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ABSTRACT

This paper documents the procedures of constructing China's input-output tables (IOTs) and supply-use tables (SUTs) in time series for the period 1981-2010 under the East Asian Industrial Productivity/China KLEMS Project. We begin with basic data problems in terms of inconsistencies in concept, coverage, and classification of Chinese national accounts (NAs) and biases of using the NA implicit gross domestic product (GDP) deflators. We then introduce the key procedures in: 1) reconstructing national production accounts as national and industry-level "control totals", 2) constructing industry-level producer price indices, 3) converting 1981 material product system (MPS)-type IOT to the system of national accounts (SNA) standard to match China's five full-scale IOTs (1987, 1992, 1997, 2002 and 2007), 4) constructing industry-level export and import accounts to match each benchmark IOT, and 5) estimating supply-use tables in time series using the SUT-RAS approach from the World Input-Output Database (WIOD), and based on the estimated SUTs, we finally derive China's input-output accounts in time series. Furthermore, we adopt the chained-Laspeyres deflation approach to estimating SUTs in constant prices. With these procedures, we have arrived at an annual GDP growth rate of 9.4% instead of the official estimate of 10.2% for the full period. However, at the broad-sector level, we show a much faster industrial GDP growth at 15.6% per annum instead of the official estimate of 11.9% per annum. As for non-industrial GDP growth, our estimate is 5.2% per annum rather than the official estimate of 8.9% per annum.

Keywords: National accounts, Gross value of output, Gross value added, Producer price index, Input-output table, Supply-use table

JEL classification: C82, E01, E31

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1. INTRODUCTION

Despite significant efforts post reform that have been made by the Chinese statistical authority to transfer China's national economic accounts from the old Soviet-type material product system (MPS) to the widely practiced United Nations System of National Accounts (SNA),¹ there are still serious inconsistency problems that obstruct productivity studies across industries and focusing on the entire reform period, not to mention studies that intend to cover a much longer period. On the other hand, the official estimates of China's aggregate GDP growth have long been challenged for upward bias and alternative estimates have indeed shown slower growth rates than the official estimates (e.g. Adams and Chen 1996; Garnaut and Ma 1993; Maddison and Wu 2008; Ren, 1997; Wu 2002, 2011, 2013a and 2014a).² It is sensible to ask how fast the economy would have grown if major inconsistencies in the national accounts could be adjusted, if the nominal value of inputs and outputs could be properly deflated, and if the aggregate growth could be assessed across industries in a coherent system.

In a nutshell, the serious inconsistencies exist in concept, coverage and classification over time and across sectors and industries. There are some examples: despite significant revisions in the Chinese standard of industrial classification (CSIC) in 1984, 1994, 2002 and 2011 there is no official adjustment to maintain historical consistency, there is no SNA concept of gross output available in the national accounts although there is incompatible MPS concept of gross output prior to 1993 and worse, the value-added by industrial enterprises at or above the "designated size" in industrial statistics began to exceed the industrial GDP of the national accounts from 2005 onwards. Besides, there is never clear how the nominal GDP estimates are deflated. Researchers who are interested in examining price changes in the Chinese economy often have to derive implicit GDP deflators for (broad) sectors from the nominal GDP value estimates and real growth indices available in the national accounts. However, directly using such GDP deflators assumes that the input and output prices are identical.

After examining all available official statistics, we believe that the inconsistencies in the national accounts can be adjusted by incorporating the input-output tables compiled every five years since 1987. The Chinese input-output tables (IOTs) provide a more detailed industrial classification, i.e. over 100 compared with less than 10 sectors available in the GDP accounts, and are available in both product-by-product and industry-by-industry tables. Of course, the input-output accounts are not flawless and their changes in coverage and classifications have also caused inconsistencies between benchmark years. We argue that if the national accounts and IOTs can be reconciled through reclassifications, the inconsistencies can be adjusted and the errors contained in the two accounts may be minimized or to a large extent cancelled off. As a preliminary attempt under the on-going CIP (China Industry Productivity) Project (hereafter CIP), in this study we adopt the supply-use table (SUT) RAS method from the WIOD (World Input-Output Database) Project (Temurshoev and Timmer 2010) to derive China's input-output tables in time series for the period 1981-2010 by constructing time series national accounts and producer price matrix, and benchmark supply-use tables.

¹ See Xu (2009) for a comprehensive review of the transition of Chinese system of national accounts (CSNA).

² Also see Keidel (1992) and Shiau (2004) for studies on expenditure side that have arrived at similar results.

This paper is organized as follows. In the next section we explain how China's production and income accounts are constructed to define the national and industry "control totals". In Section 3 we provide data sources and procedures for constructing industry-level producer price indices. To prepare for exercising the SUT-RAS procedure, five benchmark SUTs from 1987 onwards are constructed in Section 4, the 1981 MPS-type IOT is converted to the SNA standard for the construction of the 1981 SUT in Section 5, and industry-level export and import accounts are added to each benchmark IOT in Section 6. In Section 7, we provide the SUT-RAS estimated results of supply-use tables in time series in both nominal and real terms. The results are also transformed to input-output accounts in time series. We finally conclude this study in Section 8.

2. RECONSTRUCTION OF NATIONAL OUTPUT AND INCOME ACCOUNTS

Coverage

The inconsistent, incomplete and sometimes overlapped coverage of the Chinese official statistics on output, reported through different authorities by different statistical criteria ranging from ownership type, administrative jurisdiction to the size of enterprises, has caused great confusions in empirical studies on the Chinese economy. Ignoring or mishandling the coverage problem may result in misreading China's growth and productivity performance.

Under CIP, mainly based on the Chinese System of National Accounts or CSNA and its input-output table system, plus national and sectoral level censuses, we aim to both conceptually and empirically reestablish the full statistical coverage of the economy in all input and output accounts as well as income and expenditure accounts. To this end, as will be explained later, through careful examinations and reconciliations we use aggregate and industry-level output estimates as "control totals" for gross outputs and value added. The advantage of this approach is that we can bypass tricky inconsistencies between industries and aggregates caused by over time changes in and improper implementations of classifications by ownership type, administrative jurisdiction and "size" criteria for enterprises covered by the direct statistical reporting system that began in the 1950s serving the MPS. Future studies that are interested in different ownership types or other categories can construct their output accounts within our established framework.

Industrial classification

Our first task is to establish the standard of industrial classification for CIP. We in principle adopt the 2011 version of the Chinese Standard Industrial Classification or CSIC/2011 to categorize all economic activities in the Chinese economy into 37 industries (Table 1). The CSIC/2011 is the fifth standards since the first one implemented in 1972 and in principle follows the International Standard Industrial Classification of all economic activities (ISIC) Rev. 4, implemented in 2008 (DESA/SD 2008). It should be, however, noted that at the level of CIP classification that matches the one-digit level industries of in the present Chinese standard, the CSIC/2011 is almost identical to the previous version CSIC/2002.

TABLE 1
CIP INDUSTRIAL CLASSIFICATION AND CODE

CIP	EU-KLEMS	CSIC/2011	National Accounts	Sector
1	AtB	01t05 (A)	I	Agriculture, forestry, animal husbandry & fishery
2	10	06 (B)	II.1	Coal mining
3	11	07 (B)	II.1	Oil & gas excavation
4	13	08t09 (B)	II.1	Metal mining
5	14	10t11 (B)	II.1	Non-metallic minerals mining
6	15	12t14 (C)	II.1	Food and kindred products
7	16	15 (C)	II.1	Tobacco products
8	17	16 (C)	II.1	Textile mill products
9	18	17 (C)	II.1	Apparel and other textile products
10	19	18 (C)	II.1	Leather and leather products
11	20	19t20 (C)	II.1	Saw mill products, furniture, fixtures
12	21t22	21t22 (C)	II.1	Paper products, printing & publishing
13	23	24 (C)	II.1	Petroleum and coal products
14	24	25t27 (C)	II.1	Chemicals and allied products
15	25	28t29 (C)	II.1	Rubber and plastics products
16	26	30 (C)	II.1	Stone, clay, and glass products
17	27t28	31t32 (C)	II.1	Primary & fabricated metal industries
18	27t28	33 (C)	II.1	Metal products (excluding rolling products)
19	29	34t35 (C)	II.1	Industrial machinery and equipment
20	31	37 (C)	II.1	Electric equipment
21	32	38 (C)	II.1	Electronic and telecommunication equipment
22	30t33	39 (C)	II.1	Instruments and office equipment
23	34t35	36 (C)	II.1	Motor vehicles & other transportation equipment
24	36t37	23,40t41 (C)	II.1	Miscellaneous manufacturing industries
25	E	42t44 (D)	II.1	Power, steam, gas and tap water supply
26	F	45t48 (E)	II.2	Construction
27	G	61t62 (H)	III.2	Wholesale and retail trades
28	H	63t64 (I)	III.3	Hotels and restaurants
29	I	49t57 (F)	III.1	Transport, storage & post services
30	71t74	58t60 (G)	III.6	Information & computer services
31	J	65t68 (J)	III.4	Financial Intermediations
32	K	69 (K)	III.5	Real estate services
33	71t74	70t75 (L,M)	III.6	Leasing, technical, science & business services
34	L	76t78 (N) 90t95 (S,T)	III.6	Government, public administration, and political and social organizations, etc.
35	M	81 (P)	III.6	Education
36	N	82t84 (Q)	III.6	Healthcare and social security services
37	O&P	79t80 (O) 85t89 (R)	III.6	Cultural, sports, entertainment services; residential and other services

Sources: NBS (2013, pp.44-53), AQSIQ and SCAS (2011), Timmer *et al* (2007).

Notes: In the Chinese national GDP accounts Sector I stands for primary, II for secondary and III for tertiary. Numbers in brackets indicate the available sub-category.

The CIP 37-industry classification presented in Table 1 is based on Wu's series of earlier data work to adjust classification inconsistencies over time caused by different CSIC systems implemented in 1972, 1985 and 1994, and especially by the non-standard classification method that was adopted to facilitate (vertical) administrative controls over economic activities under central planning that ignored the "homogeneity" principle in industrial classification. Despite

strong central planning legacy in the Chinese industrial classification, since its 1994 version the CSIC has largely followed the ISIC, especially Rev. 3 implemented in 1990 and Rev. 3.1 in 2002. This makes it easier for the CIP classification to conform to the EU-KLEMS system of industrial classification in line with ISIC Rev. 3.1 as presented in Timmer et al. (2007). However, Wu's earlier studies mainly concentrated on the industrial sector (e.g. Wu and Yue 2010 and 2012). The current CIP classification standard mainly incorporates one of Wu's two classification standards, i.e. 24 industries which are now covered under CIP 2-25 (Table 1). To help researchers check our results with the Chinese national accounts, in Table 1 we also provide the national accounts codes (denoted by us) corresponding to the CSIC/2011 codes.

Gross value of output and gross value added at current prices

Following Wu (2012 and 2013b), to reconstruct China's gross value of output and gross value added by industry, we take three major steps as explained below. This effort has two objectives. First, it reconstructs a complete Chinese national accounts for gross value of output, gross value added and the corresponding compensation for labor and capital. The results can be used independently without Chinese input-output accounts. Second, it prepares the basic data for a systematic estimation of the supply-use tables and based on which it derives the input-output accounts.

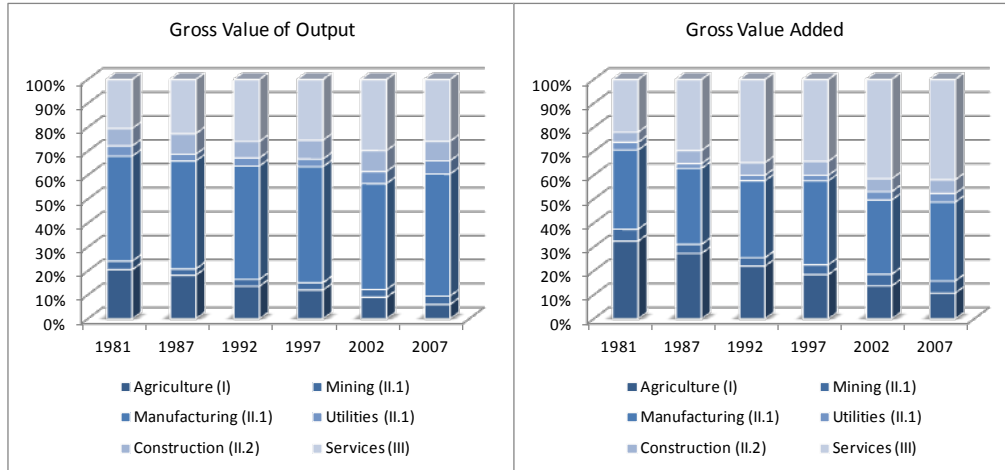
The first step is to reclassify the gross value added in both the national accounts and benchmark input-output tables according to the CIP standard for industrial classification. In this step, after necessary adjustments for consistency we ensure the annual value added by nine broad sectors from the national accounts to implicitly match the 37 CIP industries (Table 1). However, for the five benchmark years (1987, 1992, 1997, 2002 and 2007) when full input-output accounts are available (DNEB and ONIOS 1991; DNEA 1996, 1999, 2005 and 2009), we can obtain all the 37 CIP industries through reclassifications. In addition, we manage to match the "extended" IOTs (between the benchmarks i.e. 1990, 1995, 2000 and 2005 in reduced scale) to the CIP reclassified benchmark tables. At the end of this step, we categorize the Chinese economy in two parallel but fully reconcilable classification systems.

The second step is to use all available information to construct the gross value added of the national accounts between the benchmark IOTs. In principle, we use the aggregate and sectoral value added in the national accounts as "control totals" and the benchmark input-output structures as "control structures" (Figure 1). There are also other important statistics that provide industry details in value added including annual industrial statistics (see DITS annual volumes), two industrial censuses for 1985 and 1995, one tertiary census for 1992 and two non-agricultural censuses for 2004 and 2008. With more regular statistics available for the industrial sector, we treat the industrial sector differently from the service sectors.

The value added for the 24 industries of the industrial sector (CIP 2-25, Table 1) is first constructed based on the DITS annual series irrespective of the benchmark input-output tables. Since the DITS statistics only concentrate on enterprises covered by the regular reporting system with various ownership, administrative level and size criteria over time, they are further adjusted using the census data especially for activities not covered by the reporting system. The value added for service industries is constructed mainly based on the national accounts "control totals" and the input-output table "control structures". We first interpolate the structures between the

benchmark input-output tables at the sector level of the national accounts and then distribute the value added of each sector in the national accounts to the service industries within the sector according to the sector's structure. This procedure can be repeated for the period between the first 1981 IOT (converted from the 1981 MPS input-output table – see Section 5) and the latest 2007 IOT. For the period 2008-2010, we assume that the structure of the 2007 IOT is maintained.

FIGURE 1
BENCHMARK STRUCTURE OF GROSS OUTPUT AND VALUE ADDED BY SECTOR



Sources: Based on Chinese input-output tables (DNEB and ONIOS 1991; DNEA 1996, 1999, 2005 and 2009). See Table 1 for classification.

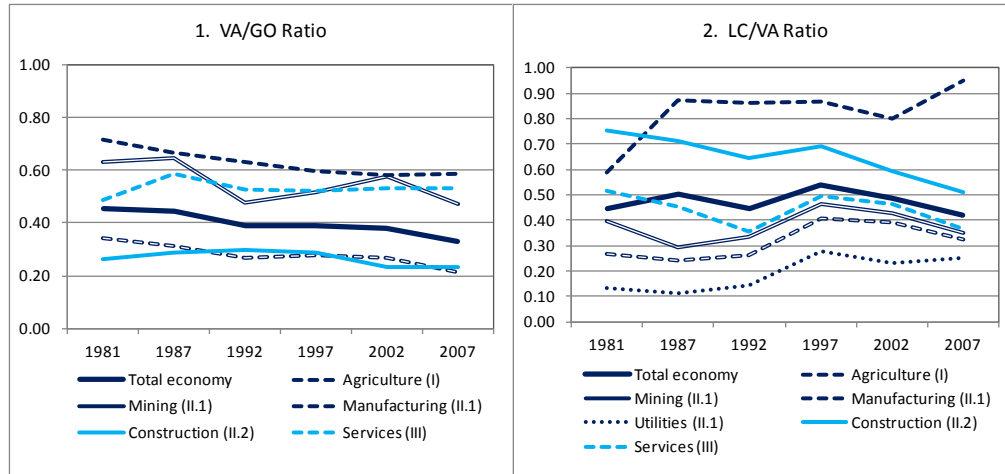
In the last step, we estimate the gross value of output for each of the 37 industries based on the benchmark input-output tables and the information obtained for gross output statistics under the MPS. We know that the gross value of output available in the input-output accounts exactly follows the SNA concept which includes total intermediate inputs and gross value added. However, the gross output statistics under the MPS (up to 1992) excludes the output by so-called “non-material services”, a Marxian concept referring to “non-productive” services. We basically rely on the ratio of value added (VA) to gross output (GO) to estimate the gross output of industries. The industry VA/GO ratios are obtained from the benchmark input-output tables and their interpolations (Figure 2, Panel 1).

Factor income accounts

Factor income accounts in the nominal terms are important for weighting factor inputs in production. To construct annual factor income accounts, the only source of information is input-output tables. Given limited coverage and nontransparent procedures in constructing the income accounts under the input-output system, we find that it is very difficult to reconcile labor compensation in IOTs with total wage bills and welfare payments to employees covered by the regular reporting system and labor administrative authorities. We thus fully rely on the above reconstructed national accounts and the compensation for labor interpolated from the benchmark input-output tables (Figure 2, Panel 2). For simplicity and as a preliminary step, we treat the rest of gross value added as compensation for capital.

FIGURE 2

BENCHMARK VALUE ADDED RATIO AND SHARE OF LABOR COMPENSATION BY SECTOR



Sources: Figure 1.

Note: In Panel 1, “utilities” is omitted because our results show that it has identical VA/GO ratio to “manufacturing”.

It should be however noted that our treatment to allocation of national income among factors is subject to further more careful research. There are several issues that have been considered on the agenda. The first one is to identify the self-employed in the workforce. Currently, all their income is implicitly and incorrectly treated as labor compensation. Their identification will allow separating part of their income as capital compensation. The next major issue is to estimate the service of land (not to mention the services of all natural capital stocks) and allow some of the national income to pay for it. Last but not least, we should also explicitly show the net taxation in the income accounts.

3. RECONSTRUCTION OF INDUSTRY-LEVEL PPIS

Although the official measure of the real GDP has been questioned for underestimating price changes (Ren 1997, Maddison 1998, Woo 1998, Wu 2000), most studies on China’s growth take the implicit GDP deflator of the national accounts for granted. That approach inappropriately treats output prices the same as the input prices. In this study, to be conceptually consistent with our input-output framework, we opt for the standard (double deflation) approach to measuring the national accounts in the real terms. Strictly speaking, with this approach the real value added should be obtained by subtracting purchase price-deflated intermediate inputs by all industries involved from producer price-deflated gross output of each industry. Given little information on purchase prices across industries, our preliminary effort in this work concentrates on the construction of industry-specific producer price index (PPI) and assume that producers pay all their inputs at respective producer prices. This assumption ignores taxes related to sales and transport costs. These should be adjusted in future when more data are available.

Based on data availability, we use two approaches to different industries. We primarily rely on the official producer prices to construct PPIs for industries of the agricultural and industrial sectors and use the components of the consumer price index (CPI) supplemented by other price information to construct PPIs for most of services. In Table 2 we summarize the approaches used

and sources of the data and in Figure 3 we compare our so-estimated value-added deflator through the SUT-RAS procedure (Section 7).

TABLE 2
APPROACHES USED IN CONSTRUCTING INDUSTRY-SPECIFIC PPIs

Industry by CIP Code	Approach
Agriculture (1)	Aggregate PPI for all agricultural products
Mining (2-5)	Industry-specific PPIs, not adjusted
Manufacturing (6-24)	Industry-specific PPIs, a weighted average of sub-industries for each CIP category
Utilities (25)	Aggregate, a weighted average of sub-industries
Construction (26)	Price index based on the cost of fixed assets construction and installation
Wholesales & retails (27)	Urban consumer price index (CPI)
Hotels and restaurants (28)	Urban consumer price index (CPI)
Transport, storage, post (29)	Transport component of CPI, excluding price of equipment (vehicles)
Information services (30)	Telecommunication component of CPI
Financial services (31)	Average of transport, communication, rental and utilities components of CPI
Real estate services (32)	Estimated based on implicit service charge per square meter for 1993 onwards and assumed to move along with housing component of CPI
Business services (33)	As financial services (31)
Government (34)	Urban consumer price index (CPI)
Education (35)	Based on education components of CPI before 2006; adjusted to CPI trend afterwards
Healthcare, social security (36)	Based on average spending of per hospital visit per outpatient (MoH, various issues)
Other services (37)	Average of culture, sports, entertainment, personal repair components of CPI

Sources: Constructed by authors based on official PPIs and CPIs available in the “Price” chapter of each available *China Statistical Yearbook*, published by NBS unless specified. Refer to Table 1 for details of the CIP classification.

Basically, for non-service sectors we mainly rely on official PPIs, but we need to combine PPIs of sub-industries in line with the CIP classification using gross output weights. There are, however, no official PPIs available for services. Prices of services, especially the so-called “non-material” services including non-market services (referring to CIP Industry 30-37 as a MPS concept), are most problematic (Maddison 2007; Maddison and Wu 2008). The official GDP estimates for these services suggest an unusually high labor productivity growth rate of over 6 percent per annum for 1978-2012, while research on physical indicator-based labor productivity for such services suggests a growth rate ranging between negative and positive one percent, which is rather slow but well in line with the international norm in history (Wu 2014b). This suggests that the official price statistics for these services may have underestimated the real price changes.

With limited information available, our attempt is surely preliminary and with a purpose to invite suggestions for further improvement. In the present work, we in most cases rely on the relevant components of CPI as proxy PPIs for price changes facing the producers of some services concerned. Besides, we also look for other information that could help measure price

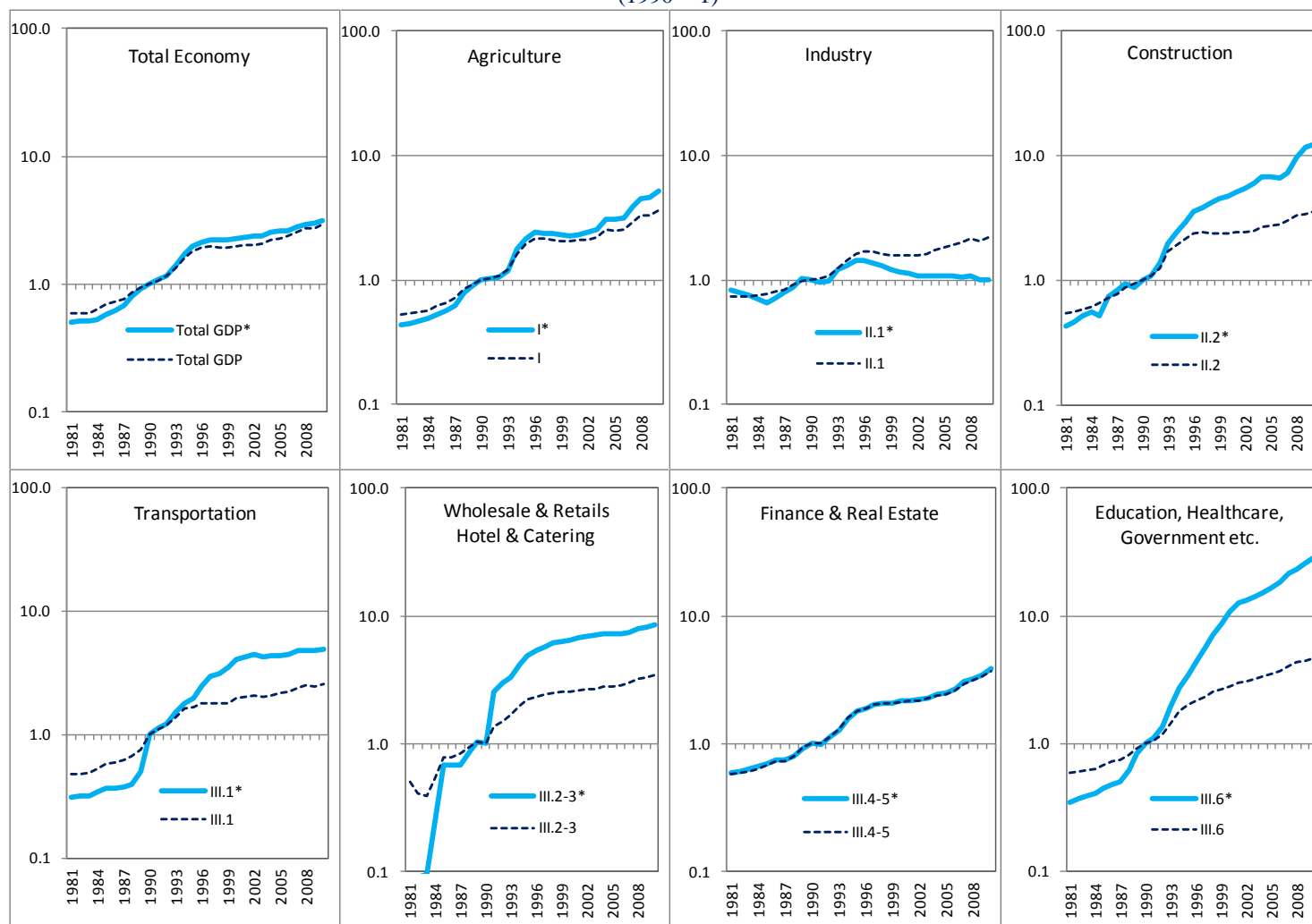
changes of services that cannot be related to components of CPI. Nevertheless, for services that cannot be related to any available price index, we have to use the urban consumer price index as a proxy for their PPI. This treatment includes wholesales and retails (CIP Industry 27), hotel and catering services (28) and government administrations (34). We do not use the general CPI (an average of urban CPI and rural CPI) because our concern about the likely downward bias in official price surveys and estimates in general. The urban CPI implies a slightly higher price change on average for the full period, i.e. 5.8 compared with the general CPI of 5.5 percent per annum.

We use relevant components of CPI as proxy PPIs for six services. Specifically, we take an average of four transport components of CPI as a proxy PPI for transportation, storage and post services (29) which includes prices of urban passenger transportation, inter-city passenger transportation, rental and repair of transportation equipment and fuel and auto parts. We take the telecommunication component of CPI as a proxy PPI for information services (30). Next, for education, we take the tuition fee component of CPI as a proxy PPI for education (35) and the culture, sports, entertainment services and residential repair services components of CPI as a proxy PPI for other services (37). It is more difficult to find a proper PPI proxy for financial services (31) and business services (33). Instead of simply adopting urban wage index, which we find almost the same as the official overall CPI, we take an average of prices changes in transportation, telecommunication, residential housing rent and utilities as a PPI proxy for these two services.

Finally, we look for other information outside CPI to measure price changes of the rest three services industries, i.e. construction (26), real estate services (32) and healthcare and social security services (36). We end up with taking the investment price index for construction of installation services as PPI for construction, the service margin (cost) index of per square meter housing service as PPI for real estate, calculated based on housing statistics, and the cost index of per hospital visit of outpatient as PPI for healthcare service, obtained from statistical publications of Ministry of Healthcare (MoH).

The dynamic effect of our newly constructed industry PPIs can be examined in [Figure 3](#). We use the results of the constant-price USE table estimated by SUT-RAS to derive GDP deflators for broad sectors that can be matched with the national accounts implicit GDP deflators. The thick solid line represents the implicit value added deflators derived from the estimated constant-price USE tables while the dotted line represents the national accounts implicit GDP deflators. With our reconstructed PPIs and exercising the double deflation approach in the SUT-RAS procedure, the overall effect on the economy-wide price change in terms of value added (i.e. GDP deflator shown in the first panel of [Figure 3](#)) is 0.8 percentage points per annum (can be calculated from the results reported in [Table 3](#)). This means that the official estimates could have underestimated the overall price change by nearly one percent per annum.

FIGURE 3
IMPLICIT VALUE-ADDED DEFLATOR BY SECTOR OF THE CHINESE ECONOMY, OFFICIAL VIS-À-VIS ALTERNATIVE
 (1990 = 1)



Sources: Official estimates are derived from the national accounts statistics (NBS 2011, pp. 44-48). Alternative estimates are estimated by the authors.

Note: See Table 1 for classification. "Dashed lines": official estimates of GDP deflators. "Solid lines" (with asterisk): alternative estimates of GDP deflators.

TABLE 3
GDP DEFLATOR: OFFICIAL VIS-À-VIS ALTERNATIVE ESTIMATES
(Percent per annum)

	Total GDP	Primary (I)	Industry (II.1)	Construction (II.2)	Transport (III.1)	Wholesales & Retail, Hotels & Catering (III.2-3)	Finance & Real & Estate (III.4-5)	Other Services (III.6)
<i>Official:</i>								
1981-1984	1.8	2.9	0.7	4.4	3.1	1.7	2.8	2.6
1984-1991	7.9	8.8	4.7	8.3	11.2	14.5	7.0	7.7
1991-2001	6.5	7.3	4.5	8.4	6.2	6.7	7.8	10.9
2001-2007	4.2	5.9	4.0	3.6	3.0	2.3	5.3	4.9
2007-2010	4.5	7.3	2.8	5.8	2.2	4.7	8.0	5.5
1981-2010	5.6	6.9	3.9	6.7	6.0	6.9	6.6	7.4
<i>Alternative:</i>								
1981-1984	1.5	4.2	-5.7	9.3	2.7	39.8	3.7	5.6
1984-1991	10.5	11.1	4.8	9.7	19.0	40.8	6.0	15.3
1991-2001	8.1	8.6	1.6	16.7	13.9	10.3	8.1	27.3
2001-2007	2.9	8.9	-1.3	6.3	2.2	1.4	5.8	9.5
2007-2010	4.1	10.4	-1.6	19.0	0.4	4.6	8.6	9.4
1981-2010	6.5	9.0	0.6	12.2	9.9	17.2	6.7	16.3

Sources: Official estimates are derived from the national accounts statistics (NBS 2011, pp. 44-48). Alternative estimates are estimated by the authors.

This effect varies greatly across sectors of the economy. There are extreme cases. For example, as shown in Table 3 our results show that “wholesale & retails” and “hotel & catering” (combined as III.2,3) might have experienced a price hike of 17.2 percent per year or 10.3 percentage points higher than that of the official estimates. The next similar case is “other services” (III.6), for which our estimate is a 16.3-percent inflation per year compared with the official figure of 7.4 per year. The opposite extreme case is, however, the industrial sector (II.1) which has been the most important driver of the Chinese economy. Our results show that the price of value added in industry only increases by 0.6 percent per year whereas the official estimates show 6.7 percent per year. Given the size of Chinese industry, our revision, if plausible, has substantially changed the structural picture of the Chinese economy in real terms. We will revisit China’s real growth rate in Section 7 after we complete our discussion of our data work for SUT-RAS procedure.

4. RECONSTRUCTION OF BENCHMARK SUPPLY-USE TABLES

Having explained how we reconstruct the national accounts and industry-specific PPIs, we now explain how we reconstruct benchmark supply-use tables which is another important data work for the estimation of annual supply-use tables. We mainly rely on the officially published supply and use tables and input-output tables. The Chinese official supply-use tables are available for five benchmark years, i.e. 1987, 1992, 1997, 2002, and 2007 (DNEB and ONIOS 1991; DNEA 1996, 1999, 2005 and 2009). The most detailed supply-use tables are those compiled for 2007, and they are available for 42 industries by 42 commodities. However, for earlier years, the supply-use tables are only available at broader industry-by-commodity level. For example, the 1987 supply-use tables are available for 33 industries by 33 commodities. On the other hand, the WIOD industry and commodity classification is at the 35-industry-by-59-commodity level. To satisfy the CIP 37-industry classification (Table 1) while exercising the

WIOD method of estimating supply-use tables in time series, we need to construct benchmark supply-use tables at the level of 37 industries cross matched by 59 commodities.

The limited details in the supply and use tables make a good concordance with 37 industries difficult. The input-output tables are, on the contrary, much more detailed (approximately 120 industries) and allow us to perform a better match. Although the official supply and use tables are in the industry-by-product format, when we aggregate products belonging to industries in the IOTs, it appears that they are exactly equal to that in the official supply and use tables. This suggests that the industrial classification in the official supply and use tables is based on the product classification adopted in the IOTs.

In constructing the supply block, we use the secondary production information (only available for industry: mining, manufacturing and utilities) from the published supply tables. Row and column totals in the supply block are obtained from the IOTs, but the distribution is obtained from the supply tables. To arrive at a new benchmark supply-use tables for 37 industries by 59 commodities starting from the broader industry-by-commodity level official use tables (e.g., the 33-industry-by-33-commodity level for 1987), we first reclassify industries and commodities using information on commodity shares taken from more detailed benchmark IO tables. As the supply-table information is not available for non-industry sectors, we assume that each non-industry sector only produces the products/services which belong to its own sector, i.e. all the non-diagonal factors for the supply tables are assumed to be zeros for the non-industry sectors. This is a strong assumption but we have no choice with available data. We take it as a necessary starting point. Finally, we apply the RAS program in order to obtain the balanced supply tables at the 37-industr-by-59-commodity level.

There are however additional benchmark input-output tables for 1981 that require different adjustments. The 1981 IOTs are compiled in line with the MPS concept not by the SNA standard. There are only material input-output tables available not supply-use tables. In order to construct the 1981 benchmark supply-use tables, we have to first convert the MPS-based IOTs to the SNA-based IOTs, which is explained in detail in the next section.

5. CONVERSION OF THE 1981 MPS INPUT-OUTPUT TABLES TO SNA STANDARD

To explain our basic strategy to convert the Chinese 1981 MPS input-output tables to the SNA standard, it is deemed necessary to have a quick review of the principles of the MPS mainly relying on the description of the Asian Historical Project at Hitotsubashi University³ and in the explanation attached to the Chinese 1987 IOTs (DNEB and ONIOS 1991).

The material product system or MPS is primarily a system of balance tables including major components such as “The balance of production, consumption and accumulation of the gross social product”, “The balance of production, distribution, redistribution and final use of the gross social product”, “The balance of labor resources” and “The balance of fixed assets”. The functions of MPS seem to be the same as those of SNA while there are essential differences between the two systems. MPS classifies the economic activities into spheres: the sphere of material production (mining, manufacturing, agriculture, and construction are included in this

³ URL: http://www.ier.hit-u.ac.jp/COE/English/online_data/index.html.

sphere while transportation, communications and distribution are only *partially* included in this sphere.⁴) and the sphere of “non-material services”, i.e. the rest of services that are not covered by the material production. By the Marxian doctrine only material production creates national income while “non-material services” consume that income, in other words non-productive.

However, the totality of spheres of material production and “non-material services” essentially conforms to the coverage of economic activities in SNA. The major difference between the two systems is only that the separation of “non-material services” from material production constitutes the basis of economic analyses in the MPS methodology. This understanding is essential for us to develop our approach to the MPS-to-SNA conversion for the Chinese 1981 input-output tables.

Given the limited information of the simply constructed 1981 MPS input-output tables, it is difficult to construct SNA input-output tables as required. Fortunately, the Chinese 1987 input-output tables provide both the tables under both SNA and MPS. Since the Chinese economy had not abandoned the central planning system by the late 1980s, it makes it less strong to assume that the relationship between material production and “non-material services” in 1987 can also be held for 1981. Basically, we rely on the 1987 IOTs-implied material-versus non-material relations in the input-output framework to convert the 1981 MPS input-output tables to the SNA standard. Figure 4 intuitively demonstrates the differences between the MPS-based and the SNA-based IO tables.

In Figure 4, the dark-shaded areas indicate the parts which are shown in the SNA-based IO tables but are not included at all in the MPS-based IO tables. The light-shaded area (2) indicates intermediate supply of non-material services to material production sectors, which is not shown in the MPS-based IO tables but of which values are included in the value added, the area (6). The pink area (3) indicates intermediate demand for non-material services to material production sectors, which is not shown in the MPS-based IO tables but of which values are included in the households and social consumption, the areas (9) and (10).

The way we constructed the SNA-based IO tables for 1981 is as follows. It should be mentioned that the Chinese industry classification before 1985 is very different from the international standard industry classification. The classification before 1985 is developed basically according to the vertical integration concept, which means that primary inputs used for production of a particular final product are classified in the same industry.⁵ On the other hand, the classification after 1985 conforms to the international standard classification. The Chinese 1981 IO tables are based on the 1972 industry classification while the 1987 IO tables are based

⁴ The services included in this sphere are freight transportation, communication services supplied to producers, social catering services and distribution activities continuing the production process such as state procurement of agricultural products and centralized deliveries of machinery and intermediate materials. On the other hand, the following sectors occupy the major part of the sphere of non-material services: (1) education, sciences, culture, health and social welfare; (2) housing and public utilities; (3) banking, insurance and administration; and 4) government and defense.

⁵ For example, there is an industry called “Metallurgical industry” in the 1981 IO tables. This industry corresponds to ferrous and non-ferrous ore mining, iron and steel manufacturing, and non-ferrous metal manufacturing for the 1987 IO tables. Similarly, the industry called “Coal and coke” in the 1981 IO tables corresponds to coal mining, coal cleaning and screening, coking, and gas and coal products manufacturing.

on the 1985 industry classification. However, as the industry classification is very different between the 1981 IOTs and the 1987 IOTs, our strategy is as follows.

FIGURE 4
DIFFERENCES BETWEEN THE MPS-BASED AND THE SNA-BASED IO TABLES FOR CHINA

		Intermediate demand		Final consumption				Industry output
		Material production	Non-material	Households consumption	Social consumption	Gross fixed capital	Changes in inventories	
Intermediate supply								
	Material production sectors	(1)	(3)	(9)	(11)	(13)	(15)	(A)
	Non-material production sectors	(2)	(4)	(10)	(12)	(14)	(16)	(B)
Value added		(5)	(7)					
		(6)	(8)					
Industry output		(C)	(D)					

Source: 1987 China Input-Output Tables

First, we reclassify both the 1981 MPS-based IOTs and the 1987 MPS-based and SNA-based IOTs. As the 1981 MPS-based IOTs are presented at the 24 material production sector level, we have to reclassify these 24 material production sectors into the 21 sectors in order to conform to the industry classification in the 1987 IOTs. Second, we regroup the industry sectors in the 1987 IOTs into the 21 sectors which are comparable to the 1981 IOTs, and we obtain both the MPS-based and the SNA-based 1987 IOTs at the broader sector level. The 24 industry classification in the original MPS-based 1981 IOTs and the aggregated 21 classification are shown in Table 3. Table 3 also shows the corresponding industrial classification in the CIP database which is presented in Table 1. More specifically, we first reclassified both the 1981 and the 1987 IO tables in order to make their industries comparable, and then, we estimated the values in the non-material production sphere in the way as explained below. After obtaining the values in the non-material production sphere for the 1981 IOTs, we convert the broad sector-level 1981 IOTs into the IOTs at the 117 sector level, using the structure of the 1987 IOTs at the 117 sector level.

The values in the non-material production sphere are estimated in the following way. Comparing the value added for the material production sectors in the SNA-based IO tables with that in the MPS-based IO tables for 1987, we calculated the ratio of the SNA value added to the MPS value added, and estimated the SNA value added for each sector for 1981 by multiplying the ratio with the MPS value added. Then, using the difference between the MPS value added and the SNA value added for 1981, we derived the total inputs of non-material services for each material production sector. Using the input-output coefficients for the material production sectors in the 1987 IO tables and the estimated figures for the total non-material service inputs, we derived the figure for each cell in the area (2). Similarly, taking the ratio of the SNA household and social consumption to the MPS household and social consumption for 1987, we estimated the area (3) using the input-output coefficients for the non-material production sectors in the 1987 IO tables. Again, using the input-output coefficients for the non-material production sectors in the 1987 IO tables and the estimated figures in the area (3), we derived figures in the

areas (4), (7), (8), and (D). Finally, using the estimated figures in the area (4) and the share of each final consumption component in the 1987 IO tables, we derived the figures in the areas (10), (12), (14), (16), and (B). In such a way, we estimated figures for the non-material production sphere for 1981.

TABLE 5
THE INDUSTRIAL CLASSIFICATION IN THE 1981 MPS-BASED IOTS

1981-original	1981-new	CIP/China KLEMS
Agriculture	Agriculture	1
Forestry	Forestry	1
Animal Husbandry	Animal Husbandry	1
Subsidiary business	Subsidiary Business	1
Fishing	Fishing	1
Metalurgical industry	Metallurgical industry	17
Electric power industry	Electric power industry	25
Coal and Coke	Coal and Coke	4
Petroleum	Petroleum	3
Heavy Chemical Light Chemical	Chemical Industry	14
Heavy machinery Light machinery	Mechanical industry	18, 19, 20, 21, 22, 23
Building materials	Building Materials	5, 16
Heavy forest industry Light forest industry	Forest Industry	1, 11
Food	Food	5, 6,7
Textiles	Textiles	8
Wearing apparel. Leather	Wearing apparel. Leather	9,10
Paper, cultural and educational articles	Paper, cultural and educational articles	12
Industries not elsewhere classified	Industries not elsewhere classified	24
Construction	Construction	26
Transport, post and telecommunications	Transport, post and telecommunications	29, 30
Commerce, restaurants and Supply and marketing of materials	Commerce, restaurants and Supply and marketing of materials	27, 28

After the SNA-type input-output tables for 1981 are constructed, we conduct the same exercise as explained in Section 4 to construct supply-use tables for 1981, which is expected to be used as our first benchmark for our research period. In this exercise, in the absence of basic information for supply and use tables for 1981, we assume that the structures of SUTs for 1981 are the same as those for 1987. This appears to be a strong assumption, but we believe that there is no better way to estimate the 1981 SUTs. This finally gives us six benchmarks of SUTs that are used in the SUT-RAS procedure to estimate China's supply-use tables in time series.

6. CONSTRUCTION OF EXTERNAL TRANSACTION ACCOUNTS

Another important data issue for the estimation of the benchmark SUTs and annual SUTs is to construct product-based exports and imports data. Although the detailed benchmark IO tables

for 2002 and 2007 provide exports and imports values at producer prices at commodity level, there is no detailed information available especially for services exports and imports for other years. Moreover, the IO tables for 1981 and 1987 only provide net exports by sector and values for exports and imports are not available. Therefore, we have constructed export and import data based on the WIOD product classification using the UN Comtrade data and the information on the exports and imports in the benchmark IO tables. We also utilized the trade statistics compiled by the WIOD project. Although the exports and imports data are available at the detailed product level for goods, detailed service exports and imports are not available for most of years except 2002 and 2007. Therefore, basically using the available information in the IO tables and the total exports and imports for services provided by the balance of payment statistics, we estimated the service exports and imports at the WIOD product level.

7. RESULTS AND DISCUSSION

SUT-RAS Model for Projecting Annual SUT Series

We estimate annual SUTs using the benchmark SUTs and various annual data which are used as the control totals for the matrix of SUTs. More specifically, required annual data are as follows:

- Gross output by industry
- Exports and imports by product
- Inventory changes by product (linearly interpolated for non-benchmark years)
- Gross output deflators by industry (PPIs)
- GDP deflator (total economy)

Using these annual data and the structures of the benchmark SUTs, we estimate annual SUTs. The estimation is conducted using the SUT-RAS method developed by Temurshoev and Timmer (2010). This method is akin to the well-known bi-proportional updating method for IOTs or the RAS technique. The SUT-RAS method is designed for joint projection of SUTs, and does not require the availability of the use and supply totals by products but endogenously derives them. This is a useful feature of the SUT-RAS program, because outputs by product are not available for projection years though outputs by industry are available from various data sources. The supply table gives us the value of commodity i made by industry j by all the industries while the use table gives us the intermediate use of commodity i by all the industries and the purchase by final demanders. In the SUT-RAS program, unlike the one-sided RAS method employed by the EU-KLEMS database, the use and the supply tables are jointly estimated with the two constraints:

$$\text{Total inputs by industry} = \text{total outputs by industry}$$

$$\text{Total supply by product} = \text{total use by product}$$

By averaging the two benchmark SUTs, the SUT-RAS program produces the SUTs estimated for any intermediate years. Extrapolation for years before the first benchmark SUT and after the last benchmark SUT is also produced by the SUT-RAS program. As a result, the SUT-RAS program produces annual supply tables and use tables (59 products by 37 industries) at the

prevailing producer prices (in nominal terms) and at the previous-year producer prices (a chained-Laspeyres deflation approach).

With our estimated Chinese annual SUTs, a number of tables can be derived for additional analysis, such as an event study or impact analysis, of which the symmetric tables (a.k.a. the analytical tables) represent the modeling aspect of the input-output framework. To obtain IOTs in time series, we use the transformation methodology recommended by the *Eurostat Manual of Supply, Use, and Input-Output Tables* (Eurostat 2008, Chapter 11), i.e. Model D assuming that the product sales structure is fixed. The SUTs-IOTs transformation formulas in Model D are presented as follows.

Supply Table

	Industries	Supply
Products	V^T	q
Output	g^T	

Use Table

	Industries	Final demand	Use
Products	U	Y	q
Value added	W		w
Output	g^T	y	

Transportation matrix $T=V*[\text{diag}(q)]^{-1}$

Input coefficients $A=T*U*[\text{diag}(g)]^{-1}$

Intermediates $B=T*U$

Value added $W=W$

Final demand $F=T*Y$

Output $g=y*(I-A)^{-1}$

The SUT-IOT transformation provides China's real value added by industry based on the double deflation approach. Figure 5 shows GDP indices for broad sectors that match with those of the national accounts (see Table 1 for the classification). Table 6 reports the annual growth rates for five designated sub-periods for the same broad sectors. Readers may also want to refer to the implicit prices changes depicted in Figure 3 and reported in Table 3.

China's real GDP growth revisited

Using our new real GDP estimates for the Chinese economy obtained after all the adjustments aiming to maintain consistency and follow the standard deflation methodology, we are now able to revisit the debate about China's growth performance during the reform period as introduced at the beginning of this paper.

Table 6 reports the annual growth rates by broad sector classified in line with the annual Chinese national accounts classification. The results are presented for the full period and designated sub-periods that are purposed to examine the growth performance against the

background of the major policy regime shifts over the three decades of the economic reform. We have arrived at an annual rate of GDP growth of 9.4 percent instead of the official estimate of 10.2 percent for this period. More specifically, we find a significant faster growth in the post WTO period (2001-07) i.e. 12.7 instead of the official 11.3 percent per annum. But, we also show that the shocks brought by the earlier reforms could be much bigger than the official accounts. For example, the economy grew at only 6.0 rather than 8.6 percent per annum when the government introduced double-track price reform in 1984-91 and 8.7 rather than 10.4 percent per annum when the government pushed for the reform of the state owned enterprises in the 1990s. These results for sub-periods appear to be more plausible than the official estimates given the nature of the shocks, positive or negative.

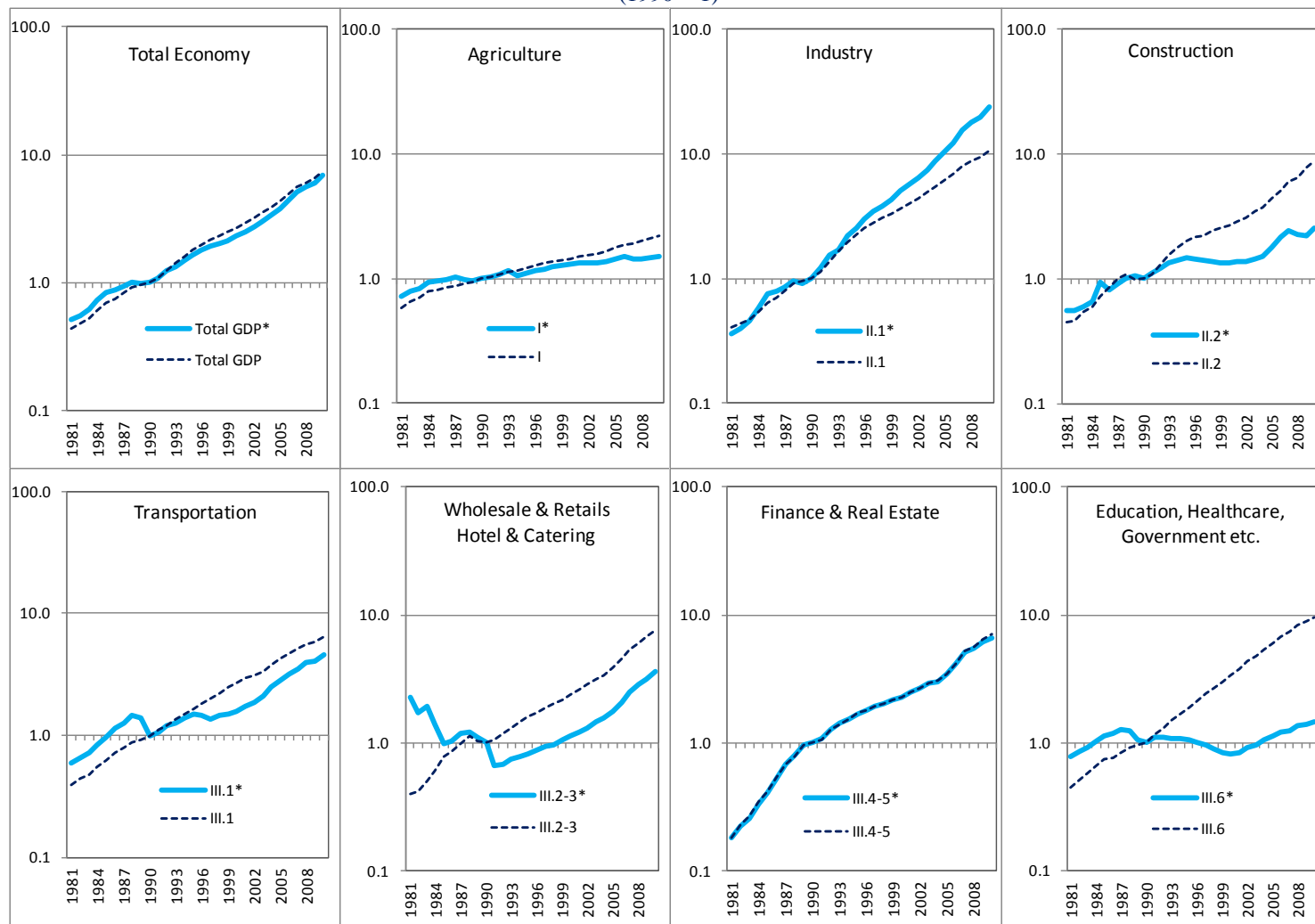
TABLE 6
ANNUAL GDP GROWTH: OFFICIAL VIS-À-VIS ALTERNATIVE ESTIMATES
 (Percent per annum)

	Total GDP	Primary (I)	Industry (II.1)	Construction (II.2)	Transport (III.1)	Wholesales & Retails, Hotels & Catering (III.2-3)	Finance & Real Estate (III.4-5)	Other Services (III.6)
<i>Official:</i>								
1981-1984	11.8	10.9	10.1	10.3	11.9	15.2	24.1	13.7
1984-1991	8.6	3.6	11.2	9.0	10.4	8.2	17.3	8.3
1991-2001	10.4	3.8	13.3	10.1	10.2	9.4	8.9	12.7
2001-2007	11.3	4.3	12.3	13.0	10.1	12.6	13.3	11.8
2007-2010	9.8	4.6	10.2	13.8	7.1	12.7	10.4	8.9
1981-2010	10.2	4.7	11.9	10.8	10.1	10.7	13.5	11.1
<i>Alternative:</i>								
1981-1984	12.1	9.4	17.6	5.4	12.7	-15.0	22.5	10.3
1984-1991	6.0	1.3	11.2	7.7	3.6	-10.0	18.3	0.7
1991-2001	8.7	2.5	16.5	2.3	4.9	6.3	8.7	-2.6
2001-2007	12.7	1.3	18.4	10.2	12.5	12.8	12.7	6.8
2007-2010	10.2	1.7	15.1	1.1	9.1	12.6	9.4	5.7
1981-2010	9.4	2.6	15.6	5.4	7.3	1.6	13.2	2.2

Sources: Official estimates are derived from the national accounts statistics (NBS 2011, pp. 44-48). Alternative estimates are estimated by the authors.

At broad-sector level, a big contrast has emerged between the industrial and non-industrial sectors when comparing our results with the official estimates. We show a much faster growth of industrial GDP at 15.6 percent per annum instead of the official estimate of 11.9 percent per annum, in other words, the new result suggests a 3.7 percentage-points faster industrial growth. As for the growth of non-industrial sectors, our estimates have arrived at a much slower growth than those of official except for the financial and real estate services. The gap for the full period ranges from 2.1 percentage-points slower in agriculture (2.6 compared to 4.7 percent) to 9.1 percentage-points slower in commerce activities (wholesales, retails, hotels and catering) (1.6 compared to 10.7 percent). Our estimated annual GDP growth for the total non-industrial economy is 5.2 percent per annum instead of the official estimate of 8.9 percent per annum, in other words, 3.7 percentage-points slower. These are clearly shown in dynamics in [Figure 5](#).

FIGURE 5
INDEX OF REAL VALUE-ADDED BY SECTOR OF THE CHINESE ECONOMY, OFFICIAL VIS-À-VIS ALTERNATIVE ESTIMATES
 (1990 = 1)



Sources: Official estimates are derived from the national accounts statistics (NBS 2011, pp. 44-48). Alternative estimates are estimated by the authors.

Note: See Table 1 for classification. “Dashed lines”: official estimates of GDP index. “Solid lines” (with asterisk): alternative estimates of GDP index.

Over the designated sub-periods, it is interesting to see that the gaps of sectors between our results and the official estimates become smaller for China's post-WTO period which saw the best growth performance over the three decades in growth. In fact, for both the post-WTO and the post-GFC (global financial crisis) periods, our results show a faster growth for transportation than the official estimates, and for commerce our results are almost the same as the official estimates. However, we also show that for all the sub-periods the growth of construction and other services ("non-material" or non-market services) was much slower than that suggested by the official estimates.

The distinct differences between our growth estimates and the official estimates for the industrial and non-industrial sectors may suggest that other things being equal, the input prices paid could be higher or lower than suggested by the official implicit GDP deflators. Therefore, *ceteris paribus*, the GDP for those sectors could grow faster or slower than the official estimates. We can go on to argue that if our new estimates are more reasonable, China's industrial productivity growth could also be much faster than that estimated by the single deflation-based approach as used in most studies, whereas the productivity growth of China's non-industrial sector, especially services, could be much slower.

8. CONCLUDING REMARKS

This paper documents our procedures for constructing China's supply-use tables in time series and hence deriving China's annual input-output tables for the period 1981-2010 under the CIP Project. We begin with tackling the inconsistencies in term of concept, coverage and classification of the Chinese national accounts and likely biases of using the national accounts implicit GDP deflators. We then focus on the key steps in reconstructing national production accounts as the national and industry-level "control totals" and industry-specific producer price indices and in converting the 1981 MPS-type IOT to the SNA standard to match China's five benchmark SNA IOTs reclassified to the CIP standard.

With these adjustments and procedures we have arrived at an annual rate of GDP growth of 9.4 percent instead of the official estimate of 10.2 percent for this period. However, at the broad-sector level we show a much faster growth of industrial GDP at 15.6 percent per annum instead of the official estimate of 11.9 percent per annum. As for the growth of non-industrial GDP, our estimate is 5.2 percent per annum instead of the official estimate of 8.9 percent per annum. These distinct differences between our growth estimates and the official estimates for the industrial and non-industrial sectors may suggest that other things being equal, the input prices paid could be higher in the case of the industrial sector or lower in the case of the non-industrial sector than that suggested by the official implicit GDP deflators. The differences imply that the productivity growth could be respectively faster or slower accordingly.

There are a few remaining issues yet to be tackled. First, we should search for more information to improve our price measures of services especially the "non-material services". Second, the income accounts or compensation for factors are too simple because we have not been able to distinguish labor and capital inputs by self-employed people, have not considered services by natural capital (e.g. land) and have not integrated them in the estimation of the annual SUTs coherently. Last, we may also need to consider using alternative deflation approaches to test for the sensitivity of our results for the real growth rate.

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