A brief note on regional industrialization in the basic metals sector in China, 1850-present

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1. Introduction

In this brief note we report our progress on deriving estimates of the basic metal sector, i.e. the smelting of ferrous (iron & steel) and nonferrous (other metals than iron & steel). We would like to stress this is progress report rather than a finished (or even unfinished) paper.

Our choice for the basic metal industry is based on its importance for economic development. Indeed, the better availability, higher quality, and lower price, aided in the development of initially boilers, railways, steam engines and, subsequently, a wide variety of machine tools aiding economic development. Indeed, this importance for economic development was also recognized by the Chinese government during the movement of Great Leap Forward (1958-1961) aimed at rapidly industrializing China. During this period, steel production was considered as one of the main indicators of modernization and pig iron production rose from ca. 6 million tons to 27 million tons. Although subsequently a collapse occurred, it was followed by fierce growth. China’s crude steel production accounted only 2.8% (International Iron and Steel Institute, 1978: 3) of the global total in 1967. As of today, this share has risen to almost 50% (The World Steel Association, 2017: 2).

In the following Sections we deal with definition and sources (section 2), data (section 3), some preliminary results (section 4) followed by a brief conclusion.

2. Definition

A first question that may come to mind is how to define the basic metal industry. We do this by using the International Standard Industrial Classification (ISIC) revision 4 from the United Nations (2008). This classification, which can be traced back to its inception in 1948, is the main vehicle for comparing industrial data over time as most countries either follow ISIC definitions, or use a classification scheme that is based on ISIC. Within revision 4 we can find the basic metal industry under Section C (manufacturing), Division 24 (Manufacture of Basic Metals) where it is defined in Group 241 and Group
242 as the “smelting and/or refining ferrous and non-ferrous metals from ore, pig or scrap”. This, in turn, may be modified in alloys by adding chemicals.

It is important to note that above definition only includes the smelting and refining of both ferrous (Group 241) and non-ferrous (Group 242) metals. It therefore excludes Group 243 (the casting of metals), which is commonly included in the metallurgical sector. The main reason for excluding casting is that in China there is no clear distinction in the casting of intermediate goods like pipes and wires (Group 243) and more refined metal casting (division 25 in the ISIC) as, contrary to many other countries, China does not use the ISIC classification or a derivative (see e.g. Holz 2013).

Looking at the smelting and refining part of basic metals only, as pointed out by Holz and Lin (2001), from 1984 onwards this was aggregated in the Smelting and rolling of ferrous metals ¹ and Smelting and rolling of non-ferrous metals ². Hence, for our study we have to remove the “rolling” from both sub-sectors. Before 1984, even though little information exist, Holz found that most classifications included smelting only in aggregated form as Metallurgical industry³, i.e. smelting, rolling, and casting. Even more complicated are the pre-New China periods, i.e. Republic of China (1912-1949) and Qing China (1644-1911). For those periods, the manufacturing of base metals was not classified in manufacturing, but rather in mining. Therefore, we had to go to every individual producing region or even enterprise, and try to distill the information of smelting of ferrous and nonferrous metals.

3. Data

It is important to note that the sources are quite different for our three benchmark years, i.e 2004, 1933, and 1850. For 2004, we used the 2004 economic census which contains for both above and below “scale” (5 million yuan revenue) factories the main product, number of laborers, and revenue. It is important to stress that this excludes the self-employed. Yet, comparison with data for e.g. Nanyang prefecture in 2004 ferrous metal shows that the share of self-employed in metallurgy is only 1.5% of revenue and number of laborers although the share of factories is, in some cases, substantial (Nanyang Municipal Bureau of Statistics, 2006). But we focus on smelting, instead of total ferrous metal which includes casting, where the share of self-employed is even lower. The total number of laborers and revenue by product and region is calculated based on the main output product of each company. That

¹ 黑色金属冶炼及压延加工业
² 有色金属冶炼及压延加工业
³ 冶金工业
is, a factory that has a main product “steel” is assumed to only produce steel. This is a big assumption, of course, but since this applies to all regions, the effect cancels out to some extent as is also shown by some preliminary comparison with prefectural yearbooks. For total output in tons of metals, we used the estimates from the various prefectural, provincial yearbooks. There are two problems. First, these output figures are mostly above scale only, but since we know revenue both below and above scale, we used those to estimate the missing part, mostly being not more than 5% of total output.

Compared to the post-1949 era, regional industrial data, especially for administrative units below province, of the two earlier benchmarks are either far less directly available or even absent in the sources. This forces us to practice a historical GDP-style approach to construct the datasets. For 1933 mercury, silver and mechanical production of pig iron are taken from the General statement on the mining industry of China edited by Hou (1935). Most native handicraft production of pig iron is estimated based on the same source. The exception is Zhejiang, which is estimated based on the Ministry of Industry (1933) and Hou (1935). Copper and steel are estimated based on Hou (1935). For antimony, Guangxi is estimated based on Guangxi Mining Bureau (1935), and Hunan is taken from Hou (1935). For tin, Guangxi is estimated based on Guangxi Provincial Bureau of Statistics (1936), Hunan, Jiangxi and Yunnan are taken from Hou (1935), and Guangdong is estimated based on Hou (1935). For lead and zinc, Yunnan is estimated with Hou (1935), Hunan is taken from a contemporary survey (1934), and Sichuan is estimated based on government archives (The Second Historical Archives of China, 1994). For gold, Gansu and Qinghai are estimated based on Hou (1935), Guangxi is proxied with 1932 data from Guangxi Provincial Bureau of Statistics (1934), Guangdong, Hebei and Rehe are estimated with Hou (1935;1932), Henan is taken from a survey (Wang, 1934), Shandong, Sichuan, Heilongjiang, Jilin and Liaoning are estimated based on Hou (1935), Hunan is taken from the Ministry of Industry (1935), Xinjiang is estimated based on Xu (1944). In order to get total output value and number of laborers, we require prices by product as well as output/worker by product. The prices are taken from Ou (1947). The productivities of pig iron (both handicraft production and modern mechanical production), copper, gold, lead, steel, tin, antimony and zinc, are taken from Ou (1947), and silver is proxied by gold. For mercury, production is calculated with output and worker number taken from Ou (1947).

In general we based our 1850 data on the Qing central government archives, e.g. memorials to the throne, which are accessed from the First Historical Archives of China in Beijing, the Institute of History and Philology (Academia Sinica) in Taipei, and the Palace Museum in Taipei. These reports to the emperor, in certain cases provide information about factory, product, region, and sometimes output
and labour. But most often, the output is not directly recorded and hence has to be estimated with other given information, e.g. taxation. It is very much work in progress, hence we also base part of our estimates on reworking of existing studies. The production in tons are re-estimated based on Xu and Zhang (2015), whose results were based on various and massive sources, including memorials to the throne, government books, local gazetteers and surveys, but were presented in provincial level. The prices are taken from Xu and Zhang (2015) as well.

Productivity/worker in 1850 is more difficult. For copper, it’s calculated with Peng (1985)’s estimation on copper for the Qing dynasty. The result for copper is used as the proxy for cupronickel. For mercury, it’s proxied by the calculated 1933 productivity. Tin is proxied by Ou (1947)’s estimation of Yunnan (without modern producing) of 1934. Lead and zinc are proxied by Ou (1947)’s estimation for 1933. Gold is proxied by Ou (1947)’s estimation for 1933 and converted from tael (500g) to Qing tael (596.8g). Then we use the result of gold to estimate silver. For steel, it’s calculated based on Xu and Zhang (2015) and An (1941). The productivity of pig iron in 1850 is even more complex than the other products, as regional difference was so significant that we had to apply specific rates for each province. For Sichuan, Shaanxi and Fujian, the productivities are taken from Xu and Zhang (2015). Guizhou and Hunan are calculated based on Xu and Zhang (2015). For Shanxi, it’s calculated based on Xu and Zhang (2015) and Fan (1985). Guangdong and Guangxi are calculated based on Xu and Zhang (2015) and Qu (1687). The productivity of Jiangxi is proxied by Zhejiang which is calculated based on Cao and Jiang (2010). Yunnan and Anhui are proxied by Ou (1947)’s estimation for 1933.

4. Geography

Our data are in principle on county level in contemporary boundaries. However, given the errors in the data, we thought it referable to only report the prefectural data, i.e. about 300 regions. Needless to say boundaries changed strongly between 1850 and present, if only because Outer Mongolia became an independent country in the first half of the 20th century. We therefore used the 1820 prefectural map from CHGIS for the benchmark 1850, but the 1930s and 2000s map were created within our project and consist, besides from political boundaries, also from roads, railways, waterways and mountains.

Our aim is to create concordance tables that allow creating more or less consistent boundary estimates over time, but that will take about another month to complete.
5. Changing patterns

Please note that we are in the process of upgrading. Amongst others:

a) Some Northern provinces are lacking in 2004;
b) Some map-related prefectural distributions in 1933.

That being said, figures 1-3 show TENTATIVELY that there was some shift to the East of China between 1850 and present. The main reason was

a) A rise in ferrous metal (Iron and steel) that was located mostly in the East and north.
b) A move towards the centers of railways and waterways (for ease of transport).
c) Other studies also show that more human capital existed in the East.

**Figure 1.** Number of metal smelting workers by prefecture 1850

**Figure 2a.** Number of metal smelting workers by prefecture 1933
Figure 2b. Number of metal smelting workers by prefecture 1933 & railways & waterways

Figure 3a. Number of metal smelting workers by prefecture 2004
Figure 3b. Number of metal smelting workers by prefecture 2004 & railways & waterways

Figure 4. Output of iron & steel in 1850
Figure 5a. Output of iron & steel & railroads and waterways in 1933

Figure 5b. Output of iron & steel & railroads in 2004
6. Conclusion

This was a brief description about our ongoing work. So every conclusion drawn from the data is tentative.

For each of the three benchmark years we use different sources ranging from (mainly but not only) memorials to the throne (1850), to scattered sources in an emerging statistical environment (1933) and the economic census (2004).

The main preliminary conclusion seems, besides a strong rise in especially ferrous smelting, a move to the East and North.
Reference