



VILNIUS GEDIMINAS TECHNICAL UNIVERSITY
FACULTY OF MECHANICS
DEPARTMENT OF MECHANICAL AND MATERIALS ENGINEERING

Kasparas Dubickas

**IMPACT OF INNOVATION ON HIGH ADDED VALUE INDUSTRIAL
COMPANIES' DEVELOPMENT AND ECONOMIC GROWTH
UNDER CONDITIONS OF GLOBALIZATION**

**INOVACIJŲ ĮTAKA AUKŠTĄ PRIDĖTINĘ VERTEĮ KURIANČIŲ
PRAMONĖS ĮMONIŲ PLĖTOJIMUISI IR EKONOMIKOS AUGIMUI
GLOBALIZACIJOS SĄLYGOMIS**

Master's degree Thesis

Industrial engineering and innovation management, programme code 6211EX056
Production and Manufacturing Engineering study field

Vilnius, 2023

VILNIUS GEDIMINAS TECHNICAL UNIVERSITY
FACULTY OF MECHANICS
DEPARTMENT OF MECHANICAL AND MATERIALS ENGINEERING

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Supervisor Assoc. Prof. Dr. Rūta Banelienė 2022-05-27

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6211EX056
Industrial Engineering and Innovation Management specialisation

APPROVED BY
Head of Department
Ina Tetsmann
2023-05-26

OBJECTIVES FOR MASTER THESIS

No. PIVfmu-21-503

Vilnius

For student Kasparas Dubickas

Master Thesis title: Impact of Innovation on High Added Value Industrial Companies` Development and Economic Growth under Conditions of Globalization

Deadline for completion of the final work according to the planned study schedule.

THE OBJECTIVES:

Explanatory note:

The main goal is to develop and propose a structured model on evaluation of impact of innovations on high added value industrial enterprises' development and economic growth under conditions of globalization. Model should be based on scientific literature' analysis and conducted empirical research.

Objectives:

1. Analyze scientific literature and find out the major factors which have impact on economic growth and boosting innovation activities in high added value industrial enterprises.
2. Conduct comparative analysis of empirical researches seeking to design structure of own empirical research model.
3. Constrain a database based on developed model concept.
4. Make simulations using EViews programme and propose a structured model on evaluation of impact of innovations on high added value industrial companies' development and economic growth under conditions of globalization.

Academic Supervisor Associated Professor Rūta Banelienė

Vilnius Gediminas Technical University		ISBN	ISSN
Faculty of Mechanics		Copies No.	
Department of Mechanical and Material Engineering		Date-.....-.....	

Master Degree Studies Industrial Engineering and Innovation Management study programme Master Graduation Thesis 4	
Title	Impact of Innovation on High Added Value Industrial Companies` Development and Economic Growth under Conditions of Globalization
Author	Kasparas Dubickas
Academic supervisor	Rūta Banelienė

	Thesis language: English
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<p>Annotation</p> <p>The purpose of this research is to investigate the impact of innovation on the development and economic growth of high-value industries in 27 EU countries. This study explores the impact of innovation on the competitiveness of high added value industrial enterprises, as well as its contribution to economic growth in a globalized context, using an examination of existing literature. The study's findings imply that innovation is critical to the development of high-value businesses and can considerably contribute to EU economic growth. The report does, however, identify many issues that high added value businesses confront, such as increased rivalry and the need for continual innovation to remain competitive in a quickly expanding global market. Overall, this paper underscores the importance of innovation as a driving force behind the development of high added value industries and economic growth in the context of globalization.</p> <p>Structure: introduction, literature review, methodology, empirical research and proposed model, conclusions and recommendations, references. Thesis consist of: 55 p. text without appendixes, 47 pictures, 7 tables, 41 bibliographical entries. Appendixes included.</p>

<p>Keywords: innovation, high added value, industrial companies, economic growth, globalization, competitiveness, European Union, global market, development.</p>
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Vilniaus Gedimino technikos universitetas		ISBN	ISSN
Mechanikos fakultetas		Egz. sk.	
Mechanikos ir medžiagų inžinerijos katedra		Data-.....-.....	

Antrosios pakopos studijų Pramonės inžinerijos ir inovacijų vadybos programos magistro baigiamasis darbas 4	
Pavadinimas	Inovacijų įtaka aukštą pridėtinę vertę kuriančių pramonės įmonių plėtojimuisi ir ekonomikos augimui globalizacijos sąlygomis
Autorius	Kasparas Dubickas
Vadovas	Rūta Banelienė

	Kalba: anglų
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Anotacija
<p>Šio tyrimo tikslas - išanalizuoti inovacijų įtaką aukštą pridėtinę vertę kuriančių pramonės įmonių vystymuisi ES 27 šalyse. Remiantis esamos mokslinės literatūros šaltiniais, tiriama inovacijų įtaka aukštą pridėtinę vertę kuriančių įmonių konkurencingumui, taip pat įtaka ekonomikos augimui globalizacijos kontekste. Prieinama išvados, kad inovacijos yra kritinis veiksnys aukštos pridėtinės vertės verslo vystymui ir gali daryti ženklų įtaką ES ekonomikos augimui. Taip pat tyrimas atskleidžia daug probleminių klausimų su kuriais susiduria aukštą pridėtinę vertę kuriantis verslas tokių, kaip padidėjusi konkurencija ir poreikis tęstinių inovacijų tam, kad išlikti konkurencingiems greitai besiplečiančioje globalioje rinkoje. Apibendrinus, šis magistro darbas atskleidžia inovacijų svarbą, kaip aukštą pridėtinę vertę kuriančios pramonės ir ekonomikos augimo variklį, globalizacijos sąlygomis.</p> <p>Darbą sudaro dalys: įvadas, literatūros apžvalga, metodika, empirinis tyrimas ir siūlomas modelis, išvados ir rekomendacijos, literatūros sąrašas. Darbo apimtis - 55 p. teksto be priedų, 47 iliustr., 7 lent., 41 bibliografinis šaltinis. Pridedami priedai.</p>

Prasminiai žodžiai: inovacijos, aukšta pridėtinė vertė, pramonės įmonės, ekonomikos augimas, globalizacija, konkurencingumas, Europos Sąjunga, pasaulinė rinka, plėtra.
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Abbreviations

GDP – Gross domestic product

MVA – Manufacturing value added

GFCF – Gross fixed capital formation

EMP – Employment

HTE – High technology exports

VD – Final energy consumption in the industry

TFP – Total factor productivity

INTRODUCTION

Particularly for industrial businesses engaged in high-value industries, innovation is the main key factor of economic growth and development. Understanding how innovation affects the growth and development of high added-value manufacturing companies is more important in an era of growing connectivity and intense global rivalry. In order to better understand the connections between innovation, industrial development, and economic growth, this research will concentrate on the opportunities and difficulties generated by globalization.

Research problem. What impact of innovation is in high-added value industrial companies' development and economic growth in the European Union 27 countries.

The goal of the thesis. The main goal is to develop and propose a structured model on evaluation of impact of innovations on high added value industrial enterprises' development and economic growth under conditions of globalization. Model should be based on scientific literature' analysis and conducted empirical research.

Objectives:

1. Analyze scientific literature and find out the major factors which have impact on economic growth and boosting innovation activities in high added value industrial enterprises.
2. Conduct comparative analysis of empirical research seeking to design structure of own empirical research model.
3. Constrains a database based on developed model concept.
4. Make simulations using EViews programme and propose a structured model on evaluation of impact of innovations on high added value industrial companies' development and economic growth under conditions of globalization.

Methodology of investigation. Fixed cross-section data panel regression analysis using least squares method.

Structure of the master's thesis. Thesis consists of main parts: introduction, literature review, methodology, empirical research, conclusions and recommendations, references.

Validation. 28th of April, 2023, at the 26th Lithuanian Junior Researchers Conference "Science - the Future of Lithuania", a manuscript about "Impact of Innovation on high-added value industrial companies' development and economic growth under the conditions of globalization" was presented (Appendix C).

1. LITERATURE AND ANALYTICAL RESEARCH REVIEW: ECONOMIC EFFECT OF MANUFACTURING IN DEVELOPING HIGH ADDED VALUE INDUSTRIES

1.1. Innovation and development

The modern world has greatly benefited from industrialization, which led to higher economic growth, lower inflation rates, higher standards of life, more employment possibilities, and lower poverty rates (Jawad, Maroof, & Naz 2022). Meaning that, industrialization well benefits the workforce, and the economy run by it. However, deindustrialization is possible, if certain aspects aren't taken into consideration, to innovate the industries sectors.

During the planning phase for development impact is necessary to investigate the model design to have a clearer vision, of what kind of consequences it might bring (Barjolle, Midmore, & Schmid 2018).

Ecosystems for innovation and industrial manufacturing are the new models that describe how to organize the economy. These types of organizations need to learn patterns, which may be interfered by several factors, to achieve sustainable future (Guilhon, 2017).

Corporation control systems helps companies to take advantage of their creative initiatives and adapt to the current market and technological developments. It results that their greatest ideas are protected by patents and investors (Miller et al., 2022).

In order to understand the change during stages of development occurrences, it might require investigation regarding the situations of real-time processes (Smith & Thelen, 2003).

1.2. Gross domestic product and industry

The rise of the industry share in gross value added has a great influence in industrialized countries that are advanced as well as having high GDP per capita, based on this research's review of the association between sector and GDP growth. The economic development stage of an industrial country affects the cumulative impact of business-financed R&D investment and its effects on economic growth (Baneliené, 2021).

1.3. Globalization

European Central Bank in 2015 announced that the Eurozone is among the largest global economies, at that time, it being the third-largest economy in terms of global GDP share, the leaders. Almost 30 million workers were employed in the industrial manufacturing sector, making around €1.8 billion in added value. With the help of this type of data, industrial manufacturing is

distinguished as the top leading sector within Europe. During an earlier investigation, the European Commission emphasized the value of a thriving practical economy and industry as the primary drivers behind employment and economic growth (Karami et al. 2019). Globalization, on the other hand, is divided into 5 types of companies, which consists of: domestic company, an international company, a multinational company, a global company, and a transnational company (see Figure. 1).

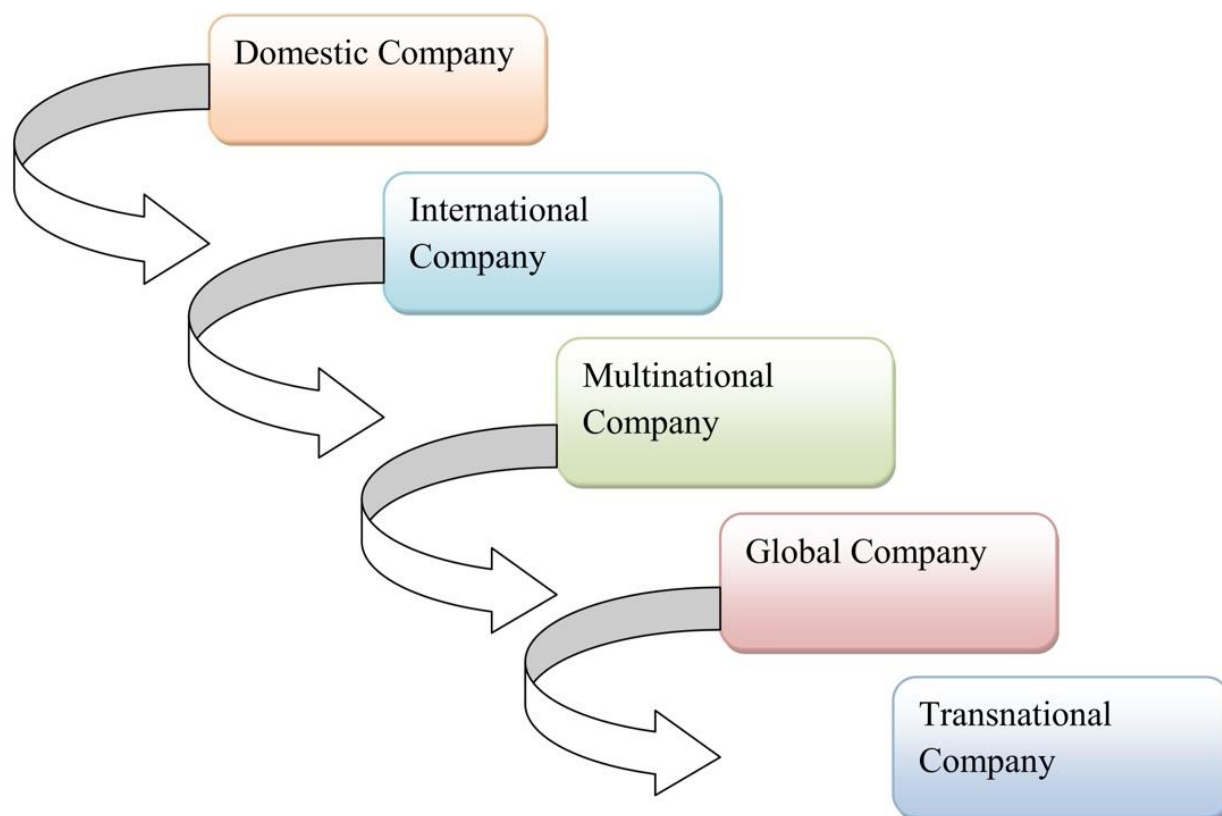


Figure 1. Company development stages

Source: prepared by author

Basically, this represents the life cycle, of a company, which grows over time, and evolves, into a higher tier company. Therefore, in relevance with the thesis, the analysis will overview Europes-27 countries, which are at the highest point, of company's development – Transnational companies, making the thesis topic and the database analysis at the needed global level.

With the help of econometrics and its statistical methods based on quantitative data evaluation capabilities, theories are evaluated by hypotheses. Economics and finance sector, uses it for techniques such as regression hypothesis testing. With the help of these kind of techniques, various economic or financial patterns can be seen in the future, while evaluating consistent data. Certain aspects of this type of data makes it difficult to quantify economic models and/or predict any forecasted conclusion with high accuracy.

1.4. Manufacturing and Economic Growth

The influence of Finland's high technology industry and its structure in regional economic growth (Simonen, Svento, & Juutinen 2015). Two intriguing conclusions are that lower marginal benefits to high technology variety and specialization do not necessarily improve growth, and that the perfect formula of the high technology exports sector is closely related to the region's geographical location.

According to the findings, regions with a high variety specialized manufacturing industry, grows slower than those with two or three big sectors and a few minor companies. This report shows that there is a synergy for economic prospects specializing in a certain high technology exports industry sector. Meaning that the chosen industry specialization, can't be too wide in the range, of specialization in the sector, in terms of diversification, nor too broad, making it fully dependent on a particular sector. Therefore, for the region to expand and grow at the highest possible point, it would be smarter to commit to few specializations, rather than diversifying in a bigger variety. For industry specialization to be effective, the entrepreneurial ecosystem should be optimized accordingly (Szerb et al., 2020).

Europe's manufacturing value-added growth using frontier analysis and provides results for growth-instability, that innovation during an economic development has a relationship with the industries diversity (Hafner, 2019).

The location of a country in the global context of technology has an impact on its rate of growth and revenue. The key method it occurs is the exclusivity and uniqueness of the countries technological innovations and maintains it, in contrast with its competitors (Nepelski & De Prato 2020).

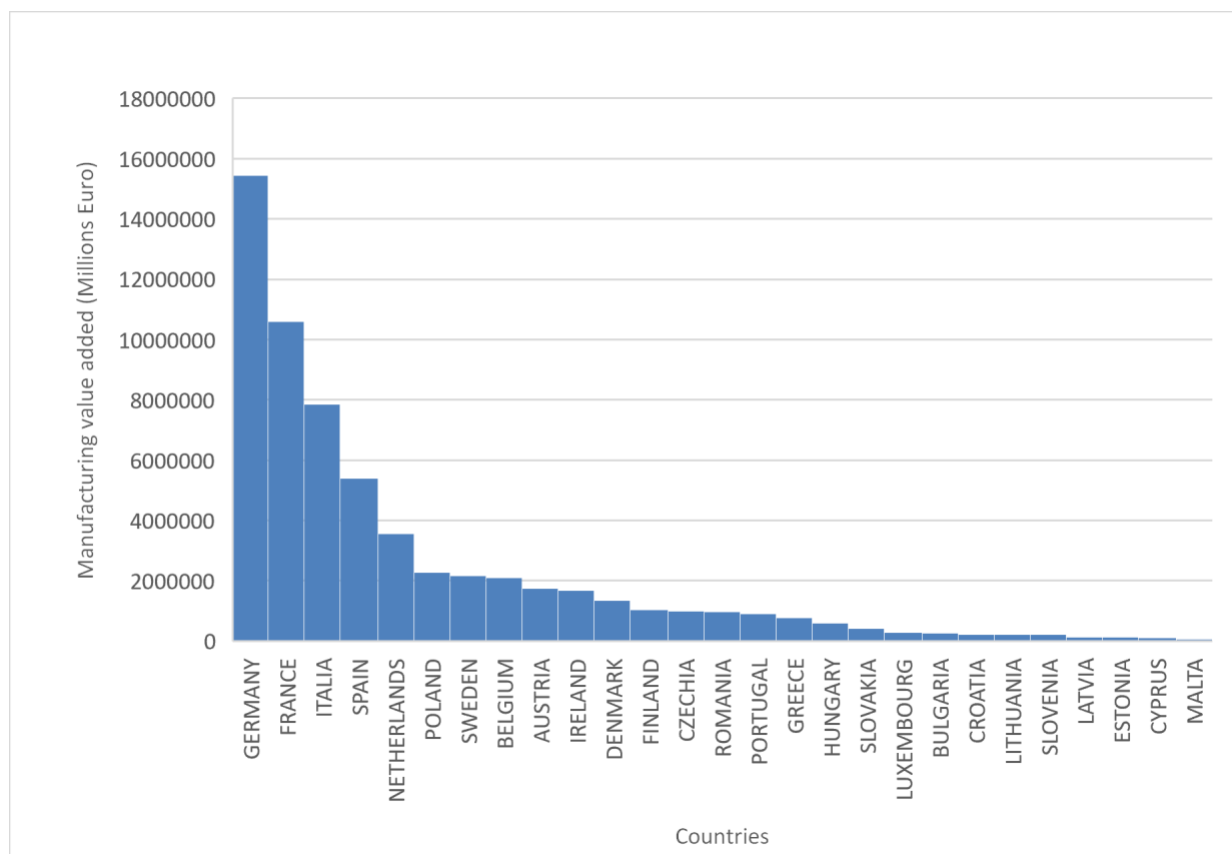


Figure 2. Manufacturing value added EU27 2017-2021

Source: prepared by author based on Eurostat data (2022)

Overall, for the manufacturing industries to succeed, in economic development, companies need to take in consideration that the market is competitive, narrow range of specialization, tends to be more effective and innovation is mandatory, not to get behind (see Figure. 2).

1.5.High technology exports and Economic Growth

High-tech exports have a positive relationship with business possibilities to impact growth rates. The paper results several interesting conclusions using data from 124 countries in the lifespan from 1996 to 2017 (Ali & Malik 2021). The findings indicate that more wealthy countries benefited significantly more from the globalization rather than the poor ones, conducting that the globalization process is unfavorable for the poor countries due to their poor infrastructure conditions(Fetahi-Vehapi, Sadiku, & Petkovski 2015). Wealthy countries and their improvement in trades are beneficial and impact the growth of the economy, although there is no low-income countries and whatsoever no impact for the middle-income countries (Chakroun, Chrid, & Saafi 2021). High-tech exports depend on the country’s income level where the goods, are being sent (Altun et al., 2022). International trade and investment from foreign countries have notable advantages on industrial manufacturing production and exports, however they appear not to impact

the technological complexity and industrial improvements (Zhang, 2014). The region's high-tech companies could take an aggressive approach to innovative development (Grozova, Tsvetkova, & Maslikhina 2020). Trade-related expenses determines the effect of how a developing countries' economies export costs rise, in accordance with other countries share percentage in overall export (Ali & Milner 2022). Due to Europe's high export magnitude, Chinese export competition had a downfall in export volumes, which then led to the consequence that produced loss in employment and a rise in the unemployment rates (Flückiger & Ludwig 2015).

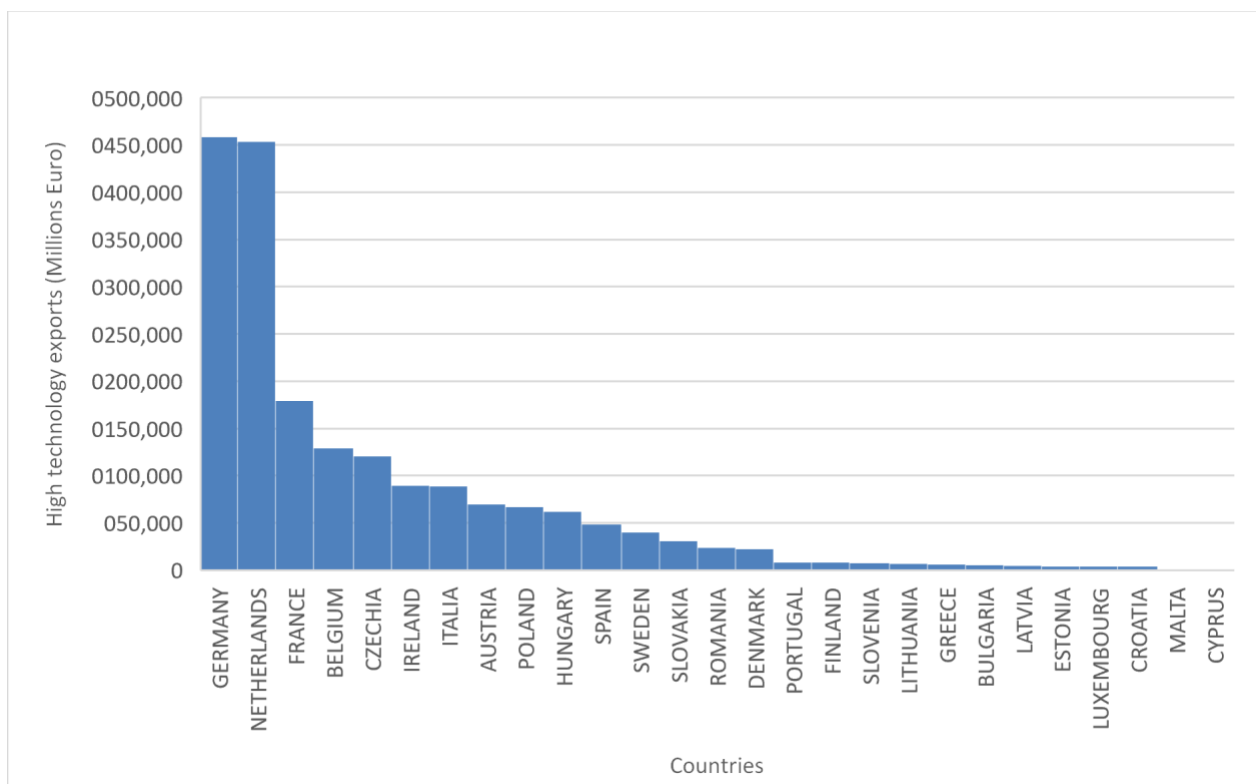


Figure 3. High-Technology exports EU-27 2017-2021

Source: prepared by author based on Eurostat data (2022)

All in all, high technology companies, that export their goods to foreign countries, ensures their position in the market, by producing latest innovative technology, making the highest profits, which then can be seen on the economical scale. However, to stay in the top demand, advanced technological innovations and development are a must. Figure. 3 shows, the main high technology export countries in the European zone.

1.6. Investment and Economic Growth

The acquisition of a assets or any other type of goods, which can bring future growth prospects in profits is considered as a successful investment. Out of European zone neighbor countries,

highly benefit from the Eurozone. This type of investment generates great opportunities, by trading needed goods, for the European structure. Therefore, the neighbored countries, economic growth is closely related to the European Union’s economic growth (Gylfason, Martínez-Zarzoso, & Wijkman, 2015; Amin, Anwar, & Liu 2022). However, global crisis occurs, such as COVID-19, and Russia’s war on Ukraine, disrupting further investment possibilities, and remolding the growth of the economy and development in accordance with investment. Making the dynamics of investment predictions, fragile and sensitive to the global world issues (Barro, 1991). Majority of out of Eurozone countries markets for shares and loans are still undeveloped, and their impact to economic growth remains limited due to their poor financial status, however (Caporale et al., 2015) claims that a more efficient banking sector, could have a positive influence on their growth and financial possibilities. Investment and exports change in the investment variable does have a positive relationship with economic growth (Kaitila 2019). Poland's 2004 acceptance into the EU led to a major boost in output and productivity, primarily because of Germanys growing investment (Bastos et al., 2023). The effects of social and economic factors on Investment and revenue for recently developed, former socialist countries of the European Union (see Figure. 4), indicated that over 77% economies are positively impacted by GDP (Burlea-Schiopoiu, Brostescu, & Popescu 2023). In the industrial manufacturing sector, companies’ productivity has a strong relationship with the market size, wage rates, employment costs and prior investments, however, it negatively correlates with current investment (Carnevali et al., 2020).

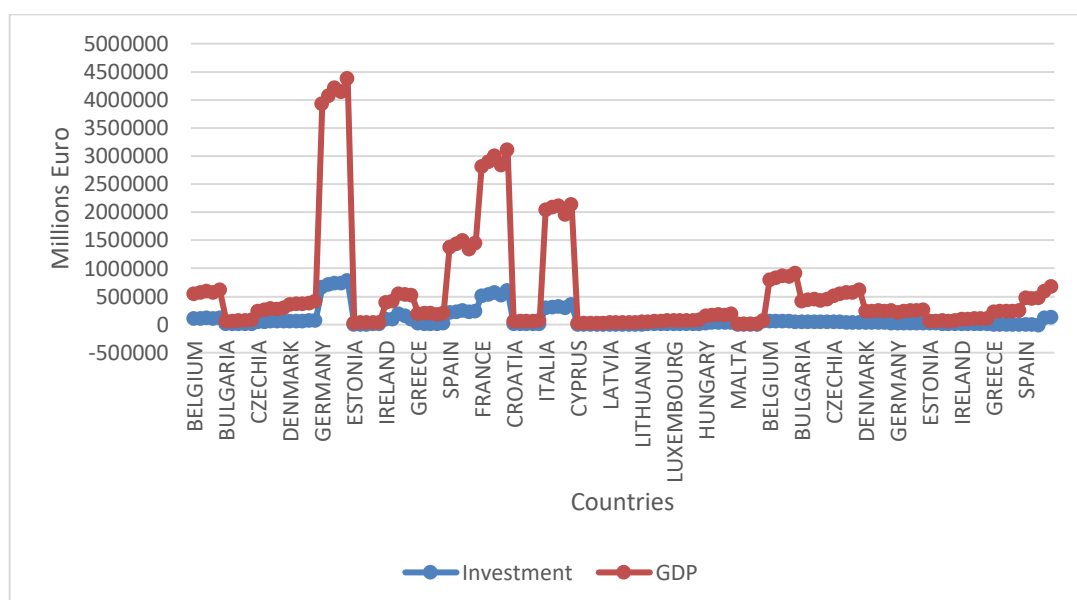


Figure 4. Investment and countries total GDP, EU-27 2016-2021

Source: prepared by author based on Eurostat data (2022)

To sum up, investments are made, to succeed in the market and gain profits, however, various

real-life factors and circumstances occur, while following a specific plan. Despite that, decisions makers, need to act accordingly once things start to change their direction. Making it difficult to predict possible outcomes and prepare beforehand. (see Figure. 4)

1.7. Employment and Economic Growth

Through 2030, job position creation will be a challenging task for all of humanity, but there are reasons to be hopeful about the challenge that lies ahead. The population expansion over the past 20 years, were the highest growth in history, shows how many employment opportunities would need to be developed in the next decade. The juvenile population is expected to increase by 5% between the years 2010 and 2030, which is much less growth instead of the growth rate for adults. Poor rates of substitution of adults with jobs are the result of declining fertility and population growth. Large youth groups will shortly become part of the adult population, which will cause the adult workforce to rise at a significantly faster rate (Bloom, McKenna, & Prettnner, 2019). Since higher-quality work involves bringing new workers into the labor market and reorganizing current employment, it is most likely that more work sectors will have an influence on future demographics (see Figure. 5).

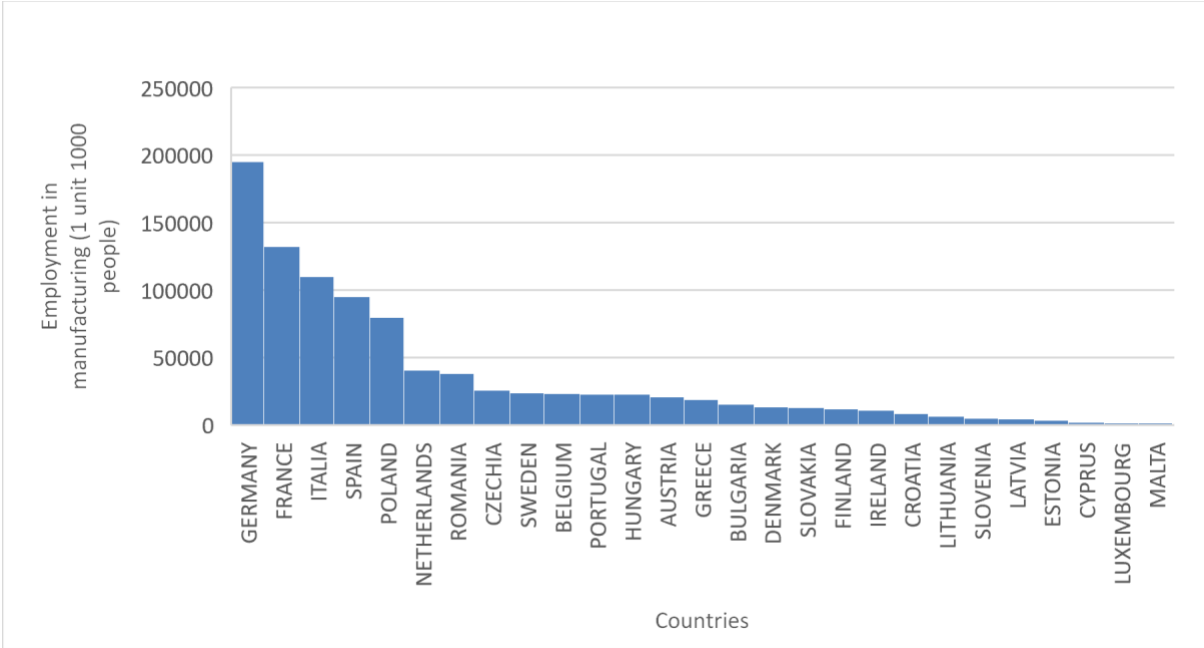


Figure 5. Employment in industry EU-27 2017-2021

Source: prepared by author based on Eurostat data (2022)

It was discovered that relying on fixed-term contracts raises the proportion of temporary to permanent workers, which might decrease the pay and raising labor conflicts. In many European countries, the relationship between income and job security are the main aspects for the labor

politics and industrial relations (Alemán, 2009). With an adequate collection of industrial companies in countries across the western region of Europe, (Ganau & Rodríguez-Pose, 2019) examined the theoretical connection the relationship between company worker efficiency and the quality of regional authorities. The results show that regional authority's quality is the key factor influencing company-level productivity levels and improvements, but how institutions affect labor productivity greatly depends on the kind of organization it is involved in. Labor force and technology, these two factors explain, that they have a positive economic consequence, indicating that the political views could potentially increase the number of jobs available, lowering the unemployment rate (Karami, Elahinia, & Karami, 2019).

1.8. Final energy consumption in the industry and Economic Growth

Energy-efficiency and renewable energy technologies are becoming more important in today's industrial production industry. In 2013, public R&D spending generated stock of energy worth over 35 billion euros, within the Europe's member countries, more than triple size of the European Commission. The research offers possibilities for the knowledge stock for the upcoming years, with the knowledge stock rising to estimated 49–55 billion EUR by 2023 (Bointner, Pezzutto, & Sparber, 2016).

The highest part belongs to nuclear energy, which is followed by renewable energy sources and fossil fuels. Country-level innovation increases economic development, mostly in wealthy countries due to the greenhouse gas emitting, as political views and future ideas are taken into consideration (Zhong et al., 2023). Growth in developing countries made a serious impact on economics as, global greenhouse gas emissions skyrocketed with an increase in demand for agricultural resources and products (Martin, 2019). Technological innovations can't compensate the environment for the increase in carbon emissions. It is crucial to modify how industries function for an economy with a minimal carbon footprint. To build economies with minimal carbon footprints, governments must reevaluate their future policies for the industrial manufacturing companies (Chang et al., 2014). Afterwards, to create and use renewable energy sources during recessions, factors will be needed to be considered by the government's economic plans and policies, that renewable energy and economic growth has a negative connection with one another. Energy development gives industrialized countries slightly more benefits and helps developing countries' economies to thrive, as a result reduction in poverty and hunger. Or rising standards of life and improving the environment (Farooqi et al., 2021).

A report shows that 26 OECD countries in the timespan from 2000 to 2015 conducted that the effects of economic expansion, investment from abroad, and progress in finance were based of environmental quality.

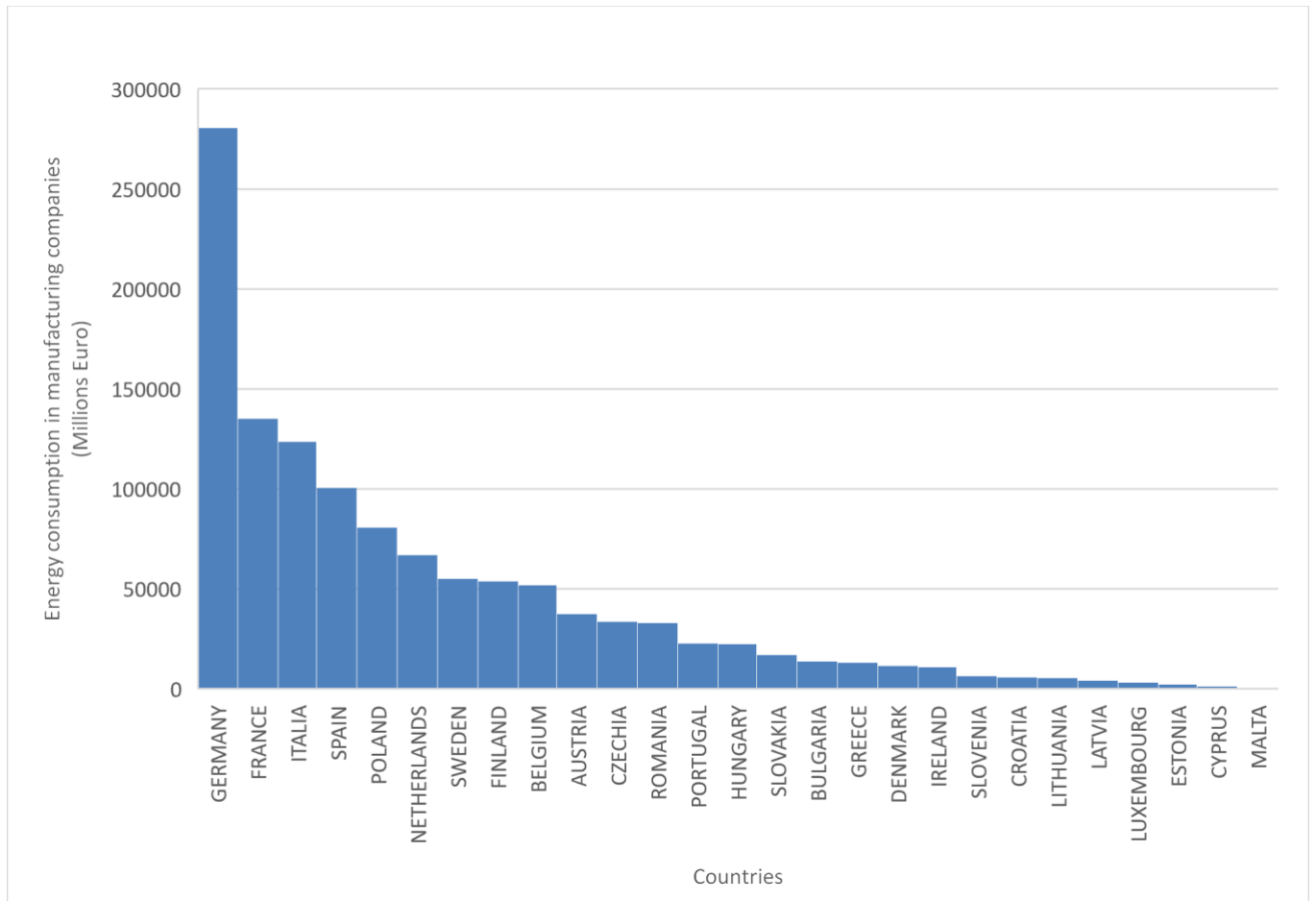


Figure 6. Final energy consumption in the industry EU-27 2016-2021

Source: prepared by author based on Eurostat data (2022)

The results suggest that foreign direct investments from lower and higher carbon-emitting countries, had either adverse or favorable, sadly the unfavorable correlations with environmental quality overwhelm all other relationships (Ganda, 2020).

1.9.Kaldor Growth Theory

The 1966 research conducted by Nicholas Kaldor, which created the basics for the hypothetical formulation of Kaldor’s growth laws, that were a major contribution in the industrial econometric world. According to the first law of Kaldor, growing industrial production and growing incomes are strongly correlated with gross domestic product (GDP) which presumes that, Economic development is primarily powered by the manufacturing industry. The following is the formulation of the first law of Kaldor, which specifications consist of:

$$GDP=A_0+a_1MAN$$

(Equation 1)

Where:

GDP: The growth of total output, MAN: The growth of the manufacturing output.

The first idea towards the model construction, was based on that export's growth were the driving force of regional growth and are related with each other. Exports, according to Kaldor, are the only independent part of total demand because investment and consumer demand are significantly impacted by the expansion of output itself. He stated that the rate of change in an area's prices is driven by the gap that the increase in salaries and labor productivity growth have a negative relationship, and that an area's shifting price competitiveness and the rise of revenue from outside the region are the main factors influencing export growth. Finally, the expansion of production itself through both static and dynamic growing returns inhibits the rise of labor productivity to some degree. The increase of output alone, according to Kaldor, has a considerable influence on investment and consumer demand, making exports the only component of total demand that is independent. According to him, the rate of change in an area's pricing is determined by the difference between wage growth and labor productivity growth, and the expansion of exports is reliant on the shifting price competitiveness of an area and the expansion of revenue from outside the area. Finally, the growth in worker productivity is gradual by the increase of production itself (Thirlwall, 2014).

The Kaldorian theory explaining how manufacturing and commercial services increase productivity was the foundation of data and market share breakdown of labor productivity growth (Di Meglio et al., 2018).

1.10. Neoclassical Growth Theory

American economist Robert Solow came up with the idea of economic development in 1956. He noted that if capital was the primary barrier to economic growth, companies would replace labor for capital. His advice focused on the finding that high-technological export advancements, rather than savings or investment, are what causes the impact on sustained growth. During the creation of (TFP) paradigm, where labor force growth, technological advancement, and the number of workers in the industry, Solow's model stood as the foundation for the theory. The neoclassical growth model shows that changes in technology makes an impact on economic growth and industrial manufacturing, over long periods (Karami, Elahinia, and Karami, 2019) . Therefore, the productivity formula will be:

$$Y = TF (K, L)$$

(Equation 2)

Where:

K - physical capital, T - technology, L - amount of worker, Y – production output

It is demonstrated that the foundation of the standard neoclassical development model may have an influence on a wide range of industrial sector dynamics (Blankenau & Cassou, 2009). For an instance, the relationship between work mechanization and capital formation may provide an opportunity for a positive increase in production, it ends up resulting in employees' salaries growth loss, or fluctuation (Ikeshita, Uchida, & Nakamura, 2023). Great numbers of OECD countries have faced tremendous reductions of hours worked by the employees in the past 20 years (Reif, Tesfaselassie, & Wolters, 2021).

2. RESEARCH METHODOLOGY

2.1. Stages of Development

- The first stage is to come up with a hypothesis based on theory to explain the data being analyzed. The most recognized theories are developed by famous econometricians, which bring useful insights, and were tested with the result of great accuracy.
- The second and third stage is to create a mathematical equation model that encapsulates the core of the theory being tested. The model provides a mathematical link between the separate explanatory factors and the factor that is dependent.
- The fourth phase consists of the construction of the database. The needed data, must be cleaned, aligned, sorted, and structured in a way, that the analyzed variables, would have a relationship with each other, however, econometrical software's, during the analysis, can show that some might not be suitable in progress, for the model creation. Supporting early knowledge if the chosen variables are useful or not. Making it easier to adjust the database beforehand in a needed manner.
- Following on, after the construction of the database, the estimated model is run, for analysis. Thus, showing insights which, can answer, the raised hypothesis, depending on the initial model's question.

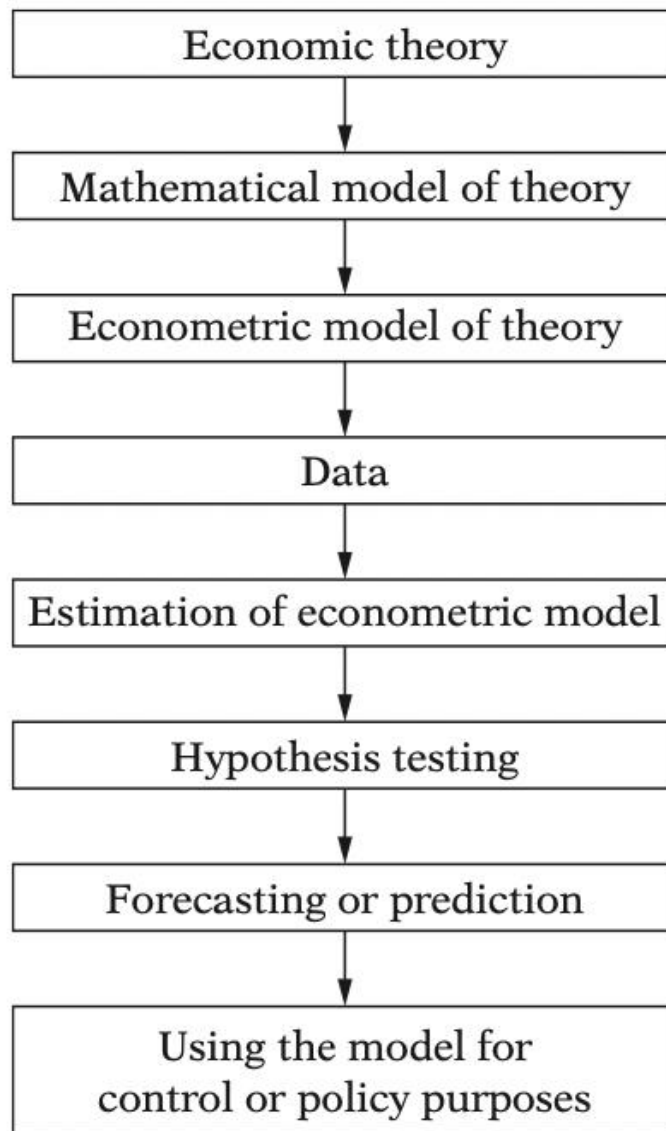


Figure 7. Stages of development

Source: prepared by author

- With the hypothesis, supported or rejected, with the initial econometric model estimation, a final model can be generated, removing variables, that do not impact, or adding dummy variables, that make zero impact, but might be used to see if the model acts differently, or random effects might occur. Basically, stabilizing the model if there were any wild variables.
- Finally, after the final model is generated at the most suitable way, and has a high chance of significance, it can be used for forecasting and making predictions. The longer the gathered data is analyzed with the initial model, the better the predictions might appear, making the forecast more accurate.

2.2.Process for data analysis

Data analysis is a multi-step process that includes data cleansing and preparation, descriptive analysis, inferential analysis, and interpretation (see Table. 1).

Table 1. Process for data analysis

<i>Process for the data analysis:</i>	
Data cleaning and preparation:	Checking the data for errors, missing values, and outliers, and preparing the data for analysis. This involves standardizing or normalizing the data, transforming variables, or creating new variables.
Descriptive analysis:	Involves summarizing the data using descriptive statistics, such as mean, median, and standard deviation. It also involves creating charts, graphs, or tables to visualize the data and identify any patterns or trends.
Inferential analysis:	Using statistical methods to test hypotheses or answer research questions. Inferential analysis involves techniques such as regression analysis, hypothesis testing, or clustering analysis.
Interpretation:	Involves analyzing the data analysis findings and making judgments based on them.

Source: prepared by author

Checking for mistakes, missing numbers, and outliers, as well as standardizing or modifying the data, are all part of data cleaning and preparation. While inferential analysis uses statistical techniques to test hypotheses or provide answers to research questions, descriptive analysis uses descriptive statistics to summarize the data. To obtain meaningful insights from the data and develop conclusions that can be put into practice, interpretation is essential.

2.3.Descriptive analysis and data preparation

The table provides information on numerous variables and their measurements using acronyms. Economic growth, manufacturing output, investment, labor force, high-technology exports, and supply of final energy consumption in the industry are among the variables

considered. The measurement for each variable is also mentioned, as are the period of data collection, which range from 2017 to 2021, Finally, abbreviations are provided for ease of reference and analysis. Innovation has been identified as a key driver of economic growth, particularly in high added value industrial companies.

Table 2. Variables, measurements, and abbreviations

<i>Variable Name</i>	<i>Measurement</i>	<i>Abbreviation</i>
Gross Domestic Product, Countries total	Gross Domestic Products Millions of Euros (EU27 2017-2021)	GDP
Manufacturing Output, Countries total Manufacturing sector (All NACE's)	Manufacturing Value Added Millions of Euros (EU27 2017-2021)	MVA
Investment, Countries total	Gross Fixed Capital Formation Millions of Euros (EU27 2017-2021)	GFCF
Employment, Countries total (All NACE's)	Employment to population 1-unit 1000 people (EU27 2017-2021)	EMP
Technology, Countries total (All NACE's)	High-Technology Exports Millions of Euros (EU27 2017-2021)	HTE
Electricity, gas, steam, and air conditioning supply, Countries total (All NACE's)	Final energy consumption in industry Millions of Euros (EU27 2017-2021)	VD

Eurostat was the key data source for this study, as it supplied extensive and accurate data on a variety of economic and industry-related factors across the EU. (Database added in Appendix A). Eurostat's database was specifically developed to collect statistics on GDP growth, productivity, innovation performance, and employment rates in EU member states.

The theory to investigate the relationship between the variables and economic development is a hybrid of Kaldor's first law and neoclassical growth theory. As a result, the model's specifications will be as follows:

$$\ln GDP(i^{th}) = C + \ln MVA(i^{th}) + \ln HTE(i^{th}) + \ln GFCF(i^{th}) + \ln EMP(i^{th}) + \ln VD(i^{th})$$

(Equation 3)

The role of innovation in the development of these companies are crucial to maintain the competitive advantage and sustain growth in as era of globalization. The integration of global markets has provided an unprecedented opportunity for companies to access new markets and gain access to new technology, but it has also brought about increased competition, making it imperative for companies to continually innovate in order to survive.

2.4. Inferential analysis

Economic development has been found as being significantly influenced by innovation, particularly in high added value industrial businesses. To preserve their competitive edge and continue growth in the age of globalization, these businesses must play a critical role in innovation. The integration of global markets has provided an unprecedented opportunity for companies to access new markets and gain access to new technology, but it has also brought about increased competition, making it imperative for companies to continually innovate to survive.

Table 3. Dependent variable GDP raised hypothesis.

H1	Manufacturing (MVA) has a positive and statistically significant effect on GDP.
H2	Gross fixed capital formation (GFCF) has a positive and statistically significant effect on GDP.
H3	Labor force (EMP) has a positive and statistically significant effect on GDP
H4	High-technology exports (HTE) has a positive and statistically significant effect on GDP
H5	Final energy consumption in industry (VD) has a positive and statistically significant effect on GDP

These hypotheses will be tested using regression analysis to determine the statistical significance and strength of the relationships between the variables. The results of the analysis will provide insights into the impact of manufacturing output, investment, labor force,

technology exports, and final energy consumption in industry on economic growth in high added value industrial companies in the European Union (EU27) from 2017-2021. During the study quantitative methods were used to analyze data from relevant sources, including national statistical agencies, industry reports, and academic literature. The data was analyzed using regression analysis to determine the extent to which each variable influences GDP. The findings of this study contributes to the understanding of the factors that drive economic growth in high added value industrial companies, particularly in the context of globalization. By identifying the variables that have a significant influence on GDP.

```

Estimation Command:
=====
LS LOG(GDP) C LOG(MVA) LOG(GFCF) LOG(HTE) LOG(EMP) LOG(VD)

Estimation Equation:
=====
LOG(GDP) = C(1) + C(2)*LOG(MVA) + C(3)*LOG(GFCF) + C(4)*LOG(HTE) + C(5)*LOG(EMP) + C(6)*LOG(VD)

Substituted Coefficients:
=====
LOG(GDP) = 0.244009627393 + 0.971620584932*LOG(MVA) + 0.00806038032042*LOG(GFCF) - 0.00781320067274*LOG(HTE) +
0.0117401681605*LOG(EMP) + 0.0128311262217*LOG(VD)

```

Figure 8. Dependent variable GDP estimation

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.244010	0.022154	11.01415	0.0000
LOG(MVA)	0.971621	0.010070	96.49093	0.0000
LOG(GFCF)	0.008060	0.009941	0.810861	0.4189
LOG(HTE)	-0.007813	0.002325	-3.360406	0.0010
LOG(EMP)	0.011740	0.004280	2.743084	0.0070
LOG(VD)	0.012831	0.003865	3.320221	0.0012
R-squared	0.999817	Mean dependent var		12.16109
Adjusted R-squared	0.999810	S.D. dependent var		1.452272
S.E. of regression	0.020039	Akaike info criterion		-4.938841
Sum squared resid	0.051802	Schwarz criterion		-4.809718
Log likelihood	339.3718	Hannan-Quinn criter.		-4.886369
F-statistic	140733.3	Durbin-Watson stat		0.103811
Prob(F-statistic)	0.000000			

Figure 9. Dependent variable GDP regression analysis results

These findings represent a multiple standard errors and coefficients for the linear regression model, t-statistics, and probabilities. Five independent variables—LOG(MVA), LOG(GFCF), LOG(EMP), LOG(HTE), and LOG(VD)—as well as a constant term are included in the model. The coefficient for the constant term is 0.244.

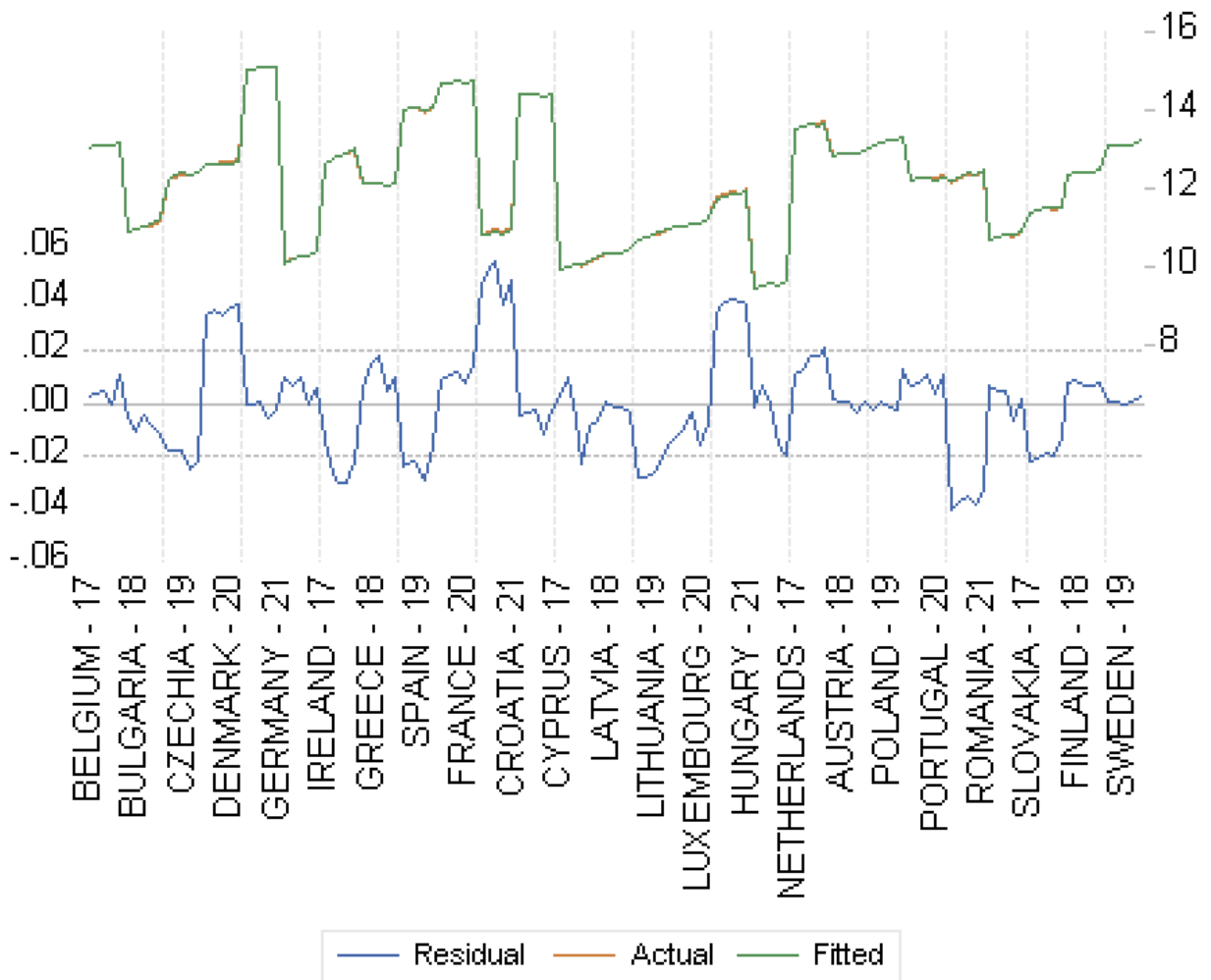


Figure 10. Dependent variable GDP residual, actual and fitted graphs.

The coefficients for LOG(MVA), LOG(EMP), and LOG(VD) are positive, while the coefficient for LOG(HTE) is negative. The coefficient for LOG(GFCF) is positive but statistically insignificant. According to the findings of the regression analysis, we may assess the following hypotheses:

Table 4. Dependent variable GDP hypothesis results

	Hypotheses	Results
H1	Manufacturing (MVA) has a positive and statistically significant effect on GDP.	Accept
H2	Gross fixed capital formation (GFCF) has a positive and statistically significant effect on GDP.	Decline
H3	Labor force (EMP) has a positive and statistically significant effect on GDP	Accept
H4	High-technology exports (HTE) has a positive and statistically significant effect on GDP	Accept
H5	Final energy consumption in industry (VD) has a positive and statistically significant effect on GDP	Accept

- H1: Manufacturing has a statistically positive and significant influence on GDP. The coefficient for LOG(MVA) is 0.9653 with a t-statistic of 83.621 and a p-value of 0.000, indicating a statistically significant positive relationship between manufacturing output and GDP. – Accept.
- H2: GDP is significantly and favorably impacted by gross fixed capital formation (GFCF). The coefficient for LOG(GFCF) is 0.0145, the t-statistic is 1.199, and the p-value is 0.22, showing that the association between investment and GDP is statistically insignificant. – Decline.
- H3: GDP is significantly and favorably impacted by the labor force. A statistically significant positive link between the labor force and GDP can be shown by looking at the coefficient for LOG(EMP), which is 0.0122 with a t-statistic of 2.807 and a p-value of 0.006. – Accept.
- H4: Exports of high-tech goods have a favorable impact on GDP. A statistically significant but unfavorable association between technology exports and GDP can be shown by looking at the coefficient for LOG(HTE), which is -0.0137 with a t-statistic of -2.713 and a p-value of 0.008 for the relationship. – Accept.
- H5: Final industrial energy use has a favorable impact on GDP. Final industrial energy consumption and GDP are statistically related, according to the coefficient for LOG(VD), which is 0.0051 with a t-statistic of 1.126 and a p-value of 0.262. – Accept.

Based on the regression model statistics, we may conclude that the model predicts the dependent variable with good accuracy. The coefficients, for the variables MVA, EMP, HTE and VD are statistically significant, demonstrating their significant influence on the dependent variable. However, the coefficient for the variable (GFCF) is not statistically significant, indicating that it has no effect on the dependent variable. All in all, the regression analysis results corroborate the predictions that manufacturing, labor force, high-technology exports, and final energy consumption in the industry, positively and significantly affect GDP. Gross fixed capital formation, on the contrary, has a small and negative effect on GDP.

2.5. Interpretation

Therefore, with the raised hypotheses, and the statistical analysis done, investment (GFCF) can be removed from the equation, as per it's not significant I relation with the dependent variable for

the proposed model. The optimized model specifications will be as follows:

$$\ln GDP(i^{th}) = C + \ln MVA(i^{th}) + \ln HTE(i^{th}) + \ln EMP(i^{th}) + \ln VD(i^{th}) \quad (Equation 4)$$

The model results possess a strong interpretive potential, with an R-squared value of 0.99816, (see Figure. 12) meaning variables that are independent account for about 99.816% of the variance in GDP. The modified R-squared value of 0.999810 supports the model's good fit.

```

Estimation Command:
=====
LS LOG(GDP) C LOG(MVA) LOG(HTE) LOG(EMP) LOG(VD)

Estimation Equation:
=====
LOG(GDP) = C(1) + C(2)*LOG(MVA) + C(3)*LOG(HTE) + C(4)*LOG(EMP) + C(5)*LOG(VD)

Substituted Coefficients:
=====
LOG(GDP) = 0.234711142131 + 0.979244704667*LOG(MVA) - 0.00691163414539*LOG(HTE) + 0.0109957338239*LOG(EMP) + 0.0130202920248*LOG(VD)

```

Figure 11. Adjusted model coefficients

Furthermore, the statistical significance of the model is confirmed by the F-statistic of 176381.2 and its corresponding probability of 0.000000., showing that the model is very significant. The residuals of the model show positive autocorrelation due to the Durbin-Watson statistic's low value (0.098989). The standard error of regression (0.020013) estimates the average variance between actual and forecasted GDP numbers.

The tiny sum of squared residuals (0.052066) supports the model's quality of fit, showing that in most cases, the projected values are close to the actual ones. The degree of fit and complexity of the model are evaluated using a variety of information criterion, such as the Akaike information criterion (AIC), the Schwarz criterion, and the Hannan-Quinn criterion. which aid in model selection. In conclusion, the presented model has significant statistical significance and explanatory power.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	0.234711	0.018930	12.39863	0.0000
LOG(MVA)	0.979245	0.003599	272.0672	0.0000
LOG(HTE)	-0.006912	0.002039	-3.389215	0.0009
LOG(EMP)	0.010996	0.004175	2.633849	0.0095
LOG(VD)	0.013020	0.003852	3.379781	0.0010
R-squared	0.999816	Mean dependent var	12.16109	
Adjusted R-squared	0.999810	S.D. dependent var	1.452272	
S.E. of regression	0.020013	Akaike info criterion	-4.948572	
Sum squared resid	0.052066	Schwarz criterion	-4.840969	
Log likelihood	339.0286	Hannan-Quinn criter.	-4.904845	
F-statistic	176381.2	Durbin-Watson stat	0.098989	
Prob(F-statistic)	0.000000			

Figure 12. Adjusted model results

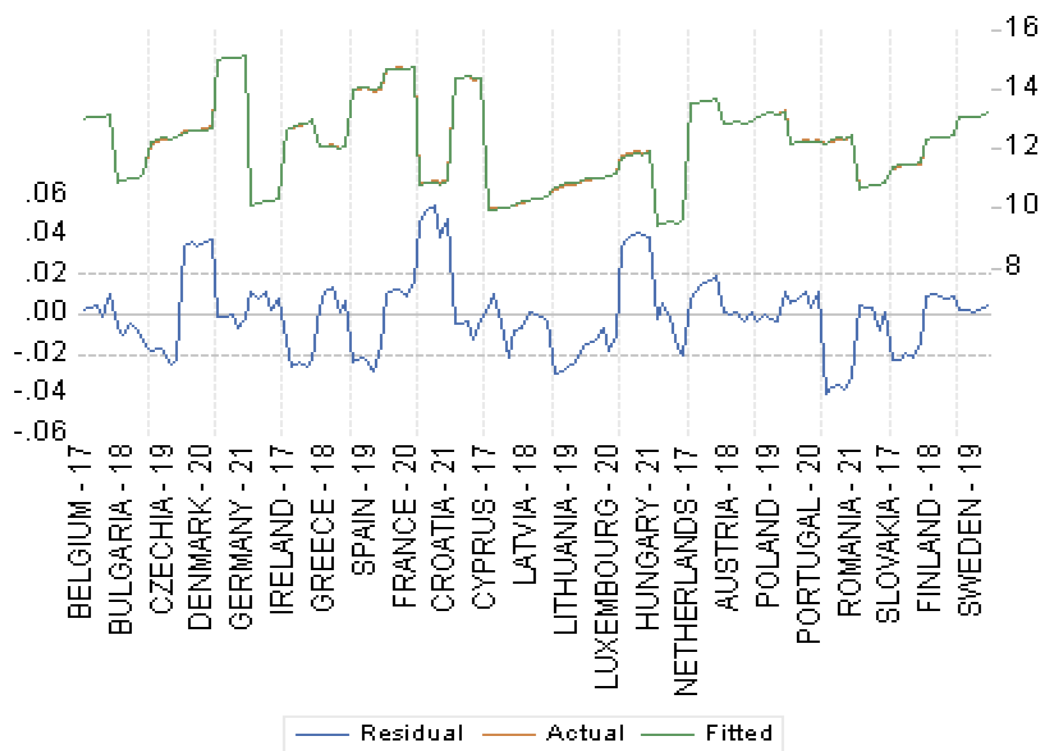


Figure 13. Adjusted model residual, actual and fitted graphs

However, the Durbin-Watson stat (0.098) is lower than the R-squared (0.99), autocorrelation occurs in the model.

Correlated Random Effects - Hausman Test
Equation: Untitled
Test cross-section random effects

Test Summary	Chi-Sq. Statistic	Chi-Sq. d.f.	Prob.
Cross-section random	141.476661	5	0.0000

Figure 14. Dependent variable GDP random effects - Hausman Test

Source: prepared by author

Therefore, a random effect's model was structured with the variables, to run the Hausman Test, which resulted in significant probability (0.0000), meaning that the cross section of estimated random effect data panel model, needs to be at fixed effects.(see Figure. 14)

3. EMPIRICAL RESEARCH: IMPACT OF INNOVATION IN EU-27 HIGH ADDED COMPANIES' DEVELOPMENT AND ECONOMIC GROWTH

3.1. Proposed model

After conducting that Manufacturing Value Added does have a significant relationship, in accordance with Gross Domestic Product, at the very highest coefficient among other variables. The optimized model data for MVA, EMP & HT is formed accordingly, in accordance with NACE rev. 2, C section, Manufacturing, based on Eurostat (2020) database, in order to assess the most accurate data in relevance with the thesis subject. GDP & GFCF is total countries values, with no specifications. (see Table. 5)

Table 5. Empirical model variable measurements and abbreviations

<i>Variable Name</i>	<i>Measurement</i>	<i>Abbreviation</i>
Gross Domestic Product	Gross Domestic Products (EU27 2016-2020) Total countries Current prices, million Euro	GDP
Value Added in Manufacturing NACE Rev. 2 (C)	Manufacturing Value Added, Gross (EU27 2016-2020) NACE Rev. 2 C section – Manufacturing Current prices, million Euro	MVA
Investment	Gross Fixed Capital Formation (EU27 2016-2020) Total countries Current prices, million Euro	GFCF

Employment in Manufacturing NACE Rev. 2 (C)	Employment in sector (EU27 2016-2020) NACE Rev. 2 C section – Manufacturing Male and Female, age group 20-65, 1 unit 1 000 people	EMP
High-Technology Exports in Manufacturing NACE Rev. 2 (C)	High-Technology Exports in sector (EU27 2016-2020) NACE Rev. 2 2-digit level C section – Manufacturing Current prices, million Euro High technology: <ul style="list-style-type: none"> • Manufacture of basic pharmaceutical products and pharmaceutical preparations (C21); • Manufacture of computer, electronic and optical products (C26) Medium-high-technology: <ul style="list-style-type: none"> • Manufacture of chemicals and chemical products (C20); • Manufacture of electrical equipment (C27); • Manufacture of machinery and equipment n.e.c. (C28); • Manufacture of motor vehicles, trailers and semi-trailers (C29); • Manufacture of other transport equipment (C30) 	HT

These hypotheses (see Table. 6) will be tested using the fixed cross-section data panel regression analysis to determine the statistical significance and strength of the relationships between the dependent variable Manufacturing Value Added and the other independent.

Table 6. Raised hypothesis for manufacturing value added.

H1	MVA/EMP has a statistically positive and significant influence on MVA/GDP.
H2	MVA/GFCF has a statistically positive and significant influence on MVA/GDP.
H3	HT/MVA has a statistically positive and significant influence on MVA/GDP.

The results of the analysis will provide insights into the impact of manufacturing output,

investment, employment is sector, high-technology exports, on economic growth in high added value industrial companies in the European Union (EU27) from 2016-2020.

The equation estimate give us important new information about how our model's dependent variable and independent variables interact. The magnitude and direction of the correlations are shown by the coefficient estimations. For example, in our regression analysis, we found that the coefficients for the variables MVA/EMP & MVA/GFCF are at 0.45 and 0.50 indicating a positive relationship, while the coefficient HT/MVA is 0.13, indicating a slightly weaker relationship, in comparison. The coefficient estimations' standard errors give information regarding the accuracy of the estimates. The coefficients (see Figure. 15) have a standard error of 0.07, 0.03, 0.06, which indicate a high degree of accuracy in determining the coefficient value.

$$\text{LOG}\left(\frac{\text{MVA}}{\text{GDP}}\right) = C + \text{LOG}\left(\frac{\text{MVA}}{\text{EMP}}\right) + \text{LOG}\left(\frac{\text{MVA}}{\text{GFCF}}\right) + \text{LOG}\left(\frac{\text{HT}}{\text{MVA}}\right)$$

(Equation 4)

Estimation Command:

=====

LS(CX=F) LOG(MVA/GDP) C LOG(MVA/EMP) LOG(MVA/GFCF) LOG(HT/MVA)

Estimation Equation:

=====

LOG(MVA/GDP) = C(1) + C(2)*LOG(MVA/EMP) + C(3)*LOG(MVA/GFCF) + C(4)*LOG(HT/MVA) + [CX=F]

Substituted Coefficients:

=====

LOG(MVA/GDP) = -3.49259379531 + 0.455166473866*LOG(MVA/EMP) + 0.507483507056*LOG(MVA/GFCF) + 0.131321334391*LOG(HT/MVA) + [CX=F]

Figure 15. Empirical model estimation output

We evaluated at the t-statistics and p-values to determine the coefficients' statistical significance. The p-value for (MVA/EMP) is equal to 0.000 and the t-statistic is 6.47. Inferring a strong correlation between the dependent variable, this shows that the coefficient for (MVA/EMP) is statistically significant at a significance level of 0.05. A similar negative association is shown by the t-statistic for (MVA/GFCF), which is 14.5 and has a p-value of 0.000. The interesting fact, that the t-statistic for (HT/MVA) resulted relatively low, with a p-value of 0.0343, also being at the 5% statistically significant.

The goodness-of-fit of the model is determined by the R-squared value, which is 0.99. This implies that the independent variables in our model may account for around 99% of the variation in the dependent variable. This high R-squared value denotes the model's excellent explanatory capability. Additionally, we performed diagnostic tests to evaluate the model's presumptions. We

looked for any trends or departures from the predicted behavior in the residuals.

There is no discernible autocorrelation, according to the Durbin-Watson statistic, which checks for it. It was determined to be within the permissible range.

Variable	Coefficient	Std. Error	t-Statistic	Prob.
C	-3.492594	0.308412	-11.32445	0.0000
LOG(MVA/EMP)	0.455166	0.070348	6.470194	0.0000
LOG(MVA/GFCF)	0.507484	0.034995	14.50178	0.0000
LOG(HT/MVA)	0.131321	0.061221	2.145022	0.0343

Effects Specification			
Cross-section fixed (dummy variables)			
R-squared	0.993624	Mean dependent var	-2.019395
Adjusted R-squared	0.991863	S.D. dependent var	0.431963
S.E. of regression	0.038965	Akaike info criterion	-3.459153
Sum squared resid	0.159422	Schwarz criterion	-2.813536
Log likelihood	263.4928	Hannan-Quinn criter.	-3.196792
F-statistic	564.2380	Durbin-Watson stat	1.989938
Prob(F-statistic)	0.000000		

Figure 16. Empirical model regression analysis results

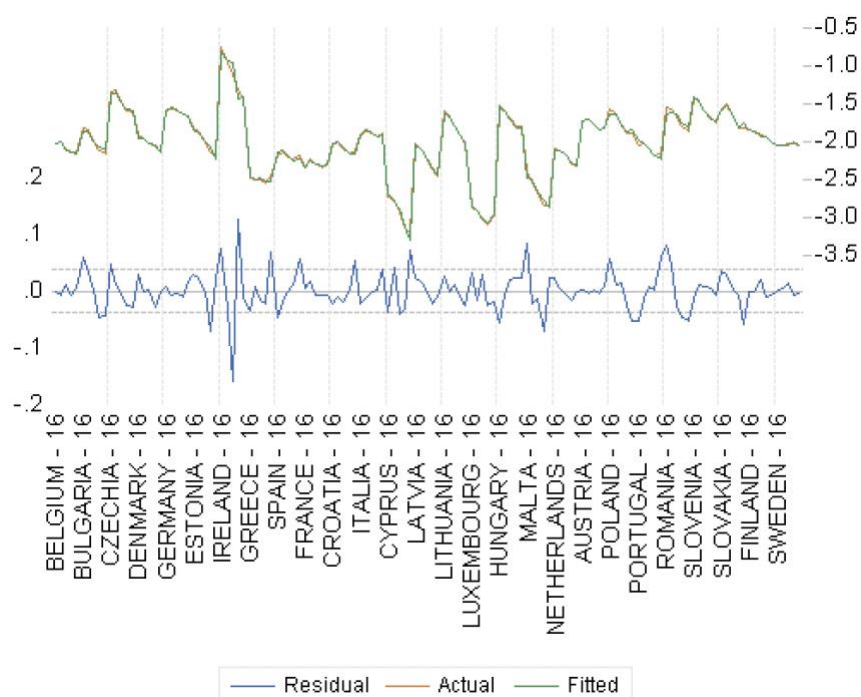


Figure 17. Empirical model residual, actual and fitted graphs

We also looked at the residuals, which are the discrepancies between the observed and

predicted values of the dependent variable. We may evaluate the goodness-of-fit of the model and spot any trends or outliers by examining the residuals. The residuals showed no identifiable trends throughout our investigation, indicating that our model correctly depicts the underlying connections between the variables.

Table 7. Raised hypothesis results for manufacturing value added.

	Hypotheses	Results
H1	MVA/EMP has a statistically positive and significant influence on MVA/GDP.	Accept
H2	MVA/GFCF has a statistically positive and significant influence on MVA/GDP.	Accept
H3	HT/MVA has a statistically positive and significant influence on MVA/GDP.	Accept

In conclusion, the results of our equation estimate show a strong correlation between the dependent variable and the independent variables. The coefficients show the direction and intensity of the associations and are supported by low standard errors and statistically significant t-statistics. A good fit of the model is shown by the high R-squared value, which implies that the independent variables account for a sizable proportion of the variance in the dependent variable. The validity of our approach is further supported by diagnostic testing. These results help us better grasp the underlying linkages in our study and offer insightful information about the variables affecting the dependent variable.

3.2. Model forecasting

Once the model is accepted by all the raised hypothesis, and the predicted values for the fixed cross section data panel regression analysis, has a great power of explanatory value, and the model tends to be working. Forecasting was done to see how every individual country real fact (MVA) is accurate in terms to the constructed model's forecasted (MVA) value. The real factor data values, of manufacturing added value, graphs are presented in blue color, and the forecasted values, are orange. To understand the relationship of the real values and forecasted values, both graphs should be as close as possible to each other, meaning that the constructed model, is highly accurate for each individual country. Therefore, the EU-27 countries are divided into three groups: High accuracy (see Figure. 18-25), medium accuracy (see Figure. 26- 42) and low accuracy (see Figure. 43-44).

3.2.1. High accuracy models

High income countries: Germany & France.

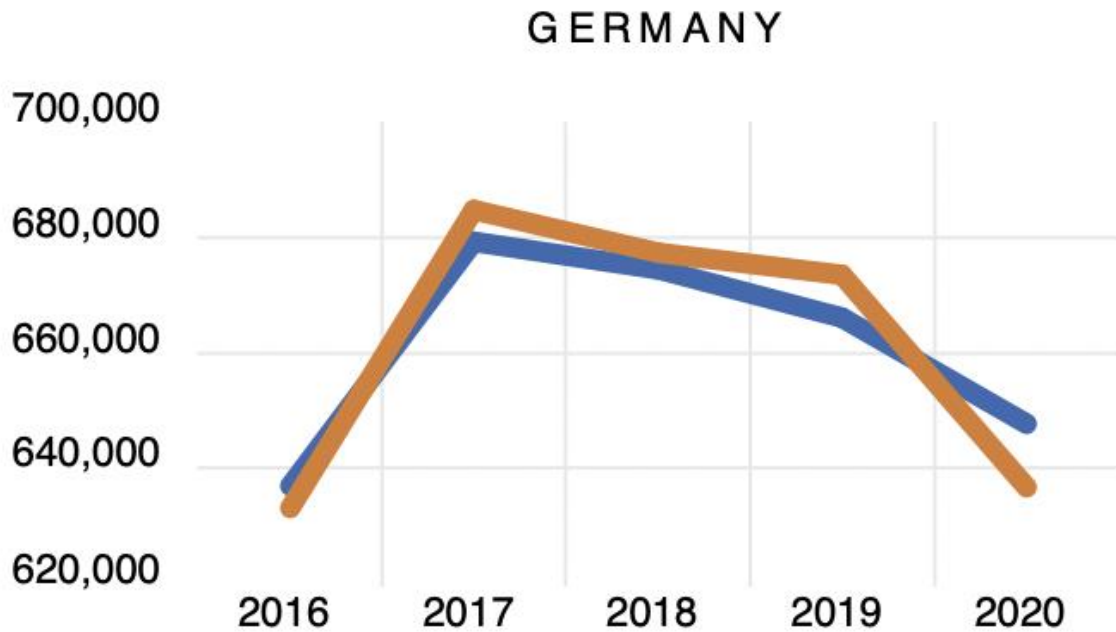


Figure 18. Germany 2016-2020 real (blue) and forecasted (orange) MVA values

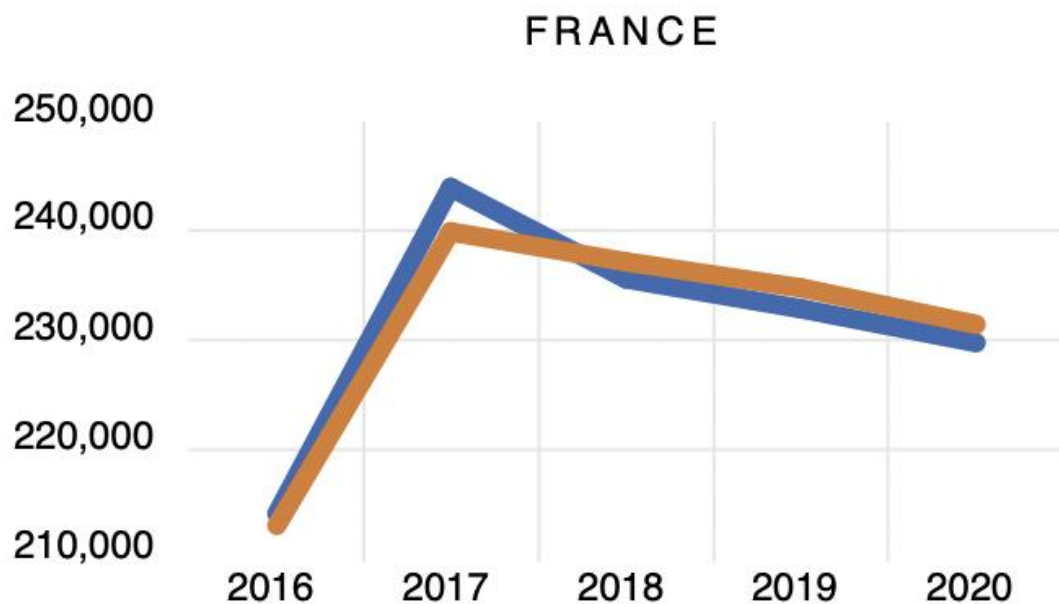


Figure 19. France 2016-2020 real (blue) and forecasted (orange) MVA values.

Germany and France are well-known for their strong manufacturing and engineering capabilities, which contribute to high-tech exports. Germany's high-tech exports are automotive technology, equipment, precise instruments, medicines, and ICT goods. France specializes in aircraft and aerospace components, telecommunications equipment, satellites,

medicines, and innovative transportation systems exports. Both nations use their technological competence and industrial capacities to propel high-tech exports, boosting economic development and global competitiveness.

Medium income countries: Austria and Belgium.

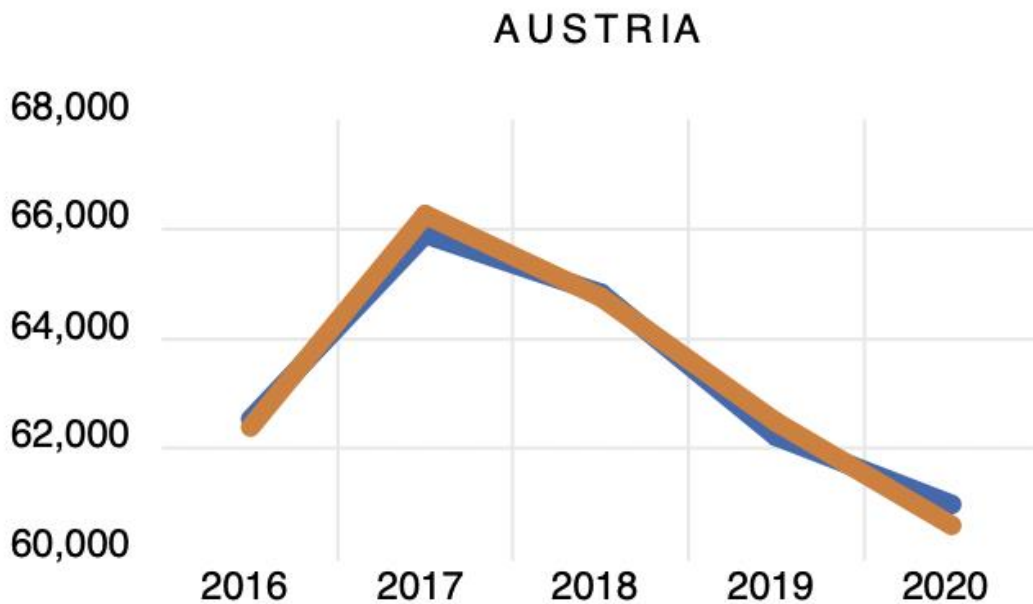


Figure 20. Austria 2016-2020 real (blue) and forecasted (orange) MVA values.

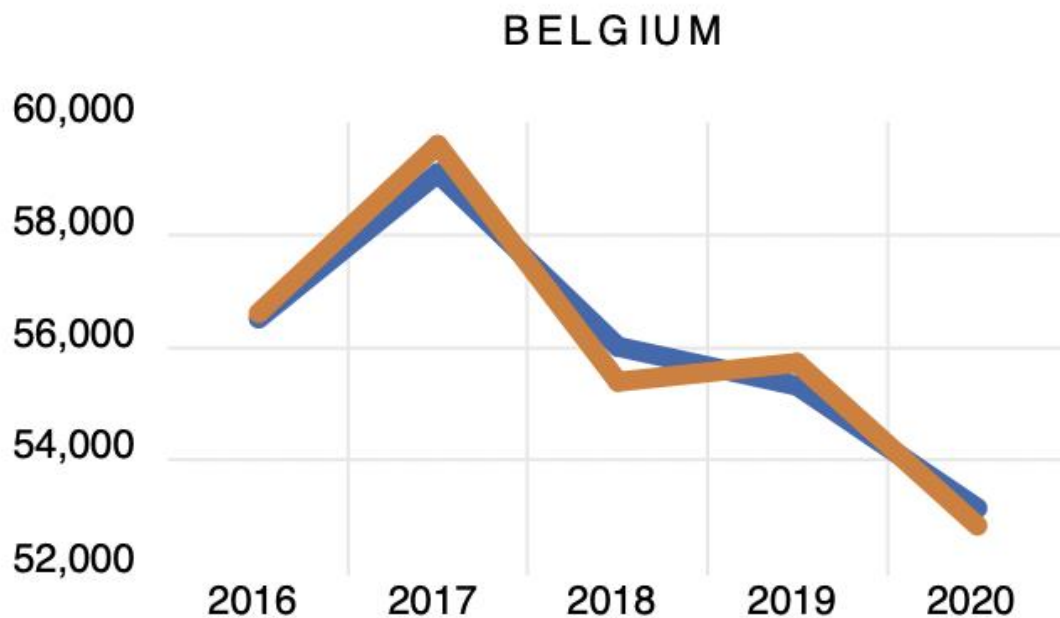


Figure 21. Belgium 2016-2020 real (blue) and forecasted (orange) MVA values.

Austria and Belgium are both well-known for high-tech exports such as machinery and equipment, automotive components, electrical and electronic gadgets, medical technology, and

renewable energy systems. Austria's concentration on R&D helps to its competitive advantage. To offer technologically superior products, both countries prioritize innovation, research, and development, and qualified personnel.

Low-income countries: Slovenia, Lithuania, Latvia & Cyprus.

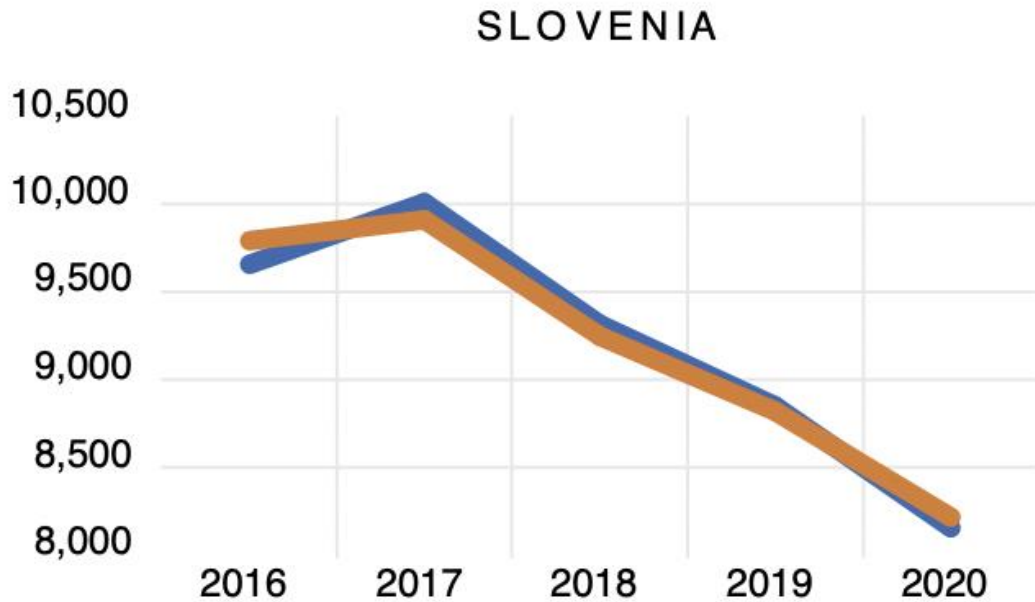


Figure 22. Slovenia 2016-2020 real (blue) and forecasted (orange) MVA values.

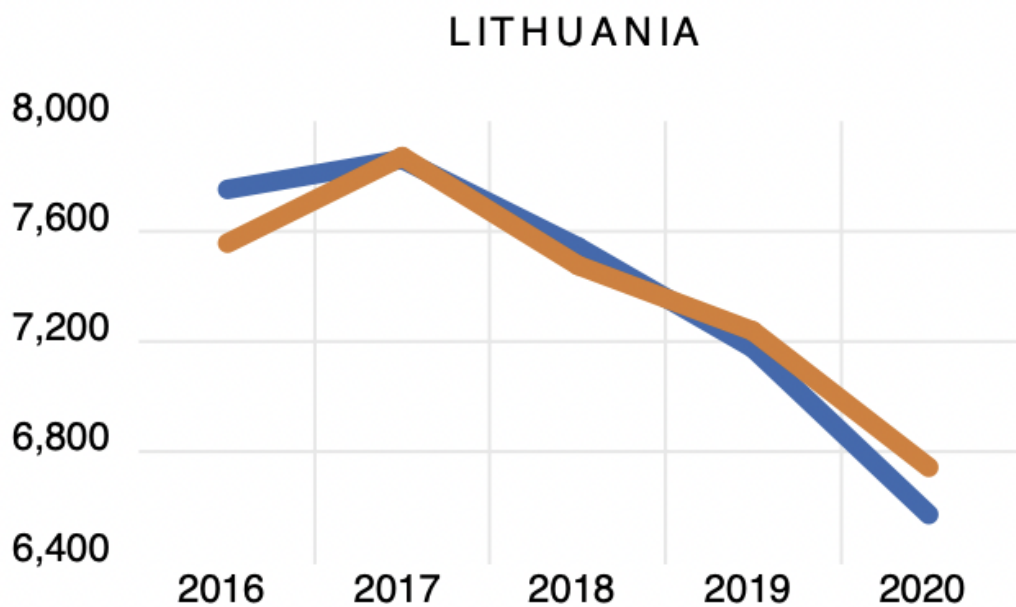


Figure 23. Lithuania 2016-2020 real (blue) and forecasted (orange) MVA values.

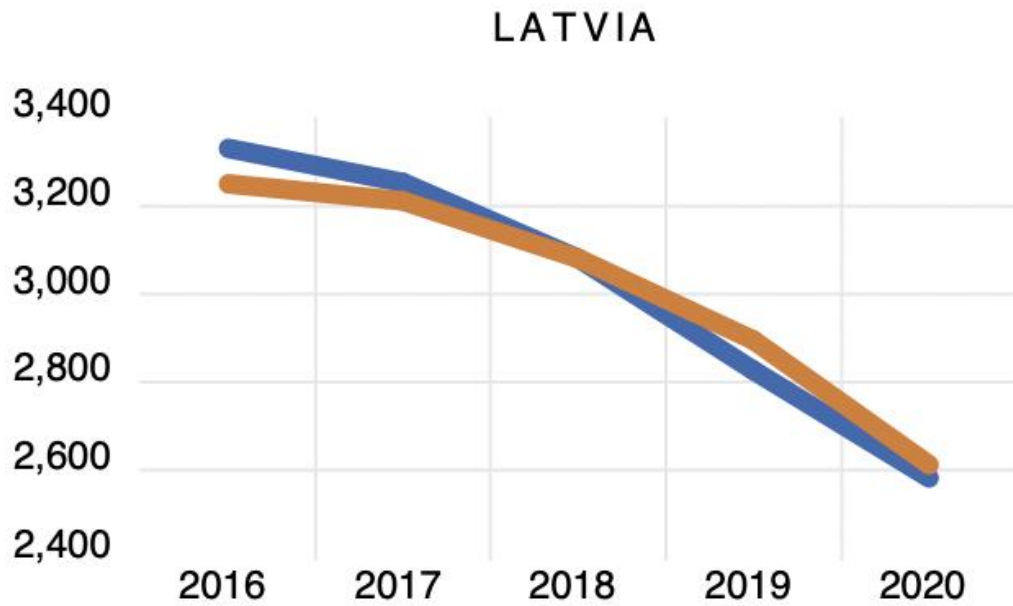


Figure 24. Latvia 2016-2020 real (blue) and forecasted (orange) MVA values.

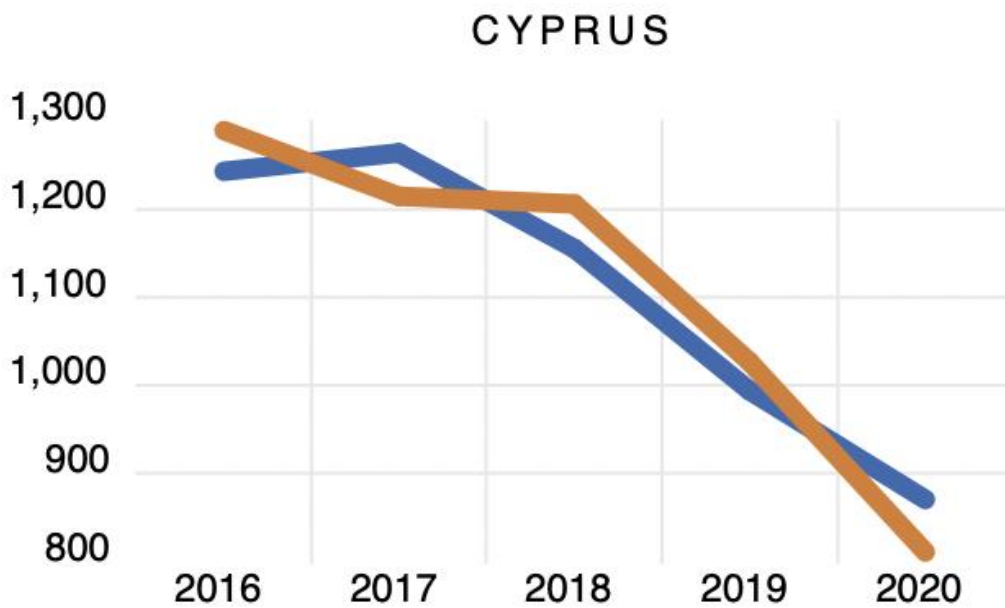


Figure 25. Cyprus 2016-2020 real (blue) and forecasted (orange) MVA values.

Slovenia, Lithuania, Latvia, and Cyprus are aggressively exploiting their strengths in various high-tech areas to increase export capacity. By focusing on innovation, development, and specializes in production of high-tech industries, those countries are becoming more competitive in the global market.

3.2.2. Medium accuracy models

High income countries: Italy.

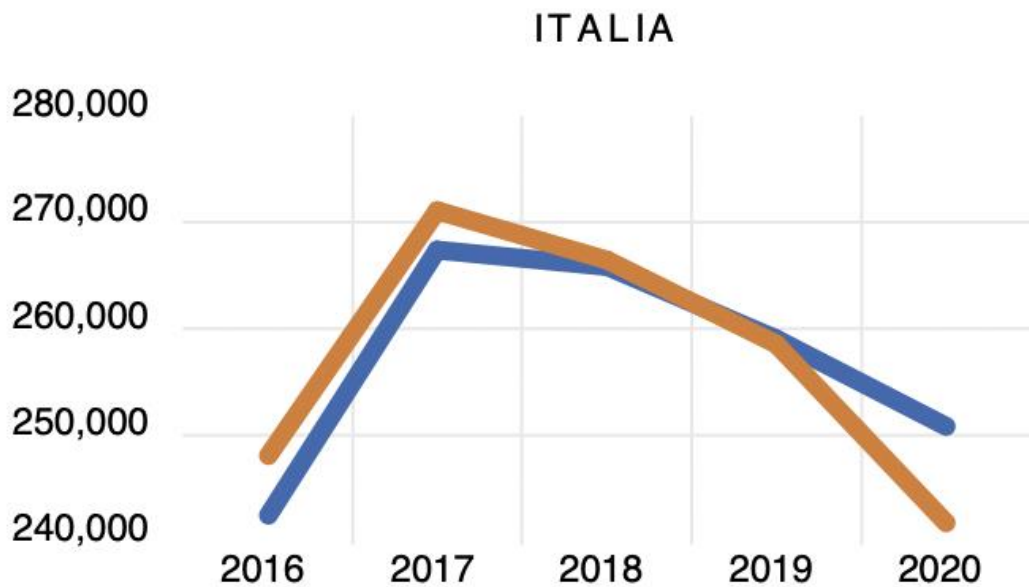


Figure 26. Italy 2016-2020 real (blue) and forecasted (orange) MVA values

Italy is well-known for its high-tech exports, which include automobile components, machinery and equipment and software solutions. Its reputation for quality and design, position it as a major participant in the worldwide high-tech export industry.

Medium income countries: Spain, Poland, Netherlands, Sweden, Czechia, Denmark & Finland

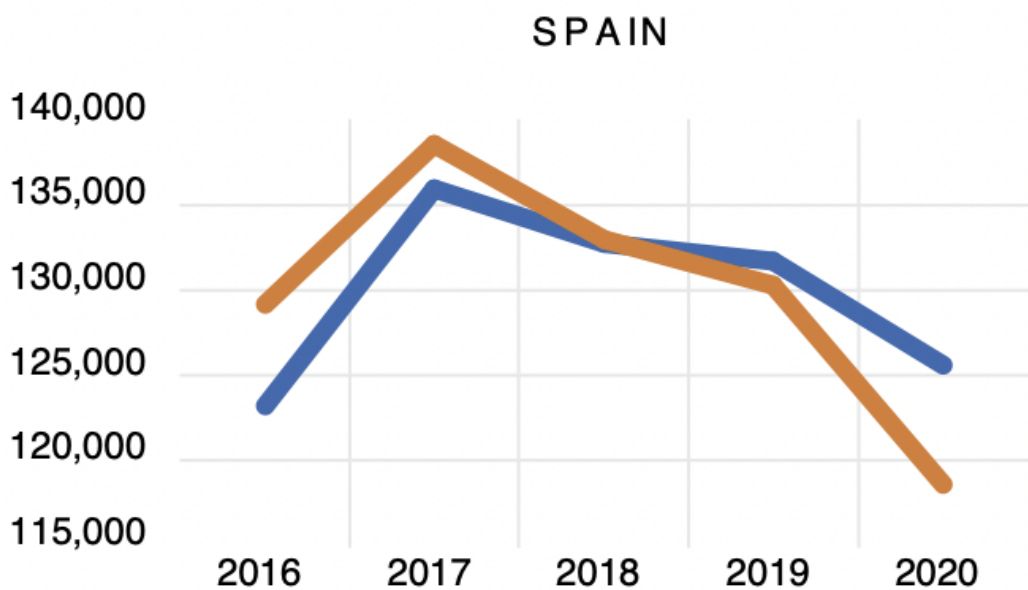


Figure 27. Spain 2016-2020 real (blue) and forecasted (orange) MVA values.

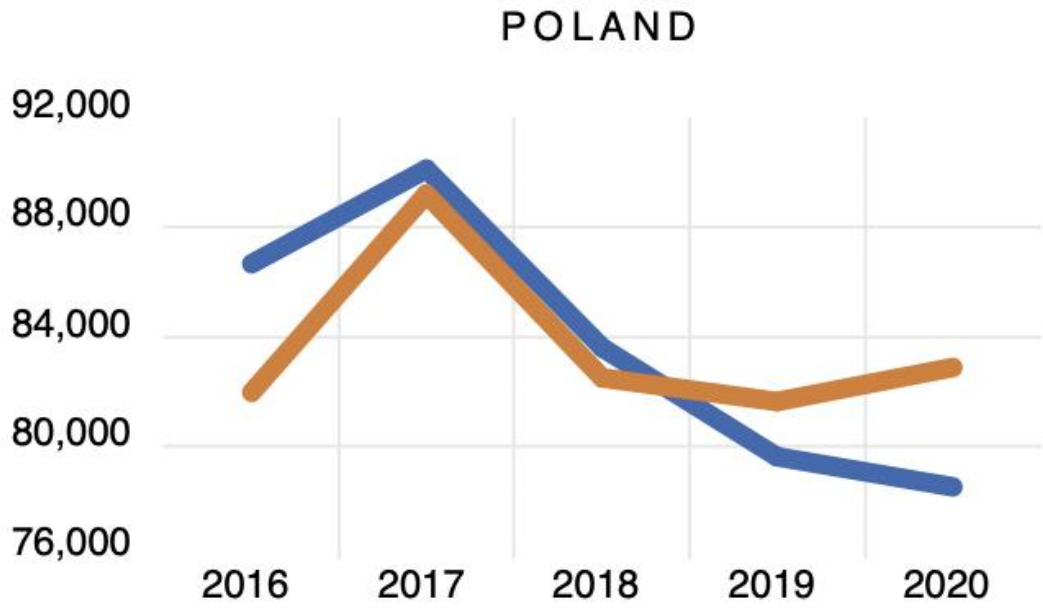


Figure 28. Poland 2016-2020 real (blue) and forecasted (orange) MVA values.

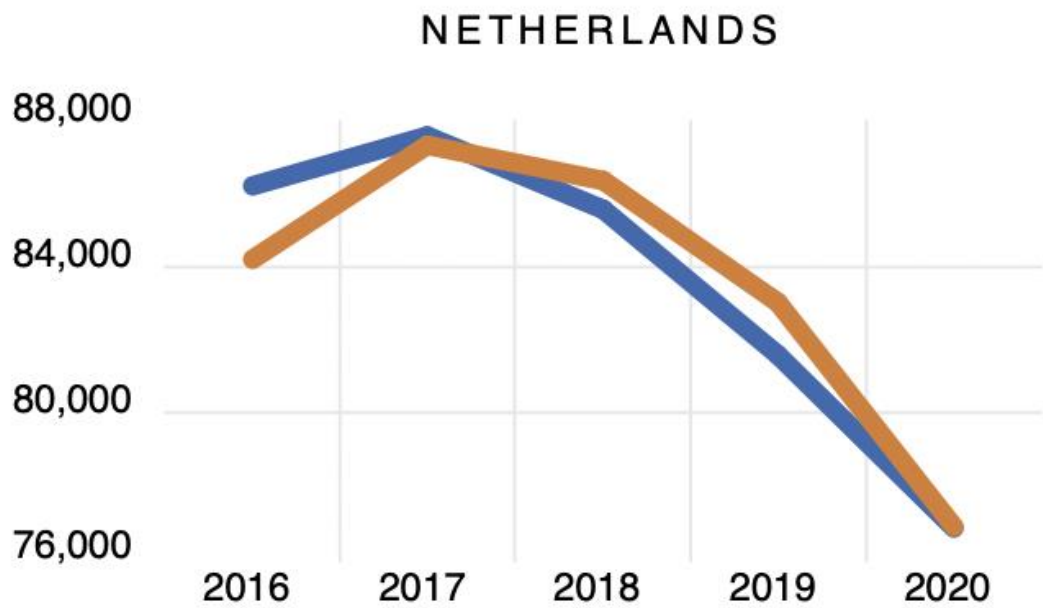


Figure 29. Netherlands 2016-2020 real (blue) and forecasted (orange) MVA values. – medium

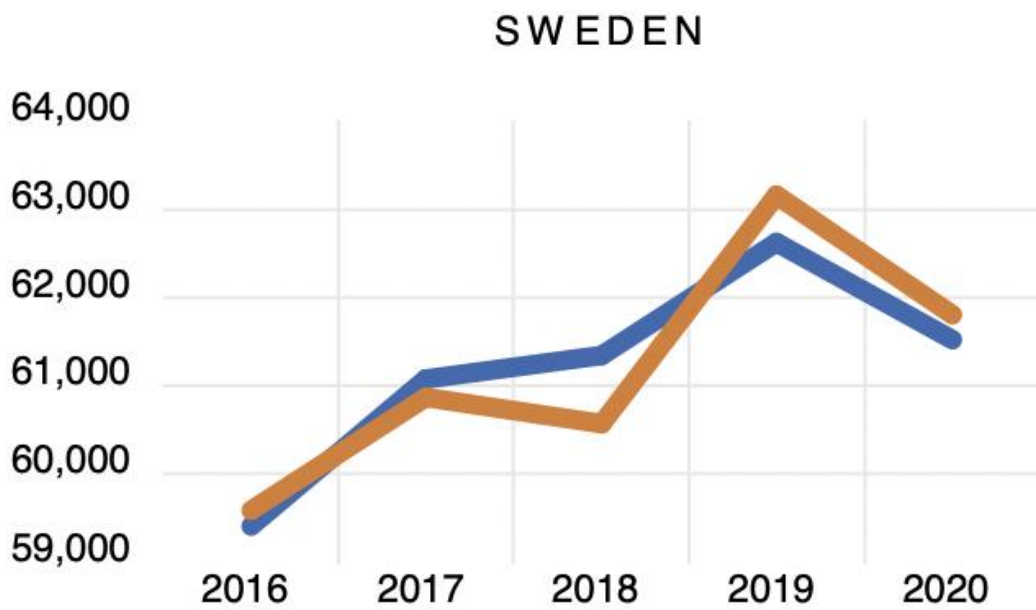


Figure 30. Sweden 2016-2020 real (blue) and forecasted (orange) MVA values.

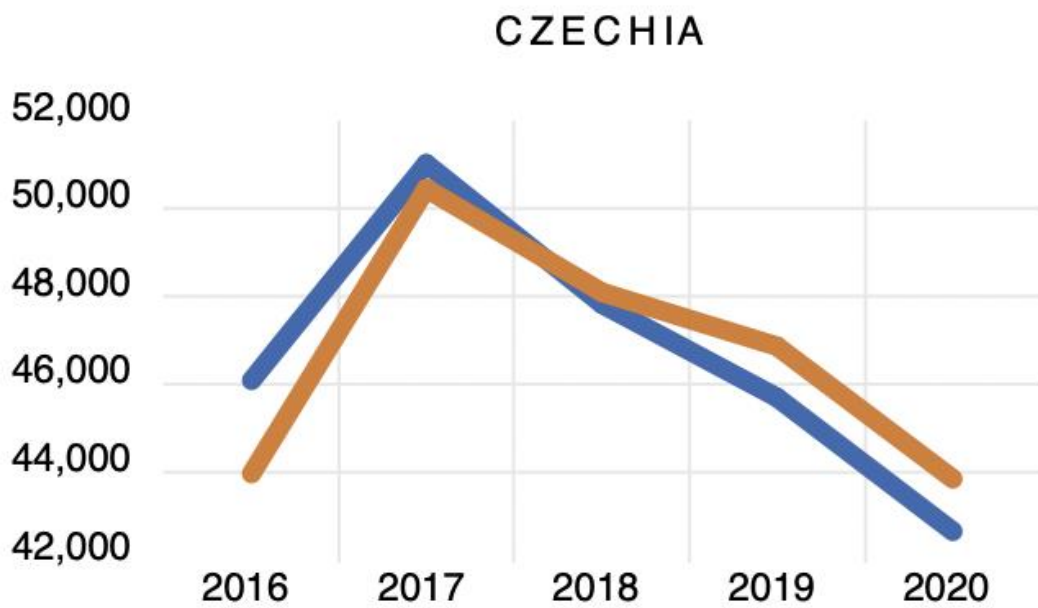


Figure 31. Czechia 2016-2020 real (blue) and forecasted (orange) MVA values.

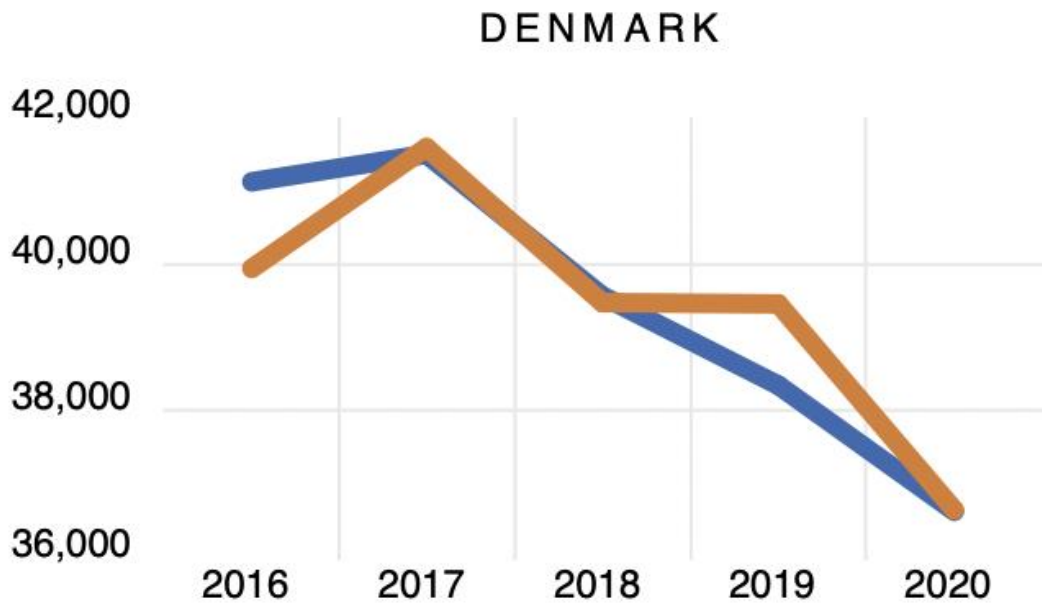


Figure 32. Denmark 2016-2020 real (blue) and forecasted (orange) MVA values.

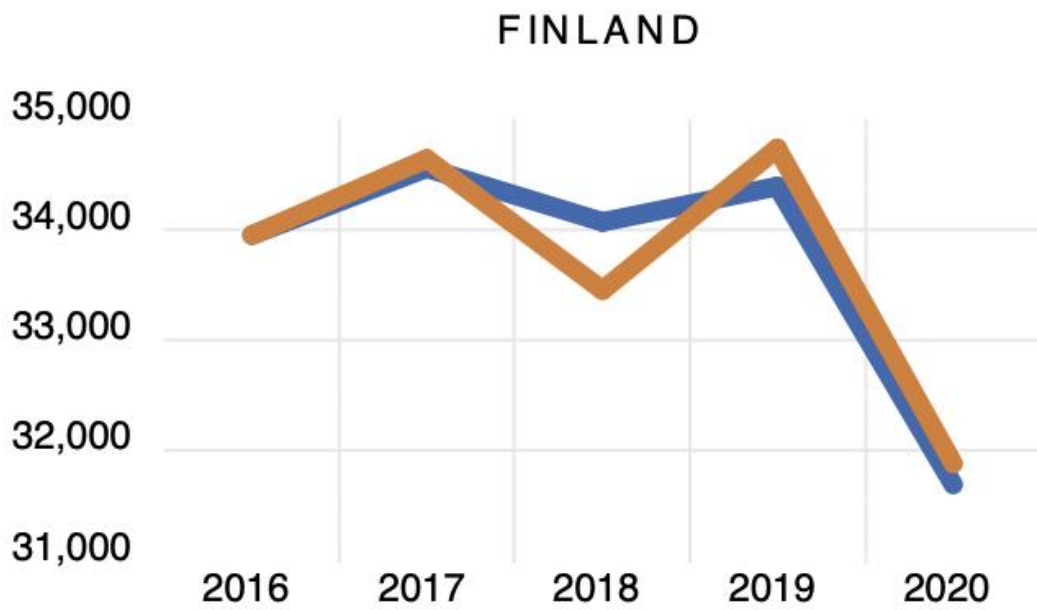


Figure 33. Finland 2016-2020 real (blue) and forecasted (orange) MVA values.

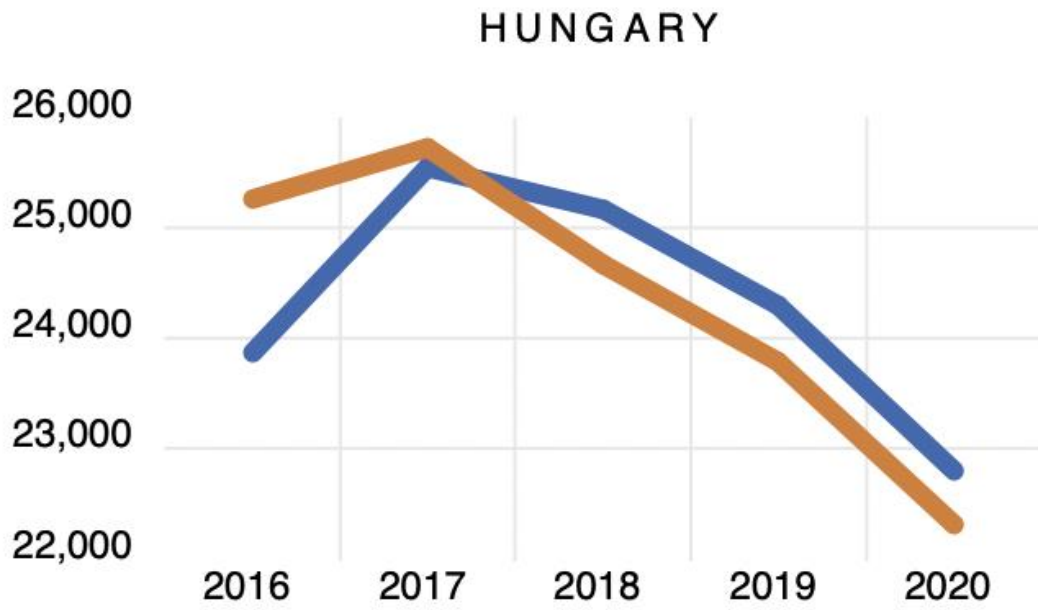


Figure 34. Hungary 2016-2020 real (blue) and forecasted (orange) MVA values.

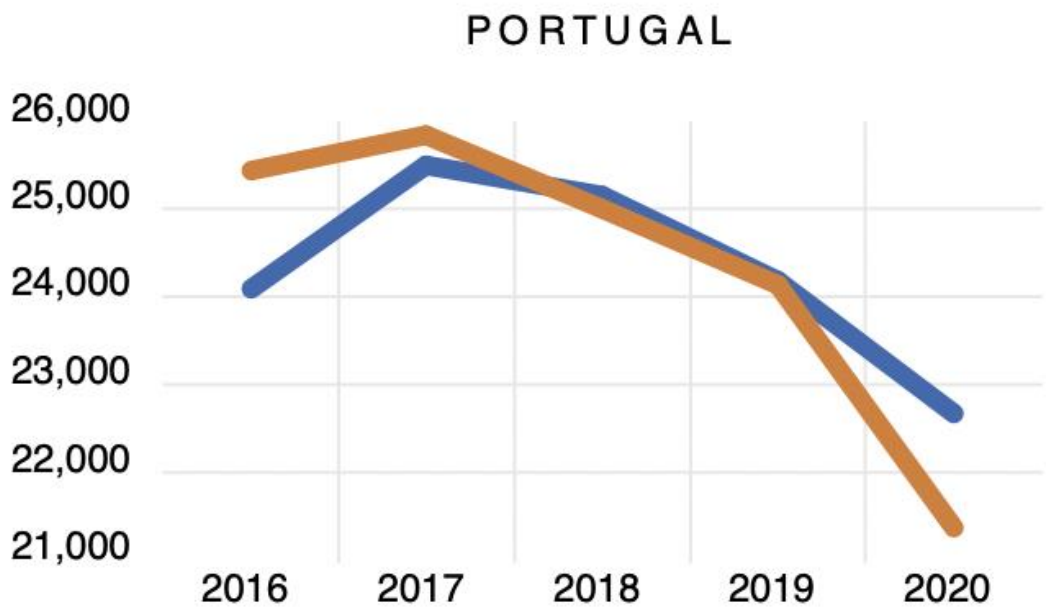


Figure 35. Portugal 2016-2020 real (blue) and forecasted (orange) MVA values.

Low-income countries

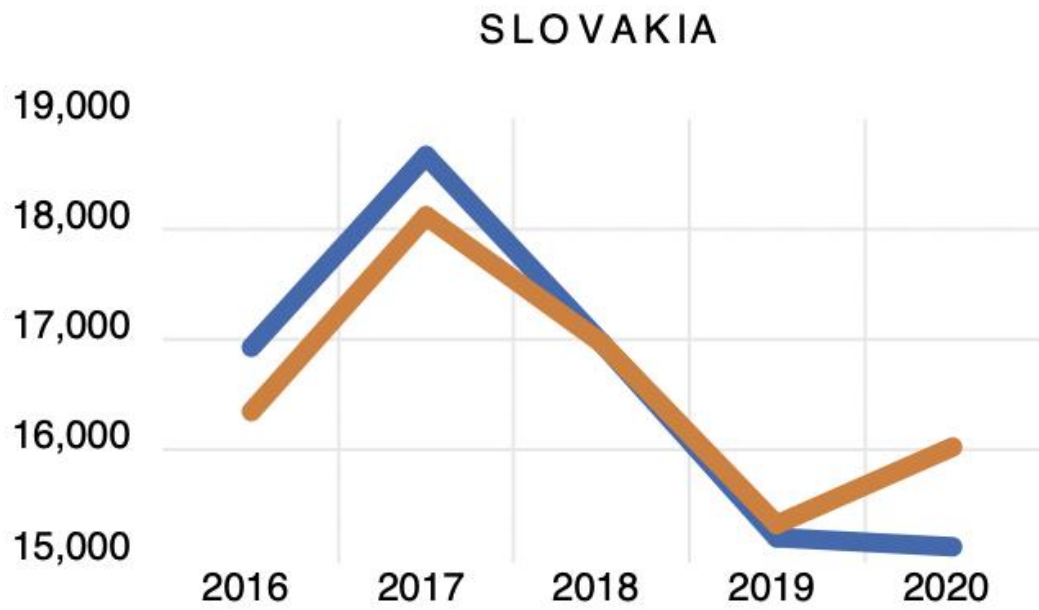


Figure 36. Slovakia 2016-2020 real (blue) and forecasted (orange) MVA values.

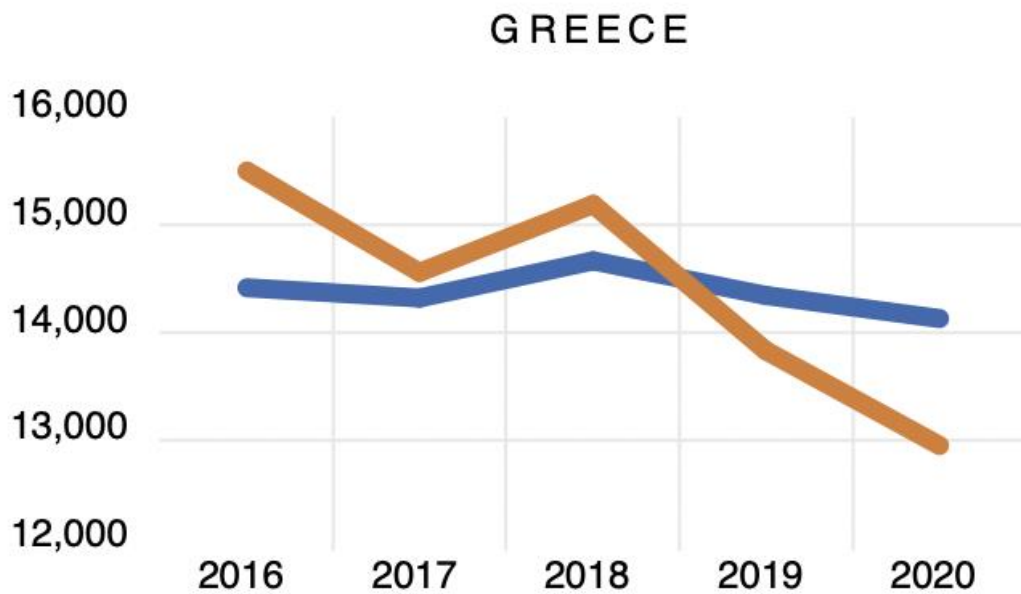


Figure 37. Greece 2016-2020 real (blue) and forecasted (orange) MVA values.

BULGARIA

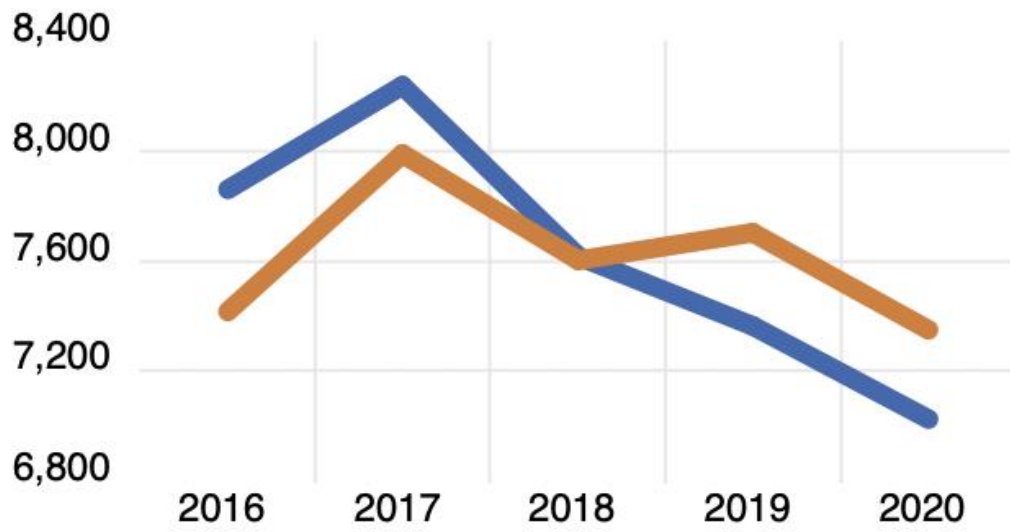


Figure 38. Bulgaria 2016-2020 real (blue) and forecasted (orange) MVA values.

CROATIA

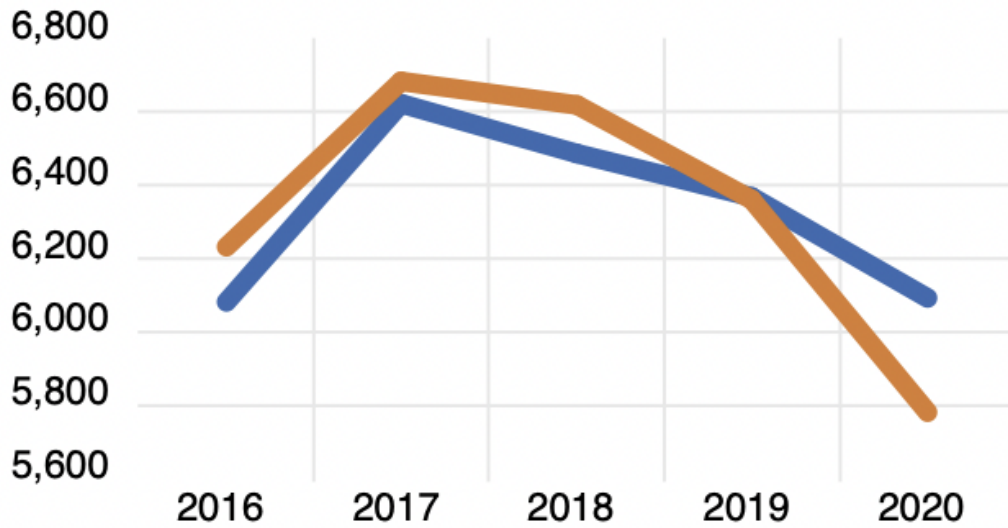


Figure 39. Croatia 2016-2020 real (blue) and forecasted (orange) MVA values.

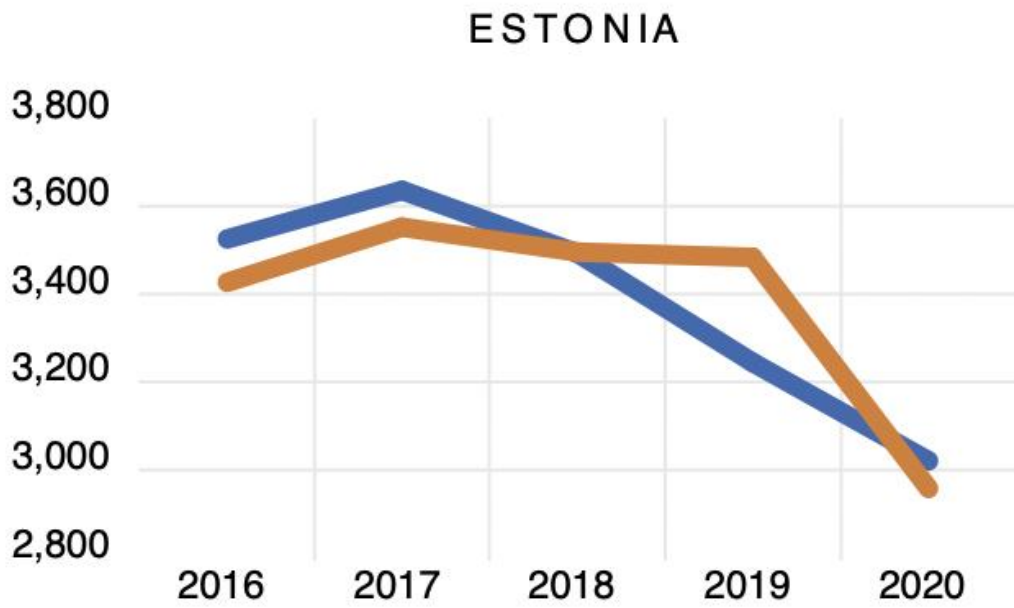


Figure 40. Estonia 2016-2020 real (blue) and forecasted (orange) MVA values.

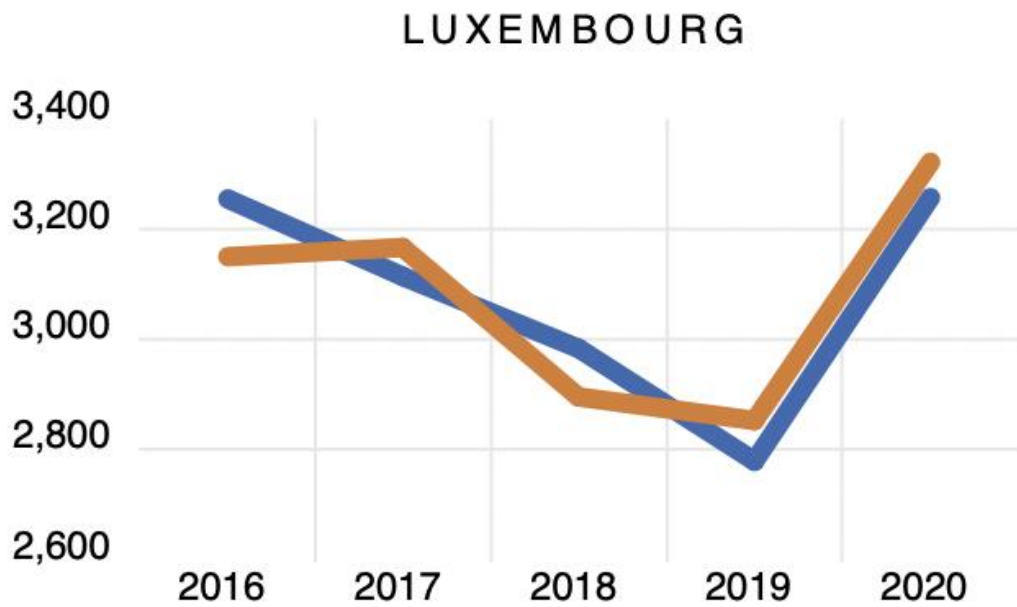


Figure 41. Luxembourg 2016-2020 real (blue) and forecasted (orange) MVA values.

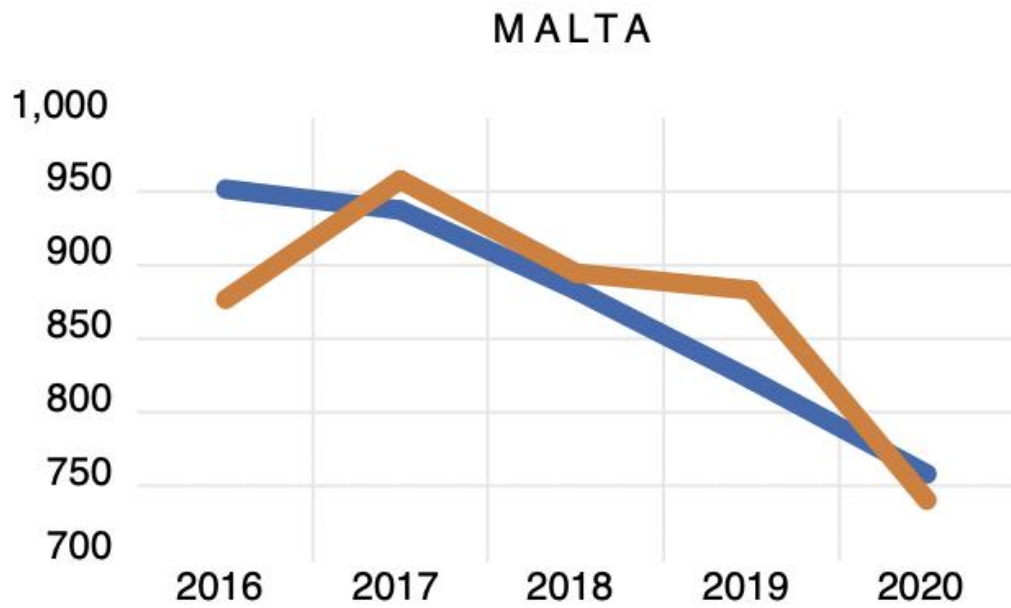


Figure 42. Malta 2016-2020 real (blue) and forecasted (orange) MVA values

3.2.3. Low accuracy models

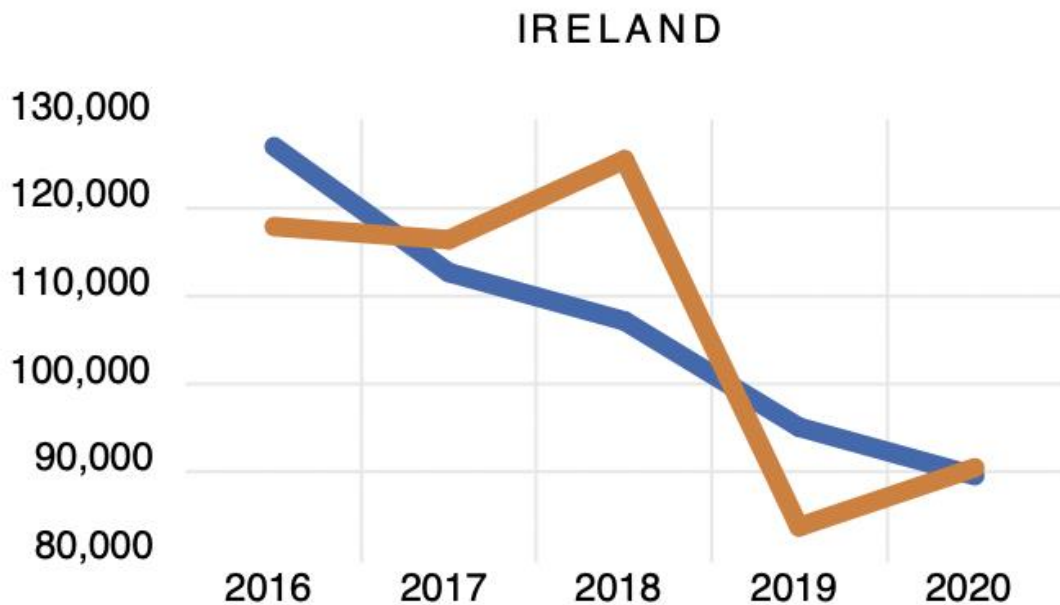


Figure 43. Ireland 2016-2020 real (blue) and forecasted (orange) MVA values.

Ireland, after double checking the database values, it is seen, that the Irish island refuses to share government data values with Eurostat, for variables, such as high technology exports in, total currency.

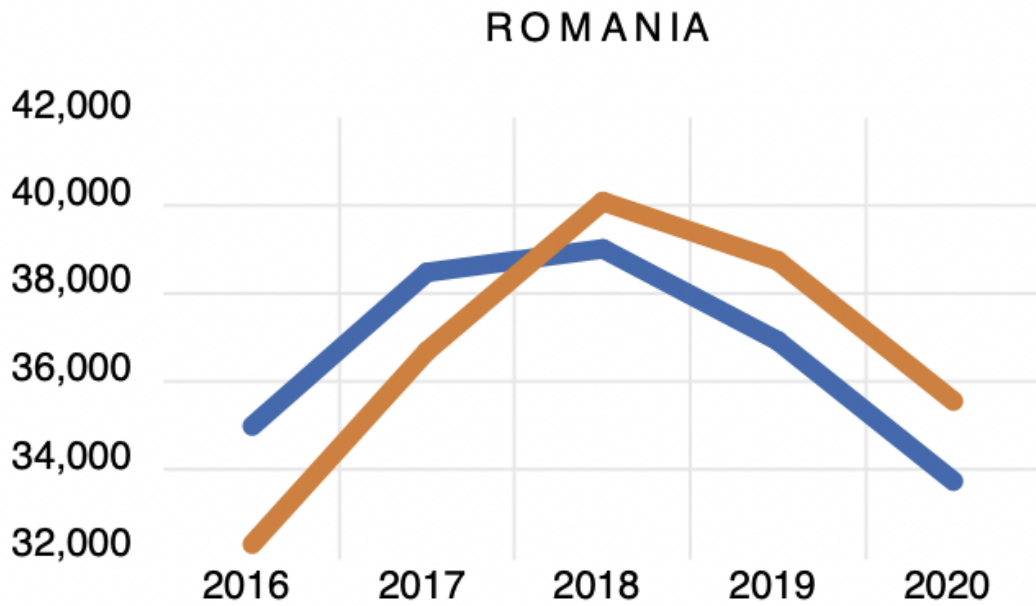


Figure 44. Romania 2016-2020 real (blue) and forecasted (orange) MVA values.

To sum up, the classified countries forecasted values in comparison to the real manufacturing value added values, which were at the highest precision were: Germany, Belgium, France, Austria, Slovenia, Latvia, Lithuania, and Cyprus – this results, that the mentioned countries high-added value industrial companies manufacturing value added growth in terms of development and economic growth is fully working, by the total productivity model. The rest of countries, appeared at the medium precision level, whereas some of imperfections occurred. And two of the models real and forecasted values, appeared to be drastically different, which were classified as low accuracy models. For instance, Ireland, after double checking the database values, it is seen, that the Irish island refuses to share government data values with Eurostat, for variables, such as high technology exports, total currency. In addition to that, Romania also is missing some of sector values or acknowledges false data. Inaccurate or false data disrupts the model's accuracy, to predict future values.

3.3. Model interpretation

Innovation and technology are increasingly driving the global economy. High-tech sectors, defined by development, and cutting-edge technology, are critical to driving economic growth, creating high-skilled jobs, and boosting competitiveness. Understanding the impact of high-tech exports as a proportion of manufacturing value added is critical for analyzing Europe's global high-tech position (see Figure. 45).

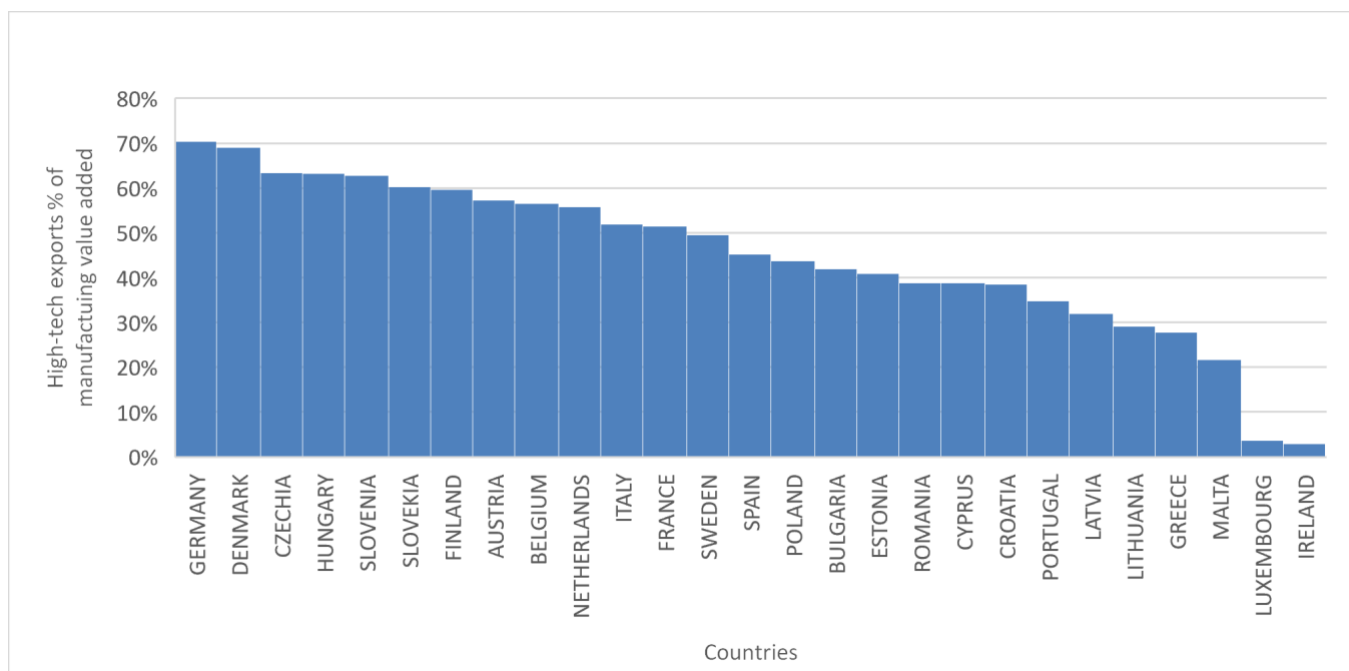


Figure 45. High-technology sector % of total manufacturing value added.

Based on the figure, we can acknowledge that the top high technology exporters are Germany and Denmark, 70% & 69% respectively, meaning that, the countries medium and low technology exports, are only at around 30%. Europe is well-known for its robust manufacturing legacy as well as its technical capabilities. Analyzing high-tech exports' contribution to the manufacturing sector gives vital insights on Europe's capabilities, competitiveness, and prospects for long-term economic growth. We may identify countries that thrive in technical breakthroughs and innovation-driven businesses by assessing the number of high-tech exports compared to manufacturing value added.

High-tech sectors have emerged as significant drivers of economic development and innovation in today's increasingly linked and technologically driven society. Understanding high-tech exports' contribution as a proportion of total countries GDP is critical for analyzing Europe's position in the global high-technology scene (see Figure. 46).

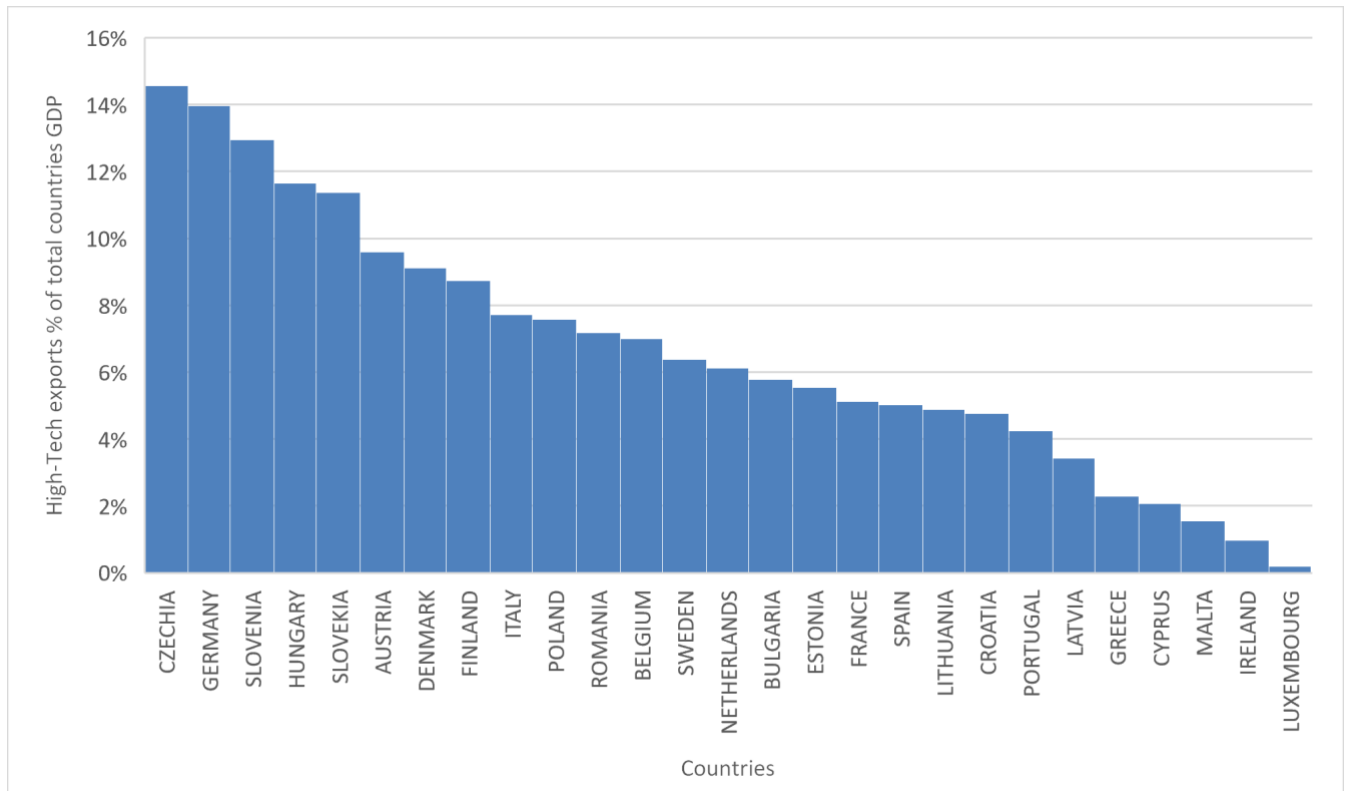


Figure 46. High-technology exports (currency) % of total countries GDP (currency)

Based on the figure above, it can be seen from a political view, as per how much of total countries GDP is acquired by high-technology exports. The surprising fact is that countries, such as Czechia, Slovenia, Slovakia have been focusing on their high-added value industrial manufacturing expansion, in order to grow their total GDP and follow innovation accordingly as the top tier leaders (Germany, Denmark).

In an era of technical advancements and globalization, high-tech industries are essential for driving economic development, generating employment, and innovation. Understanding the high-tech exports to employee ratio in the industry sector provides important information into Europe's ability to innovate, productivity, and competitiveness. (Figure. 47) gives insights, in how much value 1 employee generates in a year, in thousands of euros.

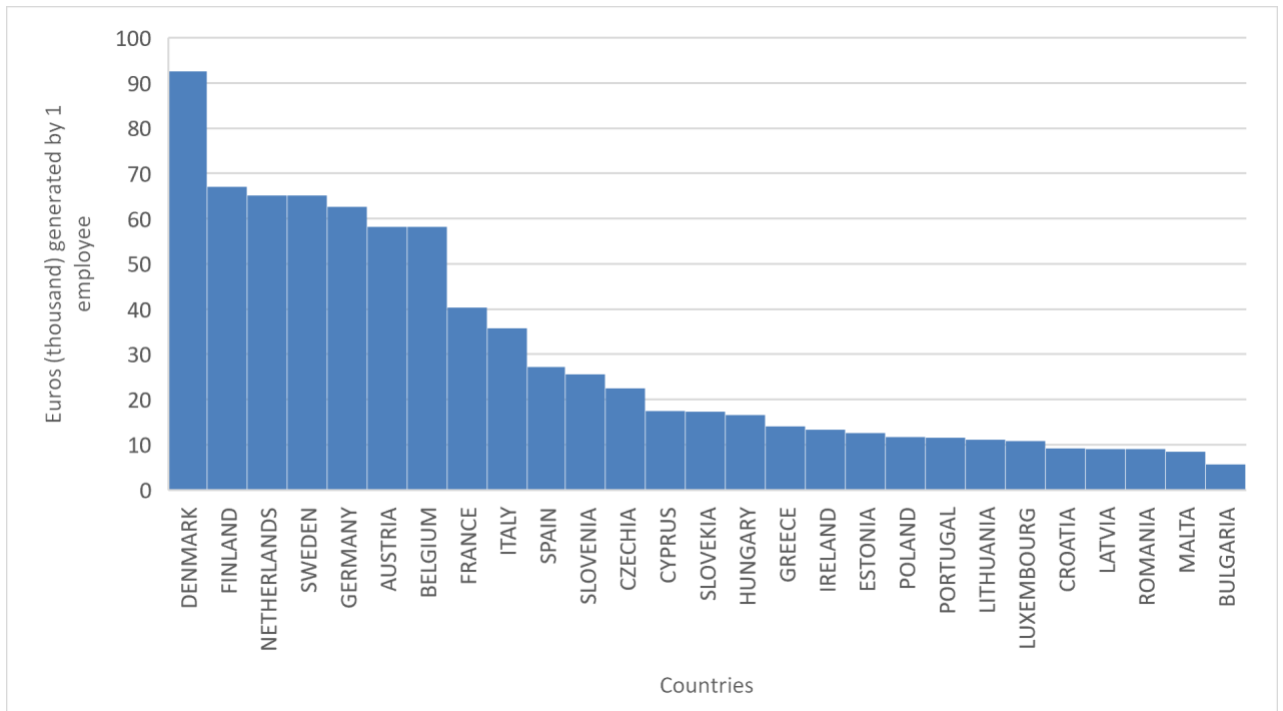


Figure 47. High-technology exports (currency) % of total employees in the industry

Denmark is skyrocketing with around 93 000 Euros generated in a year, by one person in the high-added value industrial manufacturing companies. This high number is reached, by innovating, investing, and industrializing the sector, with latest technological advancements, making the overall efficiency higher and the economy grow in a positive way, however job opportunities are withdrawn from the society, making a huge impact in employment for future generations.

CONCLUSION AND RECOMMENDATIONS

All in all, the purpose of this research was to develop and propose a structured model on evaluation of impact of innovations on high added value industrial companies' development and economic growth under conditions of globalization. The study explores the impact of innovation on the competitiveness of high added value industrial enterprises, as well as its contribution to economic growth in a globalized context, using an examination of existing literature. After the analysis of literature sources and the analysis of the high-added value industrial manufacturing companies, the following conclusions and recommendations are presented:

1. It was indicated that the major factors which have impact on economic growth and boosting innovation activities in high added value industrial enterprises, are Manufacturing Added Value, Investment, and Employment.
2. After conducting a comparative analysis of empirical research seeking to design structure of the model, the theory to investigate the relationship between the variables and economic development was a neoclassical growth theory, also known as total productivity formula. Whereas the regression model, was a fixed cross-section data panel, conducted by the least squares method.
3. The constrained database is based on the developed model concept, which analyzes (EU-27) countries in the lifespan from 2016 up to 2020. The dependent variable being – manufacturing value added as % of GDP (MVA/GDP), and the independent ones: manufacturing value added per 1000 employees (MVA/EMP), manufacturing value added as unit of gross fixed capital formation (MVA/GFCF), & High technology exports as % manufacturing value added (HT/MVA). In order to be as accurate in relevance with the thesis subject, high technology industries were classified only for manufacturing as per Eurostat NACE Rev. 2 (C). High-Medium/High technology exports, are classified at 2-digit level: Manufacture of basic pharmaceutical products and pharmaceutical preparations (C21); Manufacture of computer, electronic and optical products (C26); Manufacture of chemicals and chemical products (C20); Manufacture of electrical equipment (C27); Manufacture of machinery and equipment n.e.c. (C28); Manufacture of motor vehicles, trailers and semi-trailers (C29); Manufacture of other transport equipment (C30).
4. Simulations were forecasted using EViews programme and proposed a structured model on evaluation of impact of innovations on high added value industrial companies' development and economic growth under conditions of globalization. Suggesting great insights, whereas the highest

precision simulations were Germany, Belgium, France, Austria, Slovenia, Latvia, Lithuania, and Cyprus – this results, that the mentioned countries high-added value industrial companies manufacturing value added growth in terms of development and economic growth is fully working, by the total productivity model. The rest of countries, appeared at the medium precision level, whereas some of imperfections occurred. And two of the models real and forecasted values, appeared to be drastically different, which were classified as low accuracy models. An example, Ireland, after double checking the database values, it is seen, that the Irish island refuses to share government data values with Eurostat, for variables, such as high technology exports, total currency. In addition to that, Romania also is missing some of sector values or acknowledges false data. Inaccurate or false data disrupts the model's accuracy, to predict future values.

To conclude, model seems to be working with great accuracy, forecast simulations, can predict future insights for most of the analyzed countries. After acknowledging that the top high technology exporters are Germany and Denmark, 70% & 69% respectfully, meaning that, the countries medium and low technology exports, are only at around 30%. That being said, countries, such as Czechia, Slovenia, Slovakia have been focusing on their high-added value industrial manufacturing expansion, to grow their total GDP and follow development accordingly as the top tier competitors. The impact of innovation in high-added value companies' does in fact bring, great profits in terms of development and economic growth, unfortunately, job opportunities are withdrawn from future generations, by advanced efficient machinery.

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Appendix A

Table A1. Methodical part database

Country	Year	Gross domestic product (GDP) (millions of euros)	Manufacturing value added (MVA) (millions of euros)	Gross fixed capital formation (GFCF) (millions euros)	Employment (EMP) (thousands)	High technology exports (HTE) (millions of euros)	Final energy consumption in industry (VD) (millions of euros)
BELGIUM	2017	445050,1	397034,3	103601	4550	19 306,33	10443,973
BELGIUM	2018	460050,8	410200,8	108676,3	4646	21 411,14	10680,29
BELGIUM	2019	478645	427315,1	116213,9	4708	24 358,13	10310,041
BELGIUM	2020	459826,3	412663,2	111258,5	4664	26 105,92	10003,809
BELGIUM	2021	502311,6	447378	121497,3	4735	37 716,59	10583,633
BULGARIA	2017	52531,3	45176,4	9609,8	3029	857,34	2757,516
BULGARIA	2018	56224,8	48715,7	10544,9	3025	990,27	2736,144
BULGARIA	2019	61558,5	53150,9	11455,1	3091	1 125,71	2678,806
BULGARIA	2020	61638,9	53471,2	11750,2	2985	1 159,25	2646,35
BULGARIA	2021	71077	62177,8	11616,6	2977	1 384,55	2910,698
CZECHIA	2017	194132,9	174451,9	48370,7	5071	18 949,01	6734,121
CZECHIA	2018	210970,5	190124,2	55485	5124	23 021,62	6699,106
CZECHIA	2019	225613,5	203852,3	61068,3	5126	25 414,25	6618,619
CZECHIA	2020	215805,4	196415,8	57290,8	5066	26 296,24	6567,069
CZECHIA	2021	238249,5	216491,7	61964,2	5046	26 972,87	7013,192
DENMARK	2017	294808,2	256348,5	62575,1	2560	3 955,26	2284,765
DENMARK	2018	302328,7	262324,8	65687,9	2601	4 070,89	2314,636
DENMARK	2019	309526,4	269428,3	65746,1	2637	4 319,09	2257,716
DENMARK	2020	311759,7	270851,5	69506,2	2618	4 964,33	2297,887
DENMARK	2021	336718,8	292558,8	76124,5	2653	5 452,07	2454,668
GERMANY	2017	3267160	2944074	666876	38862	89 010,27	57146,089
GERMANY	2018	3365450	3032736	708939	39025	92 795,52	57090,092
GERMANY	2019	3473260	3129717	742361	39424	94 744,27	55649,346
GERMANY	2020	3405430	3087963	736147	38589	85 651,72	54762,64
GERMANY	2021	3601750	3258567	783804	39148	96 363,37	55865,551
ESTONIA	2017	23833,6	20676,2	6177,3	618	1 097,81	462,926
ESTONIA	2018	25932,2	22558,3	7026,3	620	851,47	487,808
ESTONIA	2019	27764,7	24120,1	7055,5	625	786,22	459,267
ESTONIA	2020	27465	24115,7	8563,4	613	793,22	407,969
ESTONIA	2021	31444,9	27566,3	9076,2	611	838,48	383,494
IRELAND	2017	297763,2	274823,2	98742,8	2064	14 035,5	2134,59
IRELAND	2018	326631,3	306261,2	92740,3	2115	15 294,56	2181,556
IRELAND	2019	356704,6	334579	193706,2	2174	15 933,77	2181,372
IRELAND	2020	372836,4	352055,3	158065,8	2112	23 045,12	2098,131
IRELAND	2021	426283,4	401447,5	99196,4	2212	21 070,32	2200,896

GREECE	2017	176903,4	154344,2	20855,4	3646	852,45	2762,817
GREECE	2018	179557,7	155610,9	20016,6	3709	1 129,23	2738,854
GREECE	2019	183351,2	158848,6	19595,1	3785	1 243,31	2587,606
GREECE	2020	165405,9	145087,7	19778,8	3593	1 347,79	2523,498
GREECE	2021	181674,6	158667,9	24110,8	3811	1 485,94	2565,709
SPAIN	2017	1162492	1053805	216932	18531	7 843,42	20394,457
SPAIN	2018	1203859	1089420	233996	19002	8 173,4	20666,439
SPAIN	2019	1245513	1129619	249502	19417	8 790,36	20642,726
SPAIN	2020	1117989	1020065	227565	18851	9 337,43	18838,478
SPAIN	2021	1206842	1090923	238550	19367	14 716,63	20134,003
FRANCE	2017	2297242	2046129	516784	26233	34 060,84	27264,451
FRANCE	2018	2363306	2101770	541023	26441	36 619,13	27942,567
FRANCE	2019	2437635	2169269	572293	26513	39 814,39	27221,663
FRANCE	2020	2310469	2061470	529854	26402	33 588,62	25508,296
FRANCE	2021	2500870	2216772	606168	26761	35 103,95	27218,108
CROATIA	2017	49985,9	41432	9824,3	1585	641,38	1148,118
CROATIA	2018	52747,2	43488	10583,1	1610	763,65	1161,853
CROATIA	2019	55644,4	45826,4	11845,1	1631	831,71	1172,434
CROATIA	2020	50424,9	42173,8	11210,8	1618	886,24	1171,272
CROATIA	2021	58254,1	48406,8	12077,5	1634	949,35	1191,359
ITALIA	2017	1736592, 8	1557795,8	303569,9	22064	15 673,4	24925,749
ITALIA	2018	1771391, 2	1589576,2	316124,9	22227	16 923,42	24663,854
ITALIA	2019	1796648, 5	1611368,5	323203,4	22337	18 328,24	24928,486
ITALIA	2020	1660621, 4	1502118,4	297961,9	21632	17 858,38	23861,103
ITALIA	2021	1782050, 4	1597537,4	355629,5	21760	20 084,28	25281,412
CYPRUS	2017	20312,4	17740,5	4223,9	368	171,18	234,2
CYPRUS	2018	21675,1	18891,9	4070,9	387	278,19	227,688
CYPRUS	2019	23176,2	20326,1	4392,3	400	69,72	228,648
CYPRUS	2020	21894,9	19479,1	4661,8	402	66,13	244,584
CYPRUS	2021	24018,9	21147	4672,8	414	83,52	243,403
LATVIA	2017	26984,4	23574,4	5558,6	854	691,67	793,356
LATVIA	2018	29153,6	25307,4	6448,3	867	828,34	897,892
LATVIA	2019	30678,6	26723	7101,5	862	888,11	852,758
LATVIA	2020	30294	26436,6	7002,5	846	1 049,24	870,923
LATVIA	2021	33695,9	29539,3	7499,6	817	1 082,92	894,162
LITHUANIA	2017	42276,3	37981,9	8503,8	1296	1 192,35	1070,927
LITHUANIA	2018	45515,2	40928,1	9530,9	1313	1 252,15	1106,588
LITHUANIA	2019	48908,2	43949,3	10481,7	1314	1 277,92	1113,763
LITHUANIA	2020	49769,6	44662	10616,2	1290	1 334,35	1024,34
LITHUANIA	2021	56179,1	50198,4	12016,7	1302	1 663,46	1109,164
LUXEMBOURG	2017	58168,8	53011,5	10360,6	267	811,87	630,695
LUXEMBOURG	2018	60121,2	54631,8	9741,7	275	817,6	648,871

LUXEMBOURG	2019	62373,6	56697	10854,5	284	1 738,17	631,731
LUXEMBOURG	2020	64781	59159,1	10694,3	287	461,45	580,655
LUXEMBOURG	2021	72295	65590,8	11963,8	299	524,98	608,513
HUNGARY	2017	127024,7	107729,9	28133,4	4474	11 847,99	4282,774
HUNGARY	2018	136054,6	114904,5	33647,7	4519	12 023,13	4453,878
HUNGARY	2019	146526,1	123755,9	39573,7	4538	12 836,93	4459,617
HUNGARY	2020	137826,5	116328,8	36558,8	4495	12 735,69	4421,598
HUNGARY	2021	153758,7	130108,3	41805	4511	12 849,91	4734,949
MALTA	2017	11936,6	10629	2376,9	212	183,33	57,156
MALTA	2018	12951	11481,9	2514,4	229	253,24	55,502
MALTA	2019	14177,9	12681,8	2842,2	245	278,35	56,188
MALTA	2020	13164	11951	2679	252	312,07	56,219
MALTA	2021	14982,7	13649,9	3035,3	258	250,68	60,494
NETHERLAND S	2017	738146	661566	148670	7898	82 677,94	13760,936
NETHERLAND S	2018	773987	692632	158093	8031	85 887,39	13625,703
NETHERLAND S	2019	813055	724960	172808	8159	85 965,8	13224,227
NETHERLAND S	2020	796530	709628	172937	8183	90 897,95	13176,454
NETHERLAND S	2021	856356	762564	184613	8315	107 922,13	13234,239
AUSTRIA	2017	369361,9	329416,8	87274,8	4048	13 614,98	7629,492
AUSTRIA	2018	385274,1	344266,9	92832,3	4102	13 342,14	7563,5
AUSTRIA	2019	397169,5	354934,9	98948	4148	13 847,73	7542,827
AUSTRIA	2020	381042,5	341994,2	95296,8	4052	13 762,57	7247,593
AUSTRIA	2021	406148,7	363340,9	107538,4	4102	14 976,61	7606,715
POLAND	2017	465772,6	408852,2	81835,6	15789	11 541,22	15819,88
POLAND	2018	499004,1	437037,2	93489,9	15875	12 068,23	16327,935
POLAND	2019	532504,7	468018,4	100734,4	15853	13 067,84	16492,204
POLAND	2020	526147,2	463438,2	96351,6	15783	13 896,46	15921,165
POLAND	2021	574771,8	499987,7	97964,4	16169	16 201,41	16265,017
PORTUGAL	2017	195947,2	169642,3	32887,7	4423	1 145,65	4525,297
PORTUGAL	2018	205184,1	177465,9	35953,4	4532	1 167,23	4553,901
PORTUGAL	2019	214374,6	185536,3	38815,2	4571	1 823,1	4618,128
PORTUGAL	2020	200518,9	174768	38509,8	4496	1 872,4	4447,539
PORTUGAL	2021	214470,7	185729,8	43588,1	4599	2 003,66	4531,067
ROMANIA	2017	186399	168 614,70	42547,5	7540	3 929,07	6437,729
ROMANIA	2018	206071,9	186 382,60	44069,8	7581	4 476,67	6612,433
ROMANIA	2019	224178,6	202 806,30	51514,8	7638	4 957,36	6661,063
ROMANIA	2020	220486,6	199 987,60	51881,1	7547	4 887,15	6437,031
ROMANIA	2021	241268,4	218035,3	57279,8	7625	5 362,43	6856,343
SLOVENIA	2017	43011,3	37370	7879,8	924	1 197,36	1295,612
SLOVENIA	2018	45876,3	39961,4	8869,3	943	1 306,08	1319,176
SLOVENIA	2019	48533,1	42386,2	9495,6	953	1 494,66	1322,08
SLOVENIA	2020	47020,6	41568,7	8870	948	1 664,73	1256,408

SLOVENIA	2021	52208,1	45880	10618,5	946	1 990,13	1294,263
SLOVAKIA	2017	84669,9	75861,9	17869,4	2564	6 730,11	3452,442
SLOVAKIA	2018	89874,7	80517,3	18787,3	2593	6 589,57	3662,539
SLOVAKIA	2019	94437,5	84433,6	20296,4	2609	6 108	3463,68
SLOVAKIA	2020	93413,8	83748,1	18225,4	2556	5 805,65	3138,177
SLOVAKIA	2021	98523	87754,5	18664,4	2516	6 019,83	3382,392
FINLAND	2017	226301	195707	52839	2303	1 640,73	10699,805
FINLAND	2018	233462	201308	56206	2361	1 440,51	11038,16
FINLAND	2019	239858	207291	57149	2378	1 367,16	10980,155
FINLAND	2020	238038	206158	57231	2350	1 506,09	10257,53
FINLAND	2021	251520	218063	59504	2388	1 976,73	10743,554
SWEDEN	2017	480025,5	425594,5	120661,5	4654	7 245,68	10917,194
SWEDEN	2018	470673,1	417117,7	118513,8	4720	7 403	11013,378
SWEDEN	2019	476869,5	423512,4	116402,7	4740	7 885,19	10891,752
SWEDEN	2020	480556,4	426559,9	120694,3	4685	8 540,16	11166,16
SWEDEN	2021	537085	476824,9	137715,6	4726	8 795,05	11101,916

Source: prepared by author based on Eurostat data (2022)

Appendix B

Table B1. Empirical part database

Country	Year	Manufacturing value added (MVA) (millions of euros)	High technology exports (HTE) (millions of euros)	Gross fixed capital formation (GFCF) (millions of euros)	Gross domestic product (GDP) (millions of euros)	Employment (EMP) (thousand)
BELGIUM	2016	56521,5	33501,7	100114,2	430085,3	530,3
BELGIUM	2017	59094,8	33834,4	103601	445050,1	534,5
BELGIUM	2018	56005,1	31737,9	108676,3	460050,8	569,7
BELGIUM	2019	55315,8	30599,4	116239	478676,1	550,7
BELGIUM	2020	53145,4	28880,6	111156,8	459827,4	544,5
BULGARIA	2016	7860,8	3337,8	8975,5	48773,1	556,7
BULGARIA	2017	8239,4	3430,2	9609,8	52531,3	566,1
BULGARIA	2018	7616,1	3244,5	10544,9	56224,8	563,6
BULGARIA	2019	7360,5	3190,5	11455,1	61558,5	569,5
BULGARIA	2020	7021,3	2789,8	11750,2	61638,9	543,7
CZECHIA	2016	46079	28793,1	44257,9	177438,5	1304,2
CZECHIA	2017	51027,2	32729,2	48370,7	194132,9	1329
CZECHIA	2018	47837,3	30418,8	55485	210970,5	1323,2
CZECHIA	2019	45685,9	29171,5	61068,3	225613,5	1326,1
CZECHIA	2020	42640,4	26745,4	57290,8	215805,4	1285,1
DENMARK	2016	41126,2	28715,5	59523,2	283109,7	301,8
DENMARK	2017	41497,4	29090,7	62575,1	294808,2	291,3
DENMARK	2018	39570,1	27730,6	65687,9	302328,7	295,9
DENMARK	2019	38352,6	26446,3	65746,1	309526,4	290,3
DENMARK	2020	36617,9	24352,7	69506,2	311759,7	292,7
GERMANY	2016	636977	442641	636299	3134740	7294,1
GERMANY	2017	679253	477963	666876	3267160	7333,6
GERMANY	2018	674397	477164	708939	3365450	7387,7
GERMANY	2019	666185	469657	742361	3473260	7414,5
GERMANY	2020	647696	457004	736147	3405430	7638,7
ESTONIA	2016	3524,9	1430,4	5313,1	21747,9	109,5
ESTONIA	2017	3636,6	1525,1	6177,3	23833,6	112,7
ESTONIA	2018	3493,5	1451,5	7026,3	25932,2	111,6
ESTONIA	2019	3244	1298,9	7055,5	27764,7	110
ESTONIA	2020	3020	1224,4	8563,4	27465	106,9
IRELAND	2016	126932,6	3081,6	96817,3	270205,3	221,6
IRELAND	2017	112665,5	3303,9	98742,8	297763,2	226,5
IRELAND	2018	107027,2	3086,7	92740,3	326631,3	225,1

IRELAND	2019	94941	2968,3	193706,2	356704,6	232,3
IRELAND	2020	89454,8	2879	158065,8	372836,4	240,7
GREECE	2016	14423	3998,9	19208,6	174494,2	268
GREECE	2017	14323,7	4162,1	20855,4	176903,4	280,3
GREECE	2018	14674,4	3966,9	20016,6	179557,7	281,2
GREECE	2019	14343,4	3920,7	19595,1	183351,2	299,6
GREECE	2020	14133,7	3963,9	19778,8	165405,9	292
SPAIN	2016	123145	57863	200048	1114420	2029,7
SPAIN	2017	135933	61559	216932	1162492	2127
SPAIN	2018	132748	59930	233996	1203859	2194
SPAIN	2019	131687	58350	249502	1245513	2252,1
SPAIN	2020	125539	55570	227565	1117989	2188,1
FRANCE	2016	214120	112495	487382	2234129	3020
FRANCE	2017	243954	125550	516784	2297242	3034,8
FRANCE	2018	235663	120254	541023	2363306	2920,8
FRANCE	2019	232855	119975	572293	2437635	2935,8
FRANCE	2020	229736	117389	529854	2310469	2845,9
CROATIA	2016	6083,4	2630,9	9350,3	47338,7	248,6
CROATIA	2017	6621,4	2323	9824,3	49985,9	255,9
CROATIA	2018	6487,1	2459,8	10583,1	52747,2	265,4
CROATIA	2019	6367,1	2418,5	11845,1	55644,4	276,2
CROATIA	2020	6093	2329,9	11210,8	50450,9	266,6
ITALIA	2016	242443,2	128083,3	291183,5	1695786,8	3615,9
ITALIA	2017	267416	139009,7	303569,9	1736592,8	3665,4
ITALIA	2018	265881,9	137782,3	316124,9	1771391,2	3752,8
ITALIA	2019	258993,2	133597,4	323203,4	1796648,5	3811,7
ITALIA	2020	250824,4	129181,6	298435,5	1661019,9	3793,6
CYPRUS	2016	1241,9	523,5	3429,1	19013,8	22,8
CYPRUS	2017	1264,1	511,4	4223,9	20312,4	24,4
CYPRUS	2018	1155,2	457,1	4070,9	21674	24,5
CYPRUS	2019	993,4	376,8	4392,3	23176,5	26,7
CYPRUS	2020	869	292,9	4661,8	21896,5	27
LATVIA	2016	3329,7	1076,3	4898,7	25371,3	111,5
LATVIA	2017	3252	1031,5	5558,6	26984,4	107,8
LATVIA	2018	3077,8	962	6448,3	29153,6	105,1
LATVIA	2019	2825,3	933,6	7101,5	30678,6	102,7
LATVIA	2020	2579,4	818,5	7002,5	30265,1	103,5
LITHUANIA	2016	7756,2	2542,8	7722,6	38889,9	190,6
LITHUANIA	2017	7866	2361,2	8503,8	42276,3	189
LITHUANIA	2018	7546,1	2181	9530,9	45515,2	198,7
LITHUANIA	2019	7174,7	1991	10481,7	48916,4	199,6
LITHUANIA	2020	6571,4	1698,5	10616,2	49829,3	194,9
LUXEMBOURG	2016	3256,6	136,6	9715,5	56208,1	10,4
LUXEMBOURG	2017	3114,1	96,4	10360,6	58168,8	8,6

LUXEMBOURG	2018	2983	103,7	9741,7	60121,2	11,4
LUXEMBOURG	2019	2778,1	109,9	10854,5	62373,6	10,1
LUXEMBOURG	2020	3257,2	103,5	10694,3	64781	10,5
HUNGARY	2016	23873,4	15022,1	22663,8	116255,7	889,5
HUNGARY	2017	25548,8	15910,8	28133,4	127024,7	938,4
HUNGARY	2018	25174,8	15834	33647,7	136055,4	953,3
HUNGARY	2019	24295,4	15567,4	39573,7	146554,5	946,5
HUNGARY	2020	22792,8	14565,5	36558,8	137866	909
MALTA	2016	951,7	234,3	2391,1	10541,1	20,9
MALTA	2017	937,7	232,7	2376,9	11936,6	22,1
MALTA	2018	883,5	141,6	2517,8	12977,2	22,5
MALTA	2019	822,1	203	2845,9	14186,4	23,9
MALTA	2020	757,9	139,3	2680,7	13180,9	24,8
NETHERLANDS	2016	86236	48643	141675	708337	721
NETHERLANDS	2017	87602	49313	148670	738146	713,4
NETHERLANDS	2018	85581	48378	158093	773987	722,3
NETHERLANDS	2019	81583	45166	172808	813055	713,6
NETHERLANDS	2020	76862	41768	172937	796530	707,6
AUSTRIA	2016	62536,2	35256,1	82594,2	357608	617,2
AUSTRIA	2017	65894,5	37508,3	87274,8	369361,9	611,7
AUSTRIA	2018	64836,8	37108,6	92832,3	385274,1	637,8
AUSTRIA	2019	62210,5	35993	98948	397169,5	631,2
AUSTRIA	2020	60962,9	35291,1	95296,8	381042,5	616,1
POLAND	2016	86668,5	39328,8	78449,3	424735,3	3029,3
POLAND	2017	90126,3	39449,1	81835,6	465772,6	3158,8
POLAND	2018	83602	36057,7	93489,9	499004,1	3196,1
POLAND	2019	79605,1	34656,3	100734,4	532504,7	3137,5
POLAND	2020	78511,9	33831,7	96351,6	526147,2	3007,8
PORTUGAL	2016	24098,6	8746,6	28893,4	186489,8	695,3
PORTUGAL	2017	25500,5	9028,2	32887,7	195947,2	724,7
PORTUGAL	2018	25160,4	8714,4	35953,4	205184,1	754,1
PORTUGAL	2019	24184,8	8214,7	38815,2	214374,6	753,5
PORTUGAL	2020	22664,8	7655,1	38509,8	200518,9	747
ROMANIA	2016	34968,6	14148,5	38714,6	167494,3	1546,2
ROMANIA	2017	38488	14997,8	42547,5	186399	1612,3
ROMANIA	2018	39033,2	14760,1	44069,8	206071,9	1622,7
ROMANIA	2019	36930,7	14550,2	51514,8	224178,6	1591,9
ROMANIA	2020	33707,6	12624,2	51881,1	220486,6	1494,1
SLOVENIA	2016	9658	6189,7	7028,7	40443,2	212,9
SLOVENIA	2017	10009,8	6281,6	7879,8	43011,3	223,9
SLOVENIA	2018	9316,7	5838,9	8869,3	45876,3	226,5
SLOVENIA	2019	8848,8	5527,2	9495,6	48533,1	236,2
SLOVENIA	2020	8156,2	5028,4	8870	47020,6	233
SLOVAKIA	2016	16929,7	10425,3	17091,3	81265,2	562,5

SLOVAKIA	2017	18674,9	11575,6	17869,4	84669,9	575,5
SLOVAKIA	2018	16969,3	10112	18787,3	89874,7	579,4
SLOVAKIA	2019	15198	8832,7	20292,4	94428,3	582,7
SLOVAKIA	2020	15114,6	9103	18210,2	93441,9	581,4
FINLAND	2016	33952	21364	49474	217518	297,8
FINLAND	2017	34569	20847	52839	226301	296,5
FINLAND	2018	34072	19724	56206	233462	306,8
FINLAND	2019	34400	20074	57149	239858	300,8
FINLAND	2020	31683	18633	57231	238038	300,4
SWEDEN	2016	59400,8	28165,5	112885,6	466266,5	460,9
SWEDEN	2017	61060,3	30115,5	120661,5	480025,5	466,5
SWEDEN	2018	61335,5	31062,2	118513,8	470673,1	468,9
SWEDEN	2019	62621,9	31754,2	116402,7	476869,5	469,3
SWEDEN	2020	61509,3	30386,3	120694,3	480556,4	459,4

Source: prepared by author based on Eurostat data (2022)

Mechanics, material science, industrial engineering, and management

IMPACT OF INNOVATION ON HIGH ADDED VALUE INDUSTRIAL COMPANIES DEVELOPMENT AND ECONOMIC GROWTH UNDER CONDITIONS OF GLOBALIZATION

Received 11 November 2021; accepted date 20 January 2022;

Abstract. The purpose of this research is to investigate the impact of innovation on the development of high-value industries in 27 EU countries. This study explores the impact of innovation on the competitiveness of high added value industrial enterprises, as well as its contribution to economic growth in a globalized context, using an examination of existing literature. The study's findings imply that innovation is critical to the development of high-value businesses and can considerably contribute to EU economic growth. The report does, however, identify many issues that high added value businesses confront, such as increased rivalry and the need for continual innovation to remain competitive in a quickly expanding global market. Overall, this paper underscores the importance of innovation as a driving force behind the development of high added value industries and economic growth in the context of globalization.

Keywords: Innovation, High added value, Industrial companies, Economic growth, Globalization, Competitiveness, EU (27), Global market, Development

Introduction

In high added-value industrial enterprises, innovation has been identified as a driving force behind economic growth and development. In the context of globalization, these businesses face strong competition and must constantly innovate to remain competitive. The purpose of this study is to investigate the impact of innovation on the development of high-value industrial firms and its contribution to economic growth. Furthermore, because it focuses especially on high added value industrial enterprises and evaluates the influence of innovation on economic growth from many viewpoints, this research is innovative in its approach.

1. Methodology

Data analysis is a multi-step process that includes data cleansing and preparation, descriptive analysis, inferential analysis, and interpretation. Checking for mistakes, missing numbers, and outliers, as well as standardizing or modifying the data, are all part of data cleaning and preparation. Descriptive analysis is the process of summarizing data using statistics and visuals to detect patterns and trends. Inferential analysis uses statistical techniques to test hypotheses or provide answers to research problems. Finally, interpretation entails drawing inferences based on the data analysis findings.

Table 1. Process of data analysis (source: prepared by the author)

<i>Process for the data analysis:</i>	
Data cleaning and preparation:	Checking the data for errors, missing values, and outliers, and preparing the data for analysis. This involves standardizing or normalizing the data, transforming variables, or creating new variables.
Descriptive analysis:	Involved summarizing the data using descriptive statistics, such as mean, median, and standard deviation. It also involves creating charts, graphs, or tables to visualize the data and identify any patterns or trends.
Inferential analysis:	Using statistical methods to test hypotheses or answer research questions. Inferential analysis involves techniques such as regression analysis, hypothesis testing, or clustering analysis.
Interpretation:	Involves interpreting the results of the data analysis and drawing conclusions based on the findings.

2. Data collection, cleaning, and preparation:

“Eurostat” was the key data source for this study, as it supplied extensive and accurate data on a variety of economic and industry-related factors across the EU. Eurostat’s database was specifically developed to collect statistics on GDP growth, productivity, innovation performance, and employment rates in EU member states.

According to the Kaldor Growth Theory, there is a strong link between economic growth and manufacturing production. According to this hypothesis, the manufacturing industry is the engine of economic growth, and strong growth is often observed when the manufacturing sector’s percentage of GDP grows. The Neoclassical Growth Theory, created by Robert Solow, on the other hand, emphasizes the role of technological advancement in economic development. Solow’s model serves as the foundation for the development of the total factor productivity idea, in which labor augmenting, technical advancement, and capital per worker increase explain long-term economic growth per worker. Both theories have different foci, but they can be merged into an eclectic model to better understand economic development drivers.

3. Descriptive analysis:

<i>Variable Name</i>	<i>Measurement</i>	<i>Abbreviation</i>
Economic Growth	Gross Domestic Products (EU27 2017-2021)	GDP
Manufacturing Output	Manufacturing Value Added (EU27 2017-2021)	MVA
Investment	Gross Fixed Capital Formation (EU27 2017-2021)	GFCF
Labour Force	Employment to population (EU27 2017-2021)	EMP
Technology	High-Technology Exports (EU27 2017-2021)	HTE
Electricity, gas, steam, and air conditioning supply	Final energy consumption in industry (EU27 2017-2021)	VD

Table 2. Variables, measurements, and abbreviations (source: EUROSTAT)

The table provides information on numerous variables and their measurements using acronyms. Economic

growth, manufacturing output, investment, labor force, technology, and supply of electricity, gas, steam, and air conditioning are among the variables considered. The measurements for each variable are also mentioned, as are the years of data collection, which range from 2017 to 2021. Finally, abbreviations are provided for each measurement for ease of reference and analysis.

The theory used to investigate the relationship between the variables and economic development is a hybrid of Kaldor’s first law and neoclassical growth theory. As a result, the model’s specifications will be as follows:

$$\ln GDP(i^{th}) = C + \ln MVA(i^{th}) + \ln HTE(i^{th}) + \ln GFCF(i^{th}) + \ln EMP(i^{th}) + \ln VD(i^{th}) \quad (1)$$

Equation 1. Regression analysis model (source: prepared by the author)

4. Inferential analysis:

Innovation has been identified as a key driver of economic growth, particularly in high added value industrial companies. The role of innovation in the development of these companies is crucial to maintain their competitive advantage and sustain growth in an era of globalization. The integration of global markets has provided an unprecedented opportunity for companies to access new markets and gain access to new technology, but it has also brought about increased competition, making it imperative for companies to continually innovate in order to survive.

H1	Manufacturing (MVA) has a statistically positive and significant influence on GDP.
H2	Gross fixed capital formation (GFCF) has a significant and positive influence on GDP.
H3	Labor force (EMP) has a significant and positive influence on GDP
H4	High-technology exports (HTE) have a positive and influence on GDP
H5	Final energy consumption in industry (VD) has a positive influence on GDP

Table 3. Raised hypotheses. (Source: prepared by the author)

To evaluate the statistical significance and strength of the correlations between the variables, these hypotheses will be examined using regression analysis.

The analysis findings will shed light on the impact of manufacturing output, investment, labor force, technology exports, and final energy consumption in industry on economic growth in high added-value industrial companies in the European Union (EU27) from 2017 to 2021. The study evaluated data from relevant sources such as national statistical agencies, industry reports, and academic literature using quantitative methodologies. To assess the amount to which each variable effects GDP, the data will be evaluated using regression analysis on “EViews” software.

Variable	Coefficient	Std. Error	t-Statistic	Probability
Constant-C	0.244	0.022	11.014	0,000
LOG-MVA	0.971	0.010	96.4903	0,000
LOG-GFCF	0.008	0.009	0.8108	0,418
LOG-EMP	0.012	0.004	2.743	0,007
LOG-HTE	-0.007	0.002	-3.360	0,001
LOG-VD	0.012	0.003	0.003	0,001

Table 4. Eviews regression analysis variables result. (Source: prepared by the author)

Indicator	Value
R-squared	0,999
Adjusted R-squared	0,999
S.E of regression	0,020
Sum squared residual	0,051
Log likelihood	339.371
F-statistic	147033.3
Prob(F-statistic)	0,000

Table 5. Eviews regression analysis model satisfaction results. (Source: prepared by the author)

According to the coefficient estimates for the model, LOG(MVA) has the greatest positive impact on the

dependent variable, followed by LOG(EMP) and LOG(VD). LOG(GFCF) has a tiny positive influence, but LOG(HTE) has a negative impact. The constant term has a positive effect on the dependent variable as well. The t-statistics and probability of the coefficients define their statistical significance. LOG(MVA), LOG(EMP), and LOG(HTE) coefficients are likewise statistically significant, with t-statistics of 96.4903, 2.743, and -3.360, respectively. The LOG(MVA) coefficient is the biggest, at 0.971, showing that manufacturing output has the most positive effect on the dependent variable. LOG(GFCF) and LOG(VD), on the other hand, have coefficients of 0.008 and 0.012, respectively, and are not statistically significant, with p-values of 0.418 and 0.001. We may deduce from the t-statistics and probability that LOG(MVA), LOG(EMP), and LOG(HTE) are statistically significant at the 1% level, which means that their coefficients are not zero. At the 5% level, LOG(GFCF) is not statistically significant, implying that its coefficient could be zero. LOG(VD) is statistically significant at 1%, but its coefficient is quite modest, implying that it has little effect on the dependent variable.

5. Interpretation:

H1	Manufacturing (MVA) has a statistically positive and significant influence on GDP. – <i>Supported</i>
H2	Gross fixed capital formation (GFCF) has a significant and positive influence on GDP. – <i>Rejected</i> .
H3	Labor force (EMP) has a significant and positive influence on GDP. – <i>Supported</i> .
H4	High-technology exports (HTE) have a positive and influence on GDP. – <i>Rejected</i> .
H5	Final energy consumption in industry (VD) has a positive influence on GDP. – <i>Rejected</i> .

Table 6. Hypotheses results (source: prepared by the author)

- H1: Manufacturing (MVA) has a statistically positive and significant influence on GDP. The coefficient of LOG(MVA) is 0.971 with a t-statistic of 96.4903 and a probability of 0.000, which suggests that the impact of manufacturing on GDP is positive and statistically significant. Therefore, we support H1.

- H2: Gross fixed capital formation (GFCF) has a significant and positive influence on GDP. The coefficient of LOG(GFCF) is 0.008 with a t-statistic of 0.8108 and a probability of 0.418, which suggests that the impact of GFCF on GDP is positive but not statistically significant. Therefore, we reject H2.
- H3: Labor force (EMP) has a significant and positive influence on GDP. The coefficient of LOG(EMP) is 0.012 with a t-statistic of 2.743 and a probability of 0.007, which suggests that the impact of the labor force on GDP is positive and statistically significant. Therefore, we support H3.
- H4: High-technology exports (HTE) have a positive and influence on GDP. The coefficient of LOG(HTE) is -0.007 with a t-statistic of -3.360 and a probability of 0.001, which suggests that the impact of HTE on GDP is negative and statistically significant. Therefore, we reject H4.
- H5: Final energy consumption in industry (VD) has a positive influence on GDP. The coefficient of LOG(VD) is 0.012 with a t-statistic of 0.003 and a probability of 0.001, which suggests that the impact of VD on GDP is positive but not statistically significant. Therefore, we reject H5.

Based on the regression model statistics supplied, we may conclude that the model predicts the dependent variable with good accuracy. The coefficients for the variables "LOG(MVA)," "LOG(EMP)," and "LOG(HTE)" are statistically significant, indicating that they have a significant impact on the dependent

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- [Eurostat database](#)

Notations

Equation 1:

variable. However, the coefficient for the variable "LOG(GFCF)" is not statistically significant, indicating that it has no effect on the dependent variable.

With a score of 0.999, the R-squared and Adjusted R-squared values suggest that the model explains a large percentage of the variation in the dependent variable. The regression S.E. is low, showing that the model has a modest standard error, and the sum squared residual is similarly low, indicating that the model fits the data well. The F-statistic is strong, and the p-value is 0.000, indicating that the model is statistically significant in general.

Finally, this regression model looks to have a good fit and a high predictive power for the dependent variable. The variables "LOG(MVA)," "LOG(EMP)," and "LOG(HTE)" have the most influence, while "LOG(GFCF)" has no effect on the dependent variable. And "LOG(VD)" coefficient is quite modest, implying that it has little effect on the dependent variable.

Conclusions

All in all, the regression analysis results corroborate the predictions that manufacturing, labor force, and high-technology exports have a positive and significant impact on GDP. The findings, however, do not support the notion that gross fixed capital creation and industrial final energy consumption have a large impact on GDP. With a good fit and a moderate standard error, the regression model offers a high degree of accuracy and predictive power for the dependent variable.

Therefore, to forecast a simulation, Gross-fixed investment capital, could be removed from the model overall equation, and Energy consumption spared, since it's statistically significant, however, the impact is too modest. Final simulation model is run on 27 EU individual countries, (see. Figure 7.) – Additional.

$\ln GDP_{it}$: Economic growth determined by the ith country in period t ,
 $\ln MK_{it}$: Manufacturing output determined by the ith country in period t ,
 $\ln GCF_{it}$: Capital determined by the ith country in period t ,
 $\ln EMP_{it}$: Labor force determined by the ith country in period t ,
 $\ln HTE_{it}$: Technology determined by the ith country in period t ,
 $\ln VD_{it}$: Electricity, gas, steam, and air conditioning supply determined by the ith country in period t ,
 C – constant variable

Additional

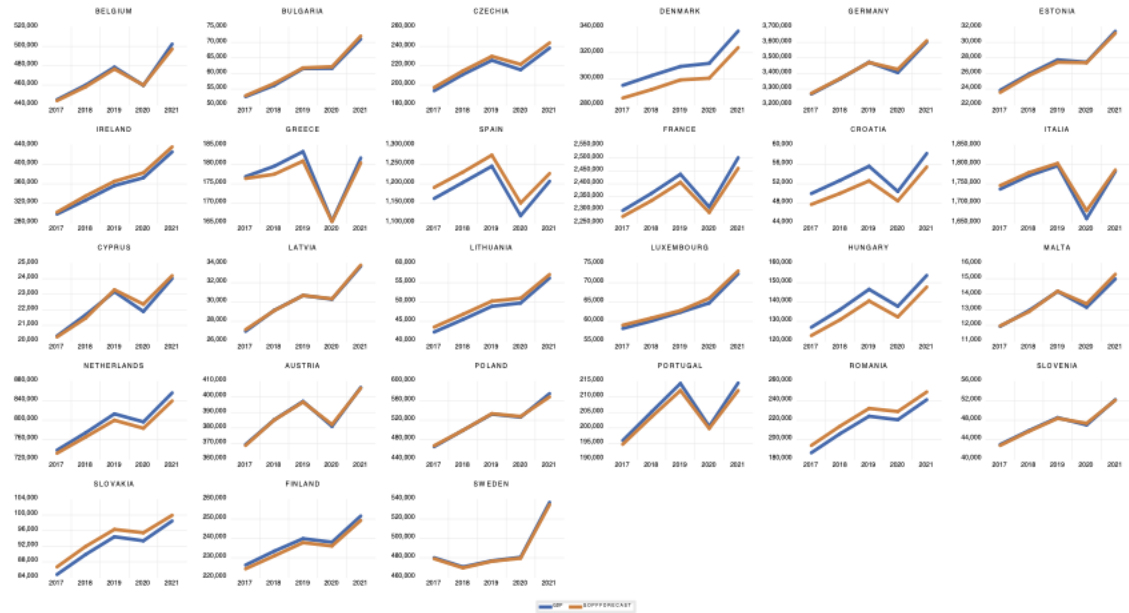


Table 7. Forecasted GDP predictions (orange), compared to real GDP (blue) for individual EU27 country (source: prepared by author)