

## **HIGH-TECH EXPORTS AND INCOMES IN THE BALTIC SEA REGION IN THE LONG-RUN: CAN HIGH-TECH BOOST GENERAL WELFARE IN THE ECONOMY?**

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**Abstract.** Governments heavily focus on advancing capital-intensive high-tech production and exports for economic growth. The findings on seven European Union (EU) countries associated as the Baltic Sea region countries argue that despite more than 15 years in the EU, Latvia, Lithuania, Poland maintain dissimilar pattern compared to Sweden, Finland, but Estonia and Denmark are outliers in 2007–2021. Strong correlation between high-tech exports in total exports and income level per capita is detected only in Poland, Latvia, and Lithuania; weak and even negative in Sweden and Finland. Growing high-tech exports are resulted in greenhouse emissions reductions. Policy makers are recommended to modify the plans on digital transformation, productivity and the European Green Deal for sustainable and long-term effect.

**Keywords:** high-tech exports, growth, transport, labour productivity, economic modelling, input-output.

**JEL Classification:** O10, O11, O18, O19, O40.

### **Introduction**

Many governments heavily focus on advancing capital-intensive production with a severe leverage towards high-tech production and exports as key instruments in income level increase and economic growth. This study focuses on seven European Union (EU) countries associated as the Baltic Sea region countries – Denmark, Estonia, Finland, Latvia, Lithuania, Poland, Sweden, but excluding non-EU countries and several regions of Germany that are also included in the regions (for example, for Interreg transnational cooperation in the Baltic Sea region).

The literature review on existing studies in long-term impact of high-tech trade outlines increased interest in recent large-scale economic events – as economic crisis, the COVID-19 pandemic etc., and long-term linkages. Dependence on imported high-tech products (as medical and pharmaceutical products) were strongly examined during the COVID pandemic, however, the findings claim that de-globalization is not a viable long-term vision for the future (Gereffi, 2020).

The study on long-term (in 1986–2015) trends in OECD countries (Kabaklarli et al., 2018) claims that

there is a long-term relationship results between high-technology exports and economic growth in selected 14 OECD countries.

The study on export performance in the high-tech manufactured goods of all the EU economies over the period 2008–2017 (Braja & Gemzik-Salwach, 2020) reveals that the development of the high technology sector is a key factor determining the innovation and competitiveness of the economy and it influences economic growth and development, emphasizing that an active state policy is needed.

Regional imbalances in technological capabilities and high-tech sector in the EU are very severe (Archibugi & Mariella, 2021); some EU countries implemented trade liberation and export transformation (Stojčić et al., 2018); however, relatively low international competitiveness (compared to countries in the same region) results in growing negative trade balance in high-technology goods (Falkowski, 2018).

The study on the impact of high-tech internationalization on the start-up process of new company creation in the EU in 2009–2018 applying cluster analysis and panel modelling (Gawel, 2021) argues that international trade of the high-tech industry is a factor which contributes to the

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start-up process, however, this influence is of a relatively limiting nature and high-tech openness affects mostly negatively the start-up process.

High value-added industries and high-tech industries depend on national and external factors; the long-term study on seven CEE countries in 1995–2011 highlights the importance of labour productivity and highly skilled employees for high-value added manufacturing (Olczyk & Kordalska, 2017).

Smart Specialisation is the EU regional policy element and it is both agreed and criticized to have a notable effect on high-tech sector and innovations (Simonen et al., 2015; Tiits et al., 2015; Wigger, 2023), and concerning Smart specialisation implementation emphasizing that the Baltic Sea Region is one of the most innovative regions in the EU (Philipp et al., 2019).

High-tech industry and wage level have an impact on other sectors, high-tech employment has notable, positive, but diffident effects on the real wages of employees in nontradable sectors in USA (Kemeny & Osman, 2018); high-tech job adds less than one job to the local nontraded sector (Osman & Kemeny, 2022); other sector employees benefit from higher wages in the UK (Lee & Clarke, 2019). However, the long-run study of (Idris et al., 2021) reveal negative relationship between high-tech trade and employment. Larger high-tech exports lead to higher economic growth ensuring larger incomes. Export specialization in high-value-added products and export diversification across partners leads to higher growth rates (Ribeiro et al., 2016), however, the composition of exports values as well (Wierst et al., 2014).

A recent cross-Europe study on the basis of a sample of 22 European countries argues that relationship between growth, technology and skills is statistically insignificant (Gil et al., 2019). The studies reveal both positive impact of high-tech sector and exports, and negative impact as well.

In the EU, and hence in the Baltic Sea regions, the huge policy focus has put on climate neutrality the reduction of greenhouse emissions and related processes in order to limit or reduce impact on the environment (the European Green Deal). The climate neutrality policy has been elaborated gradually (Skjærseth, 2021), however, the target levels are extremely high and many countries meet obstacles to implement such a huge reduction and shifts in present technologies and approaches in many sectors (Wolf et al., 2021). Debate on technical feasibility and degrowth is active (Mastini et al., 2021; Pollin, 2019; Trainer, 2022). High-tech industries can help countries to maintain or increase outputs with smaller inputs.

There is little evidence on how high-tech exports affect transportation sector. It is crystal clear than high-tech exports have higher value as a single unit transported is with larger monetary value (more expensive) and technologies and materials intensive (safer, more protective and reliable packaging, storage, transportation and linked activities are demanded). Transportation sector definitely is affected if high-tech exports grow in long-run and it is not a short-term phenomenon. Few studies

have investigated the impact of the European Green Deal on high-tech trade and income level, considerable research attention has been paid to environmental and technological issues and economic issues are less covered if compared.

The aim of this study is to assess the relations between high-tech level on the economy and income level. The principal objectives are the following: 1) examine data availability, comparability, truthfulness, applicability in order to set the research time framework; 2) perform time-series dynamics and correlation analysis to reveal trends and linkages in long-term; 3) identify statistically significant relationships, considering causal effects and causality; 4) identify possible applied application options of research findings in various fields, including state policy-making. Statistical research methods, correlation, econometric modelling is applied. The research entails analysing and detecting long-term developments in the Baltic Sea region, focusing on the EU member states. Based on the findings of the literature review, comprehensive systematic and modelling methods produce truthful and useful results.

## 1. Materials and methods

High-tech production definition applied in this research is according to the Eurostat classification. High-tech manufacturing industries are *manufacture of basic pharmaceutical products and pharmaceutical preparations* (NACE 2.rev. 2-digit level; code: 21), *manufacture of computer, electronic and optical products* (26) (Eurostat, 2020, 2023b). In the study, welfare is defined as purely economic well-being and hence income indicators are used to characterize. Nevertheless, it is clear that the concept of welfare is significantly deeper and includes also another spheres (as social, social-economic, cultural etc.) not covered in this study.

The selected research areas and list of characterizing indicators applied:

- 1) High-tech exports – *share of high-tech production in total exports of goods (%)*; annual data; 2007–2021);
- 2) Income level, representing overall economic welfare in the economy:
  - a) *gross domestic product (GDP) per capita*, current prices, euro; annual data; 2007–2021);
  - b) *gross domestic product (GDP) in ( ) PPS per capita*, current prices, euro; annual data; 2007–2021);
- 3) Income level, for labour-force – *average annual full time adjusted salary per employee*; euro; annual data; 2007–2021).
- 4) Transport sector – *share of transport in total value added (%)*; annual data; 2007–2021);
- 5) European Green Deal – *Net greenhouse gas emissions* (CO<sub>2</sub>, N<sub>2</sub>O in CO<sub>2</sub> equivalent, CH<sub>4</sub> in CO<sub>2</sub> equivalent, HFC in CO<sub>2</sub> equivalent, PFC in CO<sub>2</sub> equivalent, SF<sub>6</sub> in CO<sub>2</sub> equivalent, NF<sub>3</sub> in CO<sub>2</sub>

equivalent); tonnes per capita; annual data; 2007–2020);

The database is Eurostat (Eurostat, 2023c). Period: 2007–2021; annual data. If data are not available in the source, a shorter period is applied. All data on seven Baltic Sea region countries – Denmark, Estonia, Finland, Latvia, Lithuania, Poland, Sweden. MS Excel and EViews software are used.

## 2. Results and discussion

High-tech exports are expected to have a growing share in manufacturing (replacing the existing labour-intensive and low-skilled labour industries products) and in total exports. However, the long-term dynamics in the Baltic Sea region countries indicate that there is no common single uniform general long-run trend in the region (see Figure 1). Growing share of high-tech is detectable in Latvia, Lithuania, Poland, but not in neighbouring Estonia, neither in Denmark, Sweden and Finland.

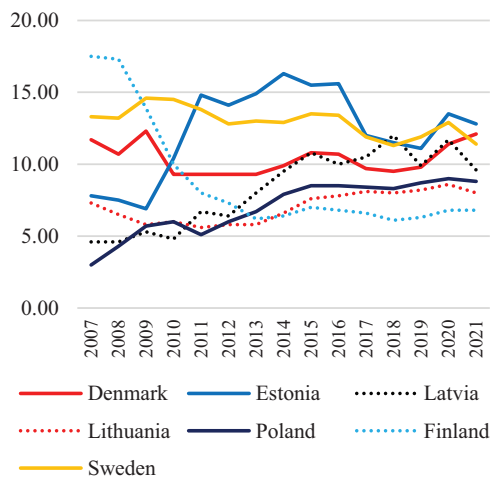


Figure 1. High-tech exports in 2007–2021 (% of total exports of goods) (source: (Eurostat, 2023c) data)

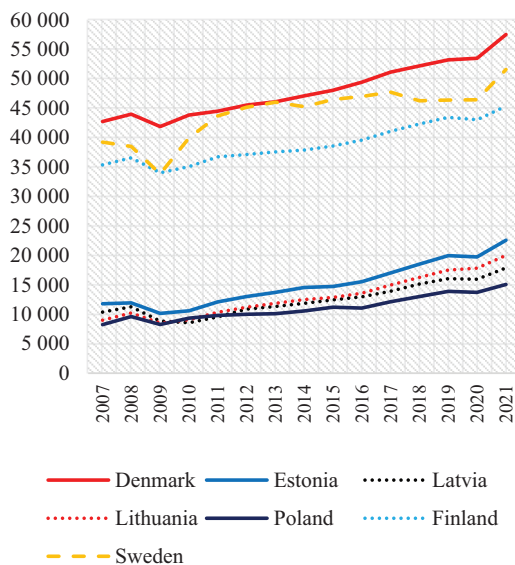


Figure 2. GDP per capita (current prices; euro) in 2007–2021 (source: (Eurostat, 2023c) data)

Definitely, during the past 15 years a notable increase in economic activity and national level well-fare improvements have took place (see Figure 2). In all Baltic Sea region countries analysed, gross domestic products (GDP) per capita in current prices were higher in 2021 compared to 2007. The evidence clearly reveals that the Baltic Sea region countries can be explicitly subdivided into 2 groups (on the basis of income level per capita): higher income level (Denmark, Sweden, Finland) and catching-up countries (Estonia, Lithuania, Latvia, Poland) that had constantly developed and grown in the period analysed.

It is worth to be stressed that price levels in countries analysed are different and purchasing power must be taken into account. Actual income level and purchasing power of income available per one inhabitant is closer within the both above-identified groups as GDP in PPS (purchasing power standards) eliminates differences in price levels between countries (Eurostat, 2023a) (see Figure 3).

The correlation analysis justifies that the linkage between high-tech exports and increase in income level significantly varies amid the Baltic Sea region countries in long-term (see Figure 4).

There is a strong correlation between the share of country’s high-tech exports in total exports and income level per capita (measured by GDP per capita; PPP) in Poland ( $r = 0.86$ ), Latvia (0.84), and Lithuania (0.80). It claims that the larger share of high-tech products the large income level per capita. Growing high-tech share leads to higher material well-being. However, in Scandinavian countries, the correlation is weak, even negative (as in Sweden ( $r = -0.81$ ) and Finland ( $-0.42$ )) in the same time period. The results claim that in the same region of countries that are sharing same values and experience alike external impacts still catching-up is topical and demanded in some countries, but other countries with high income levels should not expect the alike impact on their

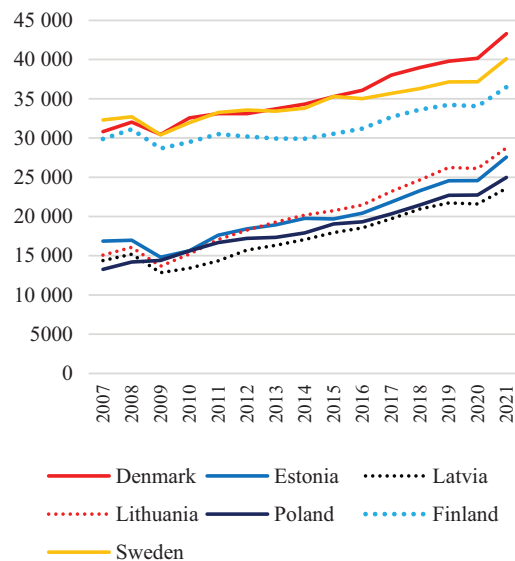


Figure 3. GDP per capita (current prices; in PPS, euro) in 2007–2021 (source: (Eurostat, 2023c) data)

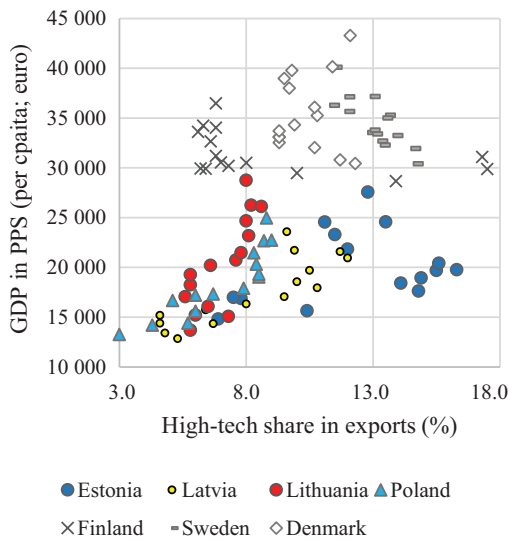


Figure 4. Correlation between high-tech exports (as share of total exports of goods (%)) and GDP per capita (current prices; PPP; euro) in 2007–2021 (source: Author's computations; (Eurostat, 2023c) data)

economies due to high-tech exports. Growing exports of higher added value products have a diverse impact on national transport sector as well.

The results argue that in the same region of countries that are sharing same values and experience alike external impacts still catching-up is topical and demanded in some countries, but other countries with high income levels should not expect the alike impact on their economies due to high-tech exports.

In stable high-income countries (Sweden and Denmark), high-tech exports have not had a notable impact on income level; however, in Latvia, Lithuania, Poland, there is an evidence of present relationship (see Figure 5).

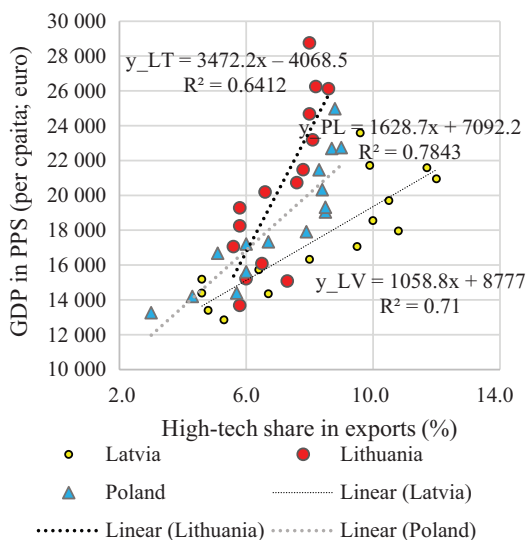


Figure 5. Relation between high-tech exports (as share of total exports of goods (%)) and GDP per capita (current prices; PPP; euro) Latvia, Lithuania, Poland in 2007–2021 (source: Author's computations; (Eurostat, 2023c) data)

The analysis of high-tech exports impact on overall national level wage (annual average full time adjusted salary per employee) outlines even more the differences amid the Baltic Sea region countries.

On the basis of trends in the past 15 years, all selected countries can be clearly subdivided into 3 groups:

- 1) high-tech exports have notable impact on wage level in the economy (Latvia, Lithuania, and Poland) (see Figure 6);
- 2) high-tech exports have no impact on average wage level in the economy (Denmark, Estonia) (see Figure 7);
- 3) higher high-tech exports and lower wages (Finland, Sweden) (see Figure 8).

According to the results, in Latvia, Lithuania, and Poland, the higher the share of high-tech exports, the higher the annual average wage. At the same time, in neighboring country that is alike in many economic, political, historical etc. other aspects (Estonia) there is no such evidence detectable.

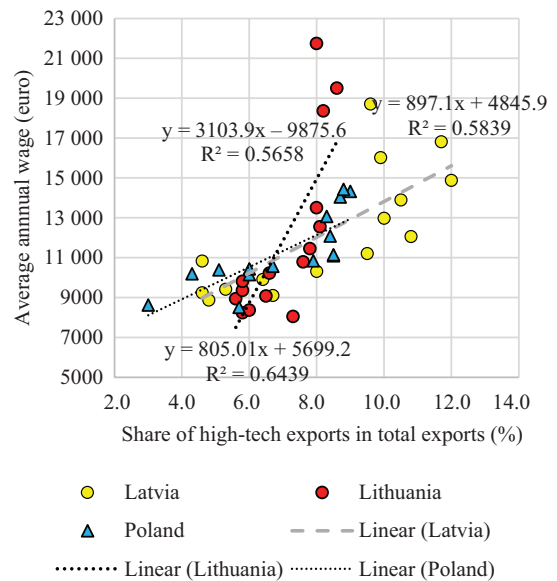


Figure 6. Relation between high-tech exports (as share of total exports of goods (%)) and average annual wage (euro) Latvia, Lithuania, and Poland in 2007–2021 (source: Author's computations; (Eurostat, 2023c) data)

In Estonia and Denmark, the higher high-tech exports had no or minor impact on average annual wage (see Figure 7).

In long-run analysis, it is detected that the higher high-tech exports, the lower annual average wages in Sweden and Finland (see Figure 8). Both countries had experienced notable structural shifts regarding high-tech sectors (as the impact of *Nokia* in Finland's economy in 2007 and 2021) contrasting other countries in the research.

Contrary to the expectations, the estimated relations give only limited application options for forecasting needs due to, mainly, policy measures and distortion in markets during the COVID-19 era. One country

(Latvia) is selected for forecasting in 2022–2030, assumptions are made on exogenous variables, dummy for the impact COVID is introduced in the equations, however, the forecasting results argue that the detected long-term

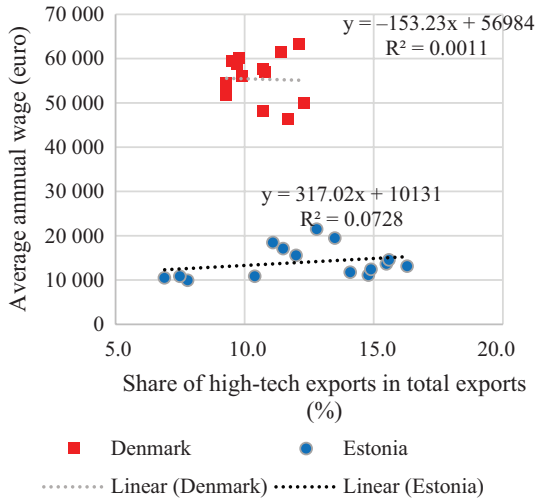


Figure 7. Relation between high-tech exports (as share of total exports of goods (%)) and average annual wage (euro) Denmark and Estonia in 2007–2021 (source: Author’s computations; (Eurostat, 2023c) data)

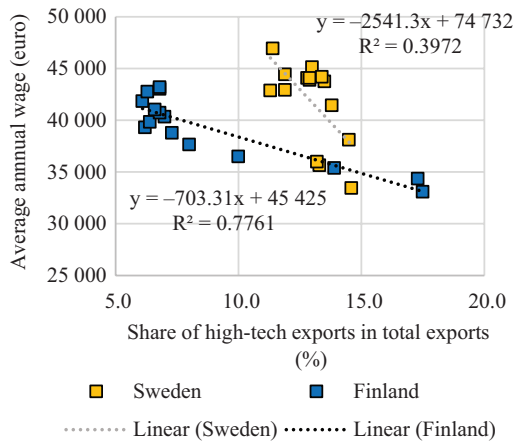


Figure 8. Relation between high-tech exports (as share of total exports of goods (%)) and average annual wage (euro) Finland and Sweden in 2007–2021 (source: Author’s computations; (Eurostat, 2023c) data)

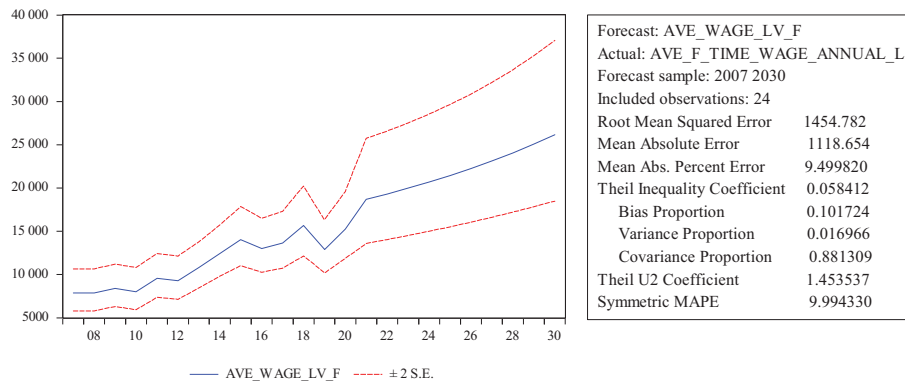


Figure 9. Actual values of average annual wage in Latvia 2007–2021 and forecasts till 2030 (euro)

relations between wages and high-tech exports should be applied in limited extent as years of 2020 and 2021 biased due to COVID-19 have changed the long-term pattern (see Figure 9). The on-going debate on *glocalisation*, *de-globalisation* and alike phenomena concerning global supply chains and location (relocation) of production continues in the post-COVID era.

The research also includes the impact on transportation and climate initiatives. However, no statistically significant relation is found between high-tech exports and transportation in the selected countries. The pre-study hypothesis stated that the more valuable the exported products and the larger the share of high-tech in exports, the less actually transportation services are demanded (as high-tech products are smaller but with larger value), was rejected if long-run relations examined.

In addition, the research attempted to include also sustainability and environmental aspect. Climate neutrality policy is already having a substantial effect and this policy is going to have significant impact in foreseeable future in all sectors, including high-tech sectors. The European Green Deal are targeted to make significant shifts in emissions, use of resources etc. For example, it is targeted to have no net emissions of greenhouse gases by 2050.

The analysis of the selected countries in 2007–2020 on linkages between high-tech exports and greenhouse gas emission (tonnes, per capita; as index 1990=100 cannot be applicable to the previously transition economies as Latvia, Lithuania, Estonia due to major shifts in economics and economic crisis in the early 1990s) argues that only in Poland higher high-tech share in total export correlates with lower emission level (the correlation is weak, but the sign is negative); however in all other countries (the higher high-tech export share has not linked with lower emission per capita) (see Table 1). It is a valuable finding to be taken into account in policy measures elaboration and implementation. If a more recent period estimated (2012–2020; that can be defined as the post-crisis period (after 2008–2010 economic crisis)), only in Denmark, Sweden, Finland the higher the share of high-tech exports, the lower emission per capita. Meanwhile, in some countries (Lithuania, Latvia) the recovery caused opposite processes than expected.

Table 1. Relations between high-tech exports and greenhouse emissions in the Baltic Sea region countries (source: Author's computations; (Eurostat, 2023c) data)

Country	Correlation between greenhouse emissions and high-tech exports (2007–2020)	Correlation between greenhouse emissions and high-tech exports (2012–2020)
Denmark	0.279	-0.715
Estonia	0.248	0.211
Latvia	0.781	0.686
Lithuania	0.735	0.949
Poland	-0.436	0.219
Finland	0.610	-0.619
Sweden	0.256	-0.314

The forecasting results (for Latvia, Lithuania, Denmark, introducing assumptions on high-tech exports growth rates in future and dummy variable for COVID impact in 2020–2021) lead to the findings that the detected linkages are not applicable for reliable forecasting due to market distortion caused by external factors during the COVID pandemic, for example, policy measures, financial support activities for service sectors (catering, hospitality etc.), keeping employees in production companies etc. The findings suggest a need for greater examinations of quantitative assessment of the COVID impact on long-term trends and preserve the *new post-COVID reality* level rather than returning to the previous levels.

## Conclusions

The findings demonstrate that the detected long-term in Latvia, Lithuania and Poland reveal existing and positive correlation between high-tech exports and income level in 2007–2021, however, the COVID pandemic has made notable shifts in linkages hence the detected relations cannot be used for forecasting, neither for short, medium term, and additional factors (as technological changes in production and supply changes due the COVID pandemic etc.) must be introduced in relations.

The findings argue that despite more than 15 years as the EU member states, the formerly emerging economies as Latvia, Lithuania, Poland still maintain significantly different pattern compared to Sweden, Finland, but Estonia and Denmark are outliers in research period of 2007–2021. There is a strong correlation between the share of country's high-tech exports in total exports and income level per capita (measured by GDP per capita in PPS) in Poland, Latvia, and Lithuania. It claims that the larger share of high-tech products the large income level per capita. Growing high-tech share leads to higher material well-being. Though, in Scandinavian countries, the correlation is weak, even negative (as in Sweden and Finland) in the same time period. The results claim that in the same region of countries that are sharing same values and experience alike external impacts (long term factors as demographic trends, aging, growing level of education

in society etc. and short term (as the COVID pandemic) still catching-up is topical and demanded in some countries, but other countries with high income levels should not expect the alike impact on their economies due to high-tech exports. Growing exports of higher added value products have a diverse impact on national transport sector as well.

Policy makers and national governments are recommended to modify the economic recovery plans, boosting productivity and implementing the European Green Deal in practice to ensure balanced and long-term effect. This awareness is agreed by many national governments and focus on innovations and high-tech products is high and rising.

The European Green Deal demands to be paid additional attention in near future, when severer measures will be implemented as the deadlines are coming closer. At the moment, on the basis of the evidence of period of 2007–2021 no statistically significant relationships between high-tech exports and greenhouse emissions. The shorter period gives more promising results, however, due to being too short cannot be used for long-run modelling purposes.

The findings argue that there is no clear evidence that growing high-tech exports result in growing income level in high-income economy and boost welfare in the economy. The existing and gradually growing high-tech exports maintains the existing income level but they are not directly resulting in higher incomes in the whole Baltic Sea region.

Detected existing long-term association are valuable information for policy making and implementation and decision making on further policy initiatives and target levels.

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