High Technology Sectors' Participation in Downstream GVC: Case of Baltic Region

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ABSTRACT

. The concept of global value chains (GVC) is elaborated by the scientists and applied by practices in the fields of management, economics and politics. Contemporary due to the globalization of the creation, production and consumption process the boundaries between national, regional and international innovation systems becoming fuzzy. This phenomenon is not extensively explored consequently it encouraged to investigate GVC at sectoral level highlighting the high technology sectors' peculiarities of the downstream GVC processes The article is addressed to underline the relevance of GVC approach and empirically observe the trends of high technology sectors' fragmentation and shifts of downstream value added in Baltic region countries. The high technology sectors are distinct due to high rate of investments to R&D, therefore the decomposition of the high technology sector's value added to local and foreign consumption is appropriate. The empirical research is accomplished by comparative investigation of high technology sectors in the Baltic Region countries and based on longitudinal World Input Output Data (WIOD) available for the period from 2000 till 2014. The descriptive and predictive statistical methods were applied exploring proposed indicators for the investigation the dynamics of high technology sectors' downstream value added distribution within GVC. It enabled to compare the high technology sectors in Baltic region countries and to develop predictive models for distinct high technology sectors. The findings could be applied to examine the international business environment trends at sectoral level.

INTRODUCTION

There is a consensus between scientific that technological progress is the core of economic development, although the management of innovation is highly complex due to required long gun investments to R&D and high risk of return. The scientist proposed national innovation systems paradigm for coping with these sophisticated issues. Contemporary the intensified processes of globalization encouraged economists, managers, policy scientist and practitioners evaluate the gainers and losers in the global value chain (GVC) to catch up value and upgrade national value chains. The tensions between embedded national innovation systems and spatially dispersed innovation systems are not still investigated extensively.

The aim of this article is to propose the indicators for the observation of the fragmentation of global value chain focusing on downstream value chain processes of the distinct high technology sectors. These indicators enable to perform comparative analysis of high technology sectors within countries and to model the statistical relation of involvement to downstream global value chain processes with the weight of the high technology sector in the country's economy.

The scope of the investigation is the comparative analysis of Baltic region countries with available data covering a period from 2000 till 2014. The longitudinal sectoral level data reveals the countries specialization in high technology sectors and the participation in downstream global value chain processes dynamics.

1. LITERATURE REVIEW

The foundation of value added in high technology sectors comes from innovations and it is distributed among different countries. There is a great interest attempting to quantify the benefits of R&D and the scientific empirical results indicate that highest rate value is generated in downstream value chains processes (Shin, Kraemer and Dedrick, 2009, pp. 315-330). The investigation of absorptive capacity indicates how added value should be captured at a country level (Dedrick, Kraemer and Linden, 2009, pp. 81–116). The empirical study identifies the diversity across EU28 System orientation practices evaluating innovation policy (Borrás and Laatsit, 2019).

The government science, technology and innovations policies paradigms shifted from linear models of science policy in the 1950s-60s, focusing on supporting the basic research and development to technology policy while in the 1970s- 80s, on technology push and market pull strategies. Although in European Innovation Union Europe 2020 strategy targets still cope with the rate of investments to research and development and it is defined that the public and private investments should reach the 3% norm as a percentage of GDP (GERD). In 1990s-2000s innovation policies oriented to innovation systems for the knowledge transfer by building institutions (Bergek et al., 2015) and post 2010 European innovation strategies highlighted knowledge co-creation (Voorberg, Bekkers and Tummers, 2015). The promoted partnership embrace universities with other innovation system partners to enable the firms to absorb the academic and research institutions knowledge but also other stakeholders - financial institutions, citizens, public institutions in cross border environment. Contemporary European Innovation Union strategy is based on open innovation paradigm (Bogers, Chesbrough and Moedas, 2018) and networked ecosystem that stimulates the absorption of external ideas. This evolving paradigm triggers numerous recent empirical studies (Cassiman and Valentini, 2016; Lopez-Vega, Tell and Vanhaverbeke, 2016; Lopez-Vega et al., 2016).

The traditional rationale for innovation policy has been expanded to innovation policy as imperative for solving political problems: sustainable, inclusive economic growth or economic competitiveness. This emerging transformative challenge-oriented innovation policy (Boon and Edler, 2018) stressing the firm-centred and technology-oriented tradition in innovation policy (Diercks, Larsen and Steward, 2019). This challenge-oriented public policy of innovations may lead to "defi-

cit model" of innovations in which a lack of innovations is routinely invoked as the main problem and other rationales, values, and social functions, that do not explicitly support innovations may be marginalized (Kergroach, 2019).

The innovation policy mix concept has become mainstream across countries governance as increasingly complex regional, national or supranational innovation environments requires re-think policymaking in a more rational and radical way. Innovation policy mixes are specific to geographical space, context and time dimension. Most of the political instruments target R&D but interplay between supply- and demand-driven instruments deployment is limited in most of the innovation policies (Edler, Cunningham, Gök and Shapira, 2016). Looking at the innovation as process, rather at a specific phases such as R&D, it is obvious that there is a need to build a portfolio of specific political instruments for spectrum of stages of an innovation process deploying these policies over time: chronologically linking to the dynamics of technology development stage and maturity of the market (Edler et al., 2016). The policy-making process should consider that intervention is made to a unique, complex and evolving innovation system. Therefore the integration of the foresight into a process of science, technology and innovations policy planning is inevitable assessing long term perspectives. The anticipatory governance of innovations for evaluation of extreme uncertainties and contested risk is also indispensable (Guston, 2014).

The high technology-based firms due to their intensive efforts investing in R&D activities are highly specialized. The global markets enable specialization in small markets niche by providing highly technologically advanced products, therefore most of the high-technology firms are export-oriented, thus facing the global competition. It is becoming a common tool for the large firm's relay not only on organic growth but also acquire another firm in order to overtake technological capabilities, increase production capacities or to enter new markets. These technology-based acquisitions are intricate to evaluate financially and explain the reasoning which led to the final decision. Usually, due to financial constraints, the acquisition of another firm is a viable option for large firms only, thus the smaller ones heavily depend on the quality of national innovation systems and domestic public policies supporting R&D incentives. Smaller firms usually do not carry fundamental research but outsourcing or conducting it in cooperation with external ventures, though larger firms also tend to interact with universities and research institutions rather extending the internal investments capacities significantly. In the scientific literature, dedicated to open innovations (Berchicci, 2013) it is argued that access to knowledge generated in external sources is getting more important. Distinguishing internal (e.g. strategy; diversification into new fields like integrating vertically backward or integrating vertically forward) and external parameters (e.g. environment like trends in a specific industry), that influence the decisions on R&D within a firm, it is obvious, that the public Science and Technology policies, that support private R&D investments becoming a pivoting factor for business R&D strategies.

It could be distinguished two main types of policies that reduce risk associated with investments to R&D: instruments, which reduce financial risk by providing an immediate financial contribution to R&D activities (e.g. tax incentive, project grants or loans, personnel subsidy) and other which do not necessarily affect the level of resources available to a firm but they reduce the R&D risk by sharing it in case the result is commercially unsuccessful (conditional loan or loan guarantee; stock option grant). The huge and consistent public policies designed to fund the basic research and support private R&D investments encourage numerous research assessing the economic performance of Science and Technology Policy. The efficiency thus and comparative advantage of R&D varies across countries due to differences in the quality of national innovation systems. There are developed various indicators for the evaluation of the performance of innovation systems and detect the problems (Dziallas and Blind, 2019). These indicators by different perspectives can be categorised into the more specific factors and broad field dimensions. Innovation indicators for innovation stages: the front-end indicators refer processes from the idea generation till the formal development, ex-post phase signifies innovations that are already introduced into the markets, in contrary ex-antre indicators covers early stages of the innovations. Other re-

searches focus on the indicators like direct and indirect (Becheikh, Landry and Amara, 2006), or the indicators referring science, technology, and innovation (Freeman and Soete, 2009), input, throughput and output indicators (Klomp and Van Leeuwen, 2001).

For the policy-making international organizations, public institutions and consultancies introduced well-known innovation related indicators. Organization of Economic Cooperation and Development (OECD) by Oslo Manual proposed international input-output oriented micro-level innovation indicators based on questionnaire survey which was established in European Union (Eurostat) as Community Innovation Survey (CIS), though companies are obviously unwilling to disclose sensitive information about their innovation processes. The relevant econometric measure is a gross domestic expenditure on R&D (GERD), expressed as a percentage of GDP. GERD indicates the "level of knowledge intensity" and this measure suited to international comparison, while the evaluation of expenditures based on an international standard developed by OECD by Frascati Manual. Most of the studies dedicated to the investigation of the impact of research on productivity found a positive rate of the return, however these evaluation attempts facing difficulties because are based on questionable assumptions. There are other prominent indicators like is European Innovation Scoreboard (EIS) proposed by European Commission, Science, Technology and Industry Indicators by OECD, Global Innovation Index 2018 in cooperation of Cornel University, INSEAD, and World Intellectual Property Organization. The consultancies also conduct innovation measures like the Boston Consulting Group, the McKinsey innovation metrics, and Business Application Research Metrics.

European Commission, EU members associated countries initiated various activities for the deepening relationship and alignment expectations between science and society (Strand et al., 2015). It is proposed to monitor eight Responsible Research and Innovations (RRI) criteria: governance, public engagement, gender equality, science education, open access, ethics, sustainability and social justice. RRI conceptual is very dynamic and highlights the need to develop new indicators covering quantitative and qualitative terms, though most of the methodologies for the proxy RRI indicators still under extensive elaboration. The OECD Innovation Strategy recognized that it is necessary to move beyond aggregated numbers and indices for measuring the functioning of innovation systems (OECD, 2010). The traditional "positioning" indicators produced for the policy-making based on the identification of the countries on a particular issue. There is an attempt at the statistical community to develop new methods to restructure data collection in order to maximize microdata-linking opportunities and develop the "experimental" indicators. The implementation of these incentives requires new statistical data and tools to link different data sources at an enterprise level (Nielsen, 2018).

The Global Value Chains (GVC) model formatted on input-output architecture enables data disaggregation at the sectoral level. In this model it is considered that some of the produced goods are used as inputs for the production of other goods, some used as investments to fixed assets and remaining part for the final consumption. This dynamic and network-oriented content enables to track the cross border flow of added value at the sectoral level, though there is an initiative within the European Statistical System to link existing data at an enterprise level and develop business function framework. The GVC model enables to evaluate the dissemination of technologies and distinguish developers, and implementers in terms of added value. In recent decades the internationalization is a main driving force of GVC and academic literature signalling the need for more accurate and data-demanding indicators (Amador and Cabral, 2016).

2. RESEARCH METHODOLOGY

The research covers the high technology sectors identified according to European statistical classification of economic activities (NACE). The economic activities with the highest ratio of investments to R&D and added value assigned to high technology sectors. In NACE classification Rev. 1.1. two manufacturing industries were distinguished as high technology sectors, though in

2008 NACE code grouping was revised (NACE Rev.2.) and knowledge-intensive services considered as high technology sectors, therefore this article is dedicated to high technology manufacturing industries (sectors C21, C26) as well as to knowledge-intensive services (J59, J60, 61J, J62, J63, and M72).

The longitudinal data of value-added trade was retrieved from World Input Output Database (WIOD) (Timmer, Dietzenbacher, Los, Stehrer, & de Vries, 2015, pp. 575-605) which is based on global Inter-Country and Input-Output (ICIO). The dynamics of high technology sectors' involvement into upstream and downstream global value chains is estimated evaluating indicators dedicated to the added value consumption in the country. Most of the resent research is highly oriented to the structure of exports arguing that higher level of participation in GVC's enables overtake foreign source of knowledge and upgrade value chains shifting economy to higher added value activities (Fagerberg, Lundvall, & Srholec, 2018). This research is aiming to disaggregate the domestic added-ed value of high technology sectors in order to evaluate the downstream value chain flow focusing on local value added consumption of distinct domestic high technology sectors.

The WIOD of value added data is available for the period from 2000 till 2014 and covering 43 countries with some aggregated sectors (for the high technology sectors J59-J60 and J62-63). The comparative analysis of high technology sectors is dedicated for Baltic region countries, those that have shorelines along the Baltic Sea: Denmark, Estonia, Latvia, Finland, Germany, Lithuania, Poland, and Sweden. Russia in this research was excluded due to the unavailable data for J59-J60, J62-J63 and M72 high technology sectors.

The analysis of high technology sectors dynamics of upstream global value chain processes looks on the demand side of the country. The domestic demand consists of intermediate consumption, final demand of households, government and non-profit organization also gross fixed capital formation (GFCF). Considering trade in value added (TiVA) definition of value added in final demand, following indicators introduced:

$$VASH_{c,i} = \frac{VA_{c,i}}{\sum_i VA_c} \times 100$$

$VASH_{c,i}$ - the share of value added of sector i of the country c, from the gross value added of, i.e. the value added of all sectors in the country c.

$$RDSH_c = \frac{RD_c}{\sum_i VA_c} \times 100$$

$RDSH_c$ - the share of R&D investments of the country c, from the gross value added of, i.e. the value added of all sectors in the country c.

$$ISH_{c,i} = \frac{IVA_{c,i}}{TR_{c,i}} \times 100$$

the share of i sector's added value intermediate consumption in the country c of i sector's total output (result) TR of the country c.

$$HSH_{c,i} = \frac{HVA_{c,i}}{TR_{c,i}} \times 100$$

the share of i sector's added value household consumption in the country c of i sector's total output (result) TR of the country c.

$$GNSH_{c,i} = \frac{GNVA_{c,i}}{TR_{c,i}} \times 100$$

the share of i sector's added value government and non-profit organizations domestic consumption in the country c of i sector's total output (result) TR of the country c.

$$CFSH_{c,i} = \frac{CFVA_{c,i}}{TR_{c,i}} \times 100$$

the share of i sector's added value domestic consumption in gross fixed capital formation in the country c of i sector's total output (result) TR of the country c.

$$IFSH_{c,i} = ISH_{c,i} + HSH_{c,i} + GNSH_{c,i} + CFSH_{c,i}$$

the sum of intermediate household, governmental and non-profit organization consumption either the expenditures on gross fixed capital formation.

The mathematical framework is devoted to the decomposition of domestic consumption of high technology sectors' value added, thus doesn't encounter consumption of foreign value added. These measures reveal the peculiarity of high technology sectors' value added consumption although the share is calculated from the total output of the high technology sector while it is not possible to define the origin of value added in intermediate consumption, final consumption and GFCF. In contrary the value added share of a high technology sector estimated from overall sectors' value added in the country $(VASH_c)$. This methodology limitation should be encountered interpreting results, while intermediate and final consumption, as well as GFCF embrace foreign and domestic origin of value added.

In order to perform the comparative analysis of high technology sectors in Baltic region countries first of all the share of all high technology sectors added value from gross value added in the country $(VASH_{HT})$ is compared. The investment rate to R&D in absolute values is available from Science and Technology indicators provided in OECD database. Therefore the share of R&D from gross value added $(RDSH)$ is estimated in contrary to broadly accepted GERD indicator (the share of Government Expenditure on Research and Development from GDP). Although the data for R&D is aggregated and available only for all sectors, thus it is not possible to evaluate the return on investments to R&D in sectoral level, therefore the correlation and linear regression methods were applied to investigate the R&D investment rate impact to the share of high technology sector's i value added from gross value added $(VASH_{c,i})$. The main purpose of the analysis is to compare high technology sector's downstream involvement into GVC and its weight to the country's economy $(VASH_{c,i})$.

$$VASH_i = a_0 + a_1 RDSH + a_2 ISH_i + a_3 HSH_i +$$
$$+ a_4 GNSH_i + a_5 CFSH_i$$

where the dependent variable $(VASH_i)$ is the share of value added of the high technology sector (i) from the gross value added and dependent variables are investment rate to R&D from the gross value added $(RDSH)$, share of domestic intermediate (ISH_i), household (HSH_i), governmental and non-profit organizations consumption $(GNSH_i)$ as well as expenditures to gross fixed capital formation $(CFSH_i)$. a_0 – an estimated constant; a_1, a_2, a_3, a_4, a_5 – estimated regression coefficients. The investment rate ratio $(RDSH)$ variable was introduced as exhaustively investigated variable that has impact to the economic development, therefore, it is considered as reference highlighting the downstream parameters. While Scientific Research and Development sector M72 is one of high technology sectors it was investigated the correlation with all high technology sectors and the difference between R&D investment rate and the share of M72 sectors value added consumption from the gross value added (table 1).

The multivariate regression models for distinct high technology sector (i) differ. The correlation of independent variable $(VASH_i)$ with regressors and the ones with weak correlation were excluded from the model (table 2).

Summarizing the following null hypotheses were investigated in the paper:

Hypothesis 1: There is no statistically significant difference between high technology sectors' added value in Baltic region countries.

Hypothesis 2: There is a no statistical relation between the share of high technology sector's value added and share of R&D invest rate from the gross domestic value added $(RDSH)$;

Hypothesis 3: There is no statistical relation between share of high technology sector's value

added $(VASH_i)$ and M72 sector's share of value added from the total gross value added $(VASH_{M72})$;

Hypothesis 4: There is no statistical relationship between share of high technology sector's value added $(VASH_i)$ and domestic intermediate (ISH_i) as well as final consumption of: household (HSH_i), governmental and non-profit organization $(GNSH_i)$, and domestic expenditures on gross fixed capital formation $(CFSH_i)$.

Hypothesis 5: There is no statistical relation between share of high technology sector's value added $(VASH_i)$ and domestic intermediate and final consumption of the sector's total output $(IFSH_i)$;

3. RESULTS AND DISCUSSION

The average of high technology value added share from the gross value added in Baltic region countries in years 2000-2014 is about 6.9 % with a standard deviation of 2.4 % while the average of the share of expenditure to R&D from the gross value added is 2.3 % with only about 1.0 % standard deviation (figure 1).
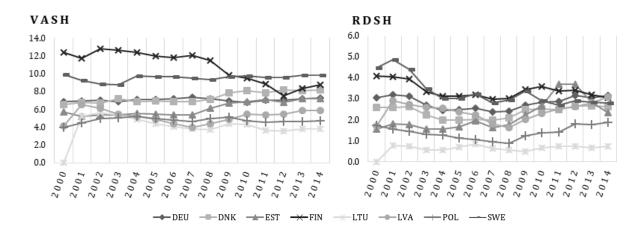

Figure 1. The structure of all high technology sector's value added share from the gross domestic value added (VASH) and share of investments to R&D (RDSH) in Baltic region countries in years 2000-2014 (share of gross value added in %)

Source: authors calculations based on World Input Output Data

It is considered that the investment to R&D is mainly dedicated to high technology sectors, although there is no statistical data to what extent of exact economic activity sector.

Sectoral data from WIOD encouraged to investigate the R&D investments and Research and Development M72 sector's correlation with the distinct high technology sectors (table 1).

Although numerous investigation indicates the link between investment rate and high technology sector's performance and economic development, the statistically significant and strong correlation denoted between R&D investment share from gross value added and J62-J62 and M72 sectors, average correlation with C26, J59-J60 and C21 sectors. The J61 sector has very weak but negative correlation. The research and development sector's M72 share of value added correlation is very strong only with J62-J63 sectors, average correlation with C26 sector and negatively with J61 and almost have no correlation with C21 and J59-J60 sectors.

Table 1. The correlation of share of investments to R&D and share of value added of R&D sector (M72) from the distinct high technology sector's share of value added

	RDSH	VASH$_{C21}$	VASH$_{C26}$	VASH$_{J59-J60}$	VASH$_{J61}$	VASH$_{J62-J63}$	VASH$_{M72}$
RDSH	1	0.339**	0.586**	0.399**	-0.322**	0.770**	0.672**
VASH$_{M72}$	0.672**	0.224*	0.432**	0.256**	-0.447**	0.839**	1
N	120	120	120	120	120	120	120

**, * denotes correlation significance at the 0.01 and 0.05 levels (2-tailed).

Source: Authors calculation based on World Input Output Data

The one sample t-test indicates that there is a statistically significant difference within the high technology sector's share of added value from the gross value added in Baltic region countries. Thus the average share of value added from the gross value added of distinct high technology sector's added value differ from the 1.1% average share of value added of six high technology sectors (figure 2).
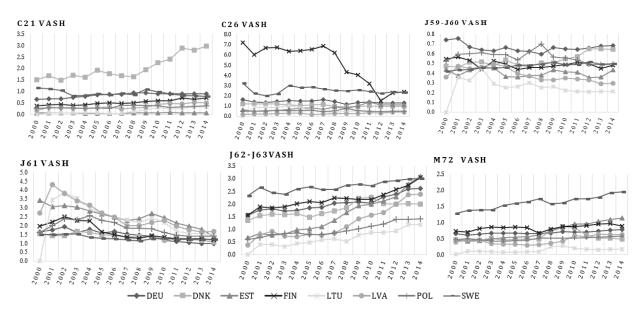

Figure 2. The share of distinct high technology sector's value added share (VASH) from the gross value added in Baltic region countries in years 2000-2014 (share of gross value added in %)

Source: authors calculations based on World Input Output Data

The highest average of value added share is 1.9 % of J61 sector, slightly lower 1.6 % of J62-J63 and 1.5 % of C26. The lower averages are: 0.7 % of M72, 0.6 % of C21 and 0.5 % of J59-60 sectors. The dynamics of high technology sector's value added share reveals specialization of the countries: Demark in manufacture of basic pharmaceutical products and pharmaceutical preparation s (C21), till 2012 Finland in manufacture of computer, electronic and optical products, Germany in motion picture, video and television program production, sound recording and music publishing activities (J59) and broadcasting activities(J60) and Sweden is a leader in computer programming, consultancy (J62) and information services (J63) activities as well in scientific re-

search and development (M72). Telecommunications sector (J61) is the most homogenous and converging sector in all Baltic region countries with the 1.8 % average share of value added and standard deviation 0.3 % in 2000 cross-section data and 1.3 % average and only about 0.1 % standard deviation in 2014.

The average domestic intermediate consumption of high technology sectors' share of value added from the total output of the sector in 2014 is high 51.4 % in J59-J60, 49.3 % in J61, and 42.0 % in J62-J63 sectors, lower 18.9 % in C21 and only about 10.4 % in C26 and 8.4 % in M72 sectors (figure 3).
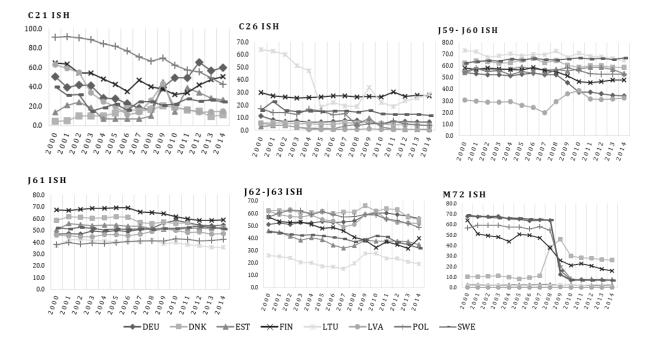

Figure 3. The share of local intermediate consumption (ISH) from the total output of high technology sectors' in years 2000-2014 (share of expenditure in %)

Source: authors calculations based on World Input Output Data

The average domestic household consumption of high technology sectors' share of value added from the total output of the sector in 2014 is high 40.0 % only in J61 sector and is significant 14.4 % in C21 while other high technology sectors value added domestic household consumption is noticeably lower 7.0 % in J62-J63 sectors, 4.3 % in J59-J60, 2.6 % in C26 and 2.0 % in M72 sectors (figure 4).
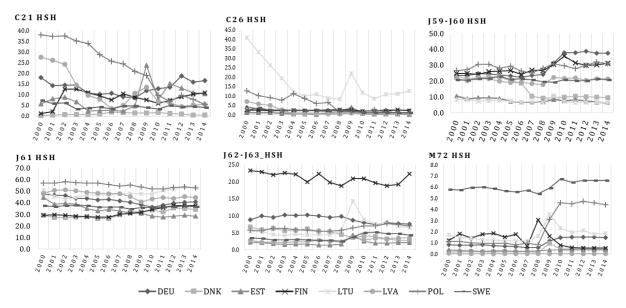
Figure 4. The share of final consumption of household (HSH) of high technology sectors' total output (TR) in Baltic region countries in years 2000 -2014 (share of expenditure in %)

Source: authors calculations based on World Input Output Data

The average domestic government and non-profit organizations consumption of high technology sectors' share of value added from the total output of the sector in 2014 is quite low varying from 13.2 % in M72, 4.8 % in C21, 0.8 % in J62-J63, 0.6 % in C26 till only 0.1 % in J61 sectors (figure 5).
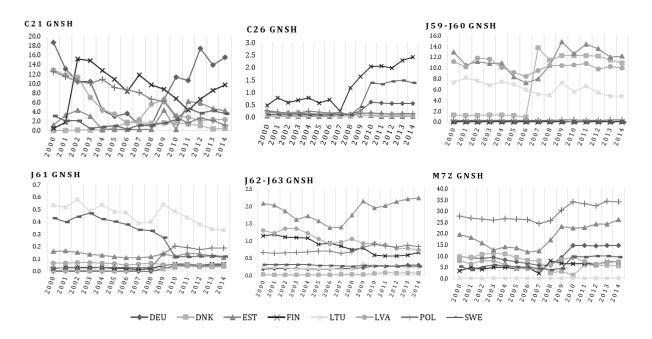

Figure 5. The share of government and non-profit organization expenditure (GNSH) from the high technology sectors' total output (TR) in Baltic region countries in years 2000-2014 (share of expenditures in %)

Source: authors calculations based on World Input Output Data

The average domestic expenditure for gross fixed capital formation of high technology sectors' share of value added from the total output of the sector in 2014 is 59.2 % in M72, 21.8 % in J62-J63, 11.2 % in C26, 3.7 % in C21 and 0.8 % in J61 sectors (figure 6).

The statistical correlation between distinct high technology sector's value added $(VASH_i)$ and independent variables: domestic intermediate (ISH_i) and final consumption of household (HSH_i), governmental and non-profit organization $(GNSH_i)$, as well as domestic expenditures on gross fixed capital formation $(CFSH_i)$ evaluated. The independent variables with low correlation (table 2), high multicollinearity or statistically insignificant were omitted from the final linear regression models:

$$VASH_{C21} = -0.212 + 0.216\,RDSH + 0.137\,CFSH_{C21}$$

$$VASH_{C26} = -0.553 + 0.551\,RDSH + 0.156\,ISH_{C26} -$$
$$-0.257\,HSH_{C26} - 0.475\,GNSH_{C26}$$

$$VASH_{J59-J60} = 0.265 + 0.024\,RDSH + 0.008\,HSH_{J59-J60}$$

$$VASH_{J61} = 2.423 - 0.235\,RDSH$$

$$VASH_{J62-J63} = 0.263 + 0.046\,RDSH$$

$$VASH_{M72} = -0.074 + 0.240\,RDSH + 0.123\,HSH_{M72}$$

The linear regression models for distinct high technology sectors differs and only share of R&D investments is statistically significant for all high technology sectors. The statistically significant correlation of share of value added with the share of R&D investments already highlight this trend with variation from the middle till strong correlation (table 1). The correlation is highest with M72 sector, although in regression model C26 sector statistically has the highest rate of statistical dependence from the share of R&D investments.
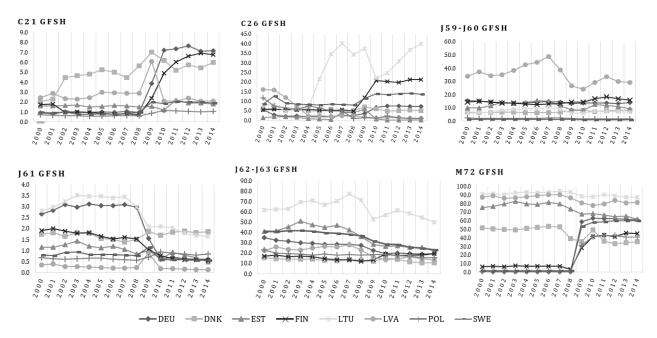

Figure 6. Structure of gross fixed capital formation in Baltic region countries in years 2000-2014 (share of expenditures in %)

Source: authors' calculations based on World Input Output Data

Table 2. The correlation of share of distinct high technology sector's value added with the share of intermediate and final consumption in domestic economy

	$VASH_{C21}$	ISH_{C21}	HSH_{C21}	$GNSH_{C21}$	$CFSH_{C21}$	$IFSH_{C21}$
$VASH_{C21}$	1	-0.382**	-0.309**	-0.296**	0.431**	-0.291**
	$VASH_{C26}$	ISH_{C26}	HSH_{C26}	$GNSH_{C26}$	$CFSH_{C26}$	$IFSH_{C26}$
$VASH_{C26}$	1	0.360**	-0.186*	0.450**	-0.028	0.559**
	$VASH_{J59\text{-}J60}$	$ISH_{J59\text{-}J60}$	$HSH_{J59\text{-}J60}$	$GNSH_{J59\text{-}J60}$	$CFSH_{J59\text{-}J60}$	$IFSH_{J59\text{-}J60}$
$VASH_{J59\text{-}J60}$	1	-0.182*	0.605**	-0.449**	-0.155	0.074
	$VASH_{J61}$	ISH_{J61}	HSH_{J61}	$GNSH_{J61}$	$CFSH_{J61}$	$IFSH_{J61}$
$VASH_{J61}$	1	-0.249**	0.260**	0.153	0.084	0.084
	$VASH_{J62\text{-}J63}$	$ISH_{J62\text{-}J63}$	$HSHR_{J62\text{-}J63}$	$GNSH_{J62\text{-}J63}$	$CFSH_{J62\text{-}J63}$	$IFSH_{J62\text{-}J63}$
$VASH_{J62\text{-}J63}$	1	0.084	0.229*	0.028	-0.430**	-0.599**
	$VASH$	ISH	HSH	$GNSH$	$CFSH_{M72}$	$IFSH$
$VASH_{M72}$	1	0.336**	0.683**	0.023	-0.406**	-0.332**

**, * denotes correlation significance at the 0.01 and 0.05 levels (2-tailed).

Source: authors calculation based on World Input Output Table

The coefficient of determination for manufacture of basic pharmaceutical products and pharmaceutical preparation (C21) model is $R = 0.55$. The local household, government and non-profit consumption phased high multicollinearity, but both variables were not statistically significant. The local expenditures for the gross fixed capital formation has some statistical influence to higher share of value added in the C21 sector.

The linear regression model for value added share in manufacture of computer, electronic and optical products (C26) sector has four significant predictors and a high coefficient of determination $R = 0.861$. This diversity of independent variables with minus signs of local household consumption, government and non-profit organizations consumption indicates that countries with higher share of value added in C26 is orientated to international markets. The participation in downstream global value chains is required to have high rate of value added share in the country. The local intermediate consumption with a positive sign suggests than in the country the procession of several local value added chain stages could be a significant factor.

The linear regression model's for the share of the added value of motion picture, video and television program production, sound recording, music publishing activities (J59) and broadcasting activities (J60) coefficient of determination $R = 0.627$. The share of R&D investments and local household consumption are significant for the model, although latter with very low coefficient. The J59-J60 service sectors oriented to the domestic markets (figure 7) with local intermediate and final consumption means variation from 93.06 % in 2000 till 91.22 % in 2014 in the Baltic region countries, thus the participation in downstream global value chain in these sectors is not relevant.

The added value share in the telecommunications sector (J61), computer programming, consultancy (J62) and information services (J63) actually has no any statistical relation with the downstream global value chain indicators only with the share to R&D investments. The coefficient of determination for J61 sector is quite low $R = 0.322$ and for J62-J63 is high $R = 0.77$. This could be explained that the mean of domestic intermediate and final consumption in the Baltic region countries above 88 % in J59-J60 and 91 % in J61sectors (figure 7), therefore the participation in downstream global value chain comparing with other high technology sectors is low and only the share of investment to R&D as independent variable is statistically significant. It has to be noted

that for all high technology sectors the share of R&D investment regressor is statistically significant although for J61 sector the sign is negative. The dynamics of the local intermediate and final consumptions converge to a lower and similar level of local consumption in different Baltic region countries. This indicates the economic cycle of the J61 sector that has negative consistency with the share of R&D investments. Despite the model for J62-J63 sectors value of predictor is very low but the coefficient of determinations is high $R = 0.77$, and for J61 sector model $R = 0.322$. On the contrary to J61 sector J62-J63 sectors are in economic growth phase with the share of value added growth trend in all Baltic region countries (figure 2), while the mean of Baltic region countries' share of local consumption is decreased from 83.34 % to 67.9 %, thus the participation in downstream global value chain is becoming significant (figure 7).

The linear regression model's value added share of scientific research and development (M72) coefficient of determination is very high $R = 0.869$. This could be explained by a strong correlation with investments to R&D although the local household consumption is quite unexpected variable. It could noticed that Sweden is exceptional in $VASH_{M72}$ (figure 1) and HSH_{M72}, (figure 3), but model indicates that this relation is statistically significant.

Starting from 2008 in the System of National Account the new category of Research and development introduced distinguishing intangible assets, thus some of categories previously were treated as intermediate consumption. This change of account encouraged to aggregate all local intermediate consumption and evaluate the impact to domestic share of value added:

$$VASH_{C21} = 0.912 - 0.005\,IFSH_{C21}; R = 0.291$$

$$VASH_{C26} = -1.085 + 0.766\,RDSH + 0.048\,IFSH_{C26}; R = 0.706$$

$$VASH_{J59-J60} = 0.349 + 0.053\,RDSH; R = 0.559$$

$$VASH_{J61} = 2.423 - 0.235\,RDSH; R = 0.322$$

$$VASH_{J62-J63} = 3.214 + 0.496\,RDSH - 0.034\,IFSH_{J62-J63}; R = 0.849$$

$$VASH_{M72} = 0.007 + 0.293\,RDSH; R = 0.672$$

The local intermediate and final consumption have a negative impact on the domestic share of value added in C21 sector. The coefficient of determination for C21 sector's model is very low and the investment rate to R&D is statistically insignificant. Also, positive relation with local GFCF in case of aggregate local intermediate and final consumption has changed to negative statistical relation. The domestic intermediate and final consumption have positive impact only to C26 sector, although in the disaggregated model only intermediate consumption was positive and for the local household, government and non-profit consumption were negative. In the case of J59-J60 sectors, the local intermediate and final consumption are not significant and household consumption have no impact on total domestic consumption.

Only the J61 model has left unchanged while the total local final and intermediate consumption have no impact on the domestic share of value added. In contrary to the J62-J63 sectors the model supplemented by the total local intermediate and final consumption with negative sign and quite a high coefficient of determination. This highlight that participation in global value chain could be significant for these sectors.

The total local intermediate and final consumption for M72 sector's model has no impact, thus domestic household consumption is not significant in overall domestic consumption of the M72 sector's output.
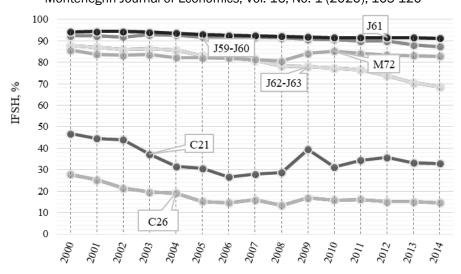
Figure 7. The average share of local intermediate and final consumption in high technology sectors in Baltic region countries (share of total sector's output in %)

Source: authors' calculations based on World Input Output Data

CONCLUSIONS

The contemporary literature review highlights the shift of innovations policies over the decades, although emerging new aspects concerning globalization are still extensively unexplored. The aim of this research is to investigate the high technology sector's downstream involvement to global value chains, thus distinguish the local intermediate and final consumption of high technology sector's value added from the foreign.

The applied concept of global value chains (GVA) provides a sector-specific data, therefore it enables to investigate the dynamics of value added of sectors and sector's position in the economy and involvement to global value chains.

The proposed indicators for the evaluation of high technology sectors involvement to downstream processes of global value chain highlighted the differences between high technology sectors. There is a prevailing assertion that high technology sectors are particularly involved in the regional and international innovation processes. Although the empirical results indicate that involvement into downstream value added significantly differ in particular high technology sectors'. Manufacturing of tangible products' considerably involved in downstream value chains comparing with intangible broadcasting, information, communication, research and development services.

The proposed indicators for evaluating the dynamics of upstream involvement to GVC could be perceived for the monitoring systems evaluating the needs of innovation ecosystems and introducing national or regional innovation policy mixes, dedicated to accelerating industrial and technological shift to higher added value activities.

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