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INTERDEPENDENCE OF INDUSTRIAL PRODUCTION INDEX AND CAPITAL MARKET IN CROATIA: VAR MODEL

Bojan Tomić, University specialist of economy
HEP – Distribution system operator, Elektra Zagreb d.o.o., Croatia
University College EFFECTUS – College for Finance and Law, Zagreb, Croatia
bojan.tomic2@gmail.com
Andrijana Sesar, Professional master of applied economics
Raiffeisenbank Austria d.d., Zagreb, Croatia
University College EFFECTUS – College for Finance and Law, Zagreb, Croatia
andrijanasesar@gmail.com

ABSTRACT

Industrial production is an important indicator of future trends in each of the economy including the Croatian economy. On the other hand, as a preceding factor of the economy dynamics changes, the equity indices of the capital market can be used. Due to different considerations and interpretations of their mutual initial causation, the paper analyzes the interdependence between the main index Croatian capital market CROBEX and indicators of total industrial production of the Republic of Croatian. Also, in the model was introduced exchange parity euro/kuna as an additional variable rate which is considered to have a significant influence on the competitiveness of the Croatian economy, as well as the capital market. The theoretical premise about the interaction of the foreign exchange rate and capital markets has been considered in the context of the "flow-oriented" and "stock-oriented" model. Aiming to determine the interdependence between aforementioned variables, the analysis was carried out using the vector autoregression model (VAR). The Granger causality test was conducted as part of the VAR model, as well as the decomposition of variance in future periods and the impulse response function of relevant variables. The results of analysis indicate the existence of causality of the exchange rate to the index of industrial production, as well as the existence

of causality of the index of industrial production to CROBEX index.

Keywords: *VAR model, causality, industrial production, CROBEX, the exchange rate.*

1. INTRODUCTION AND MOTIVATION

In the wider economic literature it is common opinion that interdependence of certain macroeconomic variables that represent the financial market are not strictly defined. The reason is cited a number of factors: time of observation, selection of analysis model, monetary policy that is carried out, economic development degree of individual countries, changes in the structure of economic and social organization that undergo the transition countries, and which are characterized by the underdevelopment of the financial system. The existing domestic researches, such as Sajter and Ćorić (2009), Tomić et al. (2014) indicate a high degree of correlation between the US and Europe, and the Croatian capital market, partly due to industrial-financial coherency of the United States and Europe, and partly because of the influence of psychological factors on the behavior of the individual, respectively the behavioral finance notion. However, the assumption is that the value changes of some observed market depends not exclusively on the changes of value the leading foreign markets. Opposed to developed markets, considerable number of research were carried out about impact of macroeconomic variables on the value changes of the share market, in Croatia there is very small number of research on this or a similar topic. Therefore, the study of causality between macro indicators and stock markets index, contributes significantly to the wider scientific community in Croatia, also through a practical approach, taking into consideration the results of new research. Considering that the study analyzes the interconnection between the index volume of total industrial production, the CROBEX index as trend value indicator of the capital market and middle exchange rate of the euro against the kuna, the following briefly describes the theoretical assumptions of the interdependence between these variables.

Classical economic theory assumes the interaction between the stock prices and foreign exchange rates in two basic models: the "flow-oriented" and "stock-oriented" model. The first model assumes that the foreign exchange rate can affect the market value of the shares (Dornbusch and Fisher, 1980). The domestic capital market reacts to the EUR/USD parity value for several reasons. As the most important reason, the competitiveness of the economy is alleged, ie. appreciation or depreciation of the kuna against the euro. In general, increase of one currency value in terms of another opens more economic questions in relation to whether the economy is more import or export oriented. If

joint-stock companies imports more goods as basic inputs for their products, depreciation of the domestic currency could result with higher operating costs which consequently can reduce the value of their shares. Further, in case of currency appreciation, the situation is reversed, and that the final outcome could be value increase stock shares. On the other hand, it can be set the opposite hypothesis which due to the depreciation of the kuna assumed revenue growth export-oriented companies, and value increase of their stock shares. Also, if appreciation of the local currency happened, it can mean a reduction in their business activities and ultimately lower value of their shares on the secondary market.

The second, "stock-oriented" model, based on the inverse assumption, suggests that the stock market can affect the exchange rate value (Branson et al., 1977). The assumption is that the increase of domestic shares value may lead to appreciation of the domestic currency for two reasons. First reason is that the rise of domestic stocks prices attracts new investments. Investors, owners internationally diversified portfolio, simultaneous sale foreign shares in foreign currencies and buying domestic shares in the domestic currency, where high demand for domestic currency causes its appreciation. The second reason is that the increase of shares value can be an indicator of positive changes in the economy trends, which again leads to higher investor demand for domestic currency, which results with higher market interest rates. Higher interest rates attracts foreign capital and increases demand for domestic currency because international funds transferring requires currency conversion, which ultimately causes currency appreciation. Of course, here are placed and reverse hypothesis which says that in case of fall in share prices investors will sell domestic shares, which will lead to the exchange rate depreciation. Finally, the hypothesis of the existence of causality between the capital market and foreign exchange rate does not exist. This is explained by the fact that the rate represents the cost of property and its price is determined by its movement in the future (Muhammad and Rasheed, 2002). Therefore, future events will affect the current exchange rate movement, and these events can be completely different from those that affect the movement of stock prices. In this case the relationship between stock prices and the exchange rate may not exist (Benazić, 2008).

The theoretical assumptions about interrelation between the CROBEX index and the industrial production index can be described in several ways. In fact, the equity indices are recognized as a very good leading indicator of real aggregate activity, and usually come as a leading (lead) variable in models. This becomes particularly evident in developed capital markets. For example, when reduction of real activity is expected in the future, investors expect weaker business results of companies.

The consequence of weaker performance is reflected in smaller dividends, which ultimately results in lower stock prices[1]. On the other hand, small open economies such as Croatian, with poorly developed financial market, are extremely susceptible to outside influences. Accordingly, it is difficult to expect that the index CROBEX to be leading factor to dynamic changes of domestic economic indicators. If causation exists between the CROBEX index and the index of total production, it is expected that the causation goes from the production index direction towards the capital market.

Finally, the theoretical assumption of causality between the exchange rate EUR/USD and industrial production index has been described in the context of the "flow-oriented" model, respectively through competitiveness economy changes that comes to the fore in the case of the exchange rate changes in direction that corresponds to the import or export oriented enterprises. Due to the large number of research, the results of relevant studies is following, and briefly describing the considerations of recent date that are served as indicators for the selection of independent variables in the analysis.

1.1 PREVIOUS RESEARCH

Different studies provide conflicting results, one of the reasons are specifications of a certain markets, due to different model specifications, as well as selection of variables in model; Cheung and Ng (1998) are thinking that conflicting results of a similar studies in different countries are due to differences in investor's perception about monetary policy of a certain country. Furthermore, Ramasamy and Yeung (2005) cite that reasons for conflicting results are wider economic factors such as the level of development and changes in the structure of economic system of a certain country, including the capital market. According to these results, and considering differences in social systems, an important factor in the analysis represents the time period in which the analysis is carried out.

Before overview of new researches, worth mentioning is some consideration of the first studies regarding relationship between macroeconomic factors and the equity markets, such as Fama (1981), Fama and French (1989), Ferson and Harvey (1991). It can be concluded that, in all above mentioned studies a significant relationship has demonstrated between the capital markets of a certain macroeconomic indicators, such as industrial production, inflation, interest rates, the yield curve and the risk premium.

[1] More about the stock market indexes as indicators of overall real economic activity see: Kunovac (2011).

New studies by Dilrukshan and Simpson (2009) conducted in Australia are about interaction between the value of the shares and the value of the Australian dollar against the US dollar by testing the relationship through the "flow-oriented" and "portfolio balance" models. Results point to "portfolio balance" model, respectively suggest that changes of value of the Australian capital market have effect on changes of value of the Australian dollar exchange rate. Furthermore, by applying multivariate VAR model, Phyllis (2010) affirms that there is a causal link between the Greek stock market and industrial production during the period from January 1996 to June 2008. Masuduzzaman (2012) using the VECM model[2] proves the link between share prices and macroeconomic indicators for Germany and the UK. Research in the United States and Japan were conducted by Humpe and Macmillan (2009), based on which they determine positive correlation between the share price with industrial production, but negative correlation with inflation and long-term interest rates in the US, while in Japan, it was determined positive correlation between stock market and industrial production, but a negative link between the stock market and money supply.

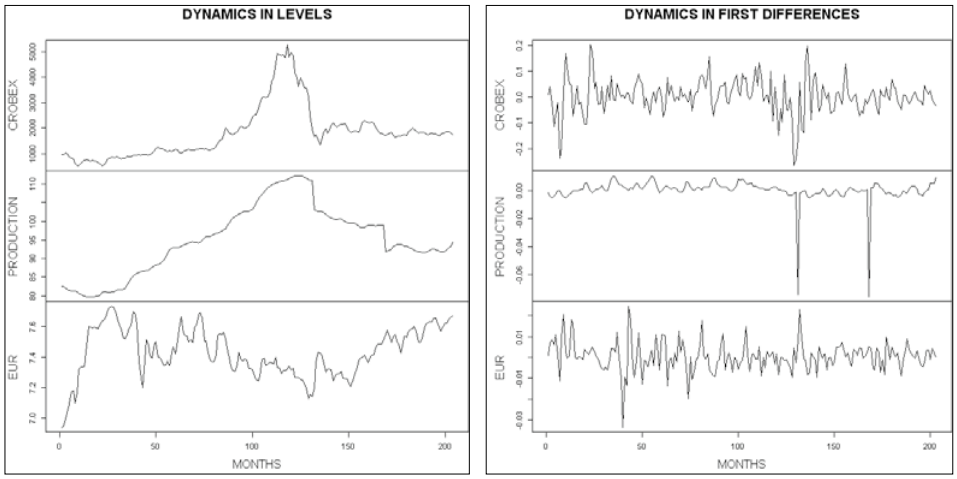
In Croatia Vizek (2006) examines impact of monetary policy implementation on the real sector by using the VECM model, which is presented as an index of industrial production. Results indicate that depreciation of the kuna against euro will cause a decrease of industrial production in the long term, while long term appreciation of the kuna causes expansion in industrial activity. This result indicates that the relationship between the exchange rate and industrial production was not in line with the fundamental economic assumptions which suggests that the depreciation of the exchange rate will have a positive impact on industrial production. Also, Benazić (2008) using the VECM model analyzes connection between the stock prices and real effective exchange rate. Long term analysis indicates that increase of stock prices will lead to appreciation of the exchange rate, while in short term analysis impact of share prices on the exchange rate is almost insignificant. Impulse response analysis showed that increase of share prices will affect to the exchange rate appreciation while the exchange rate appreciation will lead to instantaneous decline of stock prices along their growth just seven quarters after the shock occurrence. Given previous research conducted in Croatia, contribution of this study is reflected through formal examination of causality existence between the industrial production index, as a leading indicator of economy state and the leading national indexes of the CROBEX capital market.

[2] engl. Vector Error Correction Model.

2. METHODOLOGY AND SELECTION OF VARIABLE OBSERVATION

In this paper for the purpose of analysis there were used three time series data expressed on a monthly basis: the industrial production index *(PRODUCTION)*, the main national equity index *(CROBEX)* and the average middle exchange rate value of the euro against the kuna *(EUR)*[3]. Unlike previous studies, the time interval used in this paper is past 17 years, from 1 January 1998 to 31 December 2014. Considering that the purpose of analyze is causality between selected variables, the best selection of variables that presents the Croatian economy should be GDP indicator. However, the index of total industrial production as a measure of GDP was used in this paper, because the GDP figures are reported on a quarterly basis. Also, the *CROBEX* variable was expressed as monthly average value, because the exchange rate value was also expressed as the average. In order to make a visual inspection of common dynamic variables of interest and determine potential unsteadiness or co-integration between them, the following shows the variables movement in levels and in their first differences[4], according to Figure 1.[5]

Picture 1.: Comparative overview of the time series variables CROBEX, PRODUCTION and EUR time series in levels (left), comparative overview of their first differences (right)



Source: made by authors

[3] Input data sources were provided by monthly reports of the Central Bureau of Statistics (*PRODUCTION* variable), monthly bulletins of the Croatian National Bank (*EUR* variable), as well as the Zagreb Stock Exchange (*CROBEX* variable)

[4] Because of better statistical properties, the variables were differentiated by using logarithms, respectively they were expressed as series of natural logarithms using: $\left(\frac{\text{Pit}}{\text{Pit-1}}\right)$, where: *ln* – natural logarithm, P_{it} – variable value *i* in time *t*, P_{it-1} – variable value *i* in time *t – 1*

[5] Results obtained by the analysis of non-stationary time series could lead to wrong interpretation of results and creating a false assumptions about representativeness of the model Benazić (2008)

All variables indicates the existence of trend, ie. do not exhibit a tendency of returning to its average value in levels, in contrast to their differentiated values where it is apparent that the values range around its average. Dynamics of movements between EUR variables and CROBEX variables shows no tendency of cointegration. On the other hand, the dynamics of movements between CROBEX and *PROIZVODNJA* variables suggests that between them could be a long-term connection. Considering this type of variable dynamics, before the VAR model implementation, in the paper is carried out formal testing of time series data properties on stationarity, respectively integration using the unit root tests, ie. the expanded Dickey-Fuller test (ADF test), (Dickey and Fuller, 1979). Results of ADF test - Table 1, indicate that the variables are non-stationary ie. integrated of order one I (1). Accordingly, the paper is carried out, Johansen test of cointegration in order to formal examine their long-term equilibrium of relationship in levels, ie. the residuals stationarity of their regression (Johansen, 1988; 1991), (Johansen and Juselius, 1992). Hereinafter of this paper, with the aim of establishing mutual causality between the variables, is carried out a VAR model. The VAR model creates endogenous variable of all observed data series $e = (x, y, z)'$, and as such is suitable for analysis of the interdependence of important macroeconomic variables. There are two main applications of the VAR methodology: during the economic theories testing and in the dynamics of the phenomenon analysis (Jošić and Jošić, 2011). The standard Granger causality test, orthogonal variance decomposition of forecast errors (eng. *Decomposition of Variance* - DVC), and Impulse-Response function Analysis (eng. *Impulse Response Function* - IRF) was processed within the VAR methodology.

3. RESULTS OF ECONOMETRIC ANALYSIS

Table 1. shows results of the ADF test of selected variables in levels and their first differences. Variables expressed in levels do not meet the requirement of stationarity because values of ADF test are not less than the critical value, suggesting that there is a positive correlation between the residuals of regression variables. After differentiation of variables, the value of ADF test are lower than the critical value which indicates that the variables are stationary or integrated of order I (1).

Table 1.: Results of ADF unit root test (constant and trend included)

Variable	Critical values of ADF test			Level	First difference
	1%	5%	10%		
CROBEX	-3,99	-3,43	-3,13	-1,7652	-8,7158
PRODUCTION	-3,99	-3,43	-3,13	-1,4901	-8,4618
EUR	-3,99	-3,43	-3,13	-2,6546	-9,7076

The critical value of the ADF test were taken from Hamilton (1994) and Dickey and Fuller (1981). Optimal number of lags in the model were determined according to Bayes „BIC" information criterion and it is 1 for all variables.
Source: made by authors

After testing of stationarity, we carried out a formal test of long term equilibrium relationship existence between the observed variables, respectively cointegration. A prerequisite for number of cointegration vectors determination is selection of optimal lag number models (Benazić, 2006). Four criteria were used in this paper in purpose of determining the optimal lag number models: Akaiake information criterion - AIC, Hannan - Quinn information criterion - HQ, Schwarz information criterion - SC, Final prediction error - FPE. Different criteria yielded with different results, as shown in Table 2. However, Liew (2004) proves in his work that the HQ and SC criteria give better results on a sample more than 60 observations. Since in this paper the length of sample is 204 observations, the optimal lag number is determined to HQ and SC criteria, so the chosen number of lags is 2.

Table 2: Length of optimal lag number according to various criteria – variable in levels

Criterions	AIC	HQ	SC	FPE
Optimal lag number	3	2	2	3

Source: made by authors

After determining the lag number, authors were accessed testing of variables expressed in levels on existences of cointegrating vectors between them. Testing was conducted on a test size: λ_{trace} – test traceability matrix, and the size of the test: λ_{max} – the maximal-eigenvaalue test. λ_{trace} traceability test testing the null hypothesis that the number of cointegrating vectors is less than or equal to *r* against the alternative hypothesis. On the other hand, λ_{max} statistic test testing the null hypothesis that the number of cointegrating vectors is equal to *r,* against alternative *r* + l (Jošić and Jošić, 2011). Cointegrating test results are shown in Table 3.

Table 3: Results of Johansen method – determining number of cointegrating vectors

Number of cointegrating vectors	Eigenvalue	λ_{trace} statistics	Critical value	λ_{max} statistics	Critical value
0	0,0439	0,06	8,18	0,06	8,18
1	0,0227	4,68	17,95	4,62	14,90
2	0,0003	13,71	31,52	9,03	21,07

Critical values of the test for the statistical significance of 5% were taken from Osterwald-Lenum, M. (1992). The model excludes the constant and trend from the calculation.
Source: made by authors

Given that the value of the test are less than the critical value, it can be concluded that there is no long term connection between dynamics of the selected variables in levels, therefore the analysis continues with the VAR model and variables in their first differences. However, before running the VAR model, it is necessary to determine the optimal number of lags using previously described information criteria, in accordance with Table 4.

Table 4: Length of optimal lag number according to various criteria – variable in first difference

Criterion	AIC	HQ	SC	FPE
Optimal number of movements	2	1	1	2

Source: made by authors

As with Johansen method, for determining the optimum number of lags were used SC and HQ criteria, and the selected number of lags is 1. In continuation of the paper the VAR model is formed on the first variables differences and test its stability, ie, stability regression of equations in the model. In purpose of testing of the model stability, reverse characteristic polynomial was used according to express 1[6]

$$\det (I_K - A_1 z - ... - A_p z^p) \neq 0 \quad za\ |z| \leq 1 \tag{1}$$

If the above equation, has a $z = 1$ for unit root as solution, then some or all of the variables in the VAR model are integrated order I(1), which results with possibility of cointegration existence between them. Testing results of the VAR stability is shown in Table 5.

Table 5: Results of VAR model stability for 3 equations

Characteristic polynomial of the matrix	0,3882	0,3882	0,1121

Source: made by authors

[6] *Source*: http://ftp.uni-bayreuth.de/math/statlib/R/CRAN/doc/vignettes/vars/vars.pdf (page 3. i 6.)

All the values in Table 5 are less than one, so based on calculation it can be concluded that the VAR model is stable. As previously mentioned, the final objective of this paper is to determine the interdependence, respectively causality between the variables. So as to determine causality, in this paper the Granger causality test was used (Granger, 1969). Causality is described as forecasting possibility one of the variable based on relationships with the dynamics of other variable. Accordingly, this paper examines how much changes of value of the certain causal variables can have effect on values changes of other response variables. Granger causality test results are contained in Table 6.

Table 6: Results of Granger causality test

Causal variable	Response variable	*F*-value	*p*-value
PRODUCTION	***CROBEX***	**5,1787**	**0,0239**
PRODUCTION	*EUR*	0,0021	0,9636
EUR	*CROBEX*	1,9361	0,1656
EUR	***PRODUCTION***	**8,2198**	**0,0046**
CROBEX	*PRODUCTION*	0,0996	0,7527
CROBEX	*EUR*	0,9655	0,3270

Default interval of significance is 5%.
Source: made by authors

The test results indicate that the *PRODUCTION* variable according to Granger causes the *CROBEX* variable. Also, the results suggest that the *EUR* variable based on Granager test has effect on the *PRODUCTION* variable. Other causal variables showed no statistical significance in describing the dynamics of response variables. According to the results, the analysis continues with variance decomposition of forecast errors of variables *CROBEX* and variable *PRODUCTION*. Table 6 shows the variance decomposition for the time horizon of ten months.

Table 6: Orthogonal variance decomposition projection of CROBEX variables and PRODUCTION variables

	CROBEX variable			*PRODUCTION* variable		
Period	*CROBEX*	*PRODUCTION*	*EUR*	*CROBEX*	*PRODUCTION*	*EUR*
1	100,00%	0,00%	0,00%	1,38%	98,62%	0,00%
2	97,67%	1,87%	0,46%	1,31%	95,12%	3,58%
3	96,59%	2,44%	0,98%	1,33%	94,50%	4,17%
4	96,25%	2,56%	1,19%	1,35%	94,42%	4,23%
5	96,17%	2,58%	1,25%	1,36%	94,41%	4,24%
6	96,15%	2,58%	1,27%	1,36%	94,41%	4,24%
7	96,15%	2,58%	1,27%	1,36%	94,41%	4,24%
8	96,15%	2,58%	1,27%	1,36%	94,41%	4,24%
9	96,15%	2,58%	1,27%	1,36%	94,41%	4,24%
10	96,15%	2,58%	1,27%	1,36%	94,41%	4,24%

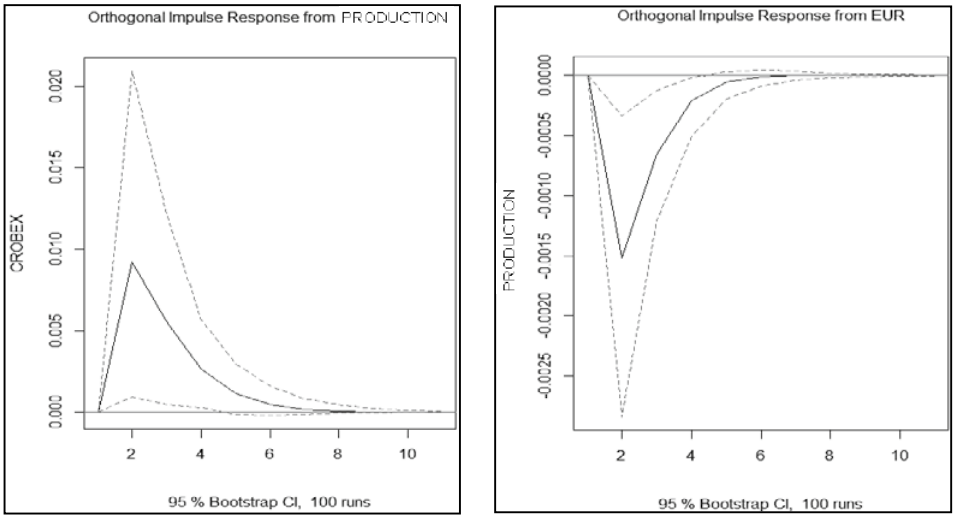
Source: made by authors

Based on variance decomposition it is possible to determine how much variation one observed variable described with variations of the same variable, but as well with variations of other variables in the model. Although causality results indicate statistically significant causality link from direction of total industrial production index towards to the capital market index, most part of the *CROBEX* variable variation was explained with the same observed variable In the first period *PRODUCTION* and *EUR* variables have no effect on the variations *CROBEX* variables, the variations are entirely possible to explain with the same observed variable. From the second to the sixth period that percentage gradually decreases to a value of 96.15%, as much as in sixth period. Additionally, since the first to the fifth period the percentage of described variation by the *PRODUCTION* variables gradually increases from 0% to 2.58%. Therefore, it can be concluded that variations of the total production index significantly do not describe variation of the capital market index. However, such results are not surprising. In the context of secondary capital market, it is hard to expect that one macro indicator or any other certain indicator, significantly describes the changes of the stock market value. If this were to happen, investors would focus all their attention to the study of prediction and other causality variables. On the other hand, from direction of the *EUR* variable towards to *PRODUCTION* variable, the situation is very similar. *EUR* variable in the first observed period does not explain the variation of *PRODUCTION* variables. From the second to the fifth period this percentage is slightly increasing, and in the end amounted to 4.24%. Accordingly, it can be concluded that changes in the value of the euro against the kuna affects on industrial production, but with a small percentage of described variations, suggesting that the industrial production

activities of the Croatian economy, as expected, depends on other macro indicators. The remaining part of the variation is described with the *PRODUCTION* variable, but also with the small part of the *CROBEX* variable variation.

So as to determine the direction of statistically significant variables impact, hereafter of the paper is presented the function of impulse response variables.[7]

Picture 2: Function of impulse response for the CROBEX variable (left picture) and function of impulse response for the PRODUCTION variable (right picture)



Source: made by authors

From Picture 2 it can be perceive how the domestic capital market positively reacts to the unit (positive) pulses of total industrial production index. This result is in line with theoretical expectations. One can assume that due to increase of domestic industrial production, capital market will react positively. This positive reaction continues through the next two periods. After a second period, the reaction on the shock pulse gradually decreases and disappears after the sixth period. On the other hand, midst to increasing value of the euro against the kuna, respectively the depreciation of the kuna, it will result with volume reduction of the industrial production index. The trend of negative dynamics is present in the first two periods, to make it through the next four months completely recovered and disappeared. The resulting dynamics is con-

[7] This paper presents the impulse response results for variables that are significant based on Granger causality. Other individual results are available upon request.

trary to the fundamental economic assumptions that describe the appreciation of the domestic currency as a priority in order to create greater economic competitiveness[8]. According Vizek (2006) as the reason for such dynamics are primarily stated monetary policy that is based on the regime of targeting the exchange rate within a range of ± 2 percent

4. CONCLUSION

The primary focus of this paper was to analyze the interdependence between the industrial production index, the main index of the Croatian capital market CROBEX and variable parity EUR/USD. Analysis was performed using the vector autoregression (VAR) model which includes standard testing of Grenger causality, orthogonal variance decomposition of forecast errors and Impulse-Response function (IRF) Analysis. In the context of interdependence of the capital markets and the exchange rate, the initial theoretical assumptions are based on *"flow-oriented"* and *"stock-oriented"* models. According to the VAR model results, it can be established that there is no significant causality between the variables that confirmed the presence of one of these models.

Furthermore, the theoretical consideration about the CROBEX index, as the leading variable in the analysis of causality between the capital market and the industrial production index is justified with the assumption that CROBEX is leading variable in real aggregate economic activity. However, the results showed the opposite causality and confirmed the industrial production index as the leading variable. As expected, the Impulse-Response Analysis suggests that there is a positive correlation between the capital market and industrial production.

Finally, the interdependence between the exchange rate and the industrial production index was examined in the context of changes in the Croatian economy competitiveness as a response to the appreciation or depreciation of the domestic currency. Results of the analysis indicate that depreciation of the kuna, will result with declining of the industrial production. These results are consistent with previously conducted considerations, but were still contrary to fundamental economic principles. Given previous research, it is clear that the form of negative reaction to depreciation of the domestic currency continued, leading to the conclusion that the import of goods as inputs in the production, continues to be a significant factor in the segment of the Croatian economy.

[8] The results are consistent with previous studies on this topic (Lang i Krznar, 2004), (Vizek, 2006).

REFERENCES

1. Benazić, M., (2006). „Fiskalna politika i gospodarska aktivnost u Republici Hrvatskoj: model kointegracije". Ekonomski pregled, 57 (12) pp. 882-918.
2. Benazić, M., (2008). „Povezanost cijene dionica i deviznog tečaja u Republici Hrvatskoj: VEC model". Ekonomski pregled, 59 (11) pp. 669-687.
3. Branson, W., Halttunen, H., i Masson, P., (1977). „Exchange rate in the short run: the dollar Deutsche mark rate". European Economic Review, 10, pp. 303–324.
4. Cheung, Y. W., Ng, L. K., (1998). „International evidence on the stock market and aggregate economic activity". Journal of Empirical Finance, (5), pp. 281-296.
5. Dickey, D. A., Fuller, W. A., (1979). „Distribution of the Estimators for Autoregressive Time Series With a Unit Root". Journal of the Arnerican Statistical Association,'74, pp. 427-43t.
6. Dickey, D. A., Fuller, W.A., (1981). „Likelihood Ratio Statistics for Autoregressive Time Series with a Unit Root". Econometrica , 49, pp. 1057-1072.
7. Dilrukshan, N., Simpson, J., (2009). „The Interaction between Exchange Rates and Stock Prices: An Australian Context". International Journal of Economics and Finance, vol. 1, pp. 3-23.
8. Dornbusch, R., Fischer, S., (1980). „Exchange Rates and the Current Account". American Economic Review, vol. 70, no. 5 (Dec., 1980), pp. 960-971.
9. Fama, E. F., (1981). „Stock returns, real activity, inflation and money". American Economic Review, 71 (4), pp. 545-565.
10. Fama, E., French, K., (1989). „Business Conditions and Expected Returns on Stocks and Bonds". Journal of Financial Economics, 25 (1), pp. 23-49.
11. Ferson, W. E., Harvey, C. R., (1991). „The variation of economic risk premia". Journal of Political Economy", 99 (2), pp. 385–415.
12. Filis, G., (2010). „Macro economy, stock market and oil prices: Do meaningful relationships exist among their cyclical fluctuations?". Energy Economics, 32 (4), pp. 877–886.
13. Granger, C. W. J., (1969). „Investigating Causal Relations by Econometric Models and Cross Spectral Methods", Econometrica, (37), pp. 424-438.
14. Hamilton, J.D., (1994). „Time Series Analysis". Princeton University Press, vol. 11, no. 3. pp. 494–495.
15. Humpe, A., Macmillan, P., (2009). „Can macroeconomic variables explain long term stock market movements? A comparison of the US and Japan". Applied Financial Economics, 19 (2), pp. 111-119.
16. Johansen, S., (1988). „Statistical Analysis of Cointegration Vectors". Journal of Economic Dynamics and Control, 12, pp. 231-254.
17. Johansen, S., (1991). „Estimation and Hypothesis Testing of Cointegration Vectors in Gaussian Vector Autoregression", Econometrica, 59(6), pp. 1551-1580.
18. Johansen, S., Juselius, K., (1992). „Testing Structural Hypothesis in a Multivariate Cointegration Analysis of the PPP and UIP for UK". Journal of Econometrics, 53, pp. 169-209.
19. Jošić, H., Jošić. M., (2011). „Dvostruki deficit ili dvostruka divergencija u Hrvatskoj?". Zbornik ekonomskog fakulteta u Zagrebu, vol.9, no.2, pp. 1-16.
20. Kunovac, D., (2011). „Asymmetric correlation on the Croatian equity market". Financial Theory and Practice, 35 (1), pp. 1-24.
21. Liew, Venus Khim–Sen., (2004) „Which Lag Length Selection Criteria Should We Employ?". Economics Bulletin, vol. 3, no.33, pp. 1–9.
22. Masuduzzaman, M., (2012). „Impact of the Macroeconomic Variables on the Stock Market Returns: The Case of Germany and the United Kingdom". Global Journal of Management and Business Research, 12 (16), pp. 22-34.
23. Muhammad, N., Rasheed, A., (2002). „Stock Prices and Exchange Rates: Are they Related? Evidence from South Asian Countries". The Pakistan Development Review, 41:4 Part II (Winter 2002.) pp. 535–550.

24. Osterwald-Lenum, M., (1992). „A Note with Quantiles of the Asymptotic Distribution of the Maximum Likelihood Cointegration Rank Test Statistics". Oxford Bulletin of Economics and Statistics, vol. 54, no 3, pp. 461–472.
25. Ramasamy, B., Yeung, M.C.H.., (2005). „The Causality between Stock Returns and Exchange Rates : Revisited". Australian Economic Papers, 44 (2), pp. 162-169.
26. Sajter, D., Ćorić, T. (2009). „(I)rationality of Investors on Croatian Stock Market – Explaining the Impact of American Indices on Croatian Stock Market". Zagreb International Review of Economics and Business, vol.12 no.2. pp. 57-72.
27. Tomić, B., Sesar, A. i Džaja, T., (2014). „Comparative analysis of european capital market and Dow Jones Industrial Average Index". Računovodstvo i menadžment – RiM: 15. International Scientific and Professional Conference. Zbornik radova, svezak I. – scientific papers. Jurić, Đ. (ur.). Rovinj Hrvatska. 05-07.06.2014. Zagreb: udruga „Hrvatski računovođa". pp. 265-283.
28. Vizek,M., (2006). „Ekonometrijska analiza kanala monetarnog prijenosa u Hrvatskoj". Privredna kretanja i ekonomska politika, vol.16, no.109, pp. 28-61.

INTERNET

1. Lang, M., Krznar, I.(2004). „Transmission Mechanism of Monetary Policy in Croatia". Referat na konferenciji „The Tenth Dubrovnik Economic Conference" u organizaciji Hrvatske narodne banke, Dubrovnik, dostupno na http://www.hnb.hr/dub-konf/10-konferencija-radovi/lang-krznar.pdf. pristupljeno: 11.02.2015.
2. http://ftp.uni-bayreuth.de/math/statlib/R/CRAN/doc/vignettes/vars/vars.pdf (str.3. i 6.)

MEĐUOVISNOST INDEKSA INDUSTRIJSKE PROIZVODNJE I TRŽIŠTA KAPITALA U HRVATSKOJ: VAR MODEL

SAŽETAK RADA

Industrijska je proizvodnja važan pokazatelj budućeg kretanja svakog gospodarstva pa tako i gospodarstva Republike Hrvatske. S druge strane, kao prethodeći faktor promjena dinamike kretanja gospodarstva mogu se koristiti i dionički indeksi tržišta kapitala. S obzirom na različita razmatranja i tumačenja njihove međusobne inicijalne uzročnosti, u radu se ispituje međuovisnost između glavnog indeksa hrvatskog tržišta kapitala CROBEX-a i pokazatelja ukupne industrijske proizvodnje Republike Hrvatske. Kao dodatna varijabla, u model se uvodi i devizni paritet eura prema kuni za kojeg se smatra da ima značajan utjecaj na konkurentnost hrvatskog gospodarstva, kao i na tržište kapitala. Teorijska pretpostavka o interakciji deviznog tečaja i tržišta kapitala razmatrana je u kontekstu „*flow oriented*" i „*stock oriented*" modela. S ciljem utvrđivanja međuovisnosti između navedenih varijabli, analiza je provedena primjenom modela vektorske autoregresije (VAR). U sklopu VAR modela, proveden je Grangerov test uzročnosti, dekompozicija varijanci u narednim razdobljima, kao i test impulsnog odaziva relevantnih varijabli. Dobiveni rezultati ukazuju na postojanje uzročnosti u smjeru od deviznog tečaja prema indeksu industrijske proizvodnje, kao i postojanje uzročnosti u smjeru od indeksa industrijske proizvodnje prema CROBEX indeksu.

Ključne riječi: *VAR model, uzročnost, industrijska proizvodnja, CROBEX, devizni tečaj.*