The Analysis of the Correlation Intensity Between Emerging Market During Economic Crisis

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Abstract
Within the study we focused on an analysis of any dependence that may connect some emerging countries aiming mainly to emphasize the intensity of correlations between different financial markets. For this purpose we took into consideration two emerging markets, i.e. Romania and Turkey, due to the fact that they are two countries with common history which goes back long time, with similar approach of facts and working, negotiating or investing capacities. It is acknowledged that Turkey is a country which has not faced the world’s economic crisis and had one of the most dynamic economic growth during the last years and now Istanbul Stock Exchange records economic growth with two figures, acting like a magnet for foreign investments and specially, portfolio investments. Furthermore, almost half of the turnover belongs to foreign investors. The main idea of our analysis is to outline how much the Turkish Stock Exchange impacts the Romanian financial market.

Key words: cointegration, emerging financial markets, normality, unit root, regression, return, risk, stationarity

JEL Classification: C10, C19
Literature Review

Previous studies on financial integration have researched several aspects like short and long term dependences, the impact of financial crisis and market shocks, macroeconomic factors, communitary cooperation and politics and bull and bear behavior on financial markets. In most of the cases, empirical evidence was conducted on long term linkages or trends. (Syriopoulus, 2004, 2006, 2007).

Many studies were concerned about the main financial markets in Europe (for example, Koutmos (1996), Alexakis et al. (1997), Dickinson (2000), Bessler si Yang (2003)). Other analysis were focused on the Asian and Pacific financial markets and they showed long term interdependences (for exemple: Janakiramanan and Lamba (1998), Dekker et al. (2001), Yang (2003)). There are studies which conducted empirical evidence on regional financial markets cointegration (i.e. Swanson, 2003; Chaudhuri and Wu, 2003; Chen et al., 2002; Francis and Leachman, 1998; Masih and Masih, 1997).

The evidence resulted so far is inconclusive due to the fact that the cointegration was weak or even absent (for European markets: Booth et al. (1997), Gerrits and Yuce, 1999, and for global markets: Choudhry (1994), Kwan (1995), Defusco (1996), Huang (2000)). On the other hand, the behavior of emerging markets and their dependence on developed markets, for example Balkans’ financial markets, were somehow neglected and the evidence is limited and even inconclusive (according to Syriopoulos, 2007, 2006, 2004).

Egert and Kocenda (2005) emphasized the correlations between financial markets from Polanda (WIG-20), Czech Republic (PX), Hungary (BUX) and Germany (DAX), France (CAC40), and England (UKX). The authors did not find powerful cointegration but they outlined there were correlations among returns and also among volatilities and the contagion effect is better transmitted among volatilities rather than returns.

There are not many studies focused on emerging markets, in one of them Samitas et al. (2006, 2007) analyzes the dynamics of the main financial markets in Balkans (Romania, Bulgaria, Serbia, Turkey, Croatia) against the developed financial markets (USA, England, Germany). The research uses linear and non-linear methods for testing possible connections between the Balkans region and developed financial markets. Empirical evidence showed an equilibrium between the Balkanic markets and their developed counterparts and the existence of these correlations between emerging and developed markets limits the benefits out of portfolio diversification and nonetheless the authors concluded active portfolio management brings higher returns than passive strategies.

Methodology

Within the methodology, we will present a brief survey on simple and multiple linear regression and also on some of the most important tests used in our models.

The term “regression analysis” was coined by Francis Galton (1822-1911), with a starting point at his research on the transmission of some features through
heredity. The author studied the link between fathers’ height and the sons’ height, discovering that it tends to an average value, no matter if the boys’ fathers are tall or short. Galton said about this phenomena that it is a regression towards mediocrity.

Simple and multiple linear regression models aim to explain a relationship among a dependent variable and one or more independent variables \( X_1, X_2 \ldots X_k \) based on a sample and considering a few assumptions describing the statistical estimation framework:

Hypothesis 0: the predictors are linearly independent
Hypothesis 1: the error is a random variable with zero mean, i.e. \( E(\varepsilon) = 0 \)
Hypothesis 2 (homoskedasticity): the variance of the errors is constant across all observations \( \text{error}_i \), i.e. \( \text{Var}(\varepsilon) = E(\varepsilon \varepsilon^T) = \sigma^2 I \)
Hypothesis 3: any information contained by the error does not belong to \( X \) matrix \( E(\varepsilon|X) = 0 \)
Hypothesis 4: the design matrix \( X \) is a full rank matrix, i.e. \( \text{rank}(X) = k+1 < n \)
Hypothesis 5 (normality): the errors have a normal distribution, i.e. \( \varepsilon \sim N(0, \sigma^2 I) \)

Intuitively, a time series is stationary if there is no systematic change in mean (no trend), in volatility (variance) and the seasonal variations were removed. The stationarity is one of the most important simplifying assumptions, meaning that the process in statistical equilibrium. It is said that a stochastic process is strictly stationary if its qualities are not affected by the moment set as origin. In other words, the probability distribution for any moment \( t_1, t_2, \ldots, t_m \) of the observations is the same with the probability distribution of the observations for the moments \( t_1+k, t_2+k, \ldots, t_m+k \). For \( m=1 \), this means that the marginal distribution at the moment \( t \) is equal to the marginal distribution at any other moment. Thus, the marginal distribution does not depend on time, which implies that the mean and variance are constant:

\[
E(x_t) = E(x_2) = \ldots = E(x_n) = E(x_t) = \mu \\
\text{Var}(x_t) = \text{Var}(x_2) = \ldots = \text{Var}(x_n) = \text{Var}(x_t) = \sigma^2 \\
\text{Cov}(x_t, x_{t+k}) = \text{Cov}(x_2, x_{2+k}) = \ldots = \text{Cov}(x_n, x_n) = \text{Cov}(x_t, x_{t+k}).
\]

Stationarity is tested using Augmented Dickey-Fuller (ADF) test, which starts from an AR(1) process: \( y_t = \mu + \alpha y_{t-1} + \varepsilon_t \), where \( \mu \) and \( \alpha \) are predictors to be estimated and \( \varepsilon_t \) is assumed to be “white noise”. If we subtract from both members of the equation \( y_{t-1} \) we obtain the equivalent equation:

\[
\Delta y_t = \mu + \gamma y_{t-1} + \varepsilon_t \quad \text{where} \quad \gamma = \alpha - 1
\]

The series is stationary if \(-1 < \alpha < 1\); if \( \alpha = 1 \) the series has a unit root and if \( \alpha > 1 \) the series is explosive. The null hypothesis of this test implies that the series has a unit root \( H_0 : \gamma = 0 \) with the alternative \( H_1 : \gamma \neq 0 \).

Empirical evidence: an analysis of the dependence between the stock exchange from Bucharest and Istanbul

Trying to find correlations among different financial markets, we proceed through this study to analyze any existing dependence between the financial
markets of emerging countries like Romania and Turkey. It is a fact that the financial market of Istanbul has registered a certified expansions lately, being the target of many investors. Romania may benefit from the dynamic development of Turkish financial market, being the most important trading partner in the area and also a real door for Turkey towards all European markets. Furthermore, Romania is an attractive market of the Eastern region considering its growth potential. The attraction of important investment and their concentration onto an area so close to Romania can lead to attracting new investors who would refresh both the local capital market and the economy which desperately needs investment.

The main idea of this analysis is to shape up how intense is the influence of Turkish stock exchange on the Romanian stock exchange and whether if there is a correlation between the two. For this purpose we considered BET-C index for the Romanian financial market and XU100 index, for the Turkish financial market. The choice for these indexes was based on a criterion which synthesizes more effectively the entire financial market, without many distortions given by low liquidity. The period under analysis was October 1st, 2011 – October 1st, 2012, and the data was provided by the Bucharest Stock Exchange web-site, www.bvb.ro and by the Istanbul Stock Exchange web-site, www.ise.org. For the dataset from Istanbul Stock Exchange, the price considered is the one from the second trading session. The database was processed by duplicating the previous price for the days when one of the indexes was computed, and the other was not.

BET-C is a composite index of Bucharest Stock Exchange. It reflects the price movement of all the companies listed on the BSE regulated market, 1st and 2nd category, excepting financial services companies.

XU100 is a composite index of IMKB (Istanbul Menkul Kiyimetler Borsasi) which gathers the movement of the first 100 companies listed on the national market, including investment trusts and real estate investors.

The notations used within our study are:

- \( L_{\text{BET-C}} = \text{natural logarithm of BET-C price at the moment } t \)
- \( L_{\text{XU100}} = \text{natural logarithm of XU-100 price at the moment } t \)
- \( R_{\text{BET-C}} = \ln(\text{BET-C price at } t / \text{BET-C price at } t-1) \)
- \( R_{\text{XU100}} = \ln(\text{XU-10 price at } t / \text{XU-100 price at } t-1) \)

The database analysis starts by a comparison of the quotations and returns for both indexes. The plot below shows the movement of the quotations for the two indexes and also their returns (expressed continuously, logarithmically).
Table 1. Evolution of BET-C and XU100

We notice that both BET-C and XU100 keep the same trend but at critical moments the Turkish index registers higher amplitudes than BET-C. To be remarked that the extreme values, both maximum and minimum are reached by XU100 index.

To go further with an analysis of the dependences between the two financial markets summed up by BET-C and XU-100 index, the series will be statistically tested for some assumptions of the regression model and for the validation of the relationship.

The stationarity condition is essential to the application of statistical inference. The stationarity is tested using Dickey-Fuller methodology, for the following hypotheses:

\[
\begin{align*}
H_0: & \text{ the series is not stationary, it has a unit root} \\
H_1: & \text{ the series is stationary}
\end{align*}
\]

For BETC and XU100 quotations, expressed as logarithms, the results are summarized in the table below:

<table>
<thead>
<tr>
<th></th>
<th>ln(BET-C)</th>
<th>ln(XU100)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Null Hypothesis:</td>
<td>LNBETC has a unit root</td>
<td>LNXU100 has a unit root</td>
</tr>
<tr>
<td>Lag Length:</td>
<td>0 (Automatic based on SIC, MAXLAG=0)</td>
<td>0 (Automatic based on SIC, MAXLAG=0)</td>
</tr>
<tr>
<td>t-Statistic</td>
<td>-</td>
<td>-</td>
</tr>
<tr>
<td>Prob.*</td>
<td>0.0228</td>
<td>0.7047</td>
</tr>
<tr>
<td>Augmented Dickey-Fuller test statistic</td>
<td>1.315740</td>
<td>1.129244</td>
</tr>
</tbody>
</table>

Test critical values:

- 1% level: 3.455486
- 5% level: 2.872499
- 10% level: 2.572684

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Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNBETC)
Method: Least Squares
Sample(adjusted): 2 260
Included observations: 259 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNBETC(-1)</td>
<td>-0.013613</td>
<td>0.010347</td>
<td>-1.315740</td>
<td>0.1894</td>
</tr>
<tr>
<td>C</td>
<td>0.107750</td>
<td>0.081914</td>
<td>1.315408</td>
<td>0.1895</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.006691</td>
<td></td>
<td>-2.38E-05</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.002826</td>
<td>S.D. dependent</td>
<td>0.010337</td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.010363</td>
<td>Akaike info criterion</td>
<td>6.293353</td>
<td></td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>0.027598</td>
<td>Schwarz criterion</td>
<td>6.266069</td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>817.0128</td>
<td>F-statistic</td>
<td>1.731172</td>
<td></td>
</tr>
<tr>
<td>Durbin-Watson stat</td>
<td>1.546889</td>
<td>Prob(F-statistic)</td>
<td>0.189434</td>
<td></td>
</tr>
</tbody>
</table>

Augmented Dickey-Fuller Test Equation
Dependent Variable: D(LNXU100)
Method: Least Squares
Sample(adjusted): 2 260
Included observations: 259 after adjusting endpoints

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>LNXU100(-1)</td>
<td>-0.012854</td>
<td>0.011383</td>
<td>-1.129244</td>
<td>0.2598</td>
</tr>
<tr>
<td>C</td>
<td>0.097670</td>
<td>0.085997</td>
<td>1.135741</td>
<td>0.2571</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.004937</td>
<td></td>
<td>0.000566</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-squared</td>
<td>0.001065</td>
<td>S.D. dependent</td>
<td>0.016612</td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.001063</td>
<td>Akaike info criterion</td>
<td>5.350784</td>
<td></td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>0.016603</td>
<td>Schwarz criterion</td>
<td>5.323319</td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>694.9266</td>
<td>F-statistic</td>
<td>1.275191</td>
<td></td>
</tr>
<tr>
<td>Durbin-Watson stat</td>
<td>2.024706</td>
<td>Prob(F-statistic)</td>
<td>0.25848</td>
<td></td>
</tr>
</tbody>
</table>

Null Hypothesis: D(LNBETC) has a unit root
Exogenous: Constant
Lag Length: 0 (Automatic based on SIC, MAXLAG=15)

Augmented Dickey-Fuller test statistic
-12.93779
Prob.* 0.0000

Test critical values:
1% level: -3.455585
5% level: -2.872542
10% level: -2.572707

Table 2. Stationarity analysis of LNBETC and LNXU100 (and 1st difference series)

For the Romanian index, τ statistics has the value of -1.31, showing we make a 62% error by rejecting the null hypothesis, thus LNBETC series is not stationary. To obtain a stationary series, we proceed with the first difference series. Dickey-Fuller test results for 1st difference series implies a stationary series.

The time series for the Turkish index XU100 followed the same validation algorithm, the results being summarized in the table below. τ statistics indicates we are in the acceptance zone of the null hypothesis because the error occurred by rejecting it is unacceptable, of over 70%. The second part of the table shows that the 1st difference series is stationary also for XU100 index on Istanbul Stock Exchange.

Next, the analysis was extended to the return series for the two indexes with the results presented in the table below:
Table 3. Stationarity analysis of BET-C and XU-100 returns

We notice that Dickey-Fuller unit root test indicates that both series are stationary, $\tau$ statistics has values like -12.96 for BET-C return series and -16.35, for XU-100 return series, both less than all three critical levels.

Firstly, we based our assumptions on a nonlinear dependence between the two indexes, such as:

$$\text{BET}_C(t) = c\text{XU}_{100}(t)^b + \varepsilon_t$$  \hspace{1cm} (5)

The relationship was turned into a linear one through logarithms, resulting the following formula:

$$\ln(\text{BET}_C(t)) = c + b\ln(\text{XU}_{100}(t)) + \varepsilon_t$$  \hspace{1cm} (6)

We also conducted an analysis of the relationship between the two indexes based on the returns:

$$\text{Return(BET}_C(t)) = x+y\text{Return(XU}_{100}(t)) + \varepsilon_t$$  \hspace{1cm} (7)

For the next step, the analysis requires estimating the regression equation between the two indexes. The equation is estimated using the least squares method. The first step implied an estimate of the simple linear equation, but Durbin-Watson Statistic in error autocorrelation led us to correct the model by a dynamic one.
The first regression model is:
LNBETCi=6.16 + 0.23xLNXU100i
(8)

We notice that this model is valid when considering the statistical significance of the coefficients because for both coefficients t – Statistic provides a 0% error by rejecting the null hypothesis (the coefficient equals to zero), thus it is rejected. We accept the alternative hypothesis which states that each coefficient is statistically different from 0.

F Statistic also confirms the model as statistically valid, as we assume a 0% error by rejecting the null hypothesis (all coefficients are zero, thus this hypothesis is rejected and the alternative is accepted (at least one coefficient is different from 0).

Durbin-Watson Statistic that analyzes the error autocorrelation has the value DW=0.02, revealing a positive autocorrelation of the errors, therefore the model requires a correction by a dynamic one, estimated in the second column of the table 2.

t – Statistic confirms that the new model is statistically valid when considering the coefficients and Durbin-Watson Statistic confirms a valid model when considering the error autocorrelation, with a value of 1.76, close to 2.00.

The third column of the table sums up the regression on returns. t – Statistic provides us with the conclusion that with 0% error the null hypothesis under which the coefficients are statistically equal to 0 can be rejected. Durbin-Watson Statistic equals to 1.76, in the proximity of 2, showing a lack of error correlation.

Another selection criterion is the value of Akaike and the best choice is based on the minimum value of it. When considering the quotation models, the dynamic model is better and overall, the relationship between returns is more appropriate.

The validation process goes on and makes the returns model subject to other validation criteria. The homoskedasticity assumption implies that the errors do not depend on the independent variables of the model and their squares:

\[ r_t^2=a+b*LNXU100_t+c*LNXU100_t^2+d*LNBETC(-1)_t+e*LNBETC(-1)_t^2+f*LNXU100(-1)_t+g*LNXU100(-1)_t^2+v_t \]

(9)

### Table 4. Regressions between BET-C and XU100
and
\[ r_t^2 = a + b \cdot R_{LNXU100} + c \cdot R_{LNXU100}^2 + v_t \]  
(10)

The verification of this assumption is done according to White test, with the following hypotheses:

\[ \begin{align*}
H_1: & \ a=b=\ldots=g=0 \text{ (homoskedasticity)} \\
H_2: & \ \text{at least one parameter is different from zero}
\end{align*} \]

**Dynamic model of quotes**

Model bazat pe cotă

**White Heteroskedasticity Test:**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>-0.361723</td>
<td>0.292171</td>
<td>-1.238052</td>
<td>0.2168</td>
</tr>
<tr>
<td>LNXU100</td>
<td>0.123004</td>
<td>0.065530</td>
<td>1.877066</td>
<td>0.0617</td>
</tr>
<tr>
<td>LNXU100^2</td>
<td>-0.008161</td>
<td>0.004364</td>
<td>-1.869866</td>
<td>0.0627</td>
</tr>
<tr>
<td>LNBETC(-1)</td>
<td>0.036165</td>
<td>0.066568</td>
<td>0.543286</td>
<td>0.5874</td>
</tr>
<tr>
<td>LNBETC(-1)^2</td>
<td>-0.002299</td>
<td>0.004195</td>
<td>-0.5842</td>
<td>0.5842</td>
</tr>
<tr>
<td>LNXU100(-1)</td>
<td>-0.064604</td>
<td>0.065048</td>
<td>-1.869866</td>
<td>0.0627</td>
</tr>
<tr>
<td>LNXU100(-1)^2</td>
<td>0.004279</td>
<td>0.004332</td>
<td>0.987593</td>
<td>0.3243</td>
</tr>
<tr>
<td></td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>R-squared</td>
<td>0.038951</td>
<td></td>
<td>8.97E-05</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-squared var</td>
<td>0.016069</td>
<td>0.000213</td>
<td>13.9855</td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.000211</td>
<td>14.04668</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Sum squared resid</td>
<td>1.12E-05</td>
<td>9.01E-05</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Log likelihood</td>
<td>1822.029</td>
<td>F-statistic 1.838370</td>
<td>0.300238</td>
<td></td>
</tr>
<tr>
<td>Durbin-Watson stat</td>
<td>0.881205</td>
<td>Prob(F-statistic) 0.120872</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

**Model based on returns**

Model bazat pe randamente

**White Heteroskedasticity Test:**

<table>
<thead>
<tr>
<th>Variable</th>
<th>Coefficient</th>
<th>Std. Error</th>
<th>t-Statistic</th>
<th>Prob.</th>
</tr>
</thead>
<tbody>
<tr>
<td>C</td>
<td>7.95E-05</td>
<td>1.53E-05</td>
<td>5.210838</td>
<td>0.0000</td>
</tr>
<tr>
<td>R_{LNXU100}</td>
<td>0.000690</td>
<td>0.000807</td>
<td>0.855719</td>
<td>0.3930</td>
</tr>
<tr>
<td>R_{LNXU100}^2</td>
<td>0.036926</td>
<td>0.026887</td>
<td>1.373405</td>
<td>0.1708</td>
</tr>
<tr>
<td>R-squared</td>
<td>0.009356</td>
<td>Mean dependent var</td>
<td>9.01E-05</td>
<td></td>
</tr>
<tr>
<td>Adjusted R-squared var</td>
<td>0.001616</td>
<td>S.D. dependent var</td>
<td>0.000215</td>
<td></td>
</tr>
<tr>
<td>S.E. of regression</td>
<td>0.000214</td>
<td>Akaike info criterion</td>
<td>14.04668</td>
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</tr>
<tr>
<td>Sum squared resid</td>
<td>1.18E-05</td>
<td>Schwarz criterion</td>
<td>14.00536</td>
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<tr>
<td>Log likelihood</td>
<td>1822.029</td>
<td>F-statistic 1.838370</td>
<td>0.300238</td>
<td></td>
</tr>
<tr>
<td>Durbin-Watson stat</td>
<td>0.881205</td>
<td>Prob(F-statistic) 0.120872</td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Table 5. Homoskedasticity analysis – White test

F Statistic for this test indicates we would accept a 12% error for the first model, 30% for the model based on the returns between the two indexes by rejecting the null hypothesis. Therefore we can state that our dataset are heteroskedastic, with an accepted error of 12, respectively 13%.
Conclusions

The study was commenced with the main purpose to emphasize the relationship that may exist between Istanbul and Bucharest stock exchange by analyzing the correlation between two indexes – BET-C and XU100 during one year. On a first level, the dataset was statistically analyzed both expressed as quotes and returns. We observed that the series for quotes are not stationary but the first difference series are stationary. After a complete analysis the model was validated, concluding that the time series for quotations are cointegrated, their dependence being statistically proven. For the time series on returns the statistic tests showed that both index series are stationary and this keeps us away from computing a false regression.

We noticed that there is a positive determination relationship between Istanbul Stock Exchange and its counterpart in Bucharest, that grows exponentially, when we analyzed the quotes. We turned it into a linear regression using logarithms. As we expected, the evidence showed a relationship between the two markets, i.e. a positive one, explaining an elasticity: 1% growth on Istanbul financial market determines 0.25% growth on Bucharest Stock Exchange. The absolute value of the coefficient is rather low and it reveals the fact that the two countries, despite the fact that they are both emerging, do not make part of such a powerful influence.

According to the regression model resulted in our analysis we may conclude that the two financial markets have their mutual contribution to the other’s evolution but not in a consistent manner.

The influence intensity between the markets is rather low, creating an advantage for selecting an international portfolio of financial securities from emerging markets and an advantage for reducing systematic risk through diversification. It is obvious that the higher the dependence between two markets is, the less the risk reduction through diversification is, as the effect occurred on a market is immediately transferred on the other one.

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