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Abstract: This paper pulls together many primary and secondary sources to arrive at consistent estimates of national income for china between the 17th and 20th centuries. We find, in line with much of the literature, that GDP per capita declined between the mid-17th and 19th centuries. This trend reversed during the 19th century, mainly due to a shift into services and, for the late 19th century onwards, also in industry. Since these sectors exhibited higher labour productivity, this fostered economic growth. This pattern of decreasing share of services and industry from the 17th century and increasing shares in the 19th century is common in many Asian countries except Japan. The reasons for this development, however, are unclear. The standard ultimate factors of growth such as institutions (low marriage age for women, exclusive society) and geography apply to almost all Asian countries. Hence, more research is necessary.

Keywords: GDP, agriculture, industry, services, growth, China

JEL Codes: N15, N35, N65, O40.

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Chinese National Income, ca. 1661-1933

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1. Introduction

Discussions about sources of economic development rise high in the last decades. Especially on China no consensus so far exists. Several qualitative studies headed by Frank (1998) and Pomeranz (2000) have argued in favour of Chinese prominence in the world economy into the 19th century. More recently, they have found quantitative support by some historians, especially for the Yangtze region (e.g. Allen 2009, Li 2010). Yet, other studies find little support for this claim. For example, following Baten, Ma, Morgan and Wang (2010) it follows that Chinese average human stature, which is considered a measure of welfare, was not surpassing that in Europe. Likewise, Allen et al. (2011) find that real wages were considerably lower than in Europe. Based on this recent evidence, Pomeranz (2011) has also argued that the take-over of China by Europe in economic terms occurred considerably before the 19th century. The views of high income in the Yangtze and the lower income in China as a whole are not inconsistent though as the Yangtze is generally considered to be considerably richer than China as a whole (e.g. Li and Van Zanden 2012).

The consensus therefore seems to be that China was considerably poorer than Northwestern Europe around 1800, but by what margin remains unclear. For example, it remains unclear whether Pomeranz' (2011) assumption can be substantiated that the Chinese economy was as rich as in Europe around the 17th century. This lack of information about the growth pattern of the Chinese economy over this period is partly due to lack of quantitative data which so far has limited the possibilities to arrive at national accounts which can be compared to those being constructed in Europe. Yet, recently, a surge in historical national accounts studies have come about both in Europe (e.g. Malanima 2011; Van Zanden and Van Leeuwen 2012; Broadberry, Campbell and Van Leeuwen 2013) which trend is mirrored in Asia with studies on Indonesia (Van Zanden 2002), Japan (Bassino et al. 2011), and India (Broadberry, Custodis and Gupta 2014)

A similar trend, based on a large array of past scholarship has also emerged for China, seemingly disproving the often claimed lack of data (e.g. Liu Guanglin 2005; Liu Di 2010; Ma and De Jong 2012; Broadberry, Guan and Li 2014). Even though contested, all studies seem to show that the Chinese economy embarked on a downward trend somewhere between the Sung and Qing Dynasties followed by a mild recovery in the late Qing.

In this paper we attempt to arrive at an integrated view discussing the entire crucial period between the first "solid" GDP estimate of 1933 and 1661, something that no-one has attempted before, by including many new archival materials. We will do so for 9 benchmarks covering turning points in Chinese history, i.e. 1661, 1685, 1724, 1776, 1812, 1850, 1887, 1911 and 1933. For each point we do not only provide estimates of GDP, but also a breakdown by economic sector. The results show a decline in per capita income from the late Ming onwards, which was only reversed in the late Qing. This suggest that the gap with Western Europe already existed

before the late Ming, but that the gap with much the remainder of Europe only started to come into existence in the 18th century.

The next section we will discuss the general sources, followed, in section 3, by population. Section 4, 5, and 6 discuss agriculture, industry and services respectively. Section 7 and 8 discuss GDP and labour productivity by economic sector. Section 9 gives briefly an international comparison and we end with a brief conclusion.

2、sources and benchmarks

This study covers both the Qing Dynasty and Republican China prior to World War two periods which were characterized by a very different statistical system. Hence, we have to draw upon very different sources to get a complete coverage. Since the first modern economic survey conducted by Qing government in the 1900s, our estimates depend mainly on countrywide surveys. Nevertheless, since these first surveys were still incomplete, it remains necessary to combine them with regional censuses, local gazetteers, and private note -and account books.

For the Qing dynasty, such surveys are rarely available and hence we have to rely on different types of sources. These consist, first, of government publications covering China as a whole such as for cultivated land, population, and government expenditure. Second, there are regional publications, which cover certain economic sectors in a specific region. An example of the latter are the Qing mining archives, which provide output in a certain mining subsector in specific regions. In addition, local gazetteers sometime provide agricultural yields, sectoral output, and the labour force in certain regions. Aggregating these local data and combining them with national level data, enables us to arrive at national Chinese estimates by economic sector.

Besides these primary sources, over the past years quite some research has been done, especially covering the period of the late Qing Dynasty. Chung-li Chang (1962) provided an estimate of the national income for the 1880s, Perkins (1975) for 1914~1918, and Ou (1947) and Liu and Yeh (1965) for 1933. Cao (2000) provided the several benchmarks on population in the Qing dynasty while Guo Songyi (1991) and Moll-Murata (2011) have supplied estimates of the employment structure for 1850. Also many studies exist on specific economic sectors. For example, Xu Dixing and Wu Chengming (1990, 2001) provided the outputs and growth ratios in different economic sectors in several benchmarks, such as 1840, 1894, 1908, 1920 and 1936 while, within the project underlying this paper, Shi (2011, 2012) provide estimates for cultivated land between 1661~1850, yields in 1661, 1724 and 1850, and population in 1661, Xu (2013, 2014) for industrial sectors in 1911 and the mining sector in 1850, Shi and Xu (2008) for government expenditure between 1661 and 1911, and Ni (2010) provides data for both customs duties and trade output.

From the previous discussion it has already become clear that annual estimates are impossible as for example gazetteers were only published at intervals of many years and, hence, many data are only available for certain benchmark years. Since our study aims at tracing the long run economic performance between 17th and 20th century, we focus on the benchmark years with the most reliable data, i.e. 1661, 1685, 1724, 1776, 1812, 1850, 1887, 1911 and 1933. Not only do these represent the best quality data, they also represent important turning points in Chinese history according to present literature. Both 1661 and 1685 witnessed the unification in mainland China and Taiwan respectively under Qing rule. Around 1724 the Chinese economy had

recovered to the levels of late Ming, with a peak in economic performance under Qing rule occurring in 1776 followed by decline after 1812. This decline set in a (slow) process of economic and social modernization around 1850, which set in motion, after a slow reversal during the *Tongzhi restoration* around 1887, the end of the Qing Dynasty in 1911 with the start of modern economic surveying. This triumph of modernization lasted until ca. 1933 when a decline set in driven by the adverse effects of the world economic crisis.

3 Population

As a first step, it is important to determine population size. Population size, however, is relatively fixed for the Qing dynasty. Government publications such as *Daqing Lichao Shilu, Qingchao Xuwenxian Tongkao,* and *Shiyichao Donghualu*, provide annual censuses in the Qing dynasty for tax purposes. However, not only were the amounts of tax frozen since early Qing dynasty but also children and women were not taxed and therefore not included in the registers. The same applies to migrants, even those who had migrated generations ago and where, as a rule, registered in their region of origin rather than that of their actual residence. Therefore, several corrections have been applied to the official figures. Cao (2001) and Shi (2012) provided the adjusted

Table 1 Adjusted population figures 1661—1933 (million)

Year	1661	1685	1724	1766	1812	1850	1887	1911	1933
Population Size	120	146	202	286	369	436	436	439	500

population for 1661, 1776, 1820 and 1911 and Ou (1947) for 1933. The remaining benchmarks, such as 1685, 1724, 1850, and 1887, were interpolated based on population growth ratios from Cao (2000). Table 1 shows the population estimates used in this study.

4 Agriculture

By far the biggest sector in the Chinese economy was agriculture. In 1933 it made up ca. 60% of GDP. This remained the case before 1933. Here we follow Ou (1946) in breaking down agriculture into arable, and livestock, forestry, and fisheries. As was the case in most parts of the world, with

Table 2 Cultivated land under food and cash crops 1661-1933 (in mu).

	Total cultivated land	Food crop	cash crop
1661	717,824,000	646,041,600	71,782,400
1685	823,296,000	740,966,400	82,329,600
1724	997,376,000	897,638,400	99,737,600
1766	1,070,962,759	931,737,600	139,225,159
1812	1,177,953,103	1,024,819,200	153,133,903
1850	1,319,900,690	1,148,313,600	171,587,090
1887	1,388,905,412	1,180,569,600	208,335,812
1911	1,458,296,471	1,239,552,000	218,744,471
1933	1,408,286,000	1,225,208,820	183,077,180

the exception of Western Europe, the arable sector was by far the largest and hence our

following estimates will concentrate on that' sector.

The estimate of the amount of cultivated land are based on corrections of the well documented figures of taxed cultivated land in the Qing Dynasty while its division into food and cash crops is reported in Table 2 (see also Appendix A). It is clearly visible that there is a strong expansion with no less than a doubling between 1661 and 1933 with the fastest growth occurring between 1661 and 1685. This expansion is the more remarkable as in England over the same period the acreage increased with only ca. 50%.

A similar spectacular increase cannot be found in the yield (see appendix A), however. As can be shown in Table 3, the yield (in jin per mu) increased from 258 in 1661 to 350 in 1933, a

Table 3 Average annual yield of food crops between 1661 and 1933 (jin/mu)

year	1661	1685	1724	1766	1812	1850	1887	1911	1933
average yield	258	270	285	303	322	322	300	291	350

rise of 36%. For comparison, the increase in yield in England over the same period amounted to 88%. Hence, a slower growth in yields, combined with a faster growth in cultivated area seems to suggest a relatively comparable increase in agricultural output in China and England over our period.

This leaves us with the pastoral sector. The shares of livestock, forestry and fisheries in total agricultural value added are given in Table 4 (see also appendix A). Adding up this sector with arable, we can calculate the value added for different benchmarks in the constant 1933 price. Here we find a truly remarkable difference with England. Whereas the share of these sectors in China was ca. 15 %, in England was rather between 40% and 50% with a faster growth rate.

Hence, a slow increase in yield and a fast increase in land under cultivation suggest that the rise in total arable output was not much different in China and Early Modern England. Yet, a low

Table 4 Livestock, forestry and fisheries as a percentage of total agriculture

year	livestock	forestry	fishery	total
1661	10.00	4.00	3.00	17.00
1766	9.00	3.50	2.50	15.00
1850	8.00	3.00	2.00	13.00
1911	8.00	3.00	2.00	13.00
1933	6.29	2.57	1.58	10.44

share of pasture, compared with much faster growth of pasture in England, implies that Chinese pastoral development lagged massively behind that of Early Modern England, suggesting in turn that total output growth in agriculture in China was also slower.

5 Industry

Details on industry are plenty for Republican China. Estimates exist from Ou (1946), Liu and Yeh (1965), Perkins (1975), Rawski (1989) and Kubo (2005). However, none of these studies runs back further than the end of the 19th century. In addition, many of these estimates use the census data from Republican China, which are to a certain extent underestimated.

Hence, we will estimate our own series. In calculating industrial output, we start with using the industrial classification by Lieu (1933) on behalf of the National Resources Commission of the Republic Chinese Government in 1930s. This survey split industry in 17 major sectors. Peng (1957) and Li and Xu (2004) made a similar classification for the industrial sector during the Qing dynasty and arrived, after going through numerous gazetteers, at a similar classification. The only difference being the exclusion of rubber (as part of the leather & rubber industry), Machinery, Electric Appliances, Hydropower and Gas, all of which only came up in china after the fall of the Qing dynasty in 1911. Hence, for the period after 1911 we have 17 sectors and for the earlier period we have 14 sectors (see Table 5).

Table 5 Comparison of classification for industry in different periods based

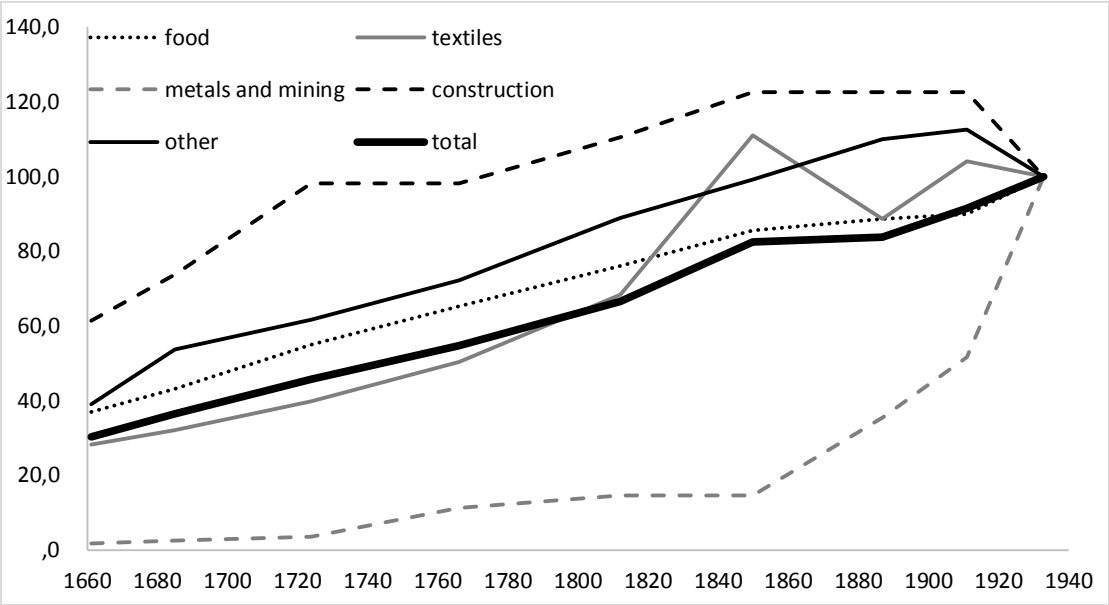
Modern classification	**Republic of China**	**Qing dynasty**
Mining	Mining	Mining
manufacture	Food Processing	Food Processing
	Textile	Textile
	Leather & rubber	Leather
	Clothing & Attire	Clothing & Attire
	Paper Manufacturing & Print	Paper Manufacturing & Print
	Metal	Metal
	Manufacture and Repair of Transportation equipment	Manufacture and Repair of Transportation equipment
	Lumber & Wood products	Lumber & Wood products
	Stone, clay & glass products	Stone, clay & glass products
	Chemicals	Chemicals
	Accessories and instruments	Accessories and instruments
	Machinery	
	Electric Appliances	
	Hydropower and Gas	
Building	Construction	Construction

Source: D. K. Lieu(1933); Peng Zheyi(1957); Li and Xu Jianqing(2004).

Our method is based on calculation value added in output in 1933, the most reliable benchmark year, and projecting it backward using output data. Hence, we assume the value added/output ratio to be constant over time, which is common in most historical national income studies. For 1933 we relied on Ou (1947), which is the most reliable. Admittedly, Liu and Yeh (1965) are used by Maddison but most of the differences with Ou follows from their calculated prices which is less reliable in the work of Liu and Yeh. The only difference is that, following Maddison (1998), we took construction sector estimates from Yeh (1979) which is considered more reliable.

The different subsectors in industry were projected backwards mainly using volume indices (see appendix B). Most series move in line with the over-all industry index. Yet, it is clear that

Figure 1 indices of industrial output (1933=100)



construction grow slower than average while metals and mining increase strongly after the 1850s, together with the modernization of the Chinese economy. Most importantly, however, we find an upward trend in industrial output since the mid-17th century, which runs counter to previous estimates such as presented by Bairoch (1982) who finds a strongly declining level of industrialization. Even though this fits in well with declines in GDP as argued by, for example, Liu (2005), we cannot find any evidence that over-all output in industry regressed between the 17th and 20th centuries.

6 Services

For services we follow Deane and Cole (1967) by breaking down services in a number of basic categories. Yet, whereas the previous authors used commerce, housing and domestic services, and government services, we included residential rents and personal services as two additional categories. Hence, we arrive at a subdivision given in Table 6. These value added shares from Ou

Table 6 Value added share in services in 1933

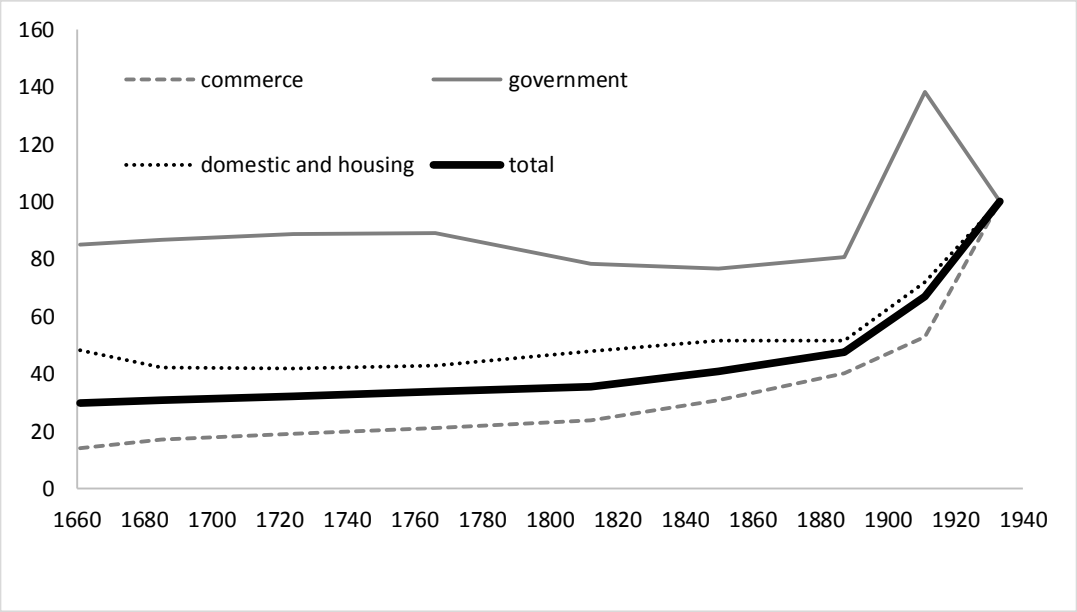
Commerce	trade and transport	64.3%
	finance	3.1%
Government		12.2%
residential rent		15.3%
personal services	domestic	2.2%
	teachers	0.9%
	other	2.0%
total services		100.0%

Source: Ou (1946)

(1946) are projected backwards using several indices of output in the services sector presented in Appendix C.

The results are plotted in Figure 2. Commerce grew faster than average, especially from the mid-18th century onwards, but accelerating in the mid-19th century. Government, however,

Figure 2 Indices of service output (1933=100)

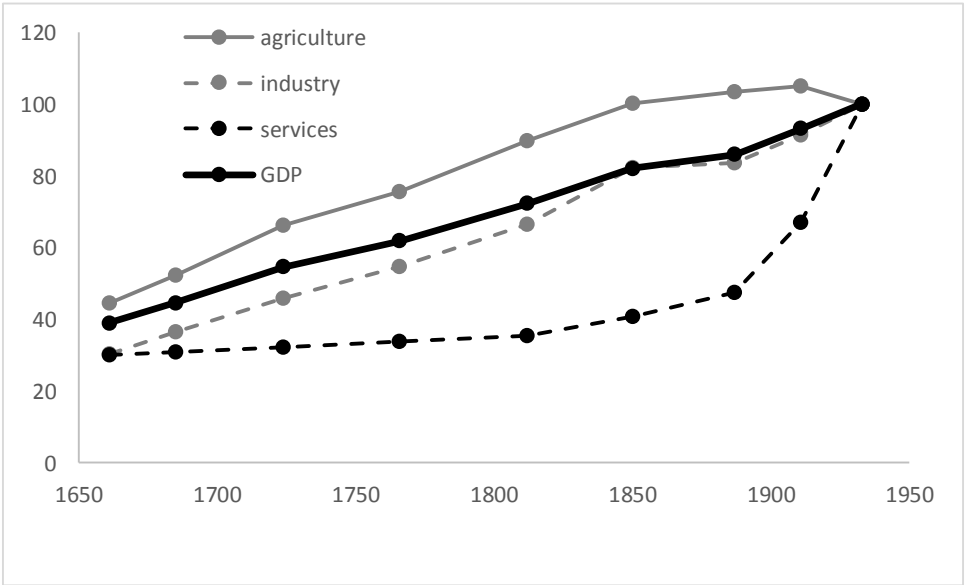


remained constant, except for a peak during the end of the Qing dynasty. These estimates correspond with a share in commerce of ca. 31% in 1661 to 66% in 1933.

7 GDP and GDP per capita

In order to arrive at GDP, we link our indices of agriculture, industry, and services to 1933 benchmark from Ou (1946). The results are given in Figure 3. It is clear that agriculture grew

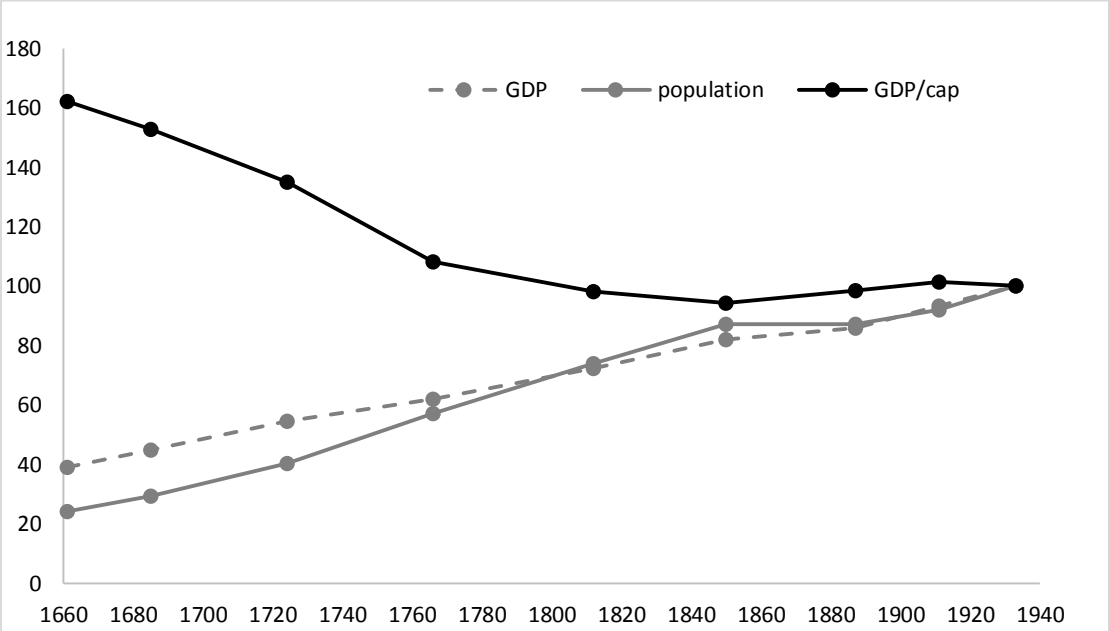
Figure 3 Constant GDP and its components (1933=100)



slower than GDP, while services grew much faster. Industry moved about at the same speed as GDP.

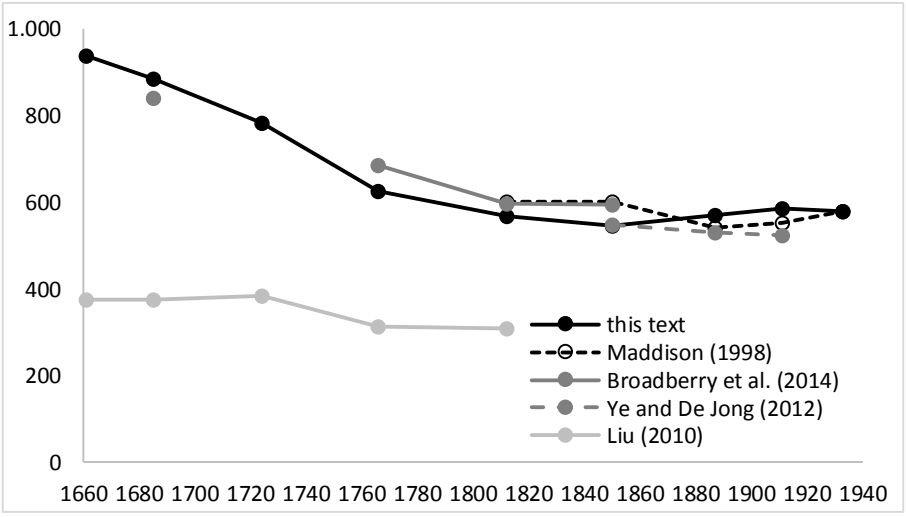
If we combine this with population, we get per capita GDP (see Figure 4). We find that there

Figure 4 GDP, population, and GDP/cap (1933=100)



was a decline from 1661 to 1850, after which stagnation, until some growth after 1911. This estimate seems to conform to evidence from heights data from Baten Ma, Morgan and Wang (2010) as well as the findings from Broadberry, Guan and Li (2014). Indeed, Figure 5 shows that

Figure 5 Competing estimates of GDP/cap in 1990 GK dollars



all GDP estimates show a decline in per capita income, even though some controversy exists on the exact levels. This controversy is not unimportant though. If we were to accept the extremely Low levels of per capita income from Liu Di (2010), it seems unlikely that China ever dominated the world economy. On the other hand, if we take the more conservative estimates of Broadberry, Guan and Li (2014), they find that China was overtaken by Southern European countries halfway the 18th century while in our estimates it already takes place a century earlier.

8 Labour productivity

It thus seems clear that the decline from the 17th century onwards was primarily caused by a decline in the share of services, with the increase in the 19th century again being primarily driven by increasing share in services output and, later, also in industry. The fact that these sectoral shifts caused changes in economic growth suggest significant differences in labour productivity by economic sector.

The first step in this analysis is looking at the shares in the labour force. For 1933 Ou (1947) provided figures for the number of labourers in various economic sectors. combined with an unemployment rate in both urban and rural areas taken from Xinglong (1999), we are able to calculate the participation rate of total population.

For the Qing dynasty data are less easy to obtain. The first modern survey on population and occupation across China was conducted by the Qing government after 1890, even though it was not finished at its overturn in 1911. Nevertheless, the occupational censuses made by counties still remain in many local and provincial gazetteers. Hence, in order to arrive at an estimate of labour force structure in 1911 we collected a sample of the occupation structure of 44 counties in Liaoning, Jiling, Shandong, Shannxi, Zhili, Hunan, and Guangxi. Each county not only presents

Table 7 The average in employment structure and labour participation in 7 provinces in 1911

province	county sample	participation rate(%)	agriculture share(%)	industry share(%)	service share(%)
Liaoning	16	45	79	6	15
Jiling	5	47	89	4	6
Shandong	13	39	90	3	7
Shaanxi	3	41	91	3	6
zhili	4	49	73	7	20
Hunan	1	42	80	5	15
Guangxi	1	31	80	3	17

Source: these samples are taken from the special gazetteers(Xiangtu Zhl), installed in http://mylib.nlc.gov.cn/web/guest/shuzifangzhi.

the subdivision by major economic sector, but also the labour participation rate (see Table 7). Based on these data, we can see that is quite some regional differentiation within China in terms of economic structure. Weighing these data by population size allows us to arrive at an estimate of both labour participation and the subdivision by economic sector around 1911.

Unfortunately for the Qing dynasty, with exception of government employment and craftsmen quota in official manufactories, there were few occupation censuses in the Qing dynasty before 1890s. Based on an amount of primary materials, Guo Songyi (1991) tentatively constructed the estimate of occupational structures used to be for 1850. Yet, as argued by Moll-Murata (2011), Guo's estimates fall short in two ways. First, he overestimated the number of government employees and, second, he did not include the priests. In this study, we follow Moll-Murata's (…) adjusted estimates with some further modifications:

1) Since agriculture in both Guo Songyi and Christine Moll-Murata's estimate refer to crops, we combine the employment in the arable sector with that of cattle breeders, fishers and hunters as estimated by Guo Songyi in order to arrive at employment in the agricultural sector.
2) We include salt maker, artisans, miners, and shipbuilders in the industrial sector.
3) We include merchants, other servants, landowners, notability, civilian officials, military and low-level government employees, and priest estimated by Guo Songyi and adjusted by Moll-Murata in the service sector.
4) Guo Songyi assumed that male labour participation was 50.5%, and female labour participation was 37.5% (one fourth to one-half of the male participation). Combined with a gender ratio of 100 women to 116 men, this result in a total participation rate of ca 42.5%.

Based on above estimates we arrive at estimates of labour force structure between 1850 and 1933 (see Table 8). Remarkably, the share in agriculture declined relatively fast, while that in

Table 8 Labour by economic sector and labour force participation rate, 1850-1933 (percentage)

	agriculture	industry	services	participation rate
1850	91.3	3.5	5.2	42.5
1911	85.0	5.0	15.0	46.0
1933	80.0	7.0	13.0	45.0

industry, and especially services increased spectacularly. This suggest that there was hardly any increase in labour productivity in the latter two sectors. Indeed, as shown in Table 9, the relative

Table 9 Relative labour productivity in China, 1850-1933

	agriculture	industry	services	total
1850	82	328	258	100
1911	85	236	136	100
1933	77	163	208	100

labour productivity in agriculture and services remained almost constant while there was a decline in industry. Nevertheless, the level of labour productivity was much higher in industry and services versus agriculture. Hence, the move out of service sin the 17th and 18th century must

have reduced per capita income while its move back into services and industry from the mid-19th century must have caused a recovery of per capita income.

9 International comparison

Chinese economic development underwent a strong decline between 1661 and 1850. This is, however, not uncommon in international development. If we look at India, for example, we also witness a decline, albeit less strong as in China. For Indonesia, even though GDP estimates only

Table 10 GDP per capita (1990 GK dollars) in Asia

	China	India	Java	Indonesia	Japan
1661	938	638			557
1685	885	630			592
1724	782	598			615
1766	626	573			596
1812	567	519	507		641
1850	545	556	462		681
1887	570	526	548	696	952
1911	586	691		836	1,356
1933	579	700		938	2,122

Source: This text, Van Zanden (2002), Bassino et al. (2011), Van der Eng (2010); Broadberry, Custodis and Gupta (2014),

Table 11 GDP per capita (1990 GK dollars) in Europe

	England/GB/UK	Holland	Netherlands	Italy	Spain
1661	1,030	1,978		1,398	687
1685	1,350	2,250		1,437	751
1724	1,586	2,239		1,505	799
1766	1,806	2,718		1,533	783
1812	2,012	2,408	1,800	1,433	916
1850	2,718		2,371	1,481	1,079
1887	3,713		3,277	1,751	1,585
1911	4,709		3,863	2,199	2,017
1933	5,277		4,956	2,565	2,486

Source: Broadberry et al (2014), Malanima (2011), Van Zanden and Van Leeuwen (2012),

reach back to the start of the 19th century, we do witness quite a reversal of fortune in this period which seems to be corroborated by height developments as calculated by Baten, Stegl, and Van der Eng (2013). The only country seemingly not conforming to this general trend is Japan that

witnessed a slow growth until the 19th century and gradually speeding up afterwards. In this, Japan much more resembles Southern Europe, only later to catch up with Northwestern Europe.

One way of looking at this is by trying to pinpoint what is driving this pattern. In china and India, it follows that the downward trend is mainly driven by a relative reduction in services in GDP. As we have seen, since labour productivity in services was considerably higher than in agriculture, this caused an economic decline. The reasons for this decline, however, are difficult to pinpoint. One often heard argument is the reduction in power of the state. Indeed, the decline in the share of services between 1661 and 1685 was mainly caused by a reduction in government expenditure and house rent. Partly this was caused by the unifying war of the Qing government, followed by a policy of appeasing local governments by freezing government income (and expenditure). Similar developments also occurred in Indonesia and India. In India, for example, the disintegration of the Mughal Empire proved a great force in reducing services. Another argument that has been brought forward as regards the disintegration in Asia concerns climatic shocks. Both government disintegration and climatic shocks caused agricultural output to decline and, hence, prices to rise causing increases in wages and, hence, a loss of competitiveness (e.g. Clingingsmith and Williamson 2008). The increase services and, hence, in per capita income in the mid-19th century China was, along with rising international and domestic trade, caused the increased absorption of people in urban areas.

Unfortunately, we have, at the moment, no comparable data for Japan. However, for Holland and England we witness that initial growth was accompanied by increases of services in GDP (e.g. Van Zanden and Van Leeuwen 2012; Broadberry, Campbelll and van Leeuwen 2013). Contrary to China, India and Indonesia, however, this increase was a persistent phenomenon.

10 Conclusion

In recent decades GDP calculations have been increasingly standardized which made it possible to arrive at long run estimates of welfare as far back as sometimes the 13th century. Yet, Chinese estimates have so far been very limited, mainly due to lack of data. Nevertheless, in the last decade a surge in estimates has started as well. In this paper we want to contribute to this debate by not only providing estimates between 1661 and 1933 using a vast array of primary and secondary sources, but also provide estimates of sectoral shares and labour productivity.

We find, in line with much of the literature as well as height and wage studies, that GDP declined from the mid-17th century onwards. This was reversed during the 19th century. This decline, much in line with the other Asian countries except Japan, was mainly caused by a reduction in the share of the service sector. Since the service sector exhibits higher labour productivity, a declining share in GDP implies lower per capita income in the economy. This decline in many Asian countries was mostly caused by a weaker government as well as climatic shocks during this period. This trend was reversed in the 19th century partly due to increasing commerce and partly due to political events forcing people to leave agriculture and move to the cities.

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Appendix A: agriculture

The arable sector includes both food crops and cash crops. Besides the direct estimate of Ou (1947) for 1933, we require 3 types of data in order to calculate our series of agricultural output, i.e. the amount of cultivated land, the distribution of crops and the yields.

Cultivated land

The amount of cultivated land can be obtained from government publications such as Daqing Huidian, Qingcao Wenxian Tongkao, Daqing Yitongzhi, and Hubu Zeli (《大清会典》、《清朝文献通考》、《大清一统志》、《户部则例》). They provide the official figure of cultivated land in the whole country for the years 1661, 1685, 1724, 1766, 1812, 1850, 1887, and 1911. Yet, these official figures only represent the amount of taxed land and have therefore been considered to be underestimated of the true cultivated area. Hence, the figures are modified in two ways. First, for the benchmarks 1661 and 1724 we compare the official figures with the land in cultivation in the Late Ming dynasty. In 1661 the land under cultivation was increasing towards the level of the Late Ming while in 1724 that level had already been reached. This observation, combined with a number of regional data on cultivated land, especially on the Jiangnan Area and the North China Plain, allowed us to calculate the actual to taxed land ratios in those two benchmarks.

The estimates of cultivated land between 1850 and 1933 were based on the benchmark estimate of 1952 which is considered the first reliable estimate. This estimate is projected back to 1850 using the multi-crop index from Yan (1955) hence allowing us to arrive at the cultivated area back to 1850. The remaining benchmarks (1685, 1766 and 1812) are interpolated using the other benchmarks as described above.

Crop distribution

The distribution of crops in the different provinces and time periods depends of course on characteristics such as climate, geography, productivity, and level of marketization. Several records show for Republican and early New China that the share of cultivated land under food crops accounted for more than 80% of the total land under cultivation while the remainder consisted of cash crops. It seems reasonable to argue that the share of cultivated land under food crops should not be less than the 80% estimated for 1933. Indeed, Xu Dixing and Wu Chengming (1990) provided a breakdown of the amount of cultivated lands by main cash crops, such as cotton, mulberry, ramie, sugar cane, and other cash crops for 1840, 1894,1919 while Perkins (1984) provided comparable figures for 1914~1918. Combining these estimates with other primary recorders from gazetteers, we estimated the share of cultivated land under cash crops for 1850, 1887 and 1911. For the benchmarks before 1850, since trade is positively related to the amount of cash crops, we use an index to project the share of cash crop lands back to 1661.

Yield

The yield obviously varies over time, place and type of crop. Ou (1947) provided a benchmark for 1933. For the earlier period, Shi (2012) estimated the average yield of all grain crops in 1850 by gathering more than 3000 per mou yields of various grain crops from a large number of primary documents including official archives, local chronicles, private account books and title deeds. For the benchmarks before 1850, Shi(2012) provided the estimates for a general average yield of all food crops. In order to include the yield of cash crops, we used the records from official archives Fuyi Quanshu《赋役全书》，local chronicles, and private account books around 1850. The resulting ratio of cash crop to food crop yields (1.6) was then assumed constant before 1850.

Livestock, forestry, and fishery sectors

For 1933 Ou (1947) estimated the value added and output in livestock, forestry and fisheries For 1887, Chung-li Chang (1962) estimated the value of output in livestock and fisheries. However, few data are available except those above. Since both cultivated land and population are negatively related to the livestock, forestry and fishery sectors, these two series data are used to project livestock, forestry and fisheries back to 1661.

Appendix B: Industries

Food Processing

For 1933, both output and value added are given by Ou (1947). For 1911 we can derive similar information from the First Statistics of Agriculture and Commerce conducted by Beiyang government in 1911, (《中华民国元年第一次农商统计表》，1914). However, the 1911 estimates are to a certain extent unreliable since it excludes certain subsectors, and over- or underestimates others. Therefore we adjusted the 1911 number based on a large number of primary sources such as gazetteers, local surveys and archives.

The pre-1911 data are assumed to move back in time along with the agricultural output. In order to do so, food processing was split in grain processing such as rice milling, flour and brewing and in cash crops such as sugar, tea and oil. The former is assumed to move in line with grain output while the latter is assumed to move in line with the index of the amount of cultivated land under food-related cash crops which is 70%, 71%, and 75% of all land under cash crops in 1661-1812, 1850, and 1887 respectively.

Textiles

For benchmarks before 1911, the textile sector is based on volume indicators of the key raw material inputs, such as cotton for cotton textile, raw silk for silk fabrics, ramie (Chinese grass) for linen and woolens for the wool sector. For these sectors, for 1850-1887 these data were modified by subtracting raw material exports and adding imports.

Unfortunately, such data are unavailable for the period prior to 1850. Yet, since the share of textile related crops in the cash plant cultivated area is 30% between 1661 and 1812, this is used as an indicator of the combination of wool, linen and silk sectors. Since raw material in woolen textile was taken from livestock and poultry products, output in these sectors is assumed to move in line with woolens between 1661 and 1887.

Leather & rubber

For Leather& rubber sector in 1911 and 1933, output and value added are given by Xu (2013) and Ou(1947) respectively. For the pre-1911 period no significant rubber industry existed. Leather was assumed to grow in line with an index of livestock and poultry products.

Clothing & Attire

The 1911 and 1933, output and value added figures are given by Xu (2013) and Ou (1947) respectively. For benchmarks before 1911, since textiles and leathers consisted of raw materials for clothing and attire, output in clothing and attire sector is assumed to grow line with aggregate output of the textile and leather industries.

Paper Manufacturing & Print

The value added of paper manufacturing and printing industries for 1933 is given by Ou (1947). This is brought back in time using an index of newly published books which are taken from the *Publishing Catalogs Compilation in the Republic of China* (《民国时期出版书目汇编》，2010), which provides a relatively complete record of new book titles published in the Republic of China. These are brought back in time further using *Collection of Engraving Book by Counties and Provinces in Qing Dynasty*(《全清分省分县刻书考》, 2009) , the Collection of Chinese imprinted book （《中国版刻综录》,1987）,*Chinese Local Histories: A Collection of 8577 Annotated Titles* (《中国地方志总目提要》,1996), Summary of Catalogues of Novel in Ancient China(《中国古代小说总目提要》，2005) *and Ancient Chinese Book Title Catalogue* (古籍图书网, http://www.gujibook.com/).

Mining, metals & and metal products

The mining sector consisted of large scale mining operations, such as iron ore, pig iron, steel, coal, coke, copper, gold, silver, lead, zinc, tin, sulfur, saltpeter, mercury, and small scale mining.

The series of report, General Statement of the Mining Industry (issue 1-7, 1921-1945), edited by The Geological Survey of Ministry of Agriculture and Commerce, were widely rated as the best statistics of Republic Of China's mining industry. The outputs in 1933 are taken from the 5th issue (1935) of these reports. These statistics were much more complete and reliable than China's Industrial Survey, which was the main basis of Liu and Yeh's (1965) estimate. The prices in 1933 are also available on the General Statement of the Mining Industry (Hou, 1935) and modified by Ou (1947). Ou (1947) provides the value added in 1933.

The outputs of 1911 were published by Ministry of Agriculture and Commerce (1912). These data cover most minerals but not perfect, so they are modified with the data from the 1st issue of General Statement of the Mining Industry (Ding and Weng, 1921). Gold is an exception. Its output in 1911 is taken from China Gold Association (2006).

For the pre-1911 period, we used an index of mining output to project the value added back in time. The outputs of large scale mining around 1880 were taken from Chung-li Chang (1962). Yet, since these were incomplete, they are upgraded using mining outputs taken from the Qing Mining archive. Based on archives, gazetteers, surveys and special narrative histories, we provide estimates of the output of large scale mining in 1850 (see also Xu, 2014). For the benchmarks before 1850, with the exception of steel and coke, the numbers of mining operations in most types of large scale mining were given by Peng (1957), which were interpolated and upgraded using Qing Mining archives and can be seen as reflecting industrial output. For steel and coke,

since they were produced by pig iron and coal, they are assumed to grow line with pig iron and coal respectively.

For small scale mining, outputs are assumed to move line with those of large scale mining. Since mining supplied the main raw materials of metal products, metal products is assumed to grow line with the mining index.

Manufacture and Repair of Transportation equipment

This sector consists of the building and repair of ships, boats, carriages, wheelbarrows, sedan chairs, oxcarts, etc. Among these, the building and repair of ships and boats were most important during Qing Dynasty as well as Republican China. For 1911 and 1933, output and value added are given by Xu (2013) and Ou (1947) respectively. Since the annual building and repair of ships and boats is related to total number of ships and boats for the whole China, we assumed this sector to grow in line with the number of ships and boats in China between 1880 and 1911 from Chung-li Chang (1962) and Xu (2013). Before 1880, we assumed land and water transport to grow in line with population.

Lumber & Wood products

For 1911 and 1933, output and value added are given by Xu (2013) and Ou (1947) respectively. For the benchmarks before 1911, output in these sectors is assumed to move in line with an index of products of wood taken from the section on agriculture (see appendix A).

Stone, clay & glass products

This sector is subdivided into the construction materials, such brick, stone, clay, and glass, and ceramics such as pottery and chinaware. For the former products, output and value added in 1911 and 1933 are given by Xu (2013) and Ou (1947) respectively. For benchmarks before 1911, they would be assumed construction materials to grow in line with output of wood from the section on agriculture (see construction in appendix B).

For ceramics the output and value added in 1911 and 1933 for the whole country are given by Xu (2013) and Ou (1947). These were brought back in time using output data from *Jing Dezheng*, the most important production center in China. These data are reported in *Ceramic Narrative History in Jing Dezheng* (1959). Unfortunately, the share of *Jing Dezheng* in total Chinese output of ceramics is not constant over time. We can calculate that it made up 8% and 32% in total output in 1911 and 1933 respectively. Since the office record claimed that the output of *Jing Dezheng* in post-Taiping years was a half of that in pre-Taiping years when the industry had been damaged by the Taiping Rebellion (Qing chao Xu wenxian tongkao,383/11302.), the share of output of Jing Dezheng in total output of the whole country is assumed to be 8% in 1887 and 16% between 1661 and 1850.

Chemicals, Accessories & Miscellaneous

For 1911 and 1933, output and value added in this sector are taken from Xu (2013) and Ou (1947). For the benchmarks before 1911, outputs in the three sectors are assumed to grow line with population.

Machinery, Electric Appliance, Hydropower and Gas

Since these sectors started production at the start of the 20th century, we only take output and value added in these sectors for 1933 from Ou (1947).

Construction

The 1933 estimate of value added for construction is from Yeh (1977) who updated earlier estimates by Liu and Yeh (1965) and Ou (1947). Unfortunately, very few data exist for earlier periods. However, in the Qing Dynasty and Republic of China the main construction materials consisted of wood, bricks and stones. Based on a large amount of local inscriptions across China between Qing and Republic China, 40 observations are collected which report a in detail which materials were used in different construction projects such as temples, ancestral halls, drama stages, schools, dams, and guild halls. Using these observations, we ran a regression which showed that the relation between wood output and building remained constant over time. Hence, we used an index of wood output from the section on agriculture to proxy for developments in the construction sector.

Appendix C: services

Commerce

Commerce can be subdivided into trade and transport and finance. For 1933, these estimates can be obtained from Liu (1963). Wu Chengming (2001) provided the volume of marked products (including domestic and net import products) in 1840, 1869, 1894, 1908, 1920 and 1936. Linking Wu's estimate to the 1933 benchmark we were able to obtain estimates for trade and transport back to 1850. For the benchmarks before 1850, we use custom duties as a proxy for the volume of marked products since the custom duties were taxed by the value of the goods. Before 1840, the international trade was fixed in Guangzhou by the Qing government, which also can be gotten by the custom duties archives stored in the China's First Historical Archive Library (Beijing).
For finance, for 1933, the output and value added are given by Liu (1963). In the early stage of the Qing dynasty (pre-1840), finance includes three subsectors: pawn shops, Qianzhuang (local banks) and Piaohao (inter-regional banks established by Shanxi businessmen). The GDP of the financial sector consists of the personal revenue of the professionals working in these subsectors plus the profits accruing to the capital employed. Data on the numbers of pawn shops and the capital employed can be combined with data on interest rates to calculate the GDP generated by pawn shops during the Qing dynasty (Qiugen Liu, 1995). Although historical data are unavailable for Qianzhuang and Piaohao, Zhongli Zhang (1987) has estimated GDP for China in the 1880s in Qianzhuang and Piaohao as well as pawn shops. The ratio of the GDP of Qianzhuang and Piaohao to the GDP of pawn shops is assumed to be the same as during the 1880s throughout the Qing dynasty.

Government

For government, we apply the income approach proposed by Ou and Chang, in which value added in government service is equal to salary and allowance of governmental employees, who were civil and military officials, clerks and yamen runners, soldiers and militiamen. With the exception of the benchmark of 1933, which is given by Ou (1947), we calculated the value added in the government sector as follows. First, we take the government expenditure between 1661

and 1911 in the current price from Shi and Xu (2008). Next, using estimates in several benchmarks such as 1766, 1887 and 1911 of the salaries and allowances of government personnel, we use total government expenditure to interpolate the remaining benchmarks. This, however, is only official income. Therefore, thirdly, we apply the irregular income to regular income ratio from Chung-li Chang (1962) to supplement our estimate for salary and allowance of governmental employees.

Residential rent

For residential rent, we followed the same method as proposed by Ou (1947). He calculated rents per capita in 1933 to be 12 Yuan for city resident who needed to pay house tax, 4 Yuan for city people who did not have to pay house tax, and 2.1 for people living in the countryside. Projecting the number people living in cities back using urbanization taken from Cao (2000), we can calculate the residential rents back to 1660.

Personal services

The value added in personal services in 1933 was given by Liu (1963). The biggest part of personal services is made up by notaries and teachers for which it seems reasonable to assume that they grow in line with Shengyuan candidates. Xu(2012) estimated annual number of Shengyuan in Qing dynasty. Hence, personal services are assumed to grown in line with Shengyuan candidates, which is not unreasonable since it assumes labour productivity in this sector to remain constant.