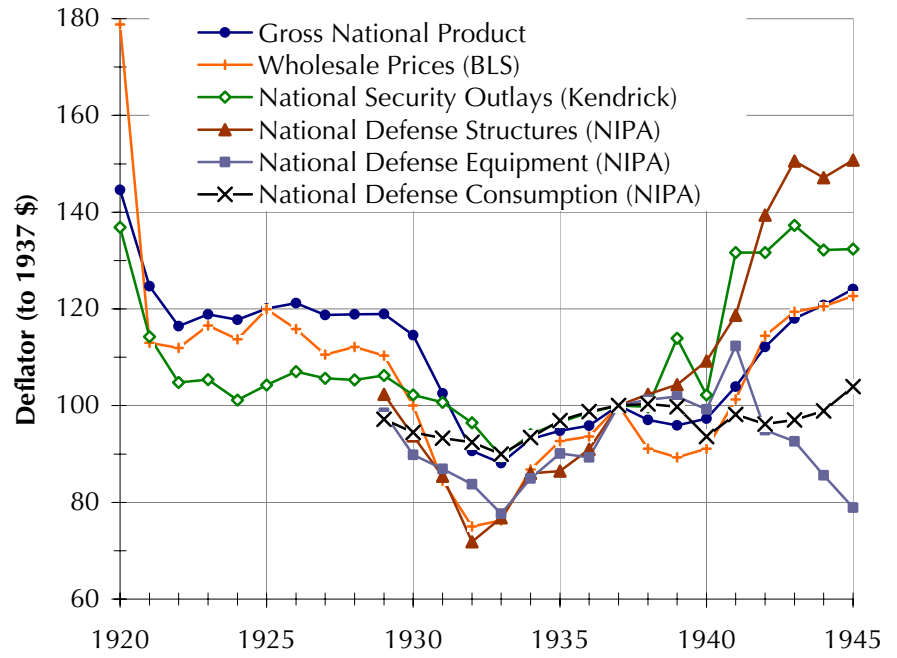
Finally, prices for structures (military construction) followed general price trends in the 1930s but then rose sharply as war came. The burst of construction for the war hugely increased overall demand in the industry, which offered little opportunity for economies of scale. Much the same thing had happened in World War I. Accordingly, I have assumed that military construction prices followed wholesale prices through the 1920s. The resulting assumptions about deflators are plotted in Figure 14.

Figure 14. Assumed deflators.
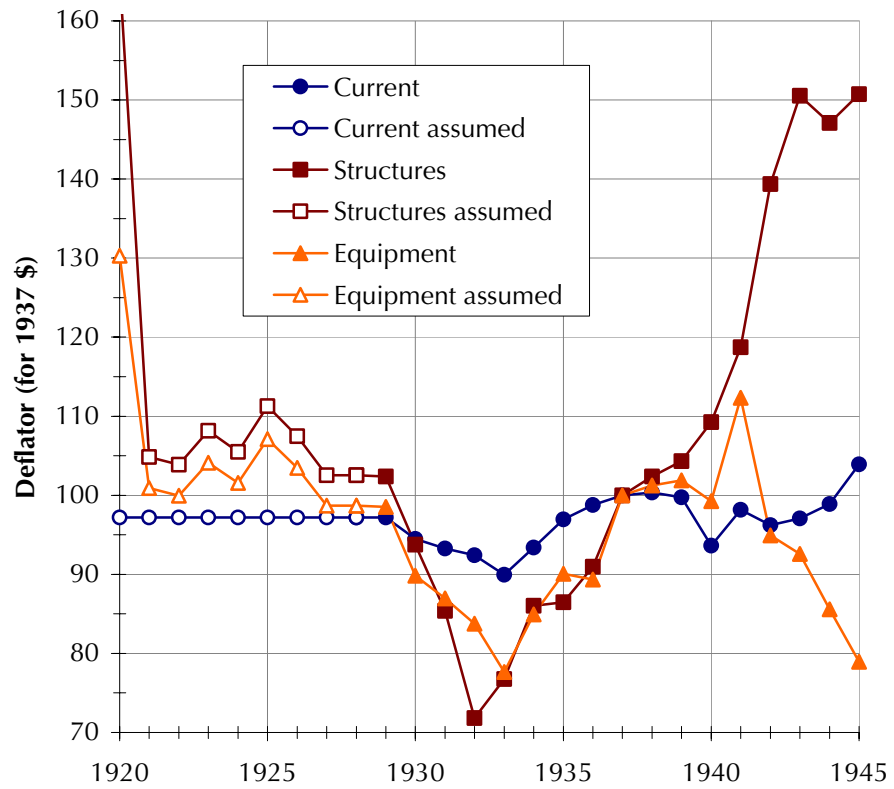
Application of these deflators produces the estimates shown in Table 8, Figure 15 , and
Figure 16.

Table 8. U.S. defense expenditure in millions of 1937 dollars.

	Defense total	Investment total	Equipment	Construct. total	(Residential)	(Industrial)	(Military facilities)	Current items
1920	3,296	155	58	97				3,141
1921	1,802	62	15	47				1,740
1922	825	49	25	24				776
1923	680	30	15	15				650
1924	636	18	10	9				617
1925	603	23	16	7				580
1926	597	30	19	10				567
1927	634	39	27	12				595
1928	694	48	33	15				646
1929	768	36	12	23				733
1930	845	65	26	39				780
1931	861	98	38	60				763
1932	872	89	29	60				783
1933	841	113	54	59			3	56	727
1934	729	131	48	83	1	14	67	598
1935	913	116	47	69	10	5	54	797
1936	1,127	288	90	198	71	50	77	839
1937	1,122	324	92	232	98	45	89	798
1938	1,177	322	114	208	33	57	118	856
1939	1,300	326	148	178	4	20	154	975
1940	2,355	794	203	592	4	136	452	1,561
	22,677	3,154	1,118	2,036				19,522

Figure 15. U.S. defense expenditure in millions of 1937 dollars.
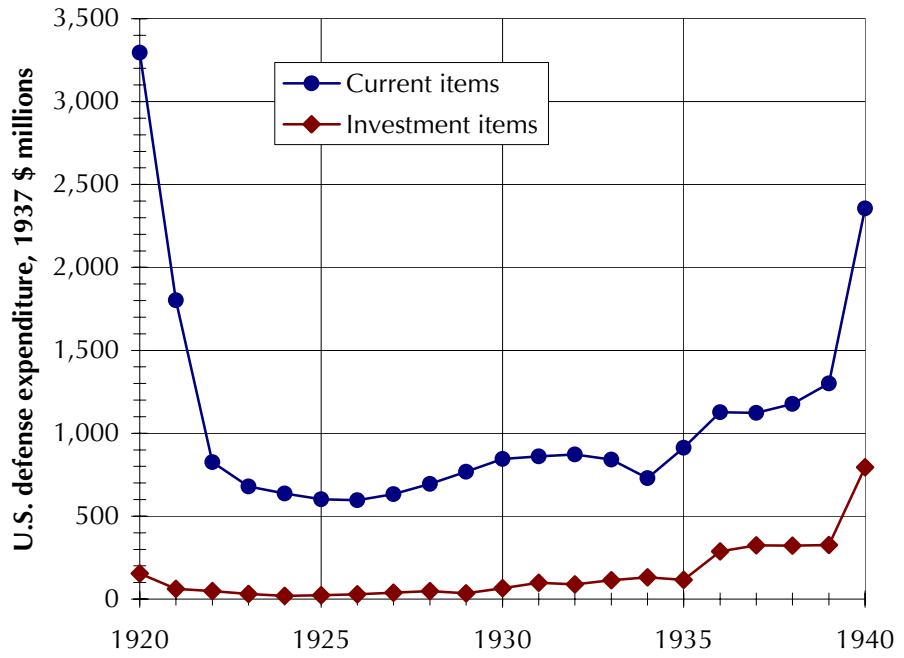
Figure 16. U.S. defense investment in millions of 1937 dollars.
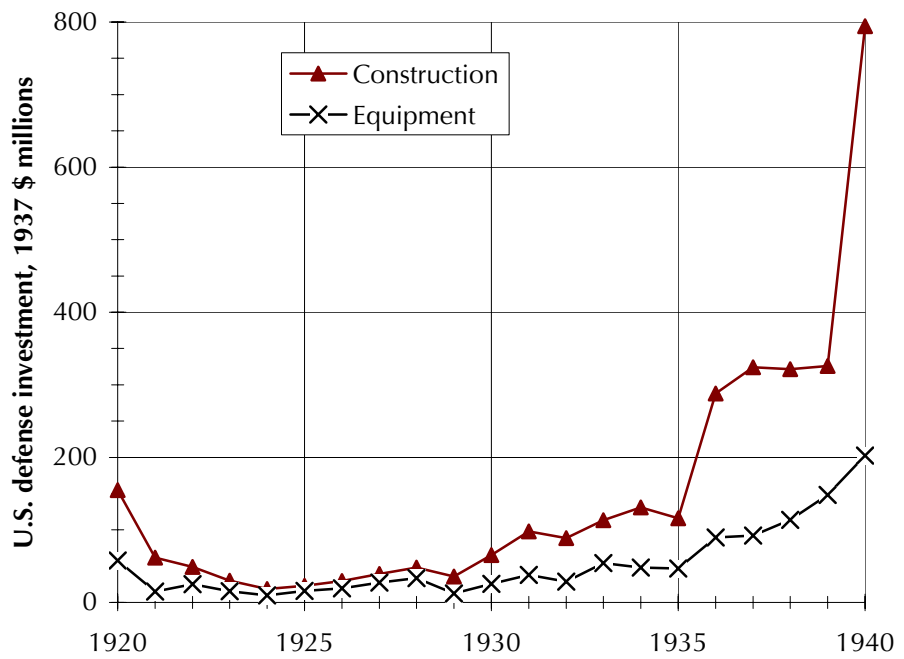
Comparison of U.S. and Japanese defense expenditures

A series of five graphs, Figure 17 to Figure 21, present side-by-side comparisons of total defense expenditures and their components.

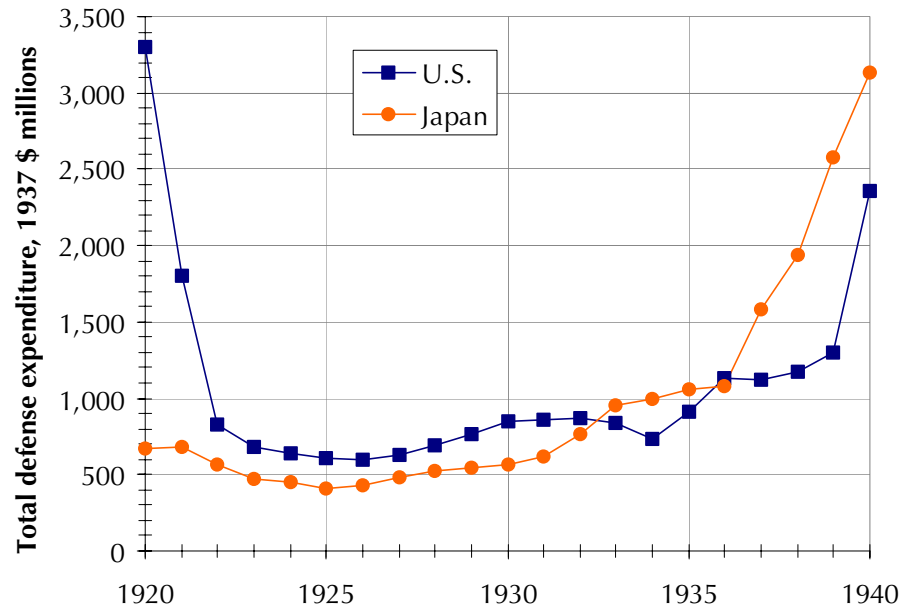Figure 17. Total U.S. and Japanese defense expenditures.

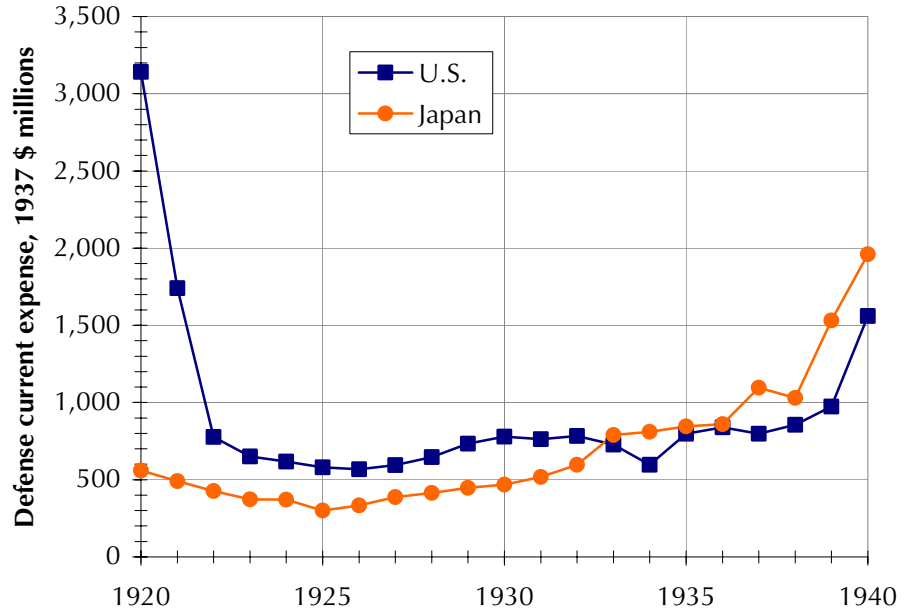Figure 18. U.S. and Japanese current defense expenses.
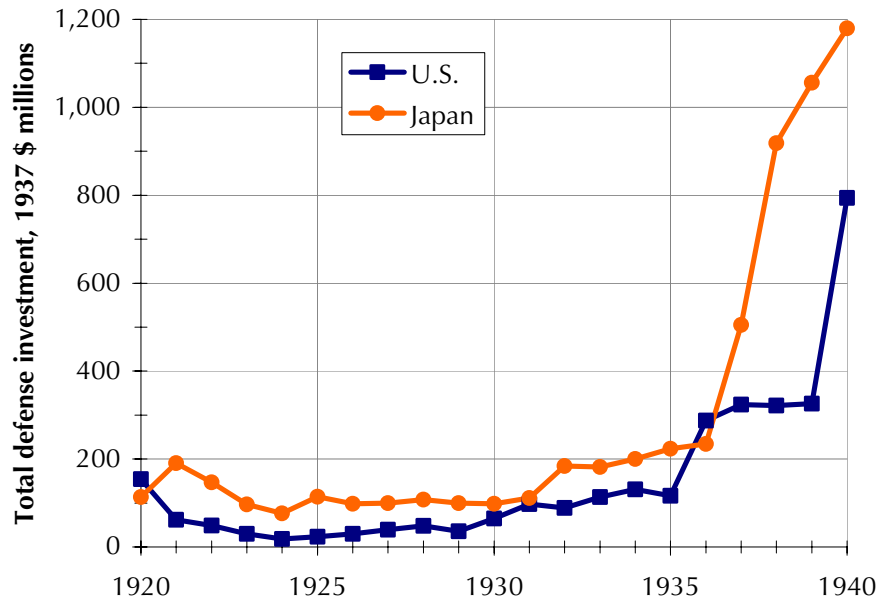

Figure 19. Total U.S. and Japanese defense investments.

Figure 20. U.S. and Japanese equipment and ordnance procurement.
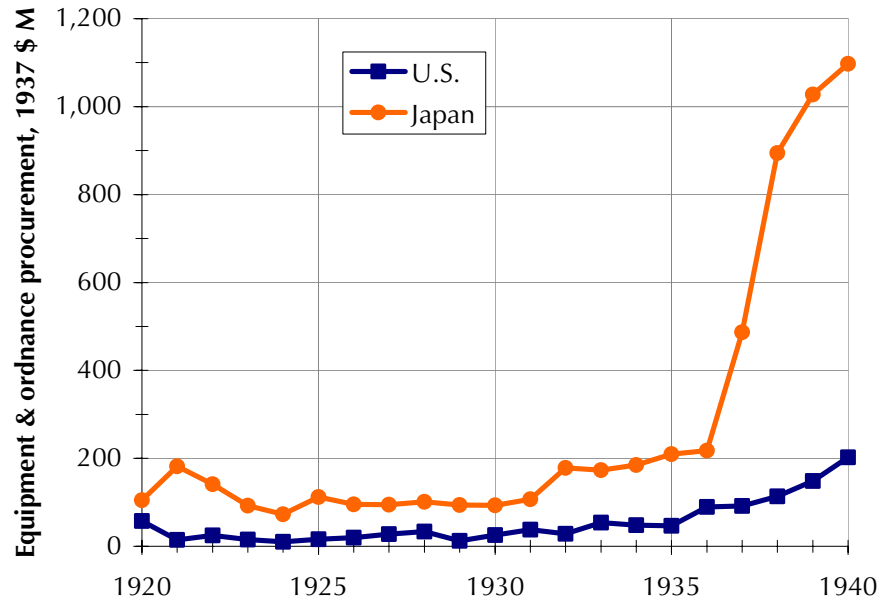
Figure 21. U.S. and Japanese defense construction.
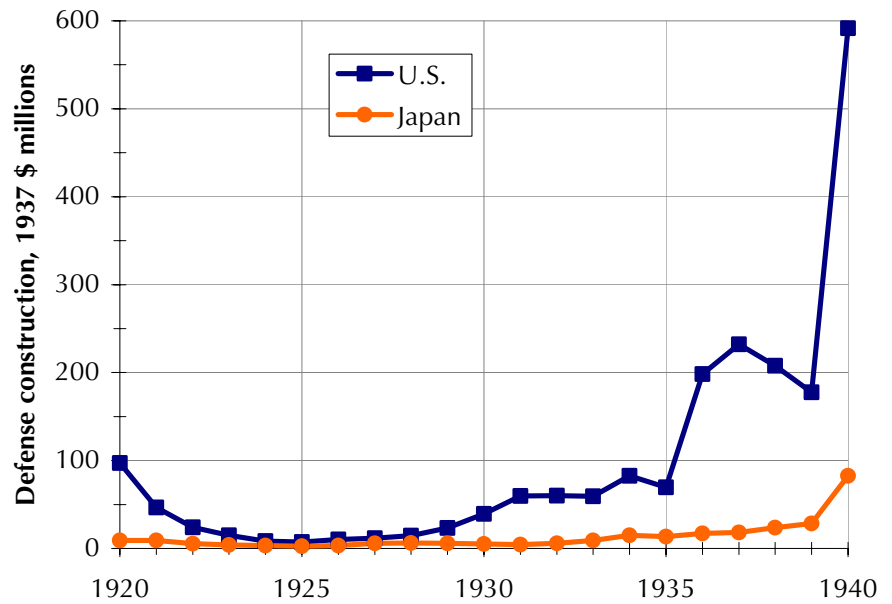
Population and manpower

Population also was a significant factor in comparisons of military potential, particularly in those days of mass armies and more labor-intensive production. The figures in Table 9 are from the League of Nations. [45]

Table 9. Population comparison, 1940.[8]

	Population (millions)		Population (millions)
Japan proper	73.1	United States (48 States)	131.7
Korea	24.2	Alaska	0.1
Taiwan	5.9	Hawaii	0.4
Kwantung	1.4	Subtotal	132.2
Sakhalin	0.4		
Subtotal	105.0	Caribbean possessions	1.9
Manchuria	43.2	Philippines	16.3
Mandates	0.1	Other possessions	0.0
Total	148.4	Total	150.4

Neither nation was prepared to make the fullest possible use of potential manpower. While both utilized women in the agricultural workforce (in a traditional gender-specific division of labor), neither made much use of them in industry. Young Japanese women had long worked in the textile industry but not elsewhere. The role of women in the U.S. industrial workforce was even more restricted. Both recruited women as industrial workers in World War II. The U.S. was more vigorous in this than Japan and benefited from the generally higher educational standards for its women as well as cultural norms that allowed for significantly greater assertiveness on their part.

Neither nation employed women as troops prior to the war, except as military nursing staff. During the war the U.S. made limited use of them as noncombatant military personnel.

Japan restricted non-Japanese to labor roles in military service. The U.S. made sub-optimal use of non-white personnel in military ser-

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[8] Totals may not add due to rounding.

vice, but did employ significant numbers of them in combat. In 1940, the U.S. white population was 118.3 million. [46]

In 1940, in the contiguous 48 States the U.S. had 15.5 million white males and 1.8 million non-white males in the age groups 15-29. No directly comparable figures are available for Japan, but in 1935 there were 10.3 million Japanese males in the age groups 10-24, suggesting a total of something a bit over 10 million aged 15-29 five years later. [47]

There is of course a great arbitrary element in the division between "white" and "non-white". It seems safe to assume, however, that the classifications employed in the U.S. census roughly paralleled those used in sorting men for military service. The same is true of Japan's distinctions among Japanese, Korean, and Chinese elements in its population.

Critical materials

Neither side anticipated a short war (although the Japanese entertained some hopes that the "weak-willed" U.S. might give in fairly quickly). Capacity to produce materials for war was thus an important factor. In this section I address one aspect of this, the capacity to produce critical raw materials.

This presents significant pitfalls. Production of raw materials varies a great deal depending on economic factors. Demand for most materials was considerably depressed during the 1930s, idling much existing capacity and retarding investment in capacity expansion. Geological factors also play a role, as deposits are exhausted and others are freshly exploited. Moreover, Japan stopped publishing statistics on its production of many critical materials after its conflict with China began, so that 1936 is the last year for which reasonably comprehensive and comparable statistics are available. Naturally, the coming of war stimulated demand, resulting in opening or re-opening of much capacity.

Despite these limitations, it is illuminating to compare production of various critical raw materials, as is done in Table 10 and Table 11, using data from League of Nations statistical year books.

Table 10. Metal content of ores mined in 1936, percentage of world totals.

Metal	Japan	Total Empire	Total E. Asia	U.S.	Total N. America	Total Americas
Iron	1.3	3.0	5.4	31.3	32.3	33.3
Nickel	0.0	0.0	1.5	0.1	86.4	87.0
Manganese	1.3	1.3	1.5	0.6	1.4	4.3
Copper	4.3	4.7	5.0	32.4	46.1	52.5
Lead	0.6	0.8	7.1	22.4	50.3	58.8
Zinc	1.0	1.0	5.2	30.3	51.5	53.1
Tin	0.1	0.1	5.8	0.0	0.0	1.5
Chromium	3.3	3.3	3.6	0.0	5.0	5.4
Tungsten	0.2	7.7	69.2	9.6	9.8	20.3
Vanadium	0.0	0.0	0.0	6.4	6.4	23.1
Molybdenum	0.0	0.4	0.4	87.3	93.3	93.4
Silver	4.0	4.8	7.8	25.1	64.8	79.4
Gold	4.2	4.8	6.4	11.6	25.4	29.8

Table 11. Production of other critical materials in 1936, percentage of world totals.

Material	Japan	Total Empire	Total E. Asia	U.S.	Total N. America	Total Americas
Crude oil	0.1	0.2	3.5	49.8	52.4	65.5
Coal	3.3	4.6	6.7	35.8	36.8	37.0
Crude rubber	0.0	0.0	85.7	0.0	0.0	1.8
Bauxite ore (aluminum)	0.0	0.0	3.5	9.9	9.9	21.8
Aluminum (smeltered)	1.9	1.9	1.9	28.6	35.9	35.9
Steel	4.2	4.6	4.6	39.2	40.2	40.3

The dismal picture these tables present of serious deficiencies almost across the board in Japan's current and potential resource position was amply borne out by wartime experience. Oil shortages are well known but shortages of aluminum and specialty steels (in part reflecting shortages of alloying elements) also were very damaging. Even in cases where Japan captured territories producing critical materials, its increasingly severe lack of shipping often prevented getting the products to the point of need. [48] The U.S., with greater resources of technology, industrial plant, and shipping, found satisfactory workarounds for its much more limited areas of deficiency.

Selected production data

The national product data presented on page 9 *et seq.* give the best overall comparison of production in the two economies. Comparisons of physical production can help to clarify the picture in some respects, however. A selection of production statistics is presented in Table 12.

Table 12. Selected production statistics.

Production of —	Unit		Year	Amount	Ref: page	Jp % of US
Merchant ships	GRT/1000	Jp	1934-37	259	A: 266	112.7%
		US	1934-37	230	HS: 447	
Cement	t/1000	Jp	1937	6,034	LoN: 133	30.0%
		US	1937	20,138	LoN: 133	
Trucks & buses	1000s	Jp	1936	9	A: 267	1.2%
		US	1936	782	HS: 462	
Machine tools	1000s	Jp	1936	16	A: 267	8.0%
		US	1940	200	Ord: 434	
Radio receivers	1000s	Jp	1936	427	A: 267	5.5%
		US	1937	7,780	HS: 417	
Pig iron	t/1000	Jp	1937	3,397	LoN: 147	9.0%
		US	1937	37,723	LoN: 147	
Steel	t/1000	Jp	1937	6,238	LoN: 147	12.1%
		US	1937	51,380	LoN: 147	
Aluminum	t/1000	Jp	1938	23.0	LoN: 155	15.5%
		US	1938	148.4	LoN: 155	
Coal	$t/10^6$	Jp	1937	45.3	LoN: 141	10.0%
		US	1937	451.2	LoN: 141	
Productive assets						
Electrical generating capacity	MW	Jp	1937	6,977	A: 266	15.7%
		US	1937	44,370	HS: 509	
Rail mileage	mile	Jp	1934	14,500	A: 268	3.4%
		US	1934	422,401	HS: 429	
Merchant shipping in service	GRT/1000	Jp	1939	5,729	A: 268	39.2%
		US	1939	14,632	HS: 444	
Trucks & buses in service	1000s	Jp	1939	145	A: 268	3.0%
		US	1939	4,784	HS: 462	
Autos in service	1000s	Jp	1939	55	A: 268	0.2%
		US	1939	26,226	HS: 462	

Sources:
A: Allen, *A Short Economic History of Modern Japan*
HS: Bureau of the Census, *Historical Statistics of the United States, from Colonial Times to 1957*
LoN: *Statistical Year-Book of the League of Nations, 1941/42*
Ord: Rowland & Boyd, *U.S. Navy Bureau of Ordnance in World War II*

Note: All tons (t) are metric

It is important to recognize that this is not and cannot be a comprehensive picture. The data vary in significance, same-year data have not been found for some items, and production figures can vary significantly from year to year.

Evaluation

I assess the meaning and implications of these data in another report. [49] Here, however, it is appropriate to mention cautions to be observed with regard to them.

It is reasonable to expect that each of the series here is generally consistent internally over the 21-year period from 1920 through 1941. Thus we can be pretty certain that the trends shown for Japanese naval equipment and aircraft procurement or U.S. defense current expense are accurate. The U.S. series benefit from better source data and more stable prices, but this is somewhat balanced by the need to guess at defense deflators for the period 1920-1928, and to piece series together for GNP and total defense expenditure.

The consistency across the series in one family also is likely to be good. That is, the relationship between Japanese construction and Japanese army equipment and aircraft procurement is probably relatively accurately portrayed. The U.S. series may be slightly better in this regard due to better source data, although the uncertainties about defense deflators for 1920-1928 again takes its toll.

The comparisons between the U.S. and Japanese series clearly involve significantly more uncertainty, as well as some differences in concept and accounting rules. Because the economies were so different and exchanged only a small proportion of their outputs, there is no way to be sure what the appropriate conversion factor between yen and dollars truly is. The conversions used here are reasonable estimates, but far from exact. This is particularly to be said of the comparison of current expenses presented in Figure 18. Nor can we be certain that the coverage of seemingly like series in the different nations is altogether comparable. The U.S. series for investment items are calculated on the basis of when the item was

delivered, while those for Japan appear to have been done on the basis of when it was paid for. There may be other discrepancies.

Yet even in this case, the comparisons yield useful information. Regardless of whether Japanese current defense expense was really lower than that of the U.S. in 1925, say, it is clear that from Figure 18 that it increased *in relative terms* thereafter.

Appendix A: Simple price structure comparison

A simple comparison illustrates how price structures can differ and how this affects the appropriate choice of international currency conversions.

1929

I take 1929 as the first year for this comparison, as a time when both economies were reasonably near full employment and not yet distorted by the effects of the Great Depression[9]. The exchange rate between dollars and yen was about $0.45/¥. (See Figure 2.) On this basis, let us compare average manufacturing hourly wages in the U.S. [50] and Japan[10] [51]; the price per dozen for eggs in the U.S. [52] and Japan[11] [53]; the price per pound of beans in the U.S. [54] and Japan [55]; the price per pound of raw silk in the U.S. [56] and Japan[12] [57]; and the price per short hundredweight of steel rails in the U.S. [58] and Japan[13].

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[9] Both had depressed agricultural sectors at this time, however.

[10] Taking the average work day as having been 9 hours. The Japanese textile industry employed females in considerable numbers, whereas there was very little employment of females in U.S. industry. As the wages of females textile workers was low compared to that of other manufacturing jobs, I have taken the male manufacturing wage.

[11] Taking a dozen eggs as weighing 600 g.

[12] Taking the *kin* as 600 g.

[13] Taken as identical to that in the U.S., applying the conversion of ¥1 = $0.45, recognizing that steel was an item of trade. In practice, the cost in Japan might have been slightly higher due to shipping costs, but these were especially low for this class of product, which was shipped in bulk.

The prices per se are shown in Table 13 and Table 14. Table 15 shows the ratios of these prices in the two economies, both in terms of dollars or yen (valued at the exchange rate) and in terms of labor hours in the economy.

Table 13. Japanese prices, 1929 (¥1 = $0.45).

Commodity	Unit	Price in ¥	Price in $	Price in labor hours
Manufacturing wage (males)	hourly	0.228	0.103	1.00
Eggs	dozen	0.496	0.223	2.18
Azuki beans	lb	0.107	0.048	0.47
Raw silk	lb	10.272	4.622	45.05
Steel rails	100 lb	95.556	43.000	419.10

Table 14. U. S. prices, 1929.

Commodity	Unit	Price in $	Price in labor hours
Manufacturing wage	hourly	0.566	1.00
Eggs	dozen	0.527	0.93
Navy beans	lb	0.141	0.25
Japanese raw silk	lb	4.933	8.71
Steel rails	100 lb	43.000	75.97

Table 15. Ratios of prices, U.S.: Japan, 1929.

Commodity	In $ or ¥	In labor hours
Manufacturing wage	5.5:1	1:1.0
Eggs	2.4:1	1:2.3
Beans	2.9:1	1:1.8
Raw silk	1.1:1	1:5.2
Steel rails	1.0:1	1:5.2

The symmetry of the price ratios is striking. The ratio of manufacturing wages is very close to that required to equalize the price of raw silk or steel rails in terms of labor hours. This reflects the fact that these were relatively typical articles of trade at this time, of the sort which influenced the exchange rate fairly strongly.

The price of eggs and beans, however, was sharply lower in Japan than in the U.S., as measured at the market exchange rate. Of course these were not traded in any volume between the two economies, and their prices reflect in part the price of the local labor and other non-tradable inputs involved in their production. Farm labor was generally more productive in the U.S. than in Japan, but the disparity in things like poultry and row crops was not too marked at this time, compared to that in manufactures. Since

the Japanese worker spent much of his income on farm products and little on silk or steel products, his standard of living was higher than would be suggested by the ratio of steel prices. In effect, this means that the yen was worth more to him than 45 U.S. cents.

1933

There is also something to be learned from repeating the comparison for 1933, a year when the U.S. economy was at the bottom of its Great Depression lows while the Japanese economy was relatively prosperous. (See Figure 5 and Figure 4.) The exchange rate varied markedly over this year, averaging about $0.26/¥. (See Figure 2.)

Table 16. Japanese prices, 1933 (¥1 = $0.26).

Commodity	Unit	Price in ¥	Price in $	Price in labor hours
Manufacturing wage (males)	hourly	0.208	0.054	1.00
Eggs	dozen	0.336	0.087	1.62
Azuki beans	lb	0.088	0.023	0.42
Raw silk	lb	6.115	1.590	29.43
Steel rails	100 lb	151.269	39.330	728.03

Table 17. U. S. prices, 1933.

Commodity	Unit	Price in $	Price in labor hours
Manufacturing wage	hourly	0.442	1.00
Eggs	dozen	0.288	0.65
Navy beans	lb	0.053	0.12
Japanese raw silk	lb	1.613	3.65
Steel rails	100 lb	39.330	88.98

Table 18. Ratios of prices, U.S.: Japan, 1933.

Commodity	In $ or ¥	In labor hours
Manufacturing wage	8.2:1	1:1.0
Eggs	3.3:1	1:2.5
Beans	2.3:1	1:3.5
Raw silk	1.0:1	1:8.1
Steel rails	1.0:1	1:8.2

Once again, in Table 18, we see a symmetry between the prices of labor and trade goods. The price of the yen having fallen drastically, the price of Japanese labor measured in dollars has fallen, and with it the purchasing power of the Japanese worker relative to

items of trade, as seen in Table 16. But measured relative to the food items that make up a much larger portion of his budget, the purchasing power of the Japanese worker has changed little. That is to say, the yen is now worth even more to him relative to the exchange rate.

I do not have actual unit prices on a comparable basis for other major items of consumer expenditure, but the overall consumer price indexes show that in general the fall of the yen relative to the dollar did nothing to worsen the Japanese standard of living. While wages fell somewhat in yen terms, other prices also fell enough to make the ratio of wages to the consumer price index 10% higher in 1933 than it had been in 1929. [59] (U.S. wages also were worth more in 1933 than in 1929 relative to consumer prices, but that was little comfort to the huge numbers who were out of work.)

It is also notable that in 1929, Japanese raw silk was worth 11.5 times as much, weight for weight, as steel rails in the U.S., whereas by 1933 the ratio had plunged to 4.1. (See Table 14 and Table 17.) This, of course, is a key factor in the decline of the value of the yen.

Appendix B: Military pay comparison

This is not a thorough survey of military pay in the two nations, but a few spot comparisons provide some insight.

From 1922 to 1940, U.S. enlisted personnel in the lowest grade were paid $21 per month, except for the depths of the Great Depression when their pay was cut 15%, to $17.85. [60] The Army ration during this period cost about $0.45 per day, or about $13.70 per month. [61] Accommodations at a workingman's rooming house would have cost about $0.25 per night, or about $7.60 per month. Thus the total compensation of privates, in money and kind, was about $42.30 per month (or $39.15 in 1933).

The Japanese Army, unlike that of the U.S., did not rely on voluntary recruitment; all of its private soldiers were procured by conscription. New recruits were paid ¥2.75 per month, doubling after four months to ¥5.50. (Japanese officers suffered a 10% cut in pay in the hard times of the late 1920s, but this did not extend to enlisted pay.) Consistent with the Japanese social structure, the Army paid the recruit's parents ¥0.30 per day, or about ¥9.10 per month. A workingman's meals were reckoned to cost about ¥0.33, or about ¥10 per month. [62] If we assume that lodging would cost about ¥5 per month, total compensation for the Japanese private soldier with four or more months of service would amount to about ¥29.60.

Thus, in terms of the yen's power to buy military manpower, the ratio of values was 42.3/29.6, or about $1.40 to the yen.

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