INFORMATION EFFICIENCY HYPOTHESIS – THE FINANCIAL VOLATILITY IN THE CZECH REPUBLIC CASE

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Abstract

If there is any market which is said to be effective, this is the the FOREX market. Here we are able to confirm in the most suitable way the Market Efficiency Hypothesis. But we must always consider the risk premium existence, which is more interconnected with the existence of term premium in bond market. Presented alternative yields are opportunity yields which influence the investment behavior. The FOREX market is also very volatile. In this article we provide analysis of volatility in order to make useful evidence of the behavior of financial assets. The main purpose of this article is to analyze the volatility of FOREX market using the autoregressive processes.

There are many approaches for volatility modelling. These are the GARCH model approach (Generalized Autoregressive Conditional Heteroscedasticity) or its modifications (EGARCH, IGARCH). The efficient model for stochastic volatility enables us to specify the proper price of particular financial security. In this article we will provide the evidence from the Czech FOREX market in comparison with the conclusions of the market efficiency hypothesis.

Key words: Efficient market hypothesis, GARCH, volatility

JEL Code: G14, G17

Introduction

Many authors (at least Fama and French, 1993) expect the FOREX market to be effective (minimally the weak version of information efficiency hypothesis). More the FOREX market is the market, in which there is the largest amount of traders included. Thus we do prefer the volatility analysis which influences their behavior. Original philosophy of uncertainty meaning (for instance Akerlof, 1970) are covered with the sophisticated assumptions based on the supply side real business cycle theory (Hansen, Hodrick, 1980). In Wickens (2012), here we can summarize all the effects solving the risk market premium existence and the falsification of the information efficiency market hypothesis.

The main purpose of this article is to analyze the volatility of FOREX market using the autoregressive processes.

There are many additional empirical studies done on the Czech Republic data sample. In this article we follow empirical research studies of Pošta (2012), Krištoufek and Vošvrda (2013) and Makovský (2016).

The time series of financial variables rates of returns are characterized for the non-normal probabilistic distribution. This unconditional probabilistic distribution has different third and fourth moment of distribution from the normal distribution which leads to more extreme rates movements. In general we do expect traditional assumptions about identically independent distribution of variables in the time series. Against these assumption firstly argued Fama (1965). Since then there is great evolution in the problems of modelling the financial volatility. For instance creating the E-GARCH model with Nelson (1990) helps us to accept the asymmetric behavior of financial variable rates. The starting point is the Box-Jenkins methodology which assumes that the time series is explained through the stochastic process with the random part of this process.

The basis is the autoregressive process (AR), the moving averages process (MA) and its combination (ARMA). The previous is useful for the stationary process, for the non-stationary processes we identify the random walk process or ARIMA. These models explain the evolution of conditional mean value.

For the volatility modelling we have to utilize the autoregressive conditional heteroscedasticity (ARCH) which describes the evolution of financial risk and uncertainty in the time series. In the simplest explanations it is the linear regression of conditional variance. The conditional variance is function of delayed squares of residuals of stationary autoregressive process. Generalized ARCH (GARCH) there is the delayed conditional variance.

The persistence of variance is solved in additional assumption for the autocorrelation function to be hyperbolic (long memory process). The shock influence the variance for the long time. The conditional variance is dependent on the input conditions whatever far the prognosis is.

Non-linear models are able to foresee the asymmetric effect. This means the differences between the positive and negative impacts to the variance. It is interconnected to the implicit contracts which assume the firms to be risk neutral while the consumers to be risk averse.

Methodology

ARCH(q) is a stochastic process under the formula No.1 Where $\alpha_i > 0$, $\omega \geq 0$ for all $i > 0$.

$$\sigma_t^2 = \omega + \sum_{i=1}^{q} \alpha_i \varepsilon_{t-i}^2 , \quad (1)$$

Stationary condition is that all the roots of polynomial equation lies inside the unit circle. Unconditional variance of the stochastic process ε_t does not differs through time, more it provides unconditional homoscedasticity.

The prediction ARCH(q) in horizon *h* is according to formula No.2. Here the $\varepsilon^2_{t+i/t} = \sigma^2_{t+i/t}$ for all i > 0, but when $\varepsilon^2_{t+i/t} = \varepsilon^2_{t+i}$ for all $i \leq 0$.

$$\sigma_{t+h/t}^2 = \hat{\omega} + \sum_{i=1}^{q} \hat{\alpha}_i \varepsilon_{t+h-i/t}^2 , \quad (2)$$

The GARCH approach is a modification of previous model with the delayed conditional variance. It is useful to use GARCH when there are many parameters α in ARCH (for high q).

Data

For the empirical analysis we used the data sample of the exchange rate CZK/EUR from 1999 to 2015. We have transformed data into the quarterly data which are each the moving averages of 60 observations. This time series is transformed into differences of logarithm. For the small changes this is appropriate approximation for the relative change of variable – the rate of return in the FOREX market. More logarithms provide better features for linear regression model which we want to use (mainly stationary). The data sample of the CZK/EUR is gained from the database of The Czech National Bank (ČNB) is shown on the Table 1.

Tab. 1: The data sample of the CZK/EUR exchange rate from 1999 to 2015

DATE	EX	LOGEX	YEX
31.3.1999	37,114	3,613994	Xxx
30.6.1999	37,61366667	3,627367	0,499667
30.9.1999	36,43066667	3,595411	-1,183
30.12.1999	36,348	3,593139	-0,08267
…	…	…	…
30.6.2015	27,38230159	3,309897	-0,24151
30.9.2015	27,06906349	3,298392	-0,31324
30.12.2015	27,05849206	3,298001	-0,01057

Source: own calculation in the MS EXCEL

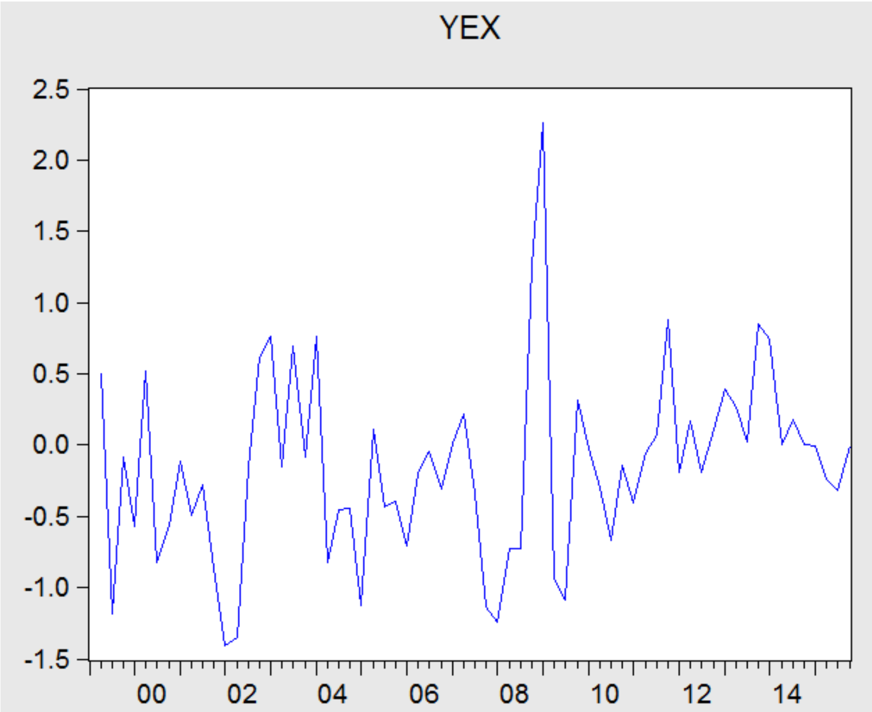
According to the evolution of variable on the Graph No. 1 we observe that the volatility of the exchange rate CZK/EUR have rapidly increased in the beginning of the financial crisis in 2008. Then the volatility is relatively stable till nowadays. Descriptive statistics give us information about the mean value of CZK/EUR at -0,15; median at -0,1557, the standard deviation at 0,6538, the skewness coefficient at 0,6538 and the curtosis coefficient at 4,59.

Due to the gained values we are able to compare the distribution to the normal distribution which does not fit. More is seen through the Jarque-Bera test normality and it´s p-value at 0,002658.

The evolution of autocorrelation function (and more the PACF) we reject the serial autocorrelation for the second level lag (the half year at our dataset). Augmented Dickey-Fuller test (ADF) reject non stationary in the time series of the returns in the CZK/EUR

The second level lag in the autocorrelation results in the volatility model GARCH(1,1). This specification is suitable with the practical experience. Trader predicts volatility on the information of volatility in the previous period and more on the newly gained information (innovations). When the yield is abnormal in both directions trader improve the volatility estimation for the following period. The GARCH(1,1) is useful in explaining the volatility clustering. This means that the important changes in volatility are also long term changes.

Graph. 1: The graphical evolution CZK/EUR rate of return from 1999 to 2015

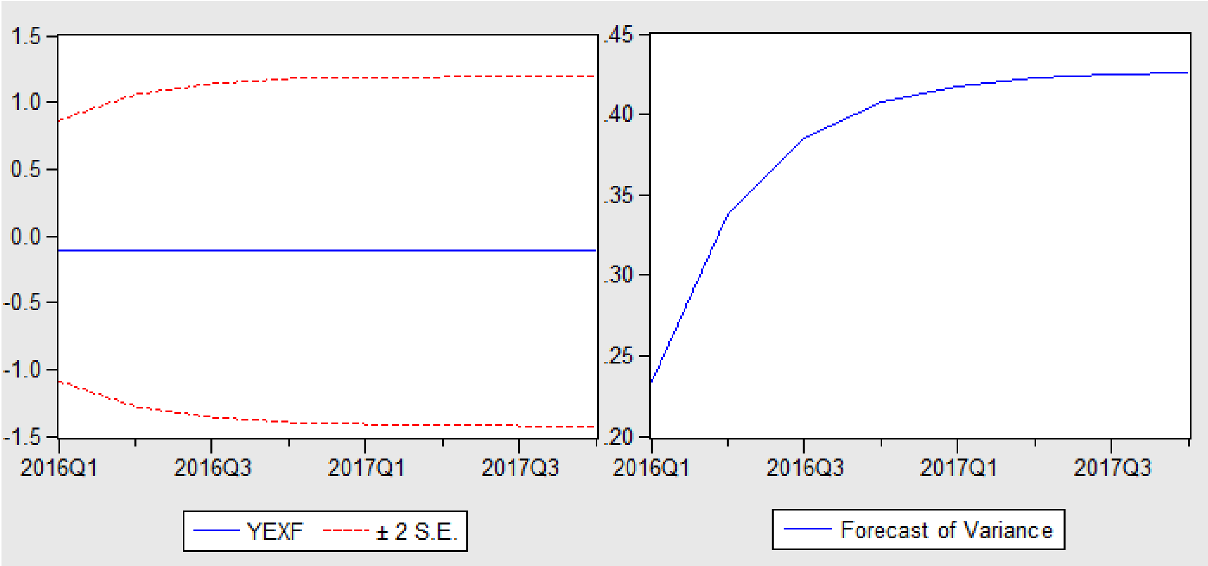


Source: own calculation in the Eviews software

At this time we want to make few comments about the result of testing the GARCH (1,1) on the empirically observed data. The mean value is confirmed at the value of -0,123378 % on the 5 % level of the statistical significance. There are unsatisfactory results in the volatility tests. All the coefficients are tested on the value of the 5 % statistical significance. The constant is in the equation for variance confirmed at the value of 0,176767, the variable ARCH (innovative information) provide the coefficient at 0,460351 with the p-value 0,0547 and finally GARCH variable (lagged variance) coefficient at value 0,13296 (absolutely rejected in the model according to its p-value). We see that this model does not fit to empirical dataset sample.

At second we try to test the model ARCH(1). We achieve more satisfactory results. On the 5 % level of the statistical significance we do see that the CZK/EUR volatility is dependent on the constant 22,8955 % and on the lagged value of the innovative information (white noise stochastic process) at the value of 46,3363 %. The mean value yield in the CZK/EUR is -0,115719 %. The ARCH model is suitable for the CZK/EUR volatility explanation more than the GARCH(1,1). On the following graph no. 2 we make forecast of the mean value (included standard deviation) and the volatility forecast for the following two years (8 periods) we do see the expected increase in volatility.

Graph. 2: The forecast of CZK/EUR rate of return for 2016q1 to 2017q4



Source: own calculation in the Eviews software

Conclusion

In this article we provide the analysis of the exchange rate volatility on the data sample of the exchange rate CZK/EUR in the period from 1999 to 2015 using the autoregressive processes. We transformed the data into the quarterly moving averages. We have presented the autoregressive conditional heteroscedasticity models for forecasting volatility. Particularly we present the GARCH(1,1) – generalized ARCH(1) model and simple ARCH(1) model. ARCH model explains the variance with the lagged innovative information (white noise). GARCH model more adds the lagged value of variance.

The GARCH(1,1) model provide unsatisfactory results, but model ARCH(1) fits the empirical dataset sample. We made forecasts for the following two years (2016q1 to 2017q4) which predicts increase in the volatility in the CZK/EUR.

In this article we add empirical research to market efficiency hypothesis – the volatility autoregressive conditional heteroscedasticity explanation. We made an important conclusion about the higher influence of new information to the CZK/EUR volatility than previous lagged level of volatility of exchange rate.

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