International Journal of Business and Applied Social Science (IJBASS)

E-ISSN: 2469-6501
VOL: 6, ISSUE: 10
October/2020
DOI: 10.33642/ijbass.v6n10p4

THE CRITIQUE OF MADDISON'S METHOD OF REVISING CHINA'S GDP DATA

Keren Sun
Department of Economics
University of Utah
USA

Hua Fang
Associate Professor former vice-chair
Department of Finance
The University of Shanghai for Science and Technology
China

ABSTRACT

Economist Angus Maddison is famous for his exploring the revision of economic statistical data, including China's GDP data since the 1990s. This is a useful work. Maddison has revised China's GDP data from multiple angles, including the revision of China's non-material service sector GDP data. Maddison assumed that the non-material service sector in China has had a zero scientific and technological progress rate since the 1990s, while based on the data from the National Bureau of Statistics of China, the rate of scientific and technological progress in the non-material service sector should be big. Maddison's assumptions have led to a significant reduction in China's GDP data, and thus China's economic growth rate has dropped significantly. This paper argues that the high-tech progress rate of the non-material service sector-led and promoted by information technology is not only possible but also very likely, so China's GDP data is credible in general, and of course, some small deviations and inaccuracies existed in China statistical GDP is understandable and acceptable.

Keywords: Maddison, China GDP, Non-material service, technological progress

1. Introduction

1937 Simon Kuznets presented the original formulation of GDP to the U.S. Congress, GDP is born. 1944 GDP became the standard tool measuring a country's economy due to the establishment of the World Bank and IMF[1].

The United States has the highest level of real per capita GDP in the world in 1990, due to the 1.75 percentage annual economic growth rate from 1870 to 1990. If provided that the United States of America had a growth rate of one percentage point per year below its actual number, the United States would have ranked 37th out of 127 countries with data. Under this provided growth rate, the real per capita GDP in the United States in 1990 would have been close to that in Mexico and Hungary (Barro, et al., 1995, pp.1).

Small changes in economic growth rates will cause huge differences in national economic status in the long run, Therefore, when Angus Maddison pointed out that China's economic growth rate was significantly overestimated in the 1990s, this caused great shock. So, this article intends to critique Maddison's method of revising China's GDP.

2. Literature Review

Before 1990 socialist countries used MPS rather than SNA to collect the statistical data, MPS is established based on Marxist theory. Under Marxism, many non-material service activities are not productive, so these non-material service activities are excluded from MPS.

These non-material service activities include passenger transport, housing, health, education, entertainment, banking, insurance, personal services, government and party administration, and the military. Excluding these non-material service activities from MPS will decrease the national income. However, MPS also exists double counting defect, because of measuring gross output without deducting inter-sector transfers of inputs, the double-counting activities will exaggerate the national income. If the quantity of intermediate inputs that are double-counted exceeds the quantity of non-material service activities that are omitted, then the national income and economic growth will be exaggerated. The above description is common sense.

Maddison (1998) re-estimated Chinese economic performance. Maddison (2007) updated of the estimate of GDP growth rate beyond 1995, he corrected the official figures of the period 1996-2003 by applying the ratio 0.7586, this coefficient 0.7586 was derived from the ratio of two values the Maddison estimates' growth rate for 1978-95 and the China

[1] https://foreignpolicy.com/2011/01/03/gdp-a-brief-history/

International Journal of Business and Applied Social Science (IJBASS)

E-ISSN: 2469-6501
VOL: 6, ISSUE: 10
October/2020
DOI: 10.33642/ijbass.v6n10p4

official growth rate for 1978-95. So that for the period 1978-2003, Maddison's estimates showed an average annual growth rate of 7.85 percentage, and for the same period, China's official estimates showed an average annual growth rate of 9.6 percentage. The estimate from Maddison is lower than that of China's official estimate.

Wu (2002) used the physical output index as an approach to make alternative estimates. Jefferson et al. (1996) used alternative price indices to make alternative estimates. Adams and Chen (1996), and Rawski (2001) used energy consumption approximation to make alternative estimates. All their results supported the hypothesis that China's official GDP was exaggerated.

Keidel (2001) re-estimated the China GDP growth from the perspective of expenditure for 1979-2000, Shiau (2004) re-estimated China GDP for 1978-2000 using the expenditure approach, their results showed that China's official GDP was exaggerated.

Xu (2002) argued that after 1992 china's statistical practice was still influenced by many central planning legacies. Wu (2000) argued that China adopted a comparable price approach, this approach would underestimate inflation, then would overestimate the GDP.

Wu (2014) revised the employment data and GDP data of "non-material services" sectors according to his revised methods.

3. Maddison's method of revising China's GDP and the most prominent flaw itself

3.1 The revised GDP data made by Maddison in 1998

3.1.1 The data adjustments on agriculture

Maddison (1998) offered such reasons as below to support his adjustments on agricultural GDP data of China from 1952 to 1995: China State Statistical Bureau published the first major statistical book in 1960, in which provided detail for 1949-58 on the output of twenty major crops, some categories of livestock, and some farm inputs, and gross output values at current prices; from 1960 to 1980 published material on agricultural performance was scarce and material on agriculture was often distorted for political reasons; China began to shift gradually to the SNA in the 1980s, but the statistical reporting system has not yet changed much.

Maddison used the official estimates for the fishery, forestry, and agricultural sidelines, but he made his estimates in farming.

3.1.2 The data adjustments on industry

Maddison's method to adjust the industry data is to deflate the Gross Output index, Net Material Product index, and Gross Value-Added index by the new industrial products producer price index for 1978-95, the Net Material Product is deflated by the industrial products rural retail price index for 1952-77.

3.1.3 The data adjustments on "Non-material Services"

The non-material services include banking, insurance, housing services, administration of the real estate, social services, health, education, entertainment, personal services, R&D activities, the armed forces, police, government, and party organizations. "Non-material services" were excluded in MPS in the era of the planned economy. Under SNA the "non-material services" are incorporated in the national accounts.

The official "non-material service" estimates are not shown explicitly, because of official estimates for the tertiary sector as a whole and a breakdown for two-component sub-sectors.

Maddison (1998) made a rough alternative estimate of "non-material service". Maddison assumed that there did not have an increase in productivity in "non-material service" activities. Maddison used employment in China Statistical Yearbook and adjusted these employment data from an end-year to a mid-year basis, then made the growth of adjusted employment data as a proxy indicator of growth rate in real value-added. Before 1992 China's official estimates did not include military service figures, Maddison added a proxy estimate of 3 million a year for the military.

3.1.4 The data adjustments on material service

Material services include "transport and communications" and "commerce and restaurants". Maddison's adjustments of the data on material service are done by reselecting and combining some data sets, for example, the SSB data set, Liu & Yeh's data set.

3.2 The revised GDP data made by Maddison and Wu in 2008

3.2.1 The data adjustments on agriculture

Comparing 1998 Maddison estimates and official estimates, it can be easily found that the two kinds of estimates have almost the same rate of growth for the agricultural sector as a whole in 1952-90, but the Value-Added level of Maddison's estimates as nearly one fifth higher in 1990. Maddison and Wu (2007) used the official estimates for agriculture to update the Maddison estimates from 1991 to 2003.

3.2.2 The data adjustments on industry

Wu's (1997) estimates of gross value added in the industry were used in Maddison (1998). Wu (2002) updated his estimates by using explicit price weights, and this update method was fully adopted in Maddison (2007) and Maddison and Wu (2008)

3.2.3 The data adjustments on "non-material services"

Maddison (1998) assumed no increase in productivity in these Non-material services activities to make a rough alternative estimate for sectoral GDP from the "Non-material services" sector. Maddison used employment in China

International Journal of Business and Applied Social Science (IJBASS)

E-ISSN: 2469-6501
VOL: 6, ISSUE: 10
October/2020
DOI: 10.33642/ijbass.v6n10p4

©Center for Promoting Education and Research (CPER) USA www.cpernet.org

Statistical Yearbook, adjusted them from an end-year to a mid-year basis, as a proxy indicator of growth in real value-added. The estimate for the military service was not included in the official statistical yearbook until 1992, Maddison (1998) added a proxy estimate of 3 million a year for the military.

Maddison and Wu (2008) used the same assumption in their 2008 revised estimates.

3.2.4 The data adjustments on material services

The Chinese Statistical office uses two types of basic survey to cross-check the accuracy of the national accounts. One is the input-output estimates; another is the census of economic activity. 2004 the Chinese statistical office made an economic census covering the whole economy excluding agriculture. According to this census, in 2006, the National Bureau of Statistics of China (NBS) made a significant upward adjustment to its earlier estimate of growth in these two sectors for 1993 onwards. Maddison and Wu (2007) adopted the office modified results.

3.3 The revised GDP data made by Wu in 2014

Wu is a collaborator of Maddison and a successor of Maddison's theory so that Wu's revision work of GDP needs to be referred too. Official aggregate employment data shows a 17-percent jump in 1990 over 1989, Wu (2014) thinks it is an enormous break and implausible and needs a careful investigation of the cause of the break and a proper adjustment with sectoral foundation.

Under the "Zero labor productivity growth" hypothesis, Maddison got an annual GDP growth rate of 5.5 percent for 1978-2003, which is just a half of the official estimate of 11 percent. Due to being challenged by Maddison's "Zero labor productivity growth" assumption, Wu (2014) makes some alternatives to the Maddison hypothesis to modify the GDP data of the "non-material services" sector.

Firstly, Wu (2014) assumes that the labor productivity of "non-material services" rose by one percent per annum throughout the period 1982-2012, then make the estimates of the GDP data of the "non-material services" sector.

Secondly, Wu (2014) further assumes that the labor productivity of "non-material services" rose by another one percent per annum from 1993 onwards. 1993 is chosen as a benchmark year, Wu thinks, the reason is that 1993 China government began to adopt the "socialist market economy" model and deepen reforms and reconstruct the state sector, it is reasonable to expect some improvement in labor productivity in "non-material services" sector.

3.4 The most prominent flaw in Maddison's method of revising China's GDP

The bulk of the post-1995 acceleration of productivity growth was within the services-producing industries rather than within the goods-producing industries (Triplett and Bosworth, 2004).

Holz (2006) thinks that Maddison's treatment of "other services" is problematic. Maddison's problematic treatment includes the following three respects: (1) military personnel; (2) choice of employment data; (3) the hypothesis of "zero labor productivity growth in other services".

Referring to the hypothesis of "zero labor productivity growth in other services", Maddison does not offer strong proof to justify his hypothesis, Maddison just uses the practice of many OECD counties in the 1970s, he does not provide a rationale for why this kind hypothesis is appropriate to China. The assumption of zero technological progress rate in the non-material services sector is the most prominent flaw.

4. The Credibility analysis of the high-tech progress rate of China's non-material service sector

Due to the development of the information technology industry, China's reform and opening-up, China's accession to the WTO, China's economic development late advantages, China's non-material services sector's technological progress rate have experienced a rapid development beyond surpassing, then we think Maddison's assumption of the non-material services sectors' zero technological progress rate seems too far away from reality.

4.1 China's progress in science and technology since reform and openness of China

Since China's reform and openness in 1978, China has gained great progress in science and technology, and have been recognized by many experts and organizations, for example, Shelton and Foland (2009) think that the US and EU have been vying for leadership of science and technology; now they are being overtaken by the People's Republic of China.

The progress in science and technology can be measured by qualitative methods. OECD provides a set of indicators that reflect the level and structure of the efforts undertaken by OECD member countries and seven non-member economies in the field of science and technology in its biannual publication[2].

[2] www.oecd.org

International Journal of Business and Applied Social Science (IJBASS)

E-ISSN: 2469-6501
VOL: 6, ISSUE: 10
October/2020
DOI: 10.33642/ijbass.v6n10p4

Table 1 OECD's triadic patent family indicator

Year	USA	EU28	JPN	PRC
1985	7828.9005	8482.3409	4999.0464	30.0543
1986	8192.3797	9048.7019	5684.4768	6.2955
1987	9260.1622	9891.0382	7204.7601	12.1083
1988	10098.7203	10359.9932	8255.9921	11.5807
1989	10946.3501	10669.0249	9627.8537	8.2459
1990	11274.8944	10010.8948	9598.9783	12.266
1991	10722.8051	9807.9885	8577.4786	12.5136
1992	10838.7307	9855.256	7924.8969	15.7022
1993	10897.4097	10241.2061	8333.5376	17.8321
1994	11376.4911	11283.0724	8291.2998	19.2325
1995	12416.6715	12010.2744	9617.7093	22.1701
1996	13117.3139	13357.6474	10776.7292	23.6936
1997	14185.3226	14034.0764	11477.1875	42.7684
1998	14925.1443	14820.6704	11977.8371	49.6936
1999	15290.1551	15167.5913	13682.3571	64.492
2000	15623.7896	17711.3411	17915.5793	87.0216
2001	15900.4703	17270.5285	16621.6695	152.4604
2002	16443.7667	17338.3273	16823.1607	271.9006
2003	16739.1105	17324.8385	17898.6809	356.6012
2004	17200.2515	18095.0141	18704.1368	401.8589
2005	17374.9334	18394.8448	17722.7276	519.3264
2006	15462.4652	16677.3258	18006.9073	561.7126
2007	13886.9588	15101.4756	17785.211	689.4949
2008	13816.9877	14733.8318	16028.2262	826.7568
2009	13502.8776	14442.899	16535.2928	1298.8386
2010	12747.5317	13209.6141	18465.1874	1425.0612
2011	13196.0136	13292.6483	18566.4305	1501.517
2012	13717.4767	13091.8626	18640.3479	1946.5862
2013	14601.4775	13328.79	17541.9487	2169.3033
2014	14687.8097	13510.9158	17483.6721	2477.3361
2015	14886.2656	13599.489	17360.8602	2889.3295

Source: https://data.oecd.org/rd/triadic-patent-families.htm#indicator-chart

Triadic patent family indicator can be considered as a proxy for the output of R&D in the form of inventions.

Table 2 Computer, electronic and optical products exports Unit: US Dollar, Thousands

Year	USA	GERMANY	JPN	PRC
2005	169 116 179	108 429 944	134 809 697	255 680 072
2006	185 047 524	118 219 196	138 043 271	323 915 592
2007	186 817 278	124 015 186	125 186 943	395 198 003
2008	190 006 939	123 354 479	124 516 602	438 948 355
2009	158 960 034	97 618 475	96 464 898	393 097 585
2010	186 930 200	114 355 435	120 620 214	509 060 256
2011	196 805 504	125 999 801	120 370 033	565 787 180
2012	195 211 303	114 383 025	116 486 357	622 454 827
2013	196 096 669	115 789 965	99 529 556	678 850 588
2014	200 335 314	121 601 239	96 206 753	678 634 938
2015	194 898 832	111 629 040	87 648 378	675 164 538
2016	191 742 820	114 662 356	88 201 432	617 601 401

Resource: Bilateral Trade in Goods by Industry and End-use (BTDIxE), ISIC Rev.4[3]

[3] https://stats.oecd.org/Index.aspx?DataSetCode=BTDIXE_I4

International Journal of Business and Applied Social Science (IJBASS)
E-ISSN: 2469-6501
VOL: 6, ISSUE: 10
October/2020
DOI: 10.33642/ijbass.v6n10p4

Table 3 2000-2010 China's World ranking of Total R&D expenditures and World ranking of number of SCI papers published

Indication	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010
China's World ranking of Total R&D expenditures	9	7	6	6	6	6	6	4	4	3	2
World ranking of number of R&D researchers	4	3	2	2	2	2	2	2	1	1	1
World ranking of number of SCI papers published	8	8	6	6	5	5	5	5	4	2	2

Source: Yearbook of Science and Technology Statistics of China, 2012

The data in Table 1, Table 2, and Table 3 can show the rapid development of Chinese science &technology at the beginning of the 21st century. This rapid development can be attributed to many reasons, but we think the two following reasons are very important, one is China's huge investment in science &technology, another is the scientific and technological cooperation between China and the United States, and China's imitation and learning from the United States in science &technology.

4.1.1 China's huge investment in science and technology since the 1990s

This huge investment in science and technology is manifested as both capital investment and human investment. Data in Table 4 represent the capital investment, and data in Table 5 represent the human investment.

Table 4 S&T input indicators: gross domestic expenditure on research and experimental development (GERD). (This indicator is measured in USD constant prices using 2010 base year and Purchasing Power Parities). Unit: million US dollars.

Year	USA	EU28	JPN	PRC
1981	151767.4171		50647.90764	
1982	159434.1896		54411.63572	
1983	170833.6809		59335.33678	
1984	187739.3774		64489.99306	
1985	203747.8411		72167.23197	
1986	208979.6141		73494.42915	
1987	214099.2216		78762.96967	
1988	219163.645		84849.7751	
1989	223574.076		92665.24638	
1990	231004.8714		100114.7443	
1991	236765.7618		102387.5609	13443.89575
1992	237867.3859		101310.8388	15431.82465
1993	232776.2165		98690.50834	16778.60565
1994	232680.4833		97579.58019	17177.75277
1995	247364.1222	195921.2582	103869.0251	17206.28136
1996	261029.4277	199532.8926	110524.5166	18739.9325
1997	275991.5448	206114.6708	114934.6171	23214.59564
1998	291287.6728	214009.666	117902.5282	25355.97244
1999	310429.641	227285.4676	118391.5773	31634.39963
2000	333146.1433	239003.6074	122223.0634	40891.39438
2001	338685.0716	247659.1184	125513.2632	46639.46617
2002	333151.4034	252744.6336	127441.9135	57261.12101
2003	342930.8138	254938.5275	130635.0733	66732.05256
2004	347142.1841	257596.7217	132925.6877	79686.65965
2005	361065.9754	263760.7233	141892.5687	95556.31777
2006	377206.7931	277356.417	148316.0345	112704.413
2007	395493.316	287894.5497	153581.7645	129161.4199
2008	415342.2702	301935.6823	151792.3903	149023.5907
2009	411368.6393	301706.2611	139019.8046	187564.4019
2010	410093	308001.9441	140619.1264	213485.6609
2011	421097.8944	320165.5318	145278.4918	242801.4863
2012	417864.4514	325424.5326	145829.0315	281115.7252
2013	430606.1846	327440.2643	153653.5139	316339.6687
2014	443140.1938	337210.4187	158195.9649	344691.9377
2015	456903.007	346959.709	154552.7803	374909.9924
2016	464324.1481	349987.6055	149494.5458	410188.0962

Source: OECD, Main Science and Technology Indicators database, March 2018, www.oecd.org

International Journal of Business and Applied Social Science (IJBASS)

E-ISSN: 2469-6501
VOL: 6, ISSUE: 10
October/2020
DOI: 10.33642/ijbass.v6n10p4

Table 5 Total researchers (Full time equivalent)

Year	USA	EU28	JPN	PRC
2000	(e) 983 259.33	(e) 1113947.56	(d) 647 572.00	(bd) 695 062.00
2001	(e) 1 013 385.35	(e) 1 156 138.00	(d) 653 021.00	(d) 742 726.00
2002	(e) 1 047 327.54	(e) 1 209 201.19	(d) 623 035.00	(d) 810 525.00
2003	(e) 1 126 356.99	(e) 1 253 160.81	(d) 652 369.00	(d) 862 108.00
2004	(e) 1 105 173.91	(e) 1 308 666.40	(d) 653 747.00	(d) 926 252.00
2005	(e) 1 101 104.93	(e) 1 374 761.87	(d) 680 631.00	(d) 1 118 698.00
2006	(e) 1 130 233.07	(e) 1 422 501.05	(d) 684 884.00	(d) 1 223 756.40
2007	(e) 1 133 582.92	(e) 1 458 114.07	(d) 684 311.00	(d) 1 423 381.00
2008	(e) 1 190 957.20	(e) 1 521 939.98	(bd) 656 676.00	(d) 1 592 420.00
2009	(e) 1 251 409.95	(e) 1 553 690.77	(d) 655 530.00	(b) 1 152 311.00
2010	(e) 1 198 776.55	(e) 1 601 114.88	(d) 656 032.00	1 210 840.80
2011	(e) 1 253 100.42	(e) 1 626 804.46	(d) 656 651.00	1 318 086.00
2012	(e) 1 264 199.10	(e) 1 681 626.01	(d) 646 347.00	1 404 017.00
2013	(e) 1 305 862.36	(e) 1 729 991.18	(bd) 660 489.00	1 484 039.70
2014	(e) 1 351 903.19	(e) 1 768 549.10	(d) 682 935.00	1 524 280.30
2015	(e) 1 379 977.16	(e) 1 846 384.70	(d) 662 071.00	1 210 840.80
2016		(e) 1 889 182.88	(d) 665 566.00	1 318 086.00

Legend: b- Time series break, d- Definition differs, e- Estimated value, m- Underestimated or based on underestimated data, p- Provisional researchers are professionals working for government institutions engage d in the conception or creation of new knowledge, products, processes, methods and systems and also in the management of the projects concerned."
(https://data.oecd.org/rd/government-researchers.htm#indicator-chart)

4.1.2 Scientific and technological cooperation between China and the United States and China's imitation and learning from the United States in science &technology

The goal of China's opening-up is to learn science and technology from the developed countries, especially from the USA, so the scientific and technological corporation between China and the USA is very important. We think the basic reason for the rapid development of the scientific and technological cooperation between China and the United States should be the support from the governments of China and the USA. The U.S.-China Agreement on Cooperation in Science and Technology was signed on January 31, 1979. A new agreement to extend and amend the agreement on cooperation in Science and Technology was signed on May 22, 1991(Xue and Simon, 2013).

From 1986-1997, China-USA cooperation made up 2.5 percent of U.S. internationally coauthored papers (NSB 2000, Table 6-61). By 2008, China's share of U.S. coauthored papers were up to 10.4 percent (NSB 2012, Table 5-19). By 2010, China had risen to second place on the list of countries co-authoring with the United States (NSB 2012, Table 5-20). By 2011, China had become the top collaborating country with the United States.

There has a table named Table 5-23 in NSB 2014 as below:

E-ISSN: 2469-6501
VOL: 6, ISSUE: 10
October/2020
DOI: 10.33642/ijbass.v6n10p4

Table 6 International co-authorship of S&E articles with the United States, by selected country/economy: 2002 and 2012. Unit: Percentage

Country/economy	U.S. share of country/economy's international articles 2002	U.S. share of country/economy's international articles 2012	Country/economy's share of U.S. international articles Country/economy 2002	Country/economy's share of U.S. international articles Country/economy 2012
World	43.8	43.0	Na	Na
China	36.8	47.5	5.1	16.2
United Kingdom	30.9	33.2	13.1	14.3
Germany	30.3	31.0	13.8	13.3
Canada	53.1	48.9	11.3	11.4
France	25.5	28.5	8.6	8.8
Italy	32.4	34.0	6.9	7.4
Japan	41.2	37.1	9.8	6.8
Australia	36.6	32.9	4.7	6.0
South Korea	55.1	53.9	3.7	6.0
Spain	26.9	29.5	3.9	5.8
Netherlands	29.6	33.7	4.4	5.6
Switzerland	31.6	33.4	4.0	4.8
Sweden	27.3	30.5	3.4	3.4
Brazil	37.0	41.5	2.5	3.2
Israel	52.8	55.6	3.5	2.8
India	34.3	34.22	1.9	2.7
Taiwan	55.4	52.3	1.9	2.7
Belgium	23.5	26.0	2.2	2.5
Russia	25.3	29.9	3.8	2.4
Denmark	29.8	32.2	2.0	2.3
Austria	24.8	28.9	1.5	2.0
Poland	26.2	32.2	1.9	2.0
Mexico	42.5	46.3	1.6	1.7
Norway	29.6	30.8	1.2	1.6
Finland	27.9	29.9	1.5	1.5
Singapore	30.0	31.7	0.7	1.5
Greece	27.7	37.7	0.9	1.5
South Africa	311.0	39.3	0.8	1.4
Turkey	39.7	40.3	0.9	1.3
Chile	40.4	45.1	0.8	1.3
Portugal	19.5	25.1	0.6	1.3
Czech Republic	21.1	29.3	0.8	1.2
New Zealand	37.4	34.1	1.1	1.2
Argentina	35.2	38.2	1.1	1.2
Ireland	23.4	30.1	0.5	1.0
Hungary	29.3	33.9	1.1	1.0

Resource: Table 5-23 in NSB 2014

From the above table, it can be found that the country that most often coauthors with the United States is China in 2012.

4.2 Impact of information technology on productivity of the Chinese insurance industry

Information technology can increase the productivity of all the functional management centers, decrease the cost of the insurance company (Devipriya &Nandhini, 2019).

In the period of 1980s-2000s, the informatization of China's insurance industry can be roughly divided into three stages[4]:

(a) the first stage is called the started stage, which is in the 1980s. In this stage, insurance informatization started, the insurance company completed the replacement of the basic operation of the manual sheet.

[4] https://www.jianshu.com/p/154f91f8216c

(b) the second stage is called the development stage, which is in the late 1990s. In this stage, insurance companies realized the electronization and networking of core business processes.

(c) the third stage is called the accelerated stage, which is since the 21st Century. In this stage, the construction of insurance informatization has accelerated. China's insurance industry has completed the data centralized operation, intensive management, digital and electronic processes, and the organic integration of information technology and management.

These informatization results in the insurance industry significantly enhance the overall competitive strength and the rapid development of insurance enterprises.

4.3 Impact of information technology on productivity of Chinese securities market

The advances in information technology, including the increasingly widespread acceptance of the Internet, have revolutionized world financial markets, including China's financial markets. The impact paths are as below: information technology increases the dissemination speed of market information, makes information flows becoming seamless and borderless, instantaneous and almost costless, offer people more chances, and improves corporate governance level.

China securities and futures market started around 1990, but the starting point of information technology for China securities and futures market and the application of information technology in China securities and futures market is very high, in twenty years, China securities and futures market achieve the electronic, paperless and network transaction settlement system.

The informatization of China's securities industry can be roughly divided into three stages[5]:

(a) the first stage was the infrastructure construction phase, which was before 2000. In this period informatization construction investment mainly concentrated in the base of the trading platform and internal data transmission network realized informatization of the transaction settlement and other core business.

(b) the second stage was the centralized trading and internet application phase, which was from 2000 to 2008. At this stage, securities companies and futures companies invested and constructed information systems around centralized trading systems and online trading large-scale systems, which realized the automation of the transaction process.

(c) the third stage was extension, integration, optimization, and upgrading based on the development strategy phase, which was since 2008.

4.4 Impact of information technology on productivity of the Chinese banking industry

Information technology focuses on the development of electronic networks that exchange information, so banks are not only intensive users of financial technologies but also the intensive users of IT. The effects of information technology's impact on the banking industry are shown as improvements in costs and lending capacity.

Online commercial transactions began in 1995, and by 1998 the Internet was processing more than $50 billion worth of transactions[6]. Electronic payment technologies are methods of transferring funds electronically with relatively little paperwork. Gerdes and Walton (2002) found that (a) the estimated number of checks paid in the U.S. fell by a statistically significant 7.0 billion from 49.5 billion in 1995 to 42.5 billion in 2000, an average annual rate of decline of 3.0%; (b) the estimated number of credit card paid in the U.S grew from 10.4 billion to 15.0 billion, an average annual rate of increase of 7.3%; (c) the estimated number of debit card paid grew from 1.4 billion to 8.3 billion, an average annual rate of increase of 35.6%. Humphrey (2002) found that the share of cash used in personal consumption spending fell from 25.7% to 16.3% from 1990 to 2000. IT improvements in the back-office processing of electronic payments resulted in productivity gains and scale economies that reduced costs dramatically over time.

All financial transactions involve the exchange of information, banks are at the forefront of both information sharing and information security technology. Jappelli and Pagano (1999) do an analysis and find that bank lending is higher and credit risk is lower in countries where lenders share information.

China banking industry informatization process can be divided into four stages of development[7]:

(a) The first period is from 1957 to the late 1970s, which is called the Single batch processing phase. This is the initial stage of the electronic and information construction of China's banking industry.

(b) The second period in the 1980s, which is called the online real-time processing phase. This period began to introduce and popularize computer systems and technology on a larger scale.

(c) The third period is from the late 1980s to the late 1990s, which is called the online network phase. In this period a network system throughout the country has been established by China banking industry.

(d) The fourth period is since the late 1990s, which is called the data centralization and bank innovation phase. The rapid development of computer networks helps financial innovation continue to increase, online

[5] http://www.chyxx.com/industry/201512/364798.html

[6] http://smallbusiness.chron.com/importance-information-technology-finance-17292.html

[7] https://wenku.baidu.com/view/1a3c77fa04a1b0717fd5ddd0.html

International Journal of Business and Applied Social Science (IJBASS)

E-ISSN: 2469-6501
VOL: 6, ISSUE: 10
October/2020
DOI: 10.33642/ijbass.v6n10p4

banking, online payment, and other new service channels continue to emerge.

In a word, information technology innovation plays an extremely important role in improving the market reaction ability and business processing efficiency of modern banks, and enhancing the core competitiveness of banks.

4.5 Impact of information technology on productivity of the Chinese education industry

Information technology can improve the development of society, and form the basis of education, it is said that "information technology is having a major impact on all areas of education- curriculum, methods of teaching, classroom learning, etc." (Bhakta, etc. 2016).

Information technology helps education institutions break through the constraints of space and time, enables the delivery of education services anywhere, anytime. Distance learning, virtual classrooms, e-learning, and m-learning are the latest concepts and trends emerging on the educational horizon. Information technology can reduce the cost of education. Information technology helps teachers in easier planning, preparation of lessons, and designing of teaching-learning materials.

The development of education informatization in China has gone through three stages[8]:

(a) the first stage is from the beginning of the 1990s to the beginning of the 21st century, which is called the germination phase. The basic characteristic of the first stage is the rise of computer education, the mainstream media in this stage is PC, the leading theory is a behaviorism learning theory, the hotspots in this stage are teaching computer and computer-aided instruction.

(b) the second stage is from 2000 to 2009, which is called the early stage of the development phase. The basic characteristic of the second stage is the rise of network education, the mainstream media in this stage is multimedia computer and internet, the leading theory is the constructivist learning theory, the hotspots are the network construction, database construction, and network teaching mode design.

(c) the third stage is from 2010 to the present, which is called the process of the development phase. The basic characteristic of the third stage is pervasive computing and the rise of mobile terminals.

In the first two stages of the development of education informatization, the construction focuses on the hardware and software infrastructure needed for education informatization, such as the national education network, the introduction of computer-assisted teaching technology.

4.6 Impact of information technology on productivity of the Chinese retail industry

The development speed of retail industry informatization in China is fast. Chinese retail enterprises in more than 10 years have experienced the same process of information development and application as retail enterprises in foreign countries in more than 40 years. Niu (2008) argued that the process of Chinese retail enterprise informatization before 2008 can be divided into three stages: (a) the first stage is from the mid1980s to the mid1990s.

In this stage, Chinese retail enterprises mainly adopted POS technology and bar code technology. (b) the second stage is from the mid-1990s. In this stage, Chinese retail enterprises mainly adopted digital management systems integrated modern communication technology, network technology, data management technology, and logistics management information technology via fiber optical communications, LAN network, Wide Area Network, Internet, to manage allocation, stock, order and sale of commodities. (c) the third stage is from the late 1990s or early twenty-first Century. In this stage, Chinese retail enterprises mainly began to adopt such information technology tools as ERP (enterprise resource planning, business), SCM (Supply Chain Management), CRM (Customer Relationship Management).

According to the results of the survey by CCW Research, the Chinese retail industry IT solution market size reached 1 billion 503 million yuan in 2008, the annual increase rate is 24.5%[9], the Chinese domestic retail mobile application market reached 450 million yuan in 2013, the mobile business in the retail industry, including mobile sales management, customer service for mobile services, mobile inventory, is approaching to maturity[10].

4.7 Impact of information technology on productivity of Chinese wholesale industry

China wholesale industry informatization process can be divided into three stages of development[11]:

(a) the first period is from 1980 to the beginning of the 1990s, it is the initial stage of China's wholesale industry informatization. Beijing Sci-tech Plaza, which opened in December 1992, is the first Chinese wholesale enterprise that introduces comprehensively from foreign countries the three types of cash machines, POS system, barcode printing and scanning equipment, electronic scales, and barcode labels printed with the price of RMB. When Beijing Sci-tech Plaza opened, the bar code application rate reached more than 95%, it is the highest rate of barcode application which wholesale enterprises reached at that time.

(b) the second period is from the middle of the 1990s to the end of the 1990s, it can be considered as the low-level stage of Chinese wholesale industry informatization. In this period the supermarket had grown gradually, the wholesale enterprise paid more attention to the application of cash machines and computer technology. In this period, China government paid more attention to the development of

[8] http://www.jzsec.com/upload/20151216/20151216092033792.pdf

[9] http://news.e-works.net.cn/category6/news32078.htm

[10] http://www.199it.com/archives/254287.html

[11] http://www.nxjintong.com/lingshoudongtai/200810/22-98.html

International Journal of Business and Applied Social Science (IJBASS)

E-ISSN: 2469-6501
VOL: 6, ISSUE: 10
October/2020
DOI: 10.33642/ijbass.v6n10p4

circulation industry informatization. The China Ministry of science and technology and relevant departments have also increased the investment in the construction of circulation industry information.

(c) the third period is since the end of the 1990s or the early 21st century, Chinese wholesale industry informatization enters into a rapid growth period. At the end of the twentieth century to the early twenty-first century, the electronic commerce tide emerges in the developed countries, so does in China. The electronic commerce tide adds fuel to the development flames of the wholesale industry informatization. A large number of foreign wholesale companies enter into the Chinese wholesale market, exalt the competition degree in the Chinese wholesale market. Increasingly fierce competition makes Chinese wholesale enterprises use industry informatization as tools for improving enterprise competitiveness. The Internet has become a path for the wholesale market in China to transform and innovate to a new high level. The number of wholesale markets practicing e-commerce by applying modern information technology such as the Internet is growing rapidly, online transaction scale is gradually enlarged. For example, Zhejiang Province is a more developed region in the wholesale market field, by the end of 2014, the number of Zhejiang Province professional wholesale market carrying out the application of e-commerce reached 382, accounting for nearly 90% of all the professional market. Viewing from the perspective of the type of e-commerce practice, the main types to carry out e-commerce by Zhejiang Province professional wholesale markets are the self-built e-commerce platform and relying on the third-party e-commerce platform, the number are 132 and 134, respectively[12].

5. Conclusion

Maddison and Wu have revised China's GDP data from multiple angles, including the revision of China's non-material service sector GDP data. Maddison assumed that the non-material service sector in China has had a zero scientific and technological progress rate since the 1990s, Maddison's assumptions have led to a significant reduction in China's GDP data, and thus China's economic growth rate has dropped significantly because the data from the National Bureau of Statistics of China shows that the rate of scientific and technological progress in the non-material service sector is very high. we argue that the high-tech progress rate of the non-material service sector-led and promoted by information technology is not only possible but also very likely due to China's heavy investment in information technology, as well as Chinese science and technology's imitation and vigorous pursuit of the United States since Reform and Opening, so China's GDP data is credible in general, and of course, that some small deviations and inaccuracies are also existence is also understandable and acceptable.

References

Adams, F. Gerard and Yimin Chen. (1996). Skepticism about Chinese GDP growth – the Chinese GDP elasticity of energy consumption. *Journal of Economic and Social Measurement*, 22, 231-240.

Barro, Robert J., Sala-I-Martin, Xavier (1995). *Economic Growth*, New York, McGraw-Hill.

Berger, Allen N. (2003). The Economic Effects of Technological Progress: Evidence from the Banking Industry. *Journal of Money, credit, and banking, volume 35, number2, March 2003*, 141–176.

Bhakta, Kaushik; Nabanita, Dutta. (2016). Impact of Information Technology on Teaching-Learning Process, *International Research Journal of Interdisciplinary & Multidisciplinary Studies* (IRJIMS), ISSN: 2394-7950, Volume-II, Issue-XI, December 2016, Page No. 131-138.

Devipriya, B., Nandhini, M.(2019). Information Technology in Insurance Sector. ResearchGate. https://www.researchgate.net/publication/334737884_INFORMATION_TECHNOLOGY_IN_INSURANCE_SECTOR

Frame, W. Scott, and Lawrence J. White (2002). Empirical Studies of Financial Innovation: Lots of Talk, Little Action? Prepared for the conference on "Innovation in Financial Services and Payments" Federal Reserve Bank of Philadelphia May 16-17, 2002. Federal Reserve Bank of Atlanta working paper.
https://pdfs.semanticscholar.org/d4c1/4aec8afec0342c81e084aeaa132fa54e7fdf.pdf

Furst, Karen, William W. Lang, and Daniel E. Nolle (2002). Internet Banking. *Journal of Financial Services Research* 22, 95–117.

Gerdes, Geoffrey R., and Jack K. Walton II (2002). The Use of Checks and Other Retail Noncash Payments in the United States, *Federal Reserve Bulletin*, 360–374. https://ideas.repec.org/a/fip/fedgrb/y2002iaugp360-374nv.88no.8.html

12 http://theory.people.com.cn/n1/2016/1219/c83865-28960601.html

International Journal of Business and Applied Social Science (IJBASS)

E-ISSN: 2469-6501
VOL: 6, ISSUE: 10
October/2020
DOI: 10.33642/ijbass.v6n10p4

Gerdes, Geoffrey R., and Jack K. Walton II (2002). The Use of Checks and Other Retail Noncash Payments in the United States, *Federal Reserve Bulletin*, 360–374. https://ideas.repec.org/a/fip/fedgrb/y2002iaugp360-374nv.88no.8.html

Holz, Carsten A. (2006). "China's Reform Period Economic Growth: How Reliable Are Angus Maddison's Estimates?" *The Review of Income and Wealth*, March: 85-119

Humphrey, David B. (2002). U.S. Cash and Card Payments over 25 Years. Florida State University working paper. https://www.philadelphiafed.org/-/media/%20research-and-data/events/2002/financial-services-and-payments/papers/Humphrey.pdf

Jappelli, Tullio, and Marco Pagano (2002). Information Sharing, Lending and Defaults: Cross-Country Evidence. *Journal of Banking & Finance 26* (2002) 2017–2045.

Jefferson, Gary H., Thomas G. Rawski and Yuxin Zheng (1996). Chinese Industrial Productivity: Trends, Measurement Issues, and Recent Developments. *Journal of Comparative Economics*, 23: 146-80.

Keidel, Albert (1992), How Badly do China's National Accounts Underestimate China's GNP? *Rock Creek Research Inc. Paper* E-8042

Keidel, Albert. (2001). China's GDP Expenditure Accounts. *China Economic Review*, 12: 355-367.

Maddison, Angus (1998). *Chinese Economic Performance in the Long Run*, OECD, Paris, www.ggdc.net/Maddison.

Maddison, Angus (2006), "Do Official Statistics Exaggerate Growth? A Reply to Caersten Holz", *Review of Income and Wealth*, March, pp. 121-6.

Maddison, Angus (2007), *Chinese Economic Performance in the Long Run, 960-2030*, OECD, Paris.

Maddison, Angus and Harry X. Wu (2008), "Measuring China's Economic Performance", with Angus Maddison, *World Economics*, Vol. 9 (2), April-June

National Science Board (2014). Science and Engineering Indicators, 2014. Washington, D.C.: National Science Foundation.

----------------------------- (2012). Science and Engineering Indicators, 2012.Washington, D.C.: National Science Foundation.

------------------------------(2000). Science and Engineering Indicators, 2000.Washington, D.C.: National Science Foundation.

Niu, Donglai (2008). "Review and development trend of retail informatization in China." *Journal of information and computer*, issue 1, 2008. http://www.eduroute.info/Impact_of_Information_Technology_on_Education.aspx

Rawski, Thomas G. (2001). What is Happening to China's GDP Statistics? *China Economic Review*, 12: 347-354.

Ren, Ruoen (1997). *China's Economic Performance in International Perspective*, OECD, Paris.

Shelton, R. D., Foland, P. (2009). The race for world leadership of science and technology: status and forecasts. *In Proceedings of the 12th International Conference of the International Society for Scientometrics and Informetrics* (pp. 369-380).

Shiau, Allen. (2004). Has Chinese Government Overestimated China's Economic Growth? in Yue, Ximing, Zhang Shuguang and Xu Xianchun (eds.), *Studies and Debates on the Rate of Growth of the Chinese Economy*, CITIC Publishing House, Beijing.

Triplett, Jack E. and Barry P. Bosworth, (2004). *Productivity in the U.S. Services Sector: New Sources of Economic Growth*. Brookings Institution Press, Washington, D.C. 2004.

Wu, Harry X. (2000). Measuring China's GDP level and Growth Performance: Alternative Estimates and the Implications, *Review of Income and Wealth*, Series 46(4): 475-499.

----------------. (2002). How Fast has Chinese Industry Grown? - Measuring the Real Output of Chinese Industry, 1949-97, *Review of Income and Wealth*, June, pp: 179-204.

----------------. (2007). The Chinese Economic Growth Rate Puzzle: How Fast Has the Chinese Economy Been Grown? *Asian Economic Papers*, 6(1): 1-23.

----------------. (2011), "The Real Growth of Chinese Industry Debate Revisited— Reconstructing China's Industrial GDP in 1949-2008", The Economic Review, Institute of Economic Research, Hitotsubashi University, Vol. 62 (3): 209-224

E-ISSN: 2469-6501
VOL: 6, ISSUE: 10
October/2020
DOI: 10.33642/ijbass.v6n10p4

----------------. (2012), "Measuring Gross Output, Value Added, Employment and Labor Productivity of the Chinese Economy at Industry Level, 1987-2008 – An Introduction to the CIP Database", RIETI Discussion Paper Series 12-E-066 October 2012. https://www.rieti.go.jp/en/publications/summary/12100008.html

-----------------.(2014). China's Growth and Productivity Performance Debate Revisited Accounting for China's Sources of Growth with a New Data Set. Economics Program Working Paper Series, EPWP #14 – 01. https://www.conference-board.org/pdf_free/workingpapers/EPWP1401.pdf

Xu, Xianchun (2002). Study on Some Problems in Estimating China's Gross Domestic Product, *Review of Income and Wealth*, 48(June): 205-216

Xue, Lan, Simon, Denis. (2013). Chaper12 U.S.-China Science and Technology Cooperation https://www.chinausfocus.com/2022/wp-content/uploads/Part-02-Chapter-122.pdf