A SHORT-RUN RELATIONSHIP BETWEEN 1-YEAR BONDS YIELD AND THE DOMESTIC CONSUMPTION IN ROMANIA

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Abstract

“What drives government bonds?” or “what are the forces which are staying behind the yield of these bonds?” are questions, which are concerning both theoreticians and practitioners nowadays. This paper analyzes the way in which the domestic consumption, represented through households’ consumption, in Romania, is able to move the sovereign bond yield for the same country, on a short horizon. In order to do this, we have used in the current study, an autoregressive vector – VAR(1), in which are included the two mentioned variables. The analyzed period starts in 2008 (q1), it ends in 2012 (q3) and the used data is expressed quarterly.

Key words: households’ consumption, bonds yield, autoregressive vector.
JEL Code: E03, E21, G12, G32.

1. Introduction – Sovereign Bonds

The idea of writing this paper came after reading on Federal Reserve Bank of San Francisco’s website the article entitled “What makes the Yield Curve Move”, written by Tao Wu (2003). Also, my main research interest during the last year was the ricardian equivalence and the state bonds issue, which is directly linked to this field. A secondary slope in starting this paper was the analysis of Vamvoukas et al. (2008), regarding the test on the ricardian equivalence on Greece, in which one year bond rates is taken as a variable in testing the above mentioned hypothesis.

Based on the field of interest, this paper presents an econometric model for the Romanian economy. The model consists in a first order autoregressive vector with two variables – VAR (1). The variables that will were taken into consideration in the current research are the households’ final consumption and Romania’s 1-year bond yield. The logic and the main reasons behind choosing these two macroeconomic variables, are detailed further, in the second section of the current paper. As far as we have studied the related literature, this represents one of the first attempts of formalizing this kind of relation for the Romanian economy.

“What drives government bonds?” or “what are the forces which are staying behind the yield of these bonds?” are questions, which are concerning both theoreticians and practitioners nowadays. Because of the last years’ financial crisis, there was a massive migration of the capitals from higher risk destinations to lower risk destinations. One of these destinations, having in mind the risk aversion background, can be considered sovereign bonds.

According to the Swiss National Bank’s, there are five major drivers for the government bonds yields:

- **a)** Inflation and inflation expectation, being by far the most important criterion. High inflation expectations are usually followed by higher bond yields and the main force behind these expectations is the wage evolution;
- **b)** Wealth of a country is negative correlated with the government bond yields;
- **c)** Interventions of the central banks (quantitative easing may be an example);
- **d)** Foreign debt as a percentage of GDP;

What is the main difference between lending the money to a company and lending the money to a country? Is the amount of risk, which the investors are supposing their money to: a corporation bond has higher degree of default risk than a state, so in order to this the bond-holder assumes this risk for his investment. The corporate bond investor will be paid more than the government bond-holder. Also, the bonds are divided in categories, regarding their degree of risk and being rated by Standard and Poor’s and Moody’s. The following table shows the bonds rating scale, considering the two rating agencies and the average credit spread:
Table 1. Bond Rating Scale

<table>
<thead>
<tr>
<th>S&amp;P’s</th>
<th>Moody’s</th>
<th>Description</th>
<th>Average Credit Spread (bps)*</th>
</tr>
</thead>
<tbody>
<tr>
<td>AAA</td>
<td>Aaa</td>
<td>Highest rating</td>
<td>57</td>
</tr>
<tr>
<td>AA</td>
<td>Aa</td>
<td>Very strong</td>
<td>64</td>
</tr>
<tr>
<td>A</td>
<td>A</td>
<td>Upper medium grade</td>
<td>91</td>
</tr>
<tr>
<td>BBB</td>
<td>Baa</td>
<td>Lower medium grade</td>
<td>150</td>
</tr>
<tr>
<td>BB</td>
<td>Ba</td>
<td>Non-investment grade</td>
<td>269</td>
</tr>
<tr>
<td>B</td>
<td>B</td>
<td>Highly speculative</td>
<td>364</td>
</tr>
<tr>
<td>C</td>
<td>Caa</td>
<td>Substantial risk</td>
<td>591</td>
</tr>
<tr>
<td>D</td>
<td>D</td>
<td>Issuer is in default</td>
<td>2279</td>
</tr>
</tbody>
</table>

* Source Barclays as if 12/31/2013

Source of the table: www.nasdaq.com

In Europe, since the crisis started, the launch of ECB quantitative easing policies exerted an influence on the credit risk between 73.78% and 86.58%, for the following countries: Romania, Bulgaria, Austria, Ukraine, Hungary, Poland, Germany, Russia and Turkey (Albu et al., 2014a). Similar results have been reported in Albu et al. (2014b).

2. Related Literature

The main research hypothesis followed in this paper is directly linked to the ricardian equivalence hypothesis (R.E.H.) and, questions the linkage between the domestic consumption and bond yields. Various authors, such as Barro (2006), Barro and Ursua (2008) or Nakamura et al. (2013) are following the strength of this linkage, but from a different perspective: the one of the shocks (from financial crisis to natural disasters), which are affecting the output or the consumption and the correspondent peak-drop in yields. Nakamura et al. (2013) is analyzing the asset-pricing implications when a consumption shock occurs. In the three analyzed scenarios, from the previous mentioned paper, a sudden decrease in consumption causes a sudden decrease in the yields of stocks (1st scenario), U.S. treasury bills (2nd scenario) or long-term bonds (3rd scenario). The main difference between the evolution of stocks or U.S. treasury bills compared to the one of the long-term bonds is that the decline in the corresponding yields is smaller than the one of the first category. This process is caused by the fact that the long-term bonds are considered and used as a tool for hedging in front of the “disaster risk”. The conclusion of this study was that it could be used as a guideline in consumption prediction only for the disaster periods. For the normality periods, its predictability power for future consumption growth is around 0% (R-squared = 0.03).

How does an asset price is formed? As the modern asset pricing theory is explaining, the core of this process consists in the fact that “assets are priced such that, ex-ante, the loss in marginal utility incurred by sacrificing current consumption and buying an asset at a certain price is equal to the expected gain in marginal utility contingent on the anticipated increase in consumption when the asset pays off in the future” (Mehra, 2001). Standard consumption-based asset pricing models are Rubinstein (1976), Lucas (1978), Grossman and Shiller (1981) and Hansen and Singleton (1983).

Ang and Piazzesi (2001) state, that “a substantial portion of short and medium-term bond yields, is driven by the macroeconomic variables”. Their findings show the fact that changes in households’ consumption preference can produce large and significant shifts in the level of the yield curve. They discover that macro components can explain up to 85% of the long-run variance of one and 12-months yields. Similar results may be found also in Evans and Marshal’s (2001) work. The same authors report that contrary to this shift, technology shocks induce “weaker and less robust patterns of interest rate responses, since they move real rates and expected inflation in opposite directions”. They also conclude that a shock that increases household’s preference for current consumption, contrary to current leisure or future consumption, has the most powerful effect over the interest rates across all maturities. The mentioned paper has as a starting point Gali’s article entitle “How Well Does The IS-LM Model Fit Postwar U.S. Data?” (1992), so, in order to this, household’s consumption shock can have as a correspondent in Gali’s model, the aggregate demand shock. The following figure explains better to which element in yield curve’s (considering that yield curve has three elements: level, slope and curvature) is a shock in consumption actioning:
The relation between the consumption and the yield curve can be a double-sensed one, depending on the economy. Studies, like Harvey (1989), showed that yield curve measures have the potential to explain more than 30% of the variation in the rhythm of output (for 1953-1989 period for the US economy), compared to the stock market which is able to explain only 5% from this variation. Irving Fischer formalized the correlation between asset markets and the real economic growth, for the first time. He showed that “in equilibrium, the one-year interest rate reflects the marginal value of income today in relation to its marginal value next year” (Harvey, 1989). Zuliu Hu (1993) discovered that, after an analysis over the G-7 group of countries, “a simple measure of the slope of the yield curve, namely the yield spread, serves as a good predictor of future economic growth”.

3. Used Data

The model aggregates two macroeconomic variables. These variables are:

- **Households’ Final Consumption in Romania** – source: Eurostat
- **Romania 1-Year Bond Yield** – source: www.investing.com

The frequency of the used data is quarterly. The first time series was inflation adjusted, using as a base year for the inflation, the year 2005. By visually analyzing the time series for the households’ consumption, we have decided that the best thing will be to seasonally adjust the data, in order to have a higher accuracy of the model. The Romanian households’ consumption has a very pronounced cyclic component, as it can be seen from the following graph. As Sims (1993) concluded in his paper that, even the use of unadjusted data may be the best alternative, sometimes, treating seasonality can be a “nuisance” and can lead to worse errors than those produced by the usage of adjusted data. The following figure shows the differences between the seasonally adjusted series and non-adjusted series.

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We have transformed, also, the seasonally adjusted series into a natural logarithm (log) series for stabilizing the variance (Michener, 2003). The second time series did not suffer any transformation. For simplicity, we are going to use as acronyms for the time series, the following notations: logHHIC (for households’ consumption) and YBR (Romanian 1-Year Bond Yield).

The analyzed period starts in 2008q1 and it ends in 2012q3. Unfortunately, there are only 19 observations because of the low availability of the data for, the YBR series before 2008 and for HHC, after 2012. This is caused by the fact that the Romanian economy is a young economy, which just joined the European Union in 2007, and the calculation methodology changed very often or the data was not reported every time or in time by the local authorities.

4. Methodology and Estimates

In order to achieve our goal and build an econometric model, we have first tested the stationarity of the data. According to the tests, we have concluded that the data are stationary. A second phase in our research, was to estimate the number of lags, which are going to be used in the model. According to the pre-estimation tests results, in STATA, we have chosen a 1st order VAR model. Test’s result can be seen in the following table:

<table>
<thead>
<tr>
<th>lag</th>
<th>LL</th>
<th>LR</th>
<th>df</th>
<th>p</th>
<th>FPE</th>
<th>AIC</th>
<th>HQIC</th>
<th>SBIC</th>
<th>Number of obs</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>3.46465</td>
<td>.002855</td>
<td>-.183082</td>
<td>-.178136</td>
<td>-.086508</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>1</td>
<td>21.9546</td>
<td>36.98*</td>
<td>4</td>
<td>0.000</td>
<td>.000471*</td>
<td>-1.99433*</td>
<td>-1.97949*</td>
<td>-1.70461*</td>
<td>16</td>
</tr>
<tr>
<td>2</td>
<td>22.4462</td>
<td>98321</td>
<td>4</td>
<td>0.912</td>
<td>.000755</td>
<td>-1.55578</td>
<td>-1.53105</td>
<td>-1.07291</td>
<td></td>
</tr>
<tr>
<td>3</td>
<td>26.4117</td>
<td>7.9309</td>
<td>4</td>
<td>0.094</td>
<td>.000825</td>
<td>-1.55146</td>
<td>-1.51685</td>
<td>-.875448</td>
<td></td>
</tr>
<tr>
<td>4</td>
<td>27.9531</td>
<td>3.0828</td>
<td>4</td>
<td>0.544</td>
<td>.001328</td>
<td>-1.24414</td>
<td>-1.19963</td>
<td>-.374974</td>
<td></td>
</tr>
</tbody>
</table>

Endogenous: logHHIC YBR  
Exogenous: _cons

Source: the author
The next phase of the model was to test the data series for co-integration, according to the methodology described by Johansen (1988, 1991, 1995), according to the following equation, corresponding to what is known as the Johansen test:

\[ \Delta X_t = \Gamma_1 \Delta X_{t-1} + \cdots + \Gamma_k \Delta X_{t-k} + \mu_t + \nu_t \]  

(1)

where:

- \( X_t \) is a vector of variables,
- \( \Delta (1 - L) \) is the first difference operator,
- \( \mu \) is a constant vector,
- \( \Gamma \) is coefficient matrix with reduced rank \( r < k \),
- \( \nu \) is a vector of innovations.

The results of the Johansen co-integration test, applied in STATA, can be found in the following table:

**Table 3. Johansen co-integration test**

<table>
<thead>
<tr>
<th>trend: constant</th>
<th>Number of obs = 19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Sample: 2008q1 - 2012q3</td>
<td>Lags = 1</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>maximum rank</th>
<th>parms</th>
<th>LL</th>
<th>eigenvalue</th>
<th>trace critical value</th>
</tr>
</thead>
<tbody>
<tr>
<td>0</td>
<td>2</td>
<td>5.7964375</td>
<td>.</td>
<td>10.3395*</td>
</tr>
<tr>
<td>1</td>
<td>5</td>
<td>10.033155</td>
<td>0.35980</td>
<td>1.8661</td>
</tr>
<tr>
<td>2</td>
<td>6</td>
<td>10.966192</td>
<td>0.09355</td>
<td></td>
</tr>
</tbody>
</table>

Source: the author

According to the previous test, according to the trace statistic, we have decided that a VECM cannot be implemented, due to the lack of co-integration over the long run of the data series. As a consequence, a VAR model is better suited. A vector autoregression follows the below reduced form:

\[ y_t = A_1 y_{t-1} + A_2 y_{t-2} + \cdots + A_p y_{t-p} + \xi_t \]  

(2)

The corresponding matrix for a VAR (1) model would be:

\[ \begin{bmatrix} y_{1,t} \\ y_{2,t} \end{bmatrix} = \begin{bmatrix} A_{1,1} & A_{1,2} \\ A_{2,1} & A_{2,2} \end{bmatrix} \begin{bmatrix} y_{1,t-1} \\ y_{2,t-1} \end{bmatrix} + \begin{bmatrix} \xi_{1,t} \\ \xi_{2,t} \end{bmatrix} \]  

(3)

A table with the current VAR (1) model’s estimates, can be found further:

**Table 4. VAR model**

<table>
<thead>
<tr>
<th>Vector autoregression</th>
<th>Sample: 2008q1 - 2012q3</th>
<th>No. of obs = 19</th>
</tr>
</thead>
<tbody>
<tr>
<td>Log likelihood = 10.96619</td>
<td>AIC = - .522757</td>
<td></td>
</tr>
<tr>
<td>FPE = .0020433</td>
<td>HQIC = - .4722823</td>
<td></td>
</tr>
<tr>
<td>Det(Sigma_m1) = .0010808</td>
<td>SBIC = - .2245132</td>
<td></td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Equation</th>
<th>Parms</th>
<th>RMSE</th>
<th>R-sq</th>
<th>chi2</th>
<th>P&gt;chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>logHHC</td>
<td>3</td>
<td>.042455</td>
<td>0.4537</td>
<td>15.78241</td>
<td>0.0004</td>
</tr>
<tr>
<td>YBR</td>
<td>3</td>
<td>.933494</td>
<td>0.8064</td>
<td>79.12425</td>
<td>0.0000</td>
</tr>
</tbody>
</table>
As it can be seen, the correlation of determination for the second equation, the one which presents interest for our research, is $R^2 = 0.8$. This value is showing as that, on the short-run, 80% of the variation of the yield for Romanian 1-year bonds is explained by the households' final consumption. Also the probability value, for the first equation, the one directly studied in this research, is within the confidence interval ($P<0.05$). This means that the equation presents statistical significance.

There were made also tests for autocorrelation of the errors (Lagrange multiplier test) and error’s distribution. One can see from the below tests (table no. 5) that it does not exist errors’ autocorrelation and the errors are normally distributed, so the VAR model doesn’t violate the assumption of the classical model. Also, a stability test, for the VAR model has been realized and the model satisfies stability condition.

| Source: the author |

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### Table 5. VAR tests

<table>
<thead>
<tr>
<th>Lagrange-multiplier test</th>
<th>Eigenvalue stability condition</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>lag</strong></td>
<td><strong>chi2</strong></td>
</tr>
<tr>
<td>1</td>
<td>2.6863</td>
</tr>
<tr>
<td>2</td>
<td>5.8182</td>
</tr>
</tbody>
</table>

H0: no autocorrelation at lag order

All the eigenvalues lie inside the unit circle, VAR satisfies stability condition.

<table>
<thead>
<tr>
<th>Jarque-Bera test</th>
<th>Equation</th>
<th>chi2</th>
<th>df</th>
<th>Prob &gt; chi2</th>
</tr>
</thead>
<tbody>
<tr>
<td>logHHC</td>
<td>2.408</td>
<td>2</td>
<td>0.29997</td>
<td></td>
</tr>
<tr>
<td>YBR</td>
<td>0.838</td>
<td>2</td>
<td>0.65756</td>
<td></td>
</tr>
<tr>
<td>All</td>
<td>3.247</td>
<td>4</td>
<td>0.51744</td>
<td></td>
</tr>
</tbody>
</table>

Source: the author
As we have shown, at the beginning of the paper, the equation which presents interest to our research is the one in which the variable YBR (Romania 1-Year Bonds Yield) is endogenous (the second equation in table 4). The estimates of this equation can be rewritten as:

$$YBR_t = 10.24 \log(\text{HHC}_t) + 0.744YBR_{t-1} + 111.375$$

This equation shows that there is a positive linear correlation between, the Romania 1-Year Bonds Yield, the same variable in a previous period and the final households’ consumption in the $t-1$ period. Also the constant (-111.375) of this equation is statistically significant.

5. Impulse Response Function Analysis

According to Eigenvalue stability condition of the model, we can proceed to the next step. In order to this, in this section, we will analyze the Impulse-Response Function of the established VAR (1) model.

An Impulse-response function can be represented as:

$$y_t = \sum_{i=0}^{\infty} \psi_i y_{j,t-i} + \sum_{i=0}^{\infty} \psi_{i,j} z_{t-i} \frac{\partial y_{i+1}}{\partial \varepsilon_{t-i}}$$

and it offers the response of $y_{i+1}$ to a one-time impulse in $y_{j,t}$ with all other variables dated $t$ or earlier held constant.

A shock was created in households’ final consumption in Romania, by using the IRF variable, as it can be seen in fig. 4, in order to see the response of the yield curve. The shock was applied over a period of 4 quarters, until the bond reaches the maturity. The orthogonalized IRF has a positive slope, so this means that if a shock in consumption occurs when the bond is issued, it will have a positive impact over the whole lifespan of a bond, until it reaches its maturity.

Fig. 4. VAR’s model IRF (Impulse: Households’ Consumption; Response: 1-Year Bonds Yield) – 4 steps

![Graph showing Impulse Response Function](image)

Source: the author

According to the Cholesky forecast-error variance decomposition table (table 6), realized according to the same IRF methodology, the influence of households’ final consumption, over the bonds’ yield is increasing in one year, on the entire bond’s lifespan (fevd column).
6. Concluding Remarks

We have shown through a VAR(1) econometric model that there is a link between a shock in the households’ final consumption and 1-Year Bonds Yield for the Romanian economy. Even though it is a very simple analysis and probably more factors should be added to the mentioned model, it can give us a hint regarding one of the most influential factors, which can move bonds’ yield curve in Romania: the households’ consumption. So in order to this, if a consumption shock occurs in the early life stages of a 1-Year Bond, this will manifest a positive influence over the whole’s bond lifespan. Also, the influence of a positive shock in households’ consumption will be also positive and its influence over time is increasing until the second quarter and it stabilizes at an upper limit, in the third and the forth quarter. Our empirical findings are inline with the related literature, in which other authors’ findings come to sustain that a shock in output or in domestic consumption can have a clear impact on an asset yield.

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7. References