РОЗДІЛ V
Підприємництво, торгівля та біржова діяльність

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MODELLING THE RELATIONSHIP BETWEEN RETAIL DEVELOPMENT AND ECONOMIC INDICATORS IN EUROPEAN COUNTRIES

Abstract. The modern global market requires extraordinary attention to the development of retail trade, which is not only the face of the economy of countries, but also plays a key role in promoting their economic prosperity. In this context, understanding the relationship between retail development indicators and indicators of the state of the economy is necessary given the importance of retail trade as one of the key elements of economic systems and is an important task for scientists and economists. Highlighting the relationship between retail trade and the state of the economy of European countries opens up opportunities for understanding and predicting economic and social trends on the path of Ukraine's accession to the EU, and promotes entrepreneurship. This study aims to model the relationship and establish statistically significant dependencies between the development of retail trade and the economic development of European countries, and to identify indicators that have an impact on the development of the industry. The study established a statistically significant impact of economic growth characteristics on the development of the retail trade industry in European countries in 2005-2022. In particular, it has been determined that the volume of trade turnover depends on such indicators as GDP per capita, consumer inflation and unemployment in the economy. The number of retailers is influenced by the volume of high-tech exports and the Gini index, which measures income inequality in the country. The number of employees in the industry depends on consumer inflation, unemployment and the Gini index. The share of income that is invested in the operating activities of the industry's enterprises depends on the level of consumer inflation, unemployment, the share of research and development expenditures in GDP and GDP per capita. GDP per capita has the strongest positive effect on turnover and consumer inflation on turnover. The unemployment rate has the strongest negative impact on turnover and the number of employees in the industry. The study confirmed the hypothesis about the positive impact of economic development on the retail industry in European countries. An economic system that promotes investment in research and development, aims to reduce unemployment and increase economic efficiency, plays a key role in the development of the retail industry in European countries. Given this, future research should focus on other factors that may influence the development of the retail industry in order to better understand the processes taking place in this area and to develop more accurate and effective strategies to promote its sustainable growth.

Keywords: retail trade, economic development, international relations, market analysis, modelling.

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МОДЕЛЮВАННЯ ВЗАЄМОЗВ'ЯЗКУ МІЖ РОЗВИТКОМ РОЗДРІБНОЇ ТОРГІВЛІ ТА ЕКОНОМІЧНИМИ ПОКАЗНИКАМИ В ЄВРОПЕЙСЬКИХ КРАЇНАХ

Анотація. Сучасний глобальний ринок вимагає надзвичайної уваги до розвитку роздрібної торгівлі, яка є не лише обличчям економіки країн, а й відіграє ключову роль у забезпеченні їх економічного процвітання. У цьому контексті розуміння взаємозв'язку між показниками розвитку роздрібної торгівлі та індикаторами стану економіки є необхідним з огляду на важливість роздрібної торгівлі як одного з ключових елементів економічних систем і є важливим завданням для науковців та економістів. Висвітлення взаємозв'язку між роздрібною торгівлею та станом економіки європейських країн відкриває можливості для розуміння та прогнозування економічних та соціальних тенденцій на шляху вступу України до ЄС, а також сприяє розвитку підприємництва. Метою даного дослідження є моделювання взаємозв'язку та встановлення статистично значущих залежностей між розвитком роздрібної торгівлі та економічним розвитком європейських країн, а також виявлення показників, які мають вплив на розвиток галузі. В статті встановлено статистично значущий вплив характеристик економічного зростання на розвиток галузі роздрібної торгівлі в європейських країнах у 2005-2022 роках. Зокрема, визначено, що обсяг товарообороту залежить від таких показників, як ВВП на душу населення, споживча інфляція та рівень безробіття в економіці. На кількість підприємств роздрібної торгівлі впливає обсяг високотехнологічного експорту та індекс Джині, який вимірює нерівність доходів у країні. Кількість працівників у галузі залежить від споживчої інфляції, рівня безробіття та індексу Джині. Частка доходу, яка інвестується в операційну діяльність підприємств галузі, залежить від рівня споживчої інфляції, безробіття, частки витрат на дослідження та розробки у ВВП та ВВП на душу населення. ВВП на душу населення має найсильніший позитивний вплив на товарооборот, а споживча інфляція - на товарооборот. Рівень безробіття має найсильніший негативний вплив на товарообіг та кількість працівників у галузі. Дослідження підтвердило гіпотезу про позитивний вплив економічного розвитку на роздрібну торгівлю в європейських країнах. Економічна система, яка сприяє інвестиціям у дослідження та розробки, спрямована на зниження рівня безробіття та підвищення економічної ефективності, відіграє ключову роль у розвитку галузі роздрібної торгівлі в європейських країнах. З огляду на це, майбутні дослідження мають бути зосереджені на інших факторах, які можуть впливати на розвиток галузі роздрібної торгівлі, з метою кращого розуміння процесів, що відбуваються в цій сфері, та розробки більш точних і ефективних стратегій сприяння її сталому зростанню.

Ключові слова: роздрібна торгівля, економічний розвиток, міжнародні зв’язки, аналіз ринку, моделювання.

Problem statement and its significance. Ukraine is currently engaged in a devastating war that has severely damaged its economy and infrastructure. As the country looks to rebuild and recover, identifying new sources of economic growth and global competitiveness will be critical. Retail trade represents a major component of Ukraine's GDP, accounting for over 10% of total economic output. With the right policies and strategies, the continued development of Ukraine's retail sector could provide an important boost to the economy during this difficult period. Specifically, retail growth and modernization would create new jobs, increase worker productivity, bring in tax revenues for the government, attract foreign investment, and promote innovation and entrepreneurship. A stronger retail industry could also enable Ukraine to better integrate with the economies of Europe as it pursues membership in the European Union. However, realizing these benefits will require a detailed understanding of the key factors and indicators influencing the performance of Ukraine's retail trade. The development of an innovative, thriving retail industry would not only benefit Ukraine economically, but could also signal that the country remains open for business on the

global stage even amidst the devastating war.

Analysis of recent research and publications. This topic has been the subject of many works by both Ukrainian and international scientists. Thus, the current state of trade and key indicators were studied: the number of business entities in the market, regional and commodity structure of retail turnover [1], global trends in the development of e-commerce and key differences between modern e-commerce and the traditional concept of retail trade [2], the state of trade enterprises in the context of aggravating socio-political challenges, in particular, the COVID-19 pandemic and the full-scale war of the Russian Federation against Ukraine [3]. A clustering of European countries was developed according to factors such as: educational factors, income characteristics and indicators of income inequality (Gini coefficients), urbanisation factors, indicators reflecting the functioning of the healthcare system, quality of life factors and the impact of the (negative) environment [4]. Researchers have also modelled financial markets using mixed-effects models [5], and studied and modelled the Slovak retail market [6].

In the context of using panel data, the relationship between stock market development and environmental quality has been studied [7], the impact of product and labour market legislation on unemployment [8], the impact of logistics efficiency on energy and environmental economic indicators in Europe [9], and the relationship between indicators of economic transformation and insurance density and penetration [10].

Based on the construction of mathematical models, researchers have investigated the relationship between industry sales and disposable personal income and consumer sentiment, and found a significant negative relationship between industry sales and consumer debt burden [11]. It has also been determined that the transition to efficient electronic retail payments stimulates overall economic growth, consumption and trade [12]; the efficiency of the retail system changes at different rates in different countries and this can be explained by the country's population density, average store size within the country, the ratio of foreign trade, concentration, economic freedom and the percentage of urban population [13]. In addition, the impact of foreign direct investment in the retail sector has been studied [14].

Thus, the issue of studying the indicators of influence on retail trade is relevant, and this article is a natural continuation in this direction, and the dependence of retail trade development on the state of the economy in terms of individual indicators is not sufficiently studied.

Purpose and tasks of the article. The purpose of this study is to model the relationship and establish statistically significant dependencies between the development of retail trade and the economic development of European countries, and to identify indicators that have an impact on the development of the industry. The objectives of the study are as follows:

1) building a linear least-squares model, a model with fixed and random effects and selecting the best one to establish the relationship between the retail industry and the economic development of European countries

2) determining the impact of economic development indicators on the retail trade industry in European countries based on the assessment of statistical significance of the obtained results.

The hypothesis for the study is that the economic development of European countries has a positive impact on the development of the retail industry.

This influence can be manifested through:

1. Growth of household incomes. The economic development of European countries is leading to an increase in household incomes, which encourages people to spend more money on goods and services. Retail trade is the main mechanism that satisfies consumer demand. Increased demand fuels the development of retail trade, as retailers need more sales to meet demand.

2. Increased investment. The economic development of European countries attracts investments that contribute to the development of retail trade. Foreign investors, wishing to benefit from the growing consumer market, invest in retail by creating new stores, shopping centres and developing existing businesses. This leads to increased competition and a wider range of goods and services in the retail sector.

3. Growth of tourist flow. Economically developed countries in Europe are often popular tourist destinations. The increase in tourist flow brings significant profits to retailers. Tourists spend money on gifts, souvenirs, clothing, food, and other goods and services during their trips. This contributes to the growth of

retail sales and the development of the industry.

4. Attracting innovations. The economic development of European countries is usually accompanied by the introduction of new technologies and innovations. This has an impact on the retail sector, as businesses become more efficient, introduce new management methods, improve their supply chain, and offer new products and services. Innovations help to attract customers, increase competitiveness and grow retailers.

5. Employment growth. Retail development depends on the availability of consumers and labour. Economic growth in Europe is driving employment growth as higher incomes and higher living standards encourage retailers to increase staff, hire new employees and create new jobs.

Results. The study was conducted on the basis of collected and processed aggregate statistical data for 2005-2022 on the retail industry and the economic situation in European countries (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Ireland, Italy, Latvia, Lithuania, Luxembourg, Malta, the Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland, the United Kingdom) from the European Commission databases [16] and World Development Indicators [17] and divided into several stages:

1. Collection and analysis of aggregated statistical data on the development of the retail industry and economic indicators of European countries.

2. Identification of indicators that will be used to measure the development of the retail sector and the economic development of countries. The indicators are divided into two groups: indicators related to retail trade and indicators reflecting economic development.

3. Reconnaissance data analysis to determine the structure, format, distribution, anomalies and features of the data, and to process and clean it before modelling.

4. Building OLS, Country-Specific Fixed Effects and Random models for each dependent variable and selecting the model that best describes the relationship between the retail industry and economic development of European countries.

5. Identification of the impact of economic development indicators on the retail trade industry in European countries based on the assessment of statistical significance of the results obtained.

Eurostat is the official statistical body of the European Union, which provides statistical data on the state of the European economy. From the databases of this organisation [16], 11 indicators on the development of retail trade in Europe were selected (Table 1).

Table 1

Variables reflecting the state of retail trade in Europe

Variable code	Variable name
IDT	Index of deflated turnover
HOWK	Volume of work done (hours worked)
WAGE	Gross wages and salaries
ENO	Enterprises – number
PRV	Production value – million euro
VAF	Value added at factor cost – million euro
TPGS	Total purchases of goods and services – million euro
CSGS	Change in stocks of goods and services – million euro
PC	Personnel costs – million euro
PEN	Employment (number of persons employed)
IR	Investment rate (investment/value added at factors cost) – percentage

Source: compiled by the authors.

The World Bank is an international financial organization that provides data and analytical information on the economic development of countries around the world. From the database of this organization [17], 15 macroeconomic indicators of European countries were selected (Table 2).

Table 2

Variables reflecting the state of the economy in European countries

Variable code	Variable name
GDPPC	GDP per capita
FDI	Foreign direct investment
HCI	Human capital index (HCI)
LIFE	Life expectancy at birth
CPI	Consumer price index
INF	Inflation, consumer prices
UNEMP	Unemployment
EXP	Exports of goods and services
HTEXP	High–technology exports
SEXP	Service exports
SIMP	Service imports
IMP	Imports of goods and services
GINI	Gini index
RDE	Research and development expenditure
EXTT	External trade of goods and services

Source: compiled by the authors.

The problem of the obtained dataset is the presence of missing data, so the authors removed the data on Human Capital Index, foreign direct investment and inflation for all countries, as well as data on countries such as Bosnia and Herzegovina, Montenegro, North Macedonia, Albania, Serbia, Turkey and Iceland, as they contained little information, and reduced the number of missing data to 10.3% and considered updated information on the missing data using the visdat library of the R programming language. Missing data were imputed using the "pmm" method, i.e. predictive mean matching, a popular imputation method.

With the complete data set, we conducted an exploratory data analysis, the results of which are presented in Fig. 1.

```
Country             CountryN          Year            IDT              HOWK
 Length:540         Min.   : 1.0   Min.   :2005   Min.   : 22.40   Min.   : 49.90
 Class :character   1st Qu.: 8.0   1st Qu.:2009   1st Qu.: 94.35   1st Qu.: 98.28
 Mode  :character   Median :15.5   Median :2014   Median :101.15   Median :100.66
                    Mean   :15.5   Mean   :2014   Mean   :102.07   Mean   :100.66
                    3rd Qu.:23.0   3rd Qu.:2018   3rd Qu.:109.60   3rd Qu.:103.72
                    Max.   :30.0   Max.   :2022   Max.   :171.00   Max.   :142.60
      WAGE              ENO              PRV              VAF              TPGS
 Min.   : 45.2   Min.   :  2974   Min.   :   398.6   Min.   :   232.5   Min.   :  1494
 1st Qu.: 93.9   1st Qu.: 19587   1st Qu.:  4500.0   1st Qu.:  2095.1   1st Qu.: 13610
 Median :105.1   Median : 81039   Median : 14285.8   Median :  8019.6   Median : 40593
 Mean   :105.8   Mean   :123470   Mean   : 30179.2   Mean   : 16909.2   Mean   : 78965
 3rd Qu.:111.0   3rd Qu.:128811   3rd Qu.: 30179.2   3rd Qu.: 16909.2   3rd Qu.: 78965
 Max.   :313.6   Max.   :698731   Max.   :236852.9   Max.   :132642.9   Max.   :551076
      CSGS               PC               PEN              IR             GDPPC
 Min.   :-2753.1   Min.   :  119.2   Min.   : 75.5   Min.   : 4.70   Min.   :3900
 1st Qu.:   70.5   1st Qu.: 1259.2   1st Qu.: 97.2   1st Qu.:11.18   1st Qu.:18095
 Median :  258.5   Median : 5522.9   Median :100.0   Median :16.39   Median :36195
 Mean   :  258.5   Mean   :11075.7   Mean   :100.5   Mean   :16.39   Mean   :37613
 3rd Qu.:  258.5   3rd Qu.:11075.7   3rd Qu.:103.5   3rd Qu.:16.82   3rd Qu.:49916
 Max.   : 5847.1   Max.   :87087.7   Max.   :134.0   Max.   :76.70   Max.   :133590
      LIFE             CPI             UNEMP             EXP              HTEXP
 Min.   :70.87   Min.   : 72.14   Min.   : 2.010   Min.   :6.637e+09   Min.   :5.477e+07
 1st Qu.:77.16   1st Qu.: 98.61   1st Qu.: 5.058   1st Qu.:4.539e+10   1st Qu.:2.095e+09
 Median :80.10   Median :105.82   Median : 6.955   Median :1.502e+11   Median :1.682e+10
 Mean   :79.16   Mean   :105.53   Mean   : 7.913   Mean   :2.661e+11   Mean   :2.501e+10
 3rd Qu.:81.40   3rd Qu.:111.04   3rd Qu.: 9.125   3rd Qu.:3.355e+11   3rd Qu.:2.501e+10
 Max.   :83.90   Max.   :151.94   Max.   :27.470   Max.   :2.003e+12   Max.   :2.156e+11
      SEXP              SIMP              IMP              GINI             RDE
 Min.   :2.467e+09   Min.   :1.602e+09   Min.   :7.306e+09   Min.   :23.20   Min.   :0.371
 1st Qu.:1.224e+10   1st Qu.:8.760e+09   1st Qu.:4.679e+10   1st Qu.:28.80   1st Qu.:1.281
 Median :3.965e+10   Median :3.178e+10   Median :1.330e+11   Median :31.33   Median :1.506
 Mean   :7.638e+10   Mean   :6.651e+10   Mean   :2.502e+11   Mean   :31.33   Mean   :1.506
 3rd Qu.:1.042e+11   3rd Qu.:8.918e+10   3rd Qu.:3.183e+11   3rd Qu.:33.73   3rd Qu.:1.506
 Max.   :4.931e+11   Max.   :4.597e+11   Max.   :1.777e+12   Max.   :41.30   Max.   :3.749
      EXTT
 Min.   :1.394e+10
 1st Qu.:9.142e+10
 Median :2.880e+11
 Mean   :5.163e+11
 3rd Qu.:6.564e+11
 Max.   :3.780e+12
```

Fig. 1. *Results of intelligence analysis of data*

Source: compiled by the authors using the R programming language.

After that, the CSGS variable was removed because it has negative values, which can affect the

efficiency of modelling, and the variables were analysed for multicollinearity. It was found that there is a significant correlation between individual variables, and the correlation matrix (Fig. 2) is presented:

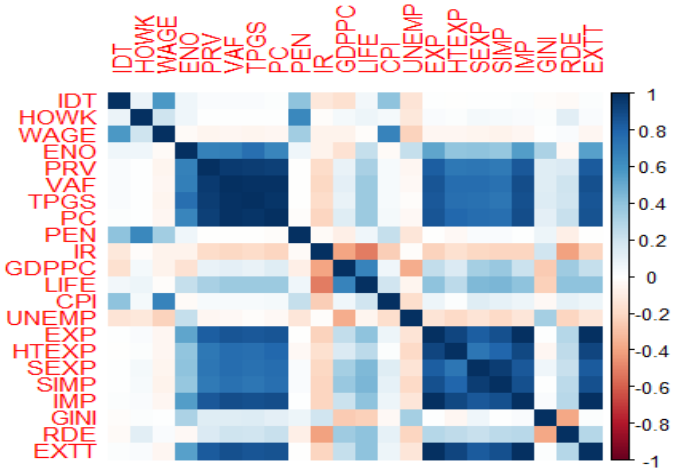

Fig. 2. *Correlation matrix of the data set*
Source: compiled by the authors using the R programming language

Since there is multicollinearity in the data block related to foreign trade, one indicator, exports of goods and services, was retained. It was found that the data from the retail trade block are highly correlated, so the variables PRV, VAF, TPGS, PC were removed from the model and re-estimated, thus improving the data set. It was also found that there are variables with less interdependence that can also distort the results of the study, and therefore WAGE, HOWK and LIFE were removed and the data were re-estimated (Fig. 3).

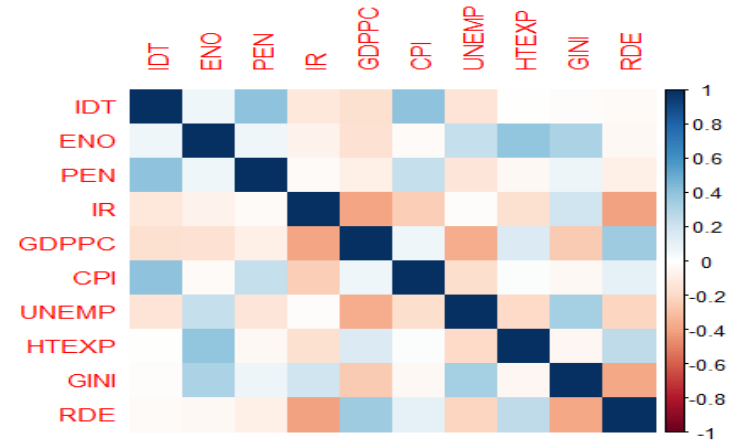

Fig. 3. *The correlation matrix of the data set after removing the variables PRV, VAF, TPGS, PC, WAGE, HOWK and LIFE*
Source: compiled by the authors using the R programming language

Thus, we removed all data that had medium and higher correlations with each other, normalised them, created OLS models, and re-checked the data for multicollinearity using VIF Values (Fig. 4).

```
   GDPPC      CPI    UNEMP    HTEXP     GINI      RDE
1.280405 1.042465 1.321283 1.109131 1.294192 1.353345
```

Fig. 4. *VIF values for the dependent variables*
Source: compiled by the authors using the R programming language

Regarding the interpretation of VIF values, it was found that the data are suitable for building models and in order to substantiate the primary hypothesis of the existence of a relationship, 4 OLS models, 4 fixed and 4 random effects models (3 for each indicator of retail market development) were built.

First, we built models with the dependent variable IDT (basic OLS model (Fig. 5)).

```
Call:
lm(formula = IDT ~ GDPPC + CPI + UNEMP + HTEXP + GINI + RDE,
    data = final_normalized_data)

Residuals:
    Min      1Q  Median      3Q     Max
-4.9406 -0.3494 -0.0272  0.4293  3.8942

Coefficients:
             Estimate Std. Error t value Pr(>|t|)
(Intercept)  1.817e-17  3.799e-02   0.000 1.000000
GDPPC       -2.517e-01  4.303e-02  -5.850 8.58e-09 ***
CPI          3.981e-01  3.883e-02  10.253  < 2e-16 ***
UNEMP       -1.597e-01  4.371e-02  -3.653 0.000285 ***
HTEXP       -6.781e-04  4.005e-02  -0.017 0.986496
GINI        -2.536e-02  4.326e-02  -0.586 0.558015
RDE         -2.389e-02  4.424e-02  -0.540 0.589351
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Residual standard error: 0.8829 on 533 degrees of freedom
Multiple R-squared:  0.2292,   Adjusted R-squared:  0.2205
F-statistic: 26.42 on 6 and 533 DF,  p-value: < 2.2e-16
```

Fig. 5. *Characteristics of the OLS model with the dependent variable IDT*
Source: compiled by the authors using the R programming language

Multiple R-squared: 0.2292 and adjusted R-squared: 0.2205 indicate a weak linear relationship in the model. GDPPC, CPI and UNEMP are also found to be significant variables.

Next, we created a Country-Specific Fixed Effects model using the plm package, which reflects a moderate dependence, with GDPPC, CPI, UNEMP as significant variables, and examined the impact of different countries on the model (Fig. 6).

```
   Austria       Belgium      Bulgaria       Croatia
-0.739823     -0.385391      0.228158      1.093918
    Cyprus       Czechia       Denmark       Estonia
 0.741455     -0.176523     -0.452243      0.027749
   Finland        France       Germany        Greece
-0.209552      0.049829     -0.071393      2.698329
   Hungary       Ireland         Italy        Latvia
 0.314611      0.126154      0.322625      0.624237
 Lithuania    Luxembourg         Malta   Netherlands
 0.468071     -3.711384     -0.575092     -0.364950
    Norway        Poland      Portugal       Romania
-1.690080      0.260542      0.802730      0.298160
   Slovakia      Slovenia         Spain        Sweden
 0.555317      0.460294      1.835684     -0.636838
Switzerland United Kingdom
 -1.246775     -0.647817
```

Fig. 6. *Fixed effects for different countries in the model*
Source: compiled by the authors using the R programming language

The coefficients show how much the dependent variable changes on average over time in each country.

Next, the authors compare the OLS model and the fixed effects model using F-testing. If the p-value is less than 0.05, then the fixed effects model is the better choice. Therefore, the OLS model is rejected.

Next, we built a model with Random Effects (Fig. 7).

```
Oneway (individual) effect Random Effect Model
   (Swamy-Arora's transformation)

Call:
plm(formula = IDT ~ GDPPC + CPI + UNEMP + EXP + GINI + RDE, data = final_norm
alized_data,
    model = "random")

Balanced Panel: n = 30, T = 18, N = 540

Effects:
                 var std.dev share
idiosyncratic 0.4189  0.6472 0.786
individual    0.1139  0.3375 0.214
theta: 0.5881

Residuals:
     Min.   1st Qu.    Median   3rd Qu.      Max.
-3.953046 -0.300193 -0.041593  0.271665  3.642601

Coefficients:
              Estimate  Std. Error  z-value Pr(>|z|)
(Intercept)  1.9550e-16  7.4873e-02   0.0000   1.0000
GDPPC       -8.9840e-02  6.7960e-02  -1.3219   0.1862
CPI          4.0436e-01  3.2615e-02  12.3980   <2e-16 ***
UNEMP       -4.5541e-01  4.4930e-02 -10.1359   <2e-16 ***
EXP         -2.0407e-03  6.6265e-02  -0.0308   0.9754
GINI         1.3302e-02  5.5110e-02   0.2414   0.8093
RDE         -3.3474e-02  4.3458e-02  -0.7703   0.4412
---
Signif. codes:  0 ‘***’ 0.001 ‘**’ 0.01 ‘*’ 0.05 ‘.’ 0.1 ‘ ’ 1

Total Sum of Squares:    435.37
Residual Sum of Squares: 273.73
R-Squared:      0.37126
Adj. R-Squared: 0.36419
Chisq: 314.732 on 6 DF, p-value: < 2.22e-16
```

Fig. 7. *Characteristics of the Random Effects model with the dependent variable IDT*
Source: compiled by the authors using the R programming language

Multiple R-squared: 0.37126 and adjusted R-squared: 0.36419 indicate a moderate linear relationship in the model, and the significant variables are CPI and UNEMP.

To determine the more appropriate model between fixed and random effects, a Hausman test is performed (Fig. 8), where the null hypothesis is that a random effects model is preferred over the alternative fixed effects model. This test tests whether the unique errors are correlated with the regressors; the null hypothesis is that they are not. If the p-value is significant (e.g., <0.05), then a fixed-effects model should be used, otherwise a random-effects model should be used.

```
Hausman Test

data:  IDT ~ GDPPC + CPI + UNEMP + EXP + GINI + RDE
chisq = 54.547, df = 6, p-value = 5.721e-10
alternative hypothesis: one model is inconsistent
```

Fig. 8. *Results of the Hausman test for random effects and fixed effects models*
Source: compiled by the authors using the R programming language

Therefore, fixed-effects models were used for the IDT variable.

Similarly, models were developed for the dependent variable ENO.

Thus, after building the OLS model, it was found that with multiple R-squared of 0.3238 and adjusted R-squared of 0.3162, there is a weak linear relationship, and the significant variables are UNEMP, HTEXP and GINI. Next, a Country-Specific Fixed Effects model is created and a very weak linear relationship is

found in the model (Multiple R-squared 0.09 and Adjusted R-squared 0.02), and the significant variables are HTEXP and GINI. The impact of different countries on the model is also examined and strong heterogeneity of results is found. Next, the OLS model and the fixed effects model are compared, after which the OLS model is rejected as the p-value is less than 0.05 and the fixed effects model is a better choice. After developing the model with Random Effects, a very weak linear relationship is found in the model (multiple R-squared: 0.10017 and adjusted R-squared: 0.09), and the significant variables are HTEXP and GINI. Further, based on the results of the Hausman test, the authors chose the fixed model for the ENO variable, as it is the best model.

Next, we build models with the dependent variable PEN.

1) OLS (multiple R-squared: 0.09812 and adjusted R-squared: 0.08797, indicating a very weak linear relationship in the model), the significant variables are CPI and UNEMP;

2) Country-Specific Fixed Effects model, using plm package (weak dependence is established), significant variables are CPI, UNEMP, and the impact of individual countries on this dependence is considered (heterogeneity of data from different countries is revealed);

3) based on the comparison of the OLS model and the fixed effects model, the OLS model is rejected and the Random Effects model is built, which reflects a weak dependence, and the significant variables are CPI, UNEMP.

4) according to the results of the Hausman test for random effects and fixed effects models, the model with fixed variables is more significant.

We also built models for the IR variable and identified them:

1) a significant linear relationship in the OLS model (multiple R-squared 0.8119 and adjusted R-squared 0.3409) and the significant variables are GDPPC, CPI, UNEMP, RDE, HTEXP, GINI;

2) weak dependence when building a Country-Specific Fixed Effects model using the plm package, and the significant variables are CPI, UNEMP, RDE;

3) the need to reject the OLS model based on the results of F-testing with a fixed effects model and build a model with Random Effects, which reflects a weak dependence, the significant variables are CPI, UNEMP, RDE, GDPPC;

4) use of a random effects model based on the Hausman test for random effects and fixed effects models.

Thus, we can summarise the results of the developed models (Table 3).

To begin with, let us consider the difference between R-Squared and adj. R-Squared, which is that the R-Squared value assumes that all the independent variables considered affect the model outcome, while adj. R-Squared takes into account only those independent variables that actually affect the performance of the model.

Table 3

Results of modelling the 4 dependent variables

№	Dependent variable	Model type	R–Squared	Adj. R–Squared	Level of interconnection
1	IDT	fixed	0.49024	0.45484	The developed model explains 45% of the changes in the values of the independent variable, which is the average result.
2	ENO	fixed	0.092401	0.029373	The developed model explains changes in the independent variable by 3%, which is a very low result, and therefore this model is irrelevant.
3	PEN	fixed	0.22641	0.17269	This model explains 17% of the changes in the independent variable, which is a low result, and therefore this model is relevant but weak.
4	IR	random	0.2452	0.2367	This model explains 24% of the changes in the independent variable, which is a low result, and therefore this model is relevant but weak.

Source: compiled by the authors

Thus, it can be summarised that IDT (number of goods sold) is influenced by GDPPC (GDP per capita), CPI (consumer inflation), UNEMP (unemployment rate in the economy); ENO (number of retailers) is influenced by HTEXP (volume of high-tech exports) and GINI (Gini index, which characterises income inequality in the country); PEN (number of employees in the industry) is influenced by CPI, UNEMP, GINI; and IR (share of income invested in the activities of the industry) is influenced by CPI, UNEMP, RDE (share of R&D expenditure in GDP), GDPPC.

Let's display these dependencies graphically (Fig. 7).

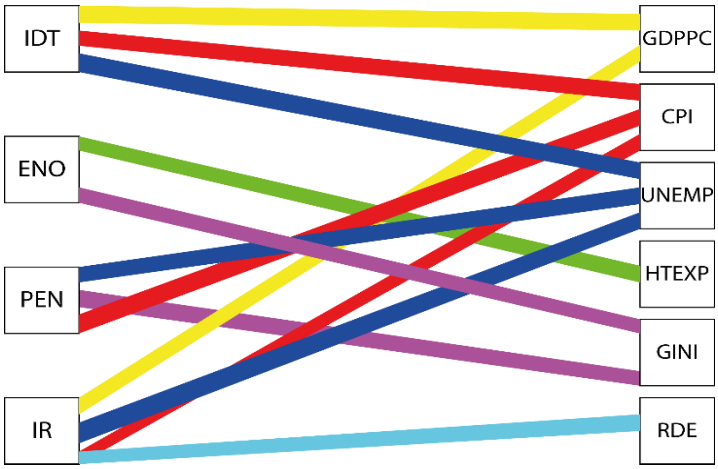

Fig. 7. *Influence of dependent variables on independent variables based on modelling results*
Source: compiled by the authors.

Let's also consider the sensitivity of the industry's indicators to macroeconomic indicators. To do this, let's place the coefficients near the significant variables (Table 4).

Table 4

Sensitivity of industry indicators to macroeconomic indicators based on modelling results

	GDPPC	CPI	UNEMP	HTEXP	GINI	RDE
IDT	0.438301	0.364879	–0.562003	–	–	–
ENO	–	–	–	0.1613563	0.1716693	–
PEN	–	0.225607	–0.47127	–	0.177498	–
IR	–0.22253	–0.25521	–0.17607	–	–	–0.26561

Source: compiled by the authors.

So, let's sort these connections by strength (from the strongest to the weakest) and direction:

1. Directly related are: 1) GDP per capita and trade turnover; 2) CPI and trade turnover; 3) CPI and number of employees; 4) Gini index and number of employees; 5) Gini index and number of retailers.

2. The inverse relationship is: 1) unemployment rate and trade turnover, 2) unemployment rate and number of employees in the industry, 3) share of research and development expenditures in GDP and investment level, 4) CPI and investment level, 5) GDP per capita and investment level, 6) unemployment and investment level.

Thus, the study based on the panel data modelling method revealed a previously unexplored aspect of the relationship between the characteristics of the retail industry and the country's economy: a balanced economic system that supports R&D investments aimed at reducing unemployment and increasing the efficiency of the economy as a whole is an important component of retail development in European countries. In the future, further research should be aimed at identifying the links between other factors that may influence the development of the retail industry.

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