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Systematic Risk of ESG Companies Listed on the Polish Capital Market in 2019-2022

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Magdalena Mikołajek-Gocejna[1]

Abstract:

Purpose: *The purpose of this paper is analysis the systematic risk of the constituent stocks of ESG-WIG for the period of 2019-2022, which also covers the Covid-19 period. The main hypothesis of this research is that ESG companies listed on Polish capital market are less risky than the market portfolio.*
Design/Methodology/Approach: *Systematic risk in this article is measured as the beta coefficient (the ratio of the covariance of the rate of return of the examined financial instrument and the rate of return of the market portfolio to the variance of the rate of return of the market portfolio, alternatively as the product of the appropriate linear Pearson correlation and the ratio of standard deviations). The beta coefficient is also an estimator of the parameter of the simple linear regression and can be interpreted as financial flexibility or the sensitivity of returns on assets to market returns. Stocks with a beta greater than one are more volatile than the market and are known as aggressive stocks, they are more risky instruments. In contrast, stocks with a beta of less than one are less volatile than the market index and are known as defensive stocks – less risky instrument.*
Findings: *The analysis of systematic risk for 53 ESG companies showed that companies with high ESG ratings have lower betas than market portfolio consisting of other companies listed on Warsaw Stock Exchange.*
Practical Implications: *Building investment portfolios with less risks.*
Originality/Value: *Author's research of systematic risk for ESG companies listed on Polish capital market. It is the first analysis of this type for this market.*

Keywords: *Capital Asset Pricing Model (CAPM), beta coefficient, systematic risk, ESG, environment, social and governance criteria.*

JEL: *G11, G12, G13.*

Paper Type: *Research study.*

[1]*Prof., Warsaw School of Economics, Institute of Value Management, Department of Axiology and Value Measurement, Poland, e-mail: magdalena.mikolajek@gmail.com;*

1. Introduction

Assessing ESG risks is paramount for companies today; necessary to meet the diverse needs of its stakeholders and to limit potential legal, operational and reputational threats. The trend of sustainable investments is strongly developing in the global markets. This means that in investment decisions and in the assessment of listed companies, factors from three areas are taken into account: environmental, social and governance.

The PwC 2021 Global Investor ESG Survey showed that almost half of investors surveyed (49%), express willingness to divest from companies that aren't taking sufficient action on ESG issues, more than half (59%) also say lack of action on ESG issues makes it likely they would vote against an executive pay agreement, while fully a third say they have already taken this action and a large majority (79%) say the way a company manages ESG risks and opportunities is an important factor in their investment decision making (PwC, 2021). Investors now define their investment goals in broader terms than ever before.

Companies with a strong ESG profile are less vulnerable to systematic market shocks and therefore show lower systematic risk. In a CAPM model (Treynor, 1961; Treynor, 1962; Sharpe, 1964; Lintner, 1965; Mossin, 1966)), the beta of a company has two important implications. First, beta measures the systematic risk exposure of companies (i.e., lower beta means less systematic risk) and second, it translates the equity risk premium into the required rate of return for the individual company.

Lower systematic risk means lower cost of euity and therefore investors require a lower rate of return, which translates into a lower cost of capital for a company. This can also be extended to multi-factor models, where the systematic risk exposure of a company is measured by several factors instead of one beta coefficient. Therefore, in a DCF model, a company with lower cost of capital would have a higher valuation, because the systematic risk exposure affects the denominator of the DCF model (Giese *et al.*, 2017).

Systematic risk (beta coefficient) is defined as the ratio of the covariance of the rate of return of the examined financial instrument R_i and the rate of return of the market portfolio R_m to the variance of the rate of return of the market portfolio (alternatively as the product of the linear Pearson correlation and the ratio of standard deviations) (Tofallis, 2008, p. 1359):

$$\beta_i = \frac{cov(R_i, R_m)}{var(R_m)} = cor(R_i, R_m) \times \sqrt{\frac{var(R_i)}{var(R_m)}} \quad (1)$$

where:
R_i measures the rate of return of the financial instrument,
R_m measures the rate of return of the market portfolio,

Cov (R_i, R_m) is the covariance between the rates od return.

Estimation directly from this definition requires the estimation of the above-mentioned covariances and variances and the calculation of their quotient (alternatively, the product of the appropriate correlation and the ratio of standard deviations).

The beta coefficient is also an estimator of the parameter of simple linear regression equation proposed by Sharpe (1963). Therefore, the rate of return on shares of the i-th company in the t-th period can be written as (Elton and Gruber, 1998, p. 154; Jajuga and Jajuga, 1998, p. 63):

$$R_{it} = \alpha_i + \beta_{i\,Sharp} R_{mt} + \varepsilon_{it}, \tag{2}$$

where:
R_{it} - rate of return of shares of the i-th company,
R_{mt} - rate of return on an index of the market,
α_i – the free expression of the model, which is a component of the return on shares of the company and independent of the market situation,
$\beta_{i\,Sharp}$ - the direction coefficient constant over time which measures the expected change in R_i depending on the change in R_m ,
ε_{it} - is Gaussian noise N (0, σ_i) with zero expected value and standard deviation σ_i
t - number of observations of the time series.

The estimator $\beta_{i\ Sharp}$ obtained from this regression using the least squares method (or the maximum likelihood method) is the beta coefficient explicitly defined in (1). With the development of the CAPM model by Treynor (1961), Treynor (1962), Sharpe (1964), Lintner (1965), Mossin (1966), an alternative to (2) regression was the regression of the equation in which there is an additional variable: risk-free rate of return R_F:

$$R_i = R_F + \beta_{i\,CAPM}(R_m - R_F) + \varepsilon_i. \tag{3}$$

In this equation, the risk-free return R_F can be a deterministic constant or a random variable. Beta coefficient is also called the aggressiveness. Dharmarante et others define beta as a measure of the systematic risk associated with a particular stock. (Dharmaratneand Harris, 2006, pp. 68-61). Malkiel and Xu (2006) identified this type of risk as the systematic risk, which is undiversifiable.

The CAPM model is widely used to analyse capital markets and their international competitions (Chan and Lakonishok 1993; Fletcher 2000), as well as the most frequently method used for estimating the cost of equity (Bruner, Eaders, Harris, and Higgins, 1998; Graham and Harvey, 2001; Byrka-Kita, 2004; Zarzecki Byrka-Kita, 2005; Cwynar, 2010).

However, the model itself, in which only one variable is taken into account and assumes linear dependence, raises a lot of controversy. Empirical studies presented in the literature both confirm the correctness of the model (Sharpe and Cooper, 1971; Black, Jensen, and Scholes, 1972; Fama and MacBeath, 1973; Amihud, Christensen, and Mendelson, 1992; Fletcher, 2000), and indicate its incorrectness, undermining the basic assumptions of the model (Roll, 1977; Basu, 1977; Stattman, 1980; Rosenberg, Reid, and Lanstein, 1985; Chan, Yasushi, and Lakonishok, 1991; Fama and French, 1992; 2004; Reilly and Brown, 2003).

Therefore, many CAPM modifications have arisen that either criticize and endure unrealistic assumptions (Roll, 1977; Ferson and Locke, 1998; Pastor and Stambauch, 1999) or introduce new elements to the model, e.g:

- Merton's intertemporal capital asset pricing model (ICAPM) - Merton (1973),
- Vasicek's shrinkage (1973),
- three-factor model for expected returns - Fama and French (1993),
- Consumption Capital Asset Pricing Model (CCAPM) - Breeden (1979) and Lucas (1978),
- Consumption-oriented capital asset pricing model (CCAPM) - Breeden, Gibbons, and Litzenberger (1989),
- Smoothing CAPM Koller, Goedhart and Wessels (2005),
- Sum-Beta tries to capture delay with which a stock price reflects market information. It is especially persistent in midsize and smaller companies (Ibbotson, Kaplan and Peterson, 1997).

Practioners and researchers rely on beta when estimating costs of capital, determining relative risk, testing asset pricing models, testing trading strategies (Odabaşı, 2003), therefore, the correctness of the beta parameter estimation is extremely important "*It is one of the few regression coefficient, simple or otherwise, that people actually pay money to get*" (Wells, 1995, p. 5).

Therefore, estimation of beta coefficient needs to resolve the basic issues that concern to the choice of the market index, the length of the return intervals, the length of the estimation period.

The simplest method of estimating the beta coefficient in the Sharpe's Model is to use the Ordinary Least Squares OLS method to evaluate its parameters. Typically, however, the single-indicator model does not meet the assumptions about the stochastic structure of the model and the beta parameter is biased. Appropriate statistical tests are used that allow to verify hypotheses about:

- Normality of the distribution of a random component, which can be verified using a number of tests, e.g., Chi -squared test, Kolmogorov-Liliefors test,

Shapiro-Wilk test, or a multidimensional test based on skewness and kurtosis measures (Jarque–Bera test) (Jarque and Bera, 1981, pp. 313-318).
- Lack of autocorrelation of the residual component, which can be verified by Durbin-Watson test for neighbouring observations, or Breusch-Godfrey test (Maddala, 2008, p. 271).
- Homoscedicity of the model (test of homogeneity of variance), which is verified by the Godfrey-Quandt or White test (Maddala, 2008, p. 247).

If the model does not meet the stochastic assumptions, the following adjustments are proposed:
- Generalized least-squares method (Kandell and Stambaugh, 1995, Amihud, Christensen, and Mendelson, 1992);
- Blume correction (Blume, 1971; 1975)
- Bayes corrections (Vasicek, 1973)
- Corrections related to the small activity of investors on the stock market: trade to trade estimator (Marsh, 1979), cohen estimators Dimson beta, (Dimson, 1979), quasi-multi period thin-trading beta (Scholes and Williams, 1997)

Other methods for determining the beta coefficient are also used:
- ARCH and GARCH class models (Lie, Brooks, and Faff, 2000; Faff, Hiller, and Hiller, 2000; Gajdka and Brzeszczyński, 2007; Piontek, 2008);
- Variable Mean Response Model (Lin, Chen, and Boot, 1992);
- Non-parametric methods (Eisenbeiss, Kauermann, and Semmler, 2007).

2. Systematic Risk of ESG Companies – Literature Review

In the literature, there is not many researches analyzing systematic risk of ESG companies or the relationship between ESG factors and company-specific risk (Sassen, Hinze, and Hardeck, 2016). Most of the research in this area concerns the impact of environmental, social and corporate governance factors on the decrease in the cost of equity, caused largely by a decrease in risk measured appropriately, e.g., by the standard deviation of rates of return or the beta coefficient.

Ghoul, Guedhami, Kwok, and Mishra (2011, p. 2394-2401) showed that companies with a higher CSR ratio are characterized by a lower cost of equity, and its reduction is mainly influenced by a lower beta ratio, which is mainly related to investments in responsible relationships with employees, environmental policy and product strategy.

Moreover operating in the area of controversial industries (in this case, the tobacco and nuclear energy industries) increases the cost of equity. Hong and Kacperczyk (2009) find sin stocks from publicly traded firms that are in the business of alcohol, tobacco, and gambling have higher risk.

The study conducted by Jo and Na (2012) confirmed the negative correlation between systematic risk and CSR. The results reflect that companies' involvement in CSR mitigates not only overall risk, but also their systematic risk or sensitivity to market volatility. Similar results were obtained (negative relationship between community and environmental responsibility and beta) by Salama *et al.* (2011). They examined the relationship between corporate environmental performance and firm risk in the British context and showed that a company's environmental performance is inversely related to its systematic financial risk. However, an increase of 1.0 in the CER score is associated with only a 0.028 reduction in its β.

The analysis conducted by Sharfman and Fernanda (2008) confirmed the negative correlation between the cost of equity (beta coefficient) and the quality of environmental management in American companies. These findings are consistent with research from MSCI (Lodh, 2020) that showed that companies with higher ESG scores generally experienced lower costs of capital when compared to companies with poorer ESG scores (in both developed and emerging markets, during a four-year study period).

In turn, research conducted by Chen *et al.* (2020) showed that there is a negative correlation between the dominant role of institutional investors in the shareholding structure of a company and its risk. The correlation is more important in regions with higher levels of marketability, in publicly traded companies and companies with better operating results.

Orlitzky and Benjamin (2001) reviewed 18 American studies on the relationship between corporate social performance (CSP) and risk, indicating that the integration of ethical factors in corporate management leads to their lower exposure to financial risk, They also found out that the relationship between corporate social performance and risk appears to be one of reciprocal causality, because prior CSP is negatively related to subsequent financial risk, and prior financial risk is negatively related to subsequent CSP. Their analysis also showed that reputation of social responsibility appeared to be the most important factor in terms of its risk implications. Similar results were obtained by Boutin-Dufresne and Savaria (2004). They looked for a relationship between idiosyncratic risk and the level of social responsibility for Canadian firms.

Albuquerque, Koskinen, and Zhang (2018) provided evidence that the impact of corporate social responsibility (CSR) in reducing systematic risk is stronger for companies with high product differentiation.

In turn, the research conducted by Bouslah, Kryzanowski, and Mzali, (2011) showed that not all ESG aspects affect the systematic risk of companies. Employee relations, environment, human rights and corporate governance negatively affect firm risk. The other dimensions (community, diversity and product) do not impact significantly firm risk.

Dunn *et al.* (2018), concluded that high-scoring ESG stocks have lower volatility and betas than lower scoring ESG stocks. Making use of a global sample of stocks and the MSCI ESG scoring database, the authors find that: “Stocks in the worst ESG quintile have total volatility and stock specific volatility that is higher by 10-15%, and betas that are higher by 3%, than the corresponding measures for stocks in the best ESG quintile”.

Most of the research on systematic risk of ESG companies was carried out for the American market. There are a few exceptions, such as Luo and Bhattacharya (2009) who used an international sample in their research, and Salama et. al (2011) who analyzed data from the UK, or Chen (2020) who used data from the Chinese capital market. Most of the researches did not concern specific industries, except for Jo and Na (2012), who conducted their analyzes for the so-called "sin" companies and Bassen, Meyer, and Schlange (2006), who analyzed companies from the media industry.

Moreover, recent research lacks comparability. Some studies used aggregated ESG measures (Boutin-Dufresne and Savaria 2004; Bassen *et al.*, 2006), whereas others used individual ESG measures (Bouslah *et al.*, 2013; Sharfman and Fernando 2008; Salama *et al.*, 2011) as explanatory variables. Furthermore, different market-based risk measures were employed. There is a lack of research the systematic risk of ESG companies listed on Polish capital market.

3. Research Methodology

3.1 Beta Estimation

In the study, we estimate the beta coefficient as defined in (1), by regression of the Sharp equation in (2). We have only one realization of the rates of return at a given point in time necessary for the estimation of the beta coefficient. In other words, for a given moment of time t = 1 ... n (at the end of a day, month, year), we have information about one rate of return of the market portfolio R_m and one rate of return for the examined financial instrument R_i. Sharp's equation (2) takes the form:

$$R_{it} = \alpha_i + \beta_{i\,Sharp} R_{mt} + \varepsilon_{it}, \qquad (4)$$

where t is the index of the moments of time from the period T from which the samples of the analysed rates of return are derived.

We estimate the beta coefficient for the entire population (assuming the stability of the model, including the beta coefficient), as a result of which we obtain the average value of the beta coefficient over the entire analysed period. In the study covering the entire population, we used the estimation of the beta coefficient by OLS regression of the Sharp equation (4), which ensures that the estimators are unbiased (or at least asymptotic unbiased and consistent when the variable R_m is random):

$$\begin{bmatrix} \alpha_i \\ \beta_{i\ Sharp} \end{bmatrix} = [R_m{}' R_m]^{-1} R_m{}' R_i, \tag{5}$$

where:

R_i – (n x 1) vector of monthly return on asset *i*,
R_m – (n x 2) matrix of monthly return on a market portfolio proxy with 1 in the first column (for intercept).

This method is the simplest computationally, although it is numerically less efficient than this used of definition (1) and efficient recursive algorithms for calculating moments. Due to the purpose of the research, we prioritize the ease of calculations over their efficiency.

3.2 Data

The analysis covered the beta coefficients established for the sets of daily rates of return:

1) in terms of time analysis covered the period of September 3, 2019 - June 6, 2022, which is conditional on the availability of data for companies listed in the WIG-ESG index. (WIG-ESG index was launched on September 3, 2019). The research period covered the covid-19 crisis, asset price inflation,
2) in terms of the subject matter, the analysis covered 57 companies.
3) we chose the rate of return from the WIG index (market index) as the variable explaining the rates of return of individual companies from the WIG-ESG index.

WIG- ESG is created on the basis of the value of the portfolio of shares of companies considered socially responsible, i.e. those that comply with the principles of socially responsible business, in particular in the field of environmental, social, economic and corporate governance issues. The base value of the index was established as at December 28, 2018 and amounted to 10,000.00 points. WIG-ESG is a total return index, which means that its calculation takes into account both the prices of transactions concluded in it and dividend income. The share of one company in the index is limited to 10%, while the total share of companies, each of which exceeds 5%, is limited to 40%.

According to the theoretical assumptions of the CAPM model, the market index should cover the broadest spectrum of investment instruments available to investors. The total index WIG-ESG was also considered as an explanatory variable. It would allow a greater degree of volatility specific to individual companies listed in this index, while suppressing the impact of general market events. The choice of the WIG index was determined by its greater compliance with the theory of finance.

The use of daily returns avoids the dilemma of how to estimate them that accompanies longer intervals. In addition, aggregating daily returns to e.g. monthly returns causes the loss of important information. An important argument for the use of high-frequency data is also the possibility of obtaining a relatively long sample for a short period of time (i.e., a large number of observations, which gives relatively low standard errors).

4. Results

The results of the beta coefficient estimation from equation (4) are presented in Table 1, and the simple regression plots in Figures 1-24.

Table 1. *Estimation of coefficients*

Walor	Beta	Std.error_ of_beta	t_value_ of_beta	pv_of_beta	Intercept	Std_error_ of_intercept	t_value_ of_intercept	pv_of_ intercept	Residual_ std_error	Multiple_R_ squared	Degrees_of_ freedom	F_statistic	DW	pv_of_DW
IIB	0,087173	0,06427	1,356344	0,175437	0,000653	0,000978	0,667979	0,504372	0,025602	0,002682	684	1,839668	2,141779	0,968566
DNP	0,254815	0,062301	4,090061	4,83E-05	0,001274	0,000948	1,344674	0,179176	0,024818	0,023873	684	16,7286	2,246378	0,999385
LTS	0,379523	0,064953	5,843079	7,93E-09	0,000124	0,000988	0,125961	0,8998	0,025874	0,047542	684	34,14157	1,932125	0,18684
MIL	0,530175	0,085876	6,173732	1,14E-09	6,10E-05	0,001306	0,046719	0,962751	0,034209	0,052782	684	38,11497	2,076594	0,842597
ING	0,257064	0,057807	4,446975	1,02E-05	0,000292	0,000879	0,332363	0,739717	0,023027	0,028099	684	19,77559	2,068696	0,816366
OPL	0,170641	0,052653	3,240862	0,001249	0,000206	0,000801	0,25747	0,796894	0,020974	0,015123	684	10,50318	2,044961	0,72251
MBK	0,613706	0,082897	7,403242	3,92E-13	0,000316	0,001261	0,250502	0,802275	0,033022	0,074184	684	54,80799	2,060181	0,785214
PGE	0,399467	0,0918	4,351501	1,56E-05	0,001066	0,001396	0,763569	0,445387	0,036569	0,026938	684	18,93556	2,033227	0,668733
CCC	0,293336	0,109446	2,68018	0,007535	-0,00044	0,001665	-0,26183	0,793532	0,043598	0,010393	684	7,183366	1,80484	0,005248
ABS	0,035036	0,046986	0,745661	0,456128	0,000763	0,000715	1,06697	0,286362	0,018717	0,000812	684	0,556011	2,348916	0,999998
KRU	0,217407	0,086812	2,504356	0,012499	0,001264	0,00132	0,957164	0,338823	0,034582	0,009086	684	6,271798	1,988757	0,441628
ALR	0,489272	0,087846	5,569674	3,67E-08	0,000306	0,001336	0,22937	0,81865	0,034994	0,043385	684	31,02127	2,007904	0,54153
EAT	0,252805	0,087513	2,888772	0,00399	-0,00059	0,001331	-0,44094	0,659397	0,034861	0,012053	684	8,345002	1,821515	0,009634
PLW	0,271644	0,083128	3,267768	0,001138	0,001357	0,001264	1,073426	0,283459	0,033114	0,015372	684	10,67831	2,205823	0,996534
KTY	0,257897	0,053094	4,857391	1,48E-06	0,001193	0,000808	1,477488	0,140005	0,02115	0,033344	684	23,59425	2,111724	0,928668
BHW	0,310701	0,053048	5,856966	7,32E-09	0,000483	0,000807	0,598794	0,549509	0,021132	0,047757	684	34,30405	2,244871	0,999341
JSW	0,576956	0,119554	4,825886	1,72E-06	0,002418	0,001818	1,329686	0,184065	0,047625	0,032927	684	23,28918	2,209626	0,99702
GTC	0,095508	0,053088	1,799051	0,072451	-0,00047	0,000807	-0,58167	0,56098	0,021148	0,00471	684	3,236584	2,072032	0,827763
CAR	0,169876	0,067977	2,499014	0,012687	0,001403	0,001034	1,356723	0,175317	0,027079	0,009048	684	6,245071	2,127929	0,953374
ATT	0,241145	0,07216	3,341799	0,000878	0,000697	0,001098	0,634934	0,525684	0,028745	0,016065	684	11,16762	2,028601	0,646444
EUR	0,329921	0,061015	5,40717	8,86E-08	-0,00062	0,000928	-0,67196	0,501835	0,024306	0,040993	684	29,23748	2,064464	0,801254
BDX	0,049512	0,058228	0,850311	0,39545	0,000958	0,000886	1,081675	0,279778	0,023195	0,001056	684	0,723029	2,231524	0,998806
ENG	0,108801	0,040415	2,692124	0,007274	0,00013	0,000615	0,210856	0,833063	0,016099	0,010485	684	7,247533	2,218056	0,997885
KER	0,62139	0,095284	6,521427	1,35E-10	6,90E-05	0,001449	0,04759	0,962057	0,037957	0,058537	684	42,52901	2,331724	0,999993
ENA	0,329427	0,073381	4,489249	8,39E-06	0,000477	0,001116	0,427657	0,669035	0,029232	0,028621	684	20,15336	2,024974	0,62861
TPE	0,292835	0,086151	3,399077	0,000715	0,001671	0,00131	1,275046	0,202726	0,034319	0,016611	684	11,55372	1,893113	0,080568
FMF	0,609979	0,079054	7,71596	4,26E-14	-4,68E-05	0,001202	-0,03893	0,968959	0,031492	0,080071	684	59,53604	1,972021	0,357057
CMR	0,225414	0,05601	4,024525	6,35E-05	0,000217	0,000852	0,254372	0,799284	0,022312	0,023132	684	16,1968	2,265225	0,999749
LCC	0,221414	0,066762	3,316478	0,00096	0,000607	0,001015	0,597897	0,550107	0,026595	0,015826	684	10,99903	2,02175	0,612517
WPL	0,156445	0,065386	2,392636	0,016997	0,0009	0,000995	0,905119	0,365721	0,026047	0,0083	684	5,724709	2,033546	0,670245
ECH	0,171476	0,046107	3,719048	0,000216	-0,00041	0,000701	-0,58164	0,560999	0,018367	0,01982	684	13,83132	2,285466	0,99991
GPW	0,103134	0,043287	2,382595	0,017463	7,48E-05	0,000658	0,113629	0,909565	0,017243	0,008231	684	5,676758	2,179568	0,990757
PKP	0,338469	0,075621	4,475857	8,91E-06	-0,00079	0,00115	-0,68983	0,490533	0,030124	0,028455	684	20,03329	2,086452	0,871704
VRG	0,173227	0,071068	2,437483	0,015044	0,000352	0,001081	0,325653	0,744787	0,02831	0,008611	684	5,941323	1,826621	0,011503
CIE	0,270594	0,069535	3,891456	0,000109	0,00062	0,001058	0,585757	0,558232	0,0277	0,02166	684	15,14343	2,068676	0,816297
BFT	0,088474	0,070111	1,26191	0,207411	0,000211	0,001066	0,197445	0,843538	0,027929	0,002323	684	1,592417	2,167072	0,985805
MAB	0,41501	0,184404	2,250542	0,024731	0,000637	0,002805	0,227024	0,820473	0,073458	0,00735	684	5,064941	2,05593	0,768578
AMC	0,20716	0,057938	3,575522	0,000374	-0,00026	0,000881	-0,29874	0,765226	0,02308	0,018348	684	12,78436	1,873089	0,048067
FTE	0,098173	0,09263	1,059849	0,289588	0,001247	0,001409	0,88479	0,376581	0,036899	0,00164	684	1,123279	1,62118	3,39E-07
LVC	0,224901	0,067881	3,313147	0,000971	0,001724	0,001032	1,670213	0,095335	0,027041	0,015795	684	10,97694	2,264203	0,999736

LWB	0,337281	0,088923	3,792956	0,000162	0,00108	0,001353	0,798653	0,424769	0,035423	0,0206	684	14,38651	1,826224	0,011347
BRS	0,109732	0,058151	1,887022	0,059581	0,00046	0,000884	0,519767	0,603394	0,023165	0,005179	684	3,56085	1,633479	7,68E-07
STP	0,330666	0,079405	4,164312	3,52E-05	0,001005	0,001208	0,831921	0,405744	0,031631	0,024726	684	17,3415	1,837695	0,016664
PXM	0,351321	0,10482	3,351667	0,000847	0,001451	0,001594	0,910336	0,362966	0,041755	0,016158	684	11,23367	1,920919	0,149969
GNB	0,363083	0,131723	2,756407	0,006	0,000495	0,002003	0,247184	0,80484	0,052472	0,010986	684	7,597781	2,107542	0,920892
CIG	0,16395	0,104202	1,573389	0,116091	0,001818	0,001585	1,147338	0,251643	0,041509	0,003606	684	2,475552	2,057183	0,773554
TRK	0,200469	0,089335	2,244011	0,025151	0,000416	0,001359	0,30602	0,759682	0,035587	0,007308	684	5,035584	2,063905	0,799199
GTN	0,117797	0,103877	1,134008	0,257188	0,001124	0,00158	0,711721	0,47688	0,04138	0,001877	684	1,285975	2,152721	0,977445
PKO	0,496097	0,061376	8,08288	2,87E-15	1,51E-06	0,000934	0,001615	0,998712	0,024449	0,087188	684	65,33295	2,19429	0,994596
PZU	0,299364	0,050209	5,962346	3,98E-09	-2,20E-05	0,000764	-0,02887	0,976976	0,020001	0,049405	684	35,54957	2,116423	0,936691
PKN	0,383112	0,061009	6,279596	6,03E-10	4,49E-06	0,000928	0,004837	0,996142	0,024303	0,054509	684	39,43333	2,170152	0,987201
CDR	0,243675	0,080086	3,042655	0,002435	-0,00076	0,001218	-0,62548	0,531864	0,031903	0,013354	684	9,257748	2,101241	0,907985
LPP	0,533858	0,082099	6,502584	1,52E-10	0,001007	0,001249	0,806562	0,420199	0,032705	0,058219	684	42,2836	2,034933	0,676806
SPL	0,429031	0,069832	6,143774	1,37E-09	0,000145	0,001062	0,136332	0,891599	0,027818	0,052298	684	37,74596	2,076644	0,842755
KGH	0,331845	0,072007	4,608535	4,84E-06	0,001323	0,001095	1,207752	0,22756	0,028684	0,030115	684	21,23859	2,143644	0,970258
CPS	0,13092	0,046099	2,839955	0,004646	-0,0003	0,000701	-0,43286	0,665254	0,018364	0,011654	684	8,065347	2,294625	0,999944
PGN	0,324556	0,06027	5,385054	9,97E-08	0,000662	0,000917	0,721838	0,470641	0,024009	0,040672	684	28,9988	2,104658	0,915165

Source: *Own calculations.*

The estimated beta coefficient is on average[2] 0,2822 with a minimum of 0,0350 (ABS) and a maximum of 0,62139 (KER). Investments in ESG companies were on average perceived as less risky (beta<1) than in the diversified market portfolio.

Although, investors evaluate individual ESG companies differently, there is no a significant differentiation in the perception of risk in individual companies to market risk. According to theory, investments in ESG companies are less risky than in other companies, even if we taking into account a COVID – 19 period.

The standard deviations of beta coefficient is on average 0,0752 and its estimates is in almost all cases low in relation to the coefficient value. As a result, the t-test statistic averaging 3,801, ranges from 0,7457 (ABS) to 8,083 (PKO). Based on the obtained t-statistic values, the p-value is on average 0,0385, ranges from $2{,}8 \cdot E^{-15}$ (PKO) to 0,4561(ABS). For 50 out of 57 companies, probability of randomly obtaining estimated beta coefficients or greater with a true coefficient of zero is very low. Therefore, at the significance level $\alpha = 0.05$ assumed in the study, we have grounds for rejecting the null hypothesis with a zero value of beta. The beta coefficient values are statistically significant.

For the rest of analyzed ESG companies, the value of p higher than the significance level (p-value>0,05) is non-informative - neither for nor against the null hypothesis. Such a value may mean that the test had too low statistical power - in this case, the confidence interval of the result will include both zero and results distant from zero. Due to the adopted model of simple linear regression, the F statistic is the square of the t statistic of the beta significance. The mean value of F-statistic is 17,68 and range from 0,556 (ABS) to 65,33 (PKO). We can reject the null hypothesis in support of the alternative hypothesis that the regression coefficient is not zero. Therefore changes in the rates of return of the ESG companies depend linearly on changes in the rates of return of the WIG.

[2] *Unweighted moments have been used to roughly estimate here and hereafter.*

Significance of the regression intercept is low, range from -0,69 for PKP to 1,67 for LVC, but doubts about the significance of the intercept are of no practical importance, because Sharp's theory does not give this coefficient a financial interpretation.

The coefficient of determination R^2 indicates a weak fit of the CAPM model (5) to the data. Mean R2 is 0,03 ranging from 0,016 for ENG to 0,073 for MAB. Average, the volatility explained by the models accounts for about 3%% of all volatility in the wide market index return. Therefore 97% of volatility is not explained by the models, which indicates the presence of other sources of variability. As a result, our model may be unstable, what will be the aim of further researches.

5. Conclusions

Our analysis showed that ESG companies listed on Warsaw Stock Exchange are less risky than portfolio of other companies listed on polish capital market, which is consistent to theory and other researches in this field. Over the last decade, companies' performance in terms of ESG factors has become strongly correlated with its investment value, in particular with the perception of the level of risk. ,

Companies that meet the social, environmental and corporate governance (ESG) criteria are more aware of the changes taking place in the world, thanks to which they better forecast their future situation, and their operations are more stable and sustainable. This corporate social responsibility translates into potentially lower risk for enterprises. companies with high ESG ratings have shown less volatile earnings and less systematic volatility, in line with the conjecture that companies with high ESG ratings show lower systematic risk exposure.

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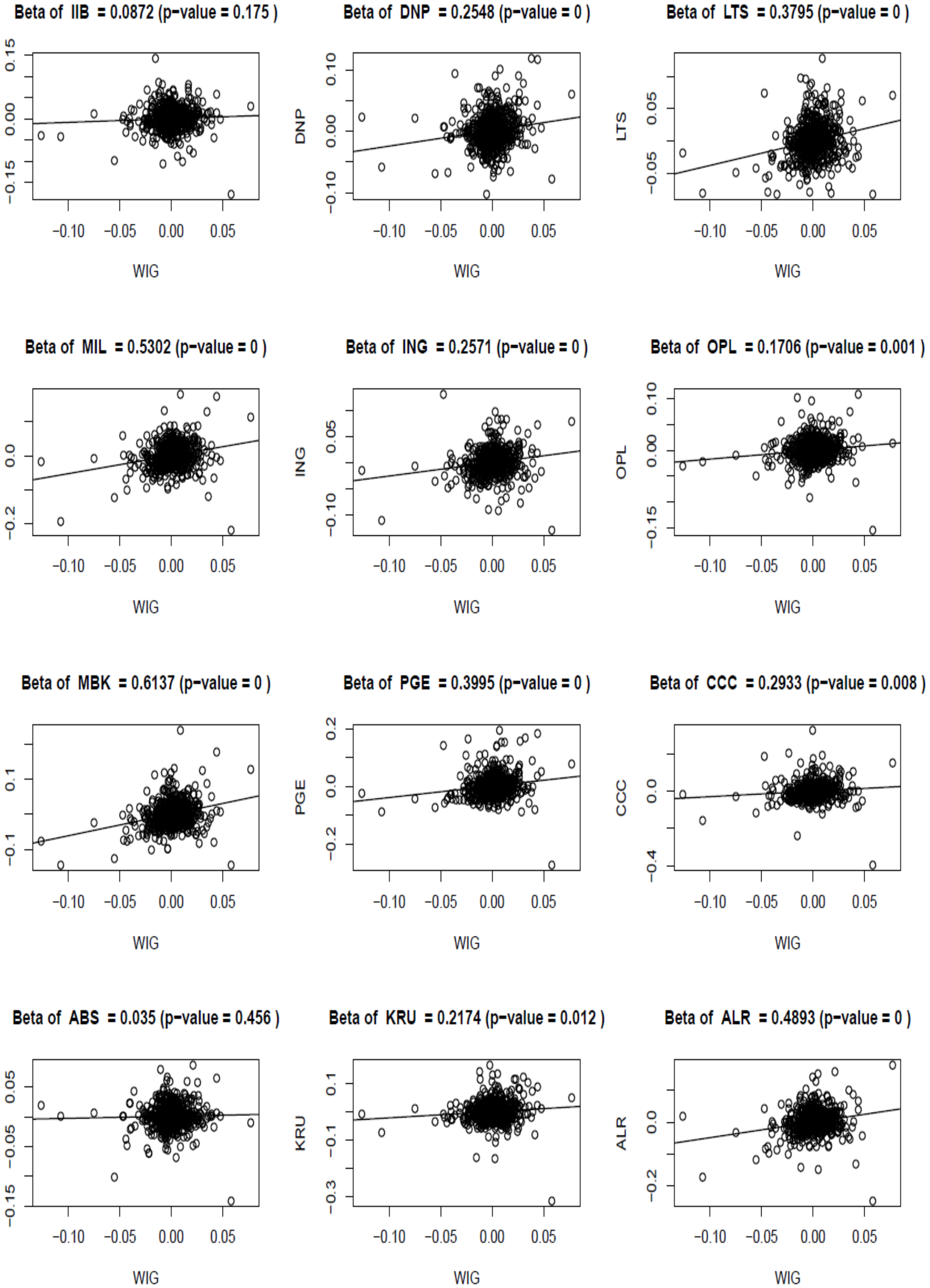
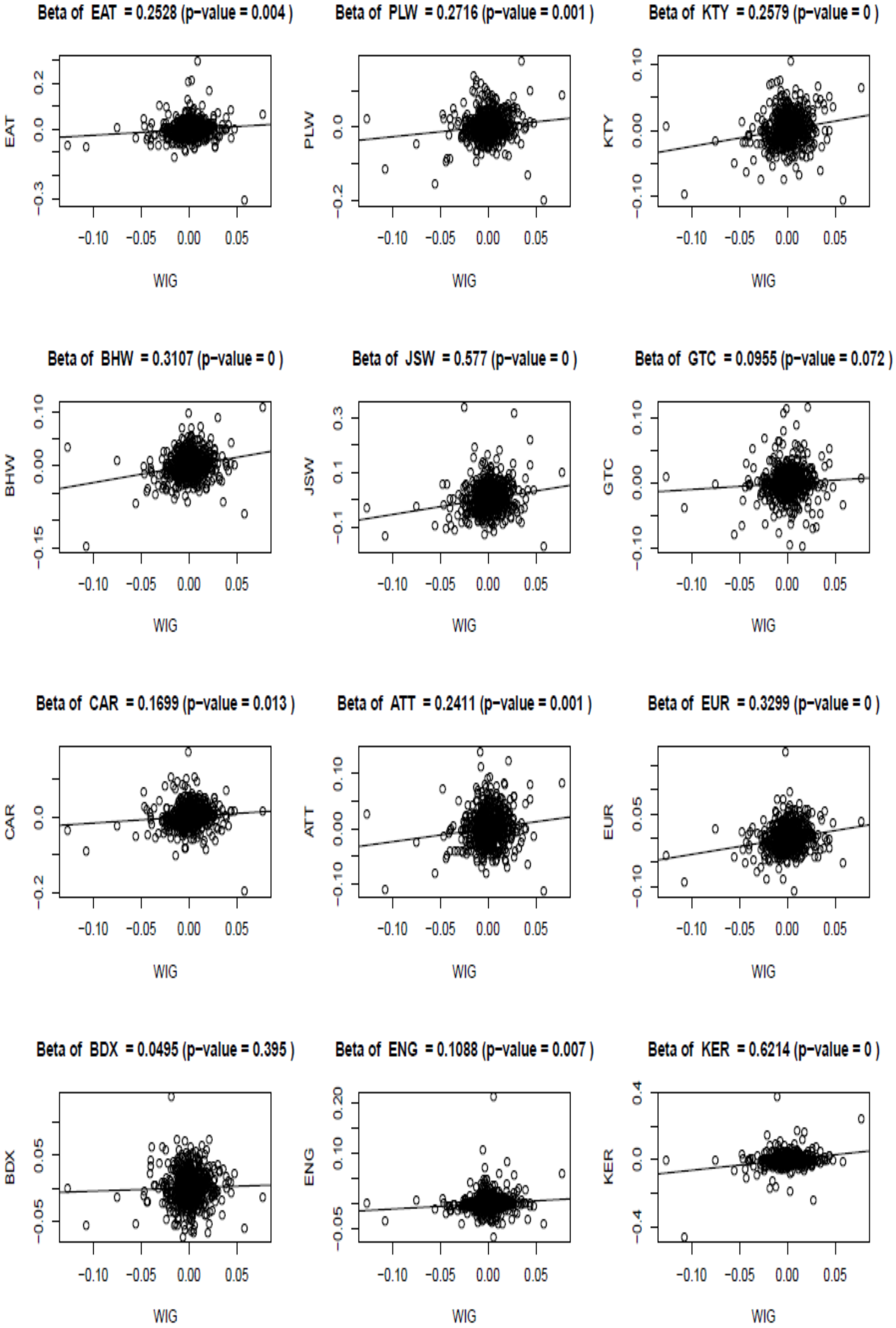
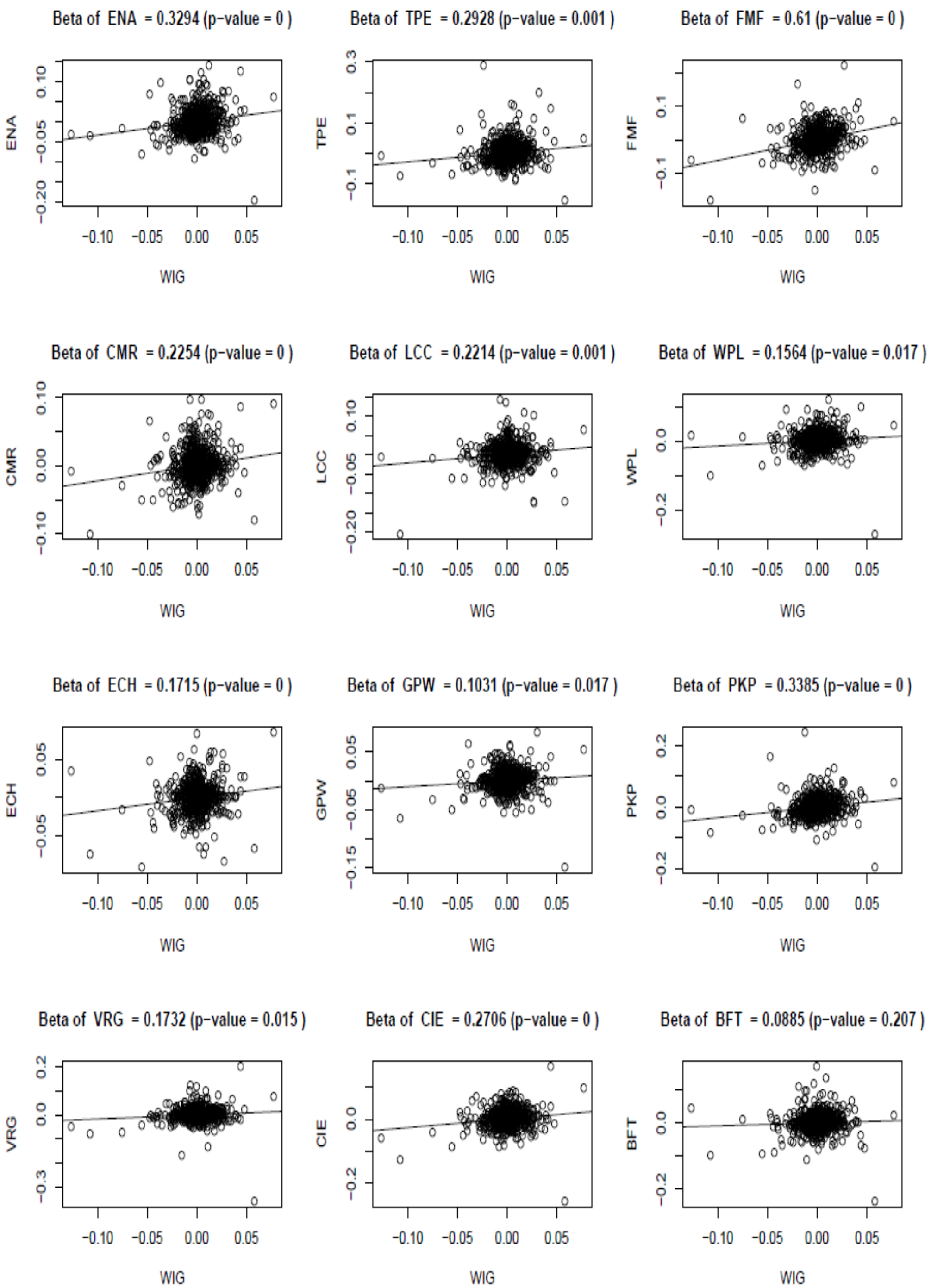
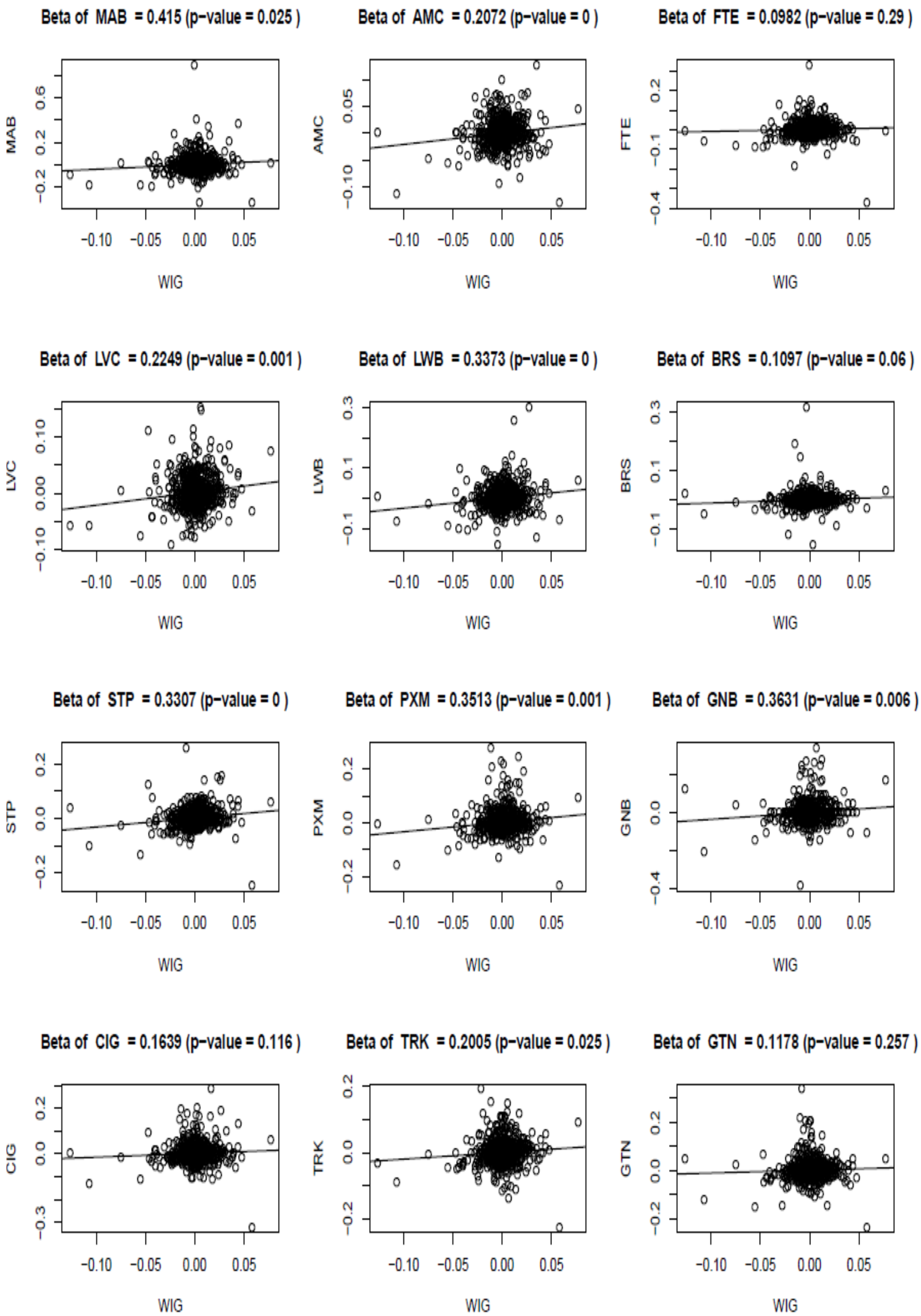
Appendix:

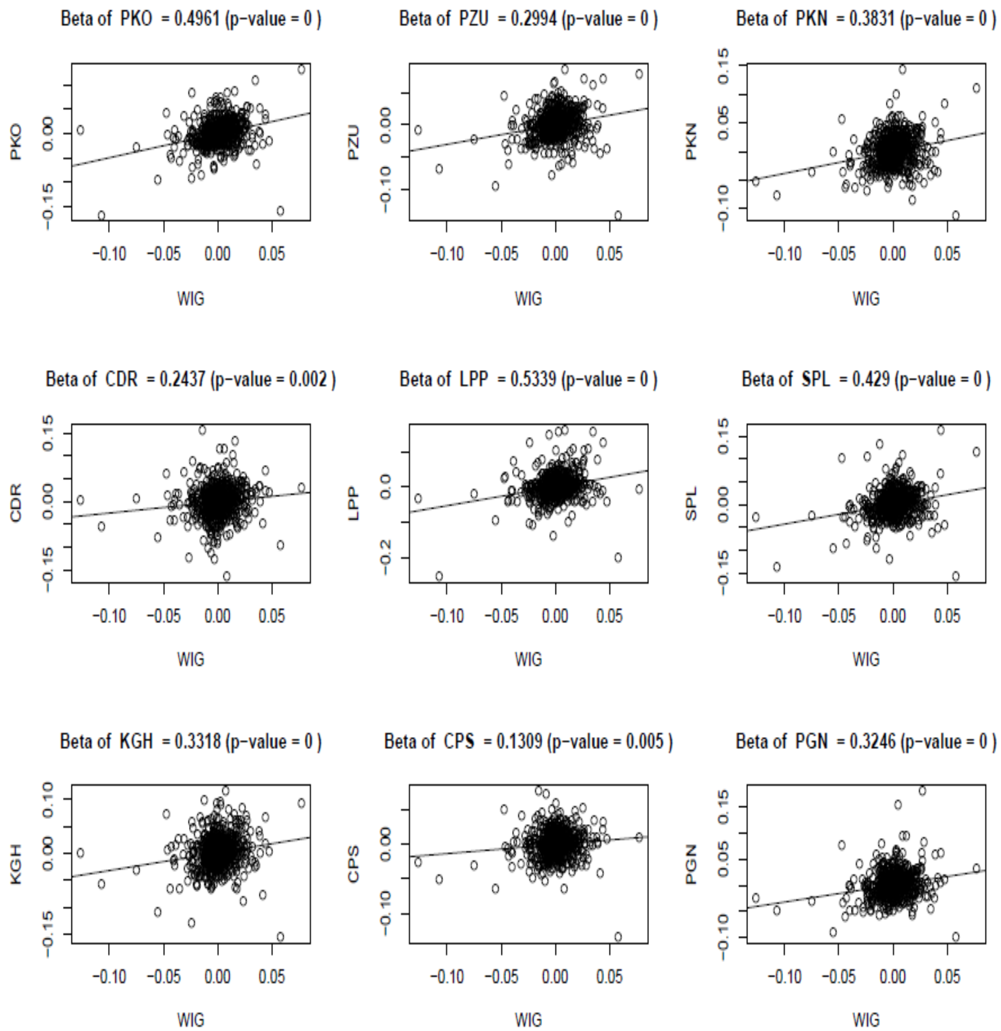
Figures 1-57. Beta coefficient of ESG companies listed on polish capital market




Beta of EAT = 0.2528 (p−value = 0.004)
EAT
WIG
Beta of PLW = 0.2716 (p−value = 0.001)
PLW
WIG
Beta of KTY = 0.2579 (p−value = 0)
KTY
WIG
Beta of BHW = 0.3107 (p−value = 0)
BHW
WIG
Beta of JSW = 0.577 (p−value = 0)
JSW
WIG
Beta of GTC = 0.0955 (p−value = 0.072)
GTC
WIG
Beta of CAR = 0.1699 (p−value = 0.013)
CAR
WIG
Beta of ATT = 0.2411 (p−value = 0.001)
ATT
WIG
Beta of EUR = 0.3299 (p−value = 0)
EUR
WIG
Beta of BDX = 0.0495 (p−value = 0.395)
BDX
WIG
Beta of ENG = 0.1088 (p−value = 0.007)
ENG
WIG
Beta of KER = 0.6214 (p−value = 0)
KER
WIG


Beta of ENA = 0.3294 (p−value = 0)
Beta of TPE = 0.2928 (p−value = 0.001)
Beta of FMF = 0.61 (p−value = 0)
Beta of CMR = 0.2254 (p−value = 0)
Beta of LCC = 0.2214 (p−value = 0.001)
Beta of WPL = 0.1564 (p−value = 0.017)
Beta of ECH = 0.1715 (p−value = 0)
Beta of GPW = 0.1031 (p−value = 0.017)
Beta of PKP = 0.3385 (p−value = 0)
Beta of VRG = 0.1732 (p−value = 0.015)
Beta of CIE = 0.2706 (p−value = 0)
Beta of BFT = 0.0885 (p−value = 0.207)
ENA
TPE
FMF
CMR
LCC
WPL
ECH
GPW
PKP
VRG
CIE
BFT
WIG


Beta of MAB = 0.415 (p−value = 0.025)
MAB
WIG
Beta of AMC = 0.2072 (p−value = 0)
AMC
WIG
Beta of FTE = 0.0982 (p−value = 0.29)
FTE
WIG
Beta of LVC = 0.2249 (p−value = 0.001)
LVC
WIG
Beta of LWB = 0.3373 (p−value = 0)
LWB
WIG
Beta of BRS = 0.1097 (p−value = 0.06)
BRS
WIG
Beta of STP = 0.3307 (p−value = 0)
STP
WIG
Beta of PXM = 0.3513 (p−value = 0.001)
PXM
WIG
Beta of GNB = 0.3631 (p−value = 0.006)
GNB
WIG
Beta of CIG = 0.1639 (p−value = 0.116)
CIG
WIG
Beta of TRK = 0.2005 (p−value = 0.025)
TRK
WIG
Beta of GTN = 0.1178 (p−value = 0.257)
GTN
WIG


Beta of PKO = 0.4961 (p−value = 0)
Beta of PZU = 0.2994 (p−value = 0)
Beta of PKN = 0.3831 (p−value = 0)
Beta of CDR = 0.2437 (p−value = 0.002)
Beta of LPP = 0.5339 (p−value = 0)
Beta of SPL = 0.429 (p−value = 0)
Beta of KGH = 0.3318 (p−value = 0)
Beta of CPS = 0.1309 (p−value = 0.005)
Beta of PGN = 0.3246 (p−value = 0)
PKO
PZU
PKN
CDR
LPP
SPL
KGH
CPS
PGN
WIG
−0.10 −0.05 0.00 0.05