Modern approaches to efficient market hypothesis of FOREX – the central European case

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Abstract

In this article the main goal is to verify the efficiency hypothesis of FOREX market in the sample of panel dataset of the Central European countries. Traditionally there are many approaches for testing the market efficiency hypothesis. We should briefly mention the regression analysis, time series analysis, vector autoregression or linear co-integration. For recent years there are modern approaches that change the technical way of testing. Pedroni’s panel co-integration method is a modern method for verification conclusions of pure economic theory. It’s innovation is in analyzing short time series but on a great range of panel data. The other way is to include non-linear co-integration into non-stationary time series. The FOREX market is market with the greater trading volumes of financial traded assets. Either the rejection or the confirmation of the market efficiency hypothesis highly influence the regulation or liberalization of financial services. More we have discussed the influence of the risk premium, the influence of transaction costs and its response to equilibrium readjustment. We have shown the empirical evidence, which results in the strong tendency of nominal convergence in EU countries.

Keywords: co-integration, panel data, stationarity, market efficiency hypothesis

1. Introduction

The information efficiency hypothesis is for many decades a stressed topic to be discussed. Nowadays it is due to recent economic recession (financial bank crisis or Eurozone sovereign debt crisis) on the first hand and

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due to Nobel Prize for economics for Eugene Francis Fama (not just for himself but even for the others) on the other hand. Basically the problem is in involvement of the real economy with financial sector. According to the efficient market hypothesis there is no space for abnormal returns in the financial market contracts. These markets are efficient, there is no space for regulation. This regulation is above that impossible. The result of efficient markets is that the more liberal financial markets mean the more productive real economy.

On the other hand the contemporary financial regulation provide newly established financial instruments based on the leveraged contracts. These options according to mainly New Keynesian economists along with the moral hazard and low ethical standards in the private and public finance were the reasons of the financial crisis in the 2007 and significant economic contraction which have followed this bust. From the previous ideas we consider the main ideas of John Maynard Keynes as overwhelmingly.

From the beginning the efficient market hypothesis is being tested on the foreign exchange market (FOREX) of many currencies. There is always sufficient data set thank to highly volume contracts and thank to the long time series. Need to say that from the 70-ties of the 20th century when it was firstly introduced by Fama to scientific public there is no relevant research which verified the hypothesis itself. Fama´s ideas is a basic building point of the neoliberal monetarism view of macro-economy policy which have been used with Ronald Reagan and with Margaret Thatcher. This period of monetarism neoliberal domination the main ideas came from the Milton Friedman, who himself 30 years after confesses his wrong own faith in the ideas more than the rational empirically verified conclusion of macro economy policy impacts.

What a surprise for anyone that in the 2014 the Nobel Prize award appeared for E. F. Fama. Need to highlight that he was awarded with Robert J. Shiller and Lars Peter Hansen. Schiller and Fama´s main ideas are very contradictory. Lars Petr Hansen have provided benefits for the field of econometrics. These three scientists were awarded for Asset Price Work.

2. Main Objective of the paper

The reason for this contribution to be made is to analyze the level of efficiency hypothesis of the FOREX market mainly in central European countries in the recent years. There are three countries with their own currency, the Czech Republic, Hungary and Poland. The others have adopted the Euro currency.

The efficient FOREX market implies that there is no reason for regulation of this part of the financial sector and moreover this regulation would be useless and impossible. Additional motivation for analysis of the fundaments of the exchange rates is gained from the monetary transmission mechanism and from the monetary exchange rate model.

3. Motivation

The exchange rate immediately responds to the proclamation of the change in the monetary base. Through the exchange rate channel there is intensive and instantaneous real economy´s product stimulation. The monetary models in comparison with fiscal policy legislative delays provide the efficient solution for the economy policy problems. Need to say that from the recent point of view we conclude that the fiscal policy need to be essentially involved in solving the recession problems main in the problems of the sovereign debt crisis. The monetary policy options are limited.

Moreover it is widely discussed that the new Keynesian point of view of monetary policy approach is not such an efficient model for recession as it was assumed in the economic boom. The inefficiency of the FOREX market would lower the importance of the previous conclusion. The monetary expansion through the exchange rate market is not so immediate and instantaneous. Moreover the inefficient FOREX market would be an argument for intensive monetary integration of non ERM mechanism countries into Eurozone.
4. Methodology

This paper is based on the pure economic science (economics), on the statistical time series analysis and marginally on the econometrics. There is both the analytical method and the synthesis method. The analysis means the division of the problem into parts which are individually solved. The synthesis in contrast with analysis unifies these parts into one complex. The theoretical framework is the Lucas model of an economy (Lucas, 1978). In Makovsky, 2014 we see in which way the main theoretical reasons for information inefficiency in the FOREX market could be proved. In the paper there are even the induction and deduction methods used. In this paper implicitly we at first go from the theory to practice. From the Lucas model we argue with the risk premium, peso problem and some others. These reasons are able to be empirically evaluated. More the empirical evidence on the real data provide theoretical improvement in the economics of the exchange rates (induction).

Time series co-integration method is widely used tool for verification for the theoretical conclusions in economics. In its linear form it has been firstly used more than thirty years ago. Modern approach to the time series analysis is the non-linear co-integration and a panel co-integration.

For the modern theory and practice the linear methods conclusions are insufficient. There is a zone in which the tendency of the variable to the equilibrium value is not so strong in comparison with dynamic strength outside the zone. This implies the validity for non-linear co-integration in the field of economic variables.

More for the recent years there is a discussion about useless analysis of long term time series. In the contemporary world, in which there is a very fast technological change from year to year, it is always better to use panel data. These panel dates a few countries data and each country data are measured for a shorter time periods. The very useful analysis is based on the Peter Pedroni panel analysis (Pedroni, 1999).

5. Data

In this chapter we introduce data that are used in this paper. These are the main descriptive statistic of the exchange rates and forward exchange rates in central European countries. Anyway we have calculated means and standard deviation for the variables in levels but even in relative changes. The period for data is from the year 2001 February to the 2013 January. We have used monthly data. Each month variable represents the average of the thirty values.

The exchange rate of the Czech koruna to Euro (CZK/EUR) has for the observed period the mean value 28,346 CZK for one Euro. The standard deviation for this time series is 3,144. The Jargue-Bera test rejects the null hypothesis about the normal probabilistic distribution at 0,5 % level of statistical significance. More the Augmented Dickey – Fuller test (ADF test) is not able to reject the null hypothesis about the non-stationary of the time series (about existence of unit root). These and other information is shown in Eviews software output on the following Figure 1.
In order to gain a data with better characteristics it useful to transform the time period in the logarithms. In order to gain the stationary time series we than transform these logarithms into the first differences. The mean value of the transformed data is in the value of -0.0021 with the standard error in the value 0.015. The J-B test rejects the null hypothesis about normality and the ADF test rejects the null hypothesis about non-stationary time series of the relative changes of the CZK/EUR exchange rate. More is clear from the following Eviews output in Figure 2.

The mean value of the forward rate for the observed period is 28.251, while the standard error of this time series is 3.0297. The probabilistic distribution is not the normal distribution. Precisely said the J-B test is able
to reject the normality of the variable even in the 1% of statistical significance. The ADF test provide the statement of non-stationary time series of forward rate. More is distinct from the following figure 3.

![Fig. 3. (a) descriptive statistics FWR rate CZK/EUR; (b) ADF test FWR rate of CZK/EUR](image)

Now we need to know what is different when we transform the data into logarithmic differences. The mean value of the transformed forward rate time series values is in the value of minus 0.00223 with the standard error 0.0144. The time series is not of normal distribution (due to J-B test) and this time series is stationary (based on the output of ADF test). The similarities between the forward rate and the spot rate characteristics provide the strong involvement between these two time series (variables). This statement is very important starting point for the market efficiency hypothesis verification. In order to have full dataset we provide the following figure 4 about the relative changes of forward rates descriptive statistics.

![Fig. 4. (a) descriptive statistics of % change of FWR rate of CZK/EUR; (b) ADF test of the same](image)

The other currencies descriptive statistics are visible in a following table 1. The time series for further analysis are the currency rates from the no EURO countries in the central Europe and the corresponding money market interest rates (3M – three months money market).
Table 1. Descriptive statistics and basic test of the FOREX time series in the Central Europe.

<table>
<thead>
<tr>
<th></th>
<th>CZE/EUR</th>
<th>HUF/EUR</th>
<th>POL/EUR</th>
<th>3MCZE</th>
<th>3MHUF</th>
<th>3MPOL</th>
<th>3MEU</th>
</tr>
</thead>
<tbody>
<tr>
<td>Mean value</td>
<td>28.35</td>
<td>262.25</td>
<td>4.027</td>
<td>2.507</td>
<td>8.27</td>
<td>6.17</td>
<td>2.485</td>
</tr>
<tr>
<td>Standard Error</td>
<td>3.11</td>
<td>17.08</td>
<td>0.33</td>
<td>1.22</td>
<td>1.82</td>
<td>3.18</td>
<td>1.38</td>
</tr>
<tr>
<td>J-B test (p-value)</td>
<td>0.005*</td>
<td>0.002*</td>
<td>0.708</td>
<td>0.0017*</td>
<td>0.035**</td>
<td>0.0000*</td>
<td>0.0225**</td>
</tr>
<tr>
<td>ADF test (p-value)</td>
<td>0.349</td>
<td>0.1507</td>
<td>0.0545***</td>
<td>0.494</td>
<td>0.223</td>
<td>0.0001*</td>
<td>0.3501</td>
</tr>
<tr>
<td>Mean value - % change in variable</td>
<td>-0.00212</td>
<td>0.0007</td>
<td>0.000667</td>
<td>-0.0165</td>
<td>-0.001</td>
<td>-0.01</td>
<td>-0.022</td>
</tr>
<tr>
<td>Standard Error - % change in variable</td>
<td>0.015</td>
<td>0.021</td>
<td>0.025</td>
<td>0.06</td>
<td>0.09</td>
<td>0.04</td>
<td>0.084</td>
</tr>
<tr>
<td>J-B test (p-value) - % change</td>
<td>0.008*</td>
<td>0.0000*</td>
<td>0.0000*</td>
<td>0.0000*</td>
<td>0.0000*</td>
<td>0.0000*</td>
<td>0.0000*</td>
</tr>
<tr>
<td>ADF test (p-value) - % change</td>
<td>0.0000*</td>
<td>0.0000*</td>
<td>0.0000*</td>
<td>0.0000*</td>
<td>0.0000*</td>
<td>0.0000*</td>
<td>0.0012*</td>
</tr>
</tbody>
</table>

6. Pedroni’s Panel Co-integration Method

This method is described into detail in Pedroni 1999, or in Pedroni 2004. Pedroni’s residual tests recognize the null co-integration on panel data. The test assumes the heterogeneity in the time series both from the view of short term dynamics and from the view of absolute volumes of the variables in the time series. For the precise deduction read Makovsky, 2014. Pedroni himself works with two types of hypotheses. The first one is testing null hypothesis sounds that "the all variables in the panel dataset are co-integrated". It is not unreal to reject this hypothesis on whatever small dataset. The second type hypothesis which is being tested sounds like that "the significant deal of variables in the panel data is co-integrated".

Pedroni’s method of panel co-integration data is nowadays an important tool for the non-stationary time series analysis. It is recommended to use wider panel dataset with shorter time period.

In the empirical part of this chapter we have tested the efficiency hypothesis of FOREX market in the central European no Euro paying countries. We have made the rational expectation assumption and we have tested the influence of the interest differential to the future spot exchange rate. The estimated regression is created on the Least Square Method (both linear and nonlinear or two stage LSM). Moreover we are able to randomize effects in a period or in a panel. Input dataset is for better idea in the following table 2.

Table 2. Sample of the Panel data for the further analysis

<table>
<thead>
<tr>
<th>Date</th>
<th>Country</th>
<th>Exchange Rate</th>
<th>Domestic interest rate</th>
<th>Foreign interest rate</th>
</tr>
</thead>
<tbody>
<tr>
<td>1996M01</td>
<td>CZE</td>
<td>34,878</td>
<td>0,0483</td>
<td>0,0479</td>
</tr>
<tr>
<td>1996M02</td>
<td>CZE</td>
<td>34,8675</td>
<td>0,0529</td>
<td>0,0512</td>
</tr>
<tr>
<td>1996M03</td>
<td>CZE</td>
<td>34,9387</td>
<td>0,0556</td>
<td>0,054</td>
</tr>
<tr>
<td>1996M04</td>
<td>CZE</td>
<td>34,7998</td>
<td>0,062</td>
<td>0,0595</td>
</tr>
<tr>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
<td>...</td>
</tr>
</tbody>
</table>
In the first step we have made the standard analysis with the LSM. Obviously we have made the panel unit root test before. This test is not able to reject the non-stationary null hypothesis. Therefore we have to use the Pedroni’s panel co-integration method instead of the panel regression method. Pedroni panel co-integration test has found the co-integration relation (for 13-14 lagged time series). Pedroni, 1999 conclude the co-integration from the unit root panel test of residuals. When the residuals are I(0) then the original time series in the panel dataset are co-integrated. Following figure 5 is the output of the panel unit root test in the Eviews software and the other Figure 6 is the output of Pedroni’s residual test.

![Panel unit root test](image)

Fig. 5. Panel unit root test
Due to recommendation for panel test of Pedroni to use at least seven time series, we have made co-integration over the VAR error correction test and more we have made the Johansen co-integration test. From the following output is clear, that the most sufficient output is in the 17 times lagged time series. But t-statistics of value in minus 0.154 is not satisfactory. When we made restriction to co-integration vector in (1,-1) we provide the best output. Moreover the risk premium constant is real (approximately in value of three). Although for the first sight these conclusion seems to be suitable, we cannot confirm co-integration. The model residuals provide autocorrelation (LM test) and provide heteroscedasticity (White test).

Nevertheless by Peter Pedroni, 2004 the main criterion for panel time series co-integration are the stationary and without autocorrelation residuals in the model.
7. Conclusion

We have shown that the panel data variables of FOREX market in the Central Europe provide evidence about a relationship between themselves. By the panel co-integration method we are able to confirm theoretical hypotheses about exchange rate and its economics included the market efficiency hypothesis. The simple linear co-integration is usually rejected in a particular time series of the financial rates. We also see that the conclusion is not uniform. The Johansen panel co-integration test rejects the co-integration in the panel dataset. Nevertheless need to realize that the economies from the central Europe are different in many ways. The long term lag in appointment of equilibrium (13 - 14 months) is in contradiction with the great volatile financial variables. But Peter Pedroni argues that only existence of the stationary stochastic process equilibrium is sufficient for verification market efficiency hypothesis in the FOREX market.

As we see from the previous analysis the Fama´s and Schiller´s work both need to be taken into account. The financial markets are effective, so in the long run there is no space for abnormal returns. But in the short run there are great psychology factors in the financial market. We needn´t argue that the financial market are effective definitely. And the regulation of financial market is not too expensive, unnecessary and thus impossible. From the empirical evidence we realize surely that the investor´s mood really influence trading and above that the perception of investors is not homogenous. Moreover in case of valid efficient market the most profitable investment subject to the expected risk would be in the market index asset. As we see in reality these indices have not the similar rate of profit by themselves which would have been result of the non-efficient FOREX market.

The further analysis need to be made is the analysis of the volatile risk premium and a volatile transaction costs. The problem of transaction costs existence results from the different spread from equilibrium in a nonlinear conformation in the “elder” EU countries and the EU countries from the Central Europe.

Moreover empirically evidence done in Kočenda and Poghosyan, 2009 conclude that there is need to strengthen acceleration in nominal convergence throughout the EU and Eurozone.

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