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Is the Development of WIG Index Determined by Certain Macroeconomic and Financial Factors?

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The aim of this paper is to present an analysis whether certain financial ratios can have a significant impact on the development of a stock exchange index. In particular the benchmark stock exchange index is considered, as well as, the selected ratios are considered as the average ones for the whole economy. Quarterly data between 2005 and 2015 were analyzed for the Warsaw Stock Exchange (Poland).

Keywords: *efficient market hypothesis, financial ratios, ratio analysis, stock exchange*

JEL Classification: *C22, G14, G17*

1. Introduction

The ratio analysis is an important tool for a potential investor on the market. It helps to determine the evaluation of a company based on objective criteria. Moreover, it allows to compare a selected company with other ones from the similar market sector. As a result, a company can be valued in comparison to its competitors. Actually, it can happen that the data from financial reports of various companies cannot be compared with each other, but in general there are certain commonly accepted rules and guides to assess a business organization. For example, Micherda (2005) stated that a company has to obtain a relatively high profitability in order to survive on the market. This is however not a sufficient condition. Moreover, Mayo (2008) stated that investors on any stock market usually make choices based on technical analysis and (or) fundamental analysis.

Indeed, according to Bauman (1996) and Penman (1992) the most important task for an analysts is to derive the information on the potential future earnings of a company from the already available financial statements. In other words, the aim of the fundamental analysis is to use the core accounting data available into a reliable prediction on the company's value.

Herein, it will be checked whether the development of WIG index (a benchmark index on the Warsaw Stock Exchange) can be determined by certain macroeconomic and financial factors within a linear regression framework.

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2. Literature Review

Within the above presented context, it can be expected that investors make their decision based on the profitability of companies. Narrowing the considerations to the companies listed on a stock exchange, companies with good financial ratios should be more attractive to investors. And, vice versa, if a company has poor financial ratios, it should be not interesting for the majority of investors. This conclusion assumes that investors are risk averse. In other words, there can always be an investor who would rather buy poorly performing stocks, because they are currently cheap, but he or she expects that if in the future the financial performance will be better, then the price of the stocks will go higher. This is connected with extraordinary risk, because if a company has already poor financial situation it is already connected with higher probability of bankruptcy than in the case of a well financially performing company.

As a result, one can expect that if a company announces good financial information, then its stock prices are going higher, and vice versa. If a company announces bad financial information, then its stock prices are going down. Such a behavior can be also extrapolated on the whole market. In other words, it can be expected that if financial ratios are on average good for the whole market, than a certain benchmark measure of this market indicates this situation. If the financial situation reflected by poor financial ratios on average is bad, than it should also be reflected by decrease of a benchmark index.

The above hypothesis is however connected with certain very important assumptions. First of all, it is assumed that the market reaction through stock prices happens after the announcement of financial statements. In other words, the financial ratios cannot be know before the publication of a financial statement. Secondly, that the financial fundamental information plays a role significant enough to impact stock prices. The first assumption is quite important and significant. If one could somehow forecast future stock prices, based on previous data, then the semi-strong market efficiency hypothesis would not be true (Fama, 1970). Although such a hypothesis is a classical topic already, it is still highly disputable whether markets are efficient or not (Dimson and Mussavian, 1998; Constantinides et al., 2003). In other words, if the market is efficient, then the prices always reflect all the available information.

It has to be emphasized the efficient market hypothesis is based on certain assumptions about the underlying market structure. For example, Fama (1970) assumed that there are no transaction costs and the method of valuing the impact of a new information available on the prices are the same for every market player. These assumptions are hardly met in practice. Therefore, sometimes it is also assumed that there are a lot of market players, the products are homogeneous (i.e., roughly the same), the market is organized (for example, there is a supervised stock exchange, regulated by law, supervised by a certain commission, etc.), and the information arrives on the market in a random way (Dimson and Mussavian, 1998; Constantinides et al., 2003).

Usually, the market efficiency is discussed in a three stage classification. In particular, it is said that the market is weakly efficient in no market player can gain abnormal returns from the market by a strategy based on historical data. This should be due to the fact that such historical information is already reflected in the current prices. The semi strong efficiency is understood as the fact that no market player can obtain abnormal gains by using all publicly available sources of information. This is assumed because of the fact that such information are already reflected in the current prices. The third – strong efficiency – assumes that no market player can gain extraordinary returns, even if he or she would use all the information, both publicly available and hidden. This is assumed due to the fact that such information should be already reflected in the current prices (Dimson and Mussavian, 1998; Constantinides et al., 2003).

Testing the strong version of market efficiency is very hard. It is questionable how the hidden information can be measured. However, in case of semi strong efficiency hypothesis usually most important financial ratios are included in the analyzed model. Bulski and Gorski (2012) have, for example, indicated the following ratios: market capitalization, price to earnings ratio, price to book value, dividend yield, and beta risk factor.

The problem of the relevance of financial information has been discussed in literature. Usually, such considerations have been done within the context of a simple linear regression model. The independent variables have been taken as several financial ratios and the dependent variable is then the stock price. Often, instead of stock prices and financial ratios for several stocks a benchmark reflecting various stocks is taken and certain average of financial ratios.

It should also be mentioned that financial and non-financial organizations prepare in Poland financial statements ruled by different law regulations. In particular, banks are financial institutions, whose balance sheets and income statements differ slightly from those of non-financial institutions. As a result, their ratio analysis looks a bit different.

The most exploited by researchers are of course the developed markets. Among them a lot of studies have been taken on the U.S. market. For example, Baruch and Thiagarajan (1993) considered in their model several fundamental factors like: the change of inventories, the change of accounts receivables, the change of sales, the change of industry capital expenditures on research and development, the change of gross margin, the change of sales and administrative expenses, the change of gross receivables, the change of doubtful receivables, the effective tax rate, the change in order backlog, the change of labor efficiency, LIFO earnings and audit qualification. Currently, their research can seem to be a bit old. Indeed, they have examined selected financial reports from the period beginning on 1974 and ending on 1990.

Baruch and Thiagarajan (1993) constructed year by year cross sectional regressions. For each year they have taken between 140 and 180 sample consisting of companies' financial reports and their stock prices. They have not found a one significant behavior patterns. Certain variables impacted stock prices in some years positively, whereas in some year the impact was opposite. Also, the predictive power of the constructed models have been quite marginal. It was between 4% and 21% measured by R squared. Nevertheless, they have found that certain variables included in their models are statistically significant.

If the developed markets can be more efficient, the emerging ones can be less efficient in the context of accounting information. This can be the result of the fact that beginning investors are not used to developed analysis. If this statement is just a hypothesis, it is commonly accepted among researchers that emerging markets needs a careful attention and findings from the developed markets cannot be moved without any consideration on emerging markets. Indeed, they can be even more likely than developed countries to be influenced by local information (Harvey, 1995).

More recent analysis has been provided by Jung et al. (2015). They have examined a sample beginning on 2002 and ending on 2009. They have found that the analysis interest (i.e., the onset of analysts not covered in a company, but just participating in its earnings conference call) is positively correlated with future stock prices. Abarbanell and Bushee (1998) examined a sample of data beginning on 1974 and ending on 1993. For each year they have examined a sample of a size between 469 and 785 observations. As a result, they have found that the fundamental analysis can lead to abnormal returns from the market. In other words, the market efficiency was indicated no to be fulfilled. The significant determinants of stock returns were found to be inventories levels, accounts receivables, gross margin, selling expenses, capital expenditures, effective tax rate, inventory methods, audit qualifications, labor sales productivity. With these information they have claimed that the abnormal return of 13.2% yearly can be generated.

Bartram and Grinblatt (2015) have claimed that fundamental analysis can lead to abnormal returns of 9% per year. They have examined a sample beginning on 1977 and ending on 2012. They have not constructed simple linear models with independent variables as financial ratios, but rather estimated more developed financial models. Moreover, they focused on estimation of a fair value and mispricing of stocks.

Piotroski (2002) has constructed a specific factor score for a company. This score is based on return on assets, cash flow from operations, net income before extraordinary items depreciated by cash flow from operations, gross margin ratio, asset turnover ratio, leverage ratio, current ratio, and the binary variable indication issuing common equity. He has analyzed the period beginning on 1976 and ending on 1996. The finally selected sample consisted of over 14 000 observations (companies) from the American market. Piotroski (2002) has shown that by using certain strategies based on these financial information an investor can generate between 7.5% and 23% annual return.

Omran (2004) have examined a quite exotic emerging market, i.e., Egyptian one. For such a market it is important to notice that except common risks, a political risk is extremely high. Such effect can significantly influence its stock market. Omran (2004) have studies 46 Egyptian companies beginning the sample on 1996 and ending on 2000. Initially the sample consisted of more companies, but due to through check certain companies were excluded from the sample. The reliability of data is quite high as they were obtained from the Egyptian Capital Market Authority. Omran (2004) initially included as potential independent variables return on sales, return on assets, return on equity, earnings per share, assets turnover, inventory turnover, current ratio, quick ratio, debt ratio and inverse time interest earnings. By the stepwise backward regression variables were excluded from the model until all included variables become statistically significant at 5% significance level. As a result, only return on equity remained in the model as the independent variable. Omran (2004) considered two models: buy and hold strategy and cumulative one. However, this has not impacted the number of significant independent variables. The first model had quite poor predictive power – R-squared was only 14% for the buy and hold model and 6% for the cumulative strategy.

Lopes and Galdi (2007) have examined selected stock from Sao Paulo Stock Exchange (Brasil) between 1994 and 2004. They have found that returns between 6% and 27% can be generated if an investor would stick to fundamental analysis. As a potential stock returns determinants they have selected book value

of equity, market value of equity, return on assets, current year change in cash and cash equivalents, net income, changes on non cash current assets decreased by current liabilities (except short term debt) and depreciation, changes in current ratio, changes in gross debt, changes in sales and changes in gross margin.

Martani et al. (2009) have analyzed the Indonesian Stock Exchange between 2003 and 2006. They have constructed simple linear regression models with independent variables as net profit margin, return on equity, current ratio, debt to equity ratio, total assets turnover, price to book value, total assets and cash flow from operations dividend by sales. For each year they have analyzed 195 companies. The obtained R squared for models were around 40%. It have been found that net profit margin, return on equity, sales divided by total assets, price to book value and total assets are statistically significant determinants of returns from stocks. Finding that total assets is significant determinant is an interesting result. It means that the returns from stocks depends on whether the firm is small or big (i.e., the size effect exists). Such an effect has been first observed by Banz (1981).

In case of the Polish stock market, there have also been some researches in the considered direction. For example, Czekaj et al. (2001) have examined the period beginning on 1994 and ending on 2000. In this time, Poland was not a member of the European Union and the country was during the economy transition. Indeed, the Warsaw Stock Exchange has been set up in 1991, and initially only five share were quoted. It is therefore not surprising that Czekaj et al. (2001) have found that although the market was usually efficient in this period, there used to be significant periods of notable market inefficiency. Indeed, Papla (2003) have examined also the very beginning period, dating back to 1991. He has found that the big stocks with high turnover and high market share behaved in an efficient way. On the other hand, small companies could have been assumed as inefficient ones. Drachal (2011) considered a small sample of biggest companies listed on the Warsaw Stock Exchange (from the WIG 20 list), and found no significant linear correlations between changes in total assets, net profit, sales, ROS, ROE and ROA with the change in a share price for the quarterly data from 2001 – 2010.

3. Methodology and Data

Basing on the above literature review and data availability, five financial information indicators have been selected for the purpose of this research. Additionally, five macroeconomic indicators have also been included. The following notation has been used herein:

- WIG – level in points of the benchmark index WIG,
- GM – average gross margin of firms (in percentages),
- ROS – average return on sales for firms (in percentages),
- CR – average current ratio for firms,
- PN – (in percentages) the number of firms generating positive net income divided by the number of all registered firms,
- SALES – total revenues of all firms (in mln PLNs),
- R – average interest rate for short term deposits (in percentages),
- INF – inflation (in percentages),
- GDP – gross domestic product in current prices (in mln PLNs),
- U – unemployment rate (in percentages),
- CA – current accounts divided by gross domestic product (in percentages).

The selection of the variables has been based on data availability and reliability. Indeed, all time series (except WIG) have been obtained from the Central Statistical Office of Poland (CSO, 2015). The WIG time series has been taken from Stooq (2015). Quarterly data have been used. The analysis has covered the period beginning on the first quarter of 2005 and ending on the second quarter of 2015.

The computation has been done in a free econometric software package (Gretl). A standard statistical and econometric methods have been applied (Brooks, 2008).

From Figure 1 it can be seen that when stock price are high, gross margin is also high, and vice versa. It can also be seen (although it seems less clear) that higher deposit rate occurs when stock prices are high and vice versa. It seems like deposit rate follows stock prices (the reaction is delayed in time). However, the selected time series presented on Figure 1 are not stationary. In other words, they do not look like scattered randomly around some flat axis, but indicate some trend patterns.

In order to fulfill the assumptions of the linear regression models the analyzed time series have been transformed. The subscript t denotes time indexing. For example, WIG_t represents the value of the variable WIG in time t.

In particular, the following linear equation has been at first estimated and analyzed:

$$\Delta WIG = \alpha_0 + \alpha_1 * \Delta GM + \alpha_2 * \Delta ROS + \alpha_3 * \Delta CR + \alpha_4 * \Delta PN + \alpha_5 * \Delta SALES + \alpha_6 * \Delta R + \alpha_7 * \Delta INF + \alpha_8 * \Delta GDP + \alpha_9 * \Delta U + \alpha_{10} * \Delta CA, \quad (1)$$

where

$\Delta WIG = \ln (WIG_t / WIG_{t-1})$,
$\Delta GM = GM_t - GM_{t-1}$,
$\Delta ROS = ROS_t - ROS_{t-1}$,
$\Delta CR = CR_t - CR_{t-1}$,
$\Delta PN = PN_t - PN_{t-1}$,
$\Delta SALES = \ln (SALES_t / SALES_{t-1})$,
$\Delta R = R_t - R_{t-1}$,
$\Delta INF = INF_t - INF_{t-1}$,
$\Delta GDP = \ln (GDP_t / GDP_{t-1})$,
$\Delta U = U_t - U_{t-1}$,
$\Delta CA = CA_t - CA_{t-1}$.

Figure 1. *Selected time series*
Source: Own elaboration in Gretl

Table 1. *ADF test*

variable	statistics	p-value
ΔWIG	-4.0980	0.0001
ΔGM	-6.2625	0.0000
ΔROS	-6.4058	0.0000
ΔCR	-2.5992	0.0091
ΔPN	-2.5992	0.0091
ΔSALES	-1.4194	0.1454
ΔR	-3.9728	0.0001
ΔINF	-4.7755	0.0000
ΔGDP	-0.8946	0.3288
ΔU	-2.1721	0.0287
ΔCA	-7.4697	0.0000

Source: Own elaboration in Gretl

Such transformations helped to obtain stationary data. The stationarity has been checked at 5% significance level by the ADF test. Lag order for the ADF test has been taken as 9, testing down from maximum lag order has been done with respect to the AIC criterion. The test without constant has been performed. The results have been presented in Table 1. After transformations all-time series (except SALES and GDP) are stationary. However, the KPSS test (p-value = 0.05) has indicated that SALES are stationary at 1% significance level. Also, for GDP (p-value = 0.01) KPSS test indicated that this variable is stationary at 1% significance level. In order to maintain the simplicity of the model no further transformations were made.

The above considerations allow to perform the linear regression for the Equation (1).

4. Results

Unfortunately, the first model estimated is not good. Assuming the 5% significance level, none of the included variables are statistically significant. On the other hand, the obtained model has moderate R squared (58%). Very high R squared would indicate very good predictive power, which could contradict the efficient market hypothesis. Therefore, moderate values seem to be more reasonable. The results of the first estimation are presented in Table 2.

In order to continue the analysis the backward regression has been performed. This method assumes that first all potential independent variables are included in the model. Then, such a model is estimated and it is checked whether all variables (except the constant term) are statistically significant at the given significance level. If yes, the model is further diagnosed. If not – the variable with highest p-value is dropped and such a modified model is estimated. The dropping of variables is performed until a model with all variables statistically significant is found.

Table 2. *First regression estimation*

OLS, using observations 2005:2-2015:2 (T = 41) Dependent variable: ΔWIG

	Coefficient	**Std. Error**	**t-ratio**	**p-value**
α_0	0.0170713	0.0197987	0.8622	0.3954
α_1	0.228099	0.195052	1.1694	0.2514
α_2	−0.0971563	0.212301	−0.4576	0.6505
α_3	1.02741	0.629921	1.6310	0.1133
α_4	0.00665947	0.0123705	0.5383	0.5943
α_5	−0.0622827	0.0970669	−0.6416	0.5260
α_6	−0.0972201	0.109548	−0.8875	0.3819
α_7	−0.0130641	0.0244371	−0.5346	0.5969
α_8	0.198215	0.58456	0.3391	0.7369
α_9	0.0400666	0.0278675	1.4378	0.1609
α_{10}	−0.0149587	0.0111237	−1.3448	0.1888

Mean dependent var	0.016360		**S.D. dependent var**	0.114511
Sum squared resid	0.221464		**S.E. of regression**	0.085919
R-squared	0.577770		**Adjusted R-squared**	0.437026
F(10, 30)	4.105128		**P-value(F)**	0.001261
Log-likelihood	48.85536		**Akaike criterion**	−75.71071
Schwarz criterion	−56.86142		**Hannan-Quinn**	−68.84684
rho	0.327765		**Durbin-Watson**	1.332021

Source: Own elaboration in Gretl

By the stepwise backward regression the model presented in Table 3 has been found. Finally, from ten initial variables only three remained in the model. Only one accounting information has remained in the model, i.e., the gross margin. However, two macroeconomic variables have remained: unemployment rate and current

accounts. Herein, 10% significance level has been assumed. But, even at a 5% significance level GM and U are still statistically significant.

The model has moderate R squared, i.e., 51%. It means that only 51% of the variability of ΔWIG can be explained by the variability of the changes of gross margin, unemployment rate and current accounts. Therefore, it cannot be said that this research managed to beat the efficient market hypothesis in case of Poland.

Also, the diagnostic of the final model has been performed. The White's test has slightly indicated the heteroskedasticity of the residuals. However, from the Breusch-Pagan test there is no evidence at 5% significance level of heteroskedasticity. In other words, the variance of the error term of the model is constant with time, as the assumptions of the linear regression model require.

By the Jarque-Bery test there is also no evidence (a very high p-value) that errors are not normally distributed at 5% significance level. Therefore, another assumption of a linear regression is met.

By the Lagrange Multipliers test there is also no evidence of autocorrelation of residuals (p-value higher than 5%) at the 5% significance level. This is in agreement with the linear regression model assumptions.

Finally, the RESET specification test has indicated that the model specification is adequate at the 5% significance level.

The above considerations allow to state that the constructed model is good from the theoretical point of view. In other words, the estimated model has not violated the underlying theoretical assumptions. (Notice also that all the variables are stationary according to the ADF test at 5% significance level.)

Table 3. *Final regression estimation*

OLS, using observations 2005:2-2015:2 (T = 41) Dependent variable: ΔWIG

	Coefficient	**Std. Error**	**t-ratio**	**p-value**	
α_0	0.0305104	0.0136376	2.2372	0.0314	**
α_1	0.162412	0.0290544	5.5899	<0.0001	***
α_9	0.0614518	0.0178973	3.4336	0.0015	***
α_{10}	−0.0181726	0.00939557	−1.9342	0.0608	*

* stands for 10% significance level, ** for 5% and *** for 1%

Mean dependent var	0.016360		**S.D. dependent var**	0.114511
Sum squared resid	0.257773		**S.E. of regression**	0.083468
R-squared	0.508546		**Adjusted R-squared**	0.468698
F(3, 37)	12.76224		**P-value(F)**	7.09e-06
Log-likelihood	45.74308		**Akaike criterion**	−83.48616
Schwarz criterion	−76.63187		**Hannan-Quinn**	−80.99020
rho	0.357111		**Durbin-Watson**	1.263461

White's test for heteroskedasticity - Null hypothesis: heteroskedasticity not present Test statistic: LM = 16.9929 with p-value = P(Chi-square(9) > 16.9929) = 0.0488278	**Test for normality of residual -** Null hypothesis: error is normally distributed Test statistic: Chi-square(2) = 0.83169 with p-value = 0.659783
Breusch-Pagan test for heteroskedasticity - Null hypothesis: heteroskedasticity not present Test statistic: LM = 5.52053 with p-value = P(Chi-square(3) > 5.52053) = 0.137416	**LM test for autocorrelation up to order 4 -** Null hypothesis: no autocorrelation Test statistic: LMF = 2.30751 with p-value = P(F(4,33) > 2.30751) = 0.0787195
RESET test for specification - Null hypothesis: specification is adequate Test statistic: F(2, 35) = 1.46498 with p-value = P(F(2, 35) > 1.46498) = 0.244906	

Source: Own elaboration in Gretl

As a result, the Equation (1) has been modified and estimated to have finally the following form:
ΔWIG = 0.03 + 0.16 * ΔGM + 0.06 * ΔU − 0.02 * ΔCA.

(Scatter plot and correlation matrix are presented in the Appendix.) The obtained estimates are interesting. First of all, the positive constant term indicate that there is a steady trend of increase of stock prices. Secondly, it seems natural that increase in gross margin results in an increase in stock prices, and vice versa. Third, it can be seen that increase in current accounts results in decrease of stock prices. This can be understood, if much of the demand on Polish stocks would be generated by foreign investors. Indeed, the negative current accounts indicate net borrowing by Poland from the rest of the world. The net inflow of foreign capital results then in increase of stock prices. But the forth conclusion seems to be a bit strange and shocking. The increase of unemployment rate results in higher stock prices. This result seems quite unnatural. High unemployment is not a positive sign in economy, therefore in such an economy investors should rather avoid investing their money. However, one can remind that there is a negative relationship between unemployment rate and inflation. Actually, the inflation variable and other interest rates has been dropped from the model. But one can follow the reasoning that if unemployment goes up, it is connected with smaller inflation. This can be connected with general decline in interest rates. This leads to "cheaper" capital, which can be invested on the market. So the demand on stocks can increase, and therefore, their prices.

5. Conclusions

The present research is robust to many factors. For example, it can be questioned whether the chosen ratios as the representatives of the information from the financial statements are proper. Indeed, it has been shown that although in literature there are certain sets of commonly used ratios, different researchers usually consider different ratios. Moreover, because of different habits, laws, policies, etc. the accounting information can slightly differ between various countries. As a result, the relevance of certain financial ratios can vary between countries and stock exchanges. Secondly, the financial ratios were considered for the whole economy - not restricted to stock exchange listed companies (this was done due to data availability).

Also, the behavioral aspect is an important one. In certain countries, investors can be more risk accepting, whereas in others the opposite may be true. On certain stock exchanges the role of investors using fundamental analysis can be higher and on others – smaller. This question can be widened on a following general problem: do the investors behave in a rational way? And finally, what is the quality of the used financial statement data (i.e., the audit quality).

Happily, in case of Poland most of the potential problems are the same as for the developed markets. Indeed, the Warsaw Stock Exchange is the biggest one in the Central and Eastern Europe. The audit standards are high and worldwide accepted. Poland is a member of European Union and perceived as a country with good "economic health". Nevertheless, it must be remembered that the problem of rationality of investors has been questioned and nowadays, it is not a dogma any more. Indeed, the behavioral finance are a dynamically expanding branch of finance in contrast with "homo oeconomicus" assumptions.

Herein, it has been shown that an increase in unemployment rate and/or gross margin leads to higher stock prices, whereas an increase in current account results in stock prices decrease. But the obtained model is characterized by relatively small R squared (indicator of a predictive power). The presented research, therefore, rather failed to show that the development of WIG index is really determined by certain macroeconomic and financial factors. However, such a result can still serve as another argument in favor of the efficiency of the Polish Stock Exchange.

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Appendices

Table 4. *Correlation matrix*

Correlation coefficients, using the observations 2005:2 - 2015:2
5% critical value (two-tailed) = 0.3081 for n = 41

ΔWIG	***ΔGM***	***ΔU***	***ΔCA***	
1.0000	0.5665	-0.0042	-0.2990	***ΔWIG***
	1.0000	-0.5535	-0.2247	***ΔGM***
		1.0000	0.2227	***ΔU***
			1.0000	***ΔCA***

Source: Own elaboration in Gretl

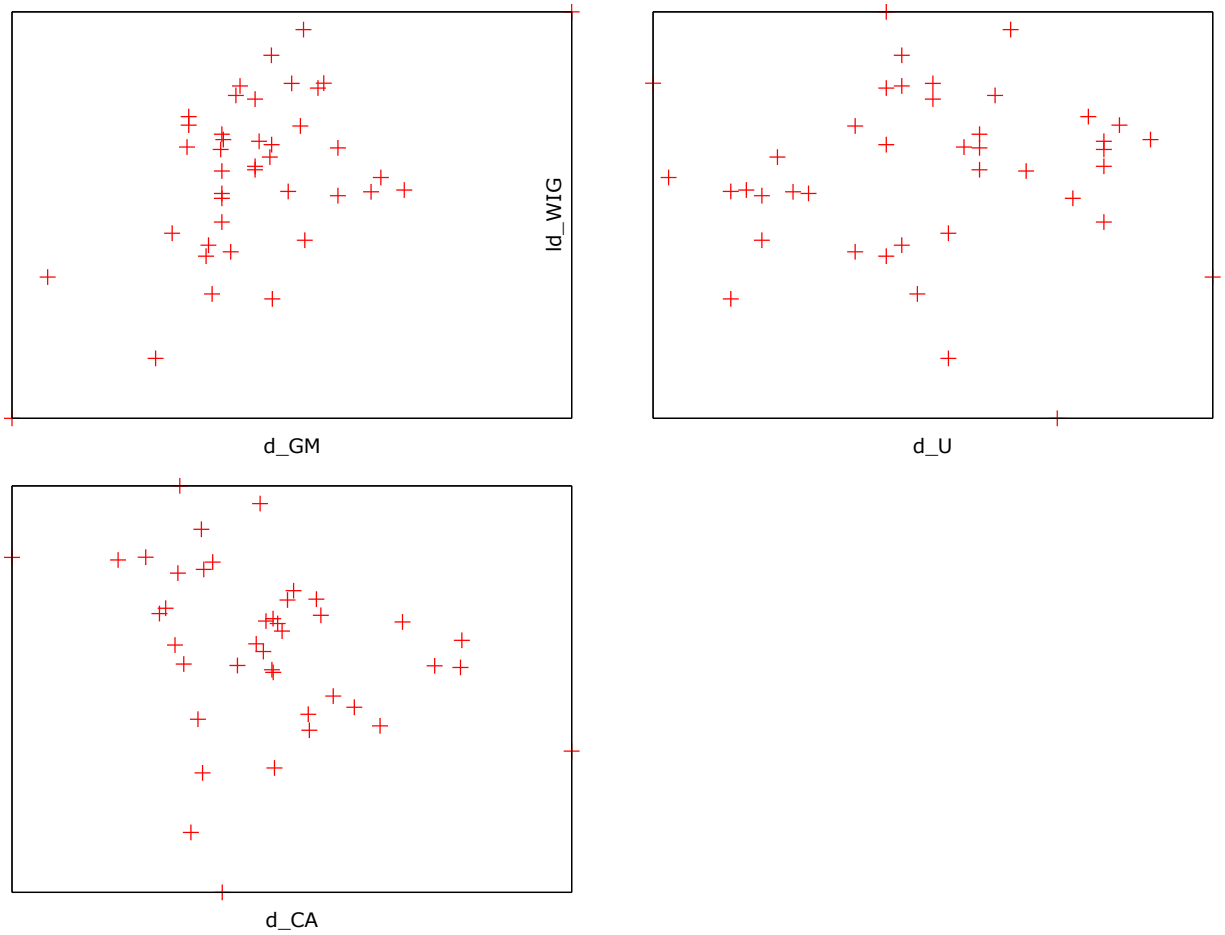

Figure 2. *Scatter plot of ΔWIG and ΔGM, ΔU and ΔCA*
Source: Own elaboration in Gretl