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# Modelling Of Investment Strategy In The Eurobond Market In Conditions Of Financial Instability

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# Modelling Of Investment Strategy In The Eurobond Market In Conditions Of Financial Instability

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## Abstract

Our task to simulate an investment portfolio, which provided to the investors the target return and target risk level and would consist of two parts: the main part are investment grade eurobonds, and the smaller part are the Russian eurobonds and other emerging markets eurobonds.

Our purpose is to establish the right balance between interests of the investors return and requirements of risk management. Hence, we need to create the default probabilities model in conditions of rising uncertainty and volatility in the world of financial markets.

Our model is based on the following approaches:

1. Two parts of portfolio: the investment grade eurobonds and the emerging markets eurobonds;
2. Minimum time horizon of investments is 1 day, maximum - 7 days;
3. Target return;
4. Minimum return;
5. Maximum level of investment grade credit rating securities in the investors portfolio;
6. Reasonable risk/return ratio;
7. The technique on reduction of level of emerging market securities in the investors portfolio in a case of risk increase.

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## 1. Introduction

It is considered that now the worst bear markets for the last 50 years. The equity market is very weak and investors look on the bond market. Investors want guaranteed income for their stock portfolios. The problem is the very low return on the USA and Europe bond markets. The emerging markets offer new opportunities for investors. But high enough return is connected to the increased risk. The Russian eurobonds can be attractive for investors in the light of good news from the Standard & Poor's. It is expected increase of the credit rating of Russia up to investment grade in 2004. In this connection it is necessary to evaluate risks of investment in the eurobond market of Russia and other countries, for example of Latin America and Eastern Europe.

Russia showed some impressive figures in 2002 thanks to high oil prices and moderate economic growth (+4,1% GDP). International reserves of Russia increased in 1,3 times (see an Appendix).

According to the Ministry of Finance of Russia, the state debt of Russia has decreased on 9 % of GDP and has made about 40 % of GDP in 2002. The charges of state debt service, on tentative estimations, were reduced in 2002 up to 2,3 % of GDP in comparison with 2,6 % of GDP in 2001. Russia has paid USD 14 billion on a state external debt in 2002, switching USD 6,8 billion of repayment of the basic debt and USD 7,2 billion of payment of percents.

As a result Standard & Poor's upgraded a long-term credit rating of Russia up to BB/stable, Moody's increased a credit rating of Russia up to Ba. Now Russia has credit rating on two steps below investment grade and has the stable forecast on scales of two lead rating agencies.

30-years Russian eurobonds have established historical minimum 8.97% YTM in December 2002. Prices of Russia-30 eurobonds increased in more than 2,5 times since 2000, showing decrease in credit risks. So investors seem Russian eurobonds

very attractive for investments. Some analytics boasted that Russia became the «safe haven» in conditions of financial instability in the world financial markets.

There are some supporting factors of the Russian eurobond market in the foreseeable future. Factors is possible to note are presidential elections and negotiation on the introduction of Russia in WTO. But these events will begin to render influence only in second half of 2003. Certainly race was finished. But if Russia will keep current rates of economic growth, the demand on the Russian eurobonds will remain stable, and yield to maturity will be reduced smoothly.

It is necessary to name increase of a rating of Russia up to an investment level among future positive factors. If the rating agencies will be satisfied of presidential elections in 2004 and condition of economy on that moment, Russia can proceed in investment category in one year.

But payments on the external debt will be the major factor of condition of the Russian eurobonds market. Let's remind, Russia must repay of USD 17,3 billion of it external debt in 2003. It is not expected any surprises. The officials do not get tired to assure, that Russia will repay successfully without new huge borrowings.

The federal budget surplus has appeared above the forecasts also has made 1 % of GDP. The Council of Federation has approved the federal budget on 2003 with incorporated surplus of 0,6 % of GDP. The basic parameters of the federal budget were estimated proceeding of the Urals oil price USD 21,5 per bbl. According to the Russian Minister of Finance Alexei Kudrin, the budget will be kept surplus in case if Urals oil price will not fall lower than USD 20 per bbl.

Re-structuring of the Soviet era debts passes successfully. The first issue of USD 1,28 billion was exchanged on the Russian eurobonds with maturity dates in 2010 and 2030 accordingly.

Hence Russia remains the most attractive segment in the emerging countries eurobond market. Russia can be a «safe haven» for global investors in conditions of financial instability.

## 2. The Model

Discussion of issues related to the use of investment portfolio models is provided by Ammann, Zimmermann (2001) Barone-Adesi, Giannopoulos, Vosper (1997), Dorsey (2000). We consider the investment portfolio model given in Dorsey (2001), can be taken for a basis of our model. In our opinion, appropriate eurobond portfolio simulation is possible with development of a multi-period, multi-investment portfolio model with the following equation that states the relative contribution that each investment makes to the performance of a eurobond portfolio:

$$\sum_{i=1}^{z} C_i (1 + r_i)^n = V(1 + r)^n, \sum_{i=1}^{z} C_i = V ,$$

where

*Ci* = the amount of capital in investment i;

*ri* = the geometric mean (compound annual) return achieved by investment i;

*n* = the investment holding period, in days;

*z* = the number of investments in the portfolio;

*V* = the total amount of capital invested in the portfolio; and

*r* = the geometric mean (compound annual) return objective for the entire portfolio.

The value of the portfolio at the end of investment period n equals $V(1+r)^n$. That consists of initial invested capital, plus gains, minus losses.

Also the return of portfolio for the period T could be estimated:

$$r_T = \frac{V_T}{V_1} - 1,$$

where $V_1$ — initial invested capital, $V_T$ — invested capital by the end of investment period.

Then we must estimate risks of investments on the eurobond market. According to Murphy, Won (2002) the traditional measures of risk in the context of a single market—duration and, more recently, convexity in both their standard and

option adjusted forms—lose all meaning in the context of an international portfolio. Before a duration number can be sensibly interpreted for a global portfolio, the markets represented in that portfolio would have to be assumed to undergo identical interest rate changes simultaneously. This assumption has not been valid for most markets over any recent period.

We estimated risks of investment portfolio with VaR technique. Known parameters: return, risk/return ratio, tracking error; correlation of asset prices, target return of portfolio (or target risk of portfolio); calculated parameters: asset weights in portfolio, risk of portfolio.

For example, the estimated portfolio consists of four assets:

$$c_1 + c_2 + c_3 + c_4 = 1,\ c_i \text{ - asset weight.}$$

Initial invested capital is $u_0$ ($u_0 = 100\,000$). The amount of $i$ bonds can be estimated:

$$N_i = \frac{u_0 c_i}{x_i},$$

And the investment portfolio consists of:

$$N_1 x_1 + N_2 x_2 + N_3 x_3 + N_4 x_4 = u_0.$$

The confidence level is 95%. The day eurobond price changes meet Normal distribution. We estimated Normal distribution parameters with following equation:

$$\mu_i = \frac{1}{K}\sum_{k=1}^{K} \Delta x_{ik},$$

$$\sigma_i^2 = \frac{1}{K-1}\sum_{k=1}^{K} \left(\Delta x_{ik} - \mu_i\right)^2,$$

where $K$ – size of data sample.

It is known that $\alpha$-percentile of Normal distribution, when $\alpha = 5\%$, is $\mu_i - 1.65\sigma_i$, where $\mu_i$ и $\sigma_i$ — parameters of Normal distribution for the asset *i*.

Hence, VaR with confidence level 95% can be estimated with the following equation:

$$VaR_{95\%} = \mu_i - 1.65\sigma_i = \frac{1}{K}\sum_{k=1}^{K}\Delta x_{ik} - 1.65\frac{1}{K-1}\sum_{k=1}^{K}\left(\Delta x_{ik} - \mu_i\right)^2 .$$

## 3. Empirical Estimation the Investment Portfolio of Eurobonds

We analyzed following eurobonds: Russia (S&P: BB/stable), Brazil (S&P: B+/negative), Mexico (S&P: BBB-/stable), Turkey (S&P: B-/negative), Poland (S&P: BBB+/stable), Germany (S&P: AAA/stable) and USA (S&P: AAA/stable). We researched 2001-2002 data on these markets.

First of all we made descriptive statistical analysis of recent eurobonds market. We found Russian eurobonds very attractive in the short-term investment horizon. In our opinion, Russia-30 eurobonds had similar risk/return ratios with US Treasuries and Germany Bundesbunds. But long-term risk character – tracking error remains more comparable with Brazil eurobonds than Mexico, for example, thanks high volatility in financial markets (table 1). Tracking error is defined as the standard deviation of the excess returns (the difference between the portfolio returns and the benchmark returns).

Then we estimated VaR for the different eurobond portfolios (table 2-6). We compared eurobonds Russia-30 with Mexico-31, Brazil-30 and Turkey-30. VaR was 1662,831095 when asset weights were equal. Eurobonds Mexico-31 had minimal VaR among others. But investment portfolio with 100% of Mexico-31 isn't optimal for private investor.

One of the portfolios (without Brazil-30) has VaR — 1005,861885, when asset weights are: Brazil-30 — 0%, Mexico-31 — 47%, Russia-30 — 28,9%, Turkey-30 — 24,1%. VaR can be a good technique for reduction of eurobonds with high risks in the portfolio (table 2).

Table 1

Sovereign eurobonds risks estimation

| Country | Return in 2002 , % | Annual coupon, % | Std. Dev. 2001-2002 | Risk/Return Ratio in 2002, % | Tracking error (US Treasuries as benchmark) |
|---|---|---|---|---|---|
| USA-30 | 8,9688 | 5,375 | 4,34 | 0,484 | - |
| Germany-30 | 4,8036 | 5,50 | 3,20 | 0,666 | - |
| Mexico-31 | 7,12 | 8,30 | 3,44 | 0,483 | 0,45 |
| Russia-30 | 24,4770 | 5 | 14,32 | 0,585 | 2,52 |
| Brazil-30 | -24,396 | 12,25 | 13,57 | - | 3,85 |
| Turkey-30 | 10,75 | 11,88 | 7,50 | 0,697 | - |

Table 2

VaR for different eurobonds portfolios

| No. | BRAGLB30 | MEXGLB31 | RUSGLB30 | TRGLB30 | VaR, USD |
|---|---|---|---|---|---|
| 1 | 1 | 0 | 0 | 0 | 4242,255562 |
| 2 | 0 | 1 | 0 | 0 | 1224,518443 |
| 3 | 0 | 0 | 1 | 0 | 1302,109021 |
| 4 | 0 | 0 | 0 | 1 | 1417,389680 |
| 5 | 0,25 | 0,25 | 0,25 | 0,25 | 1662,831095 |
| 6 | 0,5 | 0,5 | 0 | 0 | 2461,180398 |
| 7 | 0,5 | 0 | 0,5 | 0 | 2556,491164 |
| 8 | 0,5 | 0 | 0 | 0,5 | 2535,349880 |
| 9 | 0 | 0,5 | 0,5 | 0 | 1051,221198 |
| 10 | 0 | 0,5 | 0 | 0,5 | 1063,892290 |
| 11 | 0 | 0 | 0,5 | 0,5 | 1195,945193 |
| 12 | 0 | 0,333333333 | 0,333333333 | 0,333333333 | 1023,812056 |
| 13 | 0,333333333 | 0 | 0,333333333 | 0,333333333 | 1994,507365 |
| 14 | 0,333333333 | 0,333333333 | 0 | 0,333333333 | 1913,571905 |
| 15 | 0,333333333 | 0,333333333 | 0,333333333 | 0 | 1931,326782 |
| 16 | 0,000 | 0,400 | 0,400 | 0,200 | 1013,532042 |
| 17 | 0,000 | 0,450 | 0,350 | 0,200 | 1008,123397 |
| 18 | 0,000 | 0,500 | 0,300 | 0,200 | 1007,592203 |
| 19 | 0,000 | 0,500 | 0,270 | 0,230 | 1006,735021 |
| 20 | 0,000 | 0,490 | 0,280 | 0,230 | 1006,289802 |
| 21 | 0,000 | 0,470 | 0,300 | 0,230 | 1005,978506 |
| 22 | 0,000 | 0,470 | 0,290 | 0,240 | 1005,864115 |
| 23 | 0,000 | 0,470 | 0,289 | 0,241 | 1005,861885 |

Table 3

Eurobond prices correlation matrix

| | BRAGLB30 | MEXGLB31 | RUSGLB30 | TRGLB30 |
|---|---|---|---|---|
| BRAGLB30 | 1 | 0,450902191 | 0,548950719 | 0,455605112 |
| MEXGLB31 | 0,450902191 | 1 | 0,348744307 | 0,26343659 |
| RUSGLB30 | 0,548950719 | 0,348744307 | 1 | 0,49531803 |
| TRGLB30 | 0,455605112 | 0,26343659 | 0,49531803 | 1 |

Table 4

Eurobond prices co-variation matrix

| | BRAGLB30 | MEXGLB31 | RUSGLB30 | TRGLB30 |
|---|---|---|---|---|
| BRAGLB30 | 2,395771606 | 0,518671114 | 0,478729818 | 0,62587329 |
| MEXGLB31 | 0,518671114 | 0,552298699 | 0,146025449 | 0,173755368 |
| RUSGLB30 | 0,478729818 | 0,146025449 | 0,317445245 | 0,24768156 |
| TRGLB30 | 0,62587329 | 0,173755368 | 0,24768156 | 0,787680776 |

Table 5

Average day gains of eurobond prices

| BRAGLB30 | MEXGLB31 | RUSGLB30 | TRGLB30 |
|---|---|---|---|
| -0,06047198 | 0,032079646 | 0,101769912 | 0,080752212 |

Table 6

Volatility (day changes of eurobond prices)

| BRAGLB30 | MEXGLB31 | RUSGLB30 | TRGLB30 |
|---|---|---|---|
| 1,550116024 | 0,744266564 | 0,564255644 | 0,888825738 |

We estimated the return for the different eurobonds portfolios (table 7). The investment portfolios, which included Russian eurobonds, had maximum return with minimal VaR.

We also estimated month return of the eurobonds portfolio with the minimal VaR (table 8). The average month return can be estimated as the geometric mean (compound annual) return

$$r = \sqrt[k]{(1+r_1)(1+r_2)\cdot\ldots\cdot(1+r_k)} - 1,$$

where $k$ — the number of investment periods ($k = 16$ for the selected portfolio). Hence, the month return would be $r = 0{,}014751$.

Table 7

The return of simulated eurobonds portfolios with different asset weights
(Investment horizon 490 days, from 07.08.2001 to 10.12.2002)

| BRAGLB30 | MEXGLB31 | RUSGLB30 | TRGLB30 | VaR | Return |
|---|---|---|---|---|---|
| 1 | 0 | 0 | 0 | 4242,255562 | -0,255850 |
| 0 | 1 | 0 | 0 | 1224,518443 | 0,116935 |
| 0 | 0 | 1 | 0 | 1302,109021 | 0,754098 |
| 0 | 0 | 0 | 1 | 1417,389680 | 0,348726 |
| 0,25 | 0,25 | 0,25 | 0,25 | 1662,831095 | 0,126552 |
| 0,5 | 0,5 | 0 | 0 | 2461,180398 | -0,106793 |
| 0,5 | 0 | 0,5 | 0 | 2556,491164 | 0,044982 |
| 0,5 | 0 | 0 | 0,5 | 2535,349880 | -0,040885 |
| 0 | 0,5 | 0,5 | 0 | 1051,221198 | 0,364815 |
| 0 | 0,5 | 0 | 0,5 | 1063,892290 | 0,221936 |
| 0 | 0 | 0,5 | 0,5 | 1195,945193 | 0,524932 |
| 0 | 0,333333333 | 0,333333333 | 0,333333333 | 1023,812056 | 0,359409 |
| 0,333333333 | 0 | 0,333333333 | 0,333333333 | 1994,507365 | 0,129795 |
| 0,333333333 | 0,333333333 | 0 | 0,333333333 | 1913,571905 | 0,006521 |
| 0,333333333 | 0,333333333 | 0,333333333 | 0 | 1931,326782 | 0,067914 |
| 0,000 | 0,400 | 0,400 | 0,200 | 1013,532042 | 0,361566 |
| 0,000 | 0,450 | 0,350 | 0,200 | 1008,123397 | 0,332074 |
| 0,000 | 0,500 | 0,300 | 0,200 | 1007,592203 | 0,303833 |
| 0,000 | 0,500 | 0,270 | 0,230 | 1006,735021 | 0,295152 |
| 0,000 | 0,490 | 0,280 | 0,230 | 1006,289802 | 0,300631 |
| 0,000 | 0,470 | 0,300 | 0,230 | 1005,978506 | 0,311727 |
| 0,000 | 0,470 | 0,290 | 0,240 | 1005,864115 | 0,308786 |
| 0,000 | 0,470 | 0,289 | 0,241 | 1005,861885 | 0,308492 |

Table 8

The return and invested capital for the eurobonds portfolio with asset weights 0; 0,470; 0,289; 0,241

| Date | BRAGLB30 | MEXGLB31 | RUSGLB30 | TRGLB30 | Sum | Return |
|---|---|---|---|---|---|---|
| 12.2002 | 0 | 47000 | 28900 | 24100 | 100000 | 0,008203 |
| 11.2002 | 0 | 46377,858 | 28224,76636 | 24583,7072 | 99186,33156 | 0,070036 |
| 10.2002 | 0 | 44567,99037 | 27099,37695 | 21027,0366 | 92694,40392 | 0,051624 |
| 09.2002 | 0 | 43663,05656 | 25388,78505 | 19092,20779 | 88144,0494 | -0,015974 |
| 08.2002 | 0 | 44681,1071 | 25118,69159 | 19775,08855 | 89574,88724 | 0,054256 |
| 07.2002 | 0 | 42192,53911 | 23993,30218 | 18779,22078 | 84965,06207 | -0,037157 |
| 06.2002 | 0 | 44058,9651 | 24893,61371 | 19291,38135 | 88243,96016 | -0,059027 |
| 05.2002 | 0 | 45246,69073 | 25883,95639 | 22648,87839 | 93779,52551 | -0,011915 |
| 04.2002 | 0 | 46151,62455 | 25028,66044 | 23730,10626 | 94910,39124 | 0,033798 |
| 03.2002 | 0 | 45020,45728 | 23768,2243 | 23018,77214 | 91807,45372 | -0,014315 |
| 02.2002 | 0 | 46434,41637 | 23858,25545 | 22848,05195 | 93140,72377 | 0,040013 |
| 01.2002 | 0 | 44850,78219 | 22057,6324 | 22648,87839 | 89557,29298 | 0,039277 |
| 12.2001 | 0 | 43663,05656 | 20572,11838 | 21937,54427 | 86172,71921 | 0,033636 |
| 11.2001 | 0 | 43323,70638 | 19131,61994 | 20913,22314 | 83368,54946 | 0,045882 |
| 10.2001 | 0 | 42984,3562 | 17150,93458 | 19575,91499 | 79711,20577 | 0,064472 |
| 09.2001 | 0 | 40043,3213 | 16430,68536 | 18409,32704 | 74883,33369 | -0,053463 |
| 08.2001 | 0 | 43097,47292 | 17150,93458 | 18864,58087 | 79112,98838 | |

## Conclusion

We consider Russian eurobonds good investment object with some parameters similar to the eurobonds with investment grade credit rating. So expectations of increasing of Russia's credit rating up to the investment grade are proved. We didn't provide deep macroeconomic analysis of the Russian and world economy. Our task is only simulation of short-term portfolio for the private investors. We consider VaR technique good technique for reduction of low quality eurobonds in the investment portfolio.

Early Russian eurobonds could be comparing with Brazil eurobonds. We didn't find significant correlation between Russian and Brazil markets. Some analysts have hurried to compare Russian eurobonds with Mexican bonds. But we consider Russian eurobonds place between Mexico and Turkey.

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**Appendix**

Table 1

International reserves of Russia in 2002, (USD, mln.)

| | Gold and foreign currency | Include: | | | | |
|---|---|---|---|---|---|---|
| | | Foreign currency reserves | Include: | | | Gold |
| | | | Foreign currency | SDR | Reserve position in IMF | |
| 01.01.02 | 36 622 | 32 542 | 32 538 | 3 | 1 | 4 080 |
| 01.02.02 | 36 408 | 32 317 | 32 312 | 3 | 1 | 4 091 |
| 01.03.02 | 36 860 | 32 768 | 32 763 | 4 | 1 | 4 092 |
| 01.04.02 | 37 295 | 33 179 | 33 174 | 4 | 1 | 4 116 |
| 01.05.02 | 39 155 | 35 024 | 35 019 | 4 | 1 | 4 131 |
| 01.06.02 | 42 227 | 38 496 | 38 489 | 5 | 1 | 3 731 |
| 01.07.02 | 43 579 | 39 848 | 39 838 | 8 | 2 | 3 731 |
| 01.08.02 | 43 294 | 39 564 | 39 554 | 8 | 2 | 3 731 |
| 01.09.02 | 44 327 | 40 596 | 40 587 | 8 | 2 | 3 731 |
| 01.10.02 | 45 619 | 41 887 | 41 878 | 8 | 2 | 3 732 |
| 01.11.02 | 46 767 | 43 034 | 43 025 | 8 | 2 | 3 733 |
| 01.12.02 | 48 205 | 44 470 | 44 467 | 1 | 2 | 3 735 |
| 01.01.03 | 47 792 | 44 052 | 44 050 | 1 | 2 | 3 739 |

*Source:* Central Bank of Russia

Table 2

Standard deviation of eurobonds returns, 2000-2002

| | Valid N | Mean | Minimum | Maximum | Std. Dev. |
|---|---|---|---|---|---|
| P_USA30 | 96 | 99,81722 | 93,28125 | 110,8594 | 4,340028 |
| Y_USA30 | 96 | 5,395115 | 4,679 | 5,854 | 0,292351 |
| P_USA10 | 70 | 102,6205 | 96,6875 | 110,6406 | 3,76079 |
| Y_USA10 | 70 | 4,651629 | 3,59 | 5,456 | 0,505642 |
| P_RUS30 | 147 | 50,87126 | 31,45 | 80,168 | 14,3231 |
| Y_RUS30 | 147 | 14,45195 | 8,924 | 19,763 | 3,133295 |
| P_RUS10 | 145 | 79,40065 | 55,719 | 107,513 | 15,25218 |
| Y_RUS10 | 145 | 12,42563 | 6,927 | 18,151 | 3,183985 |
| P_BRA30 | 146 | 82,22533 | 45,861 | 98,944 | 13,57992 |
| Y_BRA30 | 146 | 15,46658 | 12,382 | 26,716 | 3,318951 |
| P_BRA12 | 48 | 71,45365 | 45,748 | 94,067 | 16,7094 |
| P_MEX31 | 70 | 98,10497 | 88,39 | 103,504 | 3,446523 |
| Y_MEX31 | 70 | 8,483943 | 7,985 | 9,472 | 0,333329 |
| P_MEX12 | 100 | 103,3794 | 96,905 | 110,42 | 3,404054 |
| Y_MEX12 | 100 | 7,83376 | 6,688 | 8,849 | 0,5433 |
| P_POL12 | 66 | 107,9754 | 105 | 111,875 | 1,620069 |
| P_TUR10 | 147 | 94,625 | 83,375 | 107,5 | 6,199263 |
| P_TUR30 | 147 | 90,91412 | 78,5 | 109,25 | 7,505788 |

*Source:* authors estimation

P – price, last, close.
Y – yield to maturity, average

Table 3

Eurobonds market prices correlation, 2000-2002

| | P_USA30 | P_USA10 | P_GER30 | P_GER10 | P_RUS30 | P_RUS10 | P_BRA30 | P_BRA12 | P_MEX31 | P_MEX12 | P_POL12 | P_TUR10 | P_TUR30 |
|---|---|---|---|---|---|---|---|---|---|---|---|---|---|
| P_USA30 | 1 | 0,975559 | 0,950435 | 0,976774 | 0,489422 | 0,538065 | -0,78222 | -0,77834 | -0,28879 | 0,347559 | 0,617089 | 0,826096 | 0,825033 |
| P_USA10 | 0,975559 | 1 | 0,925778 | 0,971389 | 0,590703 | 0,647734 | -0,87176 | -0,87191 | -0,37649 | 0,340825 | 0,610133 | 0,905863 | 0,898752 |
| P_GER30 | 0,950435 | 0,925778 | 1 | 0,968957 | 0,334022 | 0,397487 | -0,79597 | -0,79087 | -0,40097 | 0,167286 | 0,764407 | 0,73689 | 0,725299 |
| P_GER10 | 0,976774 | 0,971389 | 0,968957 | 1 | 0,508943 | 0,564447 | -0,80139 | -0,80106 | -0,30403 | 0,347286 | 0,668769 | 0,838663 | 0,843521 |
| P_RUS30 | 0,489422 | 0,590703 | 0,334022 | 0,508943 | 1 | 0,985737 | -0,54851 | -0,56751 | 0,063187 | 0,704465 | 0,029741 | 0,826921 | 0,847035 |
| P_RUS10 | 0,538065 | 0,647734 | 0,397487 | 0,564447 | 0,985737 | 1 | -0,62006 | -0,64061 | -0,0112 | 0,67035 | 0,100401 | 0,869237 | 0,886318 |
| P_BRA30 | -0,78222 | -0,87176 | -0,79597 | -0,80139 | -0,54851 | -0,62006 | 1 | 0,993601 | 0,688815 | -0,01752 | -0,62751 | -0,87393 | -0,83161 |
| P_BRA12 | -0,77834 | -0,87191 | -0,79087 | -0,80106 | -0,56751 | -0,64061 | 0,993601 | 1 | 0,674671 | -0,04099 | -0,62876 | -0,88145 | -0,83753 |
| P_MEX31 | -0,28879 | -0,37649 | -0,40097 | -0,30403 | 0,063187 | -0,0112 | 0,688815 | 0,674671 | 1 | 0,665194 | -0,50842 | -0,32539 | -0,25264 |
| P_MEX12 | 0,347559 | 0,340825 | 0,167286 | 0,347286 | 0,704465 | 0,67035 | -0,01752 | -0,04099 | 0,665194 | 1 | -0,13624 | 0,447345 | 0,51667 |
| P_POL12 | 0,617089 | 0,610133 | 0,764407 | 0,668769 | 0,029741 | 0,100401 | -0,62751 | -0,62876 | -0,50842 | -0,13624 | 1 | 0,400424 | 0,376828 |
| P_TUR10 | 0,826096 | 0,905863 | 0,73689 | 0,838663 | 0,826921 | 0,869237 | -0,87393 | -0,88145 | -0,32539 | 0,447345 | 0,400424 | 1 | 0,992159 |
| P_TUR30 | 0,825033 | 0,898752 | 0,725299 | 0,843521 | 0,847035 | 0,886318 | -0,83161 | -0,83753 | -0,25264 | 0,51667 | 0,376828 | 0,992159 | 1 |

P_USA30 – US Treasures-30, P_USA10 – US Treasures-10, P_GER30 – Bundesbunds-30, P_GER10 – Bundesbunds-10, P_RUS30 – Russia-30, P_RUS10, Russia-10, P_BRA30 – Brazil – 30, P_BRA12 – Brazil-12, P_MEX31 – Mexico-31, P_MEX12 – Mexico-12, P_POL12 – Poland-12, P_TUR10 – Turkey-10, P_TUR30 – Turkey-30.