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The Growth of "Non-material Services" in China

—— Maddison's "Zero-Labor-Productivity-Growth" Hypothesis Revisited ——

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"Ingenuity cannot fully or effectively compensate for lack of basic information."
Simon Kuznets (1941)

This study revisits Maddison's controversial "zero-labor-productivity-growth" hypothesis on the growth of China's "non-material services". I show that by controlling for the same development stage as the Chinese economy in 1993–2012, South Korea showed zero or slightly negative growth in those services in 1970–90. I also show that physical indicators on education and healthcare industries do not show any significant labor productivity growth. To improve Maddison's earlier work, I have adjusted the 1990s structural break in employment series, converted numbers to hours worked, and reconstructed military personnel. I also allow one to two percent growth of labor productivity to reflect the correction to factor cost distortions. My new results suggest that the labor productivity growth of this sector is between 2.2 and 2.9 percent per annum in 1993–2012.
JEL Classification Codes: C82, I12, I21, J21

1. Introduction

For various methodological and institutional reasons, the quality of the Chinese official GDP estimates has long been questioned (Maddison 1998; also see Wu 2000 and 2014 for a review). This has motivated researchers to provide alternative estimates of China's "real" growth. Most of the existing studies focus on the data problems of the aggregate economy using either physical indicators (Garnaut and Ma 1992; Adams and Chen 1996; Rawski 2001) or alternative price measures (Keidel 1992; Ren 1997; Wu 2000). However, as often said, *the devil's in the details*, studies at sectoral level, especially those using commodity-based indicators, have shown that official estimates do not fully reflect external shocks to the economy, hence exaggerating the growth especially in bad times (Wu, 2002, 2007, 2011 and 2013; Maddison and Wu 2008).

Another highly questionable part of the official growth estimates is services, especially the so-called "non-material services" including non-market services defined under the UN System of National Accounts (SNA). First of all, the concept of "non-material services" is used in the material product system (MPS) practiced in the Soviet national accounts. Following the Marxian dogma, which underlies MPS, the "non-material services" are considered *unproductive*, which are distinguished from *productive* activities in the "material economy", i.e. the so-called "material services" such as commerce, transportation, post and telecommunication. In MPS, the "non-material services" include all other services, typically banking and financing, real estate, business services, culture and entertainment services, and education, healthcare and government services.

A stylized fact of the "non-material services" is that they are highly labor-intensive and therefore very slow in terms of

labor productivity growth. Therefore, SNA rules out any imputation of productivity growth for this sector (SNA 1993: 134). However, as shown in Maddison (2007), the official GDP estimates for those services imply substantial productivity growth of 5.1 per cent per annum for 1978-2003. Based on the experience of developed economies, Maddison argued that such a fast growth of labor productivity for those services was unprecedented in human history and hence suggested that the official statistics were highly likely to be exaggerated.

Without alternative information, to gauge the real output growth for this sector Maddison proposed to use the number of employment as a proxy indicator, assuming a zero labor-productivity growth for these services (Maddison 1998 and 2007). This is a transparent and reasonable treatment to the complicated problem that involved serious price distortions and substantial undercoverage of service activities during the central planning period. To obtain a more reliable proxy, Maddison also adjusted the official employment statistics for "non-material services" by including an assumed constant number of military personnel for each year. Such an adjustment was undoubtedly rough but still reasonable and transparent. This approach was also adopted in Maddison and Wu (2008).

Maddison's "zero labor-productivity growth" assumption has been challenged by some researchers (see Holz, 2006) who argued that higher GDP growth (as high as 6 percent per year) for this sector is possible. Nevertheless, my further investigation shows that Maddison's rebuttal to Holz (Maddison, 2006) is well justified for the pre-reform period (Wu 2014). If using official estimates on the value added and employment of "non-material services" and skipping the earlier recovery period and the shocks brought by "socialization" (semi-nationalization) and the Great Leap Forward (and its aftermath), there was virtually no labor productivity growth observed up to the early 1980s.

However, whether China's super-fast labor productivity growth in the "non-material services" sector can be accepted as a reality or rejected as a statistical artifact has still remained controversial. It is not yet clear if the experiences of developed countries can be used for a developing and transition economy like China. There is so far no study that has examined the data problems in details and compared China with countries at the similar stage of development.

This paper is structured as follows. Section 2 re-examines the hypothesis from some international perspective, especially the East Asia experience. Section 3 extends the examination by constructing some volume indicators especially for health services and education to bypass problematic official price indicators. Section 4 is designed to provide a more reliable employment measure for "non-material services". Section 5 presents a new series of value added and labor productivity estimates for this sector. Section 6 concludes this study.

2. Maddison's Hypothesis in an International Perspective

In this section, using official estimates, checked and tidied up for consistency, my re-examination starts with the most updated accounts for China's sectoral performance in gross value added (GDP), labor employment and labor productivity for the planning and reform periods. Our observations on China will then be compared with other studies, specifically one by van Ark (1996) for OECD countries and one by Griliches (1992) for the US economy. Finally, I will compare China with South Korea by controlling for the stage of development using 1990 purchasing power parity (PPP)-converted per capita GDP.

Table 1. GDP, Employment and Labor Productivity in China, 1953-1978 and 1978-2012

(Percent per annum)

	1953-1978			1978-2012		
	GDP	Numbers employed	GDP/ person	GDP	Numbers employed	GDP/ person
Total economy	4.3	3.0	1.4	9.8	1.7	8.1
All goods sectors	4.2	2.8	1.4	9.2	0.4	8.8
Goods excl. agriculture	10.6	7.9	2.8	11.4	2.1	9.3
"Material services"	4.3	3.9	0.4	10.2	3.5	6.7
"Material services"(+)[1]	4.7	4.0	0.7	10.3	4.3	6.1
"Non-material services"	5.2	3.9	1.3	11.4	5.4	6.0

Source) Wu (2014).

Note) 1. Including construction.

Experiences of developed economies

Compared with Maddison's observation for the period 1952-2003, the updated accounts up to 2012 in Table 1 have slightly lowered the labor productivity growth in the planning period from (1953-1978) 1.5 to 1.3 percent per annum but further raised this productivity growth indicator from 5.1 to 6.0 percent per annum for the reform period (1978-2012). In the following comparisons, we will examine the results from the updated data. Despite problems in the official data the aggregate indicators for the total economy generally reflect the changes over the two periods as shown in Table 1. While the GDP growth more than doubled from 4.3 to 9.3 percent per annum, the employment growth slowed down almost by half from 3 to 1.7 percent per annum. Consequently, the growth of labor productivity in the reform period significantly accelerated at a rate that was nearly 6 folds of that in the planning period, rising from 1.4 to 8.1 percent per annum. There are several important observations from Table 1.

However, at sector level there are "atypical" observations in both periods. In the planning period, the growth of labor productivity in "non-material services" was not only faster than that of "material services" but also almost as fast as that of the total economy. In the reform period, all service sectors experienced an unusually fast growth by about 6 percent per annum. Particularly, that the labor productivity of "non-martial services" grew at 6 percent for 34 years makes China an extreme outlier in history.

What have been observed in China can be compared with other economies. Let us first examine the labor productivity growth of "non-material services" in developed countries as presented in Griliches (1992) for the US economy in 1948-89 (Table 2) and in van Ark (1996) for OECD countries in 1973-90 (Table 3). There are some stylized facts that can be summarized from these studies. First, with more sectoral details in Griliches, we can observe that in general the labor productivity growth of "non-material services" is much slower than that of "material services". For the entire period 1948-89, the former only grew at 1.1 percent per year whereas the latter grew at 2.4 percent per year.

The period 1969-89 in Griliches (1992) is roughly comparable with the period 1973-90 in van Ark (1996). For these comparable periods, the labor productivity growth in "non-material services" was 0.37 percent per annum in the US and was 0.06 percent per annum on average in the OECD countries. In the case of "material services", the two studies arrived at closer growth rates. i.e. 1.65 and 1.95 percent per annum for the US and the OECD average, respectively (Table 2 and Table 3 with a further calculation for the US in 1969-89).

Second, compared with that of "material services", the labor productivity growth of

Table 2. Constant Dollar GNP per Hour by Sector in the USA, 1948-89

(Percent per annum)

	1947-60	1960-69	1969-79	1979-89	*1948-89*
Commodities, total (1)	2.9	1.9	1.2	2.3	*2.1*
Services, total (2)	2.2	2.2	1.0	1.3	*1.7*
Services/commodities, (2)-(1)	−0.7	0.3	−0.2	−1.0	*−0.4*
"Material services":[1]	2.7	3.0	1.6	2.3	*2.4*
-Transport & utilities	2.9	3.8	2.8	2.4	*2.9*
-Wholesale trade	3.1	3.1	0.3	2.7	*2.3*
-Retail trade	1.6	1.4	1.0	1.8	*1.4*
"Non-material services":[1]	1.9	1.5	0.6	0.2	*1.1*
-Finance, insurance & real estate	2.2	1.4	0.5	0.1	*1.1*
-Business, government services[2]	0.9	1.5	0.9	0.5	*1.0*

Source) Griliches (1992, p. 5), checked and revised using data on constant values provided on p. 5.
Notes) 1. Author's calculation using Griliches's data. 2. This sub-sector includes personal services.

Table 3. GDP per Person Employed in OECD Countries, 1973-90

(Percent per annum)

	Agriculture	Industry	"Non-material services"	"Material services"
Denmark	6.42	2.24	0.26	1.76
France	5.22	3.01	0.98	1.84
Germany	5.48	1.83	1.00	2.62
Italy	3.35	3.14	0.00	1.12
Netherlands	4.25	1.63	−1.00	1.60
Spain	6.26	4.74	1.35	2.15
Sweden	3.84	2.12	−0.20	1.71
UK	3.77	2.79	0.57	1.25
USA	2.95	1.20	−0.11	0.77
Average	4.62	2.52	0.32	1.65

Source) van Ark (1996, pp. 109-115).

"non-material services" slowed down substantially over time. Table 2 shows that in the case of the US "non-material services", the annual growth of labor productivity slowed down from 1.9 percent in 1947-69 to 0.2 percent in 1979-89. However, in the case of the US "material services", despite fluctuations in different periods, by 1979-89 the annual growth of labor productivity had not changed much from its starting point in 1947-60.

Third, within each sector, the most labor-intensive sub-sector shows the slowest labor productivity growth, e.g. "retail trade" in "material services" and "business and government services" in "non-material services".

More recent studies on the US economy to a large extent confirm the earlier results. For example, Triplett and Bosworth (2004, pp. 172, 261-263) estimated that for the period 1995-2001, the labor productivity for the US insurance carrier industry was −0.9 percent per annum, for the US business services industry was 0.9 percent per annum, and for the healthcare industry was −0.4 percent per annum.

What if controlled for the stage of development?

Based on the examples of the developed economies, China appears to be indeed atypical with a super fast labor productivity growth in all types of service in the reform period. However, the apparent shortcoming of the above comparison is that the stage of development is not controlled. This is an important point that was missing in the debate between Holz (2006) and Maddison

Table 4. Gross Value Added, Hours Worked and Output per Hour in China, 1993-2012

(Percent per annum)

	1993-2001			2001-2012			*1993-2012*		
	VA	Hour	*VA/h*	VA	Hour	*VA/h*	VA	Hour	*VA/h*
Total economy	9.4	0.1	*9.3*	10.4	1.0	*9.4*	10.0	0.6	*9.4*
All goods sectors	9.3	−1.3	*10.6*	10.0	−0.6	*10.5*	9.7	−0.9	*10.6*
Goods excl. agriculture	11.5	−0.9	*12.5*	11.1	5.4	*5.8*	11.3	2.7	*8.6*
"Material services"	9.4	1.2	*8.2*	10.9	1.8	*9.1*	10.3	1.6	*8.7*
"Material services" (+)[1]	9.0	2.1	*6.9*	11.3	2.5	*8.8*	10.3	2.3	*8.0*
"Non-material services"	10.0	4.3	*5.8*	10.9	4.3	*6.5*	10.5	4.3	*6.2*

Source) Wu (2014).
Note) 1. Including construction.

Table 5. Gross Value Added, Hours Worked and Output per Hour in South Korea, 1970-1990

(Percent per annum)

	1970-1980			1980-1990			*1970-1990*		
	VA	Hour	*VA/h*	VA	Hour	*VA/h*	VA	Hour	*VA/h*
Total economy	8.4	6.4	*2.0*	9.4	4.9	*5.0*	8.9	5.4	*3.5*
All goods sectors	9.9	5.2	*4.7*	10.0	2.6	*7.9*	9.9	3.6	*6.3*
Goods excl. agriculture	13.0	8.1	*4.9*	11.0	5.0	*6.8*	12.0	6.2	*5.9*
"Material services"	8.3	5.0	*3.3*	7.8	3.0	*5.0*	8.0	3.9	*4.2*
"Material services" (+)[1]	8.8	7.1	*1.7*	9.3	3.6	*5.9*	9.0	5.2	*3.8*
"Non-material services"	5.8	5.8	*0.0*	8.3	8.9	*−0.2*	7.0	7.1	*−0.1*

Source) Author's calculation based on KIP database http://www.kpc.or.kr/eng/state/2011_kip.asp?c_menu=5&s_menu=5_4).
Note) 1. Including construction.

(2006). While Holz could not show that the official data from some former Soviet republics were less flawed or more reliable than the Chinese data, Maddison was not sufficiently convincing that China's experience in "non-material services" should be in line with that of the developed countries.

This shortcoming can be overcome by controlling for the stage of development and, ideally, for resource endowments and cultural background. In such consideration, East Asia economies are the best candidate for the comparison. In what follows, first, benchmarking on the current stage of the Chinese economy, I use 1990 constant-price PPP GDP measure from The Conference Board Total Economy Database (TCB/TED 2013) to define a stage of development from PPP $ 2,000 to PPP $ 8,000 on per capita basis. This matches the status of China in 1993-2012,[1] Japan in 1950-69, South Korea in 1969-89 and Taiwan in 1967-87. With available data at the moment, I then use the case of South Korea in the period 1970-90 in the comparison. Tables 4 and 5 present the case of China and the case of South Korea, respectively.

In a quick glance at the general performance of the two countries during the same stage of development, compared with South Korea China grew faster in gross value added (GDP) but substantially slower in the quantity of labor input (measured as hours worked[2]) which is attributed to China's premature demographic transition pushed by its harsh birth control policy since the early 1970s. Consequently, China shows much more rapid labor productivity growth than South Korea. Yet, our question here is whether the official estimates are reliable and whether the high growth of labor productivity reflects the truth. If the answer is no, then is it mainly attributable to problems in the official estimates of the real output of "non-material services"?

However, a further comparison between China and South Korea in terms of labor productivity performance in "non-material services" cannot change my earlier view that

China is an extreme outlier in history based on the comparison with the developed countries. As Table 5 shows, over the period 1970–90, on average the labor productivity of the South Korean "non-material services" declined by −0.1 percent per annum. It was worse in the second sub-period (1980–90) compared with that of the first sub-period (1970–80). Besides, compared with "non-material services", the labor productivity of "material services" grew at 4.2 percent per annum and accelerated over time. This sharply contrasts the case of China presented in Table 4. Maddison's hypothesis is evidently valid in the case of South Korea at the same stage of development as that of China.

3. Searching for Physical Indicators

If we rule out data manipulation, the most likely problem in the official measure of the output of "non-material services" is the underestimation of price changes which is possibly caused by biased sampling in price surveys. However, because of a higher measure of inflation will result in a lower estimate of real GDP growth, growth-motivated local officials have strong incentives to undercount price changes. This is certainly easier to do in the case of services, especially "non-material services" consisting of a much wider coverage in activities. Ihis means that they are more difficult to monitor by the central authorities compared to the case of manufacturing that is more concentrated in a locality with much smaller number of products.

If prices are biased and hence becoming the major source of the measure problem, and if no data available on the cost structure of "non-material services" at detailed activity level, one faces a considerable challenge in getting the measurement corrected. The easiest way and perhaps also the most meaningful approach is to search for physical indicators that can help explore the underlying volume movement. In doing so, we are, however, still very much in the spirit of Angus Maddison.

In the following explorations, I focus on two sectors out of China's "non-material services", that is, education and healthcare, both are also categorized as "non-market" services in SNA.

Education

In searching for a physical indicator-based labor productivity measure in education, I first measure student-to-teaching staff ratio (STR) at different level of education and then I weight different levels of schooling by returns on education. The estimated level-specific STR results are reported in Table 6. The number of students refers to the number of currently enrolled students in each year excluding graduates of the same year. In the last column of the table, students at different level of education are weighted by returns on education that has been widely researched in the literature of labor and education economics.

To have a somewhat control for the level of education, following my earlier work on education-based estimation for human capital (Wu 2014), I conduct the weighting based on a study by Zhang *et al.* (2005). Besides, I benchmark the weighting on primary schooling, thus the results are primary schooling equivalent (PSE). For teaching staff, I use the returns on tertiary education to weight tertiary and the senior-level of secondary teachers and the returns on the senior-level education to weight teaching staff from the junior-level of secondary downwards.

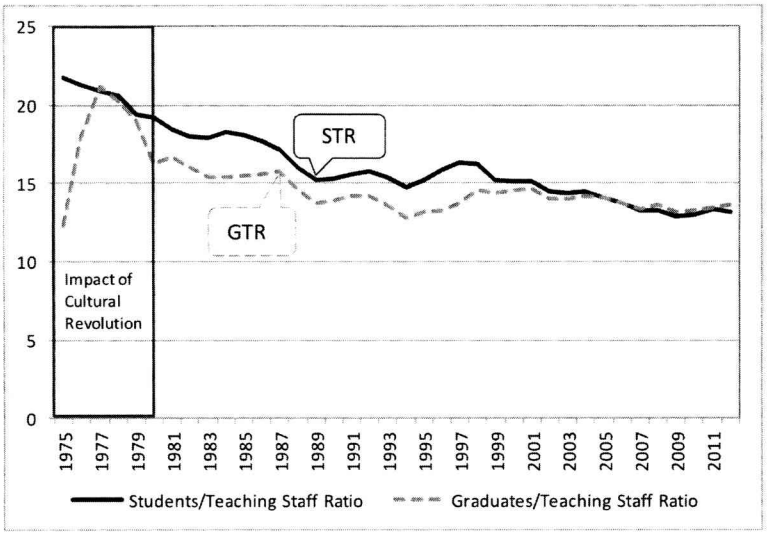
In general, for the education sector as a whole, the STR has declined by −1.3 percent per annum, indicating a decline in labor productivity. The decline was more pronounced in the secondary- and primary-level schools in the 1980s and 2000s. China's premature demographic transition is respon-

Table 6. China's Student-Teaching Staff Ratio (STR) by Level of Education, 1980-2010
(Teaching Staff=1)

	Tertiary	Secondary[1)]	Primary	Pre-primary	Weighted average[2)]
1980	4.6	18.3	26.6	28.0	19.2
1985	5.0	17.7	24.9	26.9	18.1
1990	5.2	15.1	21.9	26.3	15.4
1995	7.2	16.1	23.3	31.0	15.2
2000	12.0	18.4	22.2	26.2	15.1
2005	16.2	18.0	19.4	30.2	14.1
2010	16.6	15.3	17.7	26.0	13.0
Growth p.a.%					
1980-1990	1.2	−1.9	−1.9	−0.6	−2.2
1990-2000	8.7	2.0	0.1	0.0	−0.2
2000-2010	3.3	−1.8	−2.2	−0.1	−1.5
1980-2010	*4.4*	*−0.6*	*−1.3*	*−0.2*	*−1.3*

Source) Author's calculation based on data from NBS (2012, pp. 751-752).
Note) 1. Including junior and senior high schools. 2. Weighted by returns on education. See text for details.

Figure 1. China's Students and Graduates-Teaching Staff Ratio, 1975-2012
(Teaching Staff=1)



Source and Note) See Table 6.

sible for the declining STR in primary-level education. The rising tertiary STR indicates a fast growth in the labor productivity of tertiary institutions by 4.4 percent per annum on average for the entire period, and by 8.7 percent for the 1990s. However, this cannot change the overall performance of STR.

On the other hand, if we treat the annual graduates, weighted to obtain the PSE measure, as the final product of the education sector and the teaching staff numbers, also weighted, as the input of the education sector, we can obtain a graduates-teaching staff ratio or GTR and compare it with STR in Figure 1. This is to check if the measure of STR significantly deviates from a measure that only uses graduates.

Figure 1 shows that the two measures moved very closely after the lagging effects of the Cultural Revolution (1966-76), and virtually converged since the beginning of the 2000s. This means that the teaching staffs used as input are basically in line with both the production process (enrolled students) and the final production (graduates). Thus, both the so-measured STR and GTR for China can be used to gauge the labor productivity in education. However, Figure 1 also helps confirm that there is a declining trend in the labor productivity of China's education sector.

Healthcare

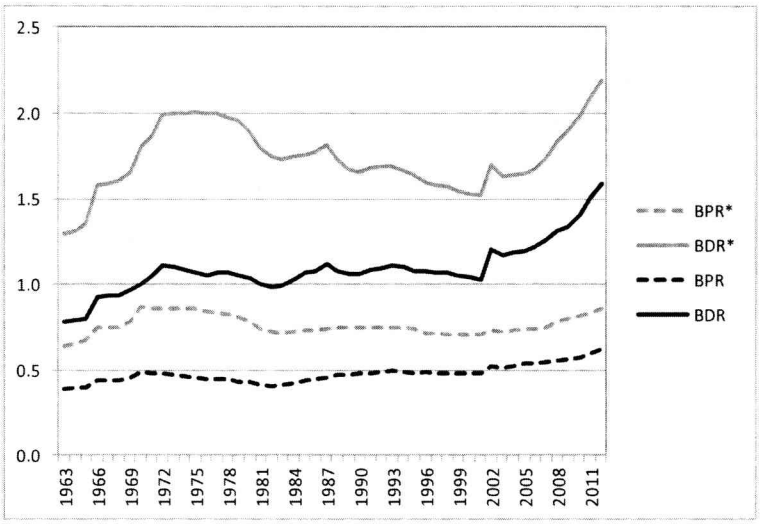
In searching for a physical indicator-

Table 7. China's Hospital Beds-Medical Personnel Ratio, 1980-2010
(Medical Personnel=1)

	All medical personnel (BPR)[1)]	Licensed doctors and assistants[2)]	Licensed doctors (BDR)	Registered nurse	Pharmacist	Technicians
1980	0.78	1.07	1.75	2.66	4.02	44.53
1985	0.73	1.11	2.17	2.47	4.31	34.15
1990	0.75	1.10	1.49	2.00	4.79	22.77
1995	0.74	1.12	1.47	1.91	5.13	17.76
2000	0.71	1.09	1.41	1.79	5.47	14.39
2005	0.74	1.26	1.59	1.91	7.36	11.40
2010	0.81	1.47	1.80	1.73	10.03	12.24
Growth p.a.%						
1980-1990	−0.4	0.3	−1.6	−2.8	1.8	−6.5
1990-2000	−0.6	−0.1	−0.6	−1.1	1.3	−4.5
2000-2010	1.4	3.0	2.4	−0.3	6.3	−1.6
1980-2010	0.1	1.1	0.1	−1.4	3.1	−4.2

Source) Author's calculation based on data from NBS (2012, pp. 833-836).
Note) 1. Including unregistered nursing personnel. 2. "Assistants" are junior level doctors with medical qualification, but not licensed doctors.

Figure 2. Hospital Beds-Medical Personnel Ratios in China, 1963-2012
(Medical Staff=1)



Source) See Table 7.

based labor productivity measure for healthcare, I first measure beds-to-medical personnel ratio (BPR) for staff members with different qualifications in ordinary hospitals, particularly beds-to-licensed doctor ratio (BDR). I then compare the two ratios for ordinary hospitals with those constructed for all medical institutions including hospitals, public health centers at all levels and community clinics. The ordinary hospitals-focused ratios are reported in Table 7. The comparison between ordinary hospitals and all types of healthcare institutions as a whole is presented in Figure 2 (indicated by asterisk).

It should be noted that due to lack of information, we cannot control for the qualification of different medical personnel. Therefore, in Table 7 not only BPR and BDR but also other ratios are not fully comparable with each other. Unlike in the case of education, we also cannot control for the quality of medical services in measurement (e.g. days for recovery by type of disease, recovery and survival rates by type of operation, etc.). However, the BDR and other similar ratios can still shed some light on the input-output relationship in medical services in physical terms. However, a primary purpose here is to examine whether the labor-intensive nature in medical services has changed, which has a bearing on the change of labor productivity in this

sector.

Table 7 shows that both BPR and BDR increased by 0.1 percent per annum over the entire period under our investigation. If including all assistant doctors (not yet licensed for providing independent medical service), this ratio will rise to 1.1 percent per annum. The sub-period that saw the most rapid increase in these ratios was 2000–10, which was a significant change from the earlier periods. However, the ratio for registered nurses and technicians declined considerably. The services provided by nurses are perhaps most labor-intensive in hospitals, whereas the services provided by pharmacists appear to be least labor-intensive, thanks to the rapid development of information technology. However, more equipment-dependent medical institutions require more and more services from technicians. That is perhaps why the beds-technician ratio has shown the most rapid decline.

The ratios presented in Figure 2 help expose the trend of change over time. Due to lack of information, I have to apply the same number of medical personnel to two different measures of medical institutions, that is, ordinary hospitals and all medical institutions marked by asterisk(*). It shows that the two measures (without or with*), either based on all medical personnel or doctors, tended to converge prior to the 2000s but this trend stopped after the 2000s. After this point, we cannot dig out more useful information from the available data. In other words, even if considering the deficiencies in measurement, BPR and BDR in Table 7 are still sufficient for our purpose. In my view, although they do not show exactly "zero labor productivity growth", they have lent a strong support to the Maddison hypothesis. The rise of the two ratios since the 2000s simply cannot change the general labor productivity trend of "non-material services".

Our search for physical indicators has by no means completed. However, the indicators in the education and healthcare sectors may have to a large extent reflected the labor-intensive nature and the change of labor productivity in most "non-materials services" in China. Together with the support by our further international comparison especially our comparison with South Korea at the same stage of development, I feel justified to improve Maddison's estimates of the real output of "non-materials services" based on the quantity of employment in this sector.

4. Constructing a Better Employment Measure

Because of the problems in the official estimates for the real output of "non-material services", more reliable, alternative estimates have to depend on better employment data for the sector. However, a more reliable employment measure needs to tackle various inconsistency problems in concept, classification and coverage. There are three basic problems in China's employment statistics that have long been ignored by researchers. They are a serious structural break in 1990, the missing of military personnel and lack of a quantity measure in natural hours.

Adjustment for the structural break in 1990

As discussed in Maddison and Wu (2008), the structural break is represented by an astonishing 17 percent or 94.2 million jump in the official employment series in 1990. This new total is available with three broad-sector breakdowns (primary, secondary and tertiary) linking to the same breakdowns prior to 1990, but not with the estimates at industry level for 16 sectors. The existing industry level estimates, which follow the pre-1990 tradition, fall short of the new estimate of total employment in 1990 by 80.1 million. The post-1990 data series is built on this new level of total employment, hence

sustaining a continuous gap with an underlying trend based on the pre-1990 data series.

There are three major steps in my adjustment. They are the preparation of the concept and classification-consistent quantitative base for examining and adjusting the break, the investigation of the nature of the break, and finally the adjustment or reconstruction of the quantitative series.

The first step is conducted on the basis of broad sectors used in the Chinese official statistics, that is, primary, secondary with the breakdown of industry and construction, and tertiary with the breakdown of "material services" and "non-material services" up to 1993 when officially shifted from MPS to SNA. Other regularly published series are used to maintain such breakdowns for consistency.[3] These five broad sectors are finally reconstructed as sectoral "control totals" for the economy-wide labor accounts.

In the second step, I investigate the nature of the break. As discussed in Yue (2006), the gap is caused by inappropriately linking the results of the 1990 Population Census to the annual estimates that are based on a regular employment registration and reporting system established in the early planning time. The population census discovered a large number employed who had been missed by the regular reporting system, yet the NBS did not integrate the results with the annual estimates at the industry level. If this 80.1 million of additional workforce recorded in the 1990 Census did not appear suddenly in 1990, which is a reasonable assumption, a logical inquiry should ask whether the gap had always existed in the economy but never covered by the labor statistical system or whether it began from a particular time when changes in employment policy allowed informal employment to emerge but not yet necessarily picked up by the rigid labor planning system. Hence, a proper investigation should be conducted on two grounds: checking earlier or pre-1990 population censuses or sample surveys to see if a similar discrepancy existed in earlier periods and examining changes in employment policy that created outside-planning-system employment.

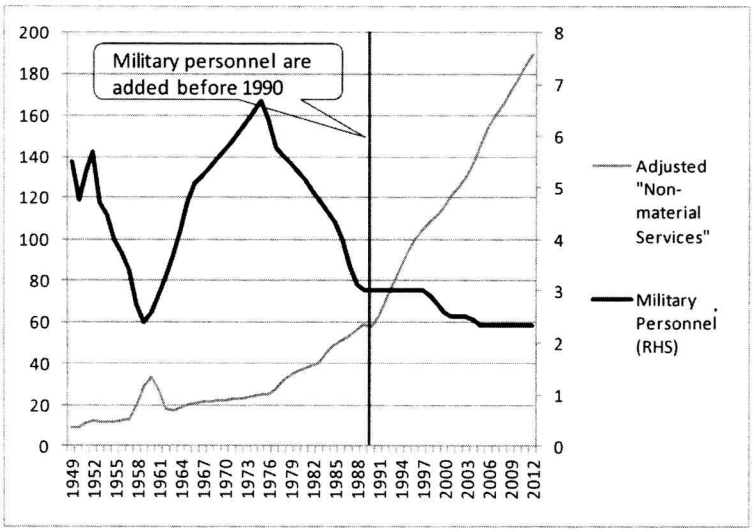
China only conducted three population censuses before the 1990 Population Census in 1953, 1964 and 1982. Unfortunately, the available data from the 1953 and 1964 censuses do not contain any useful employment information. However, the 1982 Population Census reports China's total number of employment as 521.5 million, or *68.6 million more* than the annual estimate of 452.9 million for that year. Additional information from the 1987 one-percent population sample survey gives an estimate of 584.6 million or *56.7 million more* than the annual estimate of 527.8 million. It is now clear that the structural break started at least in 1982 rather than in 1990.

The last step is to reconstruct the series. An inevitable question at the beginning is when did this additional employment begin to emerge if it did not happen all of a sudden at the time of the 1982 census? In my earlier work, I show that there have been ample evidence suggesting that the government began to relax its employment regulation in the early 1970s to make room for the development of rural enterprises (then named as "commune and brigade factories") and to allow "outside plan" hiring in cities (Wu, 1994).[4] It is then justifiable to assume that the discrepancy began in the early 1970s. This was the time when China settled down from the chaotic situation at the early period of the Cultural Revolution and began to normalize its relationship with the West.

Therefore, the discovered discrepancy is not only backward extended from 1990 (census point) to 1982 (census point), but also further extended to 1971, using 1970 as the initial point of adjustment with the trend-

Figure 3. China's Employment in "Non-material Services" and Military Personnel, 1949-2012

(Million numbers)



Source) Author's estimation.

deviation interpolation approach that incorporates annual fluctuations from the original trend in official estimates. The additional numbers employed are allocated to the reconstructed quantitative base discussed above. At sector level, I assume that they only engaged in non-farming, labor-intensive manufacturing and "material services".[5]

Construction of military personnel series

The exclusion of military personnel will exaggerate the labor productivity of government services in general and lowers the service output especially for the period when military personnel were sizeable and engaged in economic activities.[6] However, due to lack of necessary information Maddison simply assumed that the size of the military personnel was a constant 3 million for the period 1952-1996 (Maddison, 1998, pp. 168-9). In his later work, based on new information he assumed that the official employment statistics had included military personnel from 1993 onwards (Maddison 2007, p. 170).

My new evidence shows that, first, the official practice of excluding military personnel was ended in 1990 and, second, the size of military personnel prior to 1990 was not a constant 3 million over time as Maddison assumed. In fact, China's armed forces were numbered at about 5.5 million in 1949. After four rounds of demobilization between 1950 and 1956, the number was substantially reduced to 2.4 million by the end of 1958. It, however, rose again between the mid 1960s and the mid 1970s in response to the border tensions and conflicts with the Soviet Union and India, respectively. By the end of 1975, the Chinese military personnel picked at 6.8 million. There were two new rounds of demobilization conducted in the post-Mao period initiated by Deng who aimed at maintaining smaller but more modernized armed forces at around 3 million from the end of the 1980s (Table A1, Appendix). The reconstructed military personnel and the adjusted employment "non-material services" (including military personnel) are depicted in Figure 3.

The new estimation has both level and rate effects in terms of employment and any employment-based income statistics. Clearly, in terms of the level of employment, the effect of adding the newly estimated military personnel to the existing "non-material service" employment is much greater for the earlier period than for the later period. After the adjustment, the military personnel accounted for 67 percent of the "non-material service" employment in 1949, 27 percent in 1975 and only 5 percent in 1989. This has consequently changed the movement of the "non-material service" employment. Compared with Maddison's estimate of annual growth for this sector at 6.3 percent for the

Table 8. Average Hours Worked per Year by Major Sector, 1970-2010
(Medical Staff=1)

	Total Economy	Agriculture	Industry	Construction	"Material Services"	"Non-material Services"
1970	2,436	2,448	2,448	2,282	2,448	2,448
1975	2,658	2,741	2,729	2,249	2,709	2,577
1980	2,821	3,069	3,043	2,113	2,998	2,714
1985	2,831	3,074	3,048	2,160	3,026	2,744
1990	2,812	3,064	3,000	2,151	2,974	2,694
1995	2,917	3,144	3,078	2,184	3,107	2,978
2000	2,640	2,796	2,755	2,157	2,749	2,578
2005	2,659	2,524	2,888	2,848	2,736	2,687
2010	2,718	2,559	2,900	2,884	2,917	2,654

Source) Wu, Yue and Zhang (2014).

period 1952-1962, my estimate is only 4.5 percent. This implies that any employment-based level estimation for that period, such as using labor compensation to estimate value added in "non-material services" or using benchmark labor productivity to gauge the real output growth of "non-material services" will be substantially raised but the related growth rate will be accordingly reduced.

Estimation of hours worked

There have been no systematic official estimates of hours worked. Occasionally published data focus on weekly average hours worked of the state industrial sector without information on hours worked in services. Wu and Yue (2012) made the first attempt that takes the institutional weekly working hours as the baseline following the official working-day calendar and then made anecdotal information-based assumptions to adjust non-baseline industries. Wu, Yue and Zhang (2014) made a further effort to construct an hour matrix to include all services, attempting to fully use available data on hours worked from household surveys and population censuses.

The main sources are China Household Income Project (CHIP, 1988, 1995, 2002 and 2007), the 2005 1% Population Sample Survey and the 2010 population census. These benchmark years are used in the estimation based on which estimates for other time points are either interpolated or extrapolated using the constructed employment series as the "control totals" for the period 1980-2010. The estimation for 1980-2010 is made at sector level (37 sectors) and then grouped into 5 major sectors. For the period before 1980, the institutional working hours for industry, as constructed in Wu and Yue (2012), are used as the baseline to gauge working hours of other sectors. The results of average hours worked per year are presented in Table 8. The significant differences in hours worked across sectors justify the use of hours or full-time equivalent (FTE) measure of employment in productivity analysis for the Chinese economy.

5. Alternative Estimation of the Real Output

I in principle adopt Maddison's employment-based approach to estimate the real output in China's "non-material services". However, unlike Maddison I do not simply multiply the employment series by the value added in 1990. Instead, I think there is some room for further improvement. Basically, the followings should be considered before proceeding to make the estimation. First, which period is qualified for the "zero-labor-productivity" growth based on the official data? An examination of the change of labor productivity should be focused on the changes determined by the fundamental

factors. This can be done by regression or simply excluding the years that suffered from external shocks (note that not necessarily foreign shocks; political shocks are also external to the economy). Second, do annual fluctuations from the trend contain useful information that should be maintained in the estimation, even for the period of zero labor-productivity growth? Third, can reform-induced corrections to factor cost and incentive distortions account for some "productivity growth" in the reform period? I must say that these questions reflect some changes in my thinking that deviates from my earlier work with Maddison (Maddison and Wu 2008).

To respond to the first question, my further investigation shows that Maddison's rebuttal to Holz (2006) (Maddison, 2006) is well defensible for the pre-reform period up to 1981. If using official estimates of the value added and employment of "non-material services" and skipping the earlier recovery period, the shocks brought by "socialization" and the impact of the Great Leap Forward (and its aftermath), there was virtually zero growth in labor productivity.

To the second question, I argue that any adjustment to official estimates should take into account annual fluctuations from the trend, both normal cycles and shocks. Following my earlier point, shocks should be excluded in order to identify the real trend determined by fundaments. However, shocks also contain important information and should be included when constructing data based on a new trend. This rationalizes the use of the annual changes in the official estimates of real output when reconstructing the series for 1952-81. This approach should also be used for other periods when there is positive labor productivity growth.

As to my third question about the possibility of labor productivity growth in "non-material services" in the reform period, there are two effects that should be considered. The first effect refers to reform-induced corrections to cost distortions under central planning. Conceptually, this effect is not productivity change by nature and also should not be confused with price changes. However, output per worker indeed rises due to this effect. Maddison (2007) raised his 1987 benchmark-level real output for "non-material services" by one third. He argued that this was more appropriate than arbitrarily re-pricing Chinese output at sector level by foreign prices (Ren, 1997) or by relative cost adjustment based on theory (Keidel, 1992). In the present study, I also adopt Maddison's approach to the level adjustment.

The second effect refers to the real growth of labor productivity in the reform period. Reform measures are labor productivity-promoting because compared with policies under central planning they tend to better reward more productive workers. This should not be confused with technological change. Taking this into account and also considering the international experiences discussed earlier, I therefore allow the real labor productivity of "non-material services" to grow by one percent per annum from 1982 onwards and by another one percent per annum from 1992 onwards.[7] This should be a sufficient, if not too much, adjustment to Maddison's estimation based on his "zero-labor productivity growth" hypothesis.

The final results of this work for Chinese "non-material services" are reported as labor productivity growth in Table 9. The labor productivity growth rates for the goods sectors are also presented for comparison. Besides, the labor productivity is measured based on both adjusted numbers employed and estimated hours worked. For the purpose of comparison, I also include the results based on Maddison (2007) and the latest official estimates.

Table 9. Growth of Labor Productivity in China: Official vis-à-vis Alternative and Numbers vis-à-vis Hours

(Percent per annum)

	1982-1993[2]					
	Official		Maddison		Wu	
	$y(h)$	$y(n)$	$y(h)$	$y(n)$	$y(h)$	$y(n)$
Total economy	*7.9*	*8.1*	*5.4*	*5.6*	*4.0*	*4.2*
All goods sectors	8.2	8.3	6.2	6.4	4.0	4.2
Goods excl. agriculture	11.5	11.8	8.2	8.5	4.2	4.4
"Material services"	6.4	6.6	6.4	6.5	6.4	6.6
"Material services" (+)[1]	5.3	5.5	5.3	5.5	5.3	5.5
"Non-material services"	6.4	7.0	−1.1	−0.5	−0.5	0.0
	1993-2001[2]					
	Official		Maddison		Wu	
	$y(h)$	$y(n)$	$y(h)$	$y(n)$	$y(h)$	$y(n)$
Total economy	*9.3*	*8.3*	*7.2*	*6.2*	*6.3*	*5.2*
All goods sectors	10.6	9.6	8.3	7.4	6.6	5.6
Goods excl. agriculture	12.5	13.2	9.9	10.6	7.4	8.1
"Material services"	8.2	6.9	9.3	8.0	8.2	6.9
"Material services" (+)[1]	6.9	5.7	7.7	6.4	6.9	5.7
"Non-material services"	5.8	4.5	0.8	−0.5	2.2	0.9
	2001-2012[2]					
	Official		Maddison		Wu	
	$y(h)$	$y(n)$	$y(h)$	$y(n)$	$y(h)$	$y(n)$
Total economy	*9.4*	*9.6*	*n.a.*	*n.a.*	*7.5*	*7.8*
All goods sectors	10.5	10.7	n.a.	n.a.	8.2	8.4
Goods excl. agriculture	5.8	7.9	n.a.	n.a.	3.8	6.0
"Material services"	9.1	9.6	n.a.	n.a.	9.1	9.6
"Material services" (+)[1]	8.8	9.3	n.a.	n.a.	8.8	9.3
"Non-material services"	6.5	6.7	n.a.	n.a.	2.9	3.1

Source) Author's calculation.

Note) 1. Including construction.

2. $y(n)$ = Labor productivity based on numbers employed. $y(h)$ = Labor productivity based on hours worked.

The labor productivity of agriculture in the case of Maddison is based on his work on agricultural real value added which is adjusted mainly for level not for rate (Maddison 1998 and 2007). I have adopted his estimates. As in Maddison (1998 and 2007), I also adopt the official GDP estimates for construction and "material services". For the industrial sector, the real output estimates are from my results using the commodity approach (Wu 2013).

Despite a significant increase in the numbers of military personnel in this work, my estimate of the labor productivity growth for "non-material services" is higher than that from Maddison in the two comparable periods, especially the estimate in 1993-2001 based on hours worked. Taking into account all possible factors and having handled the problems with available information, the new results appear to be more plausible than Maddison's earlier estimates.

6. Concluding Remarks

My work to assess and therefore reconstruct the real output (GDP) estimates for Chinese "non-material services" is exploratory only. I am not in a much better position to conclude this work even after having examined some new evidence and developed some

new indicators for the problem. The rather traditional, if not backward, physical indicator approach is by no means ideal, but it serves the purpose when no reliable data are available, or readily available.

The priority for future research should be on prices or searching for a better approach to gauge the underlying price distortions. We should not hesitate to get back to the theoretical foundation laid by the work of Balassa (1964) and Samuelson (1964) and focus on the internal exchange rate between the tradables (goods) and nontradables (services) sectors. It seems to hold true for both individual countries and at international level that larger productivity gains are observed in the tradable goods sector than in the non-tradable goods sector. Therefore, the market's natural response to the income growth caused by the productivity growth of the tradables is a faster price increase rather than a productivity growth in the nontradables. While Maddison's physical indicator approach may not be convincing enough to show that the official real output estimates for Chinese "non-material services" are flawed, there has been no convincing evidence in the economy to suggest that the Balassa-Samuelson effect is invalid in the case of China.

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Appendix: An Estimation of Chinese Military Personnel

The earliest information can be found in the first official publication on labour statistics, *Zhongguo Laodong Gongzi Tongji Ziliao* [*China labour and Wage Statistics*] *1949-1985* by DSS (Department of Social Statistics, NBS) in 1987. In that publication's "Indicator Explanation", it specifies that both "working-age population" and "general labour resources" indicators do not include military personnel (DSS, 1987, p. 267). In one of the statistical tables, it also confirms that the "working-age population" counted in China's first (1953), second (1964) and third (1982) population censuses do not include military personnel (p. 4). This clearly implies that all official employment series back to 1949 did not include military personnel. The same definition was followed in the later DSS publication in 1989 updating the earlier data (DSS, 1989, p. 323) and in the annual labour statistical publication, *China Labour Statistical Yearbook* (CLSY), which started in 1990.

For crosschecking this finding, we have also looked at the explanations for labour statistical indicators in the NBS's annual publication, *China Statistical Yearbook* (CSY), which was firstly released in 1981. I have found that prior to the 1988 issue, CSY did not explicitly explain whether military personnel were included (e.g. see NBS, 1985, p. 657). However, it should be noted that CSY did use the same indicator "social laborers" as that used in DSS, which was in fact a subcategory of the "general labour resources" (DSS, 1987, p. 267). My comparison of the data in the two publications shows that the statistics for total and service employees in the pre-1988 issues of CSY are the same as those in the DSS publications. In 1988, one year after aforementioned the first DSS publication, CSY adopted the same DSS definition (NBS, 1988, p. 206).

An important change came with the 1994 issue of CLSY, which for the first time indicated that military personnel should be included in the category of "other persons employed" (DPES and DCPW, 1994, p. 587). This change also appeared in a collection of government policies on labour statistical indicators jointly published by NBS and Ministry of Labour in the same year (DPES and DCPW, 1994, p. 9). As for CSY, although it abandoned the DSS definition in the 1994 issue, it did not clearly indicate under what

category military personnel should be recorded until 1997. The 1997 issue of CSY showed the same definition for "other persons employed" as that in the 1994 issue of CLSY. But this inconsistency in timing might not be an accident. In fact, a closer examination of the labour statistics shows that there was not any change in statistics in 1994 associated with the change of the definition, neither in the total numbers employed nor in the numbers of service employment.

The first adjustment appeared in 1997 in both CLSY and CSY covering the data up to 1996, which only adjusted the previous employment statistics from 1990 to 1995 leaving the pre-1990 series untouched (DPES and DCPW, 1997, p. 9; NBS, 1997, Table 4-1). A further adjustment was made in 2002, which revised the series since 1990 again (NBS, 2002). Note that the adjustment was not specifically made for the missing military personnel but for all major sectors of the economy.[8] Therefore the effect of the adjustment for the military personnel is implicit. Following the new definition, one could only say that the military personnel should be included in the "others" of the tertiary employment, but could not tell its actual size for any year of this period. However, one thing is clear that there has been no adjustment for the military personnel for the pre-1990 period.

In what follows, I attempt to construct a time series for China's military personnel using publicly available information. The procedures are presented in Table A1. I mark the benchmark years with asterisk (*) for which information is available. I also provide the key assumptions for gauging the volume movement between the benchmarks. References for the information used in the estimation are also provided.

Table A1. Estimated Chinese Military Personnel with the Information for Benchmarks and Assumptions for the Movement between Benchmarks

(In thousands)

	End-year	Average	Benchmarks and Assumptions for Changes between the Benchmarks
1949*	5500	5500#	Official estimate of the size of the PLA at the end of the Chinese Civil War between the communists and the nationalists (CCSEC, 1994a, p. 144)
1950*	4000	4750	China's first post-war demobilization, mainly cutting the size of the army while increasing the air force and navy, reduced the size of the military personnel by 1500 (CCSEC, 1994a, p. 144).
1951*	6700	5350	There were large scale recruitments for the Korean War in this year, which increased the size of the military personnel to 6110 according to CCSEC (1994a, p. 144). An estimate from other sources is 6270 (Zhang, 2006, p. 23; and (Chen, *Youth Daily*, September 7, 2003). Taking an average of the two estimates and plus the armed "public security force" of 510 (CCSEC, 1994b, p. 295), our estimate is 6700.
1952*	4700	5700	The second demobilization began in January when the Korean War entered a stage of stalemate. According to CCSEC, the military personnel were demobilized by 2000 (1994a, p. 144).
1953	4700	4700	As a decision on a new round (the third) of demobilization was made in August 1953 aiming to complete it by the end of 1955 (CCSEC, 1994a, p. 145), we assume there was no change for this year.
1954	4225	4463	Interpolated based on the size in 1953 and in 1955.
1955*	3750	3988	The third demobilization was carried out in 1954-55. We only know that by the end of 1955 the size of military personnel was cut by 21.2% from the level of 1953 (CCSEC, 1994a, p. 155).
1956*	3750	3750	As given by CCSEC, at the end of the fourth demobilization (1958) the military personnel were cut by 36% from the 1956 level (1994a, p. 155).
1957	3075	3413	Interpolated based on the size in 1958 and 1956.
1958*	2400	2738	The fourth demobilization began in October 1956. By the end 1958 the Chinese military force reduced to around 2400, reaching the smallest size since 1949 (CCSEC, 1994a, p. 155). However, Zhang's source suggests 2370 (2006, p. 23).
1959	2400	2400	Assume no change from 1958.
1960	2712	2556	No information, assuming constant growth rate interpolation between 1959 and 1965.
1961	3065	2889	Constant growth rate interpolation between 1959 and 1965.

1962	3464	3265	Constant growth rate interpolation between 1959 and 1965.
1963	3915	3689	Constant growth rate interpolation between 1959 and 1965.
1964	4424	4170	Constant growth rate interpolation between 1959 and 1965.
1965*	5000	4712	Based on CCSEC, see the information for 1971 (1994a, p. 253)
1966	5154	5077	No information, assuming constant growth rate interpolation between 1965 and 1971.
1967	5313	5234	Constant growth rate interpolation between 1965 and 1971.
1968	5477	5395	Constant growth rate interpolation between 1965 and 1971.
1969	5646	5562	Constant growth rate interpolation between 1965 and 1971.
1970	5820	5733	Constant growth rate interpolation between 1965 and 1971.
1971*	6000	5910	As suggested in CCSEC, the increase of the military personnel had been out of control in the 1960s and by this year it reached a level that was 2.5 times the 1958 level, i.e. rising by 3600, or 120% of the 1965 level (1994a, pp. 253-254).
1972	6185	6093	No information, assuming to follow the growth rate of 1965-71
1973	6376	6281	Assume to follow the growth rate of 1965-71
1974	6573	6474	Assume to follow the growth rate of 1965-71
1975*	6775	6674	Assume to follow the growth rate of 1965-71. However, Zhang shows that in 1975 the size of the military personnel increased to 6600 (2006, p. 23). Since this figure is very close to our average estimate for this year, we stick to our result.
1976*	5854	6315	The fifth demobilization took place and cut the military personnel by 13.6% from the 1975 level (Chen, *Youth Daily*, September 7, 2003).
1977	5640	5747	By mid-point interpolation.
1978	5427	5534	By mid-point interpolation.
1979	5213	5320	By mid-point interpolation.
1980*	5000	5107	The sixth demobilization was conducted in the late 1980 and the seventh in 1982, together cutting the size by 1000 by the end of 1985, reaching 4000 (Chen, *Youth Daily*, September 7, 2003).
1981	4782	4891	No information, assuming constant growth rate interpolation between 1980 and 1985.
1982	4573	4677	Assume constant growth rate interpolation between 1980 and 1985.
1983	4373	4473	Assume constant growth rate interpolation between 1980 and 1985.
1984	4183	4278	Assume constant growth rate interpolation between 1980 and 1985.
1985*	4000	4091	See the entry for 1980. However, another source suggests the size was 4238 by the late 1985 (Zhang, 2006, p. 22)
1986*	3000	3500	The eighth demobilization was decided by Deng in 1985 to cut 1000 by 1986 (CCSEC, 1994a, p. 298; Zhang, 2006, p. 22). The target was achieved.
1987*	3000	3000	As announced in a press conference in 1986, the PLA would maintain a size of 3000 and officer-soldier ratio 1: 3.3 (CCSEC, 1994a, p. 312).
1988-96	3000	3000	Assume maintained 3000 as announced in 1987 until 1998.
1997*	3000	3000	The decision on the ninth demobilization was made to cut 500 in the following three years as given in China's Defense White Paper 2000 (IOSC, 2000. p. 25).
1998	2823	2912	Assume to be cut at a constant rate between 1997 and 2000.
1999	2657	2740	Assume to be cut at a constant rate between 1997 and 2000.
2000*	2500	2578	Assume to be cut at a constant rate between 1997 and 2000.
2001	2500	2500	Maintained at 2500 as given in China's Defense White Paper 2002 (IOSC, 2002. p. 10).
2002	2500	2500	Maintained at 2500.
2003*	2500	2500	The tenth demobilization was decided to further cut 200 by 2005 (Zhang, 2006, p. 22).
2004	2400	2450	Assume declined at a constant rate between 2003 and 2005.
2005*	2300	2350	The target of the tenth demobilization was achieved (IOSC, 2006).

Sources) See references in the table and the text.

Notes) Asterisk * marks the benchmark year that is supported by the available information. # Assuming the year average figure is equal to the end-year figure for 1949.

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Notes

1) Strictly speaking, according to my most recent estimates (Wu 2014), which have revised and extended the Maddison-Wu series (Maddison and Wu 2008), China still needs another 2-3 three years to reach the level of PPP $8,000. To simplify our comparison, I assume that China will grow at the same annual rate of 2010-12 in the next 2-3 years.

2) See Section 4 for work to construct hours worked matrix.

3) They are: 1) the employment series with primary, secondary and tertiary sector breakdowns, published in every issue of China Statistical Yearbook (CSY) and China Labor Statistical Yearbook (CLSY), 2) the series with "material" and "non-material" sector breakdowns, published in CSY till 1993 (NBS 1993, pp. 100-101), 3) the series with 16-sector breakdowns, published in CSY and CLSY up to 2002 (NBS 2003), and 4) the series with 19-sector breakdowns for employment in urban "unit" and 7-sector breakdowns for employment in private enterprises and self-employed people in urban "non-unit", published since 2003 in CSY and CLSY (NBS 2012, pp. 130-136).

4) However, many new jobs were created in an informal way and many of the new workers were temporal and seasonal in nature and could be engaged in multiple jobs within a year, hence they were insufficiently covered by the system.

5) They are very unlikely to engage in the majority of "non-material services", but likely to work in personal services. In this exercise, however, I leave "personal services" untouched due to lack of necessary information.

6) Apart from defense service, military personnel also engaged in construction, transportation, farming and government services in the early period of the People's Republic. Assuming that they only engaged in "non-material services" may overestimate the output of these services, but it hardly changes the conclusion.

7) Nonetheless, this is arbitrary and strong because such a productivity effect is likely one-off rather than a continuous increase over a long period. Besides, economic history has suggested that economic development is accompanied by a transition from manufacturing towards services, which will lead to a decline rather than an increase in productivity in general.

8) The adjustment in 1997 substantially raised the original estimates for employment in 1990-95. It began with the adjustment for 1990. For that year the total numbers employed was raised by 71.69 million from the previous estimation (567.40), of which 43.79 were in the primary sector, 14.96 in the secondary sector and 12.95 in the tertiary sector (NBS, 1997, Table 4-1). The second adjustment was made in 2002. For 1990 it further raised the total numbers employed by 8.4 million, of which 4.86 were in the primary sector, 2.02 in the secondary sector and 1.51 million in the tertiary sector. Note that all these adjustments were made after Maddison made his estimation based on the earlier official statistics (Maddison, 1998a).

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