

Background Paper for Chapter 2 of UNIDO's Industrial Development Report 2020

Robotization, Employment, and Industrial Growth Intertwined across Global Value Chains

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Abstract

There is a general view that the global economy is currently facing a new wave of technological change that is based on new disruptive technologies (Industry 4.0), especially in but not limited to the realm of artificial intelligence, machine learning and robotics. A key concern in this context is the consequences of such new technologies on the labour market. This paper uses industrial multipurpose robots which can be interpreted as a link between the third and the fourth industrial revolutions. This paper provides a comprehensive analysis of the direct and indirect effects of industrial robots on various industrial indicators, including employment and real value added. The indirect effects capture both domestic and international linkages across the global value chains (GVCs) which are obtained from the World Input-Output Database (WIOD). This way, the paper adds to the existing empirical work on the relationship between technological change, employment and industrial growth by using industrial robots, while controlling for other technological advancements measured by total factor productivity (TFP). The analysis of the implications of robots for labour markets is integrated into the long-run distributed lag framework. Results indicate that the overall impact of installation of new robots is not statistically significantly affecting the growth of industrial employment during the period 2000-2014, while such an overall impact on real value added growth of industries in the world is positive and significant. The methodology also allows for the differentiation of impact of robots across various industries and countries via two different perspectives of source and destination industries across the GVCs.

Keywords: Industry 4.0; robotization; digitalization; global value chains; total factor productivity; industrial growth; employment; value added

JEL-classification: D57, J21, L16, O14

1. Introduction

There is a general view that the global economy is currently facing a new wave of technological change that is based on new disruptive technologies, especially in but not limited to the realm of artificial intelligence (AI), machine learning and robotics. Packed together under headings such as Industry 4.0¹, a general interpretation is that a whole range of new technologies is going to constitute an industrial revolution by fusing the physical, digital and biological worlds, impacting all disciplines, economies and industries (Schwab, 2017). This process is expected to revolutionize products and manufacturing processes impacting strongly on factors of production and the generation and distribution of value added across sectors. Recent successes in the field of artificial intelligence (AI), such as DeepMind's AlphaZero defeating the world's leading chess-playing computer programme after having taught itself how to play in less than four hours, has intensified the debate about the challenges and opportunities of the 'Robot Age'² and whether mankind can win the race against the machine (Brynjolfsson and McAfee, 2011).

A key concern in this context is the consequences of such new technologies on the labour market. The estimates for the expected job losses due to new machines based on the share of highly potentially automatable jobs range from 47% found by Frey and Osborne (2017) to less than 10% by OECD (Arntz et al., 2016) with time spans over which this might happen not being specified.^{3 4 5} In the longer run one can argue that technological change has historically created more jobs than it destroyed (thanks to the process of creative destruction à la Schumpeter)⁶.

However, given the potentially disruptive nature of the expected new technological paradigm to come and the 'fourth industrial revolution'⁷ associated with it, future developments are hard to extrapolate from past experiences. The vast amount of uncertainty about the future technological trajectory and its economic consequences in periods of ruptures pose a serious problem for researchers and policy makers. If, as it is commonly assumed, the world is actually at the advent of the fourth industrial revolution characterised by digitalisation, the economic implications of the numerous new technologies (see e.g.

¹ Industry 4.0 constituted a so-called *Project for the Future* of the German Government initiated in 2011 and developed into a platform in 2013. See: <https://www.bmbf.de/de/zukunftsprojekt-industrie-4-0-848.html>

² "AlphaZero AI beats champion chess program after teaching itself in four hours", *The Guardian*, 7 December 2017. <https://www.theguardian.com/technology/2017/dec/07/alphazero-google-deepmind-ai-beats-champion-program-teaching-itself-to-play-four-hours>.

³ "According to our estimate, 47% of total US employment is in the high risk category, meaning that associated occupations are potentially automatable over some unspecified number of years, perhaps a decade or two." (Frey and Osborne, 2017, p. 265)

⁴ The former result relates to a sample of 32 OECD countries whereas the latter is based on US economy.

⁵ WTO (2018) argues that these new technologies could further reduce trade costs and therefore could contribute to trade and growth in the years to come. In general, however, the impact of different technologies on trade is ambiguous as new production methods could also give rise to more localised production and/or lesser scope for economies of scale.

⁶ The worries about new technologies replacing jobs is actually an old one and can be traced back to the luddites in England of the early 19th century and in the economic literature to Keynes essay on the *Economic Possibilities for our Grandchildren* (Keynes, 1930).

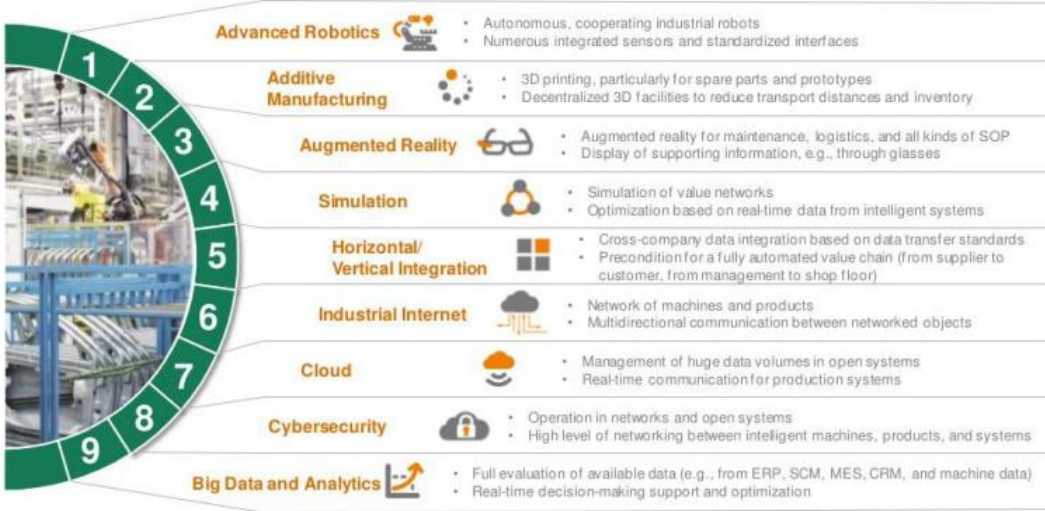
⁷ The previous industrial revolutions were the steam based industrial revolution in the early 19th century, the electricity based second industrial revolution at the end of the 19th and early 20th century and the third industrial revolution dated to the 1970s which brought about automation and digitalisation (PwC. 2016).

Figure 1) need not necessarily be the same as in the third technological wave which was based on automation.

The limited information value of past interconnections obviously poses a challenge for empirical analysis. This paper uses an indicator which can be interpreted as a link between the two industrial revolutions is one possibility to deal with this complication and the uncertainties involved. More precisely, data on the use of industrial multipurpose robots are applied in this paper⁸. Such robots have constituted a major part of the automation era but will also play an important role in the cyber-physical systems of the upcoming fourth industrial revolution. For this reason they are often subsumed under the key technologies for the emerging Industry 4.0 as shown in Figure 1.

Obviously, there is a broad range of other technologies which will shape the digital age, including additive manufacturing or big data analytics. All of these might affect labour markets and productivity by opening up new business opportunities and by replacing labour. However, since the impact of these technologies will be felt mainly in the future (or have just began to show some effects), they are difficult to be dealt with in an analytical study such as this one. Therefore the focus is put on industrial robots which have been in operation for several years.

Figure 1: Key technologies for embracing Industry 4.0



Note: SOP= Standard Operating Procedure; ERP= Enterprise Resource Planning; SCM=Supply Chain Management; MES=Manufacturing Execution System; CRM=Customer Relationship Management.
 Source: Boston Consulting Group (2016).

⁸ The disadvantage of limiting the analysis of employment effects to industrial robots as one particular technology is that only a partial probably biased, picture will emerge. It may be biased because other technologies may impact on entirely different industries in various directions and via different channels.

The expansion of value added of a given sector could indirectly influence the employment in another sector through backward or forward linkages. For instance, a service activity might never use any industrial robots and hence there will not be any direct effect from industrial multipurpose robots. However, using industrial robots in the manufacturing of computer, electronic and optics could result in productivity gains in this manufacturing sector that translates into higher quality and least expensive products. Better products from this manufacturing sector will be then used in many other sectors for example in construction services sector or in any other services activities not using robots. These more efficient intermediate inputs of production might lead to higher productivity gains in the using service sector that might eventually end up in its more employment.

This paper provides a comprehensive analysis of the direct and indirect effects of industrial robots on various macro-economic indicators, including employment and real value added. The indirect effects captured both domestic and international linkages which are obtained from inter-country input-output tables. This way, the paper adds to the existing empirical work on the relationship between technological change, employment and industrial growth by using industrial robots, pioneered by Graetz and Michaels (2018), Abeliansky and Prettnner (2017) and later Acemoglu and Restrepo (2018).

The analysis of the implications of robots for labour markets is integrated into the long-run distributed lag framework developed by Autor and Salomons (2018) (henceforth AS). Most importantly, and in contrast to most of the literature, this paper focuses on emerging and transition economies. In addition, it extends the AS framework by including the effects of international input-output linkages in the analysis, which in AS are limited to the domestic economy linkages.

The reminder of this paper is structured as follows. Section 2 provides a brief overview of the related literature. Section 3 presents some descriptive evidence on the use of industrial robots and its main implications. Section 4 explains the econometric model and data sources followed by the estimation results which are summarised in Section 5. Section 6 concludes.

2. Literature Review

The analysis of technological progress and its influence on labour market outcomes such as employment (hours), wages and wage inequality is recently attracting more and more attention. Whereas the already cited seminal study by Frey and Osborne (2017) find that almost half of current US employment is at risk of being ‘computerised’, the estimates provide by Arntz et al. (2016) are much more conservative: Rather than looking at whole occupations, they evaluate the potential automatibility of tasks within an occupation. In contrast to the findings by Frey and Osborne (2017), they conclude that only about 9% of jobs are currently automatable. They stress, in addition, that jobs of low-skilled workers are still more susceptible to automation than high-skilled workers. Based on that Nedelkoska and Quintini (2018)

expand the coverage of countries and occupational titles and calculate that about 14% of jobs in OECD countries face the risk of being ‘highly automatable’, defined as the risk of automation being above 70%.

In a model where technological progress replaces labour input but increases capital requirements, Zeira (1998) shows that only already highly productive countries will employ these labour-saving innovations, which, in turn, reinforce existing income differences among countries. Technical change can thus explain why income differences between countries persist.

Sachs and Kotlikoff (2012), Benzell et al. (2015) and Sachs, Benzell and LaGarda (2015) assume in their models that robots are not to assist humans in their work, but to replace them entirely. They come to the conclusion that the introduction of robots will boost productivity in the short run, but decrease wages and consumption in the long run. Sachs and Kotlikoff (2012), assuming that “smart machines” replace young and unskilled but favour old and skilled labour, find that only a generational (redistribution) policy is able to make the introduction of robots a profitable scenario for both generations. Similarly, Sachs, Benzell and LaGarda (2015) argue for government redistribution in this scenario to counter the “immiserization” of future generations. Autor (2015) responds to these warnings by stating that in these models “the fundamental threat is not technology per se but misgovernance”⁹: It is not a problem of scarcity of jobs, but rather a distributional problem (should robots indeed make human labour unnecessary). He argues that an appropriate capital tax can help to make technological progress a welfare-improving process for all groups of workers.

The skill premia (the relative wage of high-skilled workers to low-skilled workers) rose over most of the second half of the last century, *despite* large increases in the supply of high-skilled workers. The conclusion was that there must have been something like a ‘skill-biased technical change’ which increased the demand for high-skilled workers even more. Berman et al. (1998) were among the first to study the sources of the steadily increasing skill premia. In a similar vein, Krusell et al. (2000) model an economy with a complementarity between a type of capital and high-skilled workers. The type of capital they have in mind is Information and Communication Technology (ICT) capital. Krusell et al. (2000) document that the price of ICT capital has been falling for several years. Thus, given such a capital-skill complementarity, a fall in the price of ICT capital will lead to an increased adoption in firms and subsequently to an increased demand for high-skilled workers to operate these machines. Michaels, Natraj, and Van Reenen (2014) confirm these findings with newer data: Sectors with higher growth in ICT also had higher increases in the demand for high-skilled workers and decreases in the demand for middle-skilled workers. Spitz-Oener (2006) finds that job requirements have been increasing in the same time, i.e. the proportion of complex tasks has been increasing. These changes in the task structure have further raised the demand for skills in the labour market. Dao et al. (2017) find that industrial sectors which are specialised in routine activities tended to experience larger decreases in the labour share.

⁹ See Autor (2015), p. 8.

Graetz and Michaels (2018) employ available data on robot use to estimate the effects on labour productivity growth, total factor productivity growth, output prices and employment. Their findings indicate that robots increase labour productivity growth and total productivity growth but tend to decrease output prices. While there seems to be no effect of robots usage and total employment, they find a negative impact of robots on the employment share of low-skilled workers.

A recent report by the EBRD, EBRD (2018), finds similar results for emerging economies: On the whole economy, ‘robotisation’ shows only a small negative effect on employment. Workers with low levels of education are, however, disproportionately more affected by the adoption of robots.

In another study, Acemoglu and Restrepo (2017) focus on US local labour markets. They combine data from EU KLEMS and robot use to track the effects of increased exposure to robots on local labour markets from 1970 to 2007. As Graetz and Michaels (2018), they find that the adoption of robots leads to large and robust declines in employment and wages.

The main reference point for this study is Autor and Salomons (2018). They estimate the effect of technological progress (they prefer the term ‘automation’) on employment. Their work includes a systematic treatment of four different channels of how technological progress can affect the labour market: own-industry effects, between-industry cross-country effects and final demand effects. In their framework they quantify all these channels and come to the conclusion that total factor productivity (their proxy for technological progress) has negative direct effects on employment but positive indirect effects. In sum, the positive effects dominate such that the overall effect of technological progress on employment is positive. In our study, we aim to combine the estimation framework of Autor and Salomons (2018) with the ideas of Graetz and Michaels (2018) and Acemoglu and Restrepo (2017). This will allow us to shed light on the overall (direct and indirect) effects of robot usage in industries on employment and wages in the economy.

3. Data and selected descriptive evidence

In this section we shortly describe the data sources for this exercise and provide some descriptive evidence with respect to the use of robots by country groups and industries as well as sectoral developments.

3.1 Data

The econometric model draws on two major data sources. The first one is the 2016 version of the World Input-Output Database (WIOD) (Timmer et al., 2015) including data from accompanying Socio-

Economic Accounts (SEA)¹⁰. The second is the stocks of industrial multipurpose robots database collected from the International Federation of Robotics (IFR, 2018)¹¹.

The data from the World Input-Output Database (WIOD) covers information for 43 countries and a Rest of the World with a detailed industry structure comprising 56 industries¹² over the period 2000-2014. These are used to calculate growth rates of value added and employment by industry and country and domestic and international forward and backward linkages used in the econometric exercise. Further, investment data are used to calculate capital stocks at the country-industry level using the PIM method. This then allows to use employment (EMP), nominal labour income (W), real capital stocks (K) and (real as well as nominal) value added (VA) and calculate total factor productivity given by

$$\Delta \ln TFP_{cit} = \Delta \ln VA_{cit}^{real} - \left(\frac{W_{cit}}{VA_{cit}^{nominal}} * \Delta \ln EMP_{cit} \right) - \left(\left(1 - \frac{W_{cit}}{VA_{cit}^{nominal}} \right) * \Delta \ln K_{cit}^{real} \right) \quad (1)$$

The IFR database provides data on industrial robots by industry for all major countries in the world. The term ‘industrial robot’ follows the definition of the International Organization for Standardization which denotes an “*automatically controlled, reprogrammable multipurpose manipulator programmable in three or more axes*” (IFR, p. 29). The two key variables reported in the database are the number of robots newly installed in a year and the operational stock of robots which measures the number of robots currently deployed (IFR, 2018, p.28).¹³

As the IFR data provides data for more aggregated industries as compared to WIOD, the latter are adjusted to match the industry structure of the IFR database. For this, the WIOD-SEA data are converted into US dollars using the yearly-averaged USD in local currencies obtained from the World Development Indicator (WDI) of the World Bank augmented by the Penn World Table (Feenstra et al., 2015).

In the analysis the countries covered in the WIOD are separated into four categories (listed in Appendix Table 10): advanced economies (corresponding to the sample used in Autor and Salomons, 2018), emerging economies, transition economies (comprising in our case only Bulgaria, Romania and Russia), and the remaining countries (including the Central and Eastern European economies).

3.2 Use of robots

The use and impact of such new technologies (proxied by the number of robots) differ across countries and industries. The advanced economies have been forerunners in using industrial robots. As Figure 2

¹⁰ Data available at: <http://www.wiod.org/database/wiots16>

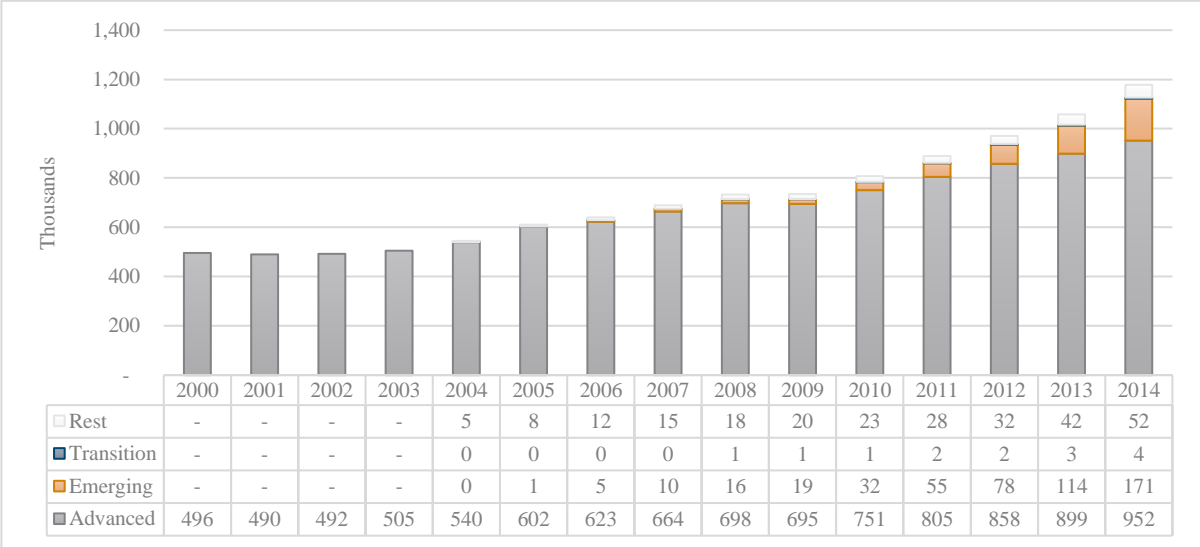
¹¹ See: <https://ifr.org/worldrobotics>

¹² The industry structure is based on the NACE Rev. 2 industry classification and the SNA2008/ESA2010 methodology

¹³ In this report the term ‘stock’ is used which indicates the number of industrial robots.

depicts, around half million industrial robots were installed and used in production of manufacturing, agriculture, mining, and some services activities in advanced economies in 2000, while information on the stocks of robots in other parts of the world was not registered until 2004. Then, from 2000 to 2014, investment in stocks of robots more than doubled so that in 2014 above 950 thousands robots were installed in advanced economies, 170 thousands in emerging economies, below 4000 in transition economies, and above 52 thousands in the remaining countries.

Figure 2 – Stocks of industrial robots by country groups in thousands – 2000-2014



Source: International Federation of Robotics, authors’ calculations

Table 1 reports the average annual growth rate of the stocks of multipurpose industrial robots by country group and industry. The largest growth in stocks took place in manufacture of rubber and plastic products (C22) with average annual growth rate of 103% in the world, 101% in advanced economies, 104% in emerging economies, 45% in transition economies, and 57% in the rest of countries. The second largest growth in stocks of robots is in the high-tech sector manufacture of basic pharmaceutical products and pharmaceutical preparations (C21) with 70% average annual growth rate. The third fastest growing sector in stocks of industrial robots is manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products (C19t20) with the world average annual growth rate of 38%.¹⁴

The fastest growing sector in stocks of robots in emerging economies is observed for manufacture of rubber and plastic products (C22) with 104.6%; the second industry with a high growth of robots is manufacture of motor vehicles, trailers and semi-trailers (C29) with growth rate of 103. The third largest growth in stocks of robots in emerging markets is in manufacture of electrical equipment (C27) with the rate of 90%. For the transition economies the sectors with high growth of the installment of robots were motor vehicles, trailers and semi-trailers (C29) at a rate of 59%, manufacture of rubber and plastic

¹⁴ One should be aware, however, that these high growth rates partly result from low starting levels.

products (C22) with an average annual rate of 45%, and manufacture of fabricated metal products, except machinery and equipment (C25) with a growth rate of 42.6%.

Table 1 – Average annual weighted growth of stocks of industrial robots, 2000-2014

Industry	Industry Description	World	Advanced	Emerging	Transition	Other
A	Agriculture	10.2%	8.9%	29.1%	17.7%	24.2%
B	Mining and quarrying	23.5%	23.0%	16.0%		13.9%
C10t12	Manufacture of food products, beverages and tobacco	16.1%	14.7%	54.9%	34.9%	50.2%
C13t15	Manufacture of textiles, wearing apparel and leather products	6.9%	-2.0%	39.5%	5.0%	53.2%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	-1.7%	-2.9%	30.6%	21.5%	41.4%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	4.2%	3.6%	39.0%	9.9%	31.1%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	38.1%	31.1%	42.4%		30.2%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	70.0%	69.6%	44.0%	18.4%	40.6%
C22	Manufacture of rubber and plastic products	103.2%	101.4%	104.6%	44.7%	57.4%
C23	Manufacture of other non-metallic mineral products	5.9%	4.1%	55.8%	31.2%	39.1%
C24	Manufacture of basic metals	23.6%	21.8%	55.9%	25.5%	48.2%
C25	Manufacture of fabricated metal products, except machinery and equipment	16.7%	14.6%	70.1%	42.6%	61.0%
C26	Manufacture of computer, electronic and optics	13.5%	11.5%	84.1%	22.9%	67.1%
C27	Manufacture of electrical equipment	4.8%	0.5%	89.8%	24.6%	60.9%
C28	Manufacture of machinery and equipment n.e.c.	4.8%	3.3%	70.7%	30.4%	51.7%
C29	Manufacture of motor vehicles, trailers and semi-trailers	12.2%	9.7%	103.1%	58.6%	72.1%
C30	Manufacture of other transport equipment	-1.8%	-5.0%	55.7%	31.2%	47.0%
C32	Manufacture of furniture; other manufacturing	1.1%	0.1%	61.6%	36.3%	46.0%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	4.9%	0.9%	34.0%	9.9%	29.4%
F	Construction	9.0%	7.3%	42.1%	26.2%	31.1%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	4.0%	1.1%	40.6%	30.4%	43.4%

The group of remaining countries (mostly covering the Central Eastern Europe) also experienced the fastest growing stocks of industrial robots with the average annual rate of 72% in manufacture of motor vehicles, trailers and semi-trailers (C29) and manufacture of computer, electronic and optics (C26) in these countries experienced growth rate of 67% in stocks of industrial robots.

3.3 Growth of main variables

The main question is how the use of robots has impacted on growth performance of industries and countries. To give some indication the next two tables show average growth rates of employment and real value added.

Specifically, Table 2 presents the average annual growth of persons employed in different industries and groups of countries. The general pattern is that for the world as a whole employment has been growing in almost all industries at rates up to almost 8%. However, for the advanced and transition economies (Bulgaria, Romania and Russia) one finds mostly negative growth rates in the manufacturing industries which is not the case in the emerging and the remaining economies. Growth of employment in the services industries has been mostly positive in all country groups.

Table 2 – Average annual weighted growth of industrial employment in %, 2000-2014

Industry	Industry Description	World	Advanced	Emerging	Transition	Rest
A	Agriculture	-0.7%	-1.5%	-0.6%	-3.4%	-3.4%
B	Mining and quarrying	2.6%	2.8%	2.8%	-0.3%	-1.1%
C10t12	Manufacture of food products, beverages and tobacco	1.5%	-0.3%	2.1%	-2.0%	0.2%
C13t15	Manufacture of textiles, wearing apparel and leather products	2.3%	-4.6%	3.1%	-2.3%	-4.8%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	4.2%	-2.7%	5.2%	-1.7%	-0.6%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.9%	-2.7%	2.6%	0.4%	0.5%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	2.1%	-1.3%	3.3%	-1.7%	0.6%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	2.5%	0.0%	3.4%	-0.8%	2.8%
C22	Manufacture of rubber and plastic products	2.2%	-1.3%	3.2%	1.8%	1.5%
C23	Manufacture of other non-metallic mineral products	2.1%	-2.3%	2.8%	-0.9%	0.2%
C24	Manufacture of basic metals	1.6%	-0.8%	2.2%	1.0%	0.3%
C25	Manufacture of fabricated metal products, except machinery and equipment	1.6%	-1.0%	3.0%	-0.5%	1.7%
C26	Manufacture of computer, electronic and optics	3.2%	-2.0%	5.8%	-2.0%	2.9%
C27	Manufacture of electrical equipment	4.4%	-1.9%	6.3%	1.0%	1.4%
C28	Manufacture of machinery and equipment n.e.c.	2.5%	-0.5%	3.9%	-3.0%	1.7%
C29	Manufacture of motor vehicles, trailers and semi-trailers	3.1%	-1.5%	6.7%	-2.6%	3.9%
C30	Manufacture of other transport equipment	3.5%	0.8%	6.3%	-1.9%	-0.3%
C32	Manufacture of furniture; other manufacturing	3.0%	-2.1%	4.1%	-2.8%	0.8%
C33	Repair and installation of machinery and equipment	1.3%	1.1%	-0.2%	3.0%	1.8%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	1.4%	0.7%	2.5%	-1.6%	2.2%
F	Construction	3.7%	-0.6%	5.0%	2.0%	0.9%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	2.0%	0.0%	2.8%	7.4%	1.9%
G46	Wholesale trade, except of motor vehicles and motorcycles	3.6%	0.0%	4.4%	2.4%	1.5%
G47	Retail trade, except of motor vehicles and motorcycles	2.6%	0.2%	4.1%	3.1%	0.8%
H49	Land transport and transport via pipelines	2.5%	0.3%	3.3%	0.2%	0.3%
H50	Water transport	-1.2%	0.0%	-1.4%	-2.4%	5.4%
H51	Air transport	0.2%	-1.2%	0.8%	-6.2%	3.6%
H52	Warehousing and support activities for transportation	4.2%	1.8%	6.4%	3.3%	3.1%
H53	Postal and courier activities	0.3%	-0.6%	2.3%	2.9%	1.2%
I	Accommodation and food service activities	3.3%	1.2%	4.9%	1.5%	1.2%
J58	Publishing activities	0.5%	-0.4%	5.6%	9.1%	1.2%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	2.4%	1.3%	7.5%	0.1%	2.1%
J61	Telecommunications	3.9%	-1.9%	6.1%	0.1%	1.2%
J62-J63	Computer programming, consultancy and related activities; information service activities	6.0%	2.4%	10.2%	9.0%	7.1%
K64	Financial service activities, except insurance and pension funding	5.6%	-0.3%	9.3%	3.9%	1.4%
K65	Insurance, pension funding, except compulsory social security	2.3%	-0.3%	8.3%	10.3%	1.9%
K66	Activities auxiliary to financial services and insurance activities	1.4%	1.2%	3.7%	-2.5%	3.0%
L68	Real estate activities	7.8%	1.0%	10.2%	0.3%	2.2%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	4.1%	2.0%	6.8%	3.9%	4.3%
M71	Architectural and engineering; technical testing and analysis	3.3%	1.9%	7.0%	1.5%	1.2%
M73	Advertising and market research	1.1%	1.0%		-2.3%	2.4%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	2.8%	1.7%	3.5%	-0.2%	1.4%
N	Administrative and support service activities	2.6%	1.3%	6.8%	3.9%	4.2%
O84	Public administration and defence; compulsory social security	3.1%	0.3%	5.4%	1.4%	0.9%
Q	Human health and social work activities	3.0%	2.3%	4.3%	0.5%	2.4%
R-S	Other service activities	2.8%	0.9%	3.4%	0.1%	2.0%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	1.1%	1.1%	1.1%		1.4%
U	Activities of extraterritorial organizations and bodies	1.2%		1.2%		

Source: WIOD; own calculations.

Table 3 – Average annual weighted growth of industrial real value added in %, 2000-2014

Industry	Industry Description	World	Advanced	Emerging	Transition	Rest
A	Agriculture	2.1%	1.5%	2.2%	0.9%	0.5%
B	Mining and quarrying	2.1%	2.0%	3.2%	2.9%	-3.0%
C10t12	Manufacture of food products, beverages and tobacco	3.3%	0.0%	8.8%	2.6%	1.6%
C13t15	Manufacture of textiles, wearing apparel and leather products	4.1%	-3.5%	8.3%	0.6%	-1.9%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	4.5%	-1.4%	11.7%	4.3%	1.8%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	1.2%	-1.3%	8.4%	4.5%	1.8%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	2.1%	0.1%	5.9%	3.6%	2.0%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	4.3%	2.4%	8.9%	2.8%	6.7%
C22	Manufacture of rubber and plastic products	2.4%	-0.5%	9.1%	8.5%	3.4%
C23	Manufacture of other non-metallic mineral products	4.9%	-0.8%	10.8%	4.1%	4.1%
C24	Manufacture of basic metals	3.3%	-0.6%	6.7%	4.2%	2.1%
C25	Manufacture of fabricated metal products, except machinery and equipment	1.4%	-1.3%	9.5%	6.2%	2.9%
C26	Manufacture of computer, electronic and optics	11.3%	8.1%	21.4%	2.2%	11.2%
C27	Manufacture of electrical equipment	6.3%	2.5%	12.6%	5.8%	4.4%
C28	Manufacture of machinery and equipment n.e.c.	5.3%	1.6%	11.8%	3.5%	4.1%
C29	Manufacture of motor vehicles, trailers and semi-trailers	6.7%	2.7%	13.2%	1.0%	8.9%
C30	Manufacture of other transport equipment	5.3%	2.3%	17.8%	1.1%	3.0%
C32	Manufacture of furniture; other manufacturing	1.7%	-0.5%	5.2%	-1.8%	2.9%
C33	Repair and installation of machinery and equipment	2.0%	0.0%	8.1%	-0.4%	0.9%
DIE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	1.1%	-0.8%	5.4%	4.3%	1.6%
F	Construction	0.5%	-1.2%	4.2%	9.5%	4.7%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	3.3%	0.9%	7.8%	6.7%	3.8%
G46	Wholesale trade, except of motor vehicles and motorcycles	2.9%	1.5%	5.9%	5.3%	2.3%
G47	Retail trade, except of motor vehicles and motorcycles	2.7%	0.7%	6.2%	1.4%	0.8%
H49	Land transport and transport via pipelines	2.2%	3.8%	4.2%	-2.6%	0.2%
H50	Water transport	1.6%	0.1%	6.0%	2.8%	3.8%
H51	Air transport	4.2%	3.1%	8.9%	4.6%	3.1%
H52	Warehousing and support activities for transportation	0.1%	-0.9%	6.5%	1.7%	1.1%
H53	Postal and courier activities	1.8%	0.6%	6.1%	3.8%	0.8%
I	Accommodation and food service activities	2.1%	2.2%	2.8%	23.4%	0.4%
J58	Publishing activities	3.5%	3.5%	6.8%	7.1%	1.9%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	5.7%	4.0%	10.8%	7.4%	4.9%
J61	Telecommunications	5.3%	4.4%	10.7%	9.4%	4.7%
J62-J63	Computer programming, consultancy and related activities; information service activities	4.3%	1.6%	8.5%	13.2%	2.3%
K64	Financial service activities, except insurance and pension funding	2.0%	1.1%	9.1%	4.7%	3.6%
K65	Insurance, pension funding, except compulsory social security	3.2%	1.9%	7.7%	7.4%	3.7%
K66	Activities auxiliary to financial services and insurance activities	2.8%	2.2%	5.8%	6.2%	1.3%
L68	Real estate activities	1.8%	1.1%	4.5%	13.5%	3.1%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	2.2%	1.7%	6.9%	8.6%	2.3%
M71	Architectural and engineering; technical testing and analysis	1.4%	1.2%		13.1%	3.4%
M73	Advertising and market research	2.1%	1.2%	4.6%	0.1%	0.8%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	3.1%	2.8%	2.6%	2.1%	4.9%
N	Administrative and support service activities	1.3%	0.9%	4.2%	-2.2%	1.0%
O84	Public administration and defence; compulsory social security	2.6%	2.3%	2.7%	0.4%	3.1%
Q	Human health and social work activities	1.7%	0.6%	4.3%	0.1%	2.9%
R-S	Other service activities	5.0%	3.7%	7.4%		2.7%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	-0.2%		-0.2%		
U	Activities of extraterritorial organizations and bodies	2.1%	1.5%	2.2%	0.9%	0.5%

Source: WIOD; own calculations.

Table 3 reports growth rates of real value added by industry and groups of countries. Generally real value added was growing in all industries and all country groups, with a few exceptions only. Growth rates in the emerging economies have been particularly high. The fastest growing industry in the sample is manufacture of computer, electronic and optics (C26), a very high-technology sector, with an average annual growth of 11.3%. The second fastest growing sector in the world is manufacture of motor vehicles, trailers and semi-trailers (C29) with an average annual real growth rate of 6.7%. Again emerging markets grew the fastest in this sector with an average annual rate of 13.2%, and the rest of the world category followed by 8.9%. Manufacture of electrical equipment (C27) is another technological advanced sector that enjoyed the third fastest average annual growth rate of 6.3%. Again emerging economies are the fastest growing group of countries in the sector with an average annual growth rate of 12.6%.

In the following a framework is presented to examine the impacts of robots and the growth of TFP on these variables (growth of employment and real value added) and other related indicators (growth of hours worked, growth of nominal value added and the share of labour income in value added).

4 Methodology

This paper applies and adapts the econometric framework based on Autor and Salomons (2018) (henceforth AS) to investigate the impact of the changes in the stocks of industrial multipurpose robots and TFP growth on important indicators at the industry level based on the data described in Section 3.

4.1 Econometric model

The applied econometric model draws on the framework developed by AS which uses total factor productivity (TFP) growth as a catch-all proxy for automation and technological progress. Apart from being readily available for a sufficient number of advanced countries, the advantage of the TFP measure is that it is theoretically akin to and empirically strongly related to technological change. The downside to it is that TFP is a residual value, derived as the difference between changes in factor inputs and the change in output. Hence, it is unclear what the residual actually captures and it is only relatively loosely related to the introduction of new technologies or a new industrial revolution.

A particularly interesting feature of the AS framework is that it does not only capture the direct effect of TFP growth but also takes into account backward and forward linkages. This is important because if an industry becomes more productive, e.g. by automating a particular sequence of the production process, this might also benefit downstream industries in the form of lower prices (resulting in positive forward linkages). Likewise suppliers in upstream industries might benefit if the productivity rise in the

automated industry leads to an expansion of that industry and as a consequence higher demand for inputs from the upstream sector (resulting in positive backward linkages). Since the time-lags of all potential impacts of technological progress is uncertain, the AS model includes in addition to the contemporaneous value of TFP growth, up to five lagged values. The overall impact is calculated as the sum of the estimated contemporaneous and lagged effects.

This paper extends the AS model in three important ways. First, the focus of the analysis is extended to emerging and transition countries, while AS was focusing on several advanced economies. Therefore, in order to ensure a cross-country variation that can be econometrically generalized to the world economy, our model includes emerging and transition economies along advanced economies as available from the WIOD (see Table 10).

Second, this paper uses the change in the stock of industrial robots (R) at the country-industry level as another proxy for technological change in addition to TFP growth. As mentioned in the introduction, industrial robots are considered as a very narrow measure for technological change. Nevertheless, in comparison to TFP growth (which is the indicator used by AS), robots are more closely related to the introduction of disruptive technologies related to Industry 4.0.

Third, the econometric model allows for an open-economy setting in the sense that the indirect effects of industrial robots on labour market outcomes and value added also include linkages to industries of foreign countries along the GVC¹⁵. Therefore, also international linkages (indicated by a superscript *int*) in addition to the domestic linkages (indicated by a superscript *dom*) are taken into account.

Following the framework of AS, the model includes contemporaneous effects of robots but also lagged effects. However, with respect to the time dimension of the WIOD data the lags are limited to three periods¹⁶. The entire model is specified in logarithmic forms, including the linkages terms, so that for the outcome variables on the left hand side, growth rates are obtained as the difference in logs.

The baseline specification of the econometric model takes the following form:

$$\begin{aligned} \Delta \ln Y_{cit} = & \beta_0 + \sum_{k=0}^3 \beta_1^k \Delta \ln R_{ci,t-k} + \sum_{k=0}^3 \beta_2^k \Delta \ln R_{ci,t-k}^{dom-BW} + \sum_{k=0}^3 \beta_3^k \Delta \ln R_{ci,t-k}^{dom-FW} \\ & + \sum_{k=0}^3 \beta_4^k \Delta \ln R_{ci,t-k}^{int-BW} + \sum_{k=0}^3 \beta_5^k \Delta \ln R_{ci,t-k}^{int-FW} + \mu_{ct} + \mu_i + \varepsilon_{ict}, \end{aligned} \quad (2)$$

$$Y \in \{EMP, HEMP, LSH, VA^{real}, VA^{nominal}\}$$

¹⁵ See Nishioka and Ripoll (2012) for a similar approach studying R&D spillovers.

¹⁶ This is shorter than the 5 year lags used in AS which is due to the much shorter sample period available for this exercise.

where $\Delta \ln Y_{cit}$ is the log growth of the dependent variable of interest in industry i in country c at time t that could be either employment (EMP) growth, growth of hours worked ($HEMP$), labour share in value added (LSH) growth, real valued added (VA^{real}) growth, and nominal value added ($VA^{nominal}$) growth.

There are five sets of explanatory variables: $\Delta \ln R_{cit}$ indicates the growth of stocks of industrial multipurpose robots in country c and in industry i at time t . The time lags are indexed by k which runs from 0 to 3 with $k = 0$ being the contemporaneous value of the variable.

There are four other variables that are indicators of stocks of robots along the backward and forwards linkages, both in domestic and in international economies. $\Delta \ln R_{cit}^{dom-BW}$ is the accumulated growth in stocks of robots along the domestic backward linkages (i.e. suppliers) to industry i in country c at time t excluding the own industry i 's contribution. $\Delta \ln R_{cit}^{dom-FW}$ is the accumulated growth in stocks of robots along the domestic forward (i.e. customers) linkages to industry i in country c at time t excluding the own industry i 's contribution. $\Delta \ln R_{cit}^{int-BW}$ is the accumulated growth in stocks of robots along the international backward linkages to industry i in country c at time t excluding the own country c 's contribution. $\Delta \ln R_{cit}^{int-FW}$ is the accumulated growth in stocks of robots along the international forward linkages to industry i in country c at time t excluding the own country c 's contribution. Given that 3 lagged values are included, each set of these explanatory variables includes 4 four terms. The estimated coefficients of each of these sets are added together to give the estimated effect of the variable in equation (2). The statistical significance of the summed effect of the contemporaneous and lags of each explanatory variable is based on the F-test for the joint significance of the 4 estimates.

The definition of the domestic backward ($\Delta \ln R_{cit}^{dom-BW}$) and forward linkages ($\Delta \ln R_{cit}^{dom-FW}$) makes use of standard input-output methodology to define the relevant production linkages. In essence it is a weighted average of the log-change in robots in the downstream and upstream industries, respectively. The weights reflect the domestic direct and indirect production linkages as recorded in the inter-country input-output tables. That is, the submatrix of the global Leontief Inverse and the submatrix of the global Ghosh Inverse respectively that corresponds to the inter-industry linkages within the domestic economy of each country. Hence, the weights are the 'domestic' input-output coefficients of the Leontief Inverse (with typical element $l_{j,i}$) in the case of backward linkages¹⁷ and the coefficient of the Ghosh Inverse (with typical element $g_{i,j}$) in the case of the forward linkages. This yields the following definition of the domestic linkages

¹⁷ In the context of all linkages terms the *first* industry index indicates the *selling* industry and the *second* index indicates the *buying* industry following the convention in input-output modelling. In the case of the backward linkages the usual labelling of indices in the input-output literature is reversed in order to stick to the general notation that i indicates the industry under consideration.

$$\begin{aligned}
\Delta \ln R_{c,i,t}^{dom-BW} &= \sum_{j(j \neq i)}^J l_{(cj,ci),t} \times \Delta \ln R_{c,j,t} \\
\Delta \ln R_{c,i,t}^{dom-FW} &= \sum_{j(j \neq i)}^J g_{(ci,cj),t} \times \Delta \ln R_{c,j,t}
\end{aligned} \tag{3}$$

The subscript $j \neq i$ in the coefficient of the Leontief and Ghosh coefficient indicates that the linkages term excludes the within-industry linkages for a given industry i as mentioned above, where J denotes the total number of industries.

The international production linkages are defined analogously, only that in this case both the intra-industry and cross-country linkages within the GVCs are included as these do not constitute within-industry linkages in the same country. Assigning the index f to the foreign countries with which the international linkages are established and with the total number of countries F they are defined as follows:

$$\begin{aligned}
\Delta \ln R_{c,i,t}^{int-BW} &= \sum_{j=1}^J \sum_{f(f \neq c)}^F l_{(fj,ci),t} \times \Delta \ln R_{f,j,t} \\
\Delta \ln R_{c,i,t}^{int-FW} &= \sum_{j=1}^J \sum_{f(f \neq c)}^F g_{(ci,fj),t} \times \Delta \ln R_{f,j,t}
\end{aligned} \tag{4}$$

The term $\Delta \ln R_{f,j,t}$ indicates the log-change in the stock of robots in industry j of a foreign country f in year t . The typical element of the Leontief inverse, $l_{(fj,ci),t}$, indicates the purchases of industry i in country c from foreign country f 's industry j at time t . Note that here the purchases of industry i in country c from all foreign industry i 's are included¹⁸. Likewise, the typical element of the Ghosh inverse, $g_{(ci,fj),t}$ indicates the sales of industry i in country c to foreign country f 's industry j at time t .

In equation (2), we include country-time- μ_{ct} and industry- μ_i fixed Effects (FE). While the latter controls for global technological progress within each industry, the former controls for macro business cycles in each country. Therefore, the remaining impacts estimated by β parameters in equation (2) are mainly the changes within industry-country pair variables over time. Note that this is a more detailed control for fixed effects than in AS which used broader aggregation of sectors than the latter FE. Therefore, this model reduces the endogeneity due to omitted variable bias to the minimum possible. ε_{ict} denotes the error term. In order to control for heteroscedasticity in the structure of error term, error terms are clustered by each country-industry pairs μ_{ci} , which controls for the shocks in the dependant variable of each country-industry pair over time that are not due to the explanatory variables.

¹⁸ The reason is that, say a purchase by the Chinese steel industry from the Indian steel industry is an inter-industry transaction.

As mentioned above, the impacts of TFP growth ($\Delta \ln TFP$) are also taken into account. Otherwise, the estimations on robots variables might suffer from omitted variable bias. In other words, including TFP variables, we control for any other possible form of technological progress apart from industrial robots. For the construction of the TFP growth of industries, the same procedure as for the robots growth is used. For example, $\Delta \ln TFP_{cit}^{int-BW}$ indicates the log TFP growth accumulated in international backward linkages of industry i in country c to all industries in foreign countries analogous to the respective variable on the growth of stocks of robots as follows:

$$\Delta \ln TFP_{c,i,t}^{int-BW} = \sum_{j=1}^J \sum_{f(f \neq c)}^F l_{(f,j,c),t} \times \Delta \ln TFP_{f,j,t} \quad (5)$$

While linkages variables on TFP growth are similarly constructed as those on robots growth, the direct effect of TFP growth contains one particular feature. Since a country's own TFP growth entails a mechanic negative relationship to employment as shown below, the own (industry-country-level) TFP growth is replaced with the average of foreign countries' TFP growth in the respective industry. This is indicated with an asterisk in the superscript of the log growth of TFP, i.e. $\Delta \ln TFP_{cit}^*$. Motivated by higher correlations with own-country TFP growth rates; for advanced countries the average TFP growth of all other advanced countries is instrumented and for emerging, transition, and the rest of economies the average TFP growth of other non-advanced economies TFP growth in a given industry is used. Considering that Φ^A is the set of advanced economies reported in Table 10 and $\Phi^{A'}$ is the set of all other countries reported in that table, $\Delta \ln TFP_{cit}^*$ is defined in the following way:

$$\Delta \ln TFP_{cit}^* = \frac{\sum_{f \neq c}^{F^X-1} \Delta \ln TFP_{fit}}{F^X - 1}, \quad f \in \Phi^X \wedge X \in \{A, A'\} \quad (6)$$

where F^A and $F^{A'}$ are total numbers of advanced and non-advanced economies, respectively.

The full model, including the TFP growth rate therefore has the following form:

$$\begin{aligned}
\Delta \ln Y_{cit} = & \beta_0 + \sum_{k=0}^3 \beta_1^k \Delta \ln R_{ci,t-k} + \sum_{k=0}^3 \beta_2^k \Delta \ln R_{ci,t-k}^{dom-BW} + \sum_{k=0}^3 \beta_3^k \Delta \ln R_{ci,t-k}^{dom-FW} \\
& + \sum_{k=0}^3 \beta_4^k \Delta \ln R_{ci,t-k}^{int-BW} + \sum_{k=0}^3 \beta_5^k \Delta \ln R_{ci,t-k}^{int-FW} + \sum_{k=0}^3 \beta_6^k \Delta \ln TFP_{ci,t-k}^* \\
& + \sum_{k=0}^3 \beta_7^k \Delta \ln TFP_{ci,t-k}^{dom-BW} + \sum_{k=0}^3 \beta_8^k \Delta \ln TFP_{ci,t-k}^{dom-FW} \\
& + \sum_{k=0}^3 \beta_9^k \Delta \ln TFP_{ci,t-k}^{int-BW} + \sum_{k=0}^3 \beta_{10}^k \Delta \ln TFP_{ci,t-k}^{int-FW} + \mu_{ct} + \mu_i + \varepsilon_{ict}, \\
& Y \in \{EMP, HEMP, LSH, VA^{real}, VA^{nominal}\}
\end{aligned} \tag{7}$$

This model features ten sets of distributed lagged explanatory variables, each one featuring the contemporary value of the variable up to three lags, in addition to country-time- and industry-FE.

5 Results and Discussion

5.1 Estimation Results

5.1.1 Benchmark results

As mentioned above, the model estimated in this paper departs from the model applied in AS in various respects. Therefore, as a prelude it is tested whether the results by AS can be reproduced with the data used in this paper. The sample of countries in our dataset is limited to only those used in AS; the important difference is that the time period is much shorter (2000-2014).

Methodologically, the model includes only direct and indirect effects of TFP growth (the effects of robots are examined later). The reported specification follows AS by including five distributed lagged values for each of the explanatory variables. Additionally, these regressions are weighted by employment shares or value-added shares as in AS. Further fixed effects for groups of industries (as in AS), are used. Departing from AS, however, international linkages– which are absent in the AS specification – are included. Therefore, the estimated model has the following form:

$$\begin{aligned}
\Delta \ln Y_{cit} = & \beta_0 + \sum_{k=0}^5 \beta_6^k \Delta \ln TFP_{ci,t-k}^* + \sum_{k=0}^5 \beta_7^k \Delta \ln TFP_{ci,t-k}^{dom-BW} + \sum_{k=0}^5 \beta_8^k \Delta \ln TFP_{ci,t-k}^{dom-FW} \\
& + \sum_{k=0}^5 \beta_9^k \Delta \ln TFP_{ci,t-k}^{int-BW} + \sum_{k=0}^5 \beta_{10}^k \Delta \ln TFP_{ci,t-k}^{int-FW} + \mu_{ct} + \mu_s + \varepsilon_{ict}, \\
& Y \in \{EMP, HEMP, LSH, VA^{real}, VA^{nominal}\}
\end{aligned} \tag{8}$$

where μ_s is the aggregate sector-FE as defined by AS, and the distributed lags of variables include the contemporaneous and 5 lags of the explanatory variables.

Table 4 shows that by and large the results that AS report for the period 1970-2007 (Table 8 in AS) or the period 2000-2015 (Table 6 in AS) are reproduced with the data constructed in this – at least qualitatively, though not quantitatively. For example, the direct effect of TFP growth on employment growth (column 1) is estimated to be -0.39 compared to -0.95 in AS. The coefficient for the domestic backward linkages is also smaller in magnitude but positive as in AS, while the domestic forward linkages are not statistically significant as in AS¹⁹. Results are robust and consistent even if we exclude international linkages.

The direct impact of TFP growth on value added variables is statistically insignificant, as for the similar period on Table 6 of AS, these two variables are also statistically insignificant.

Table 4 –Estimation results of benchmark specification

	(1)	(2)	(3)	(4)	(5)
Dependent variable:	$\Delta \ln EMP_{cit}$	$\Delta \ln HEMP_{cit}$	$\Delta \ln LSH_{cit}$	$\Delta \ln VA_{cit}^{real}$	$\Delta \ln VA_{cit}^{nominal}$
$\sum_{k=0}^5 \beta_6^k \Delta \ln TFP_{ci,t-k}^*$	-.39***	-.34***	.092	.095	.022
<i>F-Test of joint significance</i>	(0)	(0)	(.767)	(.434)	(.831)
$\sum_{k=0}^5 \beta_7^k \Delta \ln TFP_{ci,t-k}^{dom-BW}$	.708***	.869**	.148	.467	.627*
<i>F-Test of joint significance</i>	(.008)	(.021)	(.65)	(.156)	(.085)
$\sum_{k=0}^5 \beta_8^k \Delta \ln TFP_{ci,t-k}^{int-BW}$	-.903**	-1.176***	-.126	.327	-1.529***
<i>F-Test of joint significance</i>	(.011)	(.003)	(.795)	(.673)	(.001)
$\sum_{k=0}^5 \beta_9^k \Delta \ln TFP_{ci,t-k}^{dom-FW}$	.03	.017	-.375*	-.103	.433*
<i>F-Test of joint significance</i>	(.742)	(.89)	(.068)	(.517)	(.097)
$\sum_{k=0}^5 \beta_{10}^k \Delta \ln TFP_{ci,t-k}^{int-FW}$	1.011***	1.093**	-.28	.615	2.251***
<i>F-Test of joint significance</i>	(.002)	(.017)	(.441)	(.207)	(0)
Weight	Employment	Hours worked	value added	value added	value added
R-sq.	.328	.35	.15	.242	.289
Obs	8036	8036	8036	8036	8036

Note: Sample includes countries as in AS (2018). P-values for the F-test of joint significance in parentheses. ***, **, and * indicate statistical significant at the 1%, 5% and 10% level respectively. We are actually reporting p-values for the F-test that $\beta^0 + \beta^1 + \beta^2 + \beta^3 = 0$. The size of the coefficients is obtained by summing up the estimated coefficients of the contemporaneous value and the five lagged values. All specifications include country-time fixed effects and sector fixed effects. Estimated with STATA using the *reghdfe* estimation command.

¹⁹ In contrast to AS the variables are not normalised. In fact, there is no real need for normalising as a linear model is estimated.

However, when estimating the same model with the full sample of countries in our data and all available industries (including agriculture and services industries), using only three distributed lags instead of five, and including industry instead of sector-group FEs²⁰, the majority of the statistically significant coefficients disappear (Table 5). Therefore, results appear to be not particularly robust in these respects. Many other robust checks point in that direction and one can conclude out of these checks that mostly country sample matters.

Table 5 – Estimated relationship between TFP growth and industry-level outcomes - WIOD Sample

	(1)	(2)	(3)	(4)	(5)
Dependent variable:	$\Delta \ln EMP_{cit}$	$\Delta \ln HEMP_{cit}$	$\Delta \ln LSH_{cit}$	$\Delta \ln VA_{cit}^{real}$	$\Delta \ln VA_{cit}^{nominal}$
$\sum_{k=0}^3 \beta_6^k \Delta \ln TFP_{cit-k}^*$	.087	.076	-.066	.121*	.163***
<i>F-Test of joint significance</i>	(.167)	(.258)	(.284)	(.057)	(.008)
$\sum_{k=0}^3 \beta_7^k \Delta \ln TFP_{cit-k}^{dom-BW}$	.123	.235**	-.009	.238*	.209*
<i>F-Test of joint significance</i>	(.205)	(.037)	(.923)	(.05)	(.095)
$\sum_{k=0}^3 \beta_8^k \Delta \ln TFP_{cit-k}^{int-BW}$	.204	.293	-.475**	.909***	.37*
<i>F-Test of joint significance</i>	(.247)	(.114)	(.015)	(.001)	(.095)
$\sum_{k=0}^3 \beta_9^k \Delta \ln TFP_{cit-k}^{dom-FW}$	-.009	-.014	.004	-.152*	-.021
<i>F-Test of joint significance</i>	(.876)	(.817)	(.934)	(.072)	(.807)
$\sum_{k=0}^3 \beta_{10}^k \Delta \ln TFP_{cit-k}^{int-FW}$	.386***	.434***	-.375*	.647***	1.277***
<i>F-Test of joint significance</i>	(.005)	(.004)	(.069)	(.006)	(0)
R-sq.	0.118	0.135	0.079	0.174	0.246
Obs	20,609	20,191	20,609	20,609	20,609

Note: Sample includes all WIOD countries. P-values for the F-test of joint significance in parentheses. ***, **, and * indicate statistical significant at the 1%, 5% and 10% level respectively. We are actually reporting p-values for the F-test that $\beta^0 + \beta^1 + \beta^2 + \beta^3 = 0$. The size of the coefficients is obtained by summing up the estimated coefficients of the contemporaneous value and the three lagged values. All specifications include country-time fixed effects and industry fixed effects. Regressions are unweighted. Estimated with STATA using the *reghdfe* estimation command.

In particular, direct effects of TFP growth on labour market outcomes are no longer statistically significant. Only the corresponding effect on nominal value added remains statistically significant at the 5% level, the one on real value added at the 10% level. The domestic linkages effects on labour market outcomes are showing modest impacts only with the coefficient of the domestic backward linkages being the only positive and statistically significant one – and only when employment is measured in hours worked. With regard to the international linkages, international forward linkages are suggested to foster employment. Differently to above, real and nominal value added growth is positively affected by own-

²⁰ This is done in order to reduce the omitted variable bias.

industry TFP growth, backward linkages – both domestic and international - and international forward linkages.

These results suggest that the international linkages do matter. The intuition behind this is that a particular industry, say the mechanical industry in Romania, may benefit in terms of additional value added growth from TFP growth in foreign supplier industries. In fact, a 1 log growth rate improvement in the TFP of suppliers of a given industry across backward international linkages could result in about 0.909 higher log growth rate of real value added growth in the respective sector. A similar interpretation but with a smaller magnitude of 0.647 log growth rate holds for foreign customer industries across forward international linkages of a given industry.

5.1.2 Taking robots into account

The main motivation for this paper is however to assess the impact of robots on growth of employment and value added (and other variables). Thus, together with TFP growth (which is a rather broad measure of technology) the growth in the stocks of robots is included as shown in equation (7). This augmented model therefore contains the growth of robots and TFP as explanatory variables together with the associated linkages terms. The estimation results are presented in Table 6.

The result suggests that there is a positive and statistically significant direct effect of TFP growth effect only for real and nominal value added. However, no such effect is found for employment growth variables. TFP growth of suppliers along the domestic backward linkages stimulates value added outcomes, and along international backward linkages for real value added growth. Domestic forward linkages are not significantly impacting growth of the variables considered. However, forward international linkages are large and significantly positive and large.

Turning to the effects arising from the growth in installed robots, the upper part of **Error! Reference source not found.** suggests a mildly significant and positive direct effect on employment and a significant positive effect on real value added. With respect to the three other variables (hours worked, labour share and nominal value added), no statistically significant direct effect is found. This positive relationship between own industry-country's stocks of robots and real value-added growth was also evident in the descriptive statistics as discussed before in the introduction section. According to these econometric results, a one log point larger growth in stocks of robots in an industry would result in a 0.014 log growth rate in real value added of the respective industry. This deserves a more careful discussion. One possible explanation for that is that robots are introduced when being more profitable which leads to lower unit costs and lower prices in a competitive environment. Assuming that consumers react sensitive to such price changes demand for these products increases (thus having a positive impact on value-added growth), which (depending on elasticities across factors of production) may therefore result in higher employment (despite the labour-saving nature of robots). If the production function is

close to a Cobb-Douglas (i.e. substitution elasticity of one between factors of production), then, the labour share will remain unchanged. Some further theoretical arguments are summarised in Box 1

With regards to linkages, the effect of stocks of robots along the domestic backward linkages is positive for all variables except for labour share, whereas the international backward linkages statistically significantly only for growth in hours-employed.

Table 6 – Estimated relationship between growth of robots, TFP growth and industry-level outcomes

Dependent variable:	(1) $\Delta \ln EMP_{cit}$	(2) $\Delta \ln HEMP_{cit}$	(3) $\Delta \ln LSH_{cit}$	(4) $\Delta \ln VA_{cit}^{real}$	(5) $\Delta \ln VA_{cit}^{nominal}$
<i>growth of robots</i>					
$\sum_{k=0}^3 \beta_1^k \Delta \ln R_{ci,t-k}$	.005*	.003	.001	.014***	.002
<i>F-Test of joint significance</i>	(.053)	(.264)	(.827)	(0)	(.479)
$\sum_{k=0}^3 \beta_2^k \Delta \ln R_{ci,t-k}^{dom-BW}$	.026**	.038**	.011	.034**	.025*
<i>F-Test of joint significance</i>	(.027)	(.011)	(.226)	(.049)	(.063)
$\sum_{k=0}^3 \beta_3^k \Delta \ln R_{ci,t-k}^{int-BW}$	.032	.045**	.013	.03	.041
<i>F-Test of joint significance</i>	(.173)	(.048)	(.534)	(.43)	(.12)
$\sum_{k=0}^3 \beta_4^k \Delta \ln R_{ci,t-k}^{dom-FW}$	-.019**	-.021**	0.0003	-.019*	-.022**
<i>F-Test of joint significance</i>	(.01)	(.017)	(.963)	(.05)	(.015)
$\sum_{k=0}^3 \beta_5^k \Delta \ln R_{ci,t-k}^{int-FW}$	-.007	.001	.025	.013	-.037*
<i>F-Test of joint significance</i>	(.68)	(.949)	(.197)	(.556)	(.076)
<i>TFP growth</i>					
$\sum_{k=0}^3 \beta_6^k \Delta \ln TFP_{ci,t-k}^*$	.072	.063	-.076	.129**	.16***
<i>F-Test of joint significance</i>	(.262)	(.359)	(.223)	(.04)	(.008)
$\sum_{k=0}^3 \beta_7^k \Delta \ln TFP_{ci,t-k}^{dom-BW}$	.101	.232	-.035	.42***	.312**
<i>F-Test of joint significance</i>	(.411)	(.112)	(.731)	(.002)	(.043)
$\sum_{k=0}^3 \beta_8^k \Delta \ln TFP_{ci,t-k}^{int-BW}$	.269	.321	-.37*	.855***	.287
<i>F-Test of joint significance</i>	(.161)	(.112)	(.089)	(.003)	(.229)
$\sum_{k=0}^3 \beta_9^k \Delta \ln TFP_{ci,t-k}^{dom-FW}$	.059	.096	-.012	-.132	.046
<i>F-Test of joint significance</i>	(.39)	(.158)	(.877)	(.201)	(.586)
$\sum_{k=0}^3 \beta_{10}^k \Delta \ln TFP_{ci,t-k}^{int-FW}$	.412**	.453***	-.404*	.63**	1.343***
<i>F-Test of joint significance</i>	(.012)	(.009)	(.09)	(.017)	(0)
R-sq.	.12	.136	.081	.188	.262
Obs	20064	19635	20064	20064	20064

Note: Sample includes all WIOD countries. Robust standard errors clustered by country-industry pairs in parentheses. .***, **, and * indicate statistical significant at the 1%, 5% and 10% level respectively. We are actually reporting p-values for the F-test that $\beta^0 + \beta^1 + \beta^2 + \beta^3 = 0$. The size of the coefficients is obtained by summing up the estimated coefficients of the contemporaneous value and the three lagged values. All specifications include country-time fixed effects and industry fixed effects. Regressions are unweighted. Estimated with STATA using the *reghdfe* estimation command.

Box 1 - Theoretical arguments

When considering a change in productivity or an increase in capital in simple (neoclassical) model frameworks similar outcomes can be expected (though one has to keep in mind that these rest on a full-employment assumption). For example, in a simple (standard) Ricardo-Viner model (specific factors model) the increase in capital (or productivity) would shift employment into this industry. The increase in capital (or productivity) in an industry increases the marginal productivity of labour which - at given goods prices - even increase (real) wages in that industry. One might argue that the purpose of the use of robots could be more industry-specific than TFP growth, explaining significant impact of robots on employment at the industry level, which is not statistically insignificant (but positive) impact for TFP growth. Similarly, in a Heckscher-Ohlin framework (i.e. with capital mobile across industries) an increase in capital would shift employment to the capital-intensive industries.

In addition, old vintages of machineries could also be replaced and upgraded by newer machineries (or robot) as a form of process innovation²¹. In many cases, when firms are upgrading their production processes, they are also changing their products resulting in product innovation, and/or more diversification, whose net effect might be unclear.

Another argument is that industrial robots effect employed tasks within each industry differently. For instance, Sachs and Kotlikof (2012) and Benzel et al. (2015) argue that smart machines are replacing unskilled labour, while complementing skilled labour. Such a capital-skill complementarity would imply that a higher capital stock would increase demand for qualified labour, and reduce that of unqualified labour (*ceteris paribus*); thus the net effect of changes in capital intensity on total employment is unclear and depends on all substitution elasticities across production factors.

These are potential explanations that our econometric result indicate that the aggregate employment effect of instalment of new machinery (robots) is (slightly) positive (controlling for TFP growth).

The effect of the stocks of robots along the domestic forward linkages is negative on outcome variables except for labour share. This suggests that an increasing stock of robots in a downstream manufacturing sector would have negative economic consequences on all other industries along the value chains. For instance, a downstream manufacturing industry can increase its real value added (or productivity and profits) through direct installation of robots as observed in the positive coefficient of the direct effect. However, this industrial capacity building after installation of new robots will send out negative shocks to all other suppliers of material inputs to this industry. One major related reason could be that the new machineries would also need new sets of inputs. Another reason could be that digitalization allows industries to do some tasks themselves, therefore, after installing new robots they do not have to buy material inputs from their upstream suppliers but they can produce and use it in their production by themselves. While customer industries that experience high robot growth may expand because of increased productivity and therefore purchase more inputs, it is equally possible that the productivity gains are realised via increased input efficiency. The latter would actually imply less purchases and hence a negative forward linkage effect.

As a further robustness check, estimation results including only growth of robots (i.e. excluding TFP variables) are presented in Table 7. The direct effects on employment and real value added are unchanged. International backward linkages are statistically significant for employment and value added

²¹ Running a regression between the growth of capital and growth of stocks of robots while including fixed FE (as those in equation (7)) show that these two variable are not significantly correlated with each other. This might suggest that new robots could be replacement for outdated machineries.

growth. The effects of domestic forward linkages are again negative, whereas those of international forward linkages are insignificant.

Table 7 – Estimated relationship between growth of robots and industry-level outcomes

Dependent variable:	(1)	(2)	(3)	(4)	(5)
	$\Delta \ln EMP_{cit}$	$\Delta \ln HEMP_{cit}$	$\Delta \ln LSH_{cit}$	$\Delta \ln VA_{cit}^{real}$	$\Delta \ln VA_{cit}^{nominal}$
$\sum_{k=0}^3 \beta_1^k \Delta \ln R_{ci,t-k}$	0.005*	0.003	0.001	0.014***	0.004
F-Test of joint significance	(0.060)	(0.280)	(0.817)	(0.000)	(0.322)
$\sum_{k=0}^3 \beta_2^k \Delta \ln R_{ci,t-k}^{dom-BW}$	0.014	0.019	0.011	0.024	0.028
F-Test of joint significance	(0.216)	(0.209)	(0.248)	(0.163)	(0.131)
$\sum_{k=0}^3 \beta_3^k \Delta \ln R_{ci,t-k}^{int-BW}$	0.039*	0.049**	-0.013	0.079**	0.086**
F-Test of joint significance	(0.082)	(0.028)	(0.569)	(0.044)	(0.015)
$\sum_{k=0}^3 \beta_4^k \Delta \ln R_{ci,t-k}^{dom-FW}$	-0.022***	-0.026***	0.000	-0.028***	-0.021**
F-Test of joint significance	(0.004)	(0.005)	(0.946)	(0.006)	(0.044)
$\sum_{k=0}^3 \beta_5^k \Delta \ln R_{ci,t-k}^{int-FW}$	-0.013	-0.005	0.027	-0.004	-0.008
F-Test of joint significance	(0.542)	(0.831)	(0.124)	(0.845)	(0.753)
R-sq.	0.099	0.106	0.058	0.134	0.135
Obs	20,959	20,525	20,948	20,946	20,948

Note: Sample includes all WIOD countries. Robust standard errors clustered by country-industry pairs in parentheses... ***, **, and * indicate statistical significant at the 1%, 5% and 10% level respectively. We are actually reporting p-values for the F-test that $\beta^0 + \beta^1 + \beta^2 + \beta^3 = 0$. The size of the coefficients is obtained by summing up the estimated coefficients of the contemporaneous value and the three lagged values. All specifications include country-time fixed effects and industry fixed effects. Regressions are unweighted. Estimated with STATA using the *reghdfe* estimation command.

5.2 Quantitative implications based on model predictions

5.2.1 Total economy impacts

In the next step the estimation results from model equation (7), with results being presented in Table 6 are used to retrieve the implied contribution of robots growth on changes of employment and real value-added. The focus is firstly put on employment because the digital transformation debate is very much geared towards the consequences on labour demand. Moreover, aggregate real value-added as a measurement on growth of global GDP is another important factor that could be stimulated by robots in particular and Industry 4.0 in general.²² Furthermore, the implied contribution of TFP growth on changes of employment and real value-added, that are obtained from the model estimated on equation (8) whose results are presented in Table 5 are provided in the Appendix.

²² Certainly, there is also great interest in distributional issues, of which one dimension – the function distribution – could be captured by the labour share. However, since the model specification for the labour share performs very badly, model predictions for the labour share are omitted.

The annual effect of the growth of robots on employment growth ($\Delta \ln EMP$) and on real value added ($\Delta \ln VA_{cit}^{real}$) is calculated by applying the estimated coefficients of the direct effect and the indirect effect through input-output linkages to the employment-weighted average of the log growth in the stock of robots ($\Delta \ln R$). The predicted effects at the aggregate country group level on any of the outcome variables EMP or VA^{real} is retrieved in the following way:

$$\widehat{\Delta \ln Y_{\Phi^X t}^E} = \sum_{k=0}^3 \hat{\beta}_1^{kY} \sum_c^C \sum_i^I \left[\left(\frac{1}{T} \cdot \sum_t^T \frac{Y_{cit}}{Y_{\Phi^X t}} \right) \Delta \ln R_{cit}^E \right], \quad (9)$$

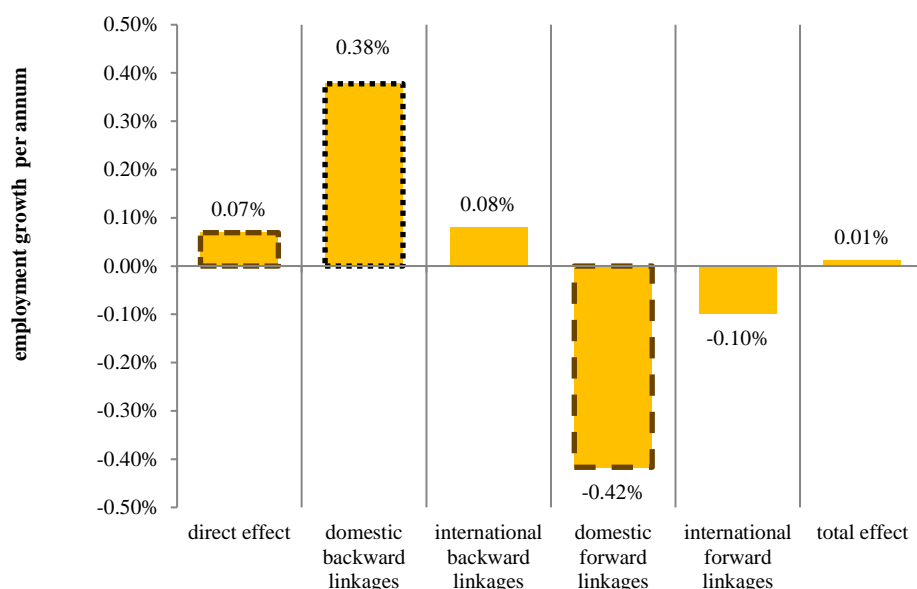
$Y \in \{EMP, VA^{real}\}, \quad f \in \Phi^X \wedge X \in \{W, A, E, T, RoW\},$
 $E \in \{Direct, dom - BW, int - BW, dom - FW, int - FW\}$

where $\widehat{\Delta \ln Y_{\Phi^X t}^E}$ is the predicted average annual growth of the outcome variable (i.e. either employment EMP or VA^{real}) in various country samples Φ^X at time t , where X indicates the set of country groups W, A, E, T, RoW (all countries included in WIOD, advanced economies, emerging economies, transition economies, and the rest of WIOD countries as reported in Appendix Table 10, respectively) under consideration. $\sum_{k=0}^3 \hat{\beta}_1^{kY}$ is the estimator reported in Table 6 of variable E of growth of stocks of robots that stands for the direct effects $\Delta \ln R_{cit}$, domestic backward linkages $\Delta \ln R_{cit}^{dom-BW}$, international backward linkages $\Delta \ln R_{cit}^{int-BW}$, domestic forward linkages $\Delta \ln R_{cit}^{dom-FW}$, and international forward linkages $\Delta \ln R_{cit}^{int-FW}$ on a given outcome variable Y . T denotes the total number of years of the sample and therefore $\left(\frac{1}{T} \cdot \sum_t^T \frac{Y_{cit}}{Y_{\Phi^X t}} \right)$ is the period-averaged share of the outcome variable. Applying this methodology yields global outcome effects for the global group sample on average which are summarised in Figure 3.

The predicted effects are rather small. For example, the direct effect across all countries included amounts to only 0.07 log growth rates which implies that annual growth in the stocks of robots in each industry has contributed to the employment growth by about 0.07 log growth rates per annum. In economic terms this effect is a rather small effect but statistically significant at 10% level as is the estimated coefficient

It is interesting to see that domestic and international backward linkages reinforce the positive direct effect and that these indirect effects via supplying industries are larger than the direct one. These cumulated positive effects are, however, overcompensated by the – in relative terms – quite strong negative domestic forward linkages of 0.42 log growth rates

Figure 3: Predicted effects of the growth of robots on economy-wide employment, WIOD average



Note: Coefficients are applied to weighted average in the change in the stock of robots across countries and industries. Coefficients retrieved from estimations in Table 6, specification (1). Solid lines around the bars indicate statistical significance at the 1% level; dotted lines indicate statistical significance at the 5% level; dashed lines indicate statistical significance at the 10% level. Bars without a frame indicate that the point estimate is not statistically significant.

Source: Point coefficients of specification (1) in Table 6 **Error! Reference source not found.** weighted by time-averaged industry shares.

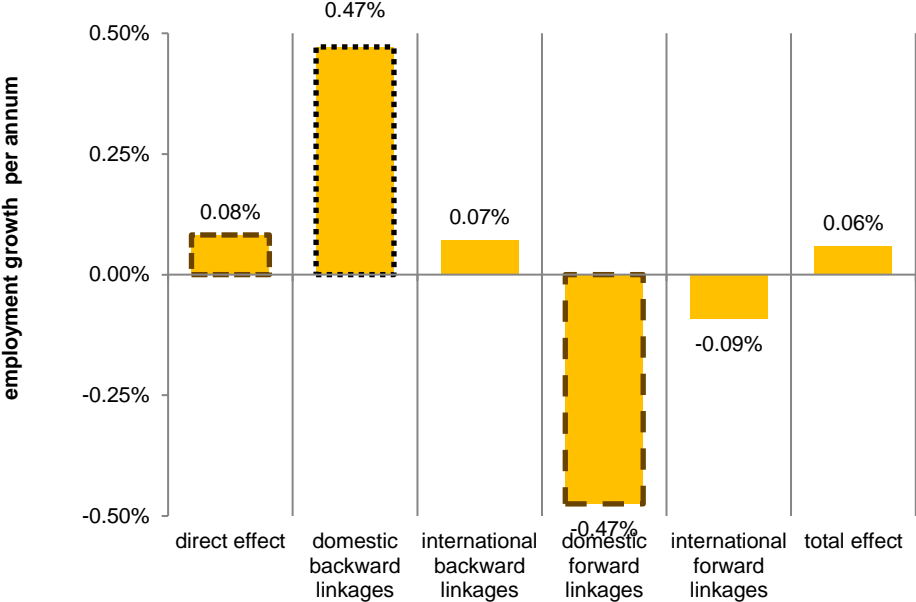
The overall result is a tiny *positive* employment effect of 0.01% per annum. So time span considered, i.e. 15 years, the average effect arising from the growth of robots results in an employment growth of 0.01 percent per year.

The same methodology can be applied to individual groups of countries. Focussing on emerging economies and transition economies respectively suggests similar patterns as the predictions are based on the some estimated coefficients (Figure 4). However, different industry structures and employment trajectories still yield some differences to the global pattern.

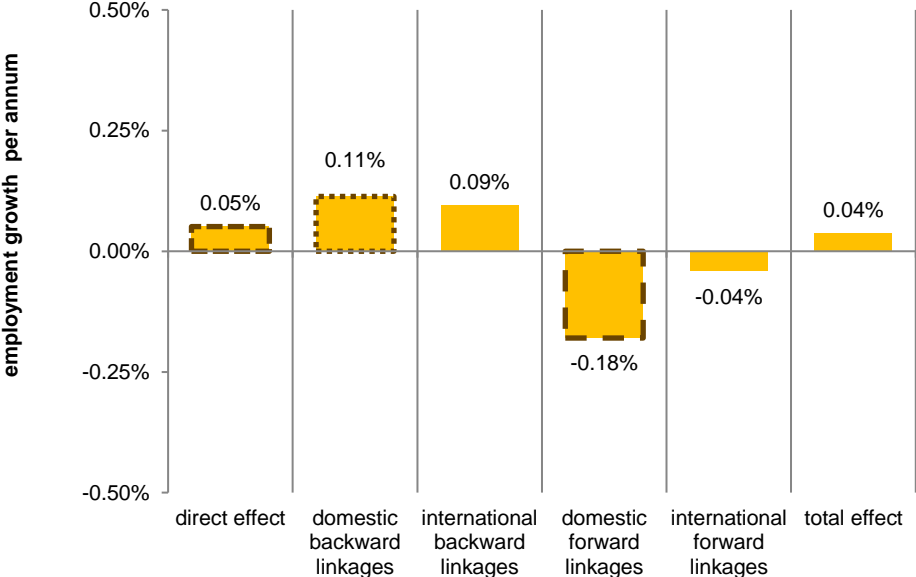
For the emerging economies (panel (a) in Figure 4) the direct effects is considerably larger than for world as a whole and is responsible for 0.08% employment growth per year. However, the indirect effects spilling over from other industries are also larger. This is in particular true for the large negative effect of the domestic forward linkages so that the overall employment effect is again negative. The annual robots-induced growth in employment amounts to 0.06%. Although we use the same coefficients in the calculation of the employment impact in Figure 3 and Figure 4, the total effect is different. This stems from the differences in growth of robots in own industry channel and growth of robots through linkages channels in different country groups. For instance, the differences in impact on employment through stocks of robots across the domestic linkages in emerging economies is much stronger from

other economies is much stronger than the differences in the direct effects. This hints that domestic value chains in emerging economies have much robust impact on the robotization-employment nexus.

Figure 4: Predicted effects of the growth of robots on economy-wide employment by country groups



(a) Emerging economies



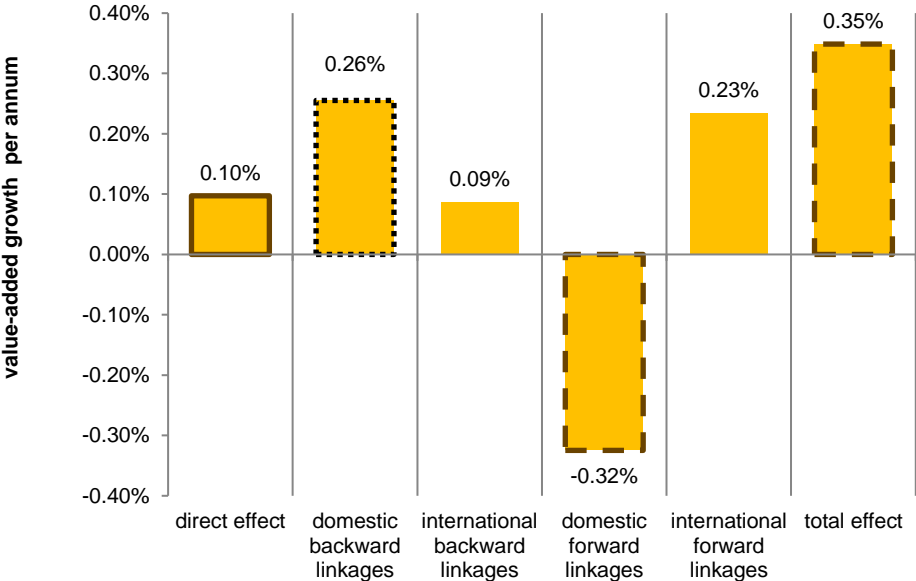
(b) Transition economies

Note: Coefficients are applied to weighted average in the change in the stock of robots across countries and industries. Coefficients retrieved from estimations in Table 6 specification (1). Solid lines around the bars indicate statistical significance at the 1% level; dotted lines indicate statistical significance at the 5% level; dashed lines indicate statistical significance at the 10% level. Bars without a frame indicate that the point estimate is not statistically significant.

Generally speaking, these relatively small total employment effects related to robot growth that is statistically and jointly not significant is surprising²³. It may either signal that it is still too early to detect sizeable employment effects from the introduction of new robots which would be in line with Graetz and Michaels (2018) who also report no measurable effect of robots growth on overall hours worked. However, the total employment effects related to robots on hours employment growth in this study is statistically significant at 10% level and equal to 0.066 log growth rate.

Figure 5 shows the predicted average effects of growth in stocks of robots on world-wide real value added growth. The overall impact is statistically significant at 10% level indicating about 0.35% average annual growth in real value added due to robots growth. The only negative impact comes through the growth of robots in domestic forward linkages, which contributes to average annual reduction of real value added of about 0.32%.

Figure 5: Predicted effects of the growth of robots on economy-wide real value added, WIOD average



Note: Coefficients are applied to weighted average value added in the change in the stock of robots across countries and industries. Coefficients retrieved from estimations in Table 6, specification (1). Solid lines around the bars indicate statistical significance at the 1% level; dotted lines indicate statistical significance at the 5% level; dashed lines indicate statistical significance at the 10% level. Bars without a frame indicate that the point estimate is not statistically significant.

²³ This joint significance is the F-test with the null hypothesis that the summation of all coefficients in the estimation is equal to zero, and it is not rejected at 10% level of significance.

5.2.2 Employment and growth effects across industries

Another interesting aspect regarding the robots-induced employment effects is the distribution of effects across industries. As pointed out by AS (2018), one can view the issue of employment creation (or destruction) from two perspectives. The first perspective is the *destination* perspective which corresponds directly to the estimated model and is calculated as in equation (9). In this case employment changes are assigned to the industry where the additional employment is generated or reduced. The way the linkages terms are defined in the explanatory variables can be used directly for calculating the predicted effects of a given destination industry where the employment is affected.

The second perspective is the *origin* perspective. Here one can ask which industry by introducing new robots is originally responsible for the employment (or value added) that has been generated in the destination industry in equation (9). In order to switch from the destination to the origin perspective, a rearrangement of the elements in equation (9) that make up the backward or forward linkages term is required. By inserting equations (3) and (4) in equation (9) and rearranging the shares with Leontief or Ghosh coefficients we can arrive to the following equation for predicting the employment (or value added) contribution originated from each industry as a supplier or as a customer. Compared to equation (9), it is basically the summation over rows rather columns:

$$\Delta \ln Y_{\Phi^X t}^{\widehat{E}_{dom}^{origin}} = \sum_{k=0}^3 \hat{\beta}_1^{kY} \sum_c^C \sum_{j \neq i}^J \Delta \ln R_{cjt} \left[\sum_i^I \left(\frac{1}{T} \cdot \sum_t^T \frac{Y_{cit}}{Y_{\Phi^X t}} \right) \Gamma_{cjt,cit} \right],$$

$$Y \in \{EMP, VA^{real}\}, \quad f \in \Phi^X \wedge X \in \{W, A, E, T, R\},$$

$$E \in \{dom - BW, dom - FW\}, \quad \Gamma \in \{l, g\}$$
(10)

$$\Delta \ln Y_{\Phi^X t}^{\widehat{E}_{int}^{origin}} = \sum_{k=0}^3 \hat{\beta}_1^{kY} \sum_c^C \sum_{j \neq i}^J \Delta \ln R_{cjt} \left[\sum_i^I \left(\frac{1}{T} \cdot \sum_t^T \frac{Y_{cit}}{Y_{\Phi^X t}} \right) \sum_{f \neq c}^F \Gamma_{fjt,cit} \right],$$

$$Y \in \{EMP, VA^{real}\}, \quad f \in \Phi^X \wedge X \in \{W, A, E, T, R\},$$

$$E \in \{int - BW, int - FW\}, \quad \Gamma \in \{l, g\}$$
(11)

where as explained earlier in equation (10) $\Gamma_{cjt,cit}$ is either the domestic Leontief inverse $l_{cjt,cit}$ for the calculation of domestic backward linkages ($E = dom - BW$) or the Ghosh inverse $g_{cjt,cit}$ for the calculation of domestic forward linkages ($E = dom - FW$); and in equation (11) $\Gamma_{cjt,cit}$ is either the Leontief inverse $l_{cjt,cit}$ for the calculation of international backward linkages ($E = int - BW$) or the Ghosh inverse $g_{cjt,cit}$ for the calculation of international forward linkages ($E = int - FW$) used.

Table 8 presents the predicted values on employment growth contributions for the destination perspective, and Table 9 presents the results for the origin perspective. Note that the direct effect is

obviously the same in both destination and origin perspectives as the direct effect is by definition relevant to only one industry where the employment effect of the same industry's growth in stocks of robots sets in. Secondly, the total (worldwide-wide) effects in both perspectives ought to be the same as well because equations (10) and (11) sum up to the total equivalent of summation of equation (9).

Most importantly, while the effects are almost all very small, it is an easily discernible systematic difference between the destination and the origin perspective for each industry. Consider first the international backward linkages effect. In the destination perspective (Table 8), the largest predicted employment effect occurs for agriculture (A) with average annual log growth rate of 0.0132% (i.e. the employment-weighted contribution in world growth of employment) that is contributed by the growth in stocks of robots in all international suppliers in the world economy. However, in the origin perspective (Table 9), growth in stocks of robots in manufacture of computer, electronic and optics (C26) is the most influential industry as an international supplier in the world that contributes to 0.0138% of world aggregate annual employment log growth. Contribution of growth in stocks of robots in agriculture (A) is the 10th effective sector that contributes through international backward linkages from the origin perspective (Table 9) only about 0.0032% of world annual employment growth. This pattern emerges because industrial robots are essentially installed in manufacturing industries. Hence, in the origin perspective all employment that is generated by the newly installed robots in the manufacturing industries is also assigned to those industries. In contrast, since market and non-market services industries do not rely on industrial robots, they are also not at the origin of any employment generation.

Given that the manufacturing sector is largely driving employment effects, it is also this sector which is mainly responsible for the overall positive effect (Figure 3). This leads to a situation where the overall employment effect for manufacturing industries that is induced by robots is still positive, but because of the manufacturing sectors' large negative forward linkages effects, they are responsible for a major decline in employment growth throughout many other industries. However, the positive impact offsets the negative impact largely, and the manufacturing industries yield a significant positive effect on world employment growth²⁴.

²⁴ These results can be split by country groups and industry. Tables 12 – 19 show the predicted values on employment growth contributions of growth in stocks of robots for both destination and origin industries across different country groups. Tables 20 – 27 show the predicted values on real value-added growth contributions of growth in stocks of robots for both destination and origin industries across different country groups. And, Table 27 - Table 34 show the predicted values on employment growth contributions of growth in TFP for both destination and origin industries across different country groups

Table 8 – Average annual growth of industrial robots contributions to predicted world employment growth by destination industry perspective – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW	Total effect
A	Agriculture	0.0264%	0.0866%	0.0132%	-0.1042%	-0.0200%	0.0020%
B	Mining and quarrying	0.0006%	0.0063%	0.0008%	-0.0053%	-0.0011%	0.0012%
C10t12	Manufacture of food products, beverages and tobacco	0.0034%	0.0076%	0.0019%	-0.0091%	-0.0018%	0.0019%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0030%	0.0156%	0.0039%	-0.0139%	-0.0042%	0.0044%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0005%	0.0037%	0.0007%	-0.0008%	-0.0003%	0.0039%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0006%	0.0035%	0.0009%	-0.0011%	-0.0004%	0.0035%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0009%	0.0032%	0.0010%	-0.0055%	-0.0018%	-0.0023%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0003%	0.0011%	0.0002%	-0.0002%	-0.0001%	0.0014%
C22	Manufacture of rubber and plastic products	0.0022%	0.0060%	0.0015%	-0.0019%	-0.0008%	0.0071%
C23	Manufacture of other non-metallic mineral products	0.0015%	0.0059%	0.0010%	-0.0033%	-0.0007%	0.0045%
C24	Manufacture of basic metals	0.0010%	0.0030%	0.0011%	-0.0043%	-0.0015%	-0.0006%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0019%	0.0072%	0.0017%	-0.0030%	-0.0011%	0.0067%
C26	Manufacture of computer, electronic and optics	0.0021%	0.0050%	0.0036%	-0.0067%	-0.0039%	0.0001%
C27	Manufacture of electrical equipment	0.0017%	0.0079%	0.0016%	-0.0051%	-0.0014%	0.0046%
C28	Manufacture of machinery and equipment n.e.c.	0.0022%	0.0097%	0.0023%	-0.0086%	-0.0029%	0.0027%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0017%	0.0040%	0.0021%	-0.0036%	-0.0022%	0.0020%
C30	Manufacture of other transport equipment	0.0003%	0.0017%	0.0006%	-0.0005%	-0.0002%	0.0018%
C32	Manufacture of furniture; other manufacturing	0.0019%	0.0054%	0.0017%	-0.0019%	-0.0004%	0.0067%
C33	Repair and installation of machinery and equipment		0.0001%	0.0002%	0.0000%	0.0000%	0.0003%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0004%	0.0022%	0.0007%	-0.0021%	-0.0006%	0.0006%
F	Construction	0.0088%	0.0524%	0.0094%	-0.1241%	-0.0222%	-0.0757%
G45	Wholesale and retail and repair of motor vehicles & motorcycles		0.0011%	0.0009%	-0.0007%	-0.0003%	0.0011%
G46	Wholesale trade, except of motor vehicles and motorcycles		0.0148%	0.0028%	-0.0155%	-0.0035%	-0.0014%
G47	Retail trade, except of motor vehicles and motorcycles		0.0058%	0.0022%	-0.0064%	-0.0018%	-0.0002%
H49	Land transport and transport via pipelines		0.0088%	0.0027%	-0.0071%	-0.0015%	0.0030%
H50	Water transport		0.0021%	0.0003%	-0.0003%	-0.0001%	0.0020%
H51	Air transport		0.0010%	0.0002%	-0.0001%	0.0000%	0.0011%
H52	Warehousing and support activities for transportation		0.0014%	0.0004%	-0.0003%	-0.0001%	0.0014%
H53	Postal and courier activities		0.0004%	0.0001%	0.0000%	0.0000%	0.0005%
I	Accommodation and food service activities		0.0177%	0.0024%	-0.0087%	-0.0017%	0.0097%
J58	Publishing activities		0.0002%	0.0001%	-0.0001%	0.0000%	0.0002%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities		0.0001%	0.0001%	-0.0001%	0.0000%	0.0001%
J61	Telecommunications		0.0021%	0.0006%	-0.0007%	-0.0002%	0.0017%
J62-J63	Computer programming, consultancy and related activities; information service activities		0.0009%	0.0005%	-0.0004%	-0.0001%	0.0009%
K64	Financial service activities, except insurance and pension funding		0.0015%	0.0004%	-0.0010%	-0.0002%	0.0006%
K65	Insurance, pension funding, except compulsory social security		0.0004%	0.0001%	-0.0002%	-0.0001%	0.0002%
K66	Activities auxiliary to financial services and insurance activities		0.0001%	0.0000%	-0.0001%	0.0000%	0.0001%
L68	Real estate activities		0.0013%	0.0003%	-0.0013%	-0.0003%	-0.0001%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities		0.0033%	0.0006%	-0.0019%	-0.0005%	0.0015%
M71	Architectural and engineering; technical testing and analysis		0.0004%	0.0003%	-0.0002%	-0.0001%	0.0004%
M73	Advertising and market research		0.0001%	0.0001%	-0.0001%	0.0000%	0.0001%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0075%	0.0158%	0.0033%	-0.0108%	-0.0027%	0.0131%
N	Administrative and support service activities		0.0019%	0.0010%	-0.0025%	-0.0011%	-0.0007%
O84	Public administration and defence; compulsory social security		0.0137%	0.0026%	-0.0238%	-0.0086%	-0.0161%
Q	Human health and social work activities		0.0151%	0.0031%	-0.0177%	-0.0044%	-0.0040%
R-S	Other service activities		0.0294%	0.0040%	-0.0117%	-0.0027%	0.0190%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use		0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies		0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0691%	0.3776%	0.0792%	-0.4169%	-0.0978%	0.0112%

Source: own calculations based on the estimators presented in Table 6.

Table 9 – Average annual growth of industrial robots contributions to predicted world employment growth by origin industry perspective – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW	Total effect
A	Agriculture	0.0264%	0.0189%	0.0032%	-0.0101%	-0.0028%	0.0356%
B	Mining and quarrying	0.0006%	0.0104%	0.0044%	-0.0108%	-0.0064%	-0.0018%
C10t12	Manufacture of food products, beverages and tobacco	0.0034%	0.0558%	0.0035%	-0.0382%	-0.0023%	0.0223%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0030%	0.0083%	0.0022%	-0.0063%	-0.0028%	0.0044%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0005%	0.0041%	0.0006%	-0.0149%	-0.0031%	-0.0129%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0006%	0.0089%	0.0016%	-0.0215%	-0.0033%	-0.0136%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0009%	0.0648%	0.0133%	-0.0305%	-0.0057%	0.0428%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0003%	0.0068%	0.0016%	-0.0200%	-0.0029%	-0.0142%
C22	Manufacture of rubber and plastic products	0.0022%	0.0207%	0.0065%	-0.0431%	-0.0139%	-0.0275%
C23	Manufacture of other non-metallic mineral products	0.0015%	0.0138%	0.0010%	-0.0354%	-0.0033%	-0.0224%
C24	Manufacture of basic metals	0.0010%	0.0371%	0.0075%	-0.0260%	-0.0113%	0.0084%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0019%	0.0156%	0.0034%	-0.0326%	-0.0061%	-0.0178%
C26	Manufacture of computer, electronic and optics	0.0021%	0.0176%	0.0138%	-0.0121%	-0.0082%	0.0133%
C27	Manufacture of electrical equipment	0.0017%	0.0160%	0.0026%	-0.0210%	-0.0056%	-0.0062%
C28	Manufacture of machinery and equipment n.e.c.	0.0022%	0.0186%	0.0037%	-0.0169%	-0.0060%	0.0016%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0017%	0.0192%	0.0044%	-0.0198%	-0.0051%	0.0005%
C30	Manufacture of other transport equipment	0.0003%	0.0035%	0.0013%	-0.0100%	-0.0033%	-0.0082%
C32	Manufacture of furniture; other manufacturing	0.0019%	0.0044%	0.0008%	-0.0145%	-0.0033%	-0.0106%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0004%	0.0196%	0.0018%	-0.0204%	-0.0015%	-0.0001%
F	Construction	0.0088%	0.0054%	0.0008%	-0.0022%	-0.0004%	0.0125%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0075%	0.0083%	0.0010%	-0.0108%	-0.0008%	0.0052%
Total		0.0691%	0.3776%	0.0792%	-0.4169%	-0.0978%	0.0112%

Source: own calculations based on the estimators presented in Table 6

Table 35 shows the top 50 most effective industry-country suppliers whose growth in stocks of robots contributed to the global employment growth through international linkages via the origin perspective. Therefore, it is observed that the growth in stocks of robots in manufacture of computer, electronic and optics (C26) in South Korea, whose products are then used in next stages of production globally, contributed 0.0047% to the annual average world employment growth of their next stages production along the GVC. The same industry in Taiwan is the second most effective industry, whose growth in stocks of robots contributed 0.0042% to the average annual growth rate of employment in next stages of production along the GVC. Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products (19t20) in China is the third most influential supplying sector, whose growth in stocks of robots contributed 0.0031% to the average annual world employment growth in next stages of production in GVC.

Table 36 shows the top 50 most effective industry-country suppliers whose growth in stocks of robots contributed to the global real value-added growth through international linkages via the origin perspective. It is observed that the growth in stocks of robots in manufacture of computer, electronic and optics (C26) in China, whose products are then used in next stages of production globally, contributed 0.0042% to the annual average world real value-added growth of their next stages production along the GVC. The same industry in South Korea is the third most effective industry, whose growth in stocks of robots contributed 0.0031% to the average annual growth rate of real value-added

in next stages of production along the GVC. Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products (19t20) in China is the second most influential supplying sector, whose growth in stocks of robots contributed 0.0035% to the average annual world real value-added growth in next stages of production in GVC.

Table 37 shows the top 50 most effective industry-country buyers whose growth in stocks of robots contributed to the global real value-added growth through international linkages via the origin perspective. Growth in stocks of robots in Manufacture of rubber and plastic products (C22) in Canada as buyer of other products, contributed 0.0051% to global annual real value added growth through its upstream linkages across the GVC. Manufacture of machinery and equipment n.e.c. (C28) and Manufacture of other transport equipment (C30) in Mexico are the next effective buyers whose growth in stocks of robots contributed 0.0035% and 0.0034%, respectively, to global real value added growth through forward linkages of affected industries across the GVC.

6 Summary and concluding remarks:

This study analyses the role of robotization in global economy, while taking in to consideration the productivity spillovers of the process innovation conveyed by robotization across the global value chains (GVCs) and through domestic and international linkages. Applying a distributed lag econometric framework used by Autor and Salomons (2018) (AS), we analyse the impact of growth in stocks of installed multipurpose industrial robots on employment, and value-added industrial growth across 41 countries in the world. Using the World Input-Output Database (WIOD), we extend their framework to include backward and forward international linkages in addition to the respective domestic linkages that AS used in the econometric analysis. While AS used industrial total factor productivity (TFP) growth as the main indicator of technological advancements, we additionally include industrial robots that is a better measurement on Industry 4.0 and its relevant use in technological advancements. The initial finding of the analysis indicates that the results obtained by AS are very sensitive to the specifications and the sample selection of the econometrics. After adding several many countries to the sample of AS the direct impact of industrial TFP growth on employment growth becomes positive and statistically insignificant.

In an improved econometric specification using industry fixed effects instead of aggregate sector fixed effects controlling for industrial long-run technological heterogeneity, the results shed lights on various aspects of industrial robots on different industrial outcomes. Growth in stocks of industrial robots in an industry improves the employment growth of the respective industry at 10% level of significance, while it improves the real-value added growth at 1% level of significance. Growth in stocks of industrial robots in suppliers of an industry that is accumulated along the domestic supply chains improves the employment and value added, while the one that is accumulated along the international backward

linkages improves only employment in hours. However, growth in stocks of robots in domestic forward linkages deteriorate employment and value added growth.

We then attempt to show the contributions of stocks of robots on employment and value added across various industries and countries. We distinguish between the origin perspective and the destination perspective. Origin perspective is the industry in which the new robots are installed and the destination is the industry whose outcome variable of interest (i.e. employment or value-added growth) is influenced by the growth in stocks of robots in the origin industry. The paper provides a database on these contributions, some of which are presented in the appendix.

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Appendix

Table 10 – WIOD countries in the sample of study

Country code (ISO 3 digit)	Country	Group
AUS	Australia	Advanced
AUT	Austria	Advanced
BEL	Belgium	Advanced
CAN	Canada	Advanced
DEU	Germany	Advanced
DNK	Denmark	Advanced
ESP	Spain	Advanced
FIN	Finland	Advanced
FRA	France	Advanced
GBR	United Kingdom	Advanced
GRC	Greece	Advanced
IRL	Ireland	Advanced
ITA	Italy	Advanced
JPN	Japan	Advanced
KOR	Rep. of Korea	Advanced
LUX	Luxemburg	Advanced
NLD	Netherlands	Advanced
NOR	Norway	Advanced
PRT	Portugal	Advanced
SWE	Sweden	Advanced
USA	United States	Advanced
BRA	Brazil	Emerging
CHN	China	Emerging
IDN	Indonesia	Emerging
IND	India	Emerging
MEX	Mexico	Emerging
TUR	Turkey	Emerging
BGR	Bulgaria	Transition
ROU	Romania	Transition
RUS	Russian Federation	Transition
CHE	Switzerland	Rest
CYP	Cyprus	Rest
CZE	Czech Republic	Rest
EST	Estonia	Rest
HRV	Croatia	Rest
HUN	Hungary	Rest
LTU	Lithuania	Rest
LVA	Latvia	Rest
MLT	Malta	Rest
POL	Poland	Rest
SVK	Slovakia	Rest
SVN	Slovenia	Rest
TWN	Taiwan	Rest

Source: WIOD, own assessment.

Table 11 – Average annual growth of industrial robots contributions to predicted employment growth effects by destination industries in advanced economies – Period 2000-2014

Industry	Industry Description	<i>Direct</i>	<i>dom – BW</i>	<i>int – BW</i>	<i>dom – FW</i>	<i>int – FW</i>
A	Agriculture	0.0024%	0.0058%	0.0038%	-0.0035%	-0.0014%
B	Mining and quarrying	0.0003%	0.0004%	0.0003%	-0.0004%	-0.0002%
C10t12	Manufacture of food products, beverages and tobacco	0.0023%	0.0045%	0.0025%	-0.0077%	-0.0029%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0003%	0.0017%	0.0017%	-0.0008%	-0.0004%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0002%	0.0008%	0.0006%	-0.0002%	-0.0002%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0007%	0.0016%	0.0014%	-0.0010%	-0.0007%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0006%	0.0009%	0.0012%	-0.0022%	-0.0015%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0005%	0.0004%	0.0004%	-0.0001%	-0.0001%
C22	Manufacture of rubber and plastic products	0.0021%	0.0016%	0.0018%	-0.0006%	-0.0007%
C23	Manufacture of other non-metallic mineral products	0.0003%	0.0007%	0.0007%	-0.0002%	-0.0002%
C24	Manufacture of basic metals	0.0005%	0.0007%	0.0013%	-0.0005%	-0.0009%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0017%	0.0028%	0.0032%	-0.0024%	-0.0027%
C26	Manufacture of computer, electronic and optics	0.0016%	0.0014%	0.0031%	-0.0026%	-0.0015%
C27	Manufacture of electrical equipment	0.0004%	0.0013%	0.0018%	-0.0007%	-0.0009%
C28	Manufacture of machinery and equipment n.e.c.	0.0011%	0.0030%	0.0034%	-0.0029%	-0.0041%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0014%	0.0028%	0.0038%	-0.0043%	-0.0066%
C30	Manufacture of other transport equipment	0.0004%	0.0013%	0.0011%	-0.0008%	-0.0006%
C32	Manufacture of furniture; other manufacturing	0.0012%	0.0023%	0.0020%	-0.0013%	-0.0007%
C33	Repair and installation of machinery and equipment	0.0000%	0.0004%	0.0007%	-0.0001%	-0.0002%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0005%	0.0008%	0.0008%	-0.0010%	-0.0008%
F	Construction	0.0062%	0.0145%	0.0103%	-0.0579%	-0.0259%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0000%	0.0020%	0.0023%	-0.0016%	-0.0010%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0000%	0.0034%	0.0025%	-0.0074%	-0.0038%
G47	Retail trade, except of motor vehicles and motorcycles	0.0000%	0.0074%	0.0039%	-0.0153%	-0.0063%
H49	Land transport and transport via pipelines	0.0000%	0.0035%	0.0023%	-0.0023%	-0.0013%
H50	Water transport	0.0000%	0.0001%	0.0002%	0.0000%	0.0000%
H51	Air transport	0.0000%	0.0005%	0.0003%	-0.0001%	-0.0001%
H52	Warehousing and support activities for transportation	0.0000%	0.0010%	0.0007%	-0.0004%	-0.0003%
H53	Postal and courier activities	0.0000%	0.0006%	0.0004%	-0.0001%	-0.0001%
I	Accommodation and food service activities	0.0000%	0.0156%	0.0045%	-0.0181%	-0.0053%
J58	Publishing activities	0.0000%	0.0007%	0.0004%	-0.0004%	-0.0001%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0000%	0.0005%	0.0003%	-0.0002%	-0.0001%
J61	Telecommunications	0.0000%	0.0007%	0.0006%	-0.0007%	-0.0004%
J62-J63	Computer programming, consultancy and related activities; information service activities	0.0000%	0.0012%	0.0009%	-0.0010%	-0.0006%
K64	Financial service activities, except insurance and pension funding	0.0000%	0.0009%	0.0006%	-0.0013%	-0.0005%
K65	Insurance, pension funding, except compulsory social security	0.0000%	0.0005%	0.0003%	-0.0008%	-0.0003%
K66	Activities auxiliary to financial services and insurance activities	0.0000%	0.0004%	0.0002%	-0.0003%	-0.0001%
L68	Real estate activities	0.0000%	0.0009%	0.0003%	-0.0033%	-0.0011%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	0.0000%	0.0017%	0.0010%	-0.0028%	-0.0012%
M71	Architectural and engineering; technical testing and analysis	0.0000%	0.0013%	0.0007%	-0.0010%	-0.0004%
M73	Advertising and market research	0.0000%	0.0006%	0.0003%	-0.0003%	-0.0001%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0048%	0.0042%	0.0029%	-0.0056%	-0.0028%
N	Administrative and support service activities	0.0000%	0.0056%	0.0032%	-0.0095%	-0.0047%
O84	Public administration and defence; compulsory social security	0.0000%	0.0156%	0.0054%	-0.0813%	-0.0356%
Q	Human health and social work activities	0.0000%	0.0128%	0.0073%	-0.0473%	-0.0178%
R-S	Other service activities	0.0000%	0.0056%	0.0032%	-0.0061%	-0.0028%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0000%	0.0001%	0.0001%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0298%	0.1373%	0.0905%	-0.2984%	-0.1398%

Table 12 – Average annual growth of industrial robots contributions to predicted employment growth effects by destination industries in emerging economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0349%	0.1168%	0.0153%	-0.1416%	-0.0268%
B	Mining and quarrying	0.0007%	0.0085%	0.0009%	-0.0070%	-0.0014%
C10t12	Manufacture of food products, beverages and tobacco	0.0038%	0.0088%	0.0015%	-0.0098%	-0.0016%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0040%	0.0210%	0.0044%	-0.0190%	-0.0056%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0006%	0.0048%	0.0007%	-0.0011%	-0.0003%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0007%	0.0042%	0.0007%	-0.0012%	-0.0003%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0010%	0.0041%	0.0009%	-0.0068%	-0.0020%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0003%	0.0014%	0.0002%	-0.0002%	0.0000%
C22	Manufacture of rubber and plastic products	0.0024%	0.0078%	0.0013%	-0.0025%	-0.0008%
C23	Manufacture of other non-metallic mineral products	0.0019%	0.0079%	0.0011%	-0.0045%	-0.0009%
C24	Manufacture of basic metals	0.0011%	0.0039%	0.0010%	-0.0056%	-0.0017%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0019%	0.0089%	0.0012%	-0.0033%	-0.0008%
C26	Manufacture of computer, electronic and optics	0.0022%	0.0063%	0.0034%	-0.0082%	-0.0048%
C27	Manufacture of electrical equipment	0.0021%	0.0104%	0.0014%	-0.0067%	-0.0017%
C28	Manufacture of machinery and equipment n.e.c.	0.0024%	0.0119%	0.0017%	-0.0107%	-0.0028%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0016%	0.0045%	0.0012%	-0.0034%	-0.0010%
C30	Manufacture of other transport equipment	0.0003%	0.0019%	0.0004%	-0.0004%	-0.0001%
C32	Manufacture of furniture; other manufacturing	0.0022%	0.0067%	0.0016%	-0.0022%	-0.0004%
C33	Repair and installation of machinery and equipment	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0004%	0.0026%	0.0005%	-0.0023%	-0.0006%
F	Construction	0.0098%	0.0667%	0.0088%	-0.1501%	-0.0225%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0000%	0.0008%	0.0005%	-0.0004%	0.0000%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0000%	0.0192%	0.0028%	-0.0184%	-0.0035%
G47	Retail trade, except of motor vehicles and motorcycles	0.0000%	0.0052%	0.0014%	-0.0033%	-0.0004%
H49	Land transport and transport via pipelines	0.0000%	0.0107%	0.0027%	-0.0084%	-0.0015%
H50	Water transport	0.0000%	0.0029%	0.0004%	-0.0004%	-0.0001%
H51	Air transport	0.0000%	0.0012%	0.0002%	-0.0001%	0.0000%
H52	Warehousing and support activities for transportation	0.0000%	0.0016%	0.0002%	-0.0002%	0.0000%
H53	Postal and courier activities	0.0000%	0.0003%	0.0000%	0.0000%	0.0000%
I	Accommodation and food service activities	0.0000%	0.0194%	0.0016%	-0.0065%	-0.0007%
J58	Publishing activities	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
J61	Telecommunications	0.0000%	0.0026%	0.0006%	-0.0007%	-0.0002%
J62-J63	Computer programming, consultancy and related activities; information service activities	0.0000%	0.0009%	0.0003%	-0.0002%	0.0000%
K64	Financial service activities, except insurance and pension funding	0.0000%	0.0017%	0.0003%	-0.0009%	-0.0002%
K65	Insurance, pension funding, except compulsory social security	0.0000%	0.0004%	0.0001%	0.0000%	0.0000%
K66	Activities auxiliary to financial services and insurance activities	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
L68	Real estate activities	0.0000%	0.0014%	0.0002%	-0.0008%	-0.0001%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	0.0000%	0.0040%	0.0006%	-0.0018%	-0.0004%
M71	Architectural and engineering; technical testing and analysis	0.0000%	0.0001%	0.0001%	0.0000%	0.0000%
M73	Advertising and market research	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0080%	0.0201%	0.0033%	-0.0128%	-0.0028%
N	Administrative and support service activities	0.0000%	0.0008%	0.0002%	-0.0003%	0.0000%
O84	Public administration and defence; compulsory social security	0.0000%	0.0140%	0.0016%	-0.0085%	-0.0014%
Q	Human health and social work activities	0.0000%	0.0167%	0.0016%	-0.0103%	-0.0009%
R-S	Other service activities	0.0000%	0.0387%	0.0043%	-0.0142%	-0.0029%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0822%	0.4718%	0.0713%	-0.4749%	-0.0915%

Table 13 – Average annual growth of industrial robots contributions to predicted employment growth effects by destination industries in transition economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0164%	0.0227%	0.0221%	-0.0313%	-0.0098%
B	Mining and quarrying	0.0000%	0.0012%	0.0008%	-0.0031%	-0.0006%
C10t12	Manufacture of food products, beverages and tobacco	0.0035%	0.0039%	0.0024%	-0.0051%	-0.0011%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0001%	0.0009%	0.0045%	-0.0004%	-0.0002%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0007%	0.0013%	0.0009%	-0.0002%	-0.0001%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0002%	0.0008%	0.0006%	-0.0003%	-0.0001%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0000%	0.0011%	0.0009%	-0.0030%	-0.0006%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
C22	Manufacture of rubber and plastic products	0.0007%	0.0004%	0.0010%	-0.0001%	-0.0001%
C23	Manufacture of other non-metallic mineral products	0.0010%	0.0016%	0.0010%	-0.0007%	-0.0001%
C24	Manufacture of basic metals	0.0019%	0.0015%	0.0016%	-0.0033%	-0.0010%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0003%	0.0002%	0.0006%	-0.0001%	0.0000%
C26	Manufacture of computer, electronic and optics	0.0011%	0.0030%	0.0017%	-0.0013%	-0.0003%
C27	Manufacture of electrical equipment	0.0000%	0.0001%	0.0003%	0.0000%	0.0000%
C28	Manufacture of machinery and equipment n.e.c.	0.0039%	0.0067%	0.0046%	-0.0042%	-0.0012%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0034%	0.0028%	0.0066%	-0.0022%	-0.0023%
C30	Manufacture of other transport equipment	0.0001%	0.0001%	0.0002%	0.0000%	0.0000%
C32	Manufacture of furniture; other manufacturing	0.0006%	0.0008%	0.0008%	-0.0002%	0.0000%
C33	Repair and installation of machinery and equipment	0.0000%	0.0001%	0.0002%	0.0000%	0.0000%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0009%	0.0024%	0.0019%	-0.0052%	-0.0010%
F	Construction	0.0073%	0.0151%	0.0086%	-0.0515%	-0.0078%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0000%	0.0005%	0.0005%	-0.0003%	-0.0001%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0000%	0.0027%	0.0025%	-0.0108%	-0.0024%
G47	Retail trade, except of motor vehicles and motorcycles	0.0000%	0.0076%	0.0062%	-0.0156%	-0.0034%
H49	Land transport and transport via pipelines	0.0000%	0.0061%	0.0047%	-0.0105%	-0.0027%
H50	Water transport	0.0000%	0.0003%	0.0002%	0.0000%	0.0000%
H51	Air transport	0.0000%	0.0003%	0.0002%	-0.0001%	0.0000%
H52	Warehousing and support activities for transportation	0.0000%	0.0014%	0.0010%	-0.0008%	-0.0002%
H53	Postal and courier activities	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
I	Accommodation and food service activities	0.0000%	0.0026%	0.0013%	-0.0008%	-0.0001%
J58	Publishing activities	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%
J61	Telecommunications	0.0000%	0.0007%	0.0005%	-0.0004%	-0.0001%
J62-J63	Computer programming, consultancy and related activities; information service activities	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%
K64	Financial service activities, except insurance and pension funding	0.0000%	0.0007%	0.0005%	-0.0007%	-0.0002%
K65	Insurance, pension funding, except compulsory social security	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
K66	Activities auxiliary to financial services and insurance activities	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
L68	Real estate activities	0.0000%	0.0013%	0.0006%	-0.0016%	-0.0003%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	0.0000%	0.0001%	0.0001%	0.0000%	0.0000%
M71	Architectural and engineering; technical testing and analysis	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%
M73	Advertising and market research	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0092%	0.0051%	0.0029%	-0.0033%	-0.0006%
N	Administrative and support service activities	0.0000%	0.0027%	0.0019%	-0.0059%	-0.0012%
O84	Public administration and defence; compulsory social security	0.0000%	0.0049%	0.0034%	-0.0095%	-0.0022%
Q	Human health and social work activities	0.0000%	0.0056%	0.0041%	-0.0050%	-0.0012%
R-S	Other service activities	0.0000%	0.0042%	0.0021%	-0.0024%	-0.0004%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0511%	0.1135%	0.0947%	-0.1798%	-0.0413%

Table 14 – Average annual growth of industrial robots contributions to predicted employment growth effects by destination industries in rest of WIOD economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0044%	0.0170%	0.0172%	-0.0121%	-0.0019%
B	Mining and quarrying	0.0002%	0.0006%	0.0008%	-0.0003%	-0.0001%
C10t12	Manufacture of food products, beverages and tobacco	0.0034%	0.0039%	0.0050%	-0.0059%	-0.0010%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0016%	0.0018%	0.0058%	-0.0008%	-0.0002%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0008%	0.0013%	0.0018%	-0.0004%	-0.0001%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0006%	0.0010%	0.0021%	-0.0004%	-0.0001%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0003%	0.0006%	0.0033%	-0.0017%	-0.0005%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0003%	0.0002%	0.0009%	-0.0001%	-0.0002%
C22	Manufacture of rubber and plastic products	0.0025%	0.0012%	0.0051%	-0.0006%	-0.0003%
C23	Manufacture of other non-metallic mineral products	0.0010%	0.0011%	0.0020%	-0.0005%	-0.0001%
C24	Manufacture of basic metals	0.0011%	0.0009%	0.0027%	-0.0008%	-0.0003%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0043%	0.0055%	0.0071%	-0.0033%	-0.0008%
C26	Manufacture of computer, electronic and optics	0.0063%	0.0019%	0.0174%	-0.0074%	-0.0033%
C27	Manufacture of electrical equipment	0.0016%	0.0026%	0.0050%	-0.0011%	-0.0003%
C28	Manufacture of machinery and equipment n.e.c.	0.0024%	0.0051%	0.0061%	-0.0031%	-0.0005%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0029%	0.0023%	0.0059%	-0.0030%	-0.0012%
C30	Manufacture of other transport equipment	0.0005%	0.0011%	0.0020%	-0.0002%	-0.0001%
C32	Manufacture of furniture; other manufacturing	0.0014%	0.0022%	0.0030%	-0.0010%	-0.0002%
C33	Repair and installation of machinery and equipment	0.0000%	0.0019%	0.0023%	-0.0006%	-0.0001%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0008%	0.0016%	0.0037%	-0.0020%	-0.0005%
F	Construction	0.0041%	0.0180%	0.0174%	-0.0433%	-0.0055%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0000%	0.0017%	0.0022%	-0.0006%	-0.0001%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0000%	0.0046%	0.0048%	-0.0094%	-0.0011%
G47	Retail trade, except of motor vehicles and motorcycles	0.0000%	0.0067%	0.0062%	-0.0091%	-0.0012%
H49	Land transport and transport via pipelines	0.0000%	0.0040%	0.0052%	-0.0035%	-0.0007%
H50	Water transport	0.0000%	0.0001%	0.0002%	0.0000%	0.0000%
H51	Air transport	0.0000%	0.0002%	0.0005%	0.0000%	0.0000%
H52	Warehousing and support activities for transportation	0.0000%	0.0007%	0.0009%	-0.0003%	0.0000%
H53	Postal and courier activities	0.0000%	0.0003%	0.0005%	0.0000%	0.0000%
I	Accommodation and food service activities	0.0000%	0.0116%	0.0079%	-0.0063%	-0.0003%
J58	Publishing activities	0.0000%	0.0007%	0.0006%	-0.0002%	0.0000%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0000%	0.0002%	0.0003%	0.0000%	0.0000%
J61	Telecommunications	0.0000%	0.0004%	0.0007%	-0.0002%	0.0000%
J62-J63	Computer programming, consultancy and related activities; information service activities	0.0000%	0.0007%	0.0010%	-0.0002%	0.0000%
K64	Financial service activities, except insurance and pension funding	0.0000%	0.0006%	0.0006%	-0.0007%	-0.0001%
K65	Insurance, pension funding, except compulsory social security	0.0000%	0.0004%	0.0003%	-0.0002%	0.0000%
K66	Activities auxiliary to financial services and insurance activities	0.0000%	0.0001%	0.0001%	0.0000%	0.0000%
L68	Real estate activities	0.0000%	0.0010%	0.0007%	-0.0012%	-0.0002%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	0.0000%	0.0008%	0.0008%	-0.0007%	-0.0001%
M71	Architectural and engineering; technical testing and analysis	0.0000%	0.0015%	0.0013%	-0.0003%	0.0000%
M73	Advertising and market research	0.0000%	0.0004%	0.0004%	-0.0001%	0.0000%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0121%	0.0065%	0.0082%	-0.0077%	-0.0009%
N	Administrative and support service activities	0.0000%	0.0024%	0.0030%	-0.0011%	-0.0002%
O84	Public administration and defence; compulsory social security	0.0000%	0.0056%	0.0044%	-0.0070%	-0.0008%
Q	Human health and social work activities	0.0000%	0.0047%	0.0073%	-0.0069%	-0.0009%
R-S	Other service activities	0.0000%	0.0044%	0.0048%	-0.0032%	-0.0003%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0528%	0.1321%	0.1795%	-0.1473%	-0.0241%

Table 15 – Average annual growth of industrial robots contributions to predicted employment growth effects by origin industries in advanced economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0024%	0.0058%	0.0093%	-0.0096%	-0.0051%
B	Mining and quarrying	0.0003%	0.0040%	0.0141%	-0.0084%	-0.0100%
C10t12	Manufacture of food products, beverages and tobacco	0.0023%	0.0162%	0.0097%	-0.0144%	-0.0034%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0003%	0.0005%	0.0010%	-0.0050%	-0.0020%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0002%	0.0014%	0.0012%	-0.0118%	-0.0049%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0007%	0.0055%	0.0054%	-0.0174%	-0.0064%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0006%	0.0191%	0.0526%	-0.0126%	-0.0121%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0005%	0.0078%	0.0081%	-0.0353%	-0.0086%
C22	Manufacture of rubber and plastic products	0.0021%	0.0142%	0.0311%	-0.0418%	-0.0239%
C23	Manufacture of other non-metallic mineral products	0.0003%	0.0028%	0.0025%	-0.0192%	-0.0053%
C24	Manufacture of basic metals	0.0005%	0.0076%	0.0153%	-0.0156%	-0.0139%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0017%	0.0102%	0.0098%	-0.0249%	-0.0081%
C26	Manufacture of computer, electronic and optics	0.0016%	0.0074%	0.0279%	-0.0139%	-0.0106%
C27	Manufacture of electrical equipment	0.0004%	0.0029%	0.0029%	-0.0144%	-0.0063%
C28	Manufacture of machinery and equipment n.e.c.	0.0011%	0.0034%	0.0092%	-0.0069%	-0.0078%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0014%	0.0064%	0.0161%	-0.0080%	-0.0075%
C30	Manufacture of other transport equipment	0.0004%	0.0014%	0.0033%	-0.0055%	-0.0040%
C32	Manufacture of furniture; other manufacturing	0.0012%	0.0035%	0.0018%	-0.0136%	-0.0046%
C33	Repair and installation of machinery and equipment					
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0005%	0.0059%	0.0063%	-0.0071%	-0.0017%
F	Construction	0.0062%	0.0061%	0.0035%	-0.0039%	-0.0007%
G45	Wholesale and retail and repair of motor vehicles & motorcycles					
G46	Wholesale trade, except of motor vehicles and motorcycles					
G47	Retail trade, except of motor vehicles and motorcycles					
H49	Land transport and transport via pipelines					
H50	Water transport					
H51	Air transport					
H52	Warehousing and support activities for transportation					
H53	Postal and courier activities					
I	Accommodation and food service activities					
J58	Publishing activities					
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities					
J61	Telecommunications					
J62-J63	Computer programming, consultancy and related activities; information service activities					
K64	Financial service activities, except insurance and pension funding					
K65	Insurance, pension funding, except compulsory social security					
K66	Activities auxiliary to financial services and insurance activities					
L68	Real estate activities					
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities					
M71	Architectural and engineering; technical testing and analysis					
M73	Advertising and market research					
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0048%	0.0052%	0.0034%	-0.0092%	-0.0013%
N	Administrative and support service activities					
O84	Public administration and defence; compulsory social security					
Q	Human health and social work activities					
R-S	Other service activities					
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use					
U	Activities of extraterritorial organizations and bodies					
Total		0.0298%	0.1373%	0.2345%	-0.2984%	-0.1481%

Table 16 – Average annual growth of industrial robots contributions to predicted employment growth effects by origin industries in emerging economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0349%	0.0240%	0.0062%	-0.0109%	-0.0011%
B	Mining and quarrying	0.0007%	0.0132%	0.0049%	-0.0124%	-0.0018%
C10t12	Manufacture of food products, beverages and tobacco	0.0038%	0.0712%	0.0077%	-0.0480%	-0.0015%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0040%	0.0113%	0.0096%	-0.0072%	-0.0005%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0006%	0.0050%	0.0016%	-0.0159%	-0.0009%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0007%	0.0105%	0.0024%	-0.0240%	-0.0010%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0010%	0.0840%	0.0204%	-0.0384%	-0.0016%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0003%	0.0071%	0.0008%	-0.0172%	-0.0006%
C22	Manufacture of rubber and plastic products	0.0024%	0.0237%	0.0074%	-0.0449%	-0.0061%
C23	Manufacture of other non-metallic mineral products	0.0019%	0.0177%	0.0032%	-0.0413%	-0.0018%
C24	Manufacture of basic metals	0.0011%	0.0472%	0.0170%	-0.0302%	-0.0048%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0019%	0.0180%	0.0060%	-0.0372%	-0.0041%
C26	Manufacture of computer, electronic and optics	0.0022%	0.0217%	0.0188%	-0.0119%	-0.0022%
C27	Manufacture of electrical equipment	0.0021%	0.0212%	0.0090%	-0.0246%	-0.0033%
C28	Manufacture of machinery and equipment n.e.c.	0.0024%	0.0240%	0.0099%	-0.0203%	-0.0042%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0016%	0.0238%	0.0092%	-0.0238%	-0.0037%
C30	Manufacture of other transport equipment	0.0003%	0.0044%	0.0011%	-0.0122%	-0.0034%
C32	Manufacture of furniture; other manufacturing	0.0022%	0.0048%	0.0018%	-0.0152%	-0.0021%
C33	Repair and installation of machinery and equipment					
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0004%	0.0243%	0.0044%	-0.0255%	-0.0003%
F	Construction	0.0098%	0.0051%	0.0012%	-0.0017%	-0.0003%
G45	Wholesale and retail and repair of motor vehicles & motorcycles					
G46	Wholesale trade, except of motor vehicles and motorcycles					
G47	Retail trade, except of motor vehicles and motorcycles					
H49	Land transport and transport via pipelines					
H50	Water transport					
H51	Air transport					
H52	Warehousing and support activities for transportation					
H53	Postal and courier activities					
I	Accommodation and food service activities					
J58	Publishing activities					
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities					
J61	Telecommunications					
J62-J63	Computer programming, consultancy and related activities; information service activities					
K64	Financial service activities, except insurance and pension funding					
K65	Insurance, pension funding, except compulsory social security					
K66	Activities auxiliary to financial services and insurance activities					
L68	Real estate activities					
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities					
M71	Architectural and engineering; technical testing and analysis					
M73	Advertising and market research					
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0080%	0.0097%	0.0014%	-0.0121%	-0.0003%
N	Administrative and support service activities					
O84	Public administration and defence; compulsory social security					
Q	Human health and social work activities					
R-S	Other service activities					
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use					
U	Activities of extraterritorial organizations and bodies					
Total		0.0822%	0.4718%	0.1438%	-0.4749%	-0.0457%

Table 17 – Average annual growth of industrial robots contributions to predicted employment growth effects by origin industries in transition economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0164%	0.0055%	0.0002%	-0.0036%	-0.0001%
B	Mining and quarrying	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
C10t12	Manufacture of food products, beverages and tobacco	0.0035%	0.0124%	0.0002%	-0.0073%	-0.0001%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0007%	0.0021%	0.0002%	-0.0158%	-0.0005%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0002%	0.0015%	0.0002%	-0.0054%	-0.0002%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0000%	0.0000%	0.0000%	-0.0001%	0.0000%
C22	Manufacture of rubber and plastic products	0.0007%	0.0067%	0.0005%	-0.0312%	-0.0017%
C23	Manufacture of other non-metallic mineral products	0.0010%	0.0063%	0.0002%	-0.0242%	-0.0003%
C24	Manufacture of basic metals	0.0019%	0.0238%	0.0031%	-0.0146%	-0.0017%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0003%	0.0012%	0.0001%	-0.0028%	-0.0007%
C26	Manufacture of computer, electronic and optics	0.0011%	0.0055%	0.0003%	-0.0125%	-0.0006%
C27	Manufacture of electrical equipment	0.0000%	0.0000%	0.0000%	-0.0001%	-0.0002%
C28	Manufacture of machinery and equipment n.e.c.	0.0039%	0.0117%	0.0008%	-0.0182%	-0.0011%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0034%	0.0138%	0.0010%	-0.0189%	-0.0016%
C30	Manufacture of other transport equipment	0.0001%	0.0002%	0.0000%	-0.0007%	-0.0001%
C32	Manufacture of furniture; other manufacturing	0.0006%	0.0026%	0.0001%	-0.0133%	-0.0003%
C33	Repair and installation of machinery and equipment					
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0009%	0.0143%	0.0010%	-0.0080%	-0.0002%
F	Construction	0.0073%	0.0054%	0.0002%	-0.0020%	-0.0001%
G45	Wholesale and retail and repair of motor vehicles & motorcycles					
G46	Wholesale trade, except of motor vehicles and motorcycles					
G47	Retail trade, except of motor vehicles and motorcycles					
H49	Land transport and transport via pipelines					
H50	Water transport					
H51	Air transport					
H52	Warehousing and support activities for transportation					
H53	Postal and courier activities					
I	Accommodation and food service activities					
J58	Publishing activities					
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities					
J61	Telecommunications					
J62-J63	Computer programming, consultancy and related activities; information service activities					
K64	Financial service activities, except insurance and pension funding					
K65	Insurance, pension funding, except compulsory social security					
K66	Activities auxiliary to financial services and insurance activities					
L68	Real estate activities					
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities					
M71	Architectural and engineering; technical testing and analysis					
M73	Advertising and market research					
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0092%	0.0006%	0.0000%	-0.0009%	-0.0001%
N	Administrative and support service activities					
O84	Public administration and defence; compulsory social security					
Q	Human health and social work activities					
R-S	Other service activities					
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use					
U	Activities of extraterritorial organizations and bodies					
Total		0.0511%	0.1135%	0.0080%	-0.1798%	-0.0097%

Table 18 – Average annual growth of industrial robots contributions to predicted employment growth effects by origin industries in rest of WIOD economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0044%	0.0035%	0.0007%	-0.0031%	-0.0007%
B	Mining and quarrying	0.0002%	0.0008%	0.0004%	-0.0032%	-0.0015%
C10t12	Manufacture of food products, beverages and tobacco	0.0034%	0.0217%	0.0018%	-0.0114%	-0.0013%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0016%	0.0014%	0.0012%	-0.0017%	-0.0037%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0008%	0.0026%	0.0009%	-0.0124%	-0.0041%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0006%	0.0044%	0.0008%	-0.0092%	-0.0024%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0003%	0.0081%	0.0029%	-0.0049%	-0.0022%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0003%	0.0015%	0.0015%	-0.0055%	-0.0016%
C22	Manufacture of rubber and plastic products	0.0025%	0.0116%	0.0041%	-0.0203%	-0.0118%
C23	Manufacture of other non-metallic mineral products	0.0010%	0.0058%	0.0012%	-0.0165%	-0.0047%
C24	Manufacture of basic metals	0.0011%	0.0157%	0.0047%	-0.0101%	-0.0109%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0043%	0.0137%	0.0044%	-0.0157%	-0.0085%
C26	Manufacture of computer, electronic and optics	0.0063%	0.0067%	0.0109%	-0.0019%	-0.0071%
C27	Manufacture of electrical equipment	0.0016%	0.0030%	0.0020%	-0.0049%	-0.0067%
C28	Manufacture of machinery and equipment n.e.c.	0.0024%	0.0028%	0.0023%	-0.0037%	-0.0061%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0029%	0.0044%	0.0067%	-0.0030%	-0.0118%
C30	Manufacture of other transport equipment	0.0005%	0.0008%	0.0003%	-0.0026%	-0.0033%
C32	Manufacture of furniture; other manufacturing	0.0014%	0.0013%	0.0005%	-0.0033%	-0.0026%
C33	Repair and installation of machinery and equipment					
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0008%	0.0087%	0.0007%	-0.0075%	-0.0013%
F	Construction	0.0041%	0.0074%	0.0011%	-0.0021%	-0.0005%
G45	Wholesale and retail and repair of motor vehicles & motorcycles					
G46	Wholesale trade, except of motor vehicles and motorcycles					
G47	Retail trade, except of motor vehicles and motorcycles					
H49	Land transport and transport via pipelines					
H50	Water transport					
H51	Air transport					
H52	Warehousing and support activities for transportation					
H53	Postal and courier activities					
I	Accommodation and food service activities					
J58	Publishing activities					
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities					
J61	Telecommunications					
J62-J63	Computer programming, consultancy and related activities; information service activities					
K64	Financial service activities, except insurance and pension funding					
K65	Insurance, pension funding, except compulsory social security					
K66	Activities auxiliary to financial services and insurance activities					
L68	Real estate activities					
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities					
M71	Architectural and engineering; technical testing and analysis					
M73	Advertising and market research					
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0121%	0.0061%	0.0007%	-0.0043%	-0.0008%
N	Administrative and support service activities					
O84	Public administration and defence; compulsory social security					
Q	Human health and social work activities					
R-S	Other service activities					
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use					
U	Activities of extraterritorial organizations and bodies					
Total		0.0528%	0.1321%	0.0496%	-0.1473%	-0.0933%

Table 19 – Average annual growth of industrial robots contributions to predicted real value-added growth effects by destination industries in advanced economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0041%	0.0040%	0.0016%	-0.0020%	0.0015%
B	Mining and quarrying	0.0025%	0.0022%	0.0012%	-0.0024%	0.0020%
C10t12	Manufacture of food products, beverages and tobacco	0.0068%	0.0073%	0.0025%	-0.0096%	0.0061%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0017%	0.0012%	0.0008%	-0.0004%	0.0004%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0026%	0.0008%	0.0004%	-0.0001%	0.0002%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0037%	0.0023%	0.0013%	-0.0011%	0.0013%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0038%	0.0051%	0.0032%	-0.0093%	0.0101%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0083%	0.0017%	0.0012%	-0.0004%	0.0007%
C22	Manufacture of rubber and plastic products	0.0131%	0.0022%	0.0016%	-0.0007%	0.0012%
C23	Manufacture of other non-metallic mineral products	0.0046%	0.0011%	0.0007%	-0.0002%	0.0003%
C24	Manufacture of basic metals	0.0056%	0.0014%	0.0018%	-0.0008%	0.0023%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0062%	0.0038%	0.0027%	-0.0025%	0.0042%
C26	Manufacture of computer, electronic and optics	0.0058%	0.0034%	0.0043%	-0.0045%	0.0045%
C27	Manufacture of electrical equipment	0.0045%	0.0022%	0.0019%	-0.0008%	0.0018%
C28	Manufacture of machinery and equipment n.e.c.	0.0050%	0.0046%	0.0036%	-0.0034%	0.0085%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0078%	0.0052%	0.0048%	-0.0063%	0.0177%
C30	Manufacture of other transport equipment	0.0030%	0.0027%	0.0016%	-0.0013%	0.0020%
C32	Manufacture of furniture; other manufacturing	0.0044%	0.0025%	0.0012%	-0.0012%	0.0012%
C33	Repair and installation of machinery and equipment	0.0000%	0.0004%	0.0006%	-0.0001%	0.0003%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0018%	0.0033%	0.0021%	-0.0027%	0.0037%
F	Construction	0.0046%	0.0153%	0.0077%	-0.0483%	0.0378%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0000%	0.0024%	0.0018%	-0.0014%	0.0017%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0000%	0.0056%	0.0025%	-0.0110%	0.0093%
G47	Retail trade, except of motor vehicles and motorcycles	0.0000%	0.0054%	0.0018%	-0.0090%	0.0065%
H49	Land transport and transport via pipelines	0.0000%	0.0037%	0.0016%	-0.0020%	0.0021%
H50	Water transport	0.0000%	0.0004%	0.0003%	-0.0001%	0.0001%
H51	Air transport	0.0000%	0.0010%	0.0004%	-0.0002%	0.0002%
H52	Warehousing and support activities for transportation	0.0000%	0.0012%	0.0007%	-0.0004%	0.0006%
H53	Postal and courier activities	0.0000%	0.0006%	0.0003%	-0.0001%	0.0001%
I	Accommodation and food service activities	0.0000%	0.0086%	0.0018%	-0.0079%	0.0042%
J58	Publishing activities	0.0000%	0.0015%	0.0004%	-0.0007%	0.0004%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0000%	0.0011%	0.0004%	-0.0005%	0.0004%
J61	Telecommunications	0.0000%	0.0026%	0.0016%	-0.0023%	0.0023%
J62-J63	Computer programming, consultancy and related activities; information service activities	0.0000%	0.0017%	0.0010%	-0.0011%	0.0011%
K64	Financial service activities, except insurance and pension funding	0.0000%	0.0022%	0.0010%	-0.0024%	0.0018%
K65	Insurance, pension funding, except compulsory social security	0.0000%	0.0013%	0.0004%	-0.0016%	0.0012%
K66	Activities auxiliary to financial services and insurance activities	0.0000%	0.0011%	0.0003%	-0.0007%	0.0004%
L68	Real estate activities	0.0000%	0.0098%	0.0021%	-0.0287%	0.0174%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	0.0000%	0.0034%	0.0011%	-0.0047%	0.0034%
M71	Architectural and engineering; technical testing and analysis	0.0000%	0.0020%	0.0007%	-0.0012%	0.0009%
M73	Advertising and market research	0.0000%	0.0009%	0.0003%	-0.0003%	0.0002%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0041%	0.0039%	0.0020%	-0.0039%	0.0038%
N	Administrative and support service activities	0.0000%	0.0040%	0.0018%	-0.0054%	0.0049%
O84	Public administration and defence; compulsory social security	0.0000%	0.0200%	0.0050%	-0.0814%	0.0634%
Q	Human health and social work activities	0.0000%	0.0110%	0.0043%	-0.0315%	0.0210%
R-S	Other service activities	0.0000%	0.0042%	0.0016%	-0.0038%	0.0034%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0000%	0.0001%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.1038%	0.1724%	0.0822%	-0.3004%	0.2585%

Table 20 – Average annual growth of industrial robots contributions to predicted real value-added growth effects by destination industries in emerging economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0040%	0.0463%	0.0050%	-0.0416%	0.0138%
B	Mining and quarrying	0.0026%	0.0319%	0.0034%	-0.0208%	0.0074%
C10t12	Manufacture of food products, beverages and tobacco	0.0112%	0.0239%	0.0038%	-0.0214%	0.0063%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0028%	0.0200%	0.0036%	-0.0141%	0.0075%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0035%	0.0056%	0.0005%	-0.0010%	0.0005%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0033%	0.0081%	0.0012%	-0.0018%	0.0009%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0042%	0.0206%	0.0040%	-0.0261%	0.0136%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0071%	0.0057%	0.0007%	-0.0008%	0.0003%
C22	Manufacture of rubber and plastic products	0.0151%	0.0105%	0.0017%	-0.0025%	0.0016%
C23	Manufacture of other non-metallic mineral products	0.0073%	0.0159%	0.0016%	-0.0070%	0.0024%
C24	Manufacture of basic metals	0.0097%	0.0233%	0.0031%	-0.0259%	0.0134%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0127%	0.0139%	0.0017%	-0.0040%	0.0016%
C26	Manufacture of computer, electronic and optics	0.0086%	0.0173%	0.0085%	-0.0174%	0.0183%
C27	Manufacture of electrical equipment	0.0091%	0.0189%	0.0026%	-0.0093%	0.0042%
C28	Manufacture of machinery and equipment n.e.c.	0.0108%	0.0298%	0.0037%	-0.0204%	0.0094%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0160%	0.0186%	0.0056%	-0.0118%	0.0060%
C30	Manufacture of other transport equipment	0.0075%	0.0076%	0.0010%	-0.0013%	0.0007%
C32	Manufacture of furniture; other manufacturing	0.0135%	0.0094%	0.0017%	-0.0021%	0.0006%
C33	Repair and installation of machinery and equipment	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0024%	0.0200%	0.0030%	-0.0137%	0.0061%
F	Construction	0.0058%	0.0727%	0.0088%	-0.1257%	0.0329%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0000%	0.0015%	0.0006%	-0.0005%	0.0001%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0000%	0.0226%	0.0032%	-0.0171%	0.0057%
G47	Retail trade, except of motor vehicles and motorcycles	0.0000%	0.0068%	0.0019%	-0.0041%	0.0009%
H49	Land transport and transport via pipelines	0.0000%	0.0227%	0.0047%	-0.0117%	0.0038%
H50	Water transport	0.0000%	0.0062%	0.0005%	-0.0007%	0.0002%
H51	Air transport	0.0000%	0.0028%	0.0004%	-0.0002%	0.0001%
H52	Warehousing and support activities for transportation	0.0000%	0.0038%	0.0006%	-0.0004%	0.0001%
H53	Postal and courier activities	0.0000%	0.0008%	0.0001%	0.0000%	0.0000%
I	Accommodation and food service activities	0.0000%	0.0191%	0.0014%	-0.0050%	0.0010%
J58	Publishing activities	0.0000%	0.0002%	0.0001%	0.0000%	0.0000%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0000%	0.0001%	0.0001%	0.0000%	0.0000%
J61	Telecommunications	0.0000%	0.0095%	0.0022%	-0.0021%	0.0010%
J62-J63	Computer programming, consultancy and related activities; information service activities	0.0000%	0.0031%	0.0007%	-0.0004%	0.0002%
K64	Financial service activities, except insurance and pension funding	0.0000%	0.0086%	0.0012%	-0.0042%	0.0011%
K65	Insurance, pension funding, except compulsory social security	0.0000%	0.0017%	0.0002%	-0.0001%	0.0000%
K66	Activities auxiliary to financial services and insurance activities	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
L68	Real estate activities	0.0000%	0.0081%	0.0010%	-0.0046%	0.0012%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	0.0000%	0.0143%	0.0014%	-0.0049%	0.0018%
M71	Architectural and engineering; technical testing and analysis	0.0000%	0.0004%	0.0003%	-0.0001%	0.0000%
M73	Advertising and market research	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0094%	0.0213%	0.0027%	-0.0109%	0.0041%
N	Administrative and support service activities	0.0000%	0.0028%	0.0011%	-0.0015%	0.0005%
O84	Public administration and defence; compulsory social security	0.0000%	0.0193%	0.0022%	-0.0107%	0.0028%
Q	Human health and social work activities	0.0000%	0.0149%	0.0015%	-0.0077%	0.0011%
R-S	Other service activities	0.0000%	0.0143%	0.0016%	-0.0042%	0.0014%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.1668%	0.6245%	0.0949%	-0.4597%	0.1748%

Table 21 – Average annual growth of industrial robots contributions to predicted real value-added growth effects by destination industries in transition economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0019%	0.0069%	0.0051%	-0.0074%	0.0041%
B	Mining and quarrying	0.0000%	0.0103%	0.0042%	-0.0221%	0.0080%
C10t12	Manufacture of food products, beverages and tobacco	0.0065%	0.0063%	0.0031%	-0.0065%	0.0024%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0005%	0.0005%	0.0016%	-0.0002%	0.0001%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0026%	0.0009%	0.0005%	-0.0001%	0.0001%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0009%	0.0013%	0.0007%	-0.0003%	0.0001%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0000%	0.0059%	0.0033%	-0.0124%	0.0048%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0015%	0.0000%	0.0001%	0.0000%	0.0000%
C22	Manufacture of rubber and plastic products	0.0096%	0.0005%	0.0010%	-0.0001%	0.0001%
C23	Manufacture of other non-metallic mineral products	0.0047%	0.0020%	0.0009%	-0.0006%	0.0002%
C24	Manufacture of basic metals	0.0059%	0.0038%	0.0028%	-0.0065%	0.0034%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0052%	0.0002%	0.0004%	-0.0001%	0.0000%
C26	Manufacture of computer, electronic and optics	0.0045%	0.0032%	0.0014%	-0.0010%	0.0004%
C27	Manufacture of electrical equipment	0.0013%	0.0001%	0.0003%	-0.0001%	0.0000%
C28	Manufacture of machinery and equipment n.e.c.	0.0076%	0.0044%	0.0023%	-0.0021%	0.0011%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0121%	0.0032%	0.0055%	-0.0020%	0.0035%
C30	Manufacture of other transport equipment	0.0022%	0.0001%	0.0002%	0.0000%	0.0000%
C32	Manufacture of furniture; other manufacturing	0.0072%	0.0017%	0.0009%	-0.0004%	0.0001%
C33	Repair and installation of machinery and equipment	0.0000%	0.0001%	0.0002%	0.0000%	0.0000%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0012%	0.0048%	0.0029%	-0.0079%	0.0028%
F	Construction	0.0041%	0.0183%	0.0079%	-0.0484%	0.0128%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0000%	0.0013%	0.0008%	-0.0006%	0.0002%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0000%	0.0129%	0.0071%	-0.0419%	0.0165%
G47	Retail trade, except of motor vehicles and motorcycles	0.0000%	0.0055%	0.0032%	-0.0086%	0.0034%
H49	Land transport and transport via pipelines	0.0000%	0.0097%	0.0056%	-0.0129%	0.0057%
H50	Water transport	0.0000%	0.0004%	0.0002%	0.0000%	0.0000%
H51	Air transport	0.0000%	0.0011%	0.0006%	-0.0002%	0.0001%
H52	Warehousing and support activities for transportation	0.0000%	0.0032%	0.0017%	-0.0014%	0.0006%
H53	Postal and courier activities	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%
I	Accommodation and food service activities	0.0000%	0.0022%	0.0009%	-0.0005%	0.0001%
J58	Publishing activities	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%
J61	Telecommunications	0.0000%	0.0019%	0.0012%	-0.0009%	0.0004%
J62-J63	Computer programming, consultancy and related activities; information service activities	0.0000%	0.0001%	0.0003%	0.0000%	0.0000%
K64	Financial service activities, except insurance and pension funding	0.0000%	0.0032%	0.0016%	-0.0026%	0.0010%
K65	Insurance, pension funding, except compulsory social security	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
K66	Activities auxiliary to financial services and insurance activities	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
L68	Real estate activities	0.0000%	0.0053%	0.0022%	-0.0052%	0.0015%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	0.0000%	0.0001%	0.0001%	0.0000%	0.0000%
M71	Architectural and engineering; technical testing and analysis	0.0000%	0.0001%	0.0001%	0.0000%	0.0000%
M73	Advertising and market research	0.0000%	0.0001%	0.0001%	0.0000%	0.0000%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0052%	0.0025%	0.0012%	-0.0013%	0.0004%
N	Administrative and support service activities	0.0000%	0.0053%	0.0026%	-0.0089%	0.0032%
O84	Public administration and defence; compulsory social security	0.0000%	0.0078%	0.0038%	-0.0115%	0.0047%
Q	Human health and social work activities	0.0000%	0.0042%	0.0024%	-0.0029%	0.0012%
R-S	Other service activities	0.0000%	0.0030%	0.0012%	-0.0013%	0.0004%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0847%	0.1445%	0.0826%	-0.2188%	0.0834%

Table 22 – Average annual growth of industrial robots contributions to predicted real value-added growth effects by destination industries in rest of WIOD economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0011%	0.0053%	0.0039%	-0.0026%	0.0007%
B	Mining and quarrying	0.0006%	0.0010%	0.0010%	-0.0003%	0.0002%
C10t12	Manufacture of food products, beverages and tobacco	0.0046%	0.0049%	0.0046%	-0.0055%	0.0016%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0018%	0.0010%	0.0023%	-0.0004%	0.0001%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0029%	0.0009%	0.0009%	-0.0002%	0.0001%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0015%	0.0012%	0.0017%	-0.0004%	0.0002%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0014%	0.0020%	0.0071%	-0.0042%	0.0022%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0027%	0.0009%	0.0071%	-0.0008%	0.0045%
C22	Manufacture of rubber and plastic products	0.0065%	0.0015%	0.0042%	-0.0006%	0.0005%
C23	Manufacture of other non-metallic mineral products	0.0031%	0.0014%	0.0019%	-0.0005%	0.0002%
C24	Manufacture of basic metals	0.0051%	0.0013%	0.0032%	-0.0011%	0.0007%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0057%	0.0050%	0.0051%	-0.0025%	0.0011%
C26	Manufacture of computer, electronic and optics	0.0038%	0.0052%	0.0272%	-0.0153%	0.0109%
C27	Manufacture of electrical equipment	0.0043%	0.0038%	0.0044%	-0.0014%	0.0006%
C28	Manufacture of machinery and equipment n.e.c.	0.0041%	0.0064%	0.0055%	-0.0040%	0.0013%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0063%	0.0033%	0.0061%	-0.0033%	0.0024%
C30	Manufacture of other transport equipment	0.0033%	0.0012%	0.0015%	-0.0002%	0.0001%
C32	Manufacture of furniture; other manufacturing	0.0038%	0.0018%	0.0018%	-0.0006%	0.0002%
C33	Repair and installation of machinery and equipment	0.0000%	0.0025%	0.0020%	-0.0005%	0.0001%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0008%	0.0039%	0.0049%	-0.0039%	0.0015%
F	Construction	0.0021%	0.0163%	0.0114%	-0.0365%	0.0087%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0000%	0.0025%	0.0020%	-0.0008%	0.0003%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0000%	0.0104%	0.0069%	-0.0189%	0.0045%
G47	Retail trade, except of motor vehicles and motorcycles	0.0000%	0.0069%	0.0040%	-0.0071%	0.0015%
H49	Land transport and transport via pipelines	0.0000%	0.0044%	0.0038%	-0.0030%	0.0010%
H50	Water transport	0.0000%	0.0001%	0.0002%	0.0000%	0.0000%
H51	Air transport	0.0000%	0.0004%	0.0006%	-0.0001%	0.0000%
H52	Warehousing and support activities for transportation	0.0000%	0.0018%	0.0014%	-0.0005%	0.0002%
H53	Postal and courier activities	0.0000%	0.0003%	0.0003%	0.0000%	0.0000%
I	Accommodation and food service activities	0.0000%	0.0062%	0.0026%	-0.0024%	0.0003%
J58	Publishing activities	0.0000%	0.0013%	0.0006%	-0.0004%	0.0000%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0000%	0.0003%	0.0003%	0.0000%	0.0000%
J61	Telecommunications	0.0000%	0.0026%	0.0022%	-0.0007%	0.0002%
J62-J63	Computer programming, consultancy and related activities; information service activities	0.0000%	0.0018%	0.0015%	-0.0004%	0.0001%
K64	Financial service activities, except insurance and pension funding	0.0000%	0.0029%	0.0016%	-0.0029%	0.0005%
K65	Insurance, pension funding, except compulsory social security	0.0000%	0.0015%	0.0007%	-0.0009%	0.0002%
K66	Activities auxiliary to financial services and insurance activities	0.0000%	0.0002%	0.0002%	0.0000%	0.0000%
L68	Real estate activities	0.0000%	0.0082%	0.0037%	-0.0085%	0.0017%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	0.0000%	0.0024%	0.0013%	-0.0019%	0.0004%
M71	Architectural and engineering; technical testing and analysis	0.0000%	0.0018%	0.0011%	-0.0003%	0.0001%
M73	Advertising and market research	0.0000%	0.0005%	0.0004%	-0.0001%	0.0000%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0040%	0.0058%	0.0046%	-0.0065%	0.0015%
N	Administrative and support service activities	0.0000%	0.0021%	0.0017%	-0.0009%	0.0002%
O84	Public administration and defence; compulsory social security	0.0000%	0.0081%	0.0043%	-0.0081%	0.0015%
Q	Human health and social work activities	0.0000%	0.0058%	0.0053%	-0.0062%	0.0018%
R-S	Other service activities	0.0000%	0.0034%	0.0025%	-0.0018%	0.0003%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0693%	0.1526%	0.1617%	-0.1573%	0.0545%

Table 23 – Average annual growth of industrial robots contributions to predicted real value-added growth effects by origin industries in advanced economies – Period 2000-2014

Industry	Industry Description	<i>Direct</i>	<i>dom – BW</i>	<i>int – BW</i>	<i>dom – FW</i>	<i>int – FW</i>
A	Agriculture	0.0041%	0.0068%	0.0060%	-0.0091%	0.0066%
B	Mining and quarrying	0.0025%	0.0077%	0.0140%	-0.0112%	0.0202%
C10t12	Manufacture of food products, beverages and tobacco	0.0068%	0.0130%	0.0068%	-0.0106%	0.0050%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0017%	0.0006%	0.0009%	-0.0050%	0.0034%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0026%	0.0018%	0.0011%	-0.0126%	0.0090%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0037%	0.0068%	0.0055%	-0.0169%	0.0121%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0038%	0.0233%	0.0502%	-0.0121%	0.0228%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0083%	0.0090%	0.0121%	-0.0299%	0.0179%
C22	Manufacture of rubber and plastic products	0.0131%	0.0178%	0.0300%	-0.0407%	0.0455%
C23	Manufacture of other non-metallic mineral products	0.0046%	0.0035%	0.0025%	-0.0193%	0.0099%
C24	Manufacture of basic metals	0.0056%	0.0109%	0.0164%	-0.0172%	0.0278%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0062%	0.0140%	0.0104%	-0.0257%	0.0157%
C26	Manufacture of computer, electronic and optics	0.0058%	0.0103%	0.0333%	-0.0152%	0.0234%
C27	Manufacture of electrical equipment	0.0045%	0.0034%	0.0037%	-0.0151%	0.0126%
C28	Manufacture of machinery and equipment n.e.c.	0.0050%	0.0045%	0.0096%	-0.0075%	0.0159%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0078%	0.0079%	0.0171%	-0.0081%	0.0148%
C30	Manufacture of other transport equipment	0.0030%	0.0017%	0.0031%	-0.0057%	0.0071%
C32	Manufacture of furniture; other manufacturing	0.0044%	0.0041%	0.0018%	-0.0131%	0.0086%
C33	Repair and installation of machinery and equipment					
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0018%	0.0071%	0.0064%	-0.0085%	0.0035%
F	Construction	0.0046%	0.0108%	0.0034%	-0.0066%	0.0014%
G45	Wholesale and retail and repair of motor vehicles & motorcycles					
G46	Wholesale trade, except of motor vehicles and motorcycles					
G47	Retail trade, except of motor vehicles and motorcycles					
H49	Land transport and transport via pipelines					
H50	Water transport					
H51	Air transport					
H52	Warehousing and support activities for transportation					
H53	Postal and courier activities					
I	Accommodation and food service activities					
J58	Publishing activities					
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities					
J61	Telecommunications					
J62-J63	Computer programming, consultancy and related activities; information service activities					
K64	Financial service activities, except insurance and pension funding					
K65	Insurance, pension funding, except compulsory social security					
K66	Activities auxiliary to financial services and insurance activities					
L68	Real estate activities					
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities					
M71	Architectural and engineering; technical testing and analysis					
M73	Advertising and market research					
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0041%	0.0072%	0.0036%	-0.0102%	0.0026%
N	Administrative and support service activities					
O84	Public administration and defence; compulsory social security					
Q	Human health and social work activities					
R-S	Other service activities					
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use					
U	Activities of extraterritorial organizations and bodies					
Total		0.1038%	0.1724%	0.2382%	-0.3004%	0.2859%

Table 24 – Average annual growth of industrial robots contributions to predicted real value-added growth effects by origin industries in emerging economies – Period 2000-2014

Industry	Industry Description	<i>Direct</i>	<i>dom – BW</i>	<i>int – BW</i>	<i>dom – FW</i>	<i>int – FW</i>
A	Agriculture	0.0040%	0.0360%	0.0039%	-0.0144%	0.0013%
B	Mining and quarrying	0.0026%	0.0230%	0.0045%	-0.0164%	0.0039%
C10t12	Manufacture of food products, beverages and tobacco	0.0112%	0.0562%	0.0052%	-0.0242%	0.0019%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0028%	0.0150%	0.0071%	-0.0070%	0.0010%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0035%	0.0074%	0.0014%	-0.0176%	0.0018%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0033%	0.0147%	0.0022%	-0.0248%	0.0018%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0042%	0.1005%	0.0179%	-0.0316%	0.0029%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0071%	0.0066%	0.0007%	-0.0123%	0.0011%
C22	Manufacture of rubber and plastic products	0.0151%	0.0351%	0.0068%	-0.0475%	0.0115%
C23	Manufacture of other non-metallic mineral products	0.0073%	0.0233%	0.0029%	-0.0391%	0.0033%
C24	Manufacture of basic metals	0.0097%	0.0729%	0.0158%	-0.0325%	0.0098%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0127%	0.0275%	0.0054%	-0.0398%	0.0079%
C26	Manufacture of computer, electronic and optics	0.0086%	0.0324%	0.0207%	-0.0125%	0.0046%
C27	Manufacture of electrical equipment	0.0091%	0.0340%	0.0085%	-0.0274%	0.0065%
C28	Manufacture of machinery and equipment n.e.c.	0.0108%	0.0361%	0.0092%	-0.0212%	0.0085%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0160%	0.0337%	0.0087%	-0.0231%	0.0075%
C30	Manufacture of other transport equipment	0.0075%	0.0051%	0.0010%	-0.0096%	0.0064%
C32	Manufacture of furniture; other manufacturing	0.0135%	0.0078%	0.0015%	-0.0183%	0.0038%
C33	Repair and installation of machinery and equipment					
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0024%	0.0348%	0.0039%	-0.0263%	0.0006%
F	Construction	0.0058%	0.0066%	0.0012%	-0.0015%	0.0007%
G45	Wholesale and retail and repair of motor vehicles & motorcycles					
G46	Wholesale trade, except of motor vehicles and motorcycles					
G47	Retail trade, except of motor vehicles and motorcycles					
H49	Land transport and transport via pipelines					
H50	Water transport					
H51	Air transport					
H52	Warehousing and support activities for transportation					
H53	Postal and courier activities					
I	Accommodation and food service activities					
J58	Publishing activities					
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities					
J61	Telecommunications					
J62-J63	Computer programming, consultancy and related activities; information service activities					
K64	Financial service activities, except insurance and pension funding					
K65	Insurance, pension funding, except compulsory social security					
K66	Activities auxiliary to financial services and insurance activities					
L68	Real estate activities					
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities					
M71	Architectural and engineering; technical testing and analysis					
M73	Advertising and market research					
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0094%	0.0159%	0.0012%	-0.0127%	0.0006%
N	Administrative and support service activities					
O84	Public administration and defence; compulsory social security					
Q	Human health and social work activities					
R-S	Other service activities					
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use					
U	Activities of extraterritorial organizations and bodies					
Total		0.1668%	0.6245%	0.1298%	-0.4597%	0.0875%

Table 25 – Average annual growth of industrial robots contributions to predicted real value-added growth effects by origin industries in transition economies – Period 2000-2014

Industry	Industry Description	<i>Direct</i>	<i>dom – BW</i>	<i>int – BW</i>	<i>dom – FW</i>	<i>int – FW</i>
A	Agriculture	0.0019%	0.0077%	0.0002%	-0.0046%	0.0001%
B	Mining and quarrying	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
C10t12	Manufacture of food products, beverages and tobacco	0.0065%	0.0082%	0.0002%	-0.0039%	0.0002%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0005%	0.0000%	0.0000%	0.0000%	0.0001%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0026%	0.0029%	0.0001%	-0.0190%	0.0010%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0009%	0.0020%	0.0001%	-0.0073%	0.0004%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0015%	0.0000%	0.0000%	-0.0001%	0.0000%
C22	Manufacture of rubber and plastic products	0.0096%	0.0096%	0.0004%	-0.0427%	0.0033%
C23	Manufacture of other non-metallic mineral products	0.0047%	0.0082%	0.0002%	-0.0259%	0.0006%
C24	Manufacture of basic metals	0.0059%	0.0295%	0.0029%	-0.0169%	0.0034%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0052%	0.0015%	0.0001%	-0.0028%	0.0014%
C26	Manufacture of computer, electronic and optics	0.0045%	0.0076%	0.0002%	-0.0158%	0.0012%
C27	Manufacture of electrical equipment	0.0013%	0.0000%	0.0000%	-0.0001%	0.0005%
C28	Manufacture of machinery and equipment n.e.c.	0.0076%	0.0160%	0.0007%	-0.0228%	0.0021%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0121%	0.0182%	0.0009%	-0.0226%	0.0032%
C30	Manufacture of other transport equipment	0.0022%	0.0002%	0.0000%	-0.0008%	0.0002%
C32	Manufacture of furniture; other manufacturing	0.0072%	0.0037%	0.0001%	-0.0178%	0.0005%
C33	Repair and installation of machinery and equipment					
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0012%	0.0207%	0.0009%	-0.0120%	0.0004%
F	Construction	0.0041%	0.0075%	0.0002%	-0.0026%	0.0002%
G45	Wholesale and retail and repair of motor vehicles & motorcycles					
G46	Wholesale trade, except of motor vehicles and motorcycles					
G47	Retail trade, except of motor vehicles and motorcycles					
H49	Land transport and transport via pipelines					
H50	Water transport					
H51	Air transport					
H52	Warehousing and support activities for transportation					
H53	Postal and courier activities					
I	Accommodation and food service activities					
J58	Publishing activities					
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities					
J61	Telecommunications					
J62-J63	Computer programming, consultancy and related activities; information service activities					
K64	Financial service activities, except insurance and pension funding					
K65	Insurance, pension funding, except compulsory social security					
K66	Activities auxiliary to financial services and insurance activities					
L68	Real estate activities					
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities					
M71	Architectural and engineering; technical testing and analysis					
M73	Advertising and market research					
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0052%	0.0009%	0.0000%	-0.0009%	0.0001%
N	Administrative and support service activities					
O84	Public administration and defence; compulsory social security					
Q	Human health and social work activities					
R-S	Other service activities					
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use					
U	Activities of extraterritorial organizations and bodies					
Total		0.0847%	0.1445%	0.0074%	-0.2188%	0.0190%

Table 26 – Average annual growth of industrial robots contributions to predicted real value-added growth effects by origin industries in rest of WIOD economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0011%	0.0035%	0.0004%	-0.0026%	0.0009%
B	Mining and quarrying	0.0006%	0.0010%	0.0003%	-0.0038%	0.0026%
C10t12	Manufacture of food products, beverages and tobacco	0.0046%	0.0169%	0.0012%	-0.0086%	0.0019%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0018%	0.0011%	0.0009%	-0.0017%	0.0059%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0029%	0.0040%	0.0007%	-0.0147%	0.0075%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0015%	0.0058%	0.0007%	-0.0114%	0.0045%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0014%	0.0071%	0.0023%	-0.0036%	0.0041%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0027%	0.0026%	0.0011%	-0.0040%	0.0026%
C22	Manufacture of rubber and plastic products	0.0065%	0.0127%	0.0036%	-0.0234%	0.0221%
C23	Manufacture of other non-metallic mineral products	0.0031%	0.0060%	0.0010%	-0.0156%	0.0084%
C24	Manufacture of basic metals	0.0051%	0.0143%	0.0044%	-0.0096%	0.0217%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0057%	0.0178%	0.0039%	-0.0189%	0.0162%
C26	Manufacture of computer, electronic and optics	0.0038%	0.0106%	0.0124%	-0.0033%	0.0155%
C27	Manufacture of electrical equipment	0.0043%	0.0044%	0.0020%	-0.0061%	0.0132%
C28	Manufacture of machinery and equipment n.e.c.	0.0041%	0.0035%	0.0021%	-0.0036%	0.0123%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0063%	0.0043%	0.0061%	-0.0024%	0.0241%
C30	Manufacture of other transport equipment	0.0033%	0.0007%	0.0002%	-0.0024%	0.0059%
C32	Manufacture of furniture; other manufacturing	0.0038%	0.0013%	0.0004%	-0.0026%	0.0045%
C33	Repair and installation of machinery and equipment					
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0008%	0.0112%	0.0006%	-0.0090%	0.0026%
F	Construction	0.0021%	0.0124%	0.0009%	-0.0036%	0.0009%
G45	Wholesale and retail and repair of motor vehicles & motorcycles					
G46	Wholesale trade, except of motor vehicles and motorcycles					
G47	Retail trade, except of motor vehicles and motorcycles					
H49	Land transport and transport via pipelines					
H50	Water transport					
H51	Air transport					
H52	Warehousing and support activities for transportation					
H53	Postal and courier activities					
I	Accommodation and food service activities					
J58	Publishing activities					
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities					
J61	Telecommunications					
J62-J63	Computer programming, consultancy and related activities; information service activities					
K64	Financial service activities, except insurance and pension funding					
K65	Insurance, pension funding, except compulsory social security					
K66	Activities auxiliary to financial services and insurance activities					
L68	Real estate activities					
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities					
M71	Architectural and engineering; technical testing and analysis					
M73	Advertising and market research					
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0040%	0.0116%	0.0006%	-0.0065%	0.0015%
N	Administrative and support service activities					
O84	Public administration and defence; compulsory social security					
Q	Human health and social work activities					
R-S	Other service activities					
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use					
U	Activities of extraterritorial organizations and bodies					
Total		0.0693%	0.1526%	0.0460%	-0.1573%	0.1789%

Table 27 – Average annual industrial TFP growth contributions to predicted employment growth effects by destination industries in advanced economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0053%	0.0000%	0.0013%	0.0000%	0.0045%
B	Mining and quarrying	-0.0001%	0.0001%	0.0001%	0.0001%	0.0006%
C10t12	Manufacture of food products, beverages and tobacco	-0.0001%	0.0005%	0.0010%	0.0005%	0.0090%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0008%	0.0000%	0.0009%	-0.0001%	0.0028%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0001%	0.0001%	0.0003%	0.0000%	0.0012%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0005%	0.0001%	0.0006%	0.0001%	0.0030%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	-0.0001%	0.0000%	0.0003%	-0.0001%	0.0042%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0002%	0.0000%	0.0001%	0.0000%	0.0004%
C22	Manufacture of rubber and plastic products	0.0004%	0.0000%	0.0006%	0.0000%	0.0023%
C23	Manufacture of other non-metallic mineral products	0.0004%	0.0000%	0.0002%	0.0000%	0.0007%
C24	Manufacture of basic metals	0.0004%	-0.0001%	0.0003%	-0.0002%	0.0023%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0009%	0.0004%	0.0010%	0.0002%	0.0082%
C26	Manufacture of computer, electronic and optics	0.0014%	0.0001%	0.0019%	0.0000%	0.0032%
C27	Manufacture of electrical equipment	0.0004%	0.0002%	0.0008%	0.0000%	0.0028%
C28	Manufacture of machinery and equipment n.e.c.	0.0016%	0.0004%	0.0014%	0.0002%	0.0138%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0013%	0.0004%	0.0016%	0.0005%	0.0237%
C30	Manufacture of other transport equipment	0.0002%	0.0002%	0.0005%	0.0001%	0.0003%
C32	Manufacture of furniture; other manufacturing	0.0005%	0.0002%	0.0008%	0.0001%	0.0030%
C33	Repair and installation of machinery and equipment	0.0005%	0.0001%	0.0004%	0.0000%	0.0006%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	-0.0006%	0.0001%	0.0002%	-0.0001%	0.0018%
F	Construction	-0.0009%	0.0012%	0.0038%	0.0036%	0.0800%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0002%	0.0005%	0.0011%	0.0002%	0.0036%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0027%	0.0004%	0.0012%	0.0008%	0.0160%
G47	Retail trade, except of motor vehicles and motorcycles	0.0055%	0.0010%	0.0016%	0.0021%	0.0195%
H49	Land transport and transport via pipelines	0.0005%	0.0002%	0.0008%	0.0001%	0.0036%
H50	Water transport	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%
H51	Air transport	0.0001%	0.0001%	0.0001%	0.0000%	0.0001%
H52	Warehousing and support activities for transportation	-0.0001%	0.0001%	0.0003%	0.0000%	0.0011%
H53	Postal and courier activities	0.0000%	0.0001%	0.0002%	0.0000%	0.0001%
I	Accommodation and food service activities	-0.0004%	0.0012%	0.0017%	0.0012%	0.0146%
J58	Publishing activities	0.0002%	0.0002%	0.0002%	0.0001%	0.0005%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	-0.0001%	0.0001%	0.0002%	0.0000%	0.0002%
J61	Telecommunications	0.0009%	0.0002%	0.0004%	0.0002%	0.0008%
J62-J63	Computer programming, consultancy and related activities; information service activities	-0.0002%	0.0003%	0.0005%	0.0002%	0.0010%
K64	Financial service activities, except insurance and pension funding	0.0023%	0.0003%	0.0003%	0.0002%	0.0020%
K65	Insurance, pension funding, except compulsory social security	0.0012%	0.0001%	0.0002%	0.0001%	0.0047%
K66	Activities auxiliary to financial services and insurance activities	-0.0006%	0.0001%	0.0001%	0.0001%	0.0003%
L68	Real estate activities	0.0002%	0.0001%	0.0001%	0.0004%	0.0044%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	-0.0006%	0.0005%	0.0005%	0.0008%	0.0030%
M71	Architectural and engineering; technical testing and analysis	-0.0003%	0.0002%	0.0003%	0.0002%	0.0009%
M73	Advertising and market research	-0.0003%	0.0001%	0.0002%	0.0000%	0.0003%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	-0.0010%	0.0004%	0.0013%	0.0001%	0.0082%
N	Administrative and support service activities	-0.0012%	0.0012%	0.0014%	0.0019%	0.0141%
O84	Public administration and defence; compulsory social security	0.0030%	0.0026%	0.0022%	0.0152%	0.0813%
Q	Human health and social work activities	-0.0013%	0.0022%	0.0030%	0.0068%	0.0533%
R-S	Other service activities	-0.0004%	0.0006%	0.0013%	0.0004%	0.0076%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0232%	0.0167%	0.0373%	0.0358%	0.4096%

Table 28 – Average annual industrial TFP growth contributions to predicted employment growth effects by destination industries in emerging economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0416%	0.0442%	0.0059%	0.0807%	0.0534%
B	Mining and quarrying	0.0003%	0.0028%	0.0003%	0.0025%	0.0011%
C10t12	Manufacture of food products, beverages and tobacco	0.0011%	0.0044%	0.0006%	0.0039%	0.0034%
C13t15	Manufacture of textiles, wearing apparel and leather products	-0.0002%	0.0085%	0.0024%	0.0084%	0.0156%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0004%	0.0021%	0.0003%	0.0005%	0.0004%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0002%	0.0015%	0.0003%	0.0005%	0.0008%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0007%	0.0009%	0.0002%	0.0019%	0.0003%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0001%	0.0006%	0.0001%	0.0001%	0.0001%
C22	Manufacture of rubber and plastic products	0.0007%	0.0027%	0.0004%	0.0010%	0.0006%
C23	Manufacture of other non-metallic mineral products	0.0005%	0.0023%	0.0004%	0.0013%	0.0001%
C24	Manufacture of basic metals	-0.0001%	0.0011%	0.0002%	0.0017%	0.0002%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0006%	0.0014%	0.0003%	0.0008%	0.0000%
C26	Manufacture of computer, electronic and optics	-0.0001%	0.0018%	0.0017%	0.0027%	0.0184%
C27	Manufacture of electrical equipment	-0.0001%	0.0023%	0.0005%	0.0017%	0.0023%
C28	Manufacture of machinery and equipment n.e.c.	0.0009%	0.0027%	0.0007%	0.0031%	0.0037%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0003%	0.0011%	0.0005%	0.0007%	0.0019%
C30	Manufacture of other transport equipment	0.0001%	0.0005%	0.0002%	0.0001%	0.0002%
C32	Manufacture of furniture; other manufacturing	-0.0012%	0.0024%	0.0006%	0.0006%	0.0006%
C33	Repair and installation of machinery and equipment	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0003%	0.0009%	0.0002%	0.0011%	0.0012%
F	Construction	0.0020%	0.0203%	0.0025%	0.0535%	0.0244%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0002%	0.0001%	0.0003%	0.0000%	0.0002%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0054%	0.0101%	0.0014%	0.0136%	0.0124%
G47	Retail trade, except of motor vehicles and motorcycles	0.0010%	0.0026%	0.0006%	0.0011%	0.0021%
H49	Land transport and transport via pipelines	0.0024%	0.0041%	0.0012%	0.0026%	0.0030%
H50	Water transport	-0.0003%	0.0014%	0.0002%	0.0005%	0.0002%
H51	Air transport	0.0003%	0.0005%	0.0001%	0.0001%	0.0000%
H52	Warehousing and support activities for transportation	0.0004%	0.0007%	0.0001%	0.0001%	0.0001%
H53	Postal and courier activities	-0.0002%	0.0002%	0.0000%	0.0000%	0.0000%
I	Accommodation and food service activities	-0.0007%	0.0075%	0.0007%	0.0027%	0.0017%
J58	Publishing activities	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%
J61	Telecommunications	0.0000%	0.0010%	0.0004%	0.0003%	0.0007%
J62-J63	Computer programming, consultancy and related activities; information service activities	0.0004%	0.0004%	0.0002%	0.0000%	0.0003%
K64	Financial service activities, except insurance and pension funding	0.0013%	0.0006%	0.0002%	0.0004%	0.0006%
K65	Insurance, pension funding, except compulsory social security	0.0000%	0.0002%	0.0000%	0.0000%	0.0000%
K66	Activities auxiliary to financial services and insurance activities	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
L68	Real estate activities	0.0010%	0.0005%	0.0001%	0.0003%	0.0004%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	0.0007%	0.0016%	0.0003%	0.0007%	0.0010%
M71	Architectural and engineering; technical testing and analysis	0.0002%	0.0000%	0.0001%	0.0000%	0.0001%
M73	Advertising and market research	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	-0.0003%	0.0078%	0.0016%	0.0054%	0.0076%
N	Administrative and support service activities	-0.0004%	0.0003%	0.0001%	0.0000%	0.0001%
O84	Public administration and defence; compulsory social security	-0.0013%	0.0057%	0.0008%	0.0053%	0.0030%
Q	Human health and social work activities	-0.0021%	0.0062%	0.0007%	0.0033%	0.0033%
R-S	Other service activities	-0.0062%	0.0154%	0.0021%	0.0072%	0.0070%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0500%	0.1714%	0.0290%	0.2102%	0.1723%

Table 29 – Average annual industrial TFP growth contributions to predicted employment growth effects by destination industries in transition economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0254%	0.0192%	0.0122%	0.0251%	0.0807%
B	Mining and quarrying	0.0000%	0.0016%	0.0005%	0.0025%	0.0049%
C10t12	Manufacture of food products, beverages and tobacco	0.0015%	0.0036%	0.0014%	0.0038%	0.0087%
C13t15	Manufacture of textiles, wearing apparel and leather products	-0.0001%	0.0018%	0.0025%	0.0007%	0.0015%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0003%	0.0011%	0.0005%	0.0002%	0.0004%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0002%	0.0008%	0.0004%	0.0002%	0.0005%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0014%	0.0012%	0.0006%	0.0014%	0.0029%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
C22	Manufacture of rubber and plastic products	0.0003%	0.0005%	0.0004%	0.0001%	0.0002%
C23	Manufacture of other non-metallic mineral products	0.0004%	0.0013%	0.0006%	0.0004%	0.0009%
C24	Manufacture of basic metals	-0.0006%	0.0020%	0.0008%	0.0029%	0.0087%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0001%	0.0002%	0.0003%	0.0001%	0.0000%
C26	Manufacture of computer, electronic and optics	0.0006%	0.0016%	0.0009%	0.0006%	0.0025%
C27	Manufacture of electrical equipment	0.0000%	0.0001%	0.0002%	0.0000%	0.0000%
C28	Manufacture of machinery and equipment n.e.c.	0.0023%	0.0036%	0.0025%	0.0019%	0.0097%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0014%	0.0016%	0.0041%	0.0012%	0.0159%
C30	Manufacture of other transport equipment	0.0001%	0.0001%	0.0001%	0.0000%	0.0000%
C32	Manufacture of furniture; other manufacturing	-0.0006%	0.0007%	0.0004%	0.0002%	0.0003%
C33	Repair and installation of machinery and equipment	0.0001%	0.0001%	0.0001%	0.0000%	0.0000%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0012%	0.0028%	0.0012%	0.0032%	0.0068%
F	Construction	0.0011%	0.0115%	0.0045%	0.0244%	0.0465%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0002%	0.0007%	0.0003%	0.0002%	0.0003%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0023%	0.0029%	0.0015%	0.0087%	0.0142%
G47	Retail trade, except of motor vehicles and motorcycles	0.0041%	0.0100%	0.0036%	0.0132%	0.0206%
H49	Land transport and transport via pipelines	0.0049%	0.0048%	0.0026%	0.0057%	0.0161%
H50	Water transport	-0.0001%	0.0002%	0.0001%	0.0000%	0.0000%
H51	Air transport	0.0002%	0.0002%	0.0001%	0.0000%	0.0001%
H52	Warehousing and support activities for transportation	0.0014%	0.0012%	0.0006%	0.0004%	0.0011%
H53	Postal and courier activities	-0.0001%	0.0001%	0.0000%	0.0000%	0.0000%
I	Accommodation and food service activities	-0.0007%	0.0018%	0.0008%	0.0004%	0.0007%
J58	Publishing activities	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
J61	Telecommunications	0.0000%	0.0008%	0.0004%	0.0004%	0.0006%
J62-J63	Computer programming, consultancy and related activities; information service activities	0.0001%	0.0000%	0.0001%	0.0000%	0.0000%
K64	Financial service activities, except insurance and pension funding	0.0012%	0.0009%	0.0003%	0.0005%	0.0010%
K65	Insurance, pension funding, except compulsory social security	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
K66	Activities auxiliary to financial services and insurance activities	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
L68	Real estate activities	-0.0002%	0.0008%	0.0003%	0.0005%	0.0012%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	0.0001%	0.0001%	0.0001%	0.0001%	0.0000%
M71	Architectural and engineering; technical testing and analysis	0.0001%	0.0001%	0.0000%	0.0000%	0.0000%
M73	Advertising and market research	0.0003%	0.0001%	0.0000%	0.0000%	0.0000%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0000%	0.0086%	0.0018%	0.0041%	0.0035%
N	Administrative and support service activities	-0.0049%	0.0035%	0.0012%	0.0040%	0.0080%
O84	Public administration and defence; compulsory social security	-0.0006%	0.0067%	0.0022%	0.0082%	0.0146%
Q	Human health and social work activities	-0.0076%	0.0070%	0.0025%	0.0041%	0.0058%
R-S	Other service activities	-0.0044%	0.0036%	0.0012%	0.0014%	0.0020%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0313%	0.1096%	0.0540%	0.1210%	0.2809%

Table 30 – Average annual industrial TFP growth contributions to predicted employment growth effects by destination industries in rest of WIOD economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0135%	0.0051%	0.0071%	0.0064%	0.0109%
B	Mining and quarrying	-0.0001%	0.0004%	0.0005%	0.0002%	0.0003%
C10t12	Manufacture of food products, beverages and tobacco	-0.0002%	0.0067%	0.0025%	0.0067%	0.0056%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0018%	0.0008%	0.0031%	0.0009%	0.0014%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0002%	0.0010%	0.0012%	0.0004%	0.0008%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0004%	0.0001%	0.0011%	0.0002%	0.0007%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	-0.0001%	0.0000%	0.0005%	0.0005%	0.0000%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0003%	0.0001%	0.0003%	0.0000%	0.0003%
C22	Manufacture of rubber and plastic products	0.0005%	-0.0002%	0.0015%	0.0002%	0.0009%
C23	Manufacture of other non-metallic mineral products	0.0007%	0.0002%	0.0008%	0.0002%	0.0006%
C24	Manufacture of basic metals	0.0005%	0.0000%	0.0007%	0.0003%	0.0007%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0012%	0.0005%	0.0023%	0.0009%	0.0022%
C26	Manufacture of computer, electronic and optics	0.0034%	-0.0001%	0.0124%	0.0043%	0.0116%
C27	Manufacture of electrical equipment	0.0006%	0.0005%	0.0029%	0.0003%	0.0011%
C28	Manufacture of machinery and equipment n.e.c.	0.0019%	0.0007%	0.0028%	0.0007%	0.0019%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0014%	0.0009%	0.0036%	0.0013%	0.0050%
C30	Manufacture of other transport equipment	0.0002%	0.0003%	0.0010%	0.0001%	0.0001%
C32	Manufacture of furniture; other manufacturing	0.0005%	0.0011%	0.0017%	0.0005%	0.0011%
C33	Repair and installation of machinery and equipment	0.0009%	0.0004%	0.0012%	0.0002%	0.0003%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	-0.0013%	0.0006%	0.0011%	0.0018%	0.0013%
F	Construction	-0.0010%	0.0049%	0.0074%	0.0146%	0.0217%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0001%	0.0007%	0.0014%	0.0004%	0.0006%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0030%	0.0021%	0.0023%	0.0114%	0.0049%
G47	Retail trade, except of motor vehicles and motorcycles	0.0047%	0.0020%	0.0030%	0.0070%	0.0056%
H49	Land transport and transport via pipelines	0.0006%	0.0013%	0.0022%	0.0021%	0.0023%
H50	Water transport	0.0000%	0.0000%	0.0001%	0.0000%	0.0000%
H51	Air transport	0.0001%	0.0000%	0.0001%	0.0000%	0.0000%
H52	Warehousing and support activities for transportation	-0.0001%	0.0002%	0.0005%	0.0002%	0.0002%
H53	Postal and courier activities	0.0000%	0.0002%	0.0002%	0.0000%	0.0000%
I	Accommodation and food service activities	-0.0015%	0.0059%	0.0028%	0.0038%	0.0012%
J58	Publishing activities	0.0001%	0.0002%	0.0004%	0.0001%	0.0001%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0000%	0.0002%	0.0002%	0.0001%	0.0000%
J61	Telecommunications	0.0007%	0.0002%	0.0005%	0.0002%	0.0002%
J62-J63	Computer programming, consultancy and related activities; information service activities	-0.0001%	0.0004%	0.0009%	0.0001%	0.0000%
K64	Financial service activities, except insurance and pension funding	0.0020%	0.0005%	0.0006%	0.0008%	0.0007%
K65	Insurance, pension funding, except compulsory social security	0.0008%	0.0003%	0.0003%	0.0002%	0.0001%
K66	Activities auxiliary to financial services and insurance activities	-0.0003%	0.0002%	0.0001%	0.0000%	0.0000%
L68	Real estate activities	0.0002%	0.0004%	0.0004%	0.0009%	0.0009%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	-0.0004%	0.0004%	0.0005%	0.0001%	0.0004%
M71	Architectural and engineering; technical testing and analysis	-0.0003%	0.0005%	0.0009%	0.0001%	0.0002%
M73	Advertising and market research	-0.0003%	0.0002%	0.0002%	0.0001%	0.0000%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	-0.0019%	0.0019%	0.0044%	0.0043%	0.0038%
N	Administrative and support service activities	-0.0007%	0.0007%	0.0017%	0.0003%	0.0001%
O84	Public administration and defence; compulsory social security	0.0019%	0.0011%	0.0022%	0.0035%	0.0043%
Q	Human health and social work activities	-0.0008%	0.0018%	0.0034%	0.0019%	0.0029%
R-S	Other service activities	-0.0006%	0.0006%	0.0023%	0.0015%	0.0010%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	-0.0005%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0322%	0.0460%	0.0875%	0.0796%	0.0979%

Table 31 – Average annual industrial TFP growth contributions to predicted employment growth effects by origin industries in advanced economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0053%	0.0011%	0.0032%	0.0008%	0.0363%
B	Mining and quarrying	-0.0001%	-0.0001%	-0.0154%	-0.0030%	-0.1019%
C10t12	Manufacture of food products, beverages and tobacco	-0.0001%	0.0000%	0.0009%	0.0001%	0.0031%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0008%	0.0003%	0.0041%	0.0013%	0.0278%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0001%	0.0002%	0.0009%	0.0004%	0.0207%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0005%	0.0012%	0.0063%	0.0026%	0.0327%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	-0.0001%	-0.0007%	0.0088%	-0.0001%	0.0379%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0002%	0.0009%	0.0019%	0.0031%	0.0360%
C22	Manufacture of rubber and plastic products	0.0004%	0.0009%	0.0060%	0.0019%	0.0158%
C23	Manufacture of other non-metallic mineral products	0.0004%	0.0004%	0.0018%	0.0020%	0.0165%
C24	Manufacture of basic metals	0.0004%	0.0006%	0.0056%	0.0019%	0.0184%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0009%	-0.0001%	0.0020%	0.0002%	0.0030%
C26	Manufacture of computer, electronic and optics	0.0014%	0.0039%	0.0272%	0.0052%	0.0379%
C27	Manufacture of electrical equipment	0.0004%	0.0008%	0.0057%	0.0021%	0.0010%
C28	Manufacture of machinery and equipment n.e.c.	0.0016%	0.0008%	0.0057%	0.0010%	0.0207%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0013%	0.0016%	0.0178%	0.0010%	0.0379%
C30	Manufacture of other transport equipment	0.0002%	0.0003%	0.0019%	0.0012%	-0.0152%
C32	Manufacture of furniture; other manufacturing	0.0005%	0.0002%	0.0004%	0.0011%	0.0021%
C33	Repair and installation of machinery and equipment	0.0005%	0.0001%	0.0006%	-0.0002%	0.0038%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	-0.0006%	-0.0031%	-0.0048%	-0.0027%	-0.0146%
F	Construction	-0.0009%	-0.0005%	-0.0001%	-0.0003%	0.0000%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0002%	0.0000%	0.0004%	-0.0003%	0.0006%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0027%	0.0017%	0.0071%	0.0008%	0.0147%
G47	Retail trade, except of motor vehicles and motorcycles	0.0055%	0.0002%	0.0006%	0.0001%	0.0014%
H49	Land transport and transport via pipelines	0.0005%	0.0012%	0.0019%	0.0012%	0.0027%
H50	Water transport	0.0000%	0.0004%	0.0025%	0.0043%	0.0030%
H51	Air transport	0.0001%	0.0002%	0.0002%	0.0007%	0.0501%
H52	Warehousing and support activities for transportation	-0.0001%	0.0008%	0.0010%	0.0027%	-0.0108%
H53	Postal and courier activities	0.0000%	0.0001%	-0.0001%	0.0004%	-0.0289%
I	Accommodation and food service activities	-0.0004%	-0.0002%	-0.0003%	-0.0003%	-0.0023%
J58	Publishing activities	0.0002%	0.0003%	0.0004%	0.0000%	0.0002%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	-0.0001%	0.0001%	0.0002%	0.0001%	-0.0049%
J61	Telecommunications	0.0009%	0.0031%	0.0042%	0.0037%	0.0264%
J62-J63	Computer programming, consultancy and related activities; information service activities	-0.0002%	0.0018%	0.0026%	0.0034%	-0.0017%
K64	Financial service activities, except insurance and pension funding	0.0023%	-0.0002%	0.0031%	-0.0001%	0.0136%
K65	Insurance, pension funding, except compulsory social security	0.0012%	0.0007%	0.0006%	0.0007%	0.0320%
K66	Activities auxiliary to financial services and insurance activities	-0.0006%	0.0008%	0.0020%	0.0011%	0.0012%
L68	Real estate activities	0.0002%	0.0002%	-0.0001%	0.0001%	-0.0007%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	-0.0006%	-0.0008%	-0.0017%	-0.0008%	-0.0006%
M71	Architectural and engineering; technical testing and analysis	-0.0003%	-0.0003%	-0.0009%	-0.0010%	0.0057%
M73	Advertising and market research	-0.0003%	-0.0013%	-0.0010%	-0.0031%	0.0112%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	-0.0010%	-0.0011%	-0.0016%	-0.0006%	-0.0032%
N	Administrative and support service activities	-0.0012%	0.0007%	-0.0014%	0.0026%	-0.0272%
O84	Public administration and defence; compulsory social security	0.0030%	0.0002%	0.0005%	0.0001%	0.0005%
Q	Human health and social work activities	-0.0013%	-0.0001%	-0.0001%	-0.0001%	-0.0004%
R-S	Other service activities	-0.0004%	-0.0001%	-0.0001%	-0.0001%	0.0008%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0000%	0.0000%	0.0000%	0.0005%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0232%	0.0167%	0.1003%	0.0358%	0.3032%

Table 32 – Average annual industrial TFP growth contributions to predicted employment growth effects by origin industries in emerging economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0416%	0.0146%	0.0065%	0.0049%	0.0067%
B	Mining and quarrying	0.0003%	-0.0072%	-0.0041%	-0.0049%	-0.0069%
C10t12	Manufacture of food products, beverages and tobacco	0.0011%	0.0202%	0.0027%	0.0121%	0.0006%
C13t15	Manufacture of textiles, wearing apparel and leather products	-0.0002%	0.0047%	0.0042%	0.0018%	-0.0047%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0004%	0.0044%	0.0012%	0.0086%	-0.0025%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0002%	0.0035%	0.0005%	0.0059%	-0.0018%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0007%	0.0391%	0.0150%	0.0194%	0.0150%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0001%	0.0027%	0.0005%	0.0053%	0.0007%
C22	Manufacture of rubber and plastic products	0.0007%	0.0050%	0.0018%	0.0067%	0.0004%
C23	Manufacture of other non-metallic mineral products	0.0005%	0.0074%	0.0016%	0.0114%	-0.0017%
C24	Manufacture of basic metals	-0.0001%	-0.0042%	-0.0054%	-0.0014%	-0.0023%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0006%	0.0053%	0.0024%	0.0080%	-0.0024%
C26	Manufacture of computer, electronic and optics	-0.0001%	0.0143%	0.0203%	0.0065%	0.0019%
C27	Manufacture of electrical equipment	-0.0001%	0.0040%	0.0019%	0.0042%	-0.0172%
C28	Manufacture of machinery and equipment n.e.c.	0.0009%	0.0089%	0.0027%	0.0058%	-0.0022%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0003%	0.0104%	0.0040%	0.0093%	0.0015%
C30	Manufacture of other transport equipment	0.0001%	0.0036%	0.0013%	0.0097%	0.0028%
C32	Manufacture of furniture; other manufacturing	-0.0012%	-0.0010%	-0.0006%	-0.0034%	-0.0092%
C33	Repair and installation of machinery and equipment	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0003%	0.0052%	0.0021%	0.0034%	0.0021%
F	Construction	0.0020%	-0.0004%	0.0013%	-0.0002%	0.0014%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0002%	0.0007%	0.0001%	0.0005%	-0.0006%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0054%	0.0015%	0.0006%	0.0017%	0.0002%
G47	Retail trade, except of motor vehicles and motorcycles	0.0010%	0.0012%	0.0004%	0.0030%	-0.0003%
H49	Land transport and transport via pipelines	0.0024%	0.0094%	0.0024%	0.0110%	0.0037%
H50	Water transport	-0.0003%	-0.0005%	0.0001%	-0.0010%	0.0045%
H51	Air transport	0.0003%	0.0007%	0.0007%	0.0039%	0.0156%
H52	Warehousing and support activities for transportation	0.0004%	0.0042%	0.0002%	0.0362%	0.0014%
H53	Postal and courier activities	-0.0002%	0.0006%	0.0001%	0.0117%	-0.0006%
I	Accommodation and food service activities	-0.0007%	0.0013%	0.0003%	0.0016%	-0.0006%
J58	Publishing activities	0.0000%	-0.0001%	0.0000%	-0.0007%	-0.0018%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0001%	-0.0001%	0.0000%	-0.0005%	-0.0014%
J61	Telecommunications	0.0000%	0.0018%	0.0003%	0.0044%	0.0016%
J62-J63	Computer programming, consultancy and related activities; information service activities	0.0004%	0.0003%	0.0001%	0.0030%	0.0014%
K64	Financial service activities, except insurance and pension funding	0.0013%	0.0132%	0.0017%	0.0184%	0.0017%
K65	Insurance, pension funding, except compulsory social security	0.0000%	0.0020%	0.0003%	0.0118%	-0.0002%
K66	Activities auxiliary to financial services and insurance activities	0.0000%	0.0000%	0.0000%	-0.0002%	-0.0014%
L68	Real estate activities	0.0010%	-0.0017%	-0.0002%	-0.0016%	0.0000%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	0.0007%	-0.0038%	-0.0015%	-0.0043%	-0.0079%
M71	Architectural and engineering; technical testing and analysis	0.0002%	0.0000%	0.0000%	0.0000%	0.0017%
M73	Advertising and market research	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	-0.0003%	0.0022%	0.0004%	0.0024%	0.0003%
N	Administrative and support service activities	-0.0004%	-0.0008%	-0.0005%	-0.0016%	-0.0039%
O84	Public administration and defence; compulsory social security	-0.0013%	0.0001%	0.0000%	0.0001%	0.0001%
Q	Human health and social work activities	-0.0021%	-0.0005%	-0.0001%	-0.0010%	-0.0004%
R-S	Other service activities	-0.0062%	-0.0011%	-0.0003%	-0.0019%	-0.0008%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0001%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0500%	0.1714%	0.0649%	0.2102%	-0.0055%

Table 33 – Average annual industrial TFP growth contributions to predicted employment growth effects by origin industries in transition economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0254%	0.0040%	0.0006%	0.0015%	0.0021%
B	Mining and quarrying	0.0000%	0.0010%	0.0025%	-0.0002%	0.0078%
C10t12	Manufacture of food products, beverages and tobacco	0.0015%	0.0028%	0.0001%	0.0013%	0.0006%
C13t15	Manufacture of textiles, wearing apparel and leather products	-0.0001%	0.0004%	0.0001%	0.0008%	0.0009%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0003%	0.0014%	0.0002%	0.0060%	0.0065%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0002%	0.0017%	0.0004%	0.0041%	0.0049%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0014%	0.0062%	0.0008%	0.0018%	0.0018%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0000%	0.0000%	0.0000%	0.0002%	0.0007%
C22	Manufacture of rubber and plastic products	0.0003%	0.0046%	0.0007%	0.0156%	0.0109%
C23	Manufacture of other non-metallic mineral products	0.0004%	0.0057%	0.0003%	0.0133%	0.0020%
C24	Manufacture of basic metals	-0.0006%	0.0042%	0.0014%	0.0004%	0.0014%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0001%	0.0009%	0.0002%	0.0018%	0.0082%
C26	Manufacture of computer, electronic and optics	0.0006%	0.0037%	0.0003%	0.0058%	0.0000%
C27	Manufacture of electrical equipment	0.0000%	0.0001%	0.0001%	0.0003%	0.0047%
C28	Manufacture of machinery and equipment n.e.c.	0.0023%	0.0062%	0.0010%	0.0064%	0.0128%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0014%	0.0025%	0.0004%	0.0018%	0.0079%
C30	Manufacture of other transport equipment	0.0001%	0.0001%	0.0000%	0.0002%	0.0010%
C32	Manufacture of furniture; other manufacturing	-0.0006%	-0.0005%	0.0000%	-0.0039%	-0.0003%
C33	Repair and installation of machinery and equipment	0.0001%	-0.0001%	0.0000%	0.0008%	0.0013%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0012%	0.0109%	0.0013%	0.0047%	0.0032%
F	Construction	0.0011%	-0.0001%	-0.0001%	0.0002%	-0.0015%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0002%	0.0029%	0.0002%	0.0060%	0.0018%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0023%	0.0169%	0.0046%	0.0047%	0.0066%
G47	Retail trade, except of motor vehicles and motorcycles	0.0041%	-0.0012%	0.0000%	-0.0001%	0.0015%
H49	Land transport and transport via pipelines	0.0049%	-0.0004%	-0.0002%	-0.0005%	0.0004%
H50	Water transport	-0.0001%	0.0001%	0.0000%	0.0004%	-0.0096%
H51	Air transport	0.0002%	0.0026%	0.0003%	0.0105%	0.0063%
H52	Warehousing and support activities for transportation	0.0014%	0.0026%	0.0003%	0.0016%	0.0025%
H53	Postal and courier activities	-0.0001%	-0.0006%	0.0000%	-0.0021%	-0.0041%
I	Accommodation and food service activities	-0.0007%	0.0011%	0.0001%	0.0024%	0.0006%
J58	Publishing activities	0.0000%	-0.0001%	0.0000%	-0.0004%	0.0007%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0000%	0.0003%	0.0000%	0.0015%	0.0042%
J61	Telecommunications	0.0000%	0.0039%	0.0003%	0.0053%	-0.0009%
J62-J63	Computer programming, consultancy and related activities; information service activities	0.0001%	0.0003%	0.0000%	0.0003%	0.0009%
K64	Financial service activities, except insurance and pension funding	0.0012%	0.0076%	0.0008%	0.0082%	0.0010%
K65	Insurance, pension funding, except compulsory social security	0.0000%	-0.0002%	0.0000%	-0.0010%	-0.0062%
K66	Activities auxiliary to financial services and insurance activities	0.0000%	0.0005%	0.0001%	0.0023%	0.0023%
L68	Real estate activities	-0.0002%	0.0144%	0.0007%	0.0102%	0.0018%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	0.0001%	0.0010%	0.0001%	0.0023%	0.0079%
M71	Architectural and engineering; technical testing and analysis	0.0001%	0.0005%	0.0001%	0.0012%	0.0065%
M73	Advertising and market research	0.0003%	0.0015%	0.0003%	0.0052%	0.0198%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	0.0000%	0.0006%	0.0001%	0.0004%	0.0001%
N	Administrative and support service activities	-0.0049%	0.0029%	0.0003%	0.0007%	-0.0033%
O84	Public administration and defence; compulsory social security	-0.0006%	-0.0035%	-0.0005%	-0.0017%	-0.0006%
Q	Human health and social work activities	-0.0076%	-0.0001%	0.0000%	-0.0001%	0.0000%
R-S	Other service activities	-0.0044%	0.0004%	0.0000%	0.0005%	-0.0045%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0313%	0.1096%	0.0175%	0.1210%	0.1128%

Table 34 – Average annual industrial TFP growth contributions to predicted employment growth effects by origin industries in rest of WIOD economies – Period 2000-2014

Industry	Industry Description	Direct	dom – BW	int – BW	dom – FW	int – FW
A	Agriculture	0.0135%	0.0150%	0.0031%	0.0095%	0.0311%
B	Mining and quarrying	-0.0001%	-0.0001%	-0.0002%	0.0022%	0.0340%
C10t12	Manufacture of food products, beverages and tobacco	-0.0002%	0.0020%	0.0002%	0.0005%	-0.0001%
C13t15	Manufacture of textiles, wearing apparel and leather products	0.0018%	0.0005%	0.0012%	0.0006%	0.0148%
C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0002%	0.0010%	0.0011%	0.0000%	0.0303%
C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0004%	0.0013%	0.0009%	0.0017%	0.0062%
C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	-0.0001%	-0.0055%	-0.0045%	0.0000%	-0.0537%
C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0003%	0.0003%	0.0009%	0.0007%	0.0054%
C22	Manufacture of rubber and plastic products	0.0005%	0.0022%	0.0021%	0.0029%	0.0264%
C23	Manufacture of other non-metallic mineral products	0.0007%	0.0031%	0.0013%	0.0068%	0.0359%
C24	Manufacture of basic metals	0.0005%	0.0002%	-0.0001%	0.0006%	0.0475%
C25	Manufacture of fabricated metal products, except machinery and equipment	0.0012%	0.0023%	0.0020%	0.0025%	0.0314%
C26	Manufacture of computer, electronic and optics	0.0034%	0.0019%	0.0057%	0.0008%	0.0188%
C27	Manufacture of electrical equipment	0.0006%	0.0007%	0.0018%	0.0012%	0.0399%
C28	Manufacture of machinery and equipment n.e.c.	0.0019%	0.0014%	0.0021%	0.0020%	0.0744%
C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0014%	0.0011%	0.0037%	0.0007%	0.0684%
C30	Manufacture of other transport equipment	0.0002%	0.0003%	0.0002%	0.0014%	0.0186%
C32	Manufacture of furniture; other manufacturing	0.0005%	0.0007%	0.0004%	0.0009%	0.0087%
C33	Repair and installation of machinery and equipment	0.0009%	0.0010%	0.0003%	0.0027%	0.0355%
DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	-0.0013%	-0.0121%	-0.0010%	-0.0082%	-0.0242%
F	Construction	-0.0010%	0.0003%	0.0001%	0.0000%	-0.0003%
G45	Wholesale and retail and repair of motor vehicles & motorcycles	0.0001%	0.0014%	0.0002%	0.0029%	0.0060%
G46	Wholesale trade, except of motor vehicles and motorcycles	0.0030%	0.0072%	0.0018%	0.0021%	0.0114%
G47	Retail trade, except of motor vehicles and motorcycles	0.0047%	0.0035%	0.0007%	0.0017%	0.0086%
H49	Land transport and transport via pipelines	0.0006%	0.0015%	-0.0002%	0.0031%	0.0184%
H50	Water transport	0.0000%	0.0001%	-0.0002%	0.0009%	-0.0168%
H51	Air transport	0.0001%	-0.0003%	-0.0002%	-0.0014%	0.0051%
H52	Warehousing and support activities for transportation	-0.0001%	0.0002%	0.0002%	0.0002%	0.0061%
H53	Postal and courier activities	0.0000%	0.0004%	0.0000%	0.0052%	0.0123%
I	Accommodation and food service activities	-0.0015%	0.0012%	0.0001%	0.0017%	0.0060%
J58	Publishing activities	0.0001%	0.0004%	0.0001%	0.0012%	0.0095%
J59-J60	Motion picture, video and television programme production, sound recording and music publishing; programming and broadcasting activities	0.0000%	0.0001%	0.0000%	0.0003%	-0.0001%
J61	Telecommunications	0.0007%	0.0017%	0.0003%	0.0017%	0.0018%
J62-J63	Computer programming, consultancy and related activities; information service activities	-0.0001%	0.0002%	0.0000%	0.0005%	-0.0031%
K64	Financial service activities, except insurance and pension funding	0.0020%	0.0022%	0.0003%	0.0024%	0.0145%
K65	Insurance, pension funding, except compulsory social security	0.0008%	0.0010%	0.0002%	0.0027%	0.0110%
K66	Activities auxiliary to financial services and insurance activities	-0.0003%	-0.0002%	0.0000%	0.0003%	-0.0220%
L68	Real estate activities	0.0002%	-0.0008%	0.0001%	-0.0004%	0.0017%
M69-M70	Legal and accounting activities; activities of head offices; management consultancy activities	-0.0004%	0.0001%	-0.0001%	0.0028%	0.0240%
M71	Architectural and engineering; technical testing and analysis	-0.0003%	0.0009%	0.0001%	0.0074%	0.0109%
M73	Advertising and market research	-0.0003%	0.0013%	0.0000%	0.0050%	-0.0160%
MtN&P	Scientific research and development; Other professional, scientific and technical activities; veterinary activities; Education	-0.0019%	0.0001%	0.0000%	0.0001%	0.0008%
N	Administrative and support service activities	-0.0007%	0.0047%	0.0004%	0.0087%	0.0093%
O84	Public administration and defence; compulsory social security	0.0019%	0.0005%	0.0000%	0.0002%	0.0004%
Q	Human health and social work activities	-0.0008%	0.0002%	0.0000%	0.0002%	0.0004%
R-S	Other service activities	-0.0006%	0.0009%	0.0000%	0.0008%	0.0008%
T	Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	-0.0005%	0.0000%	0.0000%	0.0000%	0.0000%
U	Activities of extraterritorial organizations and bodies	0.0000%	0.0000%	0.0000%	0.0000%	0.0000%
Total		0.0322%	0.0460%	0.0250%	0.0796%	0.5501%

Table 35 – Top 50 effective industry-country pairs as international suppliers contributing to average annual world employment growth from the origin perspective – Period 2000-2014

Rank	Country	Group	Industry	Industry Description	int – BW
1	Korea, Rep.	advanced	C26	Manufacture of computer, electronic and optics	0.0047%
2	Taiwan	rest	C26	Manufacture of computer, electronic and optics	0.0042%
3	China	emerging	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0031%
4	United States	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0027%
5	Australia	advanced	B	Mining and quarrying	0.0022%
6	China	emerging	C26	Manufacture of computer, electronic and optics	0.0021%
7	China	emerging	C24	Manufacture of basic metals	0.0020%
8	Korea, Rep.	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0020%
9	United States	advanced	C26	Manufacture of computer, electronic and optics	0.0018%
10	Japan	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0016%
11	Japan	advanced	C22	Manufacture of rubber and plastic products	0.0014%
12	China	emerging	C28	Manufacture of machinery and equipment n.e.c.	0.0013%
13	Germany	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0013%
14	United States	advanced	A	Agriculture	0.0012%
15	China	emerging	C27	Manufacture of electrical equipment	0.0011%
16	China	emerging	C13t15	Manufacture of textiles, wearing apparel and leather products	0.0011%
17	Korea, Rep.	advanced	C24	Manufacture of basic metals	0.0011%
18	United States	advanced	C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0010%
19	United States	advanced	C24	Manufacture of basic metals	0.0010%
20	United States	advanced	C28	Manufacture of machinery and equipment n.e.c.	0.0009%
21	Korea, Rep.	advanced	C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0009%
22	United States	advanced	C25	Manufacture of fabricated metal products, except machinery and equipment	0.0009%
23	Germany	advanced	C22	Manufacture of rubber and plastic products	0.0009%
24	China	emerging	C22	Manufacture of rubber and plastic products	0.0008%
25	United States	advanced	C10t12	Manufacture of food products, beverages and tobacco	0.0008%
26	United States	advanced	B	Mining and quarrying	0.0008%
27	United States	advanced	C30	Manufacture of other transport equipment	0.0008%
28	China	emerging	C25	Manufacture of fabricated metal products, except machinery and equipment	0.0007%
29	China	emerging	C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0007%
30	Taiwan	rest	C24	Manufacture of basic metals	0.0006%
31	United States	advanced	C22	Manufacture of rubber and plastic products	0.0006%
32	Korea, Rep.	advanced	C27	Manufacture of electrical equipment	0.0006%
33	China	emerging	DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0006%
34	United States	advanced	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0006%
35	China	emerging	C10t12	Manufacture of food products, beverages and tobacco	0.0005%
36	Indonesia	emerging	C10t12	Manufacture of food products, beverages and tobacco	0.0005%
37	United States	advanced	C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0005%
38	Brazil	emerging	A	Agriculture	0.0005%
39	China	emerging	B	Mining and quarrying	0.0005%
40	Taiwan	rest	C13t15	Manufacture of textiles, wearing apparel and leather products	0.0005%
41	Australia	advanced	C24	Manufacture of basic metals	0.0005%
42	Korea, Rep.	advanced	C13t15	Manufacture of textiles, wearing apparel and leather products	0.0005%
43	China	emerging	A	Agriculture	0.0005%
44	United States	advanced	C27	Manufacture of electrical equipment	0.0005%
45	Netherlands	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0005%
46	France	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0004%
47	Korea, Rep.	advanced	C25	Manufacture of fabricated metal products, except machinery and equipment	0.0004%
48	Russian Federation	transition	C24	Manufacture of basic metals	0.0004%
49	Korea, Rep.	advanced	C28	Manufacture of machinery and equipment n.e.c.	0.0004%
50	China	emerging	C23	Manufacture of other non-metallic mineral products	0.0004%

Table 36 – Top 50 effective industry-country pairs as international suppliers contributing to average annual world real value-added growth from the origin perspective – Period 2000-2014

Rank	Country	Group	Industry	Industry Description	int – BW
1	China	emerging	C26	Manufacture of computer, electronic and optics	0.0042%
2	China	emerging	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0035%
3	Korea, Rep.	advanced	C26	Manufacture of computer, electronic and optics	0.0031%
4	China	emerging	C24	Manufacture of basic metals	0.0028%
5	Taiwan	rest	C26	Manufacture of computer, electronic and optics	0.0026%
6	United States	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0025%
7	United States	advanced	C26	Manufacture of computer, electronic and optics	0.0020%
8	China	emerging	C28	Manufacture of machinery and equipment n.e.c.	0.0019%
9	China	emerging	C27	Manufacture of electrical equipment	0.0019%
10	United States	advanced	C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0017%
11	Germany	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0016%
12	Australia	advanced	B	Mining and quarrying	0.0014%
13	United States	advanced	C24	Manufacture of basic metals	0.0012%
14	China	emerging	C22	Manufacture of rubber and plastic products	0.0012%
15	Germany	advanced	C22	Manufacture of rubber and plastic products	0.0011%
16	China	emerging	C25	Manufacture of fabricated metal products, except machinery and equipment	0.0011%
17	China	emerging	C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0011%
18	United States	advanced	C25	Manufacture of fabricated metal products, except machinery and equipment	0.0010%
19	China	emerging	C13t15	Manufacture of textiles, wearing apparel and leather products	0.0010%
20	Korea, Rep.	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0010%
21	Japan	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0010%
22	Japan	advanced	C22	Manufacture of rubber and plastic products	0.0010%
23	United States	advanced	C28	Manufacture of machinery and equipment n.e.c.	0.0010%
24	China	emerging	DtE	Electricity, gas, steam and air conditioning supply; Water collection, treatment and supply; Sewerage; waste collection, treatment and disposal activities	0.0008%
25	United States	advanced	B	Mining and quarrying	0.0008%
26	Canada	advanced	C24	Manufacture of basic metals	0.0008%
27	Netherlands	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0008%
28	United States	advanced	C22	Manufacture of rubber and plastic products	0.0007%
29	United States	advanced	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0007%
30	United States	advanced	C30	Manufacture of other transport equipment	0.0007%
31	China	emerging	C10t12	Manufacture of food products, beverages and tobacco	0.0007%
32	Korea, Rep.	advanced	C24	Manufacture of basic metals	0.0007%
33	France	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0007%
34	China	emerging	B	Mining and quarrying	0.0006%
35	China	emerging	C23	Manufacture of other non-metallic mineral products	0.0006%
36	United States	advanced	C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0006%
37	United States	advanced	A	Agriculture	0.0006%
38	China	emerging	A	Agriculture	0.0005%
39	Russian Federation	transition	C24	Manufacture of basic metals	0.0005%
40	Mexico	emerging	C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0005%
41	Belgium	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0005%
42	Italy	advanced	C22	Manufacture of rubber and plastic products	0.0005%
43	United States	advanced	C27	Manufacture of electrical equipment	0.0005%
44	Taiwan	rest	C24	Manufacture of basic metals	0.0005%
45	Italy	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0005%
46	Canada	advanced	B	Mining and quarrying	0.0005%
47	United States	advanced	C10t12	Manufacture of food products, beverages and tobacco	0.0005%
48	Korea, Rep.	advanced	C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0005%
49	France	advanced	C22	Manufacture of rubber and plastic products	0.0004%
50	China	emerging	C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0004%

Table 37 – Top 50 effective industry-country pairs as international buyers contributing to average annual world real value-added growth from the origin perspective – Period 2000-2014

Rank	Country	Group	Industry	Industry Description	int – BW
1	Canada	advanced	C22	Manufacture of rubber and plastic products	0.0051%
2	Mexico	emerging	C28	Manufacture of machinery and equipment n.e.c.	0.0035%
3	Mexico	emerging	C30	Manufacture of other transport equipment	0.0034%
4	Canada	advanced	C24	Manufacture of basic metals	0.0033%
5	Taiwan	rest	C26	Manufacture of computer, electronic and optics	0.0029%
6	Mexico	emerging	C24	Manufacture of basic metals	0.0025%
7	Mexico	emerging	C25	Manufacture of fabricated metal products, except machinery and equipment	0.0023%
8	Mexico	emerging	C27	Manufacture of electrical equipment	0.0023%
9	Korea, Rep.	advanced	C26	Manufacture of computer, electronic and optics	0.0022%
10	Taiwan	rest	C22	Manufacture of rubber and plastic products	0.0022%
11	Mexico	emerging	C22	Manufacture of rubber and plastic products	0.0022%
12	Canada	advanced	C27	Manufacture of electrical equipment	0.0020%
13	Canada	advanced	C28	Manufacture of machinery and equipment n.e.c.	0.0020%
14	Korea, Rep.	advanced	C22	Manufacture of rubber and plastic products	0.0020%
15	Canada	advanced	C25	Manufacture of fabricated metal products, except machinery and equipment	0.0019%
16	Taiwan	rest	C24	Manufacture of basic metals	0.0019%
17	Canada	advanced	C16	Manufacture of wood and of products of wood and cork, except furniture; articles of straw and plaiting materials	0.0018%
18	Mexico	emerging	C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0017%
19	Taiwan	rest	C25	Manufacture of fabricated metal products, except machinery and equipment	0.0017%
20	Australia	advanced	B	Mining and quarrying	0.0016%
21	Taiwan	rest	C27	Manufacture of electrical equipment	0.0016%
22	Canada	advanced	C17t18	Manufacture of paper and paper products; Printing and reproduction of recorded media	0.0015%
23	Canada	advanced	C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0014%
24	Netherlands	advanced	C24	Manufacture of basic metals	0.0014%
25	Taiwan	rest	C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0014%
26	Indonesia	emerging	C22	Manufacture of rubber and plastic products	0.0014%
27	Switzerland	rest	C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0013%
28	Switzerland	rest	C24	Manufacture of basic metals	0.0013%
29	Canada	advanced	C30	Manufacture of other transport equipment	0.0013%
30	Mexico	emerging	C26	Manufacture of computer, electronic and optics	0.0013%
31	Netherlands	advanced	C22	Manufacture of rubber and plastic products	0.0013%
32	Canada	advanced	C32	Manufacture of furniture; other manufacturing	0.0013%
33	Canada	advanced	C26	Manufacture of computer, electronic and optics	0.0012%
34	Belgium	advanced	C24	Manufacture of basic metals	0.0012%
35	Japan	advanced	C22	Manufacture of rubber and plastic products	0.0012%
36	Taiwan	rest	C13t15	Manufacture of textiles, wearing apparel and leather products	0.0012%
37	Austria	advanced	C24	Manufacture of basic metals	0.0012%
38	Hungary	rest	C29	Manufacture of motor vehicles, trailers and semi-trailers	0.0012%
39	China	emerging	C22	Manufacture of rubber and plastic products	0.0011%
40	Belgium	advanced	C22	Manufacture of rubber and plastic products	0.0011%
41	Canada	advanced	B	Mining and quarrying	0.0011%
42	Korea, Rep.	advanced	C24	Manufacture of basic metals	0.0011%
43	Switzerland	rest	C22	Manufacture of rubber and plastic products	0.0010%
44	Ireland	advanced	C21	Manufacture of basic pharmaceutical products and pharmaceutical preparations	0.0010%
45	Netherlands	advanced	C19t20	Manufacture of coke and refined petroleum products; Manufacture of chemicals and chemical products	0.0010%
46	Korea, Rep.	advanced	C27	Manufacture of electrical equipment	0.0010%
47	Austria	advanced	C22	Manufacture of rubber and plastic products	0.0010%
48	Germany	advanced	C22	Manufacture of rubber and plastic products	0.0010%
49	China	emerging	C25	Manufacture of fabricated metal products, except machinery and equipment	0.0010%
50	Czech Republic	rest	C22	Manufacture of rubber and plastic products	0.0010%