SECTORAL LINKAGES IN GLOBAL PRODUCTION STRUCTURE: THE ROLE OF POLISH ECONOMY IN TRANSITION

Henryk Gurgul, Łukasz Lach

The 26th Inforum World Conference
Łódź, August 27-31, 2018

This research was founded by National Science Centre of Poland
(Research Grant no. DEC-2015/19/B/HS4/00088)

INTRODUCTION

- Interindustry linkages:
  - studied since the end of 1950's,
  - the main purpose of identifying the so-called key industries (or key sectors) which are essential for economic growth and development.

- The concept of backward and forward linkages (Hirschman, 1958).

- A topic often examined by both theoreticians and empiricists (see e.g. Chenery and Watanabe, 1958; Hewings and Romanos, 1981; Hewings, 1982; Defourny and Thorbecke, 1984; Ćmiel and Gurgul, 2002; Gurgul and Majdosz, 2005; Gurgul and Lach, 2015, Temurshoev, 2010; Temurshoev, and Oosterhaven, 2014).

THE MOTIVATION

- Two main goals of the study:

  - We propose a new multidimensional approach in which two different aspects of interindustry linkages in a global input-output model are examined.
  - In the empirical part of the study we analyze the role that the Polish economy in transition plays in the structure of interindustry linkages in the global economy.
    - In order to analyze the issues in question in a dynamic framework, the empirical results are based on the 2000 and 2014 global intercountry input-output tables for the 28 EU countries as well as 15 other major countries in the world.
    - The nature of the country-sector-specific data enables us to focus on the sectoral as well as spatial dimension of the interdependencies studied.

THE MOTIVATION

- As underlined by Timmer et al.(2016) the identification of such globally-influential fields contributes to a better understanding of the growth and development processes in global value chains and the role that Poland plays in this structure.

- Although in the era of globalization such elements are not only influenced by the Polish development as they also depend on the overall development of the world economy, from the perspective of a government that wants to foster economic activities these measures are helpful and informative, especially within periods of economic crisis.

ORIGINALITY

- To the best of our knowledge, this proposal is the first study in which the recent WIOD data on global flows of goods and services is analyzed using selected normalized sectoral and spatial measures of importance.

- Contrary to previous studies focused on output-oriented key sector analyses in post-communist CEE economies, we avoid the negative effects of double-counting by focusing on a particular fundamental policy target variable – income per gross output.

DATASET AND METHODOLOGY

In the framework of input-output models, the process of production taking place in a particular sector *j* implies two kinds of economic effects on other sectors of the economy:

- Assume that sector *j* increases its output. The latter implies that demands from sector *j* (which acts as a purchaser) on those sectors whose goods are used as production inputs in sector *j* will increase. This direction of a causal relationship is typical for a usual demand-side input-output model. In the input-output literature, this kind of interconnection of a particular sector with those ('upstream') sectors from which the latter purchases inputs is referred to as a so-called **backward linkage**.

DATASET AND METHODOLOGY

In the framework of input-output models, the process of production taking place in a particular sector *j* implies two kinds of economic effects on other sectors of the economy:

- Alternatively, an increase of output in sector *j* implies that additional amounts of products from sector *j* become available to be used as inputs to other sectors for their own production. In other words, an increase of supplies from sector *j* (acting as a seller) for the sectors that use the products of sector *j* in their production processes takes place. This in turn is the direction of causality in the usual supply-side IO model, and the term **forward linkage** is used to indicate this kind of interconnection of a particular sector with those ('downstream') sectors to which it sells its output.

DATASET AND METHODOLOGY

Key sector analysis in the framework of global input-output model – **notation remarks**

π_i^t - sector *i*'s direct (factor) coefficient indicating generation/use of a factor of interest at time point *t* (e.g., employment, income, energy usage, etc.) per unit of gross output x_i^t of country-sector *i*

$\mathbf{f}_t = [f_i^t, i = 1,...,SC]$ - final demand

$\mathbf{L}_t = (\mathbf{I} - \mathbf{A}_t)^{-1} = [l_{ij}^t, i, j = 1,...,SC]$ - Leontief inverse

$\mathbf{v}_t = \left[v_i^t, i = 1,...,SC\right]$ - sectoral value added

$\mathbf{G}_t = (\mathbf{I} - \mathbf{E}_t)^{-1} = [g_{ij}^t, i, j = 1,...,SC]$ - Ghosh inverse

Global framework: we examine S different sectors operating in C countries.

DATASET AND METHODOLOGY

Key sector analysis in framework of global input-output model – **two types of measures**

- Following the review of literature on key sector analysis of Temurshoev (2016) throughout this study two most important types of normalized measures of interindustry linkages will be studied in the framework of global IO models.

- These measures are related to two general concepts of measuring interindustry linkages:
  - Traditional mathematical measures of backward and forward linkages,
  - Hypothetical extraction approach.

DATASET AND METHODOLOGY

Traditional mathematical measures of backward and forward linkages

- Recently, these types of measures were used by Gurgul and Lach (2015) in a study aimed at analyzing the intersectoral linkages in selected CEE economies in transition.
- In general, key sector measures were predominantly used in studies focused at gross output, especially in early input-output research.
- However, the output-oriented measures of intersectoral dependencies have a serious drawback. Namely, in order to be relevant to actual policymaking, key sector measures should be defined in a way that could reflect not only the gross-output-related processes but also the other main policy goals, including income generation, job creation, or reduction of greenhouse gas emission (Oosterhaven, 1981; Lenzen, 2003; Garrett-Peltier, 2017).
- Moreover, gross output reflects double-counting as it includes both the sales of intermediate and final products (thus, it is also often referred to as 'gross duplicated output').

DATASET AND METHODOLOGY

Traditional backward linkages

$$\overline{B}_{i,t}^{TOT}(\pi) = \sum_{k=1}^{SC} \pi_k^t l_{ki}^t \qquad (1)$$

The backward input-output linkage defined above reflects the demand-pull effects in a global economy. The indicator defined in (1) measures the total (i.e., direct and indirect) intermediates' purchases-related linkages/importance of country-sector *i* that are associated with its unit final demand. In other words, this indicator is a measure of the quantitative significance of the chains of country-sector *i*'s demands for intermediate inputs from all country-sectors of the global economy.

Traditional forward linkages

$$\overline{F}_{i,t}^{TOT}(\pi) = \sum_{k=1}^{SC} g_{ik}^{t} \pi_{k}^{t} \qquad (2)$$

The forward input-output linkage defined above reflects the cost-push effects in the global economy; i.e., it is assumed that the input and output prices may change, but their quantities will remain fixed. The indicator defined in (2) refers to the total (i.e., direct and indirect) intermediates' sales-related linkages/importance of country-sector *i* (in the sense of the quantitative significance of the chains of country-sector *i*'s supplies of its intermediate inputs to all country-sectors of the global economy) that are associated with its primary inputs equal to one unit.

DATASET AND METHODOLOGY

HE backward linkages

$$\overline{B}^{HE}_{i,t}(\pi) = \overline{B}^{TOT}_{i,t}(\pi)\frac{x^t_i}{l^t_{ii}} \qquad (3)$$

- A fundamental result of Temurshoev (2010) gives the above mentioned simple analytical expression for the reduction in factor usage due to the complete extraction of country-sector *i* from the global IO system.
- The indicator given in (3) measures the economy-wide loss of the policy goal variable of interest due to the hypothetical elimination of country-sector *i* from the demand-driven global input-output model.

DATASET AND METHODOLOGY

HE forward linkages

$$\overline{F}_{i,t}^{HE}(\pi) = \overline{F}_{i,t}^{TOT}(\pi)\frac{x_i^t}{g_{ii}^t} \qquad (4)$$

- The indicator given in (4) measures the economy-wide loss of the policy goal variable of interest due to the hypothetical elimination of sector *i* from the supply-driven input-output model, which is consistent with the forward-oriented view of intersectoral linkages.

Dataset and Methodology

Normalizing the linkages - is it necessary?

- It should be stressed that, in empirical applications, the heterogeneity of industries in terms of their size should also be explicitly taken into account, which is not always the case in the existing key sector studies.
- Temurshoev (2016) signalizes that, if the effect of country-sector size is not corrected for, one would very often and not surprisingly get an expectable outcome that big (small) industries have a big (small) impact on the global economy, which will further disregard the greater cost of stimulating a large industry.
- Therefore, it is also important in practical applications to consider the total global-economy-wide impact of country-sectors per unit of their direct size/contribution.
- For this purpose, the input-output linkages used in this study are normalized by the relevant size or direct impact of the country-sectors.

Dataset and Methodology

Normalized traditional linkages

$$B_{i,t}^{TOT}(\pi) = \frac{\overline{B}_{i,t}^{TOT}(\pi)}{\pi_i^t} \tag{5}$$

$$F_{i,t}^{TOT}(\pi) = \frac{\overline{F}_{i,t}^{TOT}(\pi)}{\pi_i^t} \tag{6}$$

- The linkage defined in (5) is a dimensionless indicator that expresses the relevant non-normalized backward IO linkage of a particular sector per unit of its size given in terms of policy goal variable.
- Looking from the supply-side perspective, one may analogously define the normalized forward IO linkage using the formula (6).
- Similarly to its non-normalized counterpart, the normalized forward input-output linkage also reflects the cost-push effects in the global economy.

Dataset and Methodology

Normalized HE linkages

$$B_{i,t}^{HE}(\pi) = \frac{B_{i,t}^{TOT}(\pi)}{l_{ii}^{t}} \quad (7)$$

$$F_{i,t}^{HE}(\pi) = \frac{F_{i,t}^{TOT}(\pi)}{g_{ii}^{t}} \quad (8)$$

- In contrary to majority of previous studies focused at key sector analysis in CEE post-communist economies (Gurgul and Majdosz (2005), Gurgul and Lach (2015), among others), we analyse only the normalized linkages since these measure treat each country-sector similarly irrespective of its size in generating the policy goal variable (Miller and Blair, 2009).
- Moreover, Temurshoev (2016) stressed that the normalized IO linkages express the global-economy-wide impact of each country-sector per unit of its direct factor coefficient or total output. Therefore, they effectively indicate the indirect global-economy-wide impact of each country-sector relative to its own direct contribution.

DATASET AND METHODOLOGY

Linkage-based classification of sectors

		Forward Linkages	
		Low (< 1)	**High (> 1)**
Backward Linkages	**Low (< 1)**	Weak linkages country-sector	Strong forward linkage country-sector
	High (> 1)	Strong backward linkage country-sector	Key country-sector

Source: Own elaboration based on Gurgul and Lach (2015).
Note: Linkages are given relative to their relevant global-economy-wide average values.

.

Dataset and Methodology

Distribution of demand and supply effects in global IO model

- The discussed measures of intersectoral linkages can be applied to assess the types and intensities of the spatial interdependence or connectedness.

- For example, since the two backward (forward) measures defined previously are proportional to the column (row) sums of the Leontief (Ghosh) inverse, one may simply find a distribution of demand (supply) effects induced in a particular country across all country-sectors in a global IO model.

Dataset and Methodology

Distribution of demand and supply effects in global IO model – a two-region case

For illustrative purposes, consider the following partitioning of a Leontief and Ghosh inverse: .

$$\mathbf{L}_t = \begin{bmatrix} \mathbf{L}_{rr}^t & \mathbf{L}_{rs}^t \\ \mathbf{L}_{sr}^t & \mathbf{L}_{ss}^t \end{bmatrix} \qquad \mathbf{G}_t = \begin{bmatrix} \mathbf{G}_{rr}^t & \mathbf{G}_{rs}^t \\ \mathbf{G}_{sr}^t & \mathbf{G}_{ss}^t \end{bmatrix}$$

$$\mathbf{L}_{ij}^t = [l_{pq}^{t,ij}, p,q = 1,\ldots,S] \qquad \mathbf{G}_{ij}^t = [g_{pq}^{t,ij}, p,q = 1,\ldots,S]$$

$$\mathbf{x}_t = [\mathbf{x}_t^r \; \mathbf{x}_t^s] \qquad \mathbf{f}_t = [\mathbf{f}_t^r \; \mathbf{f}_t^s]$$

$$\mathbf{x}_t^r = [x_i^{t,r}, i = 1,\ldots,S] \qquad \mathbf{f}_t^r = [f_i^{t,r}, i = 1,\ldots,S]$$

$$\mathbf{x}_t^s = [x_i^{t,s}, i = 1,\ldots,S] \qquad \mathbf{f}_t^s = [f_i^{t,s}, i = 1,\ldots,S]$$

$$\pi_t = [\pi_t^r \;\; \pi_t^s] \qquad \pi_t^r = [\pi_i^{t,r}, i = 1,\ldots,S] \qquad \pi_t^s = [\pi_i^{t,s}, i = 1,\ldots,S]$$

DATASET AND METHODOLOGY

Global distribution of demand effects (the case of backward linkages) induced in sector *i* in country *r* in a two-country IO model

Name	Definition
Total normalized backward linkage	Intracountry component: $B_{i,t}^{TOT,rr}(\pi) = \frac{\overline{B}_{i,t}^{TOT,rr}(\pi)}{\pi_i^{t,r}}$
	Intercountry component: $B_{i,t}^{TOT,sr}(\pi) = \frac{\overline{B}_{i,t}^{TOT,sr}(\pi)}{\pi_i^{t,r}}$
Normalized HE backward linkage	Intracountry component: $B_{i,t}^{HE,rr}(\pi) = \frac{B_{i,t}^{TOT,rr}(\pi)}{l_{ii}^{t,rr}}$
	Intercountry component: $B_{i,t}^{HE,sr}(\pi) = \frac{B_{i,t}^{TOT,sr}(\pi)}{l_{ii}^{t,rr}}$

Source: Own elaboration based on Miller and Blair (2009).
Note: Linkages are given relative to their relevant global-economy-wide average values.

By focusing on the row sums of the Ghosh inverse, one may simply calculate the country-sector-specific forward linkages using analogous formulas to those defined above.

EMPIRICAL RESULTS

Sector name	YEAR 2000		CHANGES BETWEEN TIME POINTS 2000 AND 2014	
	Normalized total linkage	Normalized HE linkage	Normalized total linkage	Normalized HE linkage
Crop and animal production, hunting and related service activities	B	W	B⇨W	
Forestry and logging	F	W	F⇨W	
Fishing and aquaculture	KEY	KEY	KEY⇨W	KEY⇨W
Mining and quarrying	W	W		
Manufacture of food products, beverages and tobacco products	B	B		
Manufacture of textiles, wearing apparel and leather products	W	W		
Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials	KEY	KEY		
Manufacture of paper and paper products	KEY	KEY		
Printing and reproduction of recorded media	KEY	KEY	KEY⇨W	KEY⇨F
Manufacture of coke and refined petroleum products	KEY	KEY		
Manufacture of chemicals and chemical products	KEY	KEY		
Manufacture of basic pharmaceutical products and pharmaceutical preparations	B	B	B⇨W	B⇨W
Manufacture of rubber and plastic products	KEY	KEY		
Manufacture of other non-metallic mineral products	F	F	F⇨KEY	
Manufacture of basic metals	KEY	KEY		
Manufacture of fabricated metal products, except machinery and equipment	KEY	KEY	KEY⇨W	KEY⇨W
Manufacture of computer, electronic and optical products	B	B		
Manufacture of electrical equipment	B	B	B⇨KEY	B⇨KEY
Manufacture of machinery and equipment n.e.c.	B	B	B⇨W	
Manufacture of motor vehicles, trailers and semi-trailers	KEY	KEY		KEY⇨B
Manufacture of other transport equipment	B	B		
Manufacture of furniture; other manufacturing	B	B	B⇨W	B⇨W
Repair and installation of machinery and equipment	W	F		F⇨W
Electricity, gas, steam and air conditioning supply	KEY	KEY	KEY⇨W	KEY⇨W

KEY - key sector F - forward-linkage-oriented sector B - backward-linkage-oriented sector □ - weak-oriented sector

Sector name	YEAR 2000		CHANGES BETWEEN TIME POINTS 2000 AND 2014	
	Normalized total linkage	Normalized HE linkage	Normalized total linkage	Normalized HE linkage
Water collection, treatment and supply	W	W		
Sewerage; waste collection, treatment and disposal activities; materials recovery; remediation activities and other waste management services	W	W		
Construction	W	W		
Wholesale and retail trade and repair of motor vehicles and motorcycles	W	W		
Wholesale trade, except of motor vehicles and motorcycles	W	W		
Retail trade, except of motor vehicles and motorcycles	W	W		
Land transport and transport via pipelines	W	W		
Water transport	KEY	KEY	KEY⇨F	KEY⇨F
Air transport	KEY	KEY		
Warehousing and support activities for transportation	F	W	F⇨W	
Postal and courier activities	F	F	F⇨W	F⇨W
Accommodation and food service activities	W	W		
Publishing activities	W	F		F⇨W
Motion picture, video and television programme production, sound recording and music publishing activities; programming and broadcasting activities	F	W	F⇨W	
Telecommunications	W	W		
Computer programming, consultancy and related activities; information service activities	W	W		
Financial service activities, except insurance and pension funding	W	W		
Insurance, reinsurance and pension funding, except compulsory social security	B	B		
Activities auxiliary to financial services and insurance activities	W	W		
Real estate activities	W	W		
Legal and accounting activities; activities of head offices; management consultancy activities	F	F	F⇨W	F⇨W
Architectural and engineering activities; technical testing and analysis	W	W		
Scientific research and development	W	W		
Advertising and market research	F	F		F⇨W
Other professional, scientific and technical activities; veterinary activities	W	W		
Administrative and support service activities	W	F		F⇨W
Public administration and defence; compulsory social security	W	W		
Education	W	W		
Human health and social work activities	W	W		
Other service activities	W	W		
Activities of households as employers; undifferentiated goods- and services-producing activities of households for own use	W	W		

KEY - key sector F - forward-linkage-oriented sector B - backward-linkage-oriented sector - weak-oriented sector

EMPIRICAL RESULTS

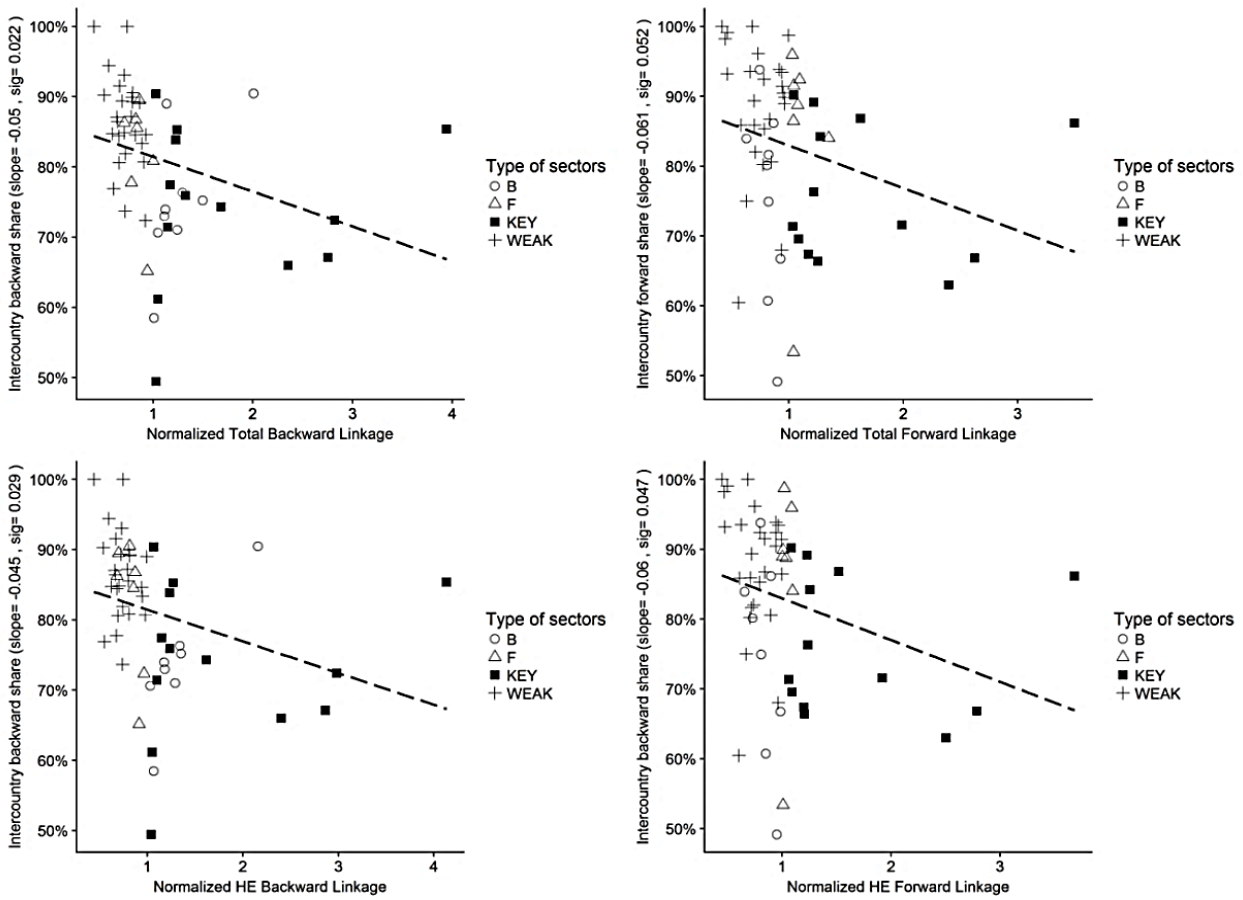

Figure 1. Relationship between normalized total backward and forward linkages of sectors of Polish economy in global IO model (*x* axis) and Poland's intercountry share in global supply/demand effects (*y* axis) in year 2000. Slope coefficients (slope) and *p*-values in respective significance tests (sig) are also provided.

EMPIRICAL RESULTS

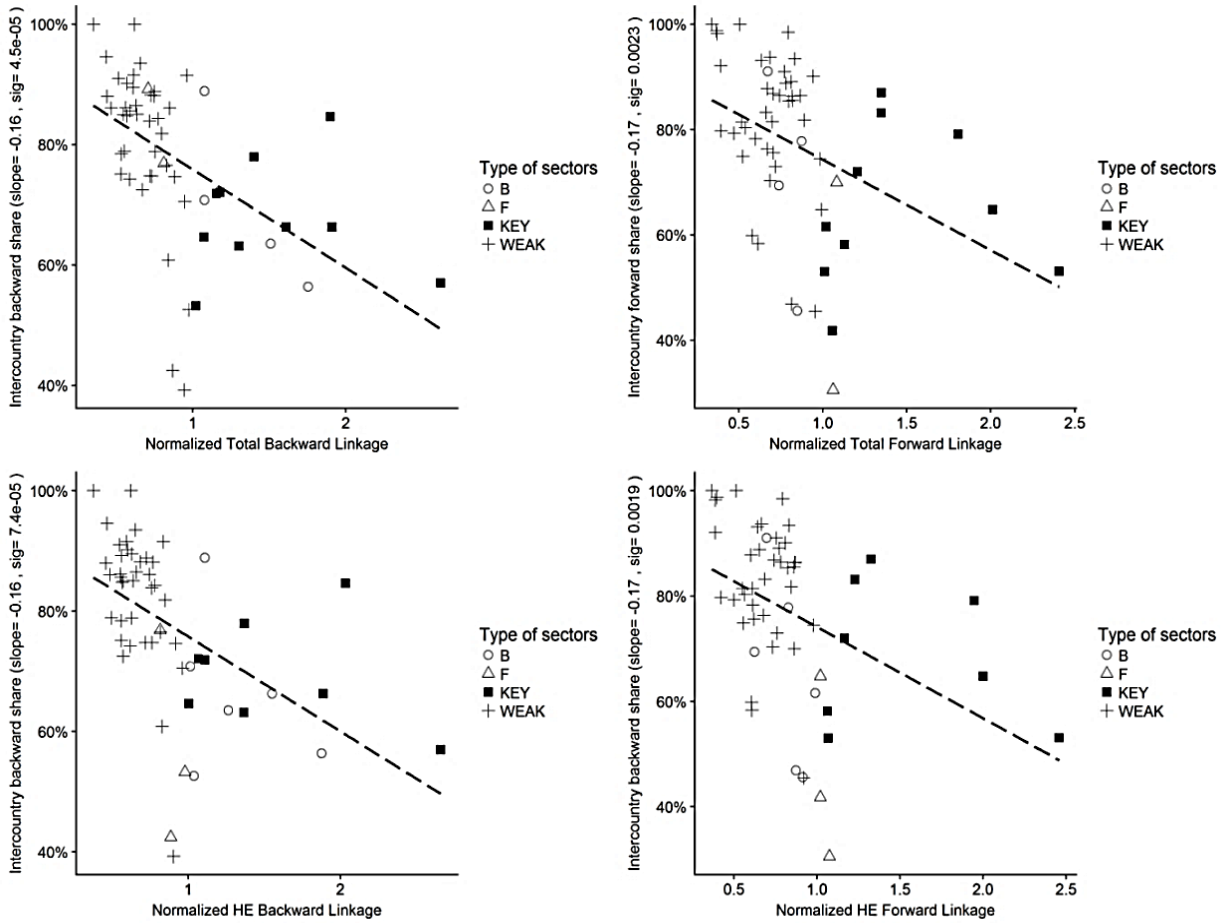

Figure 2. Relationship between normalized total backward and forward linkages of sectors of Polish economy in global IO model (*x* axis) and Poland's intercountry share in global supply/demand effects (*y* axis) in year 2014. Slope coefficients (slope) and *p*-values in respective significance tests (sig) are also provided.

EMPIRICAL RESULTS

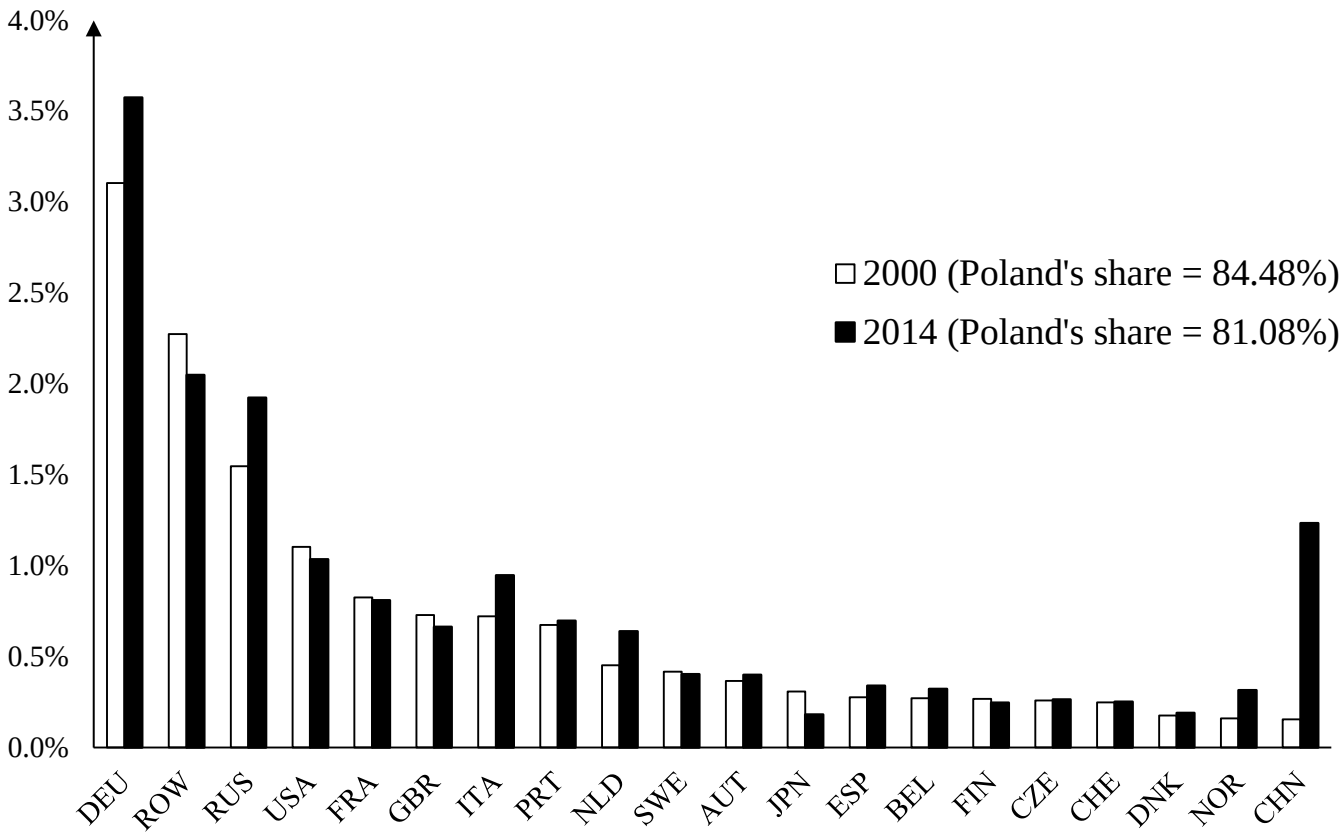

Figure 3. Distribution of demand-side effects induced in Polish economy.

Note. Values indicate weighted averages of country-sector-specific demand-side effects (normalized distribution of final demand across Polish sectors used as weights). Names of countries were abbreviated according to WIOD (http://www.wiod.org/release16).

EMPIRICAL RESULTS

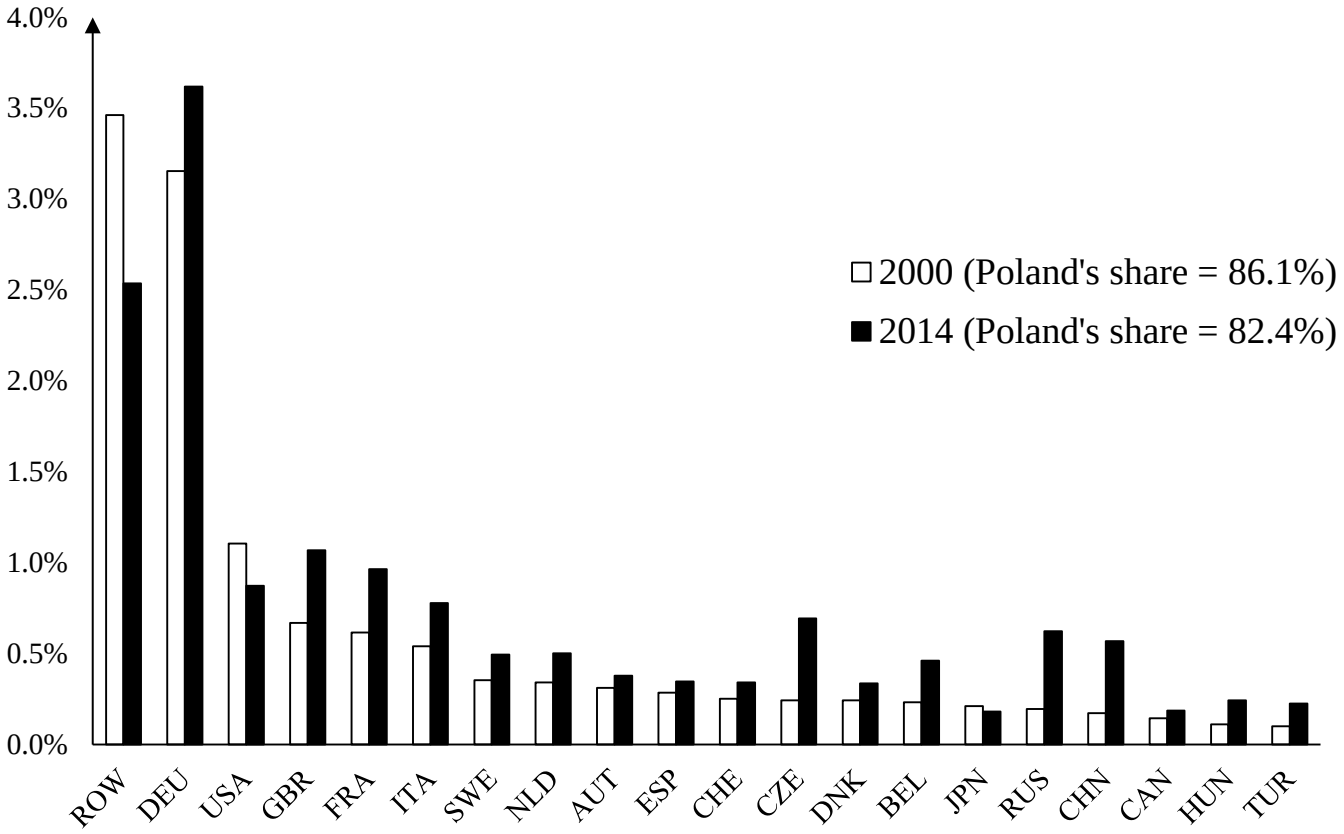

Figure 4. Distribution of supply-side effects induced in Polish economy.

Note. Values indicate weighted averages of country-sector-specific supply-side effects (normalized distribution of value added across Polish sectors used as weights). Names of countries were abbreviated according to WIOD (http://www.wiod.org/release16).

CONCLUDING REMARKS

- Remarkably, two identical sets of key sectors were found after normalizing the total-measures-based and the HE-based indices of the intersectoral linkages.
- Most of these sectors were related to manufacturing (eight sectors) and transport (two sectors). Given the chosen policy goal variable (income), the results indicate that, after adjusting the sectors for their size (in terms of income generation), 13 sectors of the Polish economy have an above-global-average impact on the global distribution of profit and wages.

CONCLUDING REMARKS

- After 15 years of economic transformation, the classification of the sectors of the Polish economy in global economic systems underwent a change. Some agriculture-and-manufacture-related sectors (namely, Fishing and aquaculture, Printing and reproduction of recorded media, Manufacture of fabricated metal products, except machinery and equipment, Manufacture of motor vehicles, trailers and semi-trailers) lost the status of key sectors with respect to income generation in the global IO model.
- A similar pattern (i.e., a loss of the key sector status during the period of 2000-2014) was also reported in the cases of several service-and-transport-related sectors, i.e., Water transport, and Electricity, gas, steam and air conditioning supply.
- On the other hand, one can list two Polish sectors that gained the status of key sectors (with respect to income generation in the global economic system) during the period of 2000-2014. These were Manufacture of other non-metallic mineral products and Manufacture of electrical equipment.

CONCLUDING REMARKS

- One can notice a negative (but statistically insignificant at a 1% significance level) relationship between the normalized backward and forward linkages of the sectors of the Polish economy in the global IO model and Poland's intercountry share in the global supply/demand effects in the year 2000. This implies that, after correcting for sector size, the intercountry share in the supply/demand effects induced in a particular sector of the Polish economy drops as the sector increases its forward/backward importance in the global economy.

- In other words, the more important the sector of the Polish economy in inducing supply/demand effects (horizontal axis in Figure 1), the smaller the relative size of this effect that actually brings benefits to the Polish economy (vertical axis in Figure 1).

CONCLUDING REMARKS

- Interesting conclusions follow from comparing the plots based on the data from 2000 (i.e., Figure 1) with their counterparts obtained for the 2014 data (Figure 2). And so, the slope coefficients of plots shown in Figure 2 turned out to be significantly smaller than the corresponding slopes in Figure 1.

- This observation leads to two conclusions. It suggests that also in the second decade of the 21st century the intercountry share in the supply/demand effects induced in a particular sector of the Polish economy were dropping as the sector was increasing its forward/backward importance in the global economy. Moreover, this drop was much more significant compared to the first years of the 21st century

CONCLUDING REMARKS

- Finally, in case of both the forward and backward linkages, the weighted intercountry share in the supply/demand-side effects induced in the Polish economy dropped by approximately 3-4% during the 15 years of transition. This drop was accompanied by a rise (of exactly the same absolute size) of the total share of the other economies in the supply/demand-side effects induced in Poland, with the German economy gaining the highest share in both indicators in 2014. This means that a unitary rise of final demand (value added) in the Polish economy in 2014 implied that approximately 3.5% of the induced rise in global income would take place in Germany.
- This result does not seem surprising as one of the consequences of the European integration is the stronger economic interconnection between Germany and Poland.

CONCLUDING REMARKS

- Secondly, from 1990s onward we witnessed another boost in globalization after China entered the WTO, which most likely had an influence on the results of the conducted analysis. This would partially explain the rapid increase in the Chinese share of per output income induced in Polish economy (Figure 3).

- In addition, the US economy probably experienced a drop in its share in per output income induced in Polish economy (see Figure 3 and Figure 4) due to the decline in manufacturing capacities of the economy (see e.g. Autor et al., 2013, 2016; Rodrik, 2015). In the first decades of 21st century the US became less competitive and Asia took a dominant role in manufacturing.

CONCLUDING REMARKS

Implications for Polish policymaking

- To summarize, in the first decades of 21st century the number of globally important sectors operating in Polish economy significantly dropped.
- At the same time it turned out that increasing the importance of the sectors of the Polish economy in inducing supply/demand effects in the global IO model leads to reducing the relative size of this effect that actually influences income in the sectors operating in the Polish economy.
- However, at the same time Poland managed to significantly increase its real GDP and – in general – has underwent a successful economic transformation. These results suggest that from the perspective of policymakers having a high number of globally important sectors might be helpful, especially in a period of economic crisis, but it is not a precondition of economic growth.

CONCLUDING REMARKS

- The results also suggest that when it comes to economic progress not the number of key sectors in global economic systems is itself important, but the nature of the international linkages with other economies.
- In this sense, a next step of future research in the field of analysis of the role of sectors of Polish economy in global economic systems would be to follow the recommendations of Hidalgo et al. (2007) and Hidalgo and Hausmann (2009) and deeply examine complexity of Polish economy by interpreting country's WIOD trade data as a network in which countries are connected to the products they export.

REFERENCES

Autor, D.H., Dorn, D., Hanson, G.H., 2013. The China Syndrome: Local Labor Market Effects of Import Competition in the United States. American Economic Review 103, 2121–2168.

Autor, D.H., Dorn, D., Hanson, G.H., 2016. The China Shock: Learning from Labor-Market Adjustment to Large Changes in Trade. Annual Review of Economics 8, 205–240.

Chenery H.B., Watanabe T. (1958) International comparisons of the structure of production. Econometrica 26(4):487-521.

Ćmiel A., Gurgul H. (2002) Application of maximum entropy principle in key sector analysis. Systems Analysis, Modelling, Simulation: A journal of mathematical modelling and simulation in systems analysis 42(9):1361-1376.

Defourny J., Thorbecke E. (1984) Structural path analysis and multiplier decomposition within a social accounting framework. Economic Journal 94:111-136.

Dietzenbacher, E. 2005. More on multipliers, Journal of Regional Science 45, 421–426.

Garrett-Peltier, H., 2017. Green versus brown: Comparing the employment impacts of energy efficiency, renewable energy, and fossil fuels using an input-output model, Economic Modelling 61, 439-447.

Gurgul H., Lach Ł. (2015) Key sectors in the post-communist CEE economies: What does the transition data say? Communist and Post-Communist Studies 48(1):15-32.

REFERENCES

Gurgul, H., Majdosz P. (2005) Key Sector Analysis: A Case of the Transited Polish Economy. Managing Global Transitions 3(1), 95-111.

Hidalgo, C.A., Hausmann, R., 2009. The building blocks of economic complexity. Proceedings of the National Academy of Sciences of the United States of America 106, 10570–10575.

Hidalgo, C.A., Klinger, B., Barabási, A.-L., Hausmann, R., 2007. The Product Space Conditions the Development of Nations. Science 317, 482–487.

Hewings G.J.D. (1982) The empirical identification of key-sectors in an economy: a regional perspective. The Developing Economies 20:173-195.

Hewings G.J.D., Romanos M.C. (1981) Simulating less developed regional economies under conditions of limited information. Geographical Analysis 13(4):373-390.

Lenzen, M., 2003. Environmentally important paths, linkages and key sectors in the Australian economy. Structural Change and Economic Dynamics 14, 1–34.

Oosterhaven, J., 1981. Interregional Input-Output Analysis and Dutch Regional Policy Problems. Aldershot: Gower.

Rodrik, D., 2015. Premature deindustrialization. Journal of Economic Growth 21, 1–33.

Temurshoev, U., 2010. Identifying optimal sector groupings with the hypothetical extraction method. Journal of Regional Science 50, 872–890.

Temurshoev, U., 2016. Backward and forward linkages and key sectors in the Kazakhstan economy. Asian Development Bank Policy Report TA 8414-KAZ.

Temurshoev, U., Oosterhaven, J., 2010. On input-output linkage measures. WPIOX 10-002, Working Papers in Input-Output Economics.

Temurshoev, U., Oosterhaven, J., 2014. Analytical and Empirical Comparison of Policy-Relevant Key Sector Measures. Spatial Economic Analysis 9, 284–308.

THANK YOU