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Recent trends in productivity in China: shift-share analysis of labour productivity growth and the evolution of the productivity gap

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RECENT TRENDS IN PRODUCTIVITY IN CHINA - SHIFT-SHARE ANALYSIS OF LABOUR PRODUCTIVITY GROWTH AND THE EVOLUTION OF THE PRODUCTIVITY GAP

ECONOMICS DEPARTMENT WORKING PAPERS No. 1221

By Margit Molnar and Thomas Chalaux

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ABSTRACT/RÉSUMÉ

Recent trends in productivity in China – shift-share analysis of labour productivity growth and the evolution of the productivity gap

The Chinese economy has been undergoing fundamental structural changes since the start of reforms in 1978. An increasing number of farmers first got engaged in off-farm activities and then started to migrate to cities in the 1990s in search of jobs. Such movement of labour from less to more productive jobs boosted overall labour productivity and growth. Agglomeration and scale economies further pushed up productivity. While the productivity gains from internal migration will diminish gradually over time, urbanisation is likely to remain an important source of productivity growth in the coming decade or so.

This paper first decomposes labour productivity growth over 2000-11 into a within-industry, a shift and a cross effect in a number of countries and compares China with other countries over this period. This shift-share analysis also allows a comparison of within-sector productivity gains across a large number of sectors and countries.

Labour productivity alongside total factor productivity is also discussed from the perspective of its gap with the United States and growth rate over 2000-11 and in comparison with other BRIICS economies. In this analysis, manufacturing and service industries are looked at separately.

This Working Paper relates to the 2015 *OECD Economic Survey of China*
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Keywords: labour productivity, total factor productivity, China, BRIIC economies, productivity gap, manufacturing, services.

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Évolution récente de la productivité en Chine – analyse structurelle-résiduelle des gains de productivité du travail et évolution de l'écart de productivité

L'économie chinoise connaît des mutations structurelles majeures depuis le début du processus de réforme, en 1978. Un nombre croissant d'exploitants agricoles commencèrent à cette époque à exercer une activité en dehors de leur exploitation, puis migrèrent vers les villes dans les années 90, à la recherche d'un travail. De tels mouvements de main-d'œuvre, quittant des emplois peu productifs pour des emplois qui l'étaient davantage, ont stimulé la productivité globale du travail et la croissance. Les économies d'agglomération et d'échelle ont constitué à leur tour une nouvelle source de gains de productivité. Si les gains liés aux migrations intérieures vont diminuer au fil du temps, l'urbanisation va probablement demeurer une source majeure d'amélioration de la productivité dans la décennie à venir.

Ce document de travail décompose les gains de productivité pour la période 2000-11 en fonction de l'effet intrasectoriel, des variations de parts et de l'effet transversal, et compare la Chine à d'autres pays pour la même période. Cette analyse structurelle-résiduelle permet également de comparer la composante intrasectorielle des gains de productivité sur un grand nombre de secteurs et de pays.

La productivité de la main-d'œuvre et la productivité globale des facteurs sont également analysées du point de vue de leur écart avec les États-Unis et du taux de croissance entre 2000 et 2011, et en comparaison avec d'autres pays BRIICS. L'industrie et les services sont considérés séparément dans cette analyse.

Ce document de travail se rapporte à *l'Étude économique de la Chine,* OCDE, 2015
www.oecd.org/fr/eco/etudes/etude-economique-chine.htm
Classification JEL : J24, D24.

Mots-clés : productivité du travail, productivité globale des facteurs, Chine, pays BRIICS, écart de productivité, industrie, services.

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RECENT TRENDS IN PRODUCTIVITY IN CHINA – SHIFT-SHARE ANALYSIS OF LABOUR PRODUCTIVITY GROWTH AND THE EVOLUTION OF THE PRODUCTIVITY GAP

By Margit Molnar and Thomas Chalaux[1]

1. The Chinese economy has been undergoing fundamental structural changes since the start of reforms in 1978. An increasing number of farmers first got engaged in off-farm activities and then started to migrate to cities in the 1990s in search of jobs. Such movement of labour from less to more productive jobs boosted overall labour productivity and growth. Agglomeration and scale economies further pushed up productivity. While the productivity gains from internal migration will diminish gradually over time, urbanisation is likely to remain an important source of productivity growth in the coming decade or so.

2. This paper first decomposes labour productivity growth over 2000-11 into a within-industry, a shift and a cross effect in a number of countries and compares China with other countries over this period. This shift-share analysis also allows a comparison of within-sector productivity gains across a large number of sectors and countries.

3. Labour productivity alongside total factor productivity is also discussed from the perspective of its gap with the United States and growth rate over 2000-11 and in comparison with other BRIICS economies. In this analysis, manufacturing and service industries are looked at separately.

Shift-share analysis of labour productivity growth

4. The productivity-decomposition analysis is based on the shift-share analysis described in EC (2003), which decomposes aggregate changes in labour productivity into an intra-industry, a shift and an interaction effect.

- The within-sector effect measures the impact of productivity growth within each sector on total economy productivity growth, assuming that sector labour shares are unchanged.

- The shift effect measures the impact on total economy productivity resulting from the movement of labour between sectors, assuming that the level of productivity in each sector is unchanged.

- The cross-term effect measures the change in both labour share and productivity in each sector and accounts for the impact of labour re-allocation between sectors with varying productivity growth rates. If the sign of the cross-term effect is positive, it indicates that the within-industry

1. Margit Molnar heads the China desk and Thomas Chalaux is a research assistant in the OECD Economics Department. This paper was originally produced as a background document for the 2015 *OECD Economic Survey of China* published in March 2015 under the authority of the Economic and Development Review Committee (EDRC). The authors thank Alvaro Pereira, Robert Ford, Vincent Koen, Ben Westmore, Molly Lesher as well as officials from the Chinese government for valuable comments on earlier drafts, and Nadine Dufour for editorial assistance.

and shift-effects are complementary, that is, productivity growth is positive in expanding industries and negative in contracting industries. Conversely, if the cross-term effect is negative, it indicates that the within-industry and shift effects are substitutes, that is, productivity growth is positive in contracting industries and negative in expanding industries.

5. A major caveat of shift-share analysis is its sensitivity to industry detail i.e. the number of industrial sectors used for the analysis. If the number of sectors is too few, a large part of cross-sectoral shifts will be unaccounted for and will appear as within-industry productivity growth. This may lead to ignoring significant structural transformations. Therefore, a large number of sectors is preferable. For international comparisons of the effects, there may be a trade-off between the number of countries and the number of sectors included in the analysis.

For each individual industry i labour productivity is defined as output (Y) divided by labour input (L):

$$LP_{it} = \frac{Y_{it}}{L_{it}}$$

$$LP_t = \frac{Y_t}{L_t} = \sum_i Y_{it} / \sum_i L_{it}$$

When expressed in nominal terms, labour productivity can be written as a weighted sum of the within-industry productivity values:

$$LP_t = \sum_t LP_{it} \frac{L_{it}}{L_t}$$

This gives, in difference terms:

$$\Delta LP_t = \sum_i \Delta(LP_{it}) \frac{L_{it-1}}{L_{t-1}} + \sum_i LP_{it-1} \Delta(\frac{L_{it}}{L_t}) + \sum_i \Delta(LP_{it}) \Delta(\frac{L_{it}}{L_t})$$

Dividing by LP_{t-1} to get the growth (percentage change) and rearranging the terms:

$$\frac{\Delta LP_t}{LP_{t-1}} = \sum_i \frac{\Delta LP_{it}}{LP_{it-1}} \frac{Y_{it-1}}{Y_{t-1}} + \sum_i \frac{LP_{it-1}}{LP_{t-1}} (\frac{L_{it}}{L_t} - \frac{L_{it-1}}{L_{t-1}}) + \sum_i \frac{1}{LP_{t-1}} (\Delta LP_{it}) \Delta(\frac{L_{it}}{L_t})$$

6. The first component is the within-industry effect, *i.e.*, the sum of industry productivity growth rates, weighted by the initial (nominal) output shares.

7. The second component is the shift effect, i.e. the sum of changes in input shares, weighted by the relative productivity level (i.e. the ratio of industry productivity to average productivity). This effect could also be written and decomposed as the sum of industry labour input growth rates, weighted by initial output shares, minus total labour input growth.

8. The sign of the residual (interaction) component is usually negative (in the economy there is a majority of industries where the productivity change and the labour input change have opposite signs). It may, however, be positive when beneficial restructuring of the economy occurs (in this case, most of the industries enjoying productivity growth are at the same time attracting more resources).

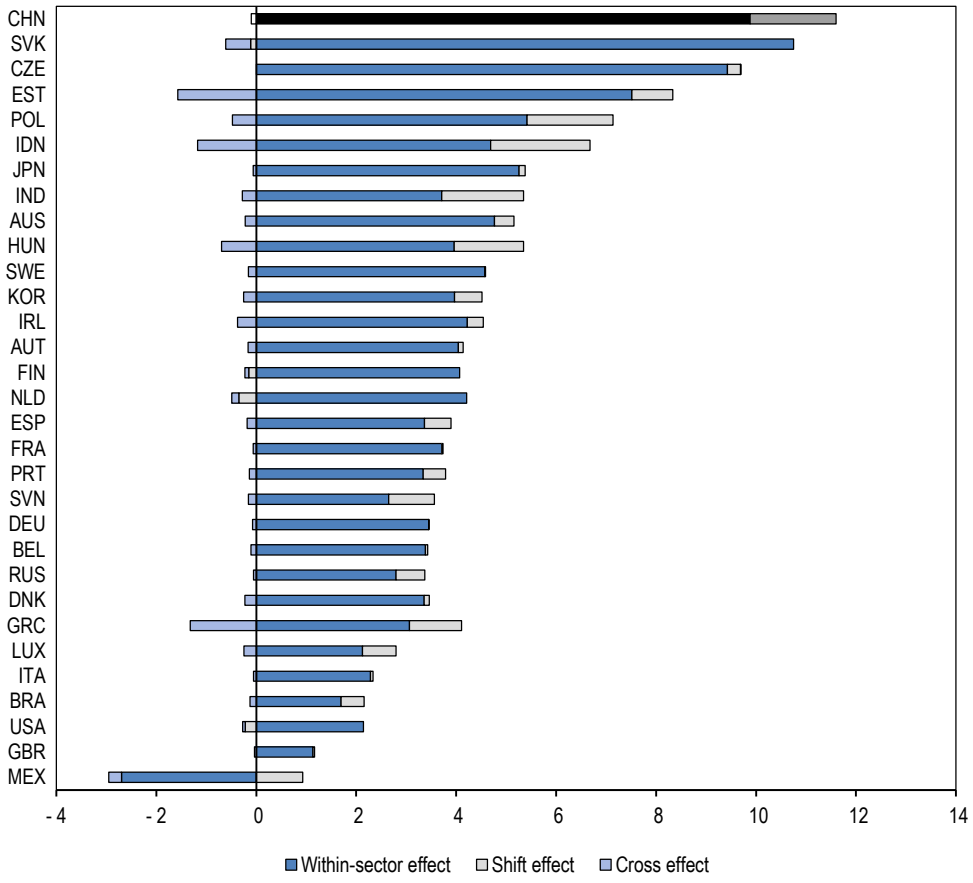
9. The decomposition described above would strictly hold only in the case of (discrete) percentage changes. The logarithmic approximation (used throughout the study) entails an error of magnitude often comparable to the interaction effect. We have, however, defined the within-industry effect and the shift effect analogously to the discrete case. A corresponding decomposition for the continuous time case can be found in Nordhaus (2002), who has also shown that when 'old-fashioned' price index methods are used (i.e. not the Törnqvist method), one should add to the decomposition an additional term accounting for the drift in prices.

Labour productivity growth in China mainly stems from within-industry growth

10. Decomposition of labour productivity changes into those resulting from shifts among sectors and those resulting from increases in productivity in individual sectors sheds light on these trends (Figure 1). Within-sector productivity gains have been the major driver of labour productivity in China, owing to a large extent to its strategy of tapping global knowledge through inward foreign direct investment as well as by acquiring new technology through mergers and acquisitions and other means (Girma et al., 2014). Productivity gains resulting from the movement of labour from less productive to more productive sectors (the so-called "shift effect") were relatively large explaining about 2 percentage points of labour productivity growth in the past decade, which indicates a healthy process of restructuring. These results are not out of line with the literature using the same method, though the time periods for which the shift effect is estimated differ. Robertson and Ye (2014) found smaller effects of labour reallocation, though they use a growth accounting framework with a Cobb-Douglas production function and human capital adjusted for rural-urban differences.

Figure 1. Labour productivity growth is mainly explained by within-sector growth

Decomposition of labour productivity growth 2000-11



Source: Authors' calculation using the WIOD and OECD National Accounts databases.

11. In OECD countries, within-sector productivity increases largely explain overall productivity developments and, in general, the within-industry effect is the largest for most non-OECD economies as well. In the longer term, once the catching-up mechanism through shifting employment to higher productivity sectors is exhausted, generating productivity gains within industries becomes the major source of productivity growth. As it assumes no changes in employment shares of industries, a within-sector term that is smaller than aggregate productivity growth may suggest that industries with higher productivity growth have increased their share in total employment (Table 1). This is observed in most economies such as Brazil, China, India, Indonesia, Korea and the Russian Federation.

12. The cross-term – measuring correlations in an economy between productivity and employment changes – reveals that among the countries examined here, none has complementary within-industry and shift effects (Table 1). More specifically, in none of the economies examined here is productivity growth positive in expanding industries and negative in contracting industries. This effect is particularly large in Indonesia, Greece and some Baltic States, indicating that productivity gains are reaped in contracting rather than expanding industries.

Table 1. Shift-share analysis of labour productivity growth per person 2000-11

	Average change	Within-sector effect	Shift effect	Cross effect

CHN	11.5	9.9	1.7	-0.1
SVK	10.1	10.7	-0.1	-0.5
CZE	9.7	9.4	0.3	0.0
EST	6.8	7.5	0.8	-1.6
POL	6.7	5.4	1.7	-0.5
IDN	5.5	4.7	2.0	-1.2
JPN	5.3	5.3	0.1	-0.1
IND	5.1	3.7	1.6	-0.3
AUS	4.9	4.8	0.4	-0.2
HUN	4.7	4.0	1.4	-0.7
SWE	4.4	4.6	0.0	-0.2
KOR	4.3	4.0	0.5	-0.3
IRL	4.2	4.2	0.3	-0.4
AUT	4.0	4.0	0.1	-0.2
FIN	3.8	4.1	-0.2	-0.1
NLD	3.7	4.2	-0.3	-0.1
ESP	3.7	3.4	0.5	-0.2
FRA	3.7	3.7	0.0	-0.1
PRT	3.7	3.3	0.4	-0.1
SVN	3.4	2.7	0.9	-0.2
DEU	3.4	3.4	0.0	-0.1
BEL	3.3	3.4	0.0	-0.1
RUS	3.3	2.8	0.6	-0.1
DNK	3.2	3.4	0.1	-0.2
GRC	2.8	3.1	1.0	-1.3
LUX	2.6	2.1	0.7	-0.2
ITA	2.3	2.3	0.0	-0.1
BRA	2.0	1.7	0.5	-0.1
USA	1.9	2.1	-0.2	-0.1
GBR	1.1	1.1	0.0	0.0
MEX	-2.0	-2.7	0.9	-0.3

Note: Results are based on 35 sectors including agriculture, mining, 14 manufacturing and 19 service industries in 32 economies. Productivity is measured by value added at constant prices per person employed. The within-sector effect measures the impact of productivity growth within each sector on total economy productivity growth, assuming that labour shares are unchanged. The shift effect measures the impact on total economy productivity resulting from the movement of labour between sectors, assuming that the level of productivity in each sector is unchanged. The cross-term effect measures the change in both labour share and productivity in each sector and accounts for the impact of labour re-allocation between sectors with varying productivity growth rates.

Source: Authors' calculation using the WIOD and OECD National Accounts databases.

13. During the past decade, non-manufacturing industries have been driving within-industry productivity gains in the BRIIC economies (except for South Africa, for which no comparable data are available). In addition to agriculture, which led productivity gains among the 35 industries used in the analyses for Brazil, China and Indonesia, several modern service industries were major engines of productivity growth (Table 2). Wholesale trade was the strongest driver in the Russian Federation, the second strongest in China and the third in Indonesia, while retail trade was the second most important in India. The contribution to productivity growth by the telecommunications industry was significant in India and Indonesia, reflecting the ICT revolution in those economies. Focusing on a different period (1980-2008), another study shows that Brazil India and the Russian Federation display high within-sector productivity growth in services, while China's productivity growth is high in manufacturing (Chansomphou and Ichihashi, 2013).

14. Major productivity growth engines among manufacturing industries differed widely across the BRIIC economies, with basic metals and food and beverages leading the manufacturing sector in China, food and beverages and automobiles in Indonesia, refinery activities in India and machinery in the Russian Federation. In Brazil, although the chemicals industry contributed most to within-industry productivity growth among manufacturing industries, its individual contribution as well as overall within-industry

productivity growth was relatively low. Moreover, many manufacturing industries registered negative contributions to within-industry productivity growth over 2000-11.

15. Analysis across provinces shows that Hunan and Hainan experienced the largest structural change over 2000-11 and Fujian, Guangdong and Shandong the least (Wu et al., 2014). This analysis focuses on 20 manufacturing industries and calculates the coefficient of structural change, which correlates the share of each sector in each region between 2000 and 2011. Industrial structural patterns can also be traced by estimating the index of dissimilarity of industrial structures across regions. Yunnan, Chongqing and Jilin have the highest values, indicating high levels of dissimilarity with the national average.

16. In a similar vein to this technical background paper, Wu et al. (2014) decompose the productivity gap across regions into a structural, regional and allocative efficiency component. The structural or industry-mix factor measures the effect of the productivity differential due to the difference between a region's industrial structure and the national average; the regional or productivity-differential factor measures the difference between regional and national average productivity in each sector and the allocative efficiency component (i.e. the analogue of the cross-term effect in the shift-share analysis in this paper), measures the relation between the two other components, being positive if the region is specialised in industries with above national-average productivity. From the nine regions with positive productivity gaps relative to the national average, only Tianjin, Beijing and Jilin achieved allocative efficiency (the cross term is positive, i.e. these regions are specialised in industries that have productivity above the national average). Although Shanghai has an even greater positive productivity gap than any other province or municipality, it is not specialised in industries with productivity above the national average, indicating allocative inefficiency.

Table 2. Within-industry effects by industry 2000-11

	15t16	17t18	19	20	21t22	23	24	25	26	27t28	29	30t33	34t35	36t37	50	51	52	60	61	62	63	64	70	71t74	AtB	C	E	F	H	J	L	M	N	O	P	TOT
Slovak Republic	0.34	0.16	0.02	0.18	0.20	0.08	0.22	0.20	0.22	0.59	0.51	0.93	0.73	0.20	0.06	0.80	0.54	0.19	-0.01	0.01	-0.04	0.30	0.26	0.50	0.83	0.06	0.29	0.67	0.00	0.28	0.77	0.30	0.09	0.27		10.75
China	0.42	0.26	0.04	0.06	0.08	0.12	0.38	0.11	0.26	0.66	0.28	0.35	0.21	0.11		0.70	0.19	0.27	0.18	0.00	0.11	0.28	0.26	0.42	0.94	0.56	0.35	0.49	0.16	0.41	0.44	0.36	0.18	0.24		9.88
Czech Republic	0.21	0.16	0.01	0.11	0.13	0.01	0.13	0.35	0.24	0.25	0.50	0.58	0.82	0.13	0.25	0.93	0.38	0.53	0.00	0.05	0.03	0.29	0.32	0.60	0.24	0.09	0.36	0.36	0.01	0.37	0.33	0.37	0.15	0.15	0.00	9.43
Estonia	0.28	0.15	0.02	0.28	0.15	0.01	0.10	0.04	0.08	0.20	0.12	0.33	0.16	0.16	0.22	0.58	0.28	0.18	0.08	0.16	0.27	0.49	0.60	0.40	0.32	0.14	0.34	0.27	0.11	0.45	0.19	0.11	0.04	0.20		7.52
Poland	0.33	0.07	0.01	0.05	0.10	0.11	0.14	0.11	0.11	0.19	0.16	0.11	0.13	0.08	0.20	0.46	0.45	0.14	0.01	0.01	0.05	0.21	0.17	0.27	0.45	0.07	0.22	0.24	0.02	0.36	-0.03	0.11	0.22	0.05	0.02	5.42
Japan	0.10	0.01	0.00	0.00	0.07	0.05	0.12	0.05	0.03	0.18	0.29	0.64	0.20	0.01	0.05	0.31	0.19	0.12	0.05	0.01	0.03	0.15	0.54	0.45	0.08	0.00	0.19	0.17	0.12	0.25	0.30	0.06	0.24	0.17		5.26
Australia	0.07	0.00	0.01	0.01	0.08	0.00	0.04	0.03	0.07	0.17	0.05	0.03	0.08	0.02	0.26	0.32	0.25	0.11	0.01	0.03	0.02	0.22	0.45	0.39	0.44	-0.14	-0.04	0.40	0.09	0.52	0.11	0.13	0.32	0.19		4.77
Indonesia	0.72	0.01	0.01	-0.02	-0.03	-0.16	0.12	0.04	0.01	-0.02	0.04	0.18	0.22	0.05		0.61	0.31	0.14	-0.01	0.10	0.06	0.59	-0.16	0.07	0.72	0.26	0.08	0.33	-0.09	0.02	0.17	0.06	0.01	0.26		4.69
Sweden	0.09	0.01	0.00	0.05	0.14	0.09	0.22	0.03	0.03	0.09	0.19	0.52	0.22	0.03	0.09	0.35	0.23	0.06	0.03	0.04	0.05	0.25	0.08	0.42	0.13	0.02	0.03	0.06	0.01	0.22	0.15	0.08	0.38	0.16	0.00	4.58
Ireland	0.56	0.02	0.01	0.02	0.45	0.02	0.82	0.04	0.04	0.05	0.04	0.22	0.04	0.02	0.03	0.26	0.17	-0.02	0.00	0.00	0.00	0.16	-0.17	0.74	0.06	0.03	0.25	-0.24	0.07	0.48	0.00	0.08	-0.03	0.00	0.00	4.22
Netherlands	0.14	0.01	0.00	0.01	0.10	0.21	0.21	0.02	0.02	0.09	0.10	0.05	0.05	0.02	0.03	0.60	0.11	0.08	0.02	0.02	0.07	0.23	0.21	0.26	0.12	0.10	0.09	0.12	0.00	0.42	0.26	0.08	0.25	0.06	0.02	4.21
Canada	0.13	0.02	0.00	0.06	0.13	0.00	0.07	0.05	0.03	0.11	0.05	0.02	0.09	0.05	0.03	0.37	0.31	0.13	0.01	0.02	0.03	0.13	0.24	0.36	0.15	0.02	0.08	0.18	0.10	0.23	0.30	0.17	0.25	0.20	0.01	4.13
Finland	0.12	0.02	0.00	0.06	0.27	0.04	0.12	0.04	0.03	0.15	0.20	0.72	0.02	0.02	0.06	0.23	0.14	0.05	0.00	0.03	0.05	0.36	0.25	0.12	0.21	0.02	0.11	0.15	0.06	0.07	0.11	0.07	0.12	0.06	0.00	4.07
Austria	0.10	0.02	0.00	0.03	0.15	0.14	0.12	0.03	0.04	0.13	0.14	0.13	0.10	0.06	0.01	0.26	0.16	0.06	0.00	-0.02	0.05	0.20	0.19	0.30	0.06	0.02	0.11	0.22	0.09	0.59	0.16	0.17	0.11	0.09	0.00	4.04
Korea	0.05	0.12	0.01	0.00	0.04	0.01	0.15	0.02	0.07	0.10	0.17	1.24	0.27	0.01	0.02	0.16	0.20	0.08	0.04	0.00	0.02	0.12	0.05	-0.12	0.21	0.01	0.23	-0.01	0.06	0.31	0.28	0.07	-0.07	0.02		3.97
Hungary	-0.02	0.04	0.01	0.03	0.06	-0.27	0.12	0.09	0.07	0.12	0.44	0.36	0.12	0.03	0.12	-0.01	0.22	0.13	0.01	0.00	0.06	0.22	0.25	0.15	0.52	0.04	0.00	0.10	-0.02	0.09	0.42	0.18	0.09	0.18		3.96
France	0.06	0.04	0.00	0.01	0.05	0.01	0.07	0.07	0.02	0.06	0.08	0.17	0.05	0.01	0.02	0.16	0.22	0.10	0.02	0.03	0.07	0.16	0.49	0.57	0.11	0.00	0.05	0.06	0.03	0.21	0.24	0.13	0.23	0.10	0.01	3.71
India	0.09	-0.04	-0.01	0.00	0.01	0.25	0.13	0.02	0.00	0.09	0.13	0.10	0.11	-0.02	0.01	0.21	0.55	0.26	0.00	0.01	0.01	0.36	-0.47	0.10	0.30	0.14	0.09	0.13	0.04	0.36	0.59	0.05	0.02	0.11	0.00	3.71
Germany	0.04	0.03	0.00	0.02	0.08	0.01	0.19	0.08	0.04	0.11	0.13	0.33	0.28	0.02	0.07	0.27	0.13	0.01	0.03	0.00	0.06	0.11	0.45	0.03	0.02	0.01	0.06	0.11	0.01	0.14	0.26	0.03	0.25	0.06	0.01	3.45
Belgium	0.15	0.04	0.00	0.02	0.10	0.09	0.15	0.06	0.04	0.10	0.04	0.05	0.05	0.03	0.04	0.27	0.15	0.09	0.00	0.02	0.05	0.17	0.16	0.36	0.06	0.01	0.08	0.19	0.03	0.32	0.22	0.10	0.08	0.05	0.01	3.38
Spain	0.08	0.03	0.01	0.02	0.06	-0.02	0.07	0.03	0.06	0.11	0.05	0.05	0.06	0.04	0.06	0.12	0.21	0.05	0.00	0.00	0.01	0.18	-0.10	0.14	0.19	0.00	0.08	0.66	0.10	0.34	0.26	0.15	0.12	0.13		3.36
Denmark	0.02	0.01	0.00	0.01	0.09	-0.01	0.13	0.04	0.02	0.05	0.08	0.16	0.02	0.04	0.05	0.29	0.12	0.05	0.01	0.14	0.07	0.15	0.15	0.25	0.16	0.05	0.06	0.04	-0.01	0.42	0.16	0.13	0.41	0.01	0.00	3.36
Portugal	0.15	0.11	0.02	0.04	0.09	0.00	0.04	0.03	0.08	0.10	0.05	0.09	0.05	0.03	0.11	0.16	0.14	0.12	0.01	0.03	0.09	0.18	0.15	-0.04	0.11	0.01	0.23	0.11	0.12	0.40	0.26	0.09	0.07	0.09	0.03	3.34
Greece	-0.08	0.01	0.01	0.01	0.04	0.07	0.07	0.00	0.02	0.06	0.04	-0.01	0.00	-0.01	0.15	0.13	0.34	-0.01	0.54	0.13	0.06	0.32	-0.08	-0.12	0.20	0.01	0.16	0.01	0.30	0.08	0.05	0.29	0.09	0.15	0.02	3.06
Russian Federati	0.07	0.00	0.00	0.02	0.03	-0.01	0.06	0.01	0.04	0.09	0.17	0.05	-0.07	-0.08	0.06	0.94	0.15	0.21	0.01	0.02	0.01	0.16	0.32	0.18	-0.06	0.24	-0.02	0.11	-0.01	0.25	-0.08	-0.02	-0.05	0.00		2.80
Slovenia	0.06	0.09	0.03	0.05	0.13	-0.01	0.26	0.05	0.03	0.28	0.16	0.27	0.07	0.05	0.03	0.24	0.09	0.08	0.02	0.02	0.10	0.12	-0.24	-0.07	0.07	0.05	0.09	-0.04	0.01	0.32	0.13	0.07	0.05	-0.01	0.00	2.65
Italy	0.04	0.03	0.01	0.01	0.03	0.00	0.03	0.02	0.03	0.09	0.07	0.06	0.00	0.02	0.05	0.10	0.09	0.16	0.00	0.00	0.02	0.21	0.19	-0.02	0.08	0.00	0.08	0.07	0.01	0.22	0.26	0.16	0.14	0.00	0.02	2.29
United States	0.02	0.01	0.00	0.01	0.03	0.02	0.03	0.01	0.01	0.00	0.10	0.28	0.04	0.06	0.06	0.27	0.21	0.01	0.02	0.02	0.01	0.17	0.14	0.29	0.03	-0.02	0.00	-0.09	0.01	0.26	0.02	-0.01	0.08	0.03	0.00	2.15
Luxembourg	-0.03	0.02		0.00	0.02		0.05	0.05	0.04	0.03	0.01	0.03	0.00	0.00	-0.07	0.32	0.15	0.17	0.00	0.05	0.01	0.13	0.12	0.40	-0.03	0.00	0.05	0.07	-0.04	0.33	0.12	0.06	0.04	0.01	0.00	2.12
Brazil	0.05	0.01	0.00	0.01	0.07	0.03	0.11	0.00	0.01	0.01	0.04	0.01	0.06	0.03	-0.02	0.12	0.13	-0.10	-0.02	-0.02	-0.05	0.02	0.19	0.03	0.43	0.07	0.15	0.01	0.08	0.30	-0.03	-0.09	0.01	0.04		1.69
United Kingdom	0.05	0.02	0.00	0.01	0.04	0.00	0.05	0.02	0.02	0.05	0.06	0.06	0.05	0.02	0.04	0.09	0.11	0.04	0.00	0.01	0.03	0.12	-0.16	0.28	0.01	-0.05	0.07	-0.03	0.02	0.15	0.01	-0.07	0.03	-0.03	0.00	1.13
Mexico	-0.12	-0.05	-0.01	0.00	-0.02	-0.02	-0.04	-0.01	-0.01	-0.02	0.00	-0.06	-0.02	-0.02	-0.01	-0.06	-0.08	-0.11	0.00	0.00	-0.01	0.10	-0.61	-0.42	-0.04	-0.34	0.06	-0.26	-0.11	0.18	-0.20	-0.21	-0.12	-0.05	-0.01	-2.70

Note: List of sectors: 15t16 Food, beverages and tobacco, 17t18 Textiles and garments,19 Leather and footwear, 20 Wood and cork, 21t22 Pulp, paper, printing and publishing, 23 Coke, refined petroleum and nuclear fuel, 24 Chemicals and chemical products, 25 Rubber and plastics, 26 Other non-metallic minerals, 27t28 Basic metals and fabricated metals, 29 Machinery, nec, 30t33 Electrical and optical equipment, 34t35 Transport equipment, 36t37 Manufacturing nec; recycling, 50 Sale, maintenance and repair of motor vehicles and motorcycles; retail sale of fuel, 51 Wholesale trade and commission trade, except of motor vehicles and motorcycles, 52 Retail trade, except of motor vehicles and motorcycles; repair of household goods, 60 Other inland transport, 6 Other water transport, 62 Other air transport, 63 Other supporting and auxiliary transport activities; activities of travel agencies, 64 Post and telecommunications, 70 Real estate activities, 71t74 Renting of machinery and equipment and other business activities, AtB Agriculture, hunting, forestry and fishing, C Mining and quarrying, E Electricity, gas and water supply, F Construction, H Hotels and restaurants, J Financial intermediation, L Public administration and defence; compulsory social security, M Education, N Health and social work, O Other community, social and personal services, P Private households with employed persons and TOT Total industries. Empty cells indicate unavailability of data. Sectors 50 (sale, maintenance and repair of motor vehicles and motorcycles and retail sale of fuel) and P (private households with employed persons) are missing from the Chinese accounts in the WIOD database.

Source: Authors' calculations based on the WIOD and OECD National Account databases.

Estimation of labour and total factor productivity at the sector level

17. Labour productivity is defined as value added per employee. The TFP estimation is based on a panel of 32 countries (including mostly OECD countries and the BRIICS, without South Africa) for 16 manufacturing and 19 service sectors classified according to the United Nations ISIC Rev. 3 system for the years 2000-11. The source of the data is the World Input Output Database (WIOD) and the OECD National Accounts database. The estimation follows the same method as OECD (2014).

18. The estimation is based on a standard Cobb-Douglas production function with technological coefficients α for physical capital and β for labour:

$$Y_{i,c,t} = A_{i,c,t}\,(K_{i,c,t})^{\alpha}(L_{i,c,t})^{\beta} \quad (1)$$

where Y, A, K and L are: real value added, total factor productivity, real capital stock and number of employees, respectively. Real values are calculated using country- and industry-specific price deflators (with the base year of 2002). The nominal data is converted into US dollars using year-average exchange rates from the WIOD database. Aggregate TFP for manufacturing and services is weighted by value added.

19. The capital stock is not directly available and is therefore constructed based on investment data using the perpetual inventory approach. The initial capital K_0 is defined as follows (country and industry subscripts are omitted):

$$K_0 = \frac{I_0}{g+\delta} \quad (2)$$

I_0 represents real gross fixed capital formation for a given industry in 1995, g the average growth rate of investment between 1995 and 2002 and δ the depreciation rate of physical capital (set to 8%).

20. Having determined the initial capital stock K_0, capital stock can be calculated for all subsequent years, as follows:

$$K_t = \ (1-\delta) * K_{t-1} + I_{t-1} \quad (3)$$

21. The following log-linearised production function is estimated for all sectors and countries at the same time (where smaller case letters stand for values in logarithmic form):

$$y_{i,c,t} = \ \alpha l_{i,c,t} + \beta k_{i,c,t} + \rho_c \ + \mu_i + \sigma_t + \varepsilon_{i,c,t} \quad (4)$$

22. The log-linearised TFP estimates are defined as follows:

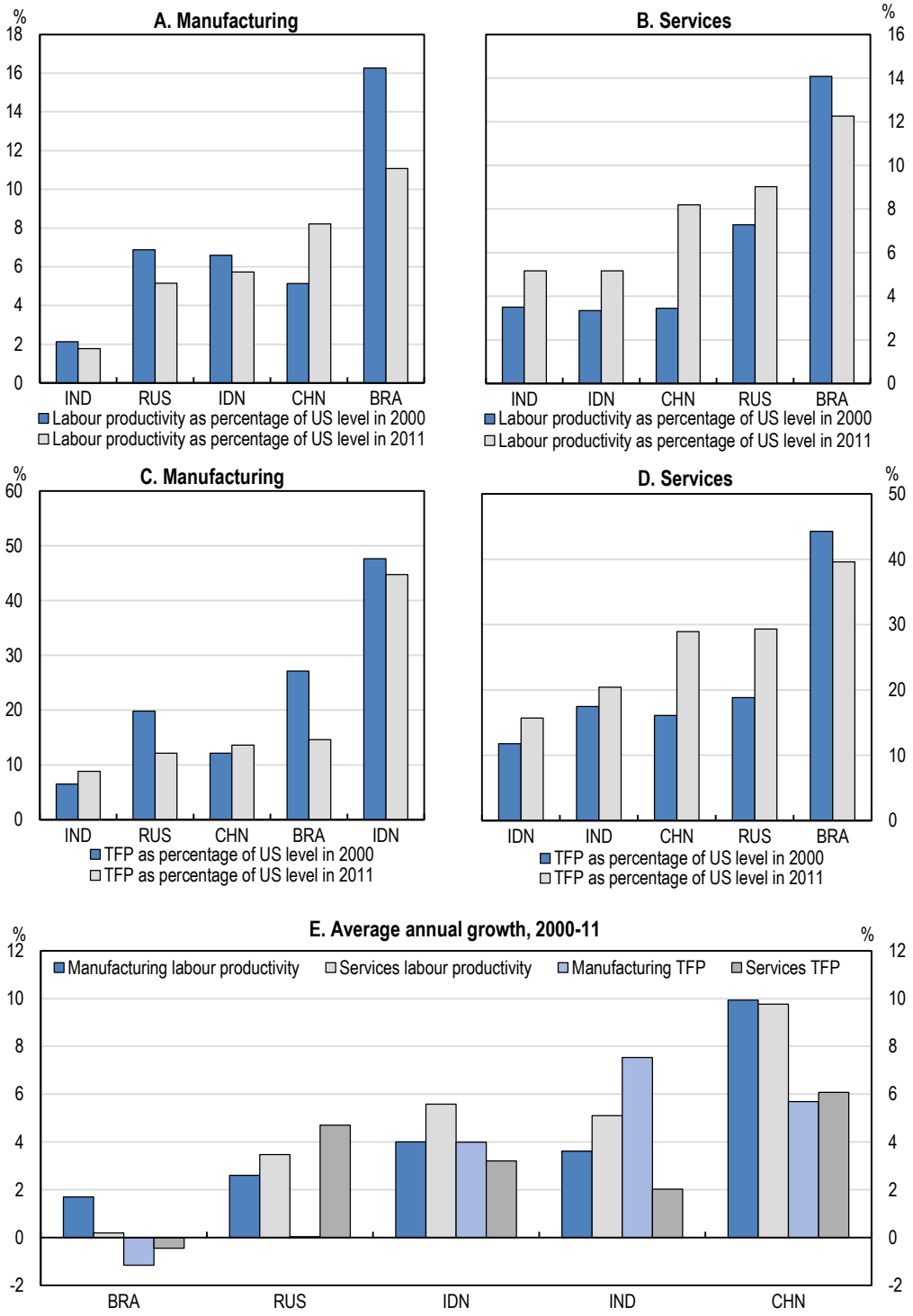
$$lTFP_{i,c,t} = \rho_c + \ \mu_i + \sigma_t + \varepsilon_{i,c,t} \quad (5)$$

where ρ_c stands for the country-specific technological factor, μ_i for the sector-specific technology factor which does not vary across countries, σ_t for the time-dependent factor constant across countries and sectors. $\varepsilon_{i,c,t}$ is the residual of the regression and varies across sectors, countries and time.

23. China fares relatively well in TFP and labour productivity levels, both in manufacturing and services compared with the other BRIICS economies, even though the gap with the United States is still sizeable (Figure 2.). Moreover, China's gap is wider than Brazil's both in labour and total factor productivity and both in manufacturing and services. The Russian Federation's gap is also slightly smaller than China's in services, though China has been catching up over the 2000s very rapidly. Indonesia fares best in manufacturing TFP, although its gap with the US increased over 2000-11. India is weak in manufacturing and its catching up is not impressive either (Joumard et al., 2014).

24. The estimation period in this study (2000-11) includes the global financial crisis, during which manufacturing industries were particularly hit. The inclusion of this period, however, does not appear to affect the results, which are similar to those obtained earlier for 2000-08 (OECD, 2014).

Figure 2. China's productivity gap with the United States is large but catching up is fast



Source: Authors' calculation using the WIOD and OECD National Accounts databases.

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