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Sustainable Economic Growth Based on R&D Amplification and Technological Content of Exports. Evidences from Romania and The V4 Economies

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Abstract: A vast body of literature recognizes the importance of exports as a driver of economic growth. The increasing share of more sophisticated exports gave birth to the idea that the composition of exports, and not just exports per se, could be crucial for economic dynamics. The aim of this paper was to estimate the relative importance of exports with different technological content on economic growth in Romania and V4 economies, considering R&D (Research and Development) expenditure as a predictor of the pattern of these exports. We used a panel analysis on a data set covering the period of 1995–2017 for Romania and V4 economies. The overall results outline significant differences among selected countries in terms of how the composition of exports influenced economic growth in selected countries. In addition, significant differences were found among selected countries in how R&D expenditure influenced the composition of exports. This paper has clearly shown that the composition of exports has different effects on economic growth in selected countries, mostly explainable by country-specific factors. At the same time, the R&D activity, as the main input in the innovation process, can determine the pattern of the structure of exports. The conclusions of such research could become useful tools in shaping macroeconomic policies focused on sustained growth and long-term economic development, especially in countries concerned about improving their status in the global value chain.

Keywords: export agenda; economic dynamics; sustainable economic growth; technological content; R&D expenditure; low/medium/high technology manufactures; regression analysis

1. Introduction

In a vast body of literature exploring the issue of export-based economic growth, the aggregate approach has gained intellectual prominence, but, most of the time, it does not explain the asymmetric effects and influences of the composition of exports on economic dynamics in different countries. However, the link between the composition of exports and economic growth remains scarcely explored.

The aim of this paper was to estimate the relative importance of exports with different technological content on economic growth in Romania and V4 (Visegrad Group) economies, considering R&D (research and development) expenditure as an important input that could shape the country’s specialization in production and trade.

In the last decades, Romania and the Visegrad Group economies (V4) have followed somewhat different trajectories in terms of economic performance, although in much of their post-war history, Romania and the four countries of the Visegrad Group have been tributary to a model of economic development of Soviet influence conceived on bad economic decisions that ignored the economic laws and did not take into account the economic realities and available resources.
At the beginning of the 1970s, countries in the USSR area of influence were trying to make their centralized planned systems more efficient in supporting growth and socialist consumerism. At that time, as Aldcroft [1] notes, Eastern European countries were aware that they were inadequately prepared for the upcoming stage of high-tech growth; consistent imports of Western technology have been seen as a mean to reduce the gap with Western economies. Hungary, Yugoslavia, Romania, and especially Poland have developed import-based growth strategies, fueled by the idea of developing sophisticated and competitive indigenous industrial sectors using Western technology, but this policy did not have the expected results. In the 1980s, Eastern European economies have been affected by what has become known as the “Polish disease”, a term used to describe the inability to overcome through imports the technological gap with the West and the negative impact of this policy on the external balance of payments [1]. Realities demonstrated that, despite some reform measures, Eastern economies could not compete with Western technology and Western consumerism. Also, the Comecon arrangements have thrown the industry in a state of technological backwardness and have generated serious re-adjustment problems, reflected in consistent trade imbalances [2]. After the collapse of the socialist regime in 1989, the former communist countries from Central and Eastern Europe have launched profound transformations in their economic, political, and social systems, with the desire to gain a new status in a world economy modeled by challenges and crises born out of the complexity and dynamism of globalization and a deeper integration into three economic blocs, namely the US, Europe, and Asia. This turning point has brought older themes into the horizon of reflection and interrogation, and at the same time has raised new questions about the direction of change and the factors/conditions that could shape capitalism in the region, the potentiality that the socialist heritage and post-communist transformations would shape a new form of capitalism, and so on [3]. The possibility of initiating a free trade area instead of Comecon was discussed quite intensely; in this context, the initiation of the Visegrad group has appeared as an important moment in economic cooperation, although the main reason for its creation was related directly to the enlargement of the EU to the East [2]. Also, as Marušiak et al. [4] point out, this cooperative structure can be seen as an effort to revive and affirm the identity in the Eastern region of Europe. Currently, the V4 economies are ranked by the World Bank as high-income economies, with high levels of human development; they also stand out by relevant positions in international rankings by the Global Innovation Index (Czech Republic-27, Hungary-33, Slovakia-36, Poland-39) [5] and the Global Competitiveness Index (Czech Republic-29, Poland-37, Slovakia-41, Hungary-48) [6]. Compared to the four dynamic economies in the V4 group, Romania has recorded and continues to record lower performance in terms of income levels (upper middle income) as well as its positions in various international rankings. The gaps accumulated by Romania with other European economies are mainly explained by economic policies incapable of sustaining development; in this respect, Murgescu [7] points to some of the aberrant economic decisions that significantly impacted macroeconomic environment during the 1980s, namely the concentration of investments towards energy, material, and human resource-intensive industries (especially in the heavy industry), promoting a model of autarchic development aimed at reducing economic and political dependence on the external market, and ignoring the benefits derived from integration into the world value chain. At the same time, Romania also ignored the advantages of the information and computer revolution (the Bucharest regime did not plan to invest in these areas even in the longer term), focusing heavily on industries based on energy and labor-intensive consumption, which have made some authors assert that Romania’s economy was gradually translated from Europe into the Third World [7]. Examining the industrialization model of the economies in Central and Eastern Europe, which in fact have tried to follow the path that Western economies have already paved, Berend [8] describes it as being somewhat anachronistic because, while the socialist economies have launched themselves into what they considered to be a catching-up process to Western economies, the Western world, due to technological advances in the 1970s and 1980s, was already on the threshold of a new stage of development, defined by D. Bell as post-industrial society [9]. The rigid model of development, regarded by Berend as suitable for the industrialization of agrarian economies, was completely unprepared for such a technological reorientation and it did nothing but detour the periphery to
periphery [8]. Therefore, Central and Eastern European countries have not been able to renew the technological bases of their old industrial branches [8]. Outward processing agreements and trade played an important role in the early years of structural transformations involving both Romania and other Central and Eastern European countries; Western multinational companies have provided businesses in these countries with materials to produce finished and semi-finished products and deliver them to the West. Such agreements were frequently implemented in low-tech industrial sectors, such as textiles, clothing, footwear, and furniture [10]. In many cases, they have “preserved” the low-tech-oriented model of industrialization, which was the basis of economic growth in Central and Eastern European economies during many decades. In Romania, for example, in 2017, according to the estimates of the National Bank of Romania, about 80% of manufacturing industry exports were concentrated by MNCs (multinational corporations), most of which were implanted in low technology and medium technology sectors [11]. This pattern of industrial development has long been reflected in the pattern of exports. As we can see in the following Figure 1, low-tech manufacturers (LTMs) held the overwhelming weight in export flows. Only around 2000s has the share of medium-tech manufactures (MTMs) outpaced the share of low-tech manufacturers in total exports, while high-tech manufacturers’ (HTMs) export remains at modest levels.

![Figure 1](image)

**Figure 1.** The evolution of the average ratio of low-tech manufactures (LTMs), medium-tech manufactures (MTMs), and high-tech manufactures (HTMs) in export flows (source: Calculated by authors based on UNCTAD data).

In this context, the following research questions have framed our study: (1) How did the composition of export influence economic growth in Romania and V4 economies? (2) How did the R&D expenditure act upon the structure of exports of Romania and the Visegrad group?

Having considered the assumption that what countries export can count more than the level of their export in economic growth, our study extends the area of knowledge because it is the first study focused on estimating the importance of the technological content of exports for economic growth, considering R&D expenditures as a predictor of exports’ composition in the case of Romania and V4 economies. These countries have a similar pace of development and the transition process from the centralized planned economy to the market economy makes them somewhat special cases since there are no previous models from which they could draw inspiration. In addition, most studies focused on the influence of technology-intensive manufacturers’ export on economic growth. However, for mature economies, which do not yet have all the conditions to develop technology-intensive sectors, understanding the nature and determinants of the export pattern is crucial for economic performance, especially in an increasingly interdependent world.

The rest of the paper is organized as follows. Section 2 highlights the outstanding contributions but also some directions in which the research can be refined. Section 3 sets out the analytical design...
of the study, empirical strategy, and the data sources. Section 4 outlines and discusses the main results of the empirical research. Finally, Section 5 summarizes the findings of this work and draws conclusions.

2. Theoretical Background

The nature of the relationship between exports and growth has captured the interest of economists over time, generating a vast theoretical and empirical body of literature. Most studies, however, have tackled this relationship/determination from an aggregate point of view, either in terms of countries or in terms of the value or dynamics of exports. However, this approach does not capture the significant impact and the various effects of the nature and composition of exports for growth [12]. Also, most studies based on aggregate approaches suffer as a result of ignoring an important variable, namely the intensity of R&D, as an important input in the innovation process [13].

The role of international trade as a driver of growth and the importance of international specialization in production and export are discussed and recognized in the literature, beginning with the influential contributions of classical economists. Classical theory explores sources of trade gains, insisting on the benefits derived from production specialization, division of labor, and the exploitation of economies of scale. The structuralist approach, on the other hand, is circumscribed to the idea that economic development is a set of interconnected transformations in the structure of an economy, necessary for its continuous growth; besides the composition of demand, production, and employment, these transformations also involve the structure of foreign trade and capital flows [12,14–17]. Modern economic growth is associated with extensive systemic changes in the structure of production, trade, use of factors, localization of economic activities, and other key economic and demographic variables [18]. Among the most spectacular transformations in the structure of economies, Lewis [19] mentions the decline in the share of primary products and the increase in the share of industrial products, especially manufactured products, in outputs, export, and employment, arguing that overall performance and structural changes in economies are interconnected, meaning that these transformations are fundamental to sustained economic growth. These developments follow the research path unveiled by Rosenstein-Rodan [20], Prebisch [21], Gerschenkron [22], etc., whose scientific contributions introduced the problem of developing countries into the equation of development, seeking to argue the need for industrialization, the role of technical progress, the disparities in income distribution, the pattern of employment, the relationship between external trade and economic growth rates, etc. More recently, theories of growth have emphasized the nature of exports and the relationship between technological advancement as a result of knowledge accumulation, foreign trade, and economic growth. Thus, a substantial record of evidence suggests that high rates of economic growth are correlated with a series of variables describing the economic and political environment. In the last decades, as Grossman and Helpman [23] argue, it has become clear that the importance of technology to economic well-being is increasing and that world economies are becoming more open and interdependent.

The experience of the post-war decades reveals a strong connection between a narrow specialization of economies, predominantly on primary products, and the vulnerability to external shocks, which delays economic growth primarily due to the deterioration of the terms of trade [16,24–26]. Against the background of the transformations that marked the economic environment and the emergence of new research agendas, which gain more and more intellectual dominance, the old paradigm cannot powerfully explain the new challenges anymore. Thus, in the core of the theoretical reflection, the question is not does trade cause growth [27], but when does trade promote growth [12]. In this context, more and more studies based on this vision led to the conclusion that export diversification and their composition could have a much more consistent impact on economic growth than the magnitude of export flows per se [12,28–34]. In other words, what countries export can count more in the equation of economic growth than the level of their export. Lederman and Maloney [35] conclude that, irrespective of the estimation methodology, the variables related to trade structure are important determinants of economic growth rates. Hesse [36] explains that many countries with a narrow structure of exports often suffer from unstable exports and an unstable global demand, and
that diversification of export may be the answer to such constraints. Similar to Lederman and Maloney [35], Hesse offers some robust empirical evidence of a positive relationship between export diversification and income per capita. However, diversification cannot sustain economic growth if the pattern of exports is dominated by low value-added products. In this regard, Rodrik [37], in a study of China’s extraordinary economic performance over the last decades, considers unequivocally that trade has played a significant role in this transformation and that if the global economy were closed, there is a little chance that China would have the same trajectory. China’s model is not a model of specialization developed on the principle of a comparative advantage in a classical tradition. Traditionally, labor-intensive manufacturers have had an important share in China’s export pattern; over the recent decades, however, it has diversified its export and has included a wide range of products with high sophistication (which is not to be expected from a developing economy), thus reaching a supply of products characteristic of an economy with an income per capita three times higher than that of China [37]. Liu and Xia [38] point out that new transformations in the pattern of international competition have revealed a series of shortcomings in the pattern of economic growth based on an excessive export dependence, and that China’s low-cost advantages have diminished or even disappeared. Currently, technological innovation has become China’s long-term strategic focus. In 2016, China was ranked among the top 25 countries of the world by the Global Innovation Index (25th position in 2016, 17th position in 2018), a notable performance if we consider that it is the only developing country in such a position [5]. The characteristics of export matter in the equation of economic growth and development, meaning that some goods generate positive externalities and higher incomes [39]. Trade liberalization and globalization have given rise to new challenges related to the composition and pattern of export. The share of primary products in world trade is gradually declining, while technology-intensive manufacturers are gaining ground faster than other product categories [40]. Lall et al. [41] also highlight that technology-intensive exports generate a greater impact on development, especially as they often reflect more sophisticated technical facilities and skills, and imply faster transfer and diffusion of new technologies. The importance of specialization on technology-intensive manufacturers was also discussed by Hatzichronoglou [42], who, in the context of OECD (Organisation for Economic Co-operation and Development)-led product classification according to their technological content, appreciates that firms in the technology-intensive industries (classified according to R&D intensity) are innovating, gaining new markets, using more productive resources, expanding more in the international environment, and that their dynamism facilitates performance in other sectors. Peneder [43], using data for 28 OECD economies over the 1990–1998 timeframe, concludes that the export of high-technology and high-skill industries has a positive and significant impact on the level and growth of GDP per capita. This conclusion is explained by Peneder, on the one hand, through a direct connection to aggregate development via differential growth that favors “entrepreneurial” industries with a greater capacity to create new markets and, on the other hand, through an indirect connection to the spillovers among industries, such as when proximity allows a better diffusion of knowledge. Cuaresma and Wörz [31], analyzing 33 industrial sectors grouped according to the taxonomy of Hatzichronoglou [42] into two broad categories, namely low-tech and high-tech intensive, from 45 economies (both developed and developing) during 1981–1997, argues that the hypothesis of a differentiated impact of the technology-intensive industrial sectors on economic growth is supported and that the dynamic benefits derived from high-tech exports outweigh the gains derived from low-tech exports. At the same time, they conclude that a pattern of export derived from sophisticated, high-tech products is crucial to long-term economic growth even if the sources of competitive advantage are likely to support and favor specialization in low-tech manufacturers. Over the recent decades, the share of high-tech exports in the aggregate value of manufacturers’ export has increased considerably in industrialized economies and other economies. However, there are differences between countries in the evolution of the share of high-tech exports and the EBRD (business expenditure on R&D) in GDP. R&D intensity in the business sector is typically considered to be the main input in the innovation process, while the share of high-tech exports is seen as an important measure of innovation output [13,44]. These differences have attracted significant interest from researchers as well as from political
decision-makers. Bassanini and Scarpetta [45], analyzing the determinants of economic growth on the basis of a harmonized dataset for OECD countries, underline that R&D may have a persistent effect on economic growth, and hence higher R&D expenditure as an investment in knowledge would be associated with sustained high rates of economic growth.

3. Research Methodology and Data Description

The aim of this paper was to estimate the relative importance of exports with different technological content on economic growth in Romania and V4 economies, considering R&D expenditure as an important input that could shape the country’s specialization in production and trade.

Our analysis combined macroeconomic data for Czechia, Hungary, Poland, Slovakia (all high-income economies according to World Bank’s classification for 2020 year), and Romania (upper-middle economy). Also, all five economies are developed economies according to the UNCTAD (United Nations Conference on Trade and Development) classification. We used a panel data set covering the period 1995–2017 for Romania and V4 economies.

We exploited the UNCTAD database because it is one of the most complex databases compiling data from national and international sources covering a multitude of areas (international trade, national accounts, foreign direct investments, etc.). UNCTAD is the only international database that compiles data on international trade according to the Lall classification.

**Hypothesis (H1):** There are significant differences among selected countries in terms of how the export of manufactures with different technological content influences economic growth.

To test this hypothesis, we estimated a number of regression models using GDP per capita as a proxy for economic growth (dependent variable). We computed economic growth as an absolute change, calculated as the logarithmic difference between the current and the previous level.

As predictors that explain the variation of the independent variable, we used the value of exports by categories according to the Lall classification. We also determined the absolute change in the case of exports as the logarithmic difference between the current and the previous level.

Explaining that different export structures have different implications for growth, Lall divided manufactured exports into the following categories (Appendix 1) [40]:

- **Resource-based manufactures**, which incorporate simple, labor-intensive products. These products do not pose important competitiveness problems.
- **Low-technology manufacturers**, products that incorporate stable, well-diffused technologies. In this case, many products are undifferentiated and compete for price, with labor costs becoming the main vector of competitiveness. Within these sectors, there were massive relocations from rich countries to poor countries; thus, assembly operations were re-implanted in low-wage locations while more complex functions remained in industrialized countries.
- **Medium-technology manufacturers**, as the core of industrial activity in mature economies. These products incorporate complex technologies, with relatively high levels of R&D, advanced skills, and long learning periods. The entry barriers tend to be high.
- **High-technology manufacturers**, i.e., products that are based on fast-changing technologies, important R&D expenditure, emphasis on product design, sophisticated infrastructures, high-specialized skills, and business and research networks.

We eliminated from the analysis the first category of products as their competitive advantage is derived mainly from the endowment with natural resources in each country.

Following the extant literature, in addition to these independent variables of interest, we employed a set of control variables.

- Foreign direct investment (inward flows) allowed us to estimate the attractiveness of the selected countries for foreign investors. In addition, foreign direct investment is one of the main vectors of economic growth.
- Total general government expenditure (as a percentage of GDP) explains the influence of the state on economic development through intervention in the upmost economic sectors.

The inflation rate was employed as a mean of estimating macroeconomic stability.
Hypothesis (H2): R&D expenditures have greater influence on more sophisticated exports and there are significant differences among selected countries in terms of how R&D expenditures influence the technological content of exports.

In order to test this hypothesis, we estimated a second set of regression models that compute the values of the exports according to the Lall classification as dependent variables this time.

To explain the variation of these dependent variables, we used as an explanatory variable, the GERD (Gross Expenditure on Research and Development). OECD defines gross domestic expenditure on R&D as the total expenditure (current and capital) on R&D carried out by all resident companies, research institutes, university and government laboratories, etc., in a country. It includes R&D funded from abroad but excludes domestic funds for R&D performed outside the domestic economy. We employed GEDR as a predictor of the technological content of exports.

Following the extant literature, we included the following control variables in these models: Foreign direct investment (inward flows), gross capital formation (percentage of GDP), and exchange rates (national currency per US dollar). Foreign direct investments allow countries to have access to new technologies to update the knowledge in the field in which the investment is made. The exchange rate is a means to stimulate exports. Gross capital formation is a proxy for investment in produced assets.

In Table 1, we summarize all variables computed in the econometric analysis.

| Variable | Description | Source |
|----------|-------------|--------|
| GDPC     | GDP per capita (USD) (It is used in logarithmic values) | UNCTAD |
| LTM      | Exports of low technology manufactures (thousands of USD) | UNCTAD |
| MTM      | Exports of medium technology manufactures (thousands of USD) | UNCTAD |
| HTM      | Exports of high technology manufactures (thousands of USD) | UNCTAD |
| FDI      | Foreign direct investments (inward flows) (mil. USD) | UNCTAD |
| GOV      | Total general government expenditure (percentage of GDP) | Eurostat |
| GERD PPP | GERD in Purchasing Power Parities | UNCTAD/OECD |
| IR       | Inflation Rate (%) | OECD Romanian Statistical Yearbook |
| GCP      | Gross capital formation (% of GDP) | The World Bank |
| ER       | Exchange rates (national currency per US dollar) | OECD |

We chose to conduct the econometric analysis using panel data, which are also referred to as longitudinal or cross-sectional time-series data, because this method [46,47]:
- Allowed us to monitor the changes occurring in given units over time;
- Is well suited for testing quite complicated economic behaviors;
- Controls individual heterogeneity;
- Offers a greater amount of information, an increased variability, a low probability of collinearity between variables, and multiple degrees of freedom; and
- Can lead to consistent estimates even with endogenous regressors, as long as they are only correlated with the time-constant component of error.

Also, the results of a panel analysis are more conclusive, since they provide the possibility to identify and measure effects that would not be detectable by analyzing cross-sectional data or time series.

This model has the following formula:

\[ y_{it} = \alpha + x_{it} \beta + \epsilon_{it} \quad i=1...N, t=1...T, \]  \hspace{1cm} (1)
where $i$ is the cross-sectional dimension and $t$ is the time dimension.

To estimate the data panel, firstly, we determined whether the regression was a panel model or a regular regression [48,49]; in other words, we tested the presence of individual effects. The next step was to decide which model is best: One with fixed effects or one with random effects. This decision can be made based on tests, economic reasons, and/or information criteria. For the fixed-effects model, the most commonly used estimator is the “within” estimator; for the model with random effects, the term $\alpha_i$ in the above relation is embedded in the error term and is assumed to be uncorrelated with the explanatory variables. Considering this, the following model is a model with random effects:

$$y_{it} = x_{it}^\prime \beta + u_{it} \quad i=1\ldots N, t=1\ldots T.$$  \hspace{1cm} (2)

To facilitate the interpretation of the coefficients of regression, we logarithmized the values of the variables. To identify the appropriate model, we used the Hausman test for the random effect model or fixed effect model [32].

4. Empirical Results and Discussions

4.1. Descriptive Statistics

Table 2 shows the descriptive statistics for the full balanced panel dataset with 5 countries and 95 country-time observations. The standard deviation of the selected variables indicates how diverse our sample is. The highest levels of LTM and MTM exports are found in Poland. Czech Republic has the highest value of HTM exports.

| Country  | Variable | Mean   | Median | Standard Deviation | Minimum | Maximum |
|----------|----------|--------|--------|--------------------|---------|---------|
| Czechia  | LTM      | 18,325,591 | 18,740,038 | 9,754,793          | 6,016,233 | 32,035,384 |
|          | MTM      | 40,267,725 | 41,160,686 | 25,329,091         | 7,954,888 | 77,009,991 |
|          | HTM      | 18,257,423 | 17,556,995 | 12,813,100         | 1,916,364 | 36,013,753 |
|          | GDPC     | 13,917    | 15,096   | 6,167              | 5,976    | 22,613   |
|          | GERD_PPP | 3,473,435 | 2,998,981 | 1,826,090          | 1,345,256 | 6,809,484 |
|          | FDI      | 5,321    | 5,462    | 3,101              | 465      | 11,653   |
|          | GOV      | 31.76    | 31.2     | 2.05               | 29.2     | 38.1     |
|          | IR       | 3.21     | 2.1      | 3.00               | 0.1      | 10.7     |
|          | ER       | 25.60    | 24.44    | 6.72               | 17.07    | 38.59    |
|          | GCF      | 29.16    | 29.16    | 2.69               | 24.66    | 35.59    |
| Hungary  | LTM      | 7,216,229 | 7,373,978 | 2,661,203          | 3,191,093 | 11,119,174 |
|          | MTM      | 26,478,579 | 27,793,954 | 15,235,028         | 3,290,776 | 49,606,937 |
|          | HTM      | 18,957,862 | 22,467,095 | 10,721,039         | 1,424,868 | 34,699,494 |
|          | GDPC     | 10,159   | 11,465   | 4,032              | 4,515    | 15,813   |
|          | GERD_PPP | 1,921,717 | 1,808,017 | 967,383            | 606,878  | 3,512,106 |
|          | FDI      | 3,360    | 3,402    | 5,523              | -14,797  | 14,409   |
|          | GOV      | 33.36    | 33.1     | 1.96               | 29.9     | 37.8     |
|          | IR       | 6.83     | 5.3      | 5.92               | -0.2     | 23.5     |
|          | ER       | 222.09   | 214.40   | 37.65              | 152.64   | 286.49   |
|          | GCF      | 24.18779 | 24.62473 | 2.768982           | 19,3343  | 28,71536 |
| Poland   | LTM      | 24,041,864 | 23,339,428 | 13,354,771         | 8,099,883 | 43,755,080 |
|          | MTM      | 41,015,938 | 43,702,134 | 27,379,306         | 6,069,710 | 77,440,368 |
|          | HTM      | 12,542,480 | 9,595,781 | 9,826,351          | 1,524,054 | 27,931,387 |
|          | GDPC     | 9,036    | 8,991    | 3,985              | 4,128    | 14,242   |
|                | GERD_PPP | FDI     | GOV    | IR     | ER     | GCF   |
|----------------|----------|---------|--------|--------|--------|-------|
|                | 4,714,296| 3,181,627| 2,795,190| 2,041,224| 10,139,887|       |

|                | FDI         | GOV         | IR           | ER           | GCF         |
|----------------|-------------|-------------|--------------|--------------|-------------|
|                | 10,109      | 26.30       | 4.72         | 3.39         | 21.66       |
|                | 10,039      | 25.9        | 3.5          | 3.25         | 20.99       |
|                | 4,892       | 3.21        | 5.37         | 0.52         | 2.27        |
|                | 2,734       | 22.8        | −0.9         | 2.40         | 18.44       |
|                | 19,836      | 37.6        | 19.9         | 4.34         | 25.46       |

|                | GERD_PPP     | FDI       | GOV     | IR     | ER     | GCF   |
|----------------|--------------|-----------|---------|--------|--------|-------|
|                | 724,463      | 2,183     | 29.19   | 4      | 1.02   | 27.03 |
|                | 509,800      | 2,274     | 27.9    | 3.6    | 0.98   | 27.05 |
|                | 42,6751      | 2,025     | 4.14    | 3.47   | 0.28   | 4.42  |
|                | 372,756      | −604      | 23.5    | −0.5   | 0.70   | 20.50 |
|                | 1,881,915    | 5,864     | 39.3    | 12     | 1.60   | 34.83 |

|                | Slovakia     | MTM      | HTM     | GDPC   | GERD_PPP |
|----------------|--------------|----------|---------|--------|----------|
| LTM            | 8,235,848    | 19,179,379| 7,846,265| 11,064| 724,463  |
|                | 8,218,647    | 16,920,878| 6,419,914| 10,574| 509,800  |
|                | 4,552,151    | 13,443,809| 6,825,844| 6,106 | 42,6751  |
|                | 1,740,456    | 2,868,641 | 388,811  | 3,830 | 372,756  |
|                | 14,371,907   | 38,618,333| 17,683,039| 18,580| 1,881,915|

|                | Romania      | MTM       | HTM     | GDPC   | GERD_PPP   |
|----------------|--------------|----------|---------|--------|------------|
| LTM            | 9,418,427    | 12,627,414| 3,029,381| 5,706 | 1,198,140  |
|                | 10,925,615   | 10,433,674| 1,858,049| 5,815 | 1,117,870  |
|                | 3,626,688    | 10,295,545| 2,601,860| 3,475 | 577,338   |
|                | 3,735,848    | 1,618,233 | 209,895  | 1,583 | 480,701   |
|                | 13,738,798   | 28,731,087| 7,695,762| 10,259| 2,189,340  |

|                | FDI     | GOV    | IR     | ER     | GCF   |
|----------------|--------|--------|--------|--------|-------|
|                | 4,077  | 26.2   | 22.8   | 2.69   | 24.44 |
|                | 3,198  | 25.8   | 7.9    | 3.04   | 24.21 |
|                | 3,532  | 1.66   | 35.04  | 1.03   | 4.05  |
|                | 263    | 23.5   | −1.5   | 0.30   | 15.64 |
|                | 13,491 | 29.5   | 154.8  | 4.059  | 33.09 |

Source: Research results.

Regarding exports, we noticed significant differences between categories, but also inter-countries and in-time differences. The central tendency, however, was to focus on more sophisticated exports in terms of technological content. Thus, the value of MTM exports in all selected countries was visible, with the Czech Republic noticing an average value of 40,742,898 thousands of US dollars; however, the standard deviations indicate scattered distributions of the values of this variable. The highest value of these exports was noted in the case of the Czech Republic (84,167,337 thousands of US dollars) in 2017, and the lowest level was found in Romania (1,618,233 thousands of US dollars) in 1998.

In the V4 countries, the trend of MTM export orientation is stronger than in Romania, where the LTM exports continued to occupy an important position on the export agenda, a situation also highlighted by the value of the standard deviation indicating a relatively normal distribution. However, the maximum level of this variable was registered in Poland (49,377,748 thousands of US dollars) in 2017, and the lowest level was noted in Slovakia (1,740,455 thousands of US dollars) in 1996.

HTM exports still hold a relatively modest position in the exports of each selected country, with Hungary and the Czech Republic having the best performance in this direction (18,521,116 thousands of US dollars and 18,315,961 thousands of US dollars, respectively). For all the selected countries, the standard deviations indicate quite dispersed distributions of the values of this variable, reflecting relatively sinuous evolutions. The highest value of HTM exports was in the Czech Republic (36,076,299 thousands of US dollars) in 2017, and the lowest level was noted in Romania (198,013 thousands of US dollars) in 1995.

We also noticed significant in-time and inter-country differences regarding economic growth.
The economic dynamics, quantified by GDPC, was uneven. Of all the selected countries, the Czech Republic stands out for the highest average level of GDPC; in this case, the standard deviation indicates a somewhat normal distribution of values, the tendency of growth being, therefore, somewhat constant. Poland, Hungary, and Slovakia also performed better in the analyzed group, although the growth trend was relatively sinuous. The highest level of GDPC was noted in the Czech Republic (US $ 22,614) in 2008, and the lowest level was recorded in Romania (US $ 1,583) in 1997. In 2009, GDPC decreased compared to the previous year in all selected countries, mainly as a consequence of the economic crisis.

Regarding the evolution of R&D expenditures, measured by GERD, there are also differences from one country to another and over time. Regarding the central tendency, in Poland, it was more evident than in the other selected countries (4,714,296 thousand PPP USD). The most modest results in this respect were recorded by Romania (1,198,140 thousand PPP USD) and Slovakia (724,463 thousand PPP USD). Standard deviations indicate scattered distributions of the values of this variable in all selected cases. The maximum level during the analyzed period was noted in Poland (10,139,887 thousand PPP USD) in 2015, and the most modest level was Slovakia (372,756 thousand PPP USD) in 1999.

In the above correlation matrix (Table 3), we can observe high positive values of the coefficients related to the categories of exports and the R&D expenditure, respectively, the economic performance expressed through the GDP per capita. However, we identified no problems regarding multicollinearity.

|        | GCF | ER  | IR  | GOV | FDI | GERD PPP | GDPC |
|--------|-----|-----|-----|-----|-----|----------|------|
| LTM    | -0.25 | -0.29 | -0.29 | -0.36 | 0.56 | 0.91     | 0.61 |
| MTM    | -0.25 | -0.01 | -0.38 | -0.11 | 0.38 | 0.86     | 0.82 |
| HTM    | -0.24 | 0.32  | -0.33 | 0.18  | 0.19 | 0.67     | 0.85 |
| GDPC   | -0.05 | 0.03  | -0.44 | 0.05  | 0.13 | 0.50     | 1.00 |
| GERD PPP | -0.29 | -0.08 | -0.27 | -0.18 | 0.48 | 1.00     |      |
| FDI    | -0.07 | -0.21 | -0.17 | -0.29 | 1.00 |          |      |
| GOV    | 0.34  | 0.53  | -0.16 | 1.00  |     |          |      |
| IR     | -0.20 | -0.07 | 1.00  |      |     |          |      |
| ER     | -0.08 | 1.00  |      |      |     |          |      |

4.2. Estimation Results

Following the introduction of the variables, we now turn to the empirical linkages between each category of manufactures (according to the Lall classification) and economic dynamics. To facilitate the interpretation of the results, the values of the variables were logged.

Since a number of observations for the absolute change of GDPC and the absolute change of the values of each category of exports are negative, we transformed the variables using the following method:

\[ X' = \text{sign}(X) \times \ln(\text{abs}(X)) \].

In order to characterize comparatively the influence of each category of manufacturers (according to the Lall classification) exported by Romania and economies from V4 on their economic dynamics, we estimated the following econometric models. The analysis was performed through the functionalities of the EViews software.

In order to estimate the differences among the selected countries in terms of how technology influences economic growth, we interacted the key explanatory variables with country dummies, using the special expression reference @expand from Eviews.

In all the three regression models, the control variables did not lead to statistically significant regression coefficients.

However, if we analyzed the coefficients for the Lall export categories, for each selected economy, we found significant positive coefficients (Table 4).
Table 4. The results of the econometric analysis of the influence of the export structure on the
economic dynamics.

| Dependent variable: The absolute change of GDP per capita | Model 1.1 | Model 1.2 | Model 1.3 |
|----------------------------------------------------------|----------|----------|----------|
| **Independent variables**                                | Coefficients/Standard error/Significance level | Coefficients/Standard error/Significance level | Coefficients/Standard error/Significance level |
| Key explanatory variable: LMT                           |          |          |          |
| Czechia                                                  | 0.42 (0.04) *** | 0.38 (0.05) *** | 0.30 (0.07) *** |
| Hungary                                                  | 0.53 (0.05) *** | 0.45 (0.06) *** | 0.31 (0.07) *** |
| Poland                                                   | 0.39 (0.04) *** | 0.39 (0.05) *** | 0.37 (0.07) *** |
| Slovakia                                                 | 0.47 (0.05) *** | 0.39 (0.06) *** | 0.37 (0.08) *** |
| Romania                                                  | 0.41 (0.05) *** | 0.35 (0.06) *** | 0.34 (0.09) *** |
| Constant                                                 | 11.40 (9.10) | 15.48 (11.35) | 5.723 (13.28) |

| Model 1.2 highlights the positive influence of MTM exports on economic growth and differences among selected countries. We found that a 1% increase of the absolute change of MTMs exports led to an average growth of GDP per capita of 0.45% in Hungary, 0.39% in Poland and Slovakia, 0.38% in Czechia, and 0.35% in Romania. Approximately 64% of the variance of the dependent variable (GDP per capita) could be explained by the variation of the predictor variables.

Comparing the economic performance of the selected countries under the influence of the predictive variable LTMs (model 1.1), we found that there were significant differences among the selected countries in terms of how the exports of low-technology manufacturers influenced the economic growth. The group’s performers are Hungary and Slovakia, with results above the group average. Poland and Romania are at the opposite pole. In addition, empirical estimation showed that about 76% of the variation of the dependent variable could be explained by the variation of the LTMs exports.

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Considering the coefficients of country dummy variables, we can see that there were significant differences within the sample of selected countries. Under the influence of MTMs exports, Hungary gained better economic results than the other selected countries.

Regarding the HTMs exports (model 1.3), we found that in Poland and Slovakia, these exports had a greater influence on economic growth: A 1% increase of absolute change in the exports of HTMs induced an average growth of GDP per capita of 0.37%. This model has a coefficient of determination of 0.43, meaning that the variation of the predictor variables could explain about 43% of the variation of the dependent variable (GDP per capita).

As we expected, the total general government expenditure (as a percentage of the GDP) and the inflation rate had a significant negative impact on the GDP per capita while FDI (foreign direct investments) had an almost negligible impact on GDP per capita.

In addition, the findings of these models corroborated with some of the results of the descriptive analysis suggest that MTMs and HTMs exports have greater growth potential than LTMs exports.

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In addition, the findings of these models corroborated with some of the results of the descriptive analysis suggest that MTMs and HTMs exports have greater growth potential than LTMs exports.

The overall estimation results confirm the hypothesis that there were significant differences among selected countries in terms of how the export of manufacturers with different technological content influences economic growth. These results agree with previous findings on different samples of countries and period, showing that that a different export composition has different implications for growth [12,13,43].

Significance test: *p<0.10, **p<0.05, ***p<0.01.
To illustrate comparatively the influence of GERD on the export of each category of manufacturers in Romania and V4 economies, we estimated the following econometric models. We applied the Hausman test to identify the optimal model (the model with fixed effects or the model with random effects). The overall results are summarized in the table 5.

Table 5. The results of the econometric estimation of the impact of R&D expenditure on the structure of export.

| Independent variables | Model 2.1 Dependent variable: LTM | Model 2.2 Dependent variable: MTM | Model 2.3 Dependent variable: HTM |
|-----------------------|-----------------------------------|-----------------------------------|-----------------------------------|
|                       | Coefficients/Standard error/Significance level | Coefficients/Standard error/Significance level | Coefficients/Standard error/Significance level |
|                       | GERD PPP                             |                                   |                                   |
|                       | Czechia 16.35 (2.01) ***             | 21.02 (2.85) ***                  | 26.30 (3.62) ***                  |
|                       | Hungary 9.69 (1.83) ***             | 17.11 (2.61) ***                  | 18.32 (3.97) ***                  |
|                       | Poland 15.69 (1.84) ***             | 21.52 (2.63) ***                  | 25.44 (3.65) ***                  |
|                       | Slovakia 13.60 (2.09) ***           | 18.65 (2.98) ***                  | 28.95 (4.13) ***                  |
|                       | Romania 10.77 (2.12) ***            | 29.28 (3.01) ***                  | 29.36 (4.18) ***                  |
|                       | FDI 0.01 (0.01)                     | 0.01 (0.01)                       | 0.03 (0.02) *                     |
|                       | GCP −0.38 (0.31)                    | −0.79 (0.44)*                     | −1.22 (0.61) **                   |
|                       | Exchange rate 0.03 (0.09)           | 0.16 (0.13)                       | 0.31 (0.18) *                     |
|                       | Constant −18.07 (2.78) ***          | −38.48 (3.9) ***                  | −49.62 (5.51) ***                 |
| Observations          | 105                                 | 105                               | 105                               |
| R-squared             | 0.85                                | 0.85                              | 0.84                              |
| F-statistic           | 45.14                               | 46.31                             | 40.51                             |
| Type of model         | Fixed effect model                  | Fixed effect model                | Fixed effect model                |

Significance test: *p<0.10, **p<0.05, ***p<0.01.

The fixed effects models best described the impact of GERD on all selected categories of exports and all models have statistical significance for the F-statistics.

The model 2.1 highlighted the influence of GERD on the variation of LTM exports and a significant difference in the variability of the LTM exports among the selected countries. In Czech Republic and Poland, the influence of GERD on LTM exports was greater than in the other selected economies. In addition, the variation of the GERD and all the control variables could explain approximately 85% of the variation of the LTM, as a dependent variable.

The second model (2.2) outlined a significant influence of the predictor GERD on MTM exports and found different effects in the selected economies. As we previously noted, MTM manufactures are the heartland of industrial activity in mature economies. A comparison among Romania and the V4 economies revealed relatively higher differences. In Romania, GERD had a greater influence on MTM exports than in V4 economies. Hungary gained modest results in this direction. The coefficient of determination of 0.85 suggests that approximately 85% of the variation of MTM, as a dependent variable, could be explained by the variation of the GERD.

In the third model, we focused on HTM exports, as a dependent variable. We found that in all selected economies, GERD has a significant influence on HTM. Consequently, we found significant differences among the selected countries regarding the way in which R&D expenditures influenced the exports of high-technology manufacturers. In Romania, this influence was greater than in the other selected economies. Among the V4 economies, Slovakia gained the greatest results. The comparative analysis of the coefficients of the country dummy revealed higher differences between Romania and Hungary. Further, this model resulted in a coefficient of determination of 0.84, meaning that about 84% of the variation of the HTM could be explained by the variation of GERD.

Among the control variables, the gross capital formation had a significant influence on the technological content of exports.

In addition, the findings of these models suggest that R&D expenditure had a greater influence on MTM and HTM exports in all the selected countries. These results agree with previous findings.
on different samples of countries and period, showing that that R&D activity can influence exports of more sophisticated manufacturers [13,38].

Thus, the overall estimation results sustain hypothesis 2 that R&D expenditure has a greater influence on the sophistication of exports and there are significant differences among the selected countries in terms of how R&D expenditure influences the technological content of exports.

5. Conclusions

A vast body of literature agrees on the crucial role of exports in economic growth. Considering the assumption that exports that are more sophisticated have greater growth potential and R&D is an important driver of a country’s specialization in production and trade, the focus of this paper was on the influence of the composition of exports on economic dynamics in Romania and the countries of the Visegrad group. This paper aimed to explore the relative importance of exports with different technological contents on economic growth in Romania and V4 economies, considering R&D expenditure as an important input that could shape the country’s specialization in production and trade.

Summing up the results, we can conclude that the composition of exports exerted a significant influence on economic growth in all selected economies. Each type of exports, according to the Lall classification, had different effects on economic growth in the selected countries, mostly explainable by country-specific factors.

Comparing the economic performances in the selected economies under the influence of predictive variables (and control variables too), we found that during the period 1995–2017, LTM exports had the greatest influence on economic growth in the selected economies. The estimation results highlighted significant differences among the selected economies regarding the variability of GDP per capita under the influence of LTMs, MTMs, and HTMs.

In addition, the overall results of the empirical models and descriptive analysis highlighted that MTMs and HTMs exports have greater growth potential than LTMs exports in all the selected economies. Further, we found better growth performances under the influence of HTMs in Hungary, while under the influence of MTMs exports, Poland, Slovakia, and Romania gained better economic results than the other three selected countries.

An interesting finding revealed that although HTMs exports still have the smallest share in the total value of exports (Figure 1), their influence on GDP per capita is comparable to that of MTM. This would be an eloquent answer to the following question: “Does what countries export matter?”. Additionally, this finding may raise questions on the efficiency of resource allocation and exploitation in the manufacturing sectors in the selected economies.

The overall results outlined that R&D expenditures, as the main input in innovation, can pattern the technological content of exports. The findings of empirical models suggest that R&D expenditure had a greater influence on MTMs and HTMs exports in all selected countries. Additionally, we found significant differences among the selected countries in how R&D expenditure influenced the composition of exports. A comparison among Romania and the V4 economies revealed different effects of GERD on the technological content of exports. In Romania, we found better results of MTMs and HTMs under the influence of GERD. In addition, we noted a higher influence of GERD on HTMs than on MTMs in V4 economies.

Romania and the economies from the V4 group are still tributaries to the industrialization model on which their development has been based for decades during the post-war period. The composition of exports and the specialization of production predominantly on products with low or medium technological content still reflect the inherited model of industrialization. Consequently, industrial policies and trade policies should be oriented towards restructuring and supporting industries with more sophisticated outputs and higher growth potential, even if the sources of the comparative advantage (cheaper labor, abundance of resources, etc.) would rather advocate a specialization in LTM products and eventually MTM. In this respect, innovation and R&D investments could support, on the one hand, more efficient exploitation of the existing comparative advantages and, on the other hand, the creation of new sources of a comparative advantage in more sophisticated industries.
These findings provide a good starting point for discussion and further research. Firstly, future studies should aim to replicate the results in a larger sample of cases. In addition, several other questions could be very challenging. Does the presence of MNCs in LTM sectors tend to “preserve” the pattern of the manufacturing industry and, implicitly, that of the exports, “condemning” the selected countries to a specialization in sectors with more modest growth potential? Can the tendency of premature deindustrialization combined with a pattern of international specialization with lower growth potential affect future economic dynamics? In the absence of firm commitments on environmental standards, can the specialization model on LTM and MTM jeopardize sustainable development? Could we avoid or escape “the middle-income trap” by developing macroeconomic policies and strategies aimed at stimulating HTMs sectors and creating new sources of competitive advantage through R&D and innovation?

**Appendix 1.** Low technology, medium technology and high technology manufactures. (Lall classification).

| Low technology manufactures: textile, garment and footwear | Medium technology manufactures: engineering |
|-----------------------------------------------------------|-------------------------------------------|
| Leather                                                   | Vapour generating boilers, auxiliary plant; parts |
| Manufactures of leather, n.e.s.; saddlery & harness       | Internal combustion piston engines, parts, n.e.s. |
| Furskins, tanned or dressed, excluding those of 8483      | Engines & motors, non-electric; parts, n.e.s. |
| Textile yarn                                              | Agricultural machinery (excluding tractors) & parts |
| Cotton fabrics, woven                                     | Tractors (excluding those of 71414 & 74415) |
| Other textile fabrics, woven                              | Civil engineering & contractors’ plant & equipment |
| Knitted or crocheted fabrics, n.e.s.                      | Textile & leather machinery, & parts thereof, n.e.s. |
| Tulles, trimmings, lace, ribbons & other small wares      | Paper mill, pulp mill machinery; paper articles man. |
| Special yarn, special textile fabrics & related           | Printing & bookbinding machinery, & parts thereof |
| Made-up articles, of textile materials, n.e.s.            | Heating & cooling equipment & parts thereof, n.e.s. |
| Floor coverings, etc.                                     | Pumps for liquids |
| Travel goods, handbags & similar containers               | Pumps (excluding liquid), gas compressors & fans; centr. |
| Men’s clothing of textile fabrics, not knitted            | Mechanical handling equipment, & parts, n.e.s. |
| Women’s clothing, of textile fabrics                      | Other non-elec. machinery, tools & mech. appar. |
| Men’s or boy’s clothing, of textile, knitted, croche.     | Ball or roller bearings |
| Women’s clothing, of textile, knitted or crocheted        | Appliances for pipes, boiler shells, tanks, vats, etc. |
| Articles of apparel, of textile fabrics, n.e.s.            | Transmis. shafts |
| Clothing accessories, of textile fabrics                  | Non-electric parts & accessor. of machinery, n.e.s. |
| Articles of apparel, clothing access., excluding textile  | Radio-broadcast receivers, whether or not combined |
| Footwear                                                  | Sound recorders or reproducers |
| Low technology manufactures: other products                | Apparatus for electrical circuits; board, panels |
| Paper & paperboard, cut to shape or size, articles        | Equipment for distributing electricity, n.e.s. |
| Glassware                                                 | Household type equipment, electrical or not, n.e.s. |
| Pottery                                                   | Ships, boats & floating structures |
| Flat-rolled prod., iron, non-alloy steel, not coated      | Prefabricated buildings |
| Flat-rolled prod., iron, non-alloy steel, coated, clad     | Sanitary, plumbing, heating fixtures, fittings, n.e.s. |
| Flat-rolled products of alloy steel                       | Lighting fixtures & fittings, n.e.s. |
| Iron & steel bars, rods, angles, shapes & sections        | Instruments & appliances, n.e.s., for medical, etc. |
| Rails & railway track construction mat., iron, steel      | Meters & counters, n.e.s. |
| Wire of iron or steel                                     | Optical goods, n.e.s. |
| Structures & parts, n.e.s., of iron, steel, aluminium     | Watches & clocks |
| Metal containers for storage or transport                 | Arms & ammunition |
| Wire products (excluding electrical) and fencing grills    | High technology manufactures: electronic and electrical |
| **Nails, screws, nuts, bolts, rivets & the like, of metal** | **Rotating electric plant & parts thereof, n.e.s.** |
| **Tools for use in the hand or in machine** | **Other power generating machinery & parts, n.e.s.** |
| **Cutlery** | **Office machines** |
| **Household equipment of base metal, n.e.s.** | **Automatic data processing machines, n.e.s.** |
| **Manufactures of base metal, n.e.s.** | **Parts, accessories for machines of groups 751, 752** |
| **Furniture & parts** | **Television receivers, whether or not combined** |
| **Articles, n.e.s., of plastics** | **Telecommunication equipment, n.e.s.; & parts, n.e.s.** |
| **Baby carriages, toys, games & sporting goods** | **Electric power machinery, and parts thereof** |
| **Office & stationery supplies, n.e.s.** | **Electro-diagnostic appa. for medical sciences, etc.** |
| **Jewellery & articles of precious materia., n.e.s.** | **Cathode valves & tubes** |
| **Musical instruments, parts; records, tapes & similar** | **Electrical machinery & apparatus, n.e.s.** |
| **Miscellaneous manufactured articles, n.e.s.** | **High technology manufactures: other** |
| **Medium technology manufactures: automotive** | **Radio-actives and associated materials** |
| **Motor vehicles for the transport of persons** | **Medicinal and pharmaceutical products, excluding 542** |
| **Motor vehic. for transport of goods, special purpo.** | **Medicaments (incl. veterinary medicaments)** |
| **Road motor vehicles, n.e.s.** | **Steam turbines & other vapour turbin., parts, n.e.s.** |
| **Parts & accessories of vehicles of 722, 781, 782, 783** | **Aircraft & associated equipment; spacecraft, etc.** |
| **Motorcycles & cycles** | **Optical instruments & apparatus, n.e.s.** |
| | **Measuring, analysing & controlling apparatus, n.e.s.** |
| | **Photographic apparatus & equipment, n.e.s.** |
| | **Unclassified products (Lall classification)** |
| | **Electric current** |
| | **Cinematograph films, exposed & developed** |
| | **Printed matter** |
| | **Works of art, collectors’ pieces & antiques** |
| | **Coin (other than gold coin), not being legal tender** |
| | **Gold, non-monetary (excluding gold ores and concentrates)** |

Source: UNCTAD.

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