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The impact of the banking sector on economic growth in Poland – an econometric analysis

Abstract

The paper analyses the impact of the banking sector on economic growth in Poland. The aim of the paper was to analyse if the banking sector has a significant effect on economic growth in the case of Poland. Hence, the following hypothesis was formulated: there is a statistically significant relation between the development of the banking sector and economic growth in Poland. On the basis of the applied econometric methods, it has been possible to demonstrate that the banking sector's development has an economically and statistically significant impact on economic growth in Poland.

Key words: *financial development, economic growth, financial market, credit, stock exchanges, banking sector, econometric model.*

JEL classification code: *G10, G15, G44.*

Paper type*: Theoretical research article*

Introduction

The issue of relations between financial development (of financial markets) and economic growth is not new to economics or finances. It emerged as early as J. Schumpeter's work (1960). He pointed to a major significance of finance to the stimulation of economic growth and development. J. Schumpeter's ideas were taken up by R. King and R. Levine (1993), who intensified the discussion. R. Levine defined financial development, too, stating: 'Financial development occurs when financial instruments, markets,

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and intermediaries ameliorate – though do not necessarily eliminate – the effects of information, enforcement, and transactions costs and therefore do a correspondingly better job at providing the five financial functions. Thus, financial development involves improvements in the (i) production of ex ante information about possible investments, (ii) monitoring of investments and implementation of corporate governance, (iii) trading, diversification, and management of risk, (iv) mobilization and pooling of savings, and (v) exchange of goods and services. Each of these financial functions may influence savings and investment decisions and hence economic growth. Since many market frictions exist and since laws, regulations, and policies differ markedly across economies and over time, improvements along any single dimension may have different implications for resource allocation and welfare depending on the other frictions at play in the economy' (Levine 2004, pp. 5-7).

The development of banking and the corresponding development of the deposit and credit markets (including instruments like bank deposits, credits and loans) can be distinguished as part of the financial development. The research whose interim results have provided the starting point for this paper is intended to answer the question, does the banking sector have a significant effect on economic growth in the case of Poland?

Hence the following hypothesis: there is a statistically significant relation between the development of the banking sector and economic growth in Poland.

Econometric methods are applied.

1. The connection between the development of the banking sector and economic growth in some empirical research

The cost of information, transactional costs, and investment risk are the major problems of investing in financial markets. They are solved by the operation of financial intermediaries, primarily banks.

The literature offers a range of results, mostly concerning the effect of the development of financial markets on economic growth. They are scarcer in relation to the impact of the bank sector on economic growth. Nonetheless, some results of selected authors can be cited here. Beck and Levine (2001, 2004) indicate, after an analysis of econometric model estimation results (dynamic panel data model for 40 countries |in the period 1976-1998, the data averaged for a 5-year period), a positive impact of securities markets and the banking sector on economic growth

The results by M. Próchniak & K. Wasiak (2016) show that domestic credit and market capitalization of listed companies both have a non-linear impact on economic growth reflected with a downward sloping parabola. In their research, they used data from 26 EU countries for the period of 1993-2013.

Gurgul & Lach (2012) have concentrated on the Polish financial market and banking sector. Their research is based on quarterly data for the period 2000-2011. They use the following independent variables in their econometric models: the ratio of bank claims on private sector to nominal GDP, the ratio of bank deposit liabilities to nominal GDP, the ratio of Warsaw Stock Exchange (WSE) turnover to nominal GDP, the reserve bank discount rate, and the interbank offer rate. The authors apply the econometric method of vector error correction model (VECM). They examine financial development for the full period and a pre-2008 crisis subsample (2000 Q1–2008 Q3). They construct two variants: bank- and stock market-oriented approaches. The authors indicate that there is a causality from stock market development to economic growth and from economic growth to banking sector development. The results of their research also suggest that the development of the Warsaw Stock Exchange (WSE) had a strong impact on economic growth before the 2008 crisis and the banking sector had a significant impact on economic growth during the 2008 crisis. The authors conclude the stock market development was a factor of the banking sector development in Poland in the analysed period. It is a very important conclusion which indicates that stock exchanges and banking sector (banking market) are connected in their impact on economic growth.
Bukowski and Zięba (2019) apply a dynamic data model to investigate 19 countries of EMU for the period of 1999-2017. The results of model estimation suggest a significant impact of the banking sector development on economic growth.

2. The measures of the bank sector's impact on economic growth

From the viewpoint of empirical research, the following measures of the bank sector's impact on economic growth can be distinguished:
- Banks' financial results – ROA and ROE,
- The ratio of credits to bank deposits,
- The ratio of credits and deposits to GDP,
- The relation of credits to the private deposits from the private sector/ GDP,
- The M3 monetary aggregate to GDP,
- Spread – the relation of credit rate of interest to deposit rate of interest,
- The net interest margin of banks,
- The relation of charter capital to risk-weighted assets.

Only some of them are used in this study due to the lack of data. At least quarterly figures are of particular importance to apply the models like VAR or VECM. Regrettably, they aren't always available.

3. The bank sector and economic growth in Poland – the model approach

3.1 Data and model

The study employs the statistics of the World Bank, namely, the Global Financial Development GFDD Data Bank Financial Structure Development Database, AMECO ONLINE. They cover the period from 1998 to 2017. The base is selected to ensure comparability with other studies using the same statistics. The Ameco Online figures are processed to produce the same comparability as in the case of the World Bank data.

The model is founded on the following standard GDP growth:

$Y_t = f(K_t, L_t, F_t, Z_t)$ – where Y stands for GDP, K_t – capital, L_t - labour, F_t for the financial factor, Z_t.

It should be mentioned a similar model, based on Solow model, is used in research into the impact of the financial sector on economic growth (cf. Hshin-Yu Liang, Alan Reichert 2006).

After an analysis of statistical data, the following econometric model is built of the bank sector's effect on economic growth for Poland:

$lnGDP_t = a_0 + a_1 lnM3GDP_t + a_2 ln_t + a_3 lnP_t + a_4 X_t + u_t,,$

where:

ln – the natural logarithm,

GDP_t - GDP for Poland in terms of 2000 constant prices,

$M3GDP_t$ - the M3 monetary aggregate to GDP in terms of 2000 constant prices as a proxy for money creation by banks,

IN_t - gross investments in the economy (as gross fixed formation in terms of 2000 constant prices) to the GDP,

P_t – population at the end of a given year,

X_t – exports to the GDP in terms of 2000 constant prices as a proxy for the remaining factors influencing economic growth,

u_t - random factor.

The model is constructed using the method of backward stepwise regression. The tests of autocorrelation and heteroscedasticity, normal distribution, and time series co-integration are carried out. The test results provide the grounds for selecting the generalised least squares method as the method of estimation. The rate of GDP growth in Poland as the natural logarithm (ln) of the GDP value is the dependent variable in the model.

The results of Engle–Granger co-integration test are presented below.

Augmented Dickey-Fuller test for uhat
including one lag of (1-L)uhat
sample size 18
unit-root null hypothesis: a = 1

test without constant
model: (1-L)y = (a-1)*y(-1) +... + e
estimated value of (a - 1): -0.671916
test statistic: tau_ct(5) = -3.31857 with the critical value -1.95 (significance level 0.05)
asymptotic p-value 0.5838
1st-order autocorrelation coeff. for e: -0.185

As we see above the time series are cointegrated.

3.2 The results of model estimation

The results of model estimation are included in Table 1.

Table 1. Cochrane-Orcutt, using observations 1998-2017 (T = 19)
Dependent variable: l_GDP
rho = 0.053368

	Coefficient	*Std. Error*	*t-ratio*	*p-value*	
const	−33.0303	17.3571	−1.903	0.0778	*
l_M3GDP	0.447461	0.0702704	6.368	<0.0001	***
l_IN	0.0661552	0.0585106	1.131	0.2772	
l_P	2.27768	0.988263	2.305	0.0370	**
l_X	0.213180	0.0223627	9.533	<0.0001	***

Statistics based on the rho-differenced data:

Sum squared resid	0.004616		S.E. of regression	0.018158
R-squared	0.994214		Adjusted R-squared	0.992561
F(4, 14)	538.3929		P-value(F)	3.73e-15
rho	0.019271		Durbin-Watson	1.863885

Statistics based on the original data:

Mean dependent var	7.250250		S.D. dependent var	0.210527

Source: The author's own calculation with using GRETL.

The independent variable, a proxy for the development of the financial sector, in this case of the banking sector (M3), is statistically significant. The model explains the variance of the dependent variable in 99%, a very good measure of matching.

The estimation results point to a significant and relatively strong impact of the development of the banking sector on economic growth in Poland.

4. The effect of banking regulations (Basel III) on economic growth in Poland in the light of empirical research

M. Marcinkowska, P. Wdowiński (eds.) *Wpływ regulacji kapitałowych i płynnościowych sektora bankowego na wzrost gospodarczy Polski* (Łódź 2016) is a fundamental work on the effect of banking regulations (Basel III) on economic growth in Poland. The authors attempt to determine how these regulation will affect the economic growth in our country both theoretically and empirically. S.I. Bukowski's chapter in (2016) is worth quoting as the author conducts a theoretical analysis of the effects of more stringent banking regulations on economic growth. He suggests an adverse impact of a higher solvency ratio that works by:

- Limiting the supply of bank credits and raising the short-term rate of interest and cost of bank customer service;
- Lowering investments as a result of growing interest rates in the long term,
- An increase of interest rate and a lower value of assets, which will reduce J. Tobin ratio.

The idea of a financial transaction tax comes in for particular criticism. The author stresses the growing costs of borrowing, bound to hit small and medium-sized enterprises in the first place and consequently impair economic growth in Poland, where these enterprises make an overwhelming contribution to GDP creation and employment. After the so-called bank tax has been introduced, which is in fact a charge on banks' assets and thus credits, the issue as as topical as ever. The question arises in this connection if it's a good idea to additionally tax banks for their effective management. An answer certainly requires more research (Bukowski 2016, pp. 25-40)

Returning to the banking sector regulations in Basel III, the authors points out the new regulations slow the rate of GDP growth and propose a range of recommendations for prudential policies (Marcinkowska, Wdowiński, 2016, pp. 290 and ff.). The effects of the principles incorporated in the so-called Basel III regulations definitely require more studies, especially as the most recent regulations were introduced in 2018 subject to a vacatio legis.

Conclusion

The analysis undertaken in this paper has demonstrated the banking sector's development has an economically and statistically significant impact on economic growth in Poland. A range of similar studies, both of individual and many economies (based on panel models), indicate the impact of the financial development, including the development of the banking sector, on economic growth is of paramount importance

and statistical significance. The effects of banking regulations (Basel III) on economic growth matter, too, as proven with reference to a number of economies, including that of Poland.

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Rafał Czupryn[1]

Operations of Deutsche Börse and the role of the German stock exchange in relation to several European stock exchanges.

Abstract

This article analyzes the operation of the German stock exchange on the basis of applicable national regulations, directives of the European Parliament and the adopted manner of operation of the entity in accordance with the information contained on the official website of the stock exchange. The following part of the article presents a comparative analysis of fifteen European stock exchanges. The comparative criterion was the achieved results concerning the offered financial instruments. The study was conducted on the basis of data from the Federation of European Stock Exchanges covering the state at the end of January 2021.

Keywords: *capital market, stock exchange, financial instruments*

JEL classification codes: *G10.*

Paper type*: Theoretical research article*

Introduction

The purpose of this research paper is to analyze how the German stock market works. The analysis of the problem is based on two pillars. The first is to analyze the legal environment and conditions that allow a company to do business in the capital markets. The second is the editing and analysis of selected figures for the financial instruments of the selected European stock exchanges. Germany is one of the most developed industrialized

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countries in the world and its economy is the fourth largest after the United States, China and Japan. Despite the serious eurozone crisis, Germany remains a relatively good export-oriented country, benefiting from rapidly increasing demand from Asian and South American countries. In addition, a lot of European capital has flowed into Germany to escape the uncertainties of the debting EU countries. Therefore, it is important to see how the Deutsche Boerse works compared to other stock exchanges and under what legal and organizational framework conditions it operates.

Legal conditions of the German financial market

The main document regulating the functioning of the financial market in Germany is the Act on Trading in Securities (WpHG, 09.09.1998). It contains regulations concerning:

1. How financial statements are monitored;
2. Issues related to the exercise of market surveillance;
3. Procedures for entering into forward transactions;
4. The applicable criminal liability of market participants and the established administrative penalties;
5. Ways of resolving disputes;
6. Principles of operation of investment companies;
7. The issue of recognition of foreign markets and the planned procedures in the event of finding abuses;
8. Applicable liability in the event of failure to comply with the disclosure obligations.

Nevertheless, it is not the only document that defines the rules of the stock exchange. Due to the established administrative division of Germany, supervision over the stock exchanges is performed at the following levels:

1. federal,
2. local,
3. stock exchange.

The federal body is the Federal Financial Supervisory Authority, which dates back to 2002. The office in question operates on the basis of the law of the federal financial supervision authority (FinDAG, 22.04.2002). The main tasks of the Federal Financial Supervisory Authority are:

1. monitoring of insurance companies,
2. banks monitoring,
3. monitoring of investment companies,
4. monitoring of companies in the financial services sector,
5. monitoring whether the disclosure obligation is met by listed companies,
6. monitoring of hedge funds,

7. approving issue prospectuses of both companies and closed-end investment funds.

If, in the course of the tasks performed, the office finds an abuse, the case is referred to the prosecutor's office, which takes the necessary steps for a given case. At the local level, the Stock Exchange Supervision Offices are responsible, and at the lowest level, these functions are performed by the Market Supervision Office.
Joint-stock companies operate in accordance with the law of joint-stock companies (AktG, 06.09.1965). Nevertheless, their functioning is influenced by the provisions of the acts related to the capital market, such as the law on the prospectus (WpPG, 22.06.2005) or the stock exchange law (BörsG, 21.06.2002).
German issuers, acting in accordance with the Act on the securities depository (DepotG, 04.02.1937), are obliged to entrust the purchased shares to the central securities depository. The selected credit institution appears on the depositary side. According to the provisions, the functioning of many depository institutions is expected. However, at present, the only institution with this role in Germany is Clearstream Banking AG. When discussing the subject of the applicable capital market legislation, one should also mention the Act on the implementation of information transparency requirements (TUG, 15.12.2004), which implements Directive 2004/109 / EC. As a result, all the most important directives of the European Commission in the field of the public market are met in Germany.

Division and functioning of the German capital market

The capital market in Germany (Fig. 1) can be divided into:
1. official regulated market,
2. regulated unofficial market.

The functioning of the official regulated market is based on the provisions of Community law. Each potential issuer is subject to one of the two mandatory disclosure requirements. Contrary to the official regulated market, the regulated unofficial market operates in accordance with the applicable restrictions of the exchange within which it is in force. Thus, the applicable rules for the functioning of the market are contained in the Open Market Regulations. Moreover, within the aforementioned market, one can distinguish the "Entry Standard" segment with an increased information requirement.

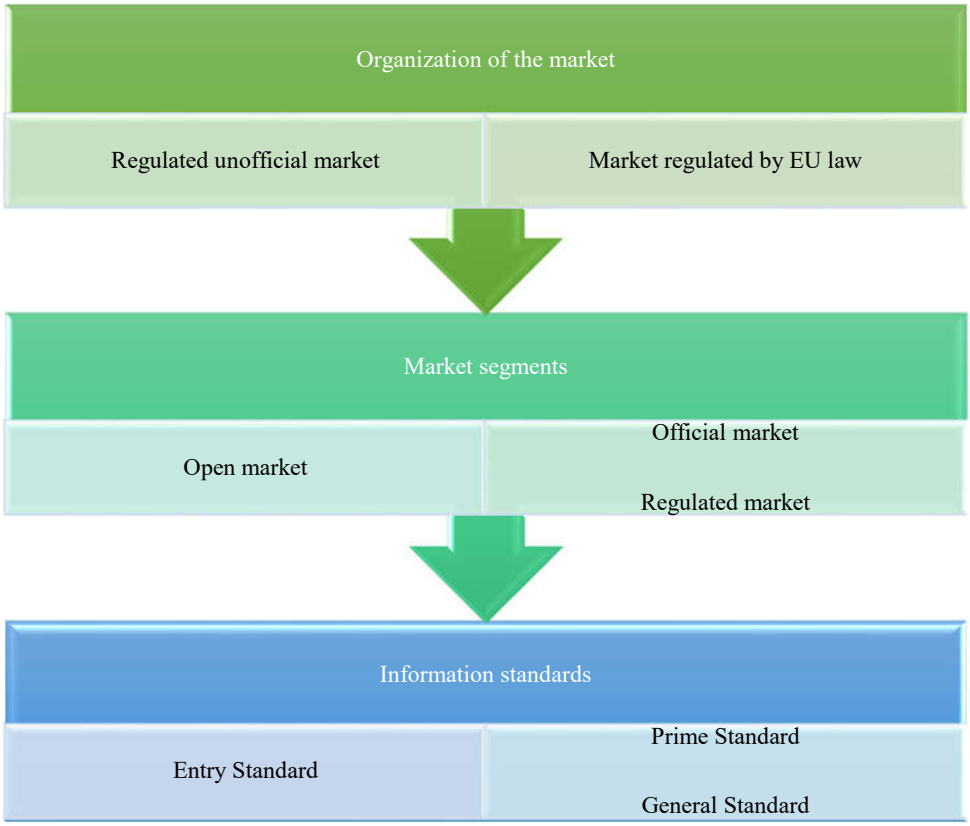

Figure 1. The structure of the capital market in Germany
Source: Source: Own study based on: Nowicki P., 2010, p. 107

Article 2 point 5 of the Act on Trading in Financial Instruments states that the official market functions in an organized manner. Before a given financial instrument is admitted to trading, the issuer must first submit a relevant application for admission to introduction. The aforementioned document may be submitted with an institution operating pursuant to article 53, point 1, paragraph 1 or article 53, point 1, paragraph 1 of the banking law. Then the application is sent to the Approval Office.
The placing company must be an entity that is admitted to the market with the right to participate in the conclusion of the commercial transactions. In addition, the company is required to provide with the application a document confirming its equity capital of EUR 730,000 or more. If a potential issuer has the above amount on its own, it may submit an application on its own behalf. In the case of the first admission to the exchange market of planned issues, the issuer must additionally meet 4 conditions:

1. have a documented history of the company's operation for at least 3 years,
2. estimate the potential value of the shares admitted to trading or have equity of at least EUR 1.25 million,
3. to introduce to the stock market at least 10,000 shares,
4. have free float shares of at least 25%.

An important document enabling the application for admission to the stock exchange market is the prepared and published prospectus. It enables the analysis and evaluation of a potential issuer (McAndrews, J., & Stefanadis, C.). The prospectus prepared in accordance with applicable regulations should contain the Management Board's report for the last year as well as the submitted financial statements for the last 3 years. In the case of domestic companies, the documents in question must be prepared in German, for foreign companies it is respectively English. It depends on the decision of the Admission Office whether the submitted documentation and the content contained therein will be sufficient to allow the selected entity to carry out the issue on the market.
Participation in the capital market also obliges issuers to comply with the disclosure obligation in accordance with the applicable law on trading in financial instruments by:

1. issuing to the public announcements on current activities,
2. information and notification of information and facts arising during the operation,
3. publishing reports covering the first 6 months of the financial year,
4. publishing financial statements for the full accounting period.

General Standard is a segment with relatively low requirements on the German market within the official regulated market. It is aimed mainly at domestic investors who will be interested in entrusting funds in shares of domestic companies. Upon entering the market, the issuer is included in this segment. Each issuer participating in the segment is included in the CDAX index. To be able to participate in the General Standard segment, an issuer must:

1. Fill the following requirements:
    a. the offered shares must already be listed on an official regulated market.
2. Comply with information obligations by:
    a. publishing reports on current activities,
    b. publishing financial statements for the first six months of operation for each commenced financial period,
    c. application of accepted accounting standards.

On the official regulated market there is also a second segment called Prime Standard. It is defined on the basis of applicable European Union law. Prime Standard's target group are international investors who require comprehensive and efficient information on issuers whose shares are in circulation. Thus, in addition to the minimum requirements set by the General Standard segment, companies are obliged to follow and comply with international practices in the field of informing investors and transparency of information. Joining the Prime Standard segment means joining the main German indices such as DAX, TecDAX, MDAX, SDAX. The body responsible for admission to the Prime Standard segment is the Admission Office. In order for an issuer to be admitted to the segment, the following requirements must be met:

1. the shares offered on the market must already be listed on an official regulated market,
2. an application will be submitted by the issuer for admission to the Prime Standard segment.

Apart from the requirements on entities that are participants of the discussed segment, they are obliged to:

1. comply with the obligations provided for the General Standard segment,
2. publish a calendar setting out the order in which financial information is published throughout the year,
3. organizing at least one conference dedicated to analysts throughout the year,
4. publication in English of information on the company's day-to-day operations,
5. publication of quarterly reports in English and German.

The operation of the Open Market is based on Article 57 of the Exchange Law, which states that if financial instruments do not exist in other segments, they may be admitted to trading on the Open Market and if the exchange is able to ensure supervision and smooth trading.
Apart from company shares, other financial instruments are also listed on the Open Market, such as:

1. investment certificates,
2. bonds,
3. warranty.

Article 2 point 5 of the Act on Trading in Financial Instruments states that the Open Market is not a regulated market or an organized market from the perspective of public law. Thus, the introduction of new instruments to the market is subject to the guidelines administered by Deutsche Börse AG. Moreover, the admission to trading process requires the support

of an entity registered on the stock exchange, authorized to conclude direct trading of listed instruments. The entity must then submit an application for approval and admission of the financial instrument to trading. Then it will be up to the administrative body whether a given company will be admitted to the market. On the discussed market, the issuer is not required to meet the disclosure requirements. It must, however, meet the formal requirements, which include:

1. Provision of all documentation and publication of information should be made in both English and German.
2. Submission of an application for admitting the instrument to trading by a supporting entity. The application must contain details of the instrument as well as details of the places where the real instrument is already listed.
    a. Where the financial instrument is not yet listed on any market, information about the issuer must be provided with the application in the form of a prospectus, which will enable the administrative body to assess it.
3. Keeping the administrative body informed about information affecting the functioning of both the issuer and the financial instruments it offers.

The open market may be an alternative solution for representatives of small and medium-sized enterprises looking for quick, simple and relatively low-cost access to stock exchange quotations and capital (Boerdlein, R. M.). Despite the lack of regulation of the market by public law, it should be borne in mind that the discussed market is monitored by two independent entities:

1. Federal Financial Supervision - an authority that monitors the course of trading in terms of possible abuses, with particular emphasis on the phenomenon of insider trading,
2. Supervisory Office - a body monitoring the formation and calculation of offered prices of shares quoted on the market.

With the emergence of the alternative market, Deutsche Börse AG created the Entry Standard segment, which is intended to be an optional choice for the existing higher-standard segments, coexisting on an official regulated market operating on the basis of Community law (Cetorelli, N., & Peristiani, S.). The target group of the Entry Standard segment are private equity / venture capital investors seeking access to the capital market while maintaining a minimum of formalities to be fulfilled. The main application documents are:

1. For public offerings, an approved prospectus by an established national regulatory authority.
2. In the case of private placement offers - information memorandum.

3. A submitted declaration on the issuer's commitment to operate in accordance with the applicable rules of the Entry Standard and the open market.
4. Submitting a declaration on the issuer's commitment to comply with the imposed disclosure requirements.
5. Document confirming the support of the entity introducing to the market.

In addition to the application requirements, it is required to publicly place on your own website information such as:
1. Current company data;
2. The current calendar of key events in the company;
3. Published audited financial statements;
4. Published reports of the Management Board subject to audits;
5. Published semi-annual reports presenting current activities;
6. Any information affecting the issuer's assessment.

The Entry Standard segment is overseen by the Federal Financial Supervisory Authority to prevent potential misuse of classified information (Kompa, K., & Witkowska, D.). The issues related to the pricing process are monitored by the Supervision Office, and the issuer is responsible for monitoring compliance with the disclosure requirements.

Comparative analysis of capital market data in Germany against the background of selected European markets

For the purpose of conducting a comparative analysis between the German entity and other European stock exchanges, data collected by the Federation of European Stock Exchanges was used. In order to conduct the research, information was obtained on 4 offered financial instruments: shares, bonds, ETF certificates and warrants . For each type of financial instrument, data was collected related to:
1. The number of financial instruments listed on the stock exchange;
2. The number of conducted buy / sell transactions of listed financial instruments;
3. Value of turnover of listed financial instruments.

In addition, at the end, the capitalization value achieved by the analyzed stock exchanges was compared. All the data subject to this analysis refer to the state at the end of January 2021.

Table 1. Summary of the financial data of the capital market of selected European stock exchanges at the end of January 2021

No.	Stock exchange name	Financial instruments											
		Shares			Bonds			ETF			Warrants		
		a	b	c	a	b	c	a	b	c	a	b	c
1.	Athens Stock Exchange	172	646120	1224,7	56	1276	13,2	1	74	0,3	0	0	0
2.	Bolsas y Mercados Españoles (BME)	2722	4370799	30966,1	2866	24487	392352	5	0	134,7	0	0	0
3.	Bucharest Stock Exchange	83	60749	160,5	7	0	0	1	788	0,3	174	9974	11,8
4.	Budapest Stock Exchange	45	184028	683	155	2	0,3	1	129	0,4	10	288	0,5
5.	Bulgarian Stock Exchange	258	7456	13,2	87	43	4,3	12	64	0,1	0	0	0
6.	Cyprus Stock Exchange	106	1731	1,4	40	13	0	0	0	0	0	0	0
7.	Deutsche Börse	485	20517763	170330,4	31474	28088	542,5	1578	1513799	22369,9	417401	60195	631,8
8.	Euronext	1489	31864480	178235	48672	22462	391	1405	539509	8031	2086	8652	126
9.	Luxembourg Stock Exchange	142	626	3,2	33614	151	5,5	86	0	0	0	0	0
10.	Malta Stock Exchange	27	521	3,7	186	1211	17,3	0	0	0	0	0	0
11.	Nasdaq Nordics & Baltics	1068	20532294	84353,6	8369	51224	61449,9	15	44716	618,6	10224	358888	580,9
12.	Prague Stock Exchange	56	74799	419,5	110	449	30,9	3	0	0	82	325	0,9
13.	Vienna Stock Exchange	806	540102	3162,6	6057	0	0	114	362	3,2	8445	2440	31,5
14.	Warsaw Stock Exchange	808	3657532	7372,4	519	5817	64,8	7	9840	12,6	2187	43482	68,2
15.	Zagreb Stock Exchange	101	7053	18,6	26	8	2,7	2	0	0	0	0	0

Source: Own study based on statistical data of the Federation of European Securities Exchanges (FESE)
Explanations:

a- Number of listed financial instruments;
b- Number of buy / sell transactions for quoted financial instruments;
c- Trading value of listed financial instruments [million euro].

In order to analyze the obtained data in detail, the following figures (2-14) compare the analyzed European stock exchanges in terms of individual offered financial instruments due to their offered quantity, interest of market participants measured by the number of buy / sell transactions, as well as the achieved value of turnover in given financial instruments.. Finally, Figure 14 presents the capitalization of the analyzed exchanges.
Figure 2 presents the number of shares listed on selected European stock exchanges as at the end of January 2021.

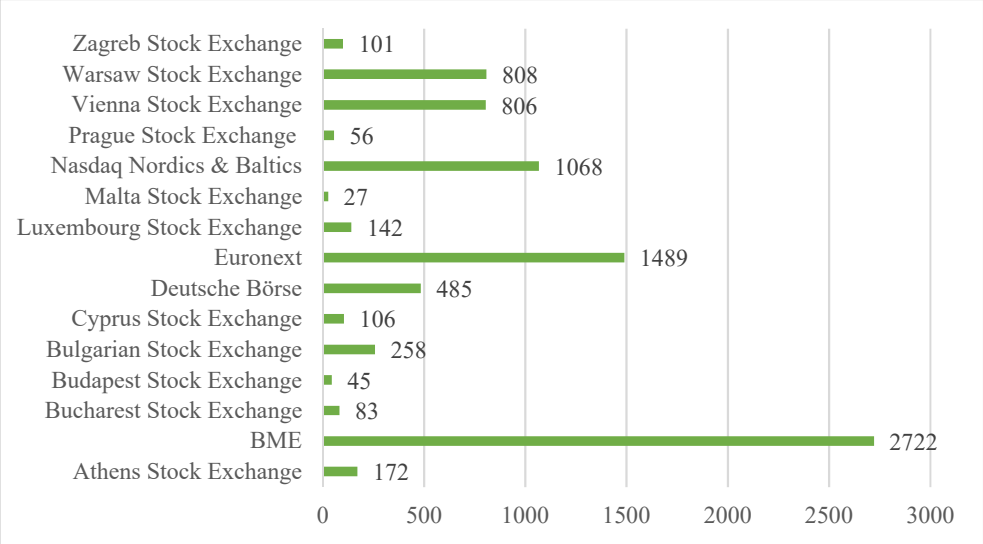

Figure 2. Number of shares listed on selected European stock exchanges at the end of January 2021
Source: Own study based on statistical data of FESE
On the basis of Figure 2, it can be seen that the Spanish stock exchange Bolsas y Mercados Españoles (BME) is the dominant entity in terms of the number of listed shares. The difference between this entity and Euronext, placed in second place, is 1,233 shares. The German stock exchange is in 6th place with 485 shares. The Malta exchange offered the lowest number of shares.
The third figure shows a graph showing the number of buy and sell transactions made at the end of January 2021 on the exchanges in question.

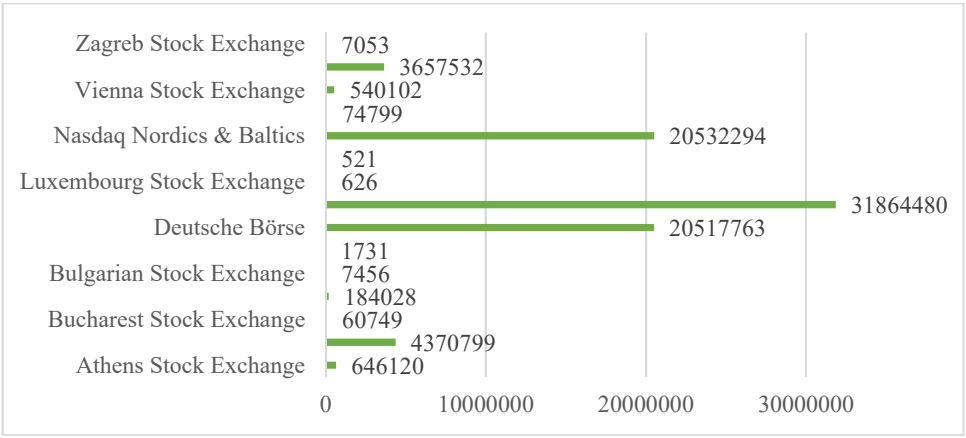

Figure 3. Number of share buy / sell transactions on selected European stock exchanges at the end of January 2021
Source: Own study based on statistical data of FESE

The data in Figure 3 shows that the German stock exchange came third in the ranking right after Nasdaq Nordics & Baltics. The stock exchange with the highest number of share transactions was Euronext. The lowest number of transactions was made on the Maltese stock exchange. The difference between the exchange with the largest number of transactions and the exchange with the smallest number of transactions is 31,863,959 transactions for buying / selling shares. Figure 4 presents the value of trading in shares on the stock exchanges at the end of January 2021.

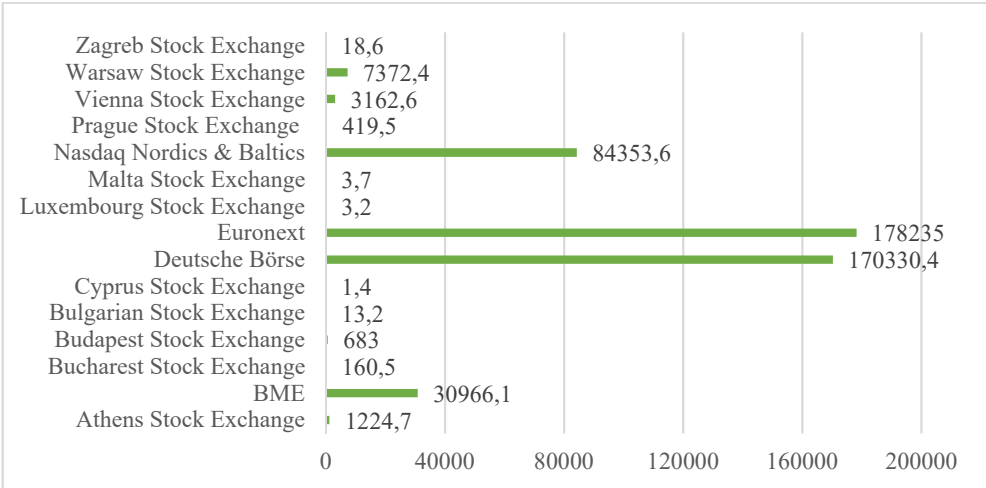

Figure 4. Value of equity trading on selected European stock exchanges at the end of January 2021 [million euro]
Source: Own study based on statistical data of FESE

On the basis of the values quoted in Figure 4, it can be seen that in the case of value from trading in shares, only Euronext is ahead of Deutsche Börse. Both entities achieved relatively similar values, which significantly differ from the results achieved by other entities. The last place was taken by the Cyprus stock exchange, the value of trading in shares at the end of January 2021 amounted to EUR 1.4 million.
Figure 5 shows the number of bonds listed on the exchanges in question.

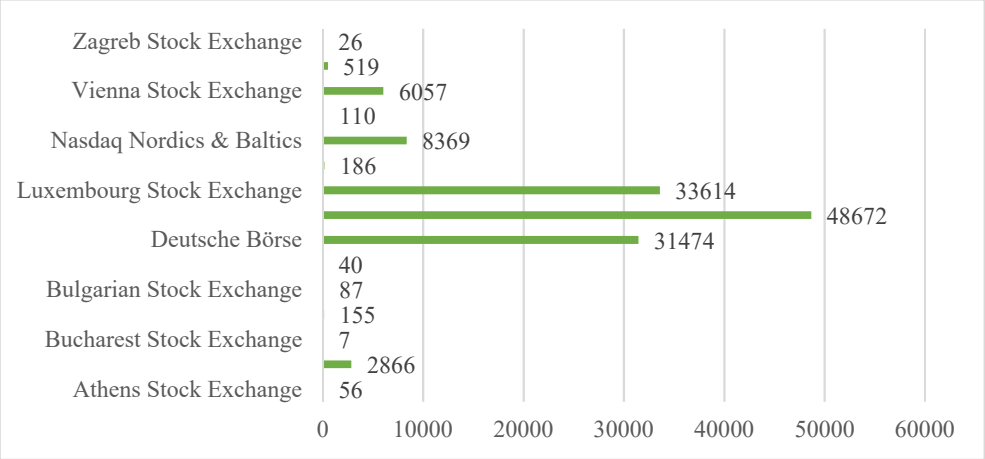

Figure 5. Number of bonds listed on selected European exchanges at the end of January 2021
Source: Own study based on statistical data of FESE

The data in Figure 5 show that Deutsche Börse ranks 3rd in the ranking in terms of the number of listed bonds. Euronext was ranked first, while the Bucharest Stock Exchange was last in the ranking. The difference between the first and the last entity is 48,665 listed bonds.
Figure 6 shows the number of bond purchase and sale transactions concluded on the analyzed exchanges.

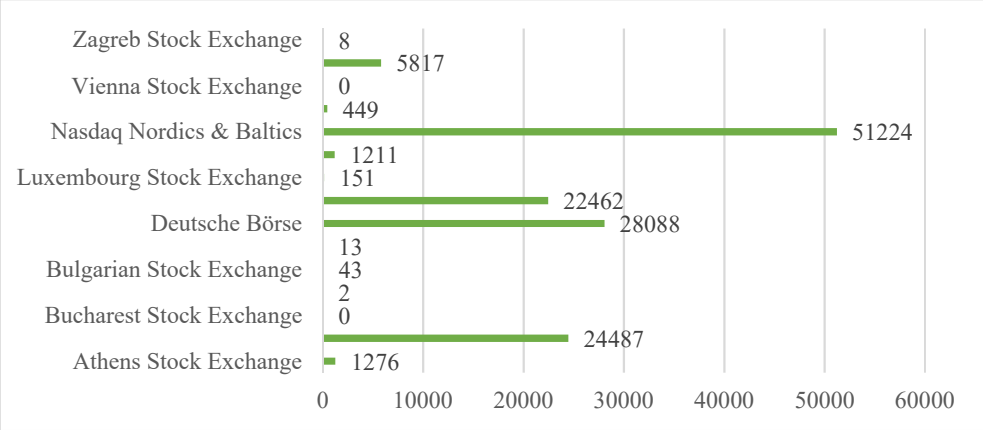

Figure 6. Number of bond buy / sell transactions on selected European exchanges at the end of January 2021
Source: Own study based on statistical data of FESE

On the basis of Figure 6, it should be noted that not all of the exchanges in question have factual data. The lack of information applies to two entities: the Bucharest Stock Exchange and the Vienna Stock Exchange. The Nasdaq achieved the highest result. Deutsche Börse is second in the ranking. The Budapest Stock Exchange shows the lowest result among the exchanges for which data exist. On the Hungarian stock exchange at the end of January 2021, only 2 purchase / sale transactions of bonds were recorded.
Figure 7 presents data on the value of bond trading on the analyzed exchanges at the end of January 2021.

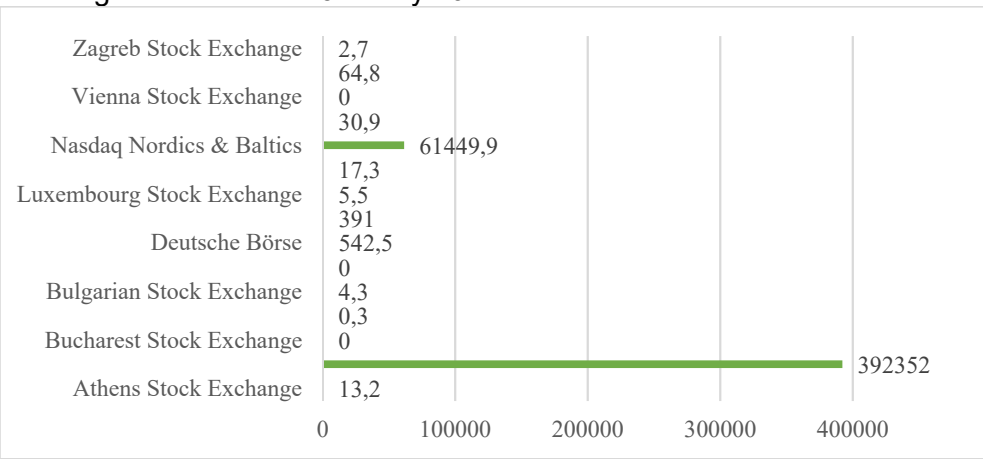

Figure 7. Value of bond trading on selected European stock exchanges at the end of January 2021 [million euro]
Source: Own study based on statistical data of FESE

As shown in Figure 7, similarly to Figure 6, there is no data for the two entities mentioned. The leader of the list is the Spanish stock exchange with a profit of over 392 billion euros. Nasdaq ranked second with EUR 61.5 billion. The remaining entities achieved the value of trading in bonds at the level below PLN 1 billion. Deutsche Börse came third in the ranking.
Figure 8 presents data on the number of ETF certificates listed at the end of January 2021.

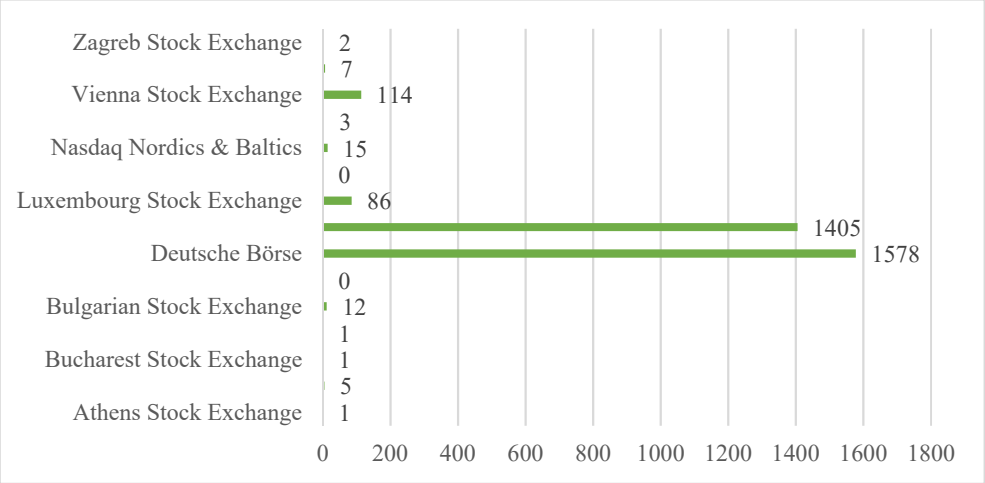

Figure 8. Number of ETF certificates listed on selected European exchanges at the end of January 2021
Source: Own study based on statistical data of FESE

From Figure 8, it can be seen that Deutsche Börse ranks first with the result of 1,578 ETF certificates listed. There is no information on the Cypriot and Maltese stock exchanges. The entity behind the German stock exchange is Euronext. The remaining entities have marginal values compared to the leading stock exchanges.
Figure 9 shows the number of concluded ETF purchase / sale transactions as of the end of January 2021.

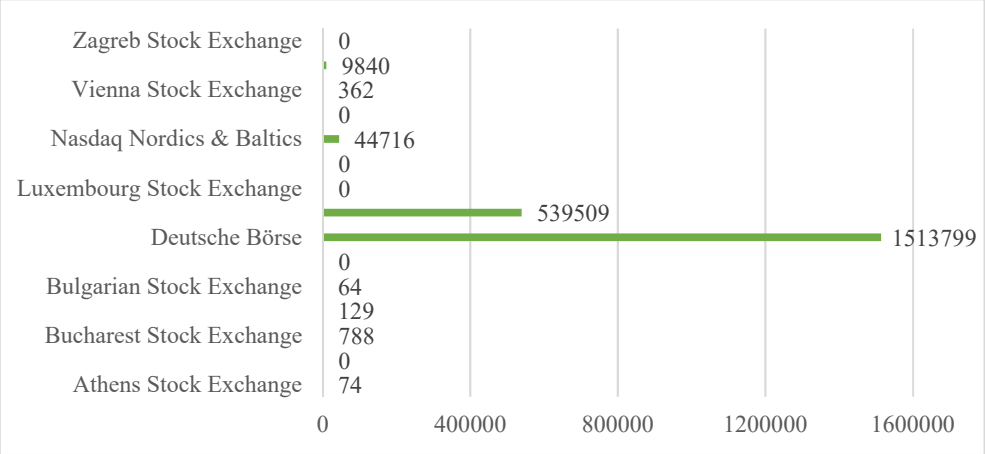

Figure 9. Number of ETF buy / sell transactions on selected European exchanges at the end of January 2021
Source: Own study based on statistical data of FESE

According to the data in Figure 9, the largest number of ETF purchase / sale transactions were performed on the German Deutsche Börse. The Euronext exchange ranks second with 539,509 transactions. The Nasdaq exchange is also located above the result of 10,000 transactions. Other entities reached marginal values or no transactions were concluded at the end of January 2021. Figure 10 shows the value of trading in ETF certificates on the exchanges in question as at the end of January 2021.

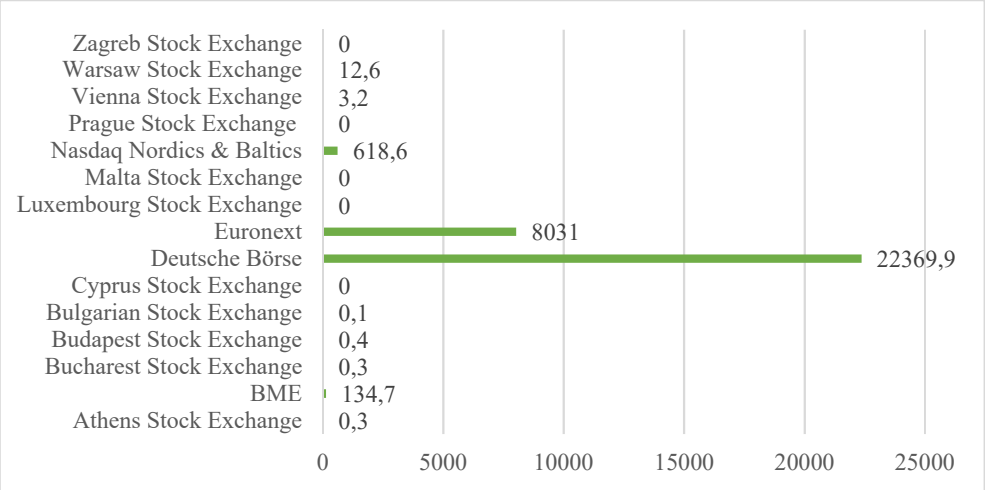

Figure 10. The value of trading in ETF certificates on selected European exchanges at the end of January 2021 [million euro]
Source: Own study based on statistical data of FESE

Based on the data presented in Figure 10, it can be concluded that in the above list there are only two dominant entities with a turnover value exceeding EUR 1 billion: Deutsche Börse and Euronext. The third entity in the classification: Nasdaq recorded the value of trading in ETF certificates at the level of less than EUR 619 million at the end of January 2021. The value of turnover up to EUR 1 million was not achieved by the 9 analyzed exchanges. Figure 11 shows the number of listed warrants on selected European exchanges as at the end of January 2021.

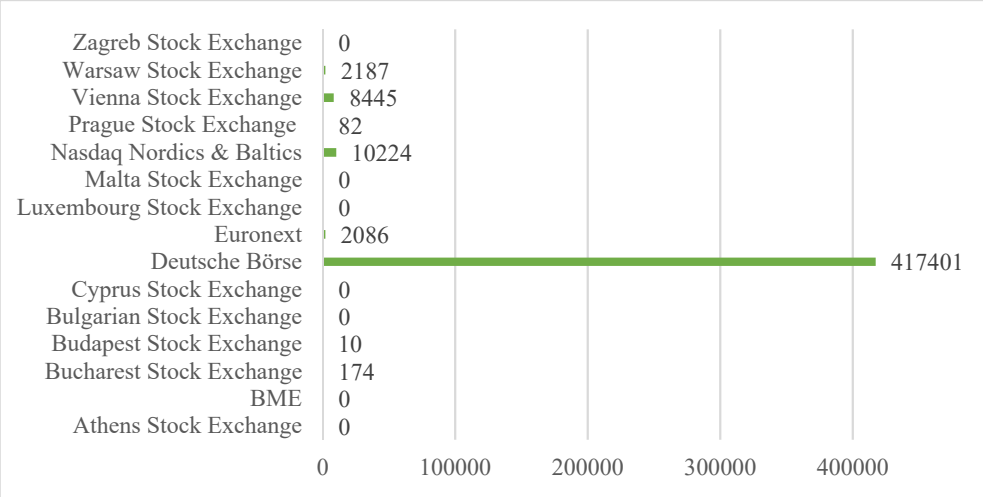

Figure 11. Number of warrants listed on selected European exchanges at the end of January 2021

Source: Own study based on statistical data of FESE

According to the data shown in Figure 11, the leading entity is Deutsche Börse with the result of 417,401 listed warrants. The achieved result represents 95% of all warrants listed on the analyzed exchanges. No warrants were recorded on the seven analyzed entities.

Figure 12 shows the number of concluded warrant purchase / sale transactions on the analyzed markets as at the end of January 2021.

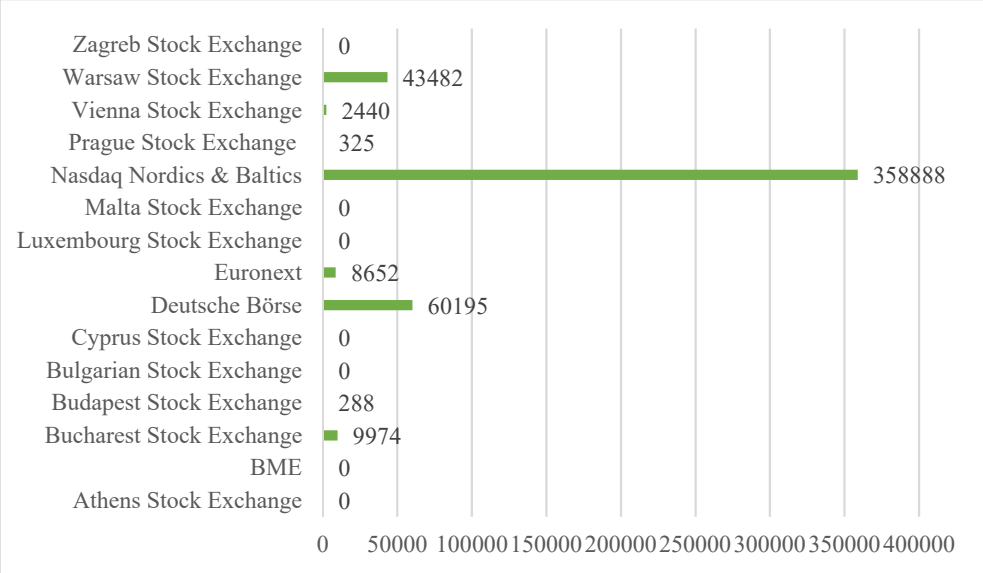

Figure 12. Number of buy / sell transactions of warrants on selected European exchanges at the end of January 2021
Source: Own study based on statistical data of FESE

According to the information presented in Figure 12, the largest number of concluded transactions was recorded on the Nasdaq Nordics & Baltics exchange. Deutsche Börse is second in the ranking with a result almost six times lower. The podium is closed by the Warsaw Stock Exchange with 43,482 concluded transactions. The remaining entities that recorded purchase / sale transactions achieved a result of less than 10,000 transactions at the end of January 2021.
Figure 13 shows the value of warrant turnover on the analyzed entities as at the end of January 2021.

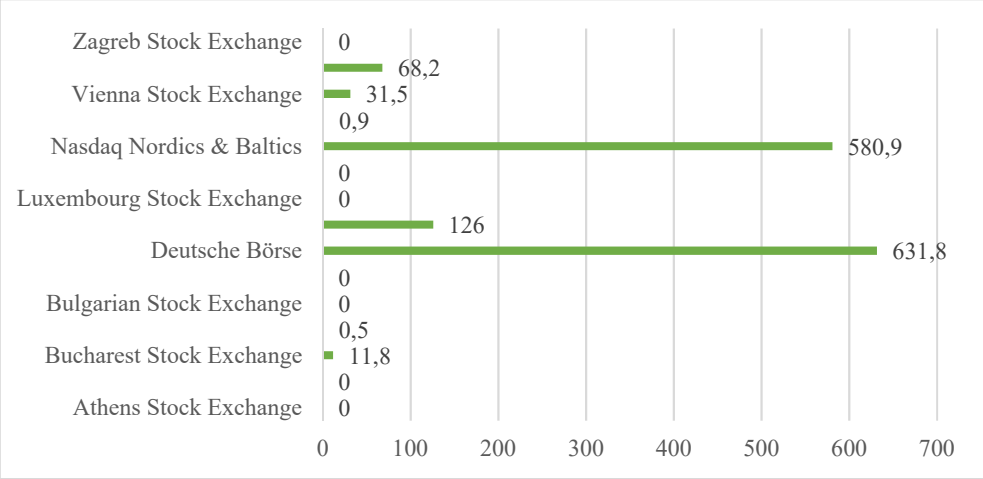

Figure 13. The value of warrant trading on selected European exchanges at the end of January 2021 [million euro]
Source: Own study based on statistical data of FESE

Based on the data presented in Figure 13, it can be observed that the highest value of turnover was recorded on the German market. Only three entities have achieved a result above EUR 100 million, they are: Deutsche Börse, Nasdaq Nordics & Baltics and Euronext. The aforementioned entities are responsible for 92% of the turnover of all analyzed European exchanges.

Conclusions

After analyzing the German stock exchange against other entities, it can be noticed that in the case of the market:

1. Shares - German Deutsche Borse, although having a relatively small number of shares listed on the stock exchange, is on the podium in terms of the purchase / sale transactions carried out and the value of trading in shares. In terms of the number of transactions, the German stock exchange came third, while the value of Deutsche Borse's turnover was second. The obtained results show that in the case of the German stock exchange, the highest average number of transactions per share was recorded among the other exchanges (average 42,304 transactions per share) and the highest average value of turnover per transaction among other exchanges (average EUR 8,301 per transaction).
2. Bonds - despite the relatively large number of listed bonds, the number of buy and sell transactions was not only lower than the number of listed bonds, but also the value of bond trading was marginal in relation to parent entities. For comparison, the trading value of Nasdaq Nordics & Baltics

was 113 times higher, and the result achieved by Deutsche Boerse was 723 times lower than the BME exchange, which is in the first place.
3. ETF - the German stock exchange recorded the best results both in terms of the number of ETF certificates listed, as well as the number of buy / sell transactions concluded and the value of turnover achieved. It is worth noting that in the discussed market there are 3 dominant entities of the said market. The number of ETF purchase / sale transactions in Deutsche Boerse is almost three times higher than the second-placed Euronext exchange. However, in the case of the turnover value, this result is more than 2.5 times higher than Euronext, which is second in the ranking.
4. Warrants - Deutsche Boerse is the leader in the number of listed warrants, representing 95% of all warrants on the discussed European exchanges. Nevertheless, the number of buy / sell transactions oscillated around 60,000 (almost six times less than Nasdaq Nordics & Baltics). Nevertheless, it was Deutsche Boerse that recorded the highest value of warrant turnover (EUR 50.9 million higher than Nasdaq Nordics & Baltics, which is ranked second).

Considering the above, it can be concluded that the position of Deutsche Boerse on the European capital market is extremely important. After a comparative analysis of the data on the offered financial instruments, the German stock exchange should be identified as an entity that has a real impact on the shaping of the capital market in Europe. A well-established position of the entity in relation to the offered financial products may have a real impact on the dynamics of growth and the position of competitive markets. Due to the possible influence of the German capital market, it is worth making an attempt to explore this area. This article is an introduction to the discussed issue and requires further research.

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ARTICLES

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THE RENEWABLE ENERGY LABOR MARKET INCLUDING COVID-19

Abstract

The aim of this paper is to present the changes taking place in the labour market in the renewable energy sector in the period before the COVID-19 pandemic and to show the opportunities and threats for this sector as a result of the changes taking place. Therefore, the factors shaping employment in the renewable energy sector, global employment in the sector and the role of the value chain in shaping the local labour market were analysed on the example of photovoltaics. Basic methods of descriptive statistics were used for this purpose. A SWOT analysis for the renewable energy market in the context of COVID-19 considerations was also carried out.

JEL classification: *J4, Q20*

Key words: *labour market, renewable energy sector, photovoltaics*

Paper type*: Theoretical research article*

Introduction

The benefits of renewable energy for the environment, such as lower carbon dioxide emissions and less air pollution, have been widely known for decades. However, many other positive socio-economic effects have only become more noticeable in recent decades as a result of the increasingly widespread implementation of this type of technology.

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Renewable energy[1] is a guarantee of maintaining the pillars of sustainable development (environmental, economic and even social). Except decreasing costs and continuous improvement of technology, the transition to renewable energy sources also creates numerous employment opportunities.

The impact of renewable energy technologies (RES) on job creation is one of the important arguments for RES support policies, found in European Union (EU), national, regional and local documents (Sidorczuk-Pietraszko, 2015, pp. 28). Renewable energy creates a significant (and growing) number of jobs every year in the world. The renewable energy sector employed a record number of 10.9 million people in the world in 2018.This fact is conditioned by increasing investments, decreasing costs, technological improvements and government policies supporting renewable energy sources.

In addition to striving for climate-related goals, many governments have recognized renewable energy as a stimulus for low-carbon economic growth. The supply chain has diversified, which has consequently contributed to the extension of the geographical coverage of the sector. More and more countries are taking an example from leading markets in this respect and combining the use of "green technologies" with wider socio-economic benefits. The anticipation that the renewable energy industry will replace the unsustainable fossil fuel industry is becoming more common.

Employment in the renewable energy sector increases every year. More and more countries produce, sell and install renewable energy technologies. Due to the accelerating pace of global energy transformation, the employment dimension in this sector ensures socio-economic stability and is another reason why countries commit to implementing renewable energy technologies.

The aim of this paper is to present the changes taking place in the labour market in the renewable energy sector in the period before the COVID-19 pandemic and to show the opportunities and threats for this sector as a result of the changes taking place. Therefore, the factors shaping employment in the renewable energy sector, global employment in the sector and the role of the value chain in shaping the local labour market were analysed on the example of photovoltaics. Basic methods of descriptive statistics were used for this purpose. A SWOT analysis for the renewable energy market in the context of COVID-19 considerations was also carried out.

[1] RES - renewable energy sources.

1. Review of research results on the impact of renewable energy technologies on employment

Research on the assessment of the effects of policies supporting renewable energy sources and the development of RES technologies on the labour market in general has been conducted in the European Union since the 1990s, among others within the projects The Potential Contribution of Renewable Energy Schemes to Employment Opportunities (ECOTEC Research & Consulting Ltd, 1995); Monitoring and Modelling Initiative on the Targets for Renewable Energy (ALTENER Programme, 2003) and The impact of renewables on employment and economic growth in the European Union (EmployRES, 2009). These analyses aimed to capture the overall effects of renewable energy support policies, including employment.

At the regional level, Moreno and Jesus López (2008, p. 11) estimated the employment impacts associated with the development of renewable energy sources in the Asturias region of Spain. For the period 2006-2010, three scenarios were analysed taking into account different levels of RES use, with more or less active policies to support RES.

Thornley, Rogers and Huang (2008, pp. 1922–1927) carried out a detailed technical, economic and environmental assessment for individual biomass energy technologies, including the labour demand at each stage of the process.

E. Sidorczuk-Pietraszko (2015, pp. 26-41) in her research presented the impact of RES technologies on local job creation. In this study, employment in renewable energy installations was determined, especially the relative measure of the impact on employment.

Golisz E., Maczynska J., Wozniak K. (2016, pp. 32-33) presented issues related to employment in the renewable energy sources sectors in Poland and in the European Union in the context of Directive 2009/28/EC. They identified opportunities for job creation in the RES sectors in Poland. They stated that development of RES markets creates opportunities for new professions resulting from both traditional and innovative activities. Moreover, they discussed the domestic market of RES equipment production in the context of new jobs.

In turn, P. Gradziuk (2017, pp. 92-98) examined the impact of renewable energy on the labour market. The study shows that the largest number of jobs in relation to the generated energy was created in the wind energy sector and in the solar energy sector, both solar and photovoltaic. The key factor influencing such a development of employment rates in these sectors was the fact that the amount of energy generated per unit of installed capacity was several times lower than in the case of other RES.

Systematic analyses of the renewable energy market are conducted by EurObserv'ER and IRENA, which prepare systematic reports for individual renewable energy subsectors. The data contained in these studies were used for the preparation of this article.

In general, the studies so far indicate that the amount of employment generated in the different phases of the life cycle of RES technologies varies, depending on the type of technology, and that the spatial distribution of these effects varies considerably. This depends decisively on the labour intensity of the individual life cycle phases.

2. Factors determining employment in the renewable energy sector

Employment in the renewable energy sector is conditioned by several basic factors. They shape the way new jobs are created and their location. These factors include government policies, supply chain diversification, trade patterns and trends in industry reorganization and consolidation. It should be noted that these factors generate an increase in labor productivity over time. As the renewable energy industry becomes more mature, it obtains economies of scale and increases its technological advancement, and thus the automation of its processes. The consequence of this automation is a lower employment rate.

Governmental activities such as auctions, tenders, guaranteed tariffs, subsidies, industrial policy and labor and trade policy are necessary due to the development and maturation of the renewable energy sector. In this way, government policies have a strong impact for employment.

Guaranteed tariffs were necessary to create many of today's markets, but if their rates are too high then they can become a budgetary burden. The growing role of tenders in recent years has resulted in lower project implementation costs, greater competitiveness with fossil fuels, and thus greater use of 'green technologies'. Competitiveness in tenders also involves some risk. This is because winning offers do not always have to result in positive results. Cost pressure may lead some companies to use cheaper and very often also low quality equipment. Cost pressure can also manifest itself in lower levels of employment, wages or skills training (IRENA, 2018a, p. 22-23; 2017a, p. 16).

Government policies on renewable energy sources need to be well-balanced. It seems necessary to balance actions between strong supporting elements and aggressive restrictions. Equipment manufacturers, project developers, and other industry players need to feel stabilized as part of their business activity. Therefore, all government regulations and strategies should be introduced well in advance so that the renewable energy sector has enough time to prepare for them.

Properly developed investment incentives support emerging industries. Preferential loans, business incubators and business development programs are also helpful. The creation of new jobs in the renewable energy sector is also supported by appropriate education and training policies. Their goal is to build a competent workforce (IRENA, 2017b, 2017c, 2018b).

An example of an effective industrial policy are well developed domestic supply chains and economies of scale that can be observed in the Chinese photovoltaic industry. Production clusters in the Yangtze River Delta play a key role. The extensive industrial infrastructure in this area, low energy prices and the presence of suppliers from sectors such as the glass industry allows solar energy companies to buy cheap raw materials. Strong support from central governments, provinces and municipalities also plays a very important role here. Many other countries can, in principle, imitate such policies in order to build viable national supply chains (Ball et al., 2017, pp. 28-30).

Domestic markets are important for creating jobs in the lower segments of the value chain. Well-developed domestic supply chains allow for a lower dependence on the import of equipment and components. On the other hand, export sales are also important for creating jobs in countries that serve as regional or global production centers. This is especially true of China and many European countries (EurObserv'ER, 2019, pp. 173-175).

Trade profiles of countries in the renewable energy sector differ significantly between its individual technologies. For example, China is the largest exporter of solar photovoltaics (Figure 1), however their wind energy companies mainly serve the domestic market. In turn, Europe is a net importer of photovoltaic devices, but the wind sector (especially in Denmark, Germany and Spain) is strongly export-oriented. In addition, European wind companies play a large role in global energy production. The USA is a small exporter of wind equipment and has a very small trade deficit in this sector, but is a large net importer of solar energy along with countries such as India and Turkey (Bloomberg New Energy Finance, 2019).

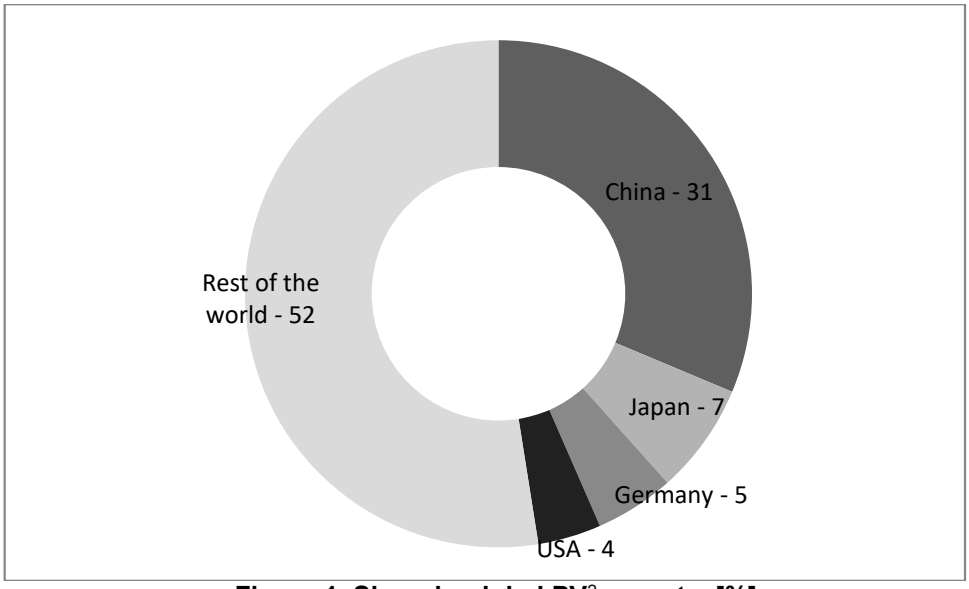


Figure 1. Share in global PV[2] exports [%]
Source: Own study based on: EurObserv'ER, *The State of Renewable Energies in Europe, 2018 Edition*, Paris 2019, p. 235.

In the case of biofuels, the USA accounted for nearly 30% of exports in 2016. They were ahead of European countries (including the Netherlands, France, Belgium, Hungary, Germany and the United Kingdom). In hydropower, China accounted for a quarter of global exports, while European companies (mainly from Germany, Austria and Italy) had a 46% market share. The US and India contribution was slightly below 5% (IRENA, 2019, p. 8).

Transformations in renewable energy supply chains are changing the geographical nature of the industry and its trading patterns. This phenomenon affects the labor market. Corporate strategies are globally recognized as a key driver of the industry. However, some countries are trying to play an active role in the industry through local/national markets.

For example, the solar industry has changed significantly since 2012. A large part of the production capacity has been transferred to Asia, which currently accounts for 92% and 85% of global cell and module capacities respectively[3]. In addition to China's dominant role, other Southeast Asian countries are also becoming significant exporters. The US, India and Europe are largely focused on imports (Roselund, 2019). In order to build or maintain a national production base, some importing countries have adopted different

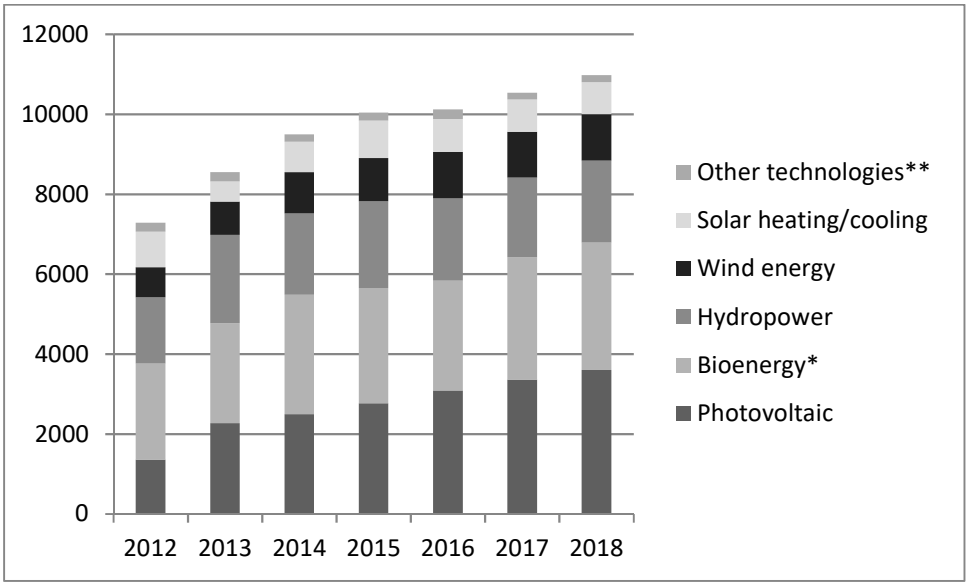
[2] PV – photovoltaics
[3] Including India.

import tariffs and compensatory charges. However, the effectiveness of such policies can also have a negative effect (Trendforce, 2019).

As a result of growing competitive pressure, industry consolidation is changing the face of the renewable energy sector. For example, Siemens and Gamesa have merged in wind energy. Mitsubishi Heavy Industries and Vestas formed an offshore joint venture (MHI Vestas). GE, in turn, bought Alsthom wind assets and acquired Danish LM Wind Power (IRENA 2019, p. 10).

3. Global employment in the renewable energy sector

Employment in renewable energy sources is constantly growing (Figure 2). In 2017, 10.5 million people were employed worldwide, while in 2018 this number increased to 10.9 million. As more and more countries produce, sell and install renewable energy technologies, the number of jobs in the renewable energy sector has risen to its highest levels so far. Global growth occurs despite the noticeable slower development in key renewable energy markets.



*Bioenergy - liquid biofuels, solid biomass and biogas

**Other technologies - geothermal energy, heat pumps, municipal and industrial waste, concentrated solar power (CSP), tidal energy

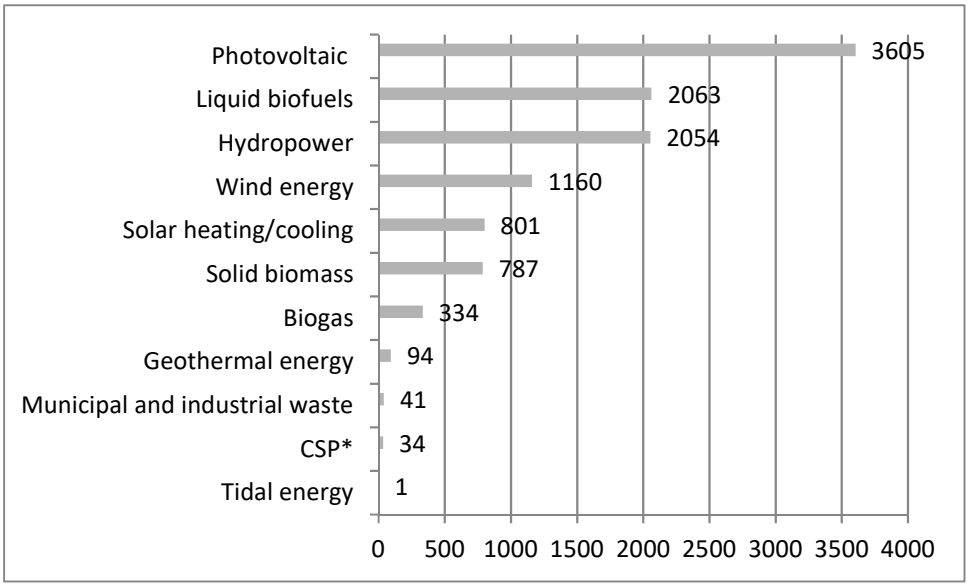
Figure 2. Employment in renewable energy sources by technology in the years 2012-2018 [thous.]

Source: Own study based on: Database International Renewable Energy Agency – www.irena.org [access 04.01.2020].

The solar industry maintains the highest position in the renewable energy industry with one-third of the total workforce of the entire sector. In 2018, employment in photovoltaics increased in India, Southeast Asia and Brazil. In contrast, China, the US, Japan and the European Union slowed down.

The growing production recorded in the biofuels sector contributed to an increase in employment in this industry by 6% to 2.1 million. Obviously, employment growth is recorded in countries where renewable energy is gaining popularity, but above all also in those whose supply chains are dominated by 'handwork'. Such countries include, for example, Brazil, Colombia and Southeast Asian countries. On the other hand, the USA or European Union countries have much more mechanized production processes and in this type of countries employment may slow down at some point in the development of the industry due to mechanization and automation.

Currently, employment in wind energy amounts to 1.2 million jobs (Figure 3). Land projects dominate, but the maritime segment is still gaining popularity and its development can be even more efficient and intensive when it begins to make full use of the knowledge and infrastructure of the offshore oil and gas sector.



*CSP – Concentrated Solar Power

Figure 3. Employment in renewable energy sources by technology in 2018 [thous.]

Source: Own study based on: Database International Renewable Energy Agency – www.irena.org [access 04.01.2020].

Hydropower has the next largest installed power from all renewable energy sources, but is currently growing slowly. The sector directly employs 2.1 million people, of whom three-quarters involved in operation and maintenance.

Employment in the renewable energy sector remains concentrated in several countries, including China, Brazil, the US, India and EU members. The share of all Asian countries in the market is recorded at 60% of the global total.

Renewable energy plays an increasingly important role in improving access to energy. Direct employment outside the network (off grid) in parts of Sub-Saharan Africa and South Asia has been estimated at 372 000 full time job (Figure 4).

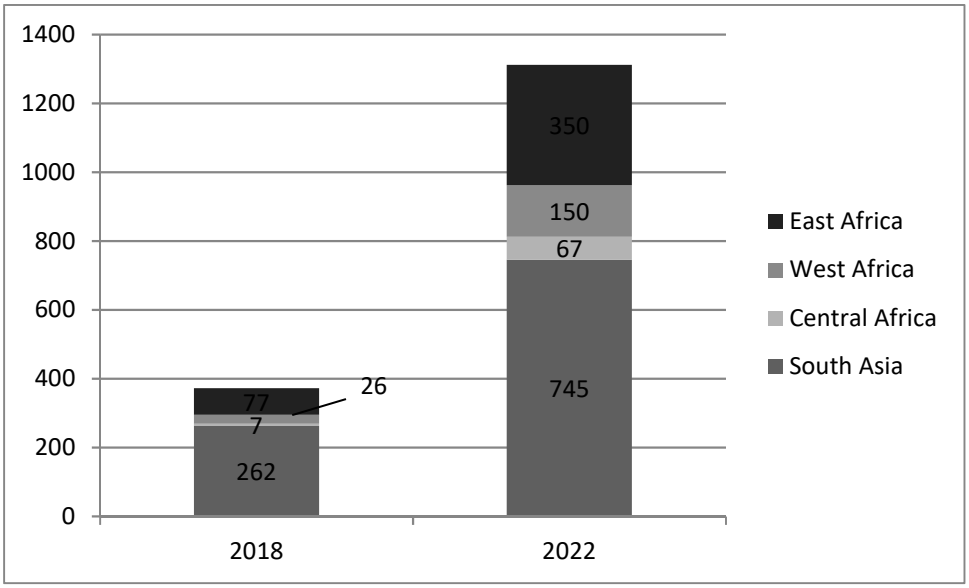


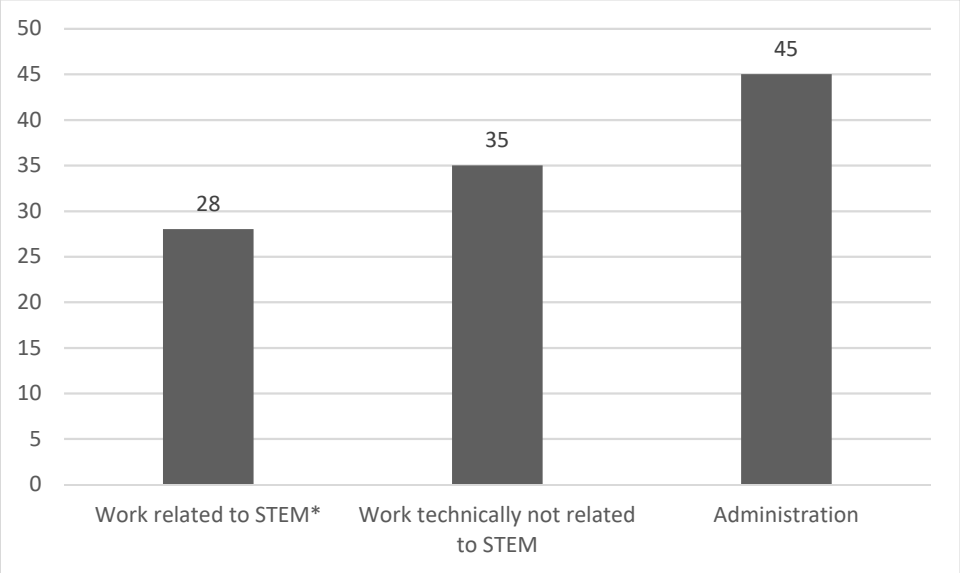
Figure 4. Direct employment outside the network (off grid) in parts of Sub-Saharan Africa and South Asia in 2018 and estimates for 2020 [thous.]
Source: Own study based on: Database International Renewable Energy Agency – www.irena.org [access 04.01.2020].

56% of these jobs are in rural areas (27% are filled by women) (GOGLA and Vivid Economics, 2018, pp. 2-4).

According to forecasts, in 2022 there will be a huge increase in off grid employment (these forecasts should be confronted with the current situation related to COVID-19). It will total about 250%.

Women currently account for 32% of the renewable energy workforce, which is much more than the average of 22% in the global oil and gas industry. The largest percentage of women work in administration (45%).

A significant proportion are employed as technical staff not associated with STEM[4]. In contrast, 28% of all STEM employees are women (Figure 5).



*STEM – Science, Technology, Engineering, Mathematics (Science, technology, engineering and mathematics as common fields of knowledge).

Figure 5. Percentage of women employed in the renewable energy sector [%]
Source: Own study based on: Database International Renewable Energy Agency – www.irena.org [access 04.01.2020].

An important mention is that as the global energy transformation gathers pace, leaders and decision makers strive to maximize social and economic benefits. In addition to decarbonisation and climate goals, countries must create jobs and boost economic development.

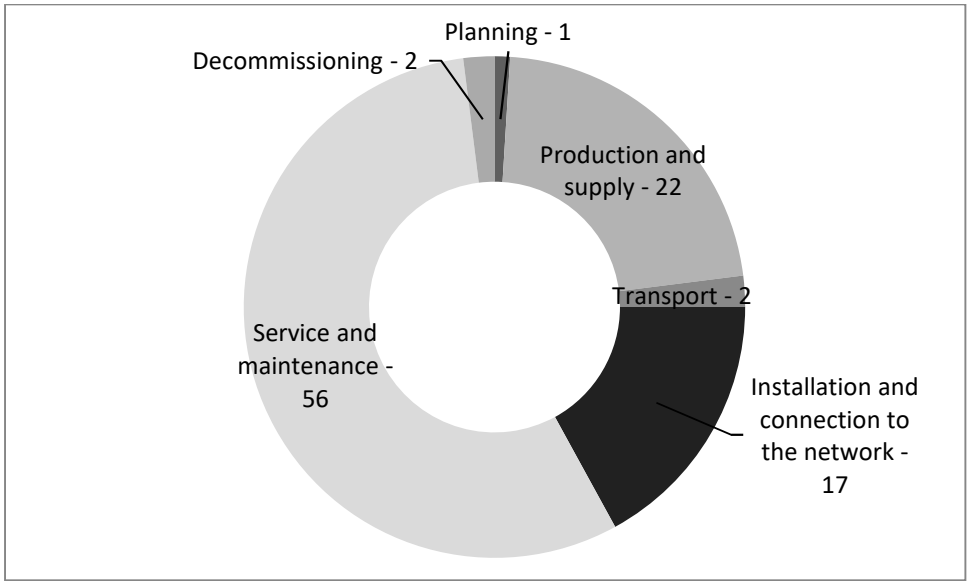
4. Value chain in the development of the local labor market on the example of photovoltaics

The process of implementing solar energy is characterized by continuous growth. In 2007, the installed capacity in this sector was less than 9 GW. However, in 2016 it was already over 290 GW. According to IRENA estimates, achieving energy transformation in the G20 countries would require cumulative investments in the solar sector of approximately USD 3630 billion USD by 2030 and 6610 billion USD by 2050. Such

[4] STEM – Science, Technology, Engineering, Mathematics (Science, technology, engineering and mathematics as common fields of knowledge).

investments can create value and bring economic benefits, including generating income and job creation (IRENA 2017d).

In PV implementing countries, the potential for generating income and creating jobs will depend on the extent to which industry in various segments of the value chain can employ people locally, can use existing economic activities or create new local economic initiatives. This part of the article focuses on the main segments of the photovoltaic value chain: project planning, production and supply, transport, installation and grid connection, operation and maintenance and liquidation. Figure 6 shows the distribution of human resources required throughout the entire value chain for the construction of a 50 MW solar plant (PV).



*The assumed duration of the project is 25 years with the assumption of increasing work efficiency by 3.8% per year.

Figure 6. The distribution of human resources required throughout the entire value chain for the construction of a 50 MW solar plant (PV) [%]

Source: Own study based on: International Renewable Energy Agency, *Renewable Energy Benefits: Leveraging Local Capacity for Solar PV*, Abu Dhabi 2017, p. 12.

56% of photovoltaic installation work is focused on operation and maintenance, and 17% on installation and connection to the network. The solar installation sector is growing rapidly in countries such as China and India, creating new jobs. A large percentage of human resources is also needed at the production and supply stages (22%). Therefore, there is also an increase in employment in this area.

The photovoltaic production process can be based primarily on local resources. This applies to both labor and construction materials. 70 tons of glass, 56 tons of steel and 19 tons of aluminum are needed for solar panels (production of 1 and installation of 1 MW). These materials are used for assembly structures and panels themselves. In turn, about 47 tons of concrete are needed for the foundations of the structure. Figure 7 illustrates the amount of materials needed to produce and install a 1 MW silicon-based solar photovoltaic installation.

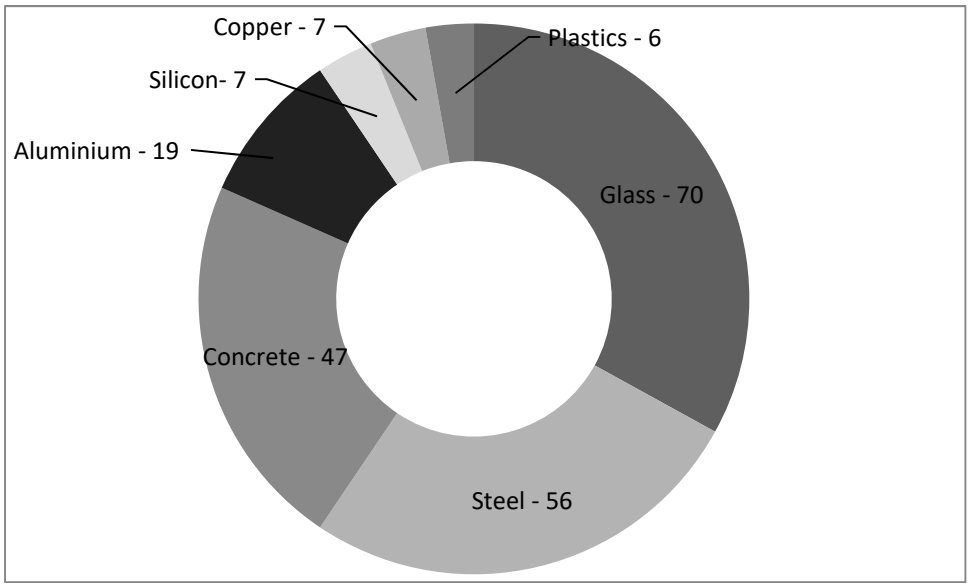


Figure 7. Materials needed to complete a 1 MW solar installation [tons]
Source: Own study based on: International Renewable Energy Agency, *Renewable Energy Benefits: Leveraging Local Capacity for Solar PV*, Abu Dhabi 2017, p. 14.

Other key materials such as silicon, copper and plastic make up a smaller proportion of the total mass of materials needed for a solar installation.

5. The impact of COVID-19 on the RES market

Due to the presentation in this article of the impact of COVID-19 on the renewable energy market on a global scale, the presented conclusions and forecasts are generalized. Therefore, it is not possible to attribute them all to one particular national market, because the development of renewable energy sources varies greatly from one country to another, which results in different reactions to the current market conditions.

Experts' opinion on the effects of coronavirus impact on the renewable energy market is diverse. Some see weaknesses and threats, while others

see opportunities. Table 1 presents the SWOT analysis for the renewable energy market in the context of conditions related to COVID-19.

According to New York Times forecasts, coronavirus is a bigger threat to fossil fuels than to the renewable energy sector. An example is the US market forecast. Renewable energy sources may reach 21% in the American energy mix in 2020, compared with 18% in 2019 and 10% in 2010. Experts believe that the US renewable energy sector, unlike the fossil fuel sector, will develop despite the recession caused by the COVID-19 crisis (CIRE 2020).

Table 1. SWOT analysis for the renewable energy market in the context of conditions related to COVID-19

Strengths	**Weaknesses**
- currently lower operating costs of RES producing plants than, for example, fossil fuel power plants; - an increase in the share of renewable energy sources in domestic energy mixes.	- dependence on advanced technologies; - sensitivity to a lack of replacement components (dependence on the Chinese market); - renewable energy market dependence to a large extent on government subsidies.
Opportunities	**Threats**
- the growing attractiveness of renewable energy sources for power plants and investors, due to lower operating costs; - natural gas and coal prices staying at a relatively constant level (despite drastic reductions in oil prices); - decrease in emissions CO_2; - traditional methods of coal mining and energy production are becoming risky for employees and their health.	- economic slowdown, which will affect parts of the RES industry, as well as the entire economy; - risk of inhibiting government incentives - lower investment capacity of prosumers; - postponed investments will mean that, for example, small companies selling and assembling panels may not survive this downtime; - decrease in energy consumption due to reduced production due to COVID-19 restrictions; - reduction of conventional energy prices; - reduction of CO_2 emission prices; - collapse of supply chains, e.g. solar panels and inverters from China.

Source: Own study

The New York Times reports that wind turbines and solar panels are currently producing cheaper electricity in many regions of the world (including California and Texas) than using natural gas or coal. This

obviously contributes to increasing the attractiveness of renewable energy sources for power plants and various types of investors. In addition, the phenomenon of the lack of a drastic fall in natural gas and coal prices is also favorable (despite a significant drop in oil prices) (Plumer, 2020).

Raymond James & Associates analysts believe that even lower electricity consumption, as a result of companies stopping their activities, can contribute to the development of renewable energy sources. They argue in this way that other enterprises that are able to operate, along with a progressive decline in their income, will tend to acquire larger amounts of electricity, including from wind or solar farms, which have lower operating costs than fossil fuel power plants (CIRE 2020).

Lower electricity consumption due to the coronavirus related situation has also been reported in Poland. The first symptoms of this phenomenon occurred in the second half of March, when for two weeks the demand for electricity dropped by 8.5%. The effect of this decline was, among others an increase in the share of renewable energy in the national energy mix. In the long term, of course, demand for energy will increase again. As the economy gradually returns to pre-pandemic levels, it will again have comparable electricity demand.

The economic slowdown caused by the fight against coronavirus will also contribute to the appearance of negative effects in parts of the renewable energy sector - as in the case of the entire economy. Enterprises that have operated successfully so far and employ new employees are now forced to reduce employment and postpone investment. Smaller companies dealing with, for example, selling and installing solar panels are characterized by the biggest sensitivity in this respect. The orders of these entities dropped dramatically due to the decisions of customers who, among others are afraid of "contact" with coronavirus and feel the financial consequences of economic downtime.

According to estimates, the trade association Solar Energy Industries Association, a large part of the RES sector employees (in the United States about 125 thousand.) may lose their jobs due to the pandemic coronavirus (in some cases at least temporarily). Solar Energy Industries Association also reduced the projected increase in new solar capacity in 2020. One-third more than the expected 19 GW. However, these forecasts are considered too pessimistic. Such opinion is, among others independent experts from Wood Mackenzie (CIRE 2020).

The difficulties of the renewable energy sector may also depend on the collapse of the supply chains of solar panels and their components from China. Therefore, in the case of already implemented investment projects, as well as those planned, there may be delays, and in some cases even their suspension. In addition, fewer (diseases and shortages

of foreigners) employee teams will be less efficient at work and more expensive.

Focusing on domestic supplies or imports from outside China can solve the problem of such supply chain disturbances. Substitutes for the Chinese market are often mentioned India, Vietnam or Southern Europe. An example of implementing such a business strategy is the German company building wind farms (Siemens Gamesa Renewable Energy). She announced that she would import the necessary components from India. The long-term goal of such action (except providing ad hoc business continuity) is to become independent of Chinese suppliers.

Negative effects may also occur on the prosumer market. This will be caused by both interruptions in the supply of components and a decrease in the efficiency of installation companies. In addition, the level of savings for individual clients and small enterprises that were to be allocated to own contributions to prosumer investments is reduced. Economic downtime and related financial difficulties forced these entities to gradually use their savings during the national quarantine. The financial difficulties of the market will also result in the fact that banks may be obliged to suspend borrowers' repayments. This process will deprive them of funds to make further investments. In addition, a significant proportion of consumers may lose or decrease their creditworthiness. The growing level of inflation will also be significant, which in some cases may even reach double digits.

One of the threats to the renewable energy market nowadays is also the possibility of stopping government incentives for prosumers. Transfer of funds to other areas of the economy will result in lowering individual investments in this energy sector. Therefore, the challenges faced by the renewable energy industry now need more than ever government stimulation.

Conclusions

Employment in the global renewable energy sector is increasing every year. In 2018, it amounted to 10.9 million people compared to 10.5 million in 2017. The highest concentration of employment in this industry is recorded in several countries, including China, Brazil, the USA, India and members of the European Union. The leaders are in this field primarily Asian countries. Their share is estimated at around 60% of the global sum.

Several basic factors are responsible for shaping the way and location of job creation in the renewable energy sector. These include national industrial strategies and policies, changes in the geographical shape of supply chains and trade patterns, and industry consolidation trends.

Among all renewable energy technologies, it is the solar sector that maintains the highest place in employment. It has with a third of its total

workforce. In 2018, employment in PV increased in India, Southeast Asia and Brazil. Countries like China, USA, Japan and EU Member States have experienced a slowdown in this respect. The growing number of jobs to date is on an increasingly large scale in the off grid sector. This fact is conditioned by the growing production of solar energy outside the network, which in turn translates into increasing access to energy and stimulating economic activity in previously isolated communities.

Growing employment has also been recorded in the biofuels sector. It increased by 6% compared to 2017 to the level of 2.1 million employees. The increase in the production of this type of energy contributed to this. The most intensive employment growth occurs in countries characterized by low industry automation. These are countries which are primarily based on "the work of human muscles". These countries include, for example, Brazil, Colombia and Southeast Asian countries. On the other hand, the USA and EU Member States have much more mechanized production processes and in this type of economies employment is slowed down at some point in development due to mechanization and automation.

Employment in wind energy is 1.2 million jobs. Above all, land projects dominate, but the maritime segment is increasingly used.

As for hydropower, it has the largest installed capacity of all renewable energy sources, but is currently developing slowly. The sector directly employs 2.1 million people, of which about 75% are involved in operation and maintenance.

The positive trend in the renewable employment sector may be shaken to a great extent by the crisis caused by the coronavirus epidemic. Negative effects appearing in the global economy, which is a "connected vessel system", must also affect the renewable energy industry.

Observing the development of the situation on the energy market, it can be concluded that any changes made or occurring automatically under the influence of coronavirus are more of a coincidence than the effect of consistent policy. In fact, we are not able to predict the long-term effects of this situation for the economy, and thus the consequences for the energy market. However, we know for certain that coronavirus is already affecting the energy market. Demand for electricity is reduced, which in turn leads to a reduction in its prices. At the beginning of the pandemic, demand for electricity decreased, which led to a temporary reduction in its price. In the longer term, however, we could see a significant increase in energy prices. Thus, the share of renewable energy sources in domestic energy production is growing. This fact causes a temporary reduction in greenhouse gas emissions.

Despite the increase in renewable energy sources in domestic energy mixes, the coronavirus pandemic is a major threat to this industry. Investments in this energy sector have been significantly slowed down.

Contributed to this, among others disruptions in supply chains, downtime in the construction industry as well as administrative obstacles and various restrictions imposed by the state administration. These are examples of just a few challenges that investors are currently facing. Therefore, it is the governments of individual countries (if they have already decided to take measures to stop the economy), more than ever must engage in saving the industry by offering increasingly attractive and effective programs to stimulate the economy.

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ARTICLES

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An analysis of the relationships among NASDAQ Baltic stock exchanges: VAR approach

Abstract

The author examines the relationships among three stock exchanges of selected Baltic countries: Latvia, Estonia, and Lithuania. The respective stock exchange indexes are used as variables, OMXR for Latvia, OMXT for Estonia, and OMXV for Lithuania. The regression equations are estimated with the use of Vector Autoregressive (VAR) model. The author employs 80 observations for the sample period from2002 Q1 to 2021 Q4. After determining the optimal lag order, the impulse response function is calculated. The variance decomposition is carried out subsequently. A causality among the stock exchanges in question is determined.

***JEL Classifications**: C51; C58; G17*

***Keywords**: Stock exchanges; VAR Model; Impulse Response Analysis; Variance Decomposition*

***Paper type**: Theoretical research article*

Introduction

The development of stock exchanges depends on many economic, social and political factors. These factors, to a greater or lesser extent, shape the financial markets of a given country and, consequently, also affect its stock exchanges. In today's global economy, it is all the more important as the free flow of capital allows for practically unlimited investment

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opportunities to individual and institutional investors. This also applies to stock exchanges. One of the consequences of such a turn of events are the processes of mergers and acquisitions of stock exchanges and the ongoing process of stock exchange consolidation. As a result, the development of stock exchanges as well as the capitalisation of companies listed in a given country may depend on some factors in other countries, regions or the situation on international financial markets. In other words, the relationships and dependencies among stock exchanges in different countries may deepen. Changes in the prices of shares listed on stock exchanges may be subject to fluctuations resulting not only from the situation in a domestic market, but also due to changes in the economic situation on foreign exchanges. This may indicate a link between the exchanges in the short term, long term or both. In this article, the author investigates whether there is a statistically significant relationship among the stock exchanges in selected Baltic countries (Lithuania, Latvia, Estonia) using the VAR method.

Literature Review

In the quantitative analysis of stock exchanges, the study of the determinants of their development, relationships, and the degree of integration among the analysed exchanges, authors use various methods. Some use the VAR model, which serves to study the determinants of the development of financial markets, stock exchanges, and the banking sector. The authors apply the VAR method together with a wide range of variables to determine the significance and direction of their impact on stock exchanges.

Thangavelu and Ang (2004) examine the relationship between financial development and economic growth in Australia with the use of the VAR model.They establish a causality from economic growth to the development of financial intermediaries and from financial markets to economic growth.

Caporale, Howells and Soliman (2004) conclude that well developed stock markets can foster economic growth in the long run. They employ the method of VAR and VAR causality tests. Their study refers to Argentina, Chile, Greece, Korea, Malaysia, Philippines, and Portugal. The quarterly data sample spans the period from 1977Q1 to 1998Q4. They use some sets of indicators like market capitalisation/GDP, total value of shares traded on the stock exchange/GDP, bank deposit/GDP, and the ratio of bank claims on the private sector/GDP.

The studies carried out by Rousseau and Wachtel (2000) on a group of 47 countries in the period of 1980-1995 use annual data. The application of econometric model uses short time series (5-year) and the VAR method. They employ the following set of indicators: M3/GDP, market

capitalization/GDP, value traded/GDP. They confirm that there is a strong impact on the liquidity increase of stock exchanges and an increased market activity of financial intermediaries for economic growth.

Dritsaki and Dritsaki-Bargiota (2005) examine empirically the causal relationship among financial development, credit market, and economic growth in Greece. They use a trivariate autoregressive VAR model and conclude that there is a bilateral causal relationship between banking sector development and economic growth and a unidirectional causality between economic growth and stock market development in Greece in the period 1988.1-2002.12.

Shan (2005) uses a Vector Autoregression (VAR) approach with quarterly time-series data for the countries examined and utilises total credit as a proxy of financial development.He finds only weak evidence to support the hypothesis that financial development leads economic growth in 10 OECD countries and China.

Abu-Bader's and Abu-Qarn's (2008) empirical results strongly support the hypothesis that the finance-growth causality is bi-directional. Financial development causes economic growth through both increasing resources for investment and enhancing efficiency. The authors examine the causal relationship between financial development and economic growth in Egypt during the period 1960-2001 using the VAR model.

Dritsakis and Adamopoulos (2004) use a M2/gdp and trade flows (imports plus exports) as variables. They employ quarterly data from 1960:I to 2000: IV and the VAR method of estimation. They find that there is a causal relationship between financial development and economic growth, and between the degree of openness of the economy and economic growth in Greece in the given timeframe.

Caporale, Howells and Soliman (2005) confirm that investment productivity is the channel through which stock market development enhances the economic growth in the long run, especially in less-developed countries. As variables, they use gross fixed capital formation/nominal GDP, real change of GDP to the real level of total investment, the value of listed shares/GDP, and thetotal value of shares traded on the stock exchange/GDP.They employquarterly data, 1979Q1 – 1998Q4 for Chile, Korea, Malaysia, and Philippines. The method of estimation is theVAR model.

Ghirmay (2006)employs the VAR model in his research. He states that financial development affects growth through the channels of investment and its productivity in the USA. He uses productivity, investment, and financial development as a set of variables. He utilises an annual dataset for the period of 1970-2001.

Shan and Jianhong (2006) use annual data for China from 1978 to 2001. The rate of change of total credit, the rate of change of investment, trade

flows/gdp, and the rate of change of labour force are variables and VAR is the method of estimation of structural parameters. They conclude that there is a bi-directional causality between financial development and economic growth in China. Financial development seems to be only the second force after labor input in contributing to economic growth in China

Theophano and Sunil (2006), using bivariate VAR models, suggest that there is a negative impact of inflation and money supply on stock returns. The study covers the period1990-1999.

Basci and Karaca (2013) examine the relationship between ISE 100 Index and a set of fourmacroeconomic variables (exchange, gold, import, export) using the Vector Autoregressive (VAR) model for Turkey. They utilise monthly data from January, 1996 to October, 2011. After running VAR, they conclude that the second default of the exchange is 31% explained by share indices.

Data and Methodology

The indexes of three NASDAQ Baltic exchanges serve as variables: OMXR for Latvia, OMXT for Estonia, and OMXV for Lithuania. They are all-share type (or broad) indexes, which means they cover all or almost all the companies listed on the respective exchanges. The author utilizes 80 observations for the sample period from 2002 Q1 to 2021 Q4. However, the final number of observations used in the model is 72 due to a data transformation applied in order to eliminate the problem of non-stationarity of variables.

The regression equations are estimated with the use of the Vector Autoregressive (VAR) model.

The regression equation can be represented in the general matrix form as follows:

$$y_t = A_0 D_t + \sum_{i=1}^{k} A_k y_{t-k} + e_t \quad (1)$$

where:

t = 1, 2, 3, …, T,

y_t – the vector of current observations of *n* variables of the model - $y_t = [y_{1t} y_{2t} \dots y_{nt}]'$,

D_t – the vector of deterministic equation components,such as intercept, time variable, zero-one variables or other non-stochastic regressors,

A_0 – the matrix of parameters of D_t vector of variables with no zero elements,

A_i – the matrix of parameters of lagged variables of y_t vector with no zero elements

e_t – the vector of stationary error terms - $e_t = [e_{1t} e_{2t} \dots e_{nt}]'$ with normal distribution and mean and variance of zero.

3 variables are under study, so it is required to estimate 3 equations as listed below:

$$y_{1t} = \mu_1 + \sum_{i=1}^{k} \alpha_{1i} y_{1t-i} + \sum_{i=1}^{k} \beta_{1i} y_{2t-i} + \sum_{i=1}^{k} \gamma_{1i} y_{3t-i} + \varepsilon_{1t} \quad (2)$$

$$y_{2t} = \mu_2 + \sum_{i=1}^{k} \alpha_{2i} y_{1t-i} + \sum_{i=1}^{k} \beta_{2i} y_{2t-i} + \sum_{i=1}^{k} \gamma_{2i} y_{3t-i} + \varepsilon_{2t} \quad (3)$$

$$y_{3t} = \mu_3 + \sum_{i=1}^{k} \alpha_{3i} y_{1t-i} + \sum_{i=1}^{k} \beta_{3i} y_{2t-i} + \sum_{i=1}^{k} \gamma_{3i} y_{3t-i} + \varepsilon_{3t} \quad (4)$$

where:
k – the number of lags, in this case up to 6,
y_{1t} – the value of Latvian stock exchange indexOMXR in time *t*,
y_{2t} – the value of Estonian stock exchange index OMXT in time *t*,
y_{3t} – the value of Lithuanian stock exchange index OMXV in time *t*,
y_{1t-i} – the lagged value of Latvian stock exchange index OMXR up to the lag order of 6,
y_{2t-i} – the lagged value of Estonian stock exchange index OMXT in time up to the lag order of 6,
y_{3t-i} – the lagged value of Lithuanian stock exchange index OMXV in time up to the lag order of 6,
$\alpha_{1i}, \alpha_{2i}, \alpha_{3i}$ – structural parameters, where the first subscript denotes the number of equation and the second subscript, the number of lags,
$\beta_{1i}, \beta_{2i}, \beta_{3i}$ – structural parameters, where the first subscript denotes the equation number and the second subscript, the number of lags,
$\gamma_{1i}, \gamma_{2i}, \gamma_{3i}$ – structural parameters, where the first subscript denotes the equation number and the second subscript, the number of lags,
μ_1, μ_2, μ_3 – the intercept, where the subscript denotes the equation number,
$\varepsilon_1, \varepsilon_2, \varepsilon_3$ – error term (called shock, innovation or impulsein the VAR nomenclature), where the subscript denotes the equation number.

The basic condition for building a VAR model is the stationarity of the variables. In the first step, the stationarity is examined. At the next stage, the length of the lags that will be used to build the model is determined. The Akaike (AIC), Hannan-Qiunn (HQC), and Schwartz information criteria (BIC) are most often used. Having stationary variables and selected lag order, the model is estimated. The tests of autocorrelation, the test of ARCH effect, and thetest for the normality of residuals should be performed then. This is also where Granger causality is defined. Engle-Granger cointegration can also be examined to determine if there is a statistically significant long-term relationship between

the variables under study. Then the unit roots of the equation are estimated, followed by the impulse response function. Finally, variance decomposition is carried out for individual variables and possibly a forecast for future periods. In order to test for the stationarity of variables, they are subjected to the augmented Dickey-Fuller test (ADF) with the intercept. For the purposes of the ADF test,11 lags suggested by the GRETL program are adopted. The variables turn out to be stationary, as the obtained p-values are lower than the accepted significance level of 0.05. In order to estimate the number of lags, all three information criteria are taken into account. The maximum lag of six is implemented. The function with the intercept is used. The results are presented in Table 1.

Table 1. The choice of lag order.

VAR system, maximum lag order 6					
The asterisks below indicate the best (that is, minimized) values of the respective information criteria, AIC = Akaike criterion, BIC = Schwarz Bayesian criterion and HQC = Hannan-Quinn criterion.					
Lags	loglik	p(LR)	AIC	BIC	HQC
1	181.50450		-4.708458	-4.329014	-4.557401
2	201.55305	0.00001	-5.015362	-4.351335*	-4.751011*
3	210.43053	0.03813	-5.011959	-4.063348	-4.634314
4	217.71758	0.10332	-4.964377	-3.731183	-4.473439
5	227.97677	0.01497	-4.999355	-3.481577	-4.395123
6	241.93492	0.00099	-5.137081*	-3.334720	-4.419556

Source: The author's own calculation using GRETL.

The optimal lag order is the one for which information criterion values are the lowest, which means the lowest information loss. Not all the information criteria indicate the same order of lags. After the multiple estimation of the VAR model for all the variables including and excluding seasonal instrumental variables, the second-order lags give a statistically insignificant result for the variables in each of the three equations, therefore, the order of 6 lags is used. It is consistent with the Akaike information criterion.

In each estimation, the seasonal variables are not statistically significant and some additional tests of seasonality confirm the absence of seasonality in the analysed time series. Moreover, the estimates for the order of 2 lags give too low values of the normality of the residuals test (below the adopted significance level of 0.05). As a result, the order of six lags is adopted for the model estimation.

Empirical Results

The model estimation results indicate that the changes in the Latvian stock exchange situation depend on their changes from previous periods (1, 2, 3, 4 and 6) and on changes from previous periods (2, 3, 4 and 5) of the Estonian stock exchange index. Changes in the stock market situation as measured by the stock exchange index in Lithuania do not have a statistically significant effect on the changes in the Latvian stock exchange index (see Table 2).

In the case of Estonia (see Table 3), the changes in the stock exchange situation areinfluenced by the changes of the Estonian stock exchange index from the previous period and the changes in the stock exchange situation in Lithuania from previous periods (2, 3, 4).

On the other hand, changes in the Lithuanian stock exchange index (see Table 4) are influenced by the changes in this index in previous periods (1, 2, 3, 4, 5) and the changes in the stock market situation in Estonia from previous periods (4, 5, 6).

The coefficient of determination for subsequent equations reaches 56%, 48% and 52%, respectively, which proves an average fit of the model to the data. However, the statistic of the Durbin-Watson test seemsmore important in the VAR model, which for all equations is in the required range of 1.85-2.20 (1.89, 1.90 and 1.94, respectively) and thus indicates the desired effect of the lack of autocorrelation in the random term. In addition, the VAR model is implemented with the option of robust standard errors in order to eliminate the problem of heteroskedasticity.

After estimating the model parameters, the model's diagnostic tests should be performed - the autocorrelation test, ARCH test, andtest for the normality of residuals. All the tests are performed on a lag order of 6. The first three tests give the desired results – no autocorrelation, no ARCH effect, and a normal distribution of residuals.

Table 2. The normality of residuals test

Test for normality of residuals
Doornik-Hansen test
Chi-square(6) = 11.2643 [0.0805]

Source: The author’s own calculation using GRETL.

Additionally, the Engle-Granger cointegration test is carried out, which examines the presence of a relationship between the variables. Both the Chi-square test for the normality of residuals and the ADF test for unit root in residuals estimations indicate that the residuals are normally distributed and there is a significant relationship between the variables under study.

Table 3. Testing for a unit root in residuals (uhat)

Augmented Dickey-Fuller test for uhat including 6 lags of (1-L)uhat, sample size 71
unit-root null hypothesis: a = 1
test without constant
model: (1-L)y = (a-1)*y(-1) + ... + e
estimated value of (a - 1): -3.73599
test statistic: tau_c(3) = -4.39103
asymptotic p-value 0.007234
Critical value of tau from Dickey-Fuller statistical tables = -1,94 with the significance level of 5%
There is no unit root in uhat. The result of the test indicates that time series is cointegrated

Source: The author's own calculation using GRETL.

After a positive verification of the aforementioned tests for the given VAR model, the unit roots of the characteristic equationare to be determined. In GRETL, the unit roots of the characteristic equation are estimated automatically. All the unit roots of the characteristic equation are to be less than one in terms of the modulus. The number of roots of the characteristic equation for the model consisting of three variables for six lags is 18. All the roots of the characteristic equation are inside the circle, so this condition has been met (see Figure 1).

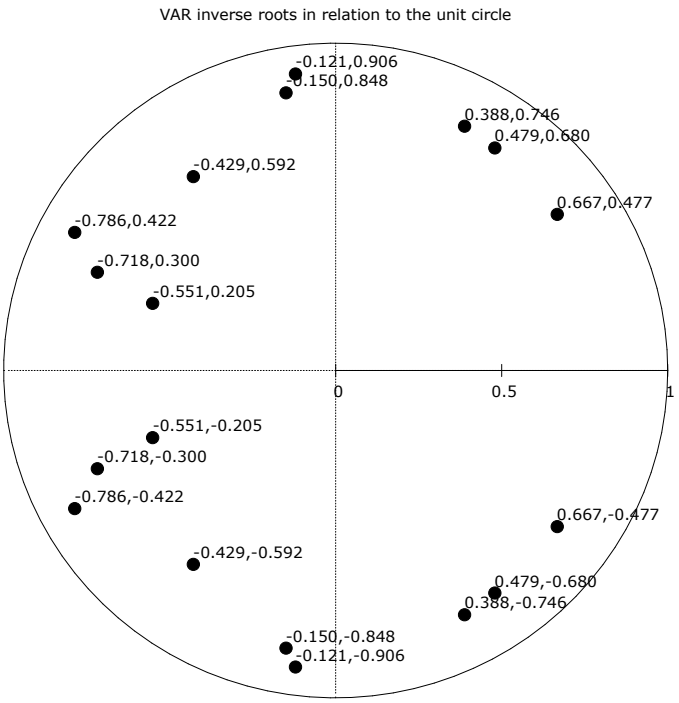

Figure 1. Characteristic equation unit roots.
Source: The author's own calculation using GRETL.

The next step is to evaluate the impulse response function. The impulse is set at one standard error of the residuals. The response from Latvia in the first equation, Estonia in the second equation, and Lithuania in the third equation to the shock from individual variables are statistically significant in the initial period, while in the following quarters this effect fades away. This is illustrated in detail for all the equations in Figure 2.

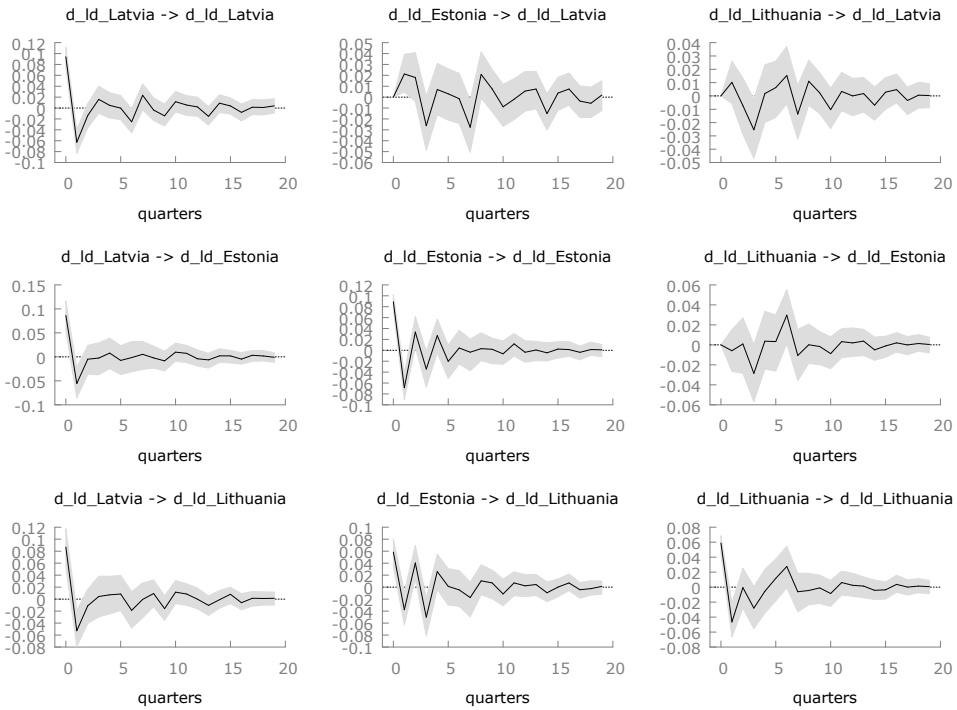

Figure 2. Impulse response functions.
Source: The author's own calculation using GRETL.

The final step in presenting the VAR model is the variance decomposition. Table 4 presents its course for Latvia. After some initial fluctuations, the variables are fairly stable since the ninth period. In the case of the Estonian stock exchange index (see Table 5), after some fluctuations in the initial period, the variables remain stable starting from the seventh period.As far as Lithuania is concerned, after some initial fluctuations, the variables remain stable from the fifth period onwards (see Table 6).

Table 4. The decomposition of variance for the variable Latvia

period	std. error	d_ld_Latvia	d_ld_Estonia	d_ld_Lithuania
1	0.0940372	100.0000	0.0000	0.0000
2	0.115513	95.8350	3.3849	0.7801
3	0.117923	93.2927	5.5793	1.1280
4	0.124468	85.3590	9.4495	5.1915
5	0.124773	85.0961	9.7178	5.1861
6	0.124967	84.8327	9.7462	5.4211
7	0.12843	84.2056	9.2405	6.5540
8	0.134148	80.2408	12.7197	7.0395
9	0.136259	77.8495	14.6705	7.4799
10	0.137231	77.8364	14.7625	7.4012
11	0.138396	77.2406	14.9280	7.8314
12	0.13856	77.2148	14.9125	7.8727
13	0.138685	77.0967	15.0448	7.8585
14	0.139732	77.1380	15.1049	7.7570
15	0.141007	76.1548	15.9844	7.8608
16	0.141137	76.0902	16.0238	7.8860
17	0.141635	75.8694	16.1877	7.9429
18	0.141731	75.7779	16.2312	7.9909
19	0.141848	75.6586	16.3621	7.9793
20	0.141917	75.6635	16.3646	7.9719

Source: The author's own calculation using GRETL.

Table 5. The decomposition of variance for the variable Estonia

period	std. error	d_ld_Latvia	d_ld_Estonia	d_ld_Lithuania
1	0.123986	48.5775	51.4225	0.0000
2	0.152349	45.5031	54.3474	0.1495
3	0.15606	43.4620	56.3925	0.1455
4	0.162367	40.1756	56.5909	3.2335
5	0.164811	39.2176	57.5938	3.1886
6	0.166258	38.7368	58.0909	3.1723
7	0.168957	37.5172	56.3132	6.1696
8	0.169409	37.4145	56.0546	6.5309
9	0.169451	37.4127	56.0595	6.5278
10	0.169677	37.5582	55.9222	6.5196
11	0.170306	37.6082	55.6536	6.7382
12	0.170907	37.5306	55.7427	6.7267
13	0.171005	37.5447	55.7231	6.7321
14	0.171163	37.6106	55.6215	6.7679
15	0.171311	37.5602	55.5982	6.8416
16	0.17134	37.5603	55.5964	6.8432
17	0.171421	37.5998	55.5501	6.8501
18	0.171491	37.6058	55.5497	6.8445
19	0.171511	37.6074	55.5434	6.8492
20	0.171516	37.6080	55.5427	6.8493

Source: The author's own calculation using GRETL.

Table 6. The decomposition of variance for the variable Lithuania

period	std. error	d_ld_Latvia	d_ld_Estonia	d_ld_Lithuania
1	0.120148	52.3606	23.6507	23.9887
2	0.144224	49.7458	23.2313	27.0229
3	0.150162	46.4345	28.6358	24.9298
4	0.160823	40.5551	34.6719	24.7730
5	0.163155	39.5971	36.2142	24.1887
6	0.163808	39.5532	35.9325	24.5143
7	0.167226	39.2110	34.5544	26.2346
8	0.168242	38.7396	35.2062	26.0543
9	0.168884	38.7485	35.3235	25.9279
10	0.169785	39.2204	35.1224	25.6572
11	0.170776	39.2269	35.1650	25.6082
12	0.171247	39.2631	35.1428	25.5940
13	0.171278	39.2490	35.1458	25.6052
14	0.171655	39.4445	35.0562	25.4993
15	0.171972	39.3023	35.2315	25.4661
16	0.172198	39.4185	35.1390	25.4426
17	0.172483	39.4080	35.1880	25.4039
18	0.172545	39.3869	35.2273	25.3858
19	0.172572	39.3784	35.2373	25.3843
20	0.172583	39.3795	35.2382	25.3823

Source: The author's own calculation using GRETL.

Conclusion

The article analyses the relationships among some selected stock exchanges in the countries of the Baltic Sea region - Lithuania, Latvia, and Estonia. The VAR method is usedto estimate the parameters of the regression equation. When the impulse response function is estimated, the response from the Latvian stock exchange to the shock from independent variables expires after the seventh quarter. The response of the Estonian stock exchange to the shocks from independent variables expires after the fourth quarter. The response of the Lithuanian stock exchange to shocks from independent variables discontinues after the third quarter.

In the case of variance decomposition for the Riga stock exchange, after some initial fluctuations the variables are fairly stable since the ninth period. The standard error of changes in the Latvian stock exchange index depends primarily on this variable.

In the case of the Estonian stock exchange index, after some fluctuations in the initial period, the variables remain stable starting from the seventh period. The standard error of changes in the stock exchange index in Estonia

depends in more than half on this variable and in 1/3 on the changes of Latvian stock exchange index.

As far as Lithuania is concerned, after some initial fluctuations, the variables remain stable from the fifth period onwards. The standard error of changes in the stock exchange index in Lithuania depends only in 25% on changes in this variable and to a greater extent on changes in other variables - 39% on the changes in the stock exchange index in Latvia and 35% on the changes in the Estonian stock exchange index, respectively. This seems to be a surprising result, but it may arise from the small size of the Lithuanian stock exchange and, at the same time, its greater union with the exchanges of the analyzed neighboring countries.

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