ECONOMICAL LINKAGES OF INDUSTRY "ELECTRICITY, GAS, STEAM AND AIR CONDITIONING SUPPLY" IN BALTIC STATES AND FINLAND

Andrejs Jaunzems, Ilze Balode
Ventspils University of Applied Sciences, Latvia
jaunzems@venta.lv

Abstract. The research is devoted to the industry "Electricity, gas, steam and air conditioning supply" (D35) in the Baltic states and Finland. The goal is to carry out the comparative dynamic analysis of the industry's D35 domestic and imported product intermediate consumption's and sales structures' influence to the value added and final demand creation. The investigation is holistic thanks to the Input-Output approach. In order to estimate the role of the industry D35 in the national economy direct and total backward linkages with respect to the domestic and imported intermediate consumption, direct and total forward linkages are calculated and interpreted (mostly in form of elasticities). The special attention is devoted to the D35 product price change's influence on the gross value added and final demand of separate industries in order to discover the most sensitive influenced industries. Although there are a lot of publications concerning the industry D35 in the recent time, nevertheless the results of the current research are new. We hope, it will help elaborate management decisions.

Keywords: input-output, Leontief inverse, industry D35.

Introduction

The theoretical background of the current study in the wide sense is the classical Input-Output Analysis explored, for example, in the significant book by Ronald E. Miller and Peter D. Blair [1], and in the line of scientific publications, for example, Jan Oosterhaven [2], Kakali Mukhopadhyay [3]. The main theoretical tool is the original version of the Input-Output model created by the author [4-6]. All economical and technological interpretations of indicators are based on the mathematical connections which result from the Input-Output model. The empirical material of the study is the National Input-Output tables (NIOT) for the period 2000-2014 available at the World Input-Output Database (WIOD), see [7]. The Mathematics of Input-Output Economics, the calculation tools and ideas of application nowadays are sufficiently developed, however, there are still serious problems with the data collection and preparation. Obviously, the real situation in Input-Output data collection and preparation area disgraces the modern statistic institutes and modern information technologies. The economists highly appreciate the research possibilities provided by WIOD and are consent about emergency to expand WIOD after 2014. We clearly realize: our research would be more valuable if the time interval [2000; 2019] would be available for us. (The time interval [2020; 2022] is singular.) However, models, methods and concepts are developed and we are ready to continue the research immediately as soon as the time diapason of WIOD is expanded.

Materials and methods

NIOT covers 28 EU countries and 15 other major countries in the world. According to NIOT the United Nations 3-letter codes are used, for example, EST (Estonia), FIN (Finland), LVA (Latvia), LTU (Lithuania). Classification of products (goods and services) covers 56 product categories following the primary outputs from 56 sectors. Data for 56 sectors are classified according to the International Standard Industrial Classification (ISIC) revision No. 4.

Therefore, the basic sources in the current research are the following.

- The National Input-Output tables (NIOT) are available thanks to the World Input-Output Database (WIOD) with its unified structured statistical information in monetary terms - in current prices, expressed in millions of US dollars http://www.wiod.org .
- NIOT is constructed by utilizing the national account's. The System of National Accounts (SNA) is the internationally agreed standard set of recommendations on how to compile measures of economic activity and forms a basis for economic analysis and policy formulation https://unstats.un.org/unsd/nationalaccount/sna.asp).
- The International Standard Industrial Classification (ISIC) is a United Nations industry classification system. The industries in ISIC are strictly defined and internationally accepted.

Each industry acts like an abstract agent without its own strategy because individuals are the sole decision making subjects. The separate industry of national economy is an abstract economic unit, whose actions are dialectic fusion of the internal firm 'owners' economic decisions and actions in the real time and under the real multiple PESTILB factors. Therefore, the terms "industry behaviour", "final demander behaviour" are conventional.

Production processes in an economy are interdependent. Each industry utilizes intermediate consumption products bought from domestic industries and bought from foreign industries (imports). Therefore, each industry in the market acts as a buyer. Each industry acts also as its product seller. Economic equilibrium requires equality between the value of input and the value of output.

The main questions are: what is the economic unit's domestic and imported purchases structure (bought resources for the intermediate consumption) and what is its gross sales structure (product sold for the intermediate consumption and for the final demand, including exports), how gross output, final demand and gross value added of industry are related, what are the sources for value added formation.

In the NIOT volumes of domestic interindustry yearly deals are presented in monetary terms in the (56×56)-matrix. The respective row of the domestic intermediate consumption explores the industry's domestic sales structure; the respective column explores the industry's domestic purchases structure. The second (56×56)-matrix in the NIOT is located under the first and explores imported intermediate consumption.

There are easily available a lot of applications of Input-Output Analysis to the study of economic issues. In the papers by Jaunzems (2018), Jaunzems & Balode (2018, 2019, 2020) the original Input-Output model adapted for NIOT is offered. Also materials and methods of the holistic research of the national economy by means of the Input-Output methodology are explained. Due to limited volume of the current paper we can not to explicate that matter and that is why we kindly appeal to the reader to get to know the chapter "Materials and methods" in the open access papers [4-6; 8].

Main points of definition of the industry "Electricity, gas, steam and air conditioning supply" according to NACE Section D (D35) [9] are as follows.

- "This section includes the activity of providing electric power, natural gas, steam, hot water and the like through a permanent infrastructure (network) of lines, mains and pipes.
- The dimension of the network is not decisive; also included are the distribution of electricity, gas, steam, hot water and the like in industrial parks or residential buildings.
- This section therefore includes the operation of electric and gas utilities, which generate, control and distribute electric power or gas. Also included is the provision of steam and air-conditioning supply.
- This section excludes the operation of water and sewerage utilities. This section also excludes the (typically long distance) transport of gas through pipelines."

The industry D35 has been investigated with help of the Input-Output Analysis in many scientific publications. Let us mention, for example, actual and easily available papers from [10-13]. Nevertheless, we are sure that our research about industry D35 is original because of the specific objects, namely, the Baltic States and Finland, a specific dynamic comparative approach and original Input-Output model adapted for NIOT [4-6].

Results and discussion

Note. All tables below are elaborated by the authors.

Table 1 shows how significant are the industry's D35 created gross value added and final demand contribution in the national total gross value added and total final demand in the referred countries.

Table 1

Gross value added created by the industry D35 as part of total gross value added and final demand of D35 as part of total final demand in the Baltic States and Finland

Description	EST	FIN	LVA	LTU
Gross value added D35/Total gross value added	0.0362	0.0232	0.0318	0.0253
Final demand D35/Total final demand	0.0247	0.0082	0.0285	0.0196

(1) Industry's D35 expenditures and revenues

Table 2 contains the general indicators that describe D35 expenditures with respect to one monetary unit of gross output.

Table 2

Industry's D35 expenditures in EST, FIN, LVA, LTU with respect to monetary unit of D35 gross output

Code	Description	EST	FIN	LVA	LTU
-	Intermediate consumption (domestic)	0.3771	0.3098	0.5594	0.3119
-	Intermediate consumption (imports)	0.1629	0.1862	0.1942	0.2489
II_fob	Total intermediate consumption	0.5401	0.4960	0.7536	0.5607
GVA	Gross value added	0.4599	0.5040	0.2464	0.4393
GO	Gross output	1	1	1	1

Table 2 gives us the first signal about Latvian D35 inefficiency: the total intermediate consumption per monetary unit of gross output 0.7536 is sufficiently bigger than in EST, FIN, LTU, and as a result, the net value added 0.2464 is considerably smaller. Let us note that imported intermediate consumption for LVA is approximately the same as in FIN, but domestic intermediate consumption sufficiently differs. What is the reason? We are going to examine the D35 intermediate consumption in detail.

Table 3 contains two arranged (from largest to smallest) excerpts from the industry's D35 joint intermediate consumption matrix (2014): arrangement by LVA indicators and arrangement by FIN indicators.

We can observe total distinction in the ten biggest total intermediate purchases (domestic plus imported) per monetary unit of total output. In order to explain the difference, further examination is needed.

Table 3

Industry's D35 ten biggest joint input (domestic plus imported) indicators in LVA and FIN, 2014

Code	EST	FIN	LVA	LTU		Code	EST	FIN	LVA	LTU
D35	0.1099	0.0354	0.3675	0.2364		D35	0.1099	0.0354	0.3675	0.2364
B	0.1894	0.1121	0.1339	0.1270		B	0.1894	0.1121	0.1339	0.1270
F	0.0120	0.0309	0.0489	0.0283		C19	0.0101	0.0235	0.0091	0.0426
N	0.0132	0.0154	0.0448	0.0016		C33	0.0139	0.0222	0.0094	0.0332
G46	0.0428	0.0271	0.0203	0.0179		F	0.0120	0.0309	0.0489	0.0283
H49	0.0032	0.0147	0.0168	0.0147		G46	0.0428	0.0271	0.0203	0.0179
M69_M70	0.0177	0.0121	0.0126	0.0038		H49	0.0032	0.0147	0.0168	0.0147
K64	0.0110	0.0174	0.0110	0.0041		K64	0.0110	0.0174	0.0110	0.0041
C33	0.0139	0.0222	0.0094	0.0332		M69_M70	0.0177	0.0121	0.0126	0.0038
C19	0.0101	0.0235	0.0091	0.0426		G45	0.0019	0.0006	0.0023	0.0038
II_fob	0.5401	0.4960	0.7536	0.5607						

Surprisingly, the indicator D35_FIN is ten times smaller than D35_LVA. What is the reason?

We do not have the answer. Let us address that question to the professionals of industry D35.

It is indicative that money spent for "Administrative and support service activities (N)" in LVA is three times higher than in FIN; but EST tries to follow FIN. The N expenditures of LTU are surprisingly low (probably, a mistake in statistics). At the same time, expenditures for products of industries "Repair and installation of machinery and equipment (C33)" and "C19 Manufacture of coke and refined petroleum products (C19)" is higher in FIN.

To estimate the collinearity between the structure of industry's D35 joint intermediate consumption vectors in the referred countries we offer to calculate the angles between the respective 54-dimensional vectors (Table 4).

Table 4

Angles between D35 joint input 54-dimensional vectors in the referred countries

Between	EST, FIN	EST, LVA	EST, LTU	FIN, LVA	FIN, LTU	LVA, LTU
Angle	27°	41°	34°	56°	48°	14°

Collinearity between the respective vector and projection:

- EST = 1.41 FIN; EST = 0.43 LVA; EST = 0.69 LTU;
- FIN = 0.20 LVA; FIN = 0.35 LTU; LVA = 1.40 LTU

As it was expected, the angles between LVA, LTU and between EST, FIN are the smallest. Table 5 contains the general indicators that describe D35 revenues with respect to one monetary unit of gross output. Table 5 confirms the phenomena observed also for other industries: due to bigger scale of economy FIN as usually has the biggest intermediate sales comparing with the other referred countries. The question arises about LTU indicators CONS_h = 0.4055 and CONS_g = 0.0139 which are sufficiently bigger than in EST, FIN, LVA. In order to explain the difference, further examination is needed. Let us note that D35 EXP in EST is approximately five times bigger than in FIN, LVA, LTU. In 2020, EST exported $118M in electricity, making it the 44th largest exporter of electricity in the world. The main destination of electricity exports from EST are LVA and FIN.

Table 5

Industry's D35 intermediate sales and final demand in EST, FIN, LVA, LTU with respect to monetary unit of D35 gross output

Code	Intermediate sales	CONS_h	CONS_np	CONS_g	GFCF	INVEN	EXP	GO
EST	0.5371	0.2563	0.0001	0.0058	0.0047	-0.0004	0.1964	1
FIN	0.7736	0.1753	0.0000	0.0011	0.0128	0.0001	0.0371	1
LVA	0.7098	0.2383	0.0002	0.0017	0.0103	0.0001	0.0396	1
LTU	0.5318	0.4055	0.0000	0.0139	0.0071	-0.0008	0.0424	1

Code and Description:

- CONS_h (Final consumption expenditure by households):
- CONS_np (Final consumption expenditure by non-profit organisations serving households (NPISH))
- CONS_g (Final consumption expenditure by government), GFCF (Gross fixed capital formation)
- INVEN (Changes in inventories and valuables), EXP (Exports), GO (Gross output).

Let us investigate the structure of the intermediate sales of D35 domestic product. We consider two arranged (from largest to smallest) intermediate sales coefficients (2014): arrangement by LVA indicators and arrangement by FIN indicators (Table 6).

Table 6

The domestic industry's D35 product ten biggest allocation coefficients for LVA and FIN, 2014 (components of the vectors S_j)

Code	D35	L68	C16	G47	C10-C12	P85	O84	H52	G46	C23	DFL
EST	0.0996	0.0363	0.0218	0.0321	0.0223	0.0243	0.0164	0.0280	0.0095	0.0131	0.5371
FIN	0.0303	0.1400	0.0180	0.0295	0.0222	0.0176	0.0318	0.0146	0.0099	0.0111	0.7736
LVA	0.3455	0.0396	0.0248	0.0222	0.0222	0.0220	0.0214	0.0208	0.0193	0.0179	0.7098
LTU	0.1863	0.0025	0.0065	0.0123	0.0269	0.0071	0.0320	0.0504	0.0031	0.0118	0.5318

Code	L68	C17	C20	C24	R_S + T + U	O84	D35	G47	Q	C19
EST	0.0363	0.0174	0.0067	0.0010	0.0343	0.0164	0.0996	0.0321	0.0303	0.0082
FIN	0.1400	0.1271	0.0405	0.0399	0.0362	0.0318	0.0303	0.0295	0.0280	0.0271
LVA	0.0396	0.0015	0.0027	0.0018	0.0102	0.0214	0.3455	0.0222	0.0113	0.0000
LTU	0.0025	0.0127	0.0087	0.0009	0.0224	0.0320	0.1863	0.0123	0.0088	0.0075

Table 6 shows sufficient differences especially concerning the following industries: C16 Manufacture of wood and of products of wood and cork, except furniture; manufacture of articles of straw and plaiting materials, C17 Manufacture of paper and paper products, L68 Real estate activities, C20 Manufacture of chemicals and chemical products, C24 Manufacture of basic metals.

(2) Dynamics of D35 gross value added and final demand

Table 7 shows the time series of D35 gross value added with respect to one monetary unit of D35 gross output (GVAj/GOj = : v_j) and final demand with respect to one monetary unit of gross output (FDj/GOj = : z_j) in EST, FIN, LVA, LTU, 2009-2014.

Note. Due to limited volume of the paper the completely time series for the period 2000-2014 are omitted.

Table 7

Time series of D35 gross value added (v_j) and D35 final demand (z_j) in EST, FIN, LVA, LTU with respect to one monetary unit of D35 gross output, 2000-2014

Year	EST	EST	FIN	FIN	LVA	LVA	LTU	LTU
	GVA/GO	FD/GO	GVA/GO	FD/GO	GVA/GO	FD/GO	GVA/GO	FD/GO
2009	0.4818	0.4490	0.5537	0.2766	0.2677	0.2774	0.4388	0.4581
2010	0.4316	0.4355	0.5276	0.2591	0.2895	0.2848	0.3544	0.4053
2011	0.4233	0.4456	0.5230	0.2328	0.2578	0.2849	0.4348	0.4453
2012	0.4033	0.4536	0.4969	0.2300	0.2478	0.2835	0.4626	0.4611
2013	0.4561	0.4537	0.5027	0.2284	0.2488	0.2857	0.4410	0.4610
2014	0.4599	0.4629	0.5040	0.2264	0.2464	0.2902	0.4393	0.4682

Table 8 contains information about the trends in a functional form $v = a \cdot \tau^b + c$ for the D35 gross value added coefficients v. Table 9 contains information about the trends $z = a \cdot \tau^b + c$ for the D35 final demand coefficients z. Trends are calculated for the latest six years (2009-2014). With help of such trends, we classify the shape of dynamics of D35 value added coefficients and final demand coefficients. The comparative approach allows us to recognize sufficient differences in the shape of the trends in different countries.

Table 8

Trends $v = a \cdot \tau^b + c$, $\tau = t - 1998$, $t \in [2009\ 2014]$. Values of the derivatives v', v'' in 2014

Indicator v	a	b	c	↑ or ↓	∩ or ∪	v'(2014)	v"(2014)
EST	0.29	-0.23	0.28	decreasing	convex	−0.0022	0.0002
FIN	0.52	-0.65	0.42	decreasing	convex	−0.0035	0.0004
LVA	0.70	-0.58	0.10	decreasing	convex	−0.0051	0.0005
LTU	0.13	0.35	0.11	increasing	concave	0.0074	−0.0003

Table 9

Trends $z = a \cdot \tau^b + c$, $\tau = t - 1998$, $t \in [2009, 2014]$. Values of the derivatives z', z'' in 2014

Indicator z	a	b	c	↑ or ↓	∩ or ∪	z'(2014)	z"(2014)
EST	0.18	0.18	0.17	increasing	concave	0.0032	−0.0002
FIN	1.35	-0.80	0.07	decreasing	convex	−0.0073	0.0008
LVA	0.12	0.15	0.11	increasing	concave	0.0016	−0.0001
LTU	0.15	0.28	0.14	increasing	concave	0.0058	−0.0003

(3) Linkages derived from the Leontief direct model X = DX + Y, IMPORT = MX, w = VX.

Table 10 contains numbers shown already in the Tables 2 and 5. But now we are going to interpret it as direct backward linkages in the context of the Leontief direct model.

For example, LVA DBL_domestic = 0.5594; DBL_import = 0.1942. It means: gross output of D35 increasing by one monetary unit *ceteris paribus* causes increasing LVA total final demand by (1 − 0.5594) units and total import by 0.1942. For FIN the analogous indicators are (1 − 0.3098); 0.1862.

Table 10

Industry's D35 linkages DBL_domestic, DBL_import, and coefficients of exports (EXP/GO)

Year	DBL_domestic	DBL_import	EXP/GO	DBL_domestic	DBL_import	EXP/GO
2014	EST	EST	EST	FIN	FIN	FIN
	0.3771	0.1629	0.1964	0.3098	0.1862	0.0371
2014	LVA	LVA	LVA	LTU	LTU	LTU
	0.5594	0.1942	0.0396	0.3119	0.2489	0.0424

Table 11 contains the elasticities of total final demand SUM(Y) and of total imports SUM(MX) with respect to the D35 gross output. The Latvian total final demand reacts to the D35 gross output changes most sensitive. Namely, D35_GO increasing per 1% *ceteris paribus* requires total final demand increasing per 0.0432%. Analogous indicator for FIN is 0.0248%. Even more differs the elasticity of total imports: for LVA it is 0.0794%, but for FIN 0.0309%.

Table 11

Total final demand and total imports elasticities with respect to the D35 gross output

Year	Elasticity of SUM(Y)	Elasticity of SUM(MX)	Elasticity of SUM(Y)	Elasticity of SUM(MX)
2014	EST	EST	FIN	FIN
	0.0332	0.0269	0.0248	0.0309
2014	LVA	LVA	LTU	LTU
	0.0432	0.0794	0.0288	0.0379

(4) Linkages derived from the Leontief inverse model X = ΛY, IMPORT = MΛY, w = VΛY, where Λ: = (I − D)$^{-1}$

Table 12 contains the industry's D35 total backward linkages TBLj_joint, TBLj_domestic, TBLj_import, and gross value added coefficients $(V\Lambda)_j$, interpreted with help of the Leontief inverse model. Latvia differs again: one unit of D35 final demand requires 2.4778 units of total gross output plus total imports; the value added coefficient is 0.6182 − smaller then in EST, FIN, LTU. The indicator $(V\Lambda)_{\cdot j}$ discovers the marginal impact of final demand chages to the gross value added coefficients.

Table 12

D35 linkages TBL_joint, TBL_domestic, TBL_import; gross value added coefficients $V\Lambda_j$

Year	TBL_joint	TBL_domestic	TBL_import	$(V\Lambda)_j$	TBL_joint	TBL_domestic	TBL_import	$(V\Lambda)_j$
2014	EST	EST	EST	EST	FIN	FIN	FIN	FIN
	1.8188	1.5624	0.2563	0.7437	1.7960	1.5139	0.2821	0.7179
2014	LVA	LVA	LVA	LVA	LTU	LTU	LTU	LTU
	2.4778	2.0960	0.3818	0.6182	1.7892	1.4413	0.3479	0.6521

Table 13 contains the elasticities of total gross output SUM(X) = SUM(ΛY), total imports SUM(MΛY), and total gross value added VΛY with respect to the D35 final demand.

Table 13

Total gross output, total imports and total gross value added elasticities with respect to the D35 final demand

Year	Elasticity of SUM(ΛY)	Elasticity of SUM(MΛY	Elasticity of VΛY	Elasticity of SUM(ΛY	Elasticity of SUM(MΛY	Elasticity of VΛY
2014	EST	EST	EST	FIN	FIN	FIN
	0.0259	0.0196	0.0271	0.0076	0.0106	0.0075
2014	LVA	LVA	LVA	LTU	LTU	LTU
	0.0350	0.0453	0.0232	0.0210	0.0248	0.0176

The indicators TBLj_domestic, TBLj_import, $(V\ \Lambda)_{\cdot j}$, elasticity of total gross value added VΛY with respect to the D35 final demand have a clear economical interpretation and provide essential general information about the industry.

We consider two arranged (from largest to smallest) coefficients (2014): arrangement by LVA indicators and arrangement by FIN indicators (Table 14). It allows us to discover distinctions in the ten biggest Leontief coefficients (domestic plus imported).

Table 14

The industry's D35 ten biggest domestic plus imported Leontief indicators in LVA and FIN, 2014 (components of the vectors $\Lambda_{\cdot j} + (M\Lambda)_{\cdot j}$)

Code	EST	FIN	LVA	LTU		Code	EST	FIN	LVA	LTU
D35	1.1333	1.0452	1.5778	1.2937		D35	1.1333	1.0452	1.5778	1.2937
B	0.2170	0.1275	0.2168	0.1719		B	0.2170	0.1275	0.2168	0.1719
F	0.0176	0.0412	0.1176	0.0449		C20	0.0122	0.0514	0.0208	0.0050
N	0.0232	0.0246	0.0841	0.0038		G46	0.0567	0.0442	0.0494	0.0273
G46	0.0567	0.0442	0.0494	0.0273		F	0.0176	0.0412	0.1176	0.0449
H49	0.0258	0.0265	0.0471	0.0223		M71	0.0109	0.0354	0.0080	0.0066
K64	0.0177	0.0222	0.0285	0.0071		C19	0.0252	0.0335	0.0278	0.0548
M69_M70	0.0285	0.0202	0.0282	0.0077		C16	0.0326	0.0325	0.0176	0.0026
C19	0.0252	0.0335	0.0278	0.0548		A02	0.0041	0.0276	0.0049	0.0002
H52	0.0233	0.0103	0.0252	0.0036		H49	0.0258	0.0265	0.0471	0.0223
TBL_joint	1.8188	1.7762	2.4778	1.7892						

The Leontief coefficients indicate a marginal impact on the gross output and imports caused by the D35 increase in final demand. Namely, if the industry D35 increases its final demand when the final demand of all the other industries remains unchanged, Leontief coefficients explore the required balanced growth of all national industries gross outputs and all kinds of imports to ensure economic equilibrium. Table 14 allows us to compare the impact of D35 final demand increase on the total output and imports required for equilibrium in the national economy. It clearly shows the inefficiency of Latvian D35; we are regularly observing big differences between the cost indicators. The most conspicuous are "Administrative and support service activities (N)", "Mining and quarrying (B)", "Construction (F)".

(5) Value linkages (elasticities) derived from the Ghosh model $W^T = (I - G^T)\,X$, $X^T = W\,\Gamma$, where $\Gamma \coloneqq (I - G)^{-1}$.

The Ghosh model is a Supply Side Input–Output model as formally logical alternative to the Demand Side Input-Output Model − Leontief Model. The Ghosh model assumes that the product of industry is sold to each sector in fixed proportions. Due to such wrong interpretation this model was strongly criticized. Erik Dietzenbacher in the paper [14] proposed an alternative interpretation and shows that the Ghosh model becomes plausible, if it is interpreted as a price model. In our research the Ghosh model interpreted in the "variable values, constant quantities" mode allows to construct value linkages and value elasticities as marginal indicators, because the matrices G, Γ in such interpretation are constant. Table 15 contains the D35 direct and total value elasticities.

Table 15

Industry's D35 direct and total value elasticities

Year	$[1-\text{SUM}(G_j \cdot)]\, x_j/\text{SUM}(W)$	$\text{SUM}(\Gamma_j \cdot)\, w_j/\text{SUM}(X)$	$[1-\text{SUM}(G_j \cdot)]\, x_j/\text{SUM}(W)$	$\text{SUM}(\Gamma_j \cdot)\, w_j/\text{SUM}(X)$
2014	EST	EST	FIN	FIN
	0.0317	0.0391	0.0058	0.0328
2014	LVA	LVA	LTU	LTU
	0.0317	0.0415	0.0184	0.0325

The most important conclusion made from the calculated elasticities is that FIN total gross value added elasticity 0.0058 is sufficiently smaller comparing to EST, LVA, LTU. It means that the FIN total value added weekly reacts to the D35 price changes. At the same time the elasticity of total gross output in the referred countries is about 0.03-0.04.

Note. Comparison and analysis of intermediate purchasing (domestic plus imported) allocation coefficients (Ghosh coefficients) are omitted due to limited volume of the current paper.

(6) Investigation with help of the Leontief dual model $P = A^T P + V^T$, $V^T = (I - A^T) P$, where $A \coloneqq D + M$.

The Leontief dual model $V^T = (I - A^T) P$ gives the formula $\Delta V = \Delta P^T (I - A)$ that allows to calculate adjustment ΔV by gross value added coefficients (with respect to gross output monetary unit) caused by perturbance in price indices ΔP. We are interested in the influence of the D35 "Electricity, gas, steam and air conditioning supply" price changes on the current industry's gross value added coefficient. Table 16 shows the industry's D35 product ten biggest purchasers for LVA and FIN.

Table 16

Industry's D35 product (domestic plus imported) ten biggest purchasers for LVA and FIN, 2014 (components of the vectors $A_{j\cdot}$)

Code	D35	C23	E36	P85	C33	I	C13-C15	C28	C30	A01	DFL
EST	0.1099	0.0509	0.0809	0.0355	0.0083	0.0318	0.0188	0.0110	0.0146	0.0258	1.1620
FIN	0.0354	0.0360	0.0767	0.0120	0.0082	0.0152	0.0121	0.0063	0.0137	0.0226	0.9293
LVA	0.3675	0.0979	0.0918	0.0486	0.0446	0.0419	0.0416	0.0388	0.0387	0.0375	1.7001
LTU	0.2364	0.0527	0.0899	0.0097	0.0192	0.0247	0.0202	0.0102	0.0051	0.0158	1.1064

Code	C17	E36	B	C20	C24	L68	C23	D35	C19	R_S + T + U
EST	0.1354	0.0809	0.0439	0.0220	0.0243	0.0242	0.0509	0.1099	0.0463	0.0606
FIN	0.0931	0.0767	0.0552	0.0527	0.0440	0.0415	0.0360	0.0354	0.0342	0.0317
LVA	0.0325	0.0918	0.0196	0.0348	0.0180	0.0317	0.0979	0.3675	0.0023	0.0255
LTU	0.0817	0.0899	0.0094	0.0110	0.0212	0.0023	0.0527	0.2364	0.0046	0.0441

Let the price of D35 product increase by 1% *ceteris paribus*. How will the considered industries' gross value added coefficients react? We can observe sufficient differences.

- GVA of LVA_D35 will grow by $(1 - 0.3675)$%, GVA of FIN_D35 will grow by $(1 - 0.0354)$%.
- GVA of LVA_C23 will decrease by 0.0979%, GVA of FIN_C23 will decrease by 0.0360%.
- (C23 Manufacture of other non-metallic mineral products.)
- GVA of LVA_E36 will decrease by 0.0918%, GVA of FIN_E36 will decrease by 0.0767%.
- (E36 Water collection, treatment and supply.)
- GVA of LVA_C17 will decrease by 0.0325%, GVA of FIN_C17 will decrease by 0.0931%.
- (C17 Manufacture of paper and paper products.)
- GVA of LVA_A01 will decrease by 0.0375%, GVA of FIN_A01 will decrease by 0.0266%.
- (A01 Crop and animal production, hunting and related service activities.)

Industry LVA_P85 (Education) demonstrates oddity! GVA of LVA_P85 will decrease by 0.0486%. At the same time GVA of FIN_P85 will decrease by 0.0120%, GVA of LTU_P85 will decrease by 0.0097%. For what reason Education in LVA consumes 0.0486 monetary units of D35 product for monetary unit of gross output?

(7) Investigation with help of the Leontief dual inverse model $P = \Psi^T V^T$, where $\Psi \coloneqq (I - A)^{-1}$.

From equality $P = \Psi^T V^T$ follows the formula $\Delta P = (\Delta V \Psi)^T$ that allows to calculate the required for equilibrium retaining adjustment ΔP by prices caused by perturbance in gross value added ΔV.

Note. Investigation with help of the Leontief dual inverse model is omitted.

(8) Investigation with help of the Ghosh inverse model $X^T = W\Gamma$, where $\Gamma \coloneqq (I - G)^{-1}$.

From the Ghosh inverse model follows the formula applied for the comparative statics: $\Delta X^T = \Delta W \, \Gamma$.

Taking in account that the Leontief price model (Leontief dual model) is equivalent to the Ghosh model when this one is interpreted as a price model, we will minimize the making use of the Ghosh model.

Conclusions

1. The dynamic comparative analysis of value added created by the industry "Electricity, gas, steam and air conditioning supply" (D35) in the Baltic States and Finland with respect to the gross output in the period of 2000-2014 clearly demonstrates the comparative inefficiency of Latvian industry D35.
2. Our conclusions about the industry D35 different efficiency in EST, FIN, LVA, LTU obtained with help of the indicators calculated mostly have a descriptive character and allow to state the facts. To explain the causality of the discovered differences deeper economic investigation is needed. We appeal the professionals of industry for further holistic investigation of D35 economics in dynamic and comparative aspects.
3. One of the managerial tools to increase value added in the Latvian D35 is the radically increasing DBL_joint. The industry D35 experts must explain the most essential differences between the line of indicators in order to clarify PESTILB environment and elaborate upgraded management decisions.

Author contributions

All the authors have contributed equally to creation of this article.

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