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THE COMPUTER PROGRAM SCIENTIFIC ARTICLE − A NEW APPROACH TO EMPIRICAL SURVEYS

PROGRAM KOMPUTEROWY ARTYKUŁ – NOWE PODEJŚCIE DO BADAŃ EMPIRYCZNYCH

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Summary: In this paper we present the first concept of a computer program using the example of a program to research the relationship between exchange rates and indexes. This solution allows using more historical data than research done by hand, on paper. The exemplary program allows the analysis of integration and variability and the results are posted on charts. Its advantage is downloading data from the file and from the websites and their processing in Excel. The program works on the idea of saving the methodology of empirical research in economics. Empirical studies constitute a large part of Polish scientific achievements. Another option is to bring a sense of historical empirical research or to treat them as a guide to making important business decisions. Unfortunately, authors often based their conclusions on fairly random historical data which had no special significance to historians.

Keywords: financial market, risk management, stock, currency rates, indexes.

Streszczenie: W artykule prezentujemy pierwszą koncepcję programu komputerowego na przykładzie programu do badania zależności między kursami walutowymi i indeksami. To rozwiązanie pozwala wykorzystywać większą liczbę danych historycznych niż badania wykonane odręcznie, na papierze. Program Artykuł umożliwia analizę integracji i zmienności, a wyniki są umieszczane na wykresach. Jego atutem jest pobieranie danych z plików i ze stron internetowych, a także przetwarzanie ich w programie Excel.

Słowa kluczowe: rynek finansowy, zarządzanie ryzykiem, kursy walutowe, indeksy.

1. Introduction

The subject of this article is a computer program to study the relations between stock market indices and exchange rates. It is an attempt to create the equivalent of a technical article on paper. This is a concept updating empirical research and doing an analysis for a large number of periods. There are many obvious advantages of such a solution. These include the ability to include a wider range of historical data, not just a few examples of periods in the stock market. In addition, this method allows to recognize a wider range of financial instruments than testing on paper. One can also freely change the data coming from the website. The results can be always up to date because the program allows one to analyze the problem, both historically and taking into account the recent trading range. The most important advantage of this program is the ability to create more conclusions on the basis of a broader analysis than on paper. This program is an innovative idea to the author and was written in Visual Basic 2010 Microsoft [Wills, Newsome 2014]. The environment enables the processing of Excel spreadsheets. The distinctive feature of this language is that, for some procedures, codes are generated by VB and macros are created automatically, which simplifies the task of the programmer.

2. Methods

In the article the author analyzed the co-integration, Pearson's correlation and historical volatility. The comparison of volatility is presented by the author on the programmed chart. Her program automatically on user command retrieves data exchange, for a fixed time frame, and imports it into Excel. Below is presented the basic information on the concepts of co-integration and historical volatility. Pearson's correlation coefficients were used to determine the correlation between the time series of exchange rates and the Polish Wig20 index.

To determine the historical volatility for 21 session we used the following formula:

$$ZH = 16\sqrt{\frac{\sum_{i=0}^{20}\left[\ln\left(W_{i-20} / W_{i-21}\right) - WW\right]^2}{20}} \cdot 100\%, \tag{1}$$

where W_t – quotation of a financial instrument at time t. The window of 21 sessions is a compromise between excessive mainstreaming process history and losing relevant information about the process. 21 represents the number of trading sessions, i.e. one month of the stock exchange.

2.1. Cointegration

The relation between the co-integrated variables can have the same direction or the opposite. Variables co-integrated in the long term exhibit the same tendency and aim for the long-term equilibrium. The co-integration theory was formulated by C.W.J. Granger in 1981 (developed by C.W.J. Granger and R.F. Engle in 1987). Suppose $yt \sim I(1)$ and $xt \sim I(1)$. We then say that these variables are co-integrated if there is such b that the difference

$$y_t - b\,x_t, \tag{2}$$

is I (0) − the random component is stationary. Then the equation:

$$y_t = b\,x_t + u_t, \tag{3}$$

describes the situation wherein the variables do not depart not too far apart with time, i.e. there is a balance between the long term. If u_t is I (1) – or a higher degree − that this balance does not exist, and the relation is not apparent. Co-integration in practice can be checked using Engle-Granger algorithm, which consists of the following steps:

Step 1: unit root test for the first variable.
The null hypothesis: there is a unit root a = 1; and the process is I(1).
Step 2: The unit root test for the second variable.
The null hypothesis: there is a unit root a = 1; and the process is I(1).
Step 3: Estimation of the co-integrating equation.
Step 4: The test element unit to process residual equation co-integration.
The null hypothesis: there is a unit root a = 1; and the process is I(1).

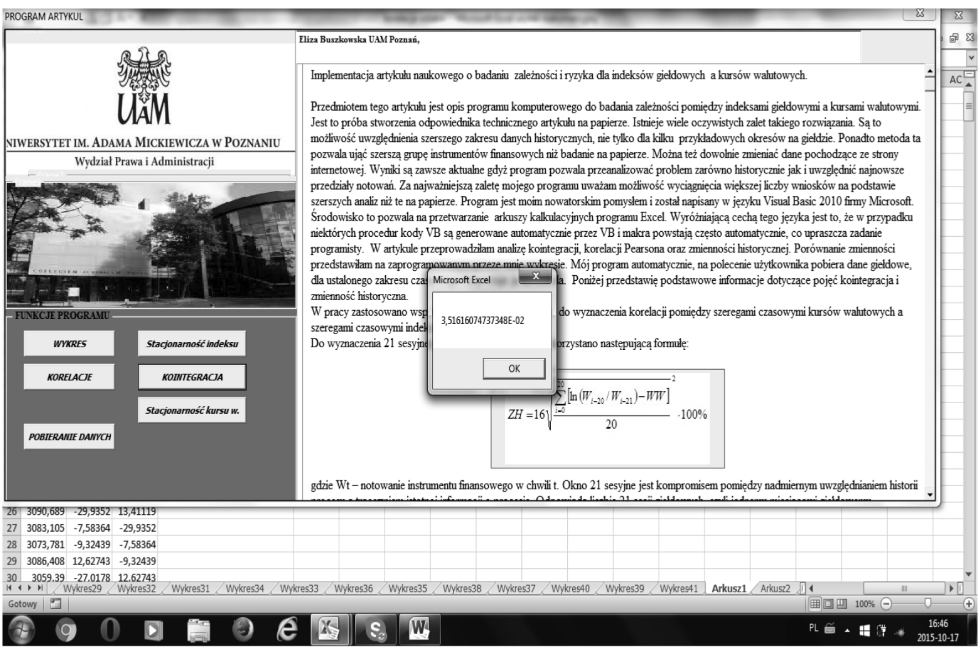

Fig. 1. DF Test of covariance

Source: own work.

2.2. Methods of detecting stationary

The KPSS test (authors: Kwiatkowski-Phillips-Schmidt-Shin) is a test for the null hypothesis of stationary time series. It was introduced in 1992 by D. Kwiatkowski, P.C.B. Phillips, P. Schmidt and Y. Shin. This series is expressed as the sum of the deterministic trend, a random walk and a fixed error. The KPSS test is a Lagrange test multiplier with the hypothesis of a zero-variance random walk. The value of a delay in the KPSS test shall be the integer part of the value 4 (T / 100) ^ (1/4). The program uses the following procedure [Kwiatkowski et al. 1992]:

$$H_0 : y_t \sim I(0)$$

$$H_1 : y_t \sim I(1).$$

Step 1. OLS estimation of model parameters (with or without trend):

$$y_t = \alpha + \beta t + \varepsilon_t.$$

We calculate the rest ε_t

Step 2. We calculate the sum of residues:

$$S_t = \sum_{r=1}^{T} \varepsilon_r \quad \text{for } t\ 1,\ldots,T,$$

and the value of long-term variance estimator compliant residues (weights Newey--West or Bartlett):

$$S^2(k) = T^{-1}\left[\sum_{t=1}^{T} e_t^2 + \sum_{s=1}^{k} w(s,k) \sum_{t=s+1}^{T} e_t e_{t-s}\right],$$

Bartlett's weights:

$$w(s,k) = 1 - \frac{s}{k+1},$$

k − we choose arbitrarily.

Step 3: compute the test statistic:

$$\eta = \frac{\sum_{t-1}^{T} S_t^2}{TS^2(k)},$$

and we compare with critical values (e.g. produced by Gretl) if

$$\eta > \eta_{kryt}.$$

We reject statistics H_0.

The stationary test method used in this paper is a test verifying the presence of the Dickey Fuller unit root in the autoregressive equation.

A simple model AR (1) has the form:

$$y_t = \rho y_{t-1} + u_t,$$

where y_t is the dependent variable, t is time index, ρ factor, and u_t is an estimation error (white noise). Unit root occurs when $\rho = 1$. In this case the model is non-stationary.

The study uses empirical observations of daily exchange rates and stock indices from 13-10-2013 to 18-09-2015. This period was chosen to include actual data and was a continuation of the last period considered in [Buszkowska 2014a].

In [Buszkowska 2014b] the author analyzed the correlation between the exchange rate and the stock index. The survey was conducted for non-stationary and stationary series. Stationary was obtained by differentiating the series once or twice. For such transformed and untransformed data, the Pearson correlations were calculated. It turned out that for the period of the financial crisis years 2007-2009, when taking into account the non-stationary series of stock quotations, and instead of causal exploration the coexistence of the graphs is under consideration; negative correlation between financial instruments is significant [Buszkowska 2014b; Buszkowska 2014a]. Data analysis on the plot makes sense for an investor who uses single stock market instruments. In the period from 01-10-2013 to 18-09-2015 there were also negative Pearson's correlations between instruments. The results are presented in the table 1.

Table 1. The values of the correlation coefficient for the pairs exchange rate − stock index

Value of Pearson's correlation coefficient
EURPLN-WIG20 -0.2542165
USDPLN-WIG20 -0.55205
GBPPLN-WIG20 -0.55385
CHFPLN-WIG20 -0.52935

Source: own elaboration.

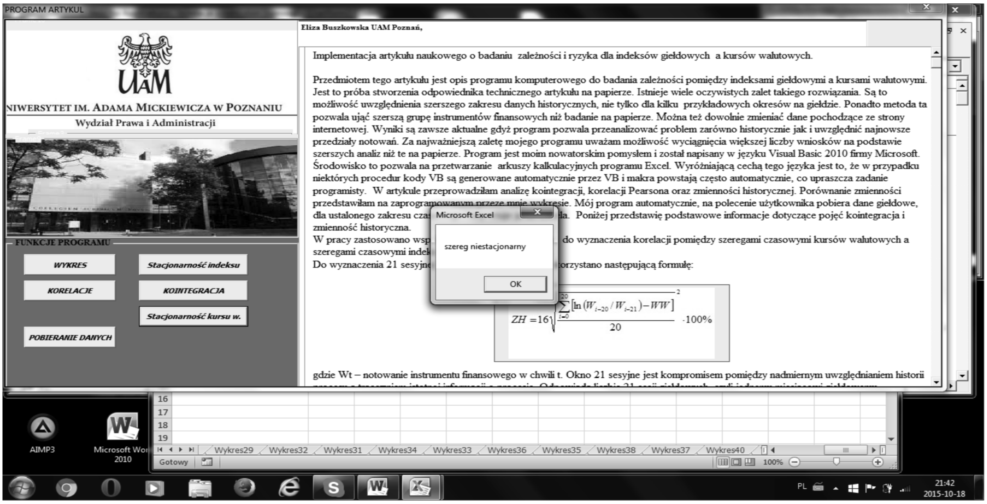

Fig. 2. Illustration of the program Article, the analysis of stationary

Source: own work.

In the second stage we conducted a study to compare the volatility of stock indices and exchange rates charts, for the analyzed period we put together the following charts:

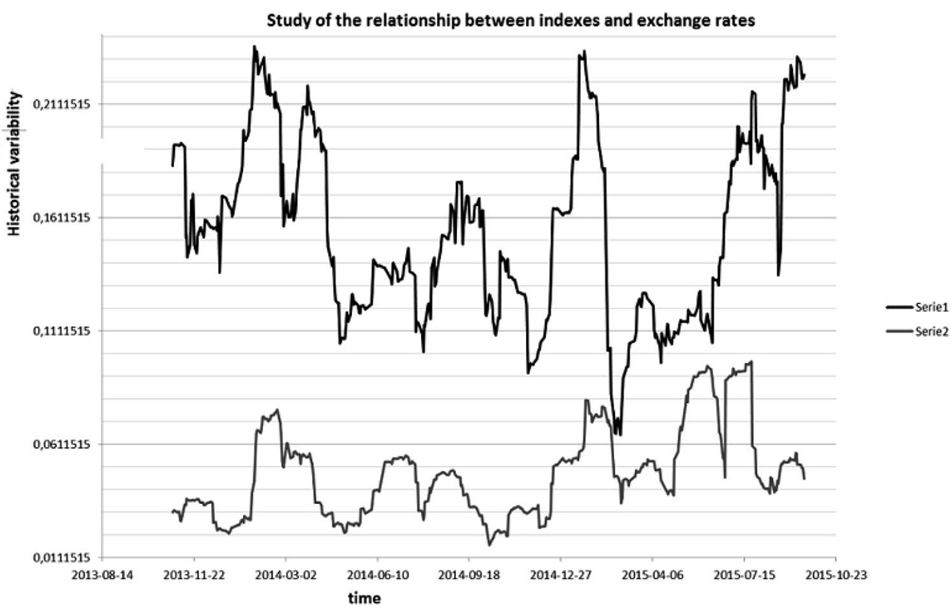

Fig. 3. Comparison of historical volatility of EURPLN-WIG20

Source: own work.

We note that, just as for other periods during the period considered, the volatility of the stock exchange exceeded index rate volatility.

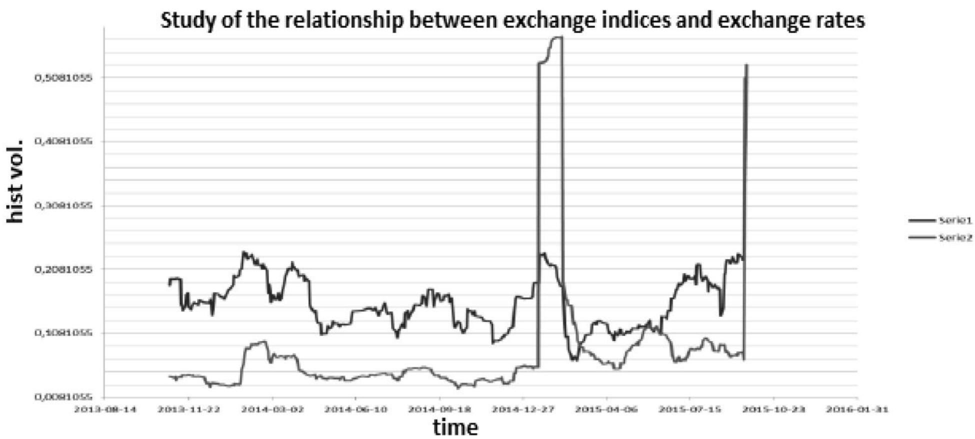

Fig. 4. Comparison of historical volatility CHFPLN-WIG20 using the Article program

Source: own work.

Similarly, for the Swiss Franc the Polish Zloty in almost the whole period the volatility of exchange rate was lower than the volatility of the WIG20 stock index.

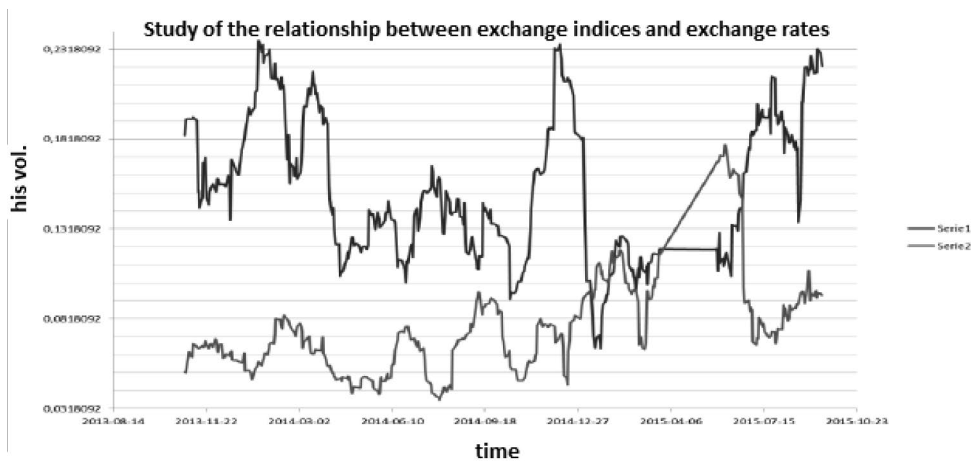

Fig. 5. Comparison of historical volatility GBPPLN-WIG20 using the Article program

Source: own work.

The same relations are true for GBP.

Fig. 6. Comparison of historical volatility of WIG20-USD PLN using the Article program

Source: own work.

Also for the US dollar this relation was true.

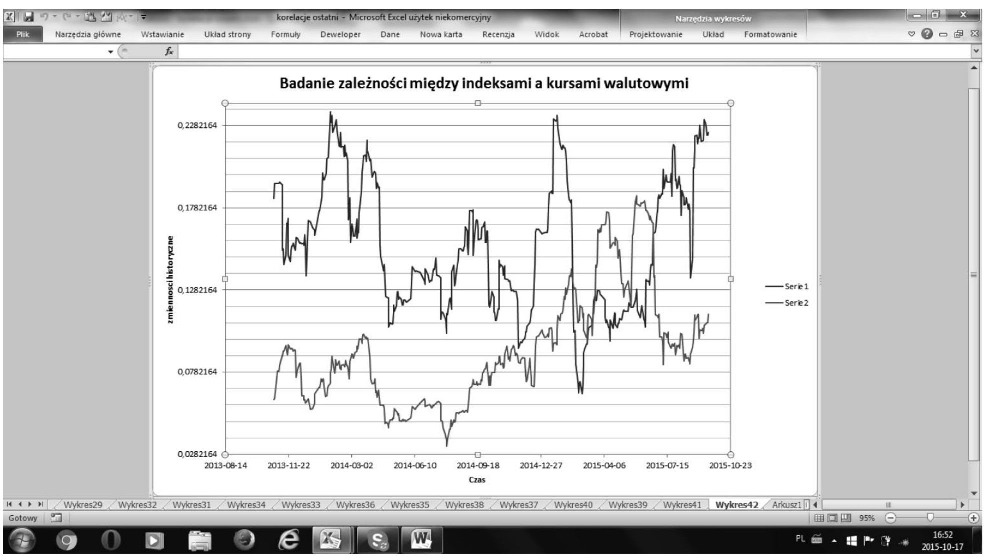

Fig. 7. The chart obtained in the Article program

Source: own work.

Then, for the periods studied, a co-integration analysis was performed. For the Dickey Fuller test we received the same request about the lack of co-integration.

Table 2. Analysis of co-integration

Variables	DF
USDPLN-WiG20 GBPPLN-WIG20 CHFPLN-WIG20 EURPL-WIG0	8,86188E-02 5,72527E-03 –0,0696E-02 3,51616E-02

Source: own work.

This is in agreement with the result for the other periods considered in [Buszkowska 2014a].

A stationary analysis was then performed. In accordance with the work [Tatarczak 2007] and [Buszkowska 2014a] there are the series are non-stationary. In this article the author examines whether this is also true in this work period. The study confirmed the earlier results.

Table 3. Non-stationary analysis

Variables	DF test
WIG20 USDPLN GBPPLN CHFPLN EURPLN	non-stationary series non-stationary series non-stationary series non-stationary series non-stationary series

Source: own work.

Analysis of the problems studied in [Buszkowska 2014a] on the relation between the WIG20 stock index and the exchange rates in the electronic program Article, written by the author, confirmed the findings obtained for other periods. The program is useful for making observations for different data. As a result, there was non-stationary and the lack of co-integration between the two instruments was noted. In all the periods, the risk connected with the stock index was generally higher than the risk connected with the exchange rate, so it could be speculated that these are the instruments with less market risk. Among the studied pairs of instruments were also high negative correlations. The author presented using the example of the program described, the concept of updating of empirical research and the use of larger amounts of data from many different historical periods. The author proved that with similar programs, empirical studies can be updated and become permanent results. With the use of information technology it is possible.

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