Debt Portfolio Management Quarterly Review

JUNE 2005

On 6 December 2004, the Ministry of Finance published its Financing and Debt Management Strategy for 2005. The Government Debt Management Unit committed itself to the number of steps aimed at making state debt management more effective in accordance with the best international practice. In the first place, the integrated management financial risks of state debt and risky state guarantees portfolio, including the effect of financial derivatives was introduced and the first results were published in the March Quarterly Review on 8 April 2005. The GDMU hereby submits its second Debt Portfolio Management Quarterly Review which is the regular follow-up of this approach. The integrated management succeeds in the first six months of its implementation and the GDMU aims at further extension and interconnection of the government liabilities structure with the current portfolio of financial assets.

The Ministry planned to finish the first version of the new measure of interest rate risk during the first half of 2005. So the so called **Cost-at-Risk** (CaR) model as a core of simulation framework is submitted in the Appendix of this Quarterly Review. We will continue in further development in the second half of 2005 and communicate the progess in this area with market participants and public.

I. Review of Strategic Targets for 2005

The 2005 state debt management policy is guided by the set of quantitative absolut and relative limits and criteria approved by the Minister of Finance for issuance activities and the active management of debt portfolio. More details on these criteria and the ministry's performance are summarized in the table.

<table>
<tr><th>Criterion</th><th>Guidelines for 2005</th><th colspan="2">June 30, 2005</th></tr>
<tr><td rowspan="2">International financing</td><td>Max. 40% of the total annual gross financing requirement</td><td colspan="2">22%</td></tr>
<tr><td>CZK 28,6 to 54,6 bn</td><td colspan="2">30,1 mld Kč</td></tr>
<tr><td>Gross T-Bonds issues</td><td>CZK 94,0 to 120,0 bn</td><td colspan="2">+ 53,8 mld Kč</td></tr>
<tr><td>Net T-Bills issues</td><td>CZK -24,0 to - 50,0 bn</td><td colspan="2">- 16,5 mld Kč</td></tr>
<tr><td>Loans from EIB</td><td>CZK 11,78 bn</td><td colspan="2">+ 5,5 mld Kč</td></tr>
<tr><td rowspan="2">Short-term state debt</td><td rowspan="2">24% and less</td><td>State debt</td><td>21,72 %</td></tr>
<tr><td>inc. Guarantees</td><td>24,13 %</td></tr>
<tr><td rowspan="2">Average time to maturity</td><td rowspan="2">5,5 to 6,5 years</td><td>State debt</td><td>5,81 years</td></tr>
<tr><td>inc. Guarantees</td><td>5,56 years</td></tr>
<tr><td rowspan="2">Modified duration</td><td rowspan="2">3,8 ± 0,4 years</td><td>State debt</td><td>4,27 years</td></tr>
<tr><td>inc. Guarantees</td><td>4,04 years</td></tr>
</table>

Note: EIB – European Investment Bank. Source: MF CR, Bloomberg.

As regards **international financing**, the Czech Republic has drawn the loans from the European Investment Bank in the amount of CZK 5,5 bn which represents 46,4% of the approved value in the State Budget Act for 2005. As for further operations of the Ministry on the foreign market, minister made no relevant decision in this area.

Regarding **domestic issuance activity**, the net issue of T-Bonds was CZK 37,5 bn in the second quarter. The total gross issue of T-Bonds was CZK 53,8 bn in the first half of 2005; it is aabout 44,8% of the maximal supply announced in December 2004. The volume in issue of T-Bills decreased by CZK 17,5 bn in the second quarter according to the announced plan to decrease the volume of T-Bills by minimally CZK 24 bn during 2005.

The short-term state debt reached the level of 21,7 %. It means that the Ministry hit the announced target to drop to the level of 24% and less by the end of 2005. Nevertheless, the impact of risky state guarantees is significant and this parameter approaches the level of 24,1 % on the aggregate level. The main reason is the Government's decision to redeem the gurantee for the Czech National Bank in the amount of CZK 22 bn in 2005 or 2006 instead of original maturity in 2007. This decision has important consequences for the ministry's financing strategy in the rest of the current year. The final solution and timing is based on the needful approval by the Parliament which must create the special legal framework for refinancing the non-standard government liability from 1997.

Average time to maturity reached the level of 5,8 years and is approaching the mid of the target band 5,5 – 6,5 for the end of 2005.

Modified duration of state debt increased further to 4,27 years and got over the upper limit of the band 3,8 ± 0,4 years. There are two main reasons behind this result. On the one hand, the ministry reported the budget surplus in the amount of CZK 3,8 bn at the end of the first half of the year. It created possibility to decrease the volume of T-Bills in issue more rapidly than expected and the GDMU exercised over it.

On the other hand, interest rates carried on the decreasing tendency over the whole yield curve (approx. 50 basis points when compared to the end of the first quarter 2005). It is clear that the sensibility to interest rates is disturbing and the interest rate development contributes to a higher duration which wasn't indicated by the simulation models used during the process of design the duration band in December 2004. In this respect we must emphasize the very positive benefit of the integrated portfolio management announced at the end of 2004. The interest rate exposure of the structure of risky state guarantees is relatively higher in comparison with the state debt itself. The result is duration on the level of 4 years on the integrated basis. This is important argument to support the decision of the GDMU in the area of management of the interest rate risk exposure of the government liabilities.

II. State Debt Parameters at the end of June 2005

Debt Parameter	December 31, 2004	March 31, 2005	June 30, 2005
Total state debt (CZK bn)	**592,9**	**618,2**	**643,6**
Market value, inc. derivatives (CZK bn))	629,8	662,5	706,6
Short-term state debt (%)	25,0	25,5	21,7
Share of T-Bills (%)	21,2	20,5	16,9
Average time to maturity (years)	5,1	5,6	5,8
Interest rate refixing up to one year, inc. derivatives (%)	27,0	27,3	24,5
Variable-rate state debt (%)	3,5	3,3	4,1
Modified duration (years)	3,9	4,1	4,3
Modified duration, exc. IRS (years)	3,4	3,6	3,8
Foreign currency state debt (%)	0,0	0,1	0,1
Foreign currency debt, exc. cross-currency swaps (%)	7,8	12,2	11,8
Nonmarketable state debt (%)	3,6	3,5	4,2
Marketable state debt (CZK bn)	**571,4**	**596,7**	**616,7**
Market value (CZK bn)	608,2	641,0	679,6
Short-term marketable debt (%)	25,8	26,2	22,5
Share of T-Bills (%)	21,9	21,2	17,7
Average time to maturity (years)	5,0	5,6	5,6
Interest rate refixing up to one year, inc. derivatives (%)	24,2	24,7	21,2
Variable-rate marketable debt (%)	0,0	0,0	0,0
Modified duration (years)	4,1	4,3	4,4
Modified duration, exc. IRS (years)	3,5	3,7	3,9
Foreign currency marketable deb (%)	0,0	0,1	0,1
Foreign currency debt, exc. cross-currency swaps (%)	8,0	12,6	12,3

Notes: **Interest rate refixing up to one year** = T-Bills + Fixed-rate short-term debt + Variable-rate state debt + Effect of interest rate derivatives. Source: MF CR, Bloomberg.

III. Integrated portfolio of state debt and risky state guarantees at the end of June 2005

From the perspective of management of financial risk of expenditure flows of the State Budget, not only the structure of state debt is relevant, but also the structure of the portfolio of provided state guarantees, for which the State Budget pays effectively principle repayments, interest payments and FX loss. These high-risk guarantees have already been transferred according to ESA95 methodology prescribed for the calculation of the Maastricht criteria into the government sector deficit and debt, nevertheless, they are not a part of state debt. Therefore, based on data delivered by the State Budget Department of the ministry and by the Czech-Moravian Guarantee and Development Bank, the GDMU started to automate regular monitoring of this portfolio according to the debt management policy and the budget-at-risk framework. In comparison with the March Review we added the amount of CZK 5 bn which was approved within the State Budget Act for 2005 to cover potential requirements of the CSOB in connection with the specific IPB guarantee from 2000.

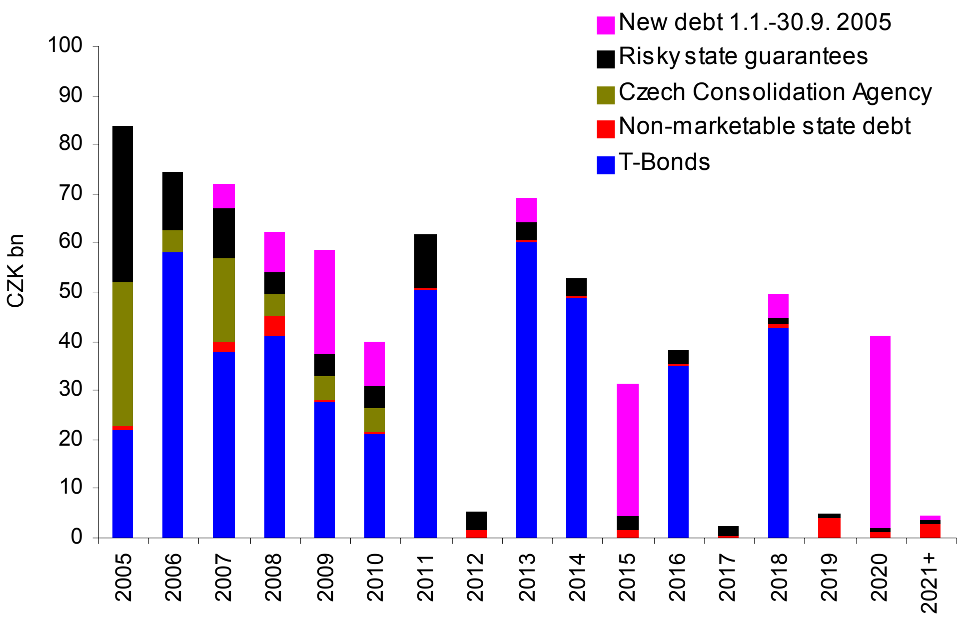
Measures of the integrated portfolio of state debt and risky state guarantees

	Nominal amount (CZK bn)	Market value (CZK bn)	Foreign currency liabilities (%)	Variable-rate liabilities (%)	Short-term liabilities (%)	Interest rate refixing (%)	Average life (years)	Modified duration (years)
Total state debt	643,6	706,6	0,1	4,1	21,7	24,5	5,8	4,3
Risky state guarantees	97,7	98,4	27,8	24,0	40,1	51,5	3,9	2,4
Portfolio total	**741,4**	**805,0**	**3,7**	**6,7**	**24,1**	**28,1**	**5,6**	**4,0**

Note: including currency and interest rate derivatives of the MF and CMZR Bank.
Source: MF CR, Czech-Moravian Guarantee and Development Bank, Bloomberg.

The risk measures of the portfolio of state guarantees were influenced significantly by the Government's decision on earlier redemption of the gurantee for the Czech National Bank in the amount of CZK 22 bn. It increases short term financing needs and decreases average life and duration of the portfolio. Even if we take it into account, the main strategic targets aren't put at risk in the medium-term.

Redemption profile of state debt, risky state guarantees and outlook of the CCA's funding (End-2004; updated on 8 July 2005, excl. T-Bills outstanding)



Note: The planned earlier redemption of the CNB guarantee is distributed subsequently: 2/3 (CZK 14.7 bn) is accounted for in the reported amount. The remaining 1/3 (CZK 7.3 bn) is accounted for in 2006. The final financing strategy is based on the approval by the Parliament and on the market conditions.
Source: MF CR, Czech Consolidation Agency, Czech-Moravian Guarantee and Development Bank.

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www.mfcr.cz/statedebt

The next issue of Quarterly Review will be published on October 8, 2005, at 2.00 pm.

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IV. Appendix:

CaR – New interest rate risk measure in the Czech case

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1 Theoretical framework

For determining the optimal issuance strategy (in terms of an attractive balance between expected interest costs and the associated risks) and for the estimation of the State's future interest cost distribution, the Government Debt Management Unit of the Ministry of Finance (GDMU) is developing a model, which allows for computing risk measures such as Cost-at-Risk (CaR). CaR is based on future yield curve simulations, which are subsequently used for obtaining simulations of the State's interest costs on the debt.

Cost-at-Risk (CaR) model

The input to the model is the current debt portfolio (outstanding T-Bills and T-Notes) and expected budget deficits. For future periods, the current portfolio and expected budget deficits are replicated according to a chosen issuance strategy. The issuance stategy dictates how the current portfolio instruments are refinanced and how the expected budget deficits will be financed. For determining the future state debt's interest costs, the interest rate scenarios of the portfolio instruments must be specified. The interest rate scenarios are generated by a yield curve model.

The yield curve model

The yield curve model tries to describe the process, which drives the evolution of the yield curve. Generally, the model consists of a stochastic equation (possibly a system of euations), which is an approximation of the real process. The goal is to build an equation, which describes the empirical features of yield curves (levels, volatilities, correlations, autocorrelations) in an appropriate manner. The mathematical formulation of the stochastic equation enables us to simulate future yield curves. The simulated yield curves are subsequantly used for computing the simulated interest costs in the model. It is apparent, that the choice of yield curve model influences the output of the model.

Currently, for the yield curve simulations, the **Cox, Ingersoll, Ross (CIR) model** is used. The CIR model is used by e.g. the central bank of Dannmark, the Portuguese Debt Agency and the World Bank. The CIR is a one factor, no-arbitrage model, based on a short interest rate, which is described by the following stochastic differential equation (SDE):

$$dr(t) = \alpha(\mu - r(t))dt + \sigma\sqrt{r(t)}dW(t),$$

where $r(t)$ is the short rate at time t, μ is the long-term equilibrium rate, α is the speed of reversion to the long-term equilibrium rate μ, σ is the volatility of the model and $W(t)$ is the standard Wiener process. In addition to the parameters above, the market price of risk λ, which determines the steepnes of the yield curve, must be estimated. The short rate simulations univocally determine the yield curve.

Indicators of the CaR model

Expected cost – the expected value of the state debt's interest cost in a given year. It is computed as the average value of the cost simulations in a given year

Cost-at-Risk (CaR) – worst case state debt's interest cost with chosen probability in a given year. It is computed as a percentilee of the cost simulations in a given year. e.g. the 95% percentile (95% CaR) determines the value, which the interest cost will not exceed with 95% probability. CaR is a measure of the risk of interest costs.

Relative CaR – is defined as the difference between CaR and expected Cost. Again, it expresses the risk of interest costs.

Expected cost and CaR are supplementary indicators to the duration, the average weighted time to maturity, the redemption profile of the state debt and the interest rate refixing.

2 The CIR yield curve in the Czech case

Using the CIR model we simulate monthly interest rates of the required maturities (used by the issuance/refinancing activity). The subsequent results were arrived at by using 500 simulations over the next five years for 3M, 6M, 9M, 3Y, 5Y, 10Y and 15Y maturities. Each simulation can be considered a random draw from a theoretical probability distribution of the interest rate's time series of five years's length.

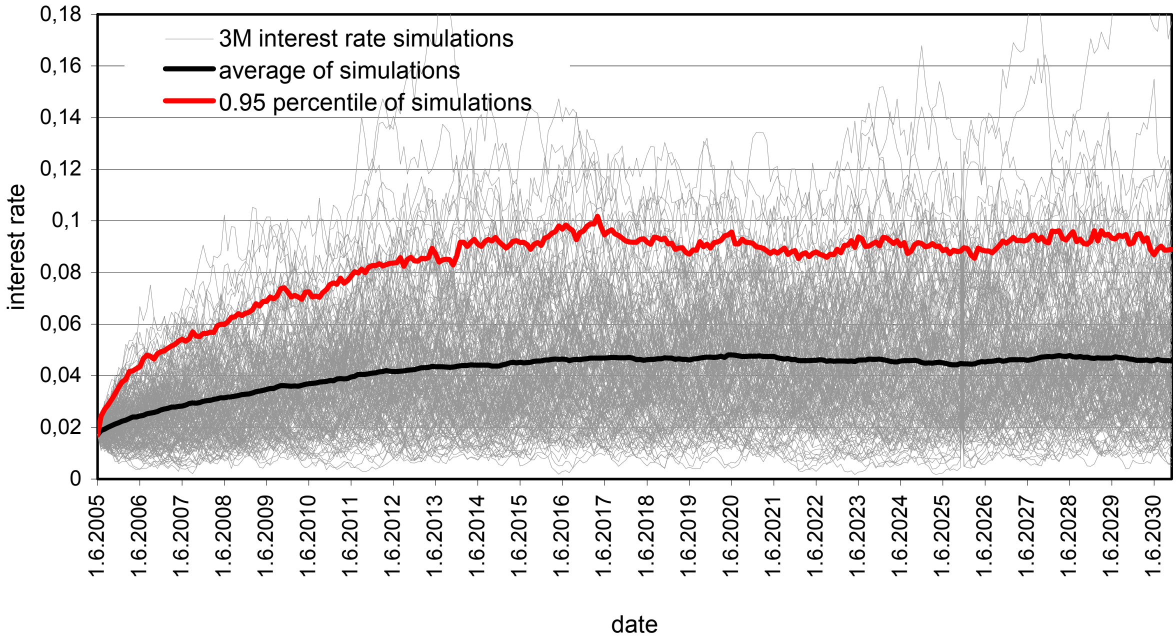
Before the simulations can be carried out it is necessary to estimate the CIR model parameters. The parameters of the short rate stochastic differential equation (SDE) are estimated from the 3M interest rate time series of monthly observations. The estimation techniques used are the General Method of Moments (GMM) and the Maximum Likelihood (ML) method. The λ parameter (market price of risk) is estimated via least squeres using the yield curve observed on the first day of simulations.

For estimating the parameters of the short rate SDE, 20 years of monthly 3M EURIBOR observationsis are used. We do not use 3M PRIBOR because there is a high number of extreme observations before 2000 and only a relatively a short time series can be obtained. In our view, using 3M EURIBOR instead of 3M PRIBOR is justified due to their high correlation since 2000. The correlation has in fact been rising over the last few years and, in our view, it is likely to continue rising because the Czech Republic is likely to be joiing the EMU. The λ parameter is estimated from the Czech yield curve from 1 June 2005, which is the first day of simulations. The data source of longer interest rates are EFFAS data from Bloomberg.

The estimation of the parameters seems not to be very robust. Using a one-factor model and linearity of the SDE drift appear to be major deviations the empirical dynamics of the interest rate process. For instance, the one-factor CIR model underestimates the volatility in the long end of the yield curve. That feature leads to an underestimation of the volatility of interest costs of long T-Notes.

Current yields are historically low and the CIR model therefore implies an increase in expected interest rates until they reach their long-term values. The expected values of the simulations will reach their long-term values in approximately 17 years. But already after five years, which means, at the end of 2010, there is a 25% probability, that the interest rates will exceed their long-term values. The evolution of 200 simulations of the 3M interest rate from 2005 to the end of 2030 is shown in graph 1.

Graph 1



Source: Bloomberg, own calculations.

3 Results from the CaR model for 2005 to 2010

The output of the CIR model (simulations of the yield curve) are used in the model for computing key figures such as expected costs, 95% CaR and relative 95% CaR. As the model refinances the instruments according to the chosen issuance strategy and the current state debt portfolio and the expected budget deficits over time it is important to establish a view on the budget deficit evolution.

The net borrowing requirements for 2005 to 2010 – Basic scenario

For 2005 to 2007 the ministry's predictions of budget deficits are used. For 2008 to 2010 the budget deficits are computed as approx. 2 % of the prediction of nominal GDP to ensure the consistency with the Maastricht criterion of 3% for the whole government sector. Finally, the estimates of the budget deficits are increased by the redemptions of the risky state guarantees (including the Czech Consolidation Agency and the Czech National Bank guarantees)

GDP is modeled technically using an ARIMA(1,1,2) model, which is estimated from the yearly 1995 - 2008 time series (last 4 observations are the official MoF predictions). The particular values of the expected budget deficits and expected nominal amount (to the year ends) of the state debt is shown in table 1.

Table 1: The net borrowing requirements and state debt 2005 – 2010 – Basic scenario (CZK bn)

Year	2005	2006	2007	2008	2009	2010
Expected deficit	**101,2**	**87, 8**	**104,9**	**74,4**	**79,2**	**83,3**
State debt	**717,6**	**805,6**	**910,5**	**984,8**	**1063,9**	**1147,3**

Note: The year 2005 – potential needs for the 3rd and the 4th quarter of 2005. The figures in the table are not official predictions of the MF CR but represents the base case fiscal scenario used for simulations and modeling.
Source: ČSO, MF ČR, own calculations.

Alternative issuance strategies

The current state debt portfolio, which is being increased by expected needs from table 1, undergoes refinancing according to the following 9 strategies:

- **A – Basic Strategy**. Approximately keeps the relative structure of the T-notes portfolio constant for the whole period. T-bills are kept at the current level of CZK 109 bn.

- **B – Long Term Strategy**. Mostly T-notes with longer maturities are issued and the ratio of issuance is constant for the whole period. Specifically, 12% of 3Y T-notes, 7% 5Y, 36% 10Y and 45% 15Y are issued. T-bills are kept at the current level of CZK 109 bn.
- **C – Short Term Strategy**. Mostly T-notes with shorter maturities are issued and the ratio of issuance is constant for the whole period. Specifically, 55% of 3Y T-notes, 45% 5Y, 0% 10Y and 0% 15Y are issued. T-bills are kept at the current level of CZK 109 bn.
- **D – 100 % 3Y T-notes.** Only 3Y T-notes are issued. T-bills are kept at the current level of CZK 109 bn.
- **E – 100 % 5Y T-notes.** Only 5Y T-Notes are issued. T-bills are kept at the current level of CZK 109 bn.
- **F – 100 % 10Y T-notes.** Only 10Y T-Notes are issued. T-bills are kept at the current level of CZK 109 bn.
- **G – 100 % 15Y T-notes.** Only 15Y T-Notes are issued. T-bills are kept at the current level of CZK 109 bn.
- **H – 100 % 10Y T-notes without T-bills.** Only 10Y T-notes are issued. No T-bills are issued.
- **I – 100 % 3M T-bills.** Only 3M T-bills are issued. No T-notes are issued.

The impact of the issuance strategies on the relative structure of the state debt portfolio for the end of 2010 is shown in table 2, e.g. if strategy A is used, the state debt portfolio will be composed of 9.7% T-bills and 90.3% T-notes, of which 9.5 % is 3Y, 25.8% is 5Y, 42.2% is 10Y and 22.5% is 15Y.

Table 2: Alternative issuance strategies – structure of the marketable portfolio as of 31 December 2010 (%)

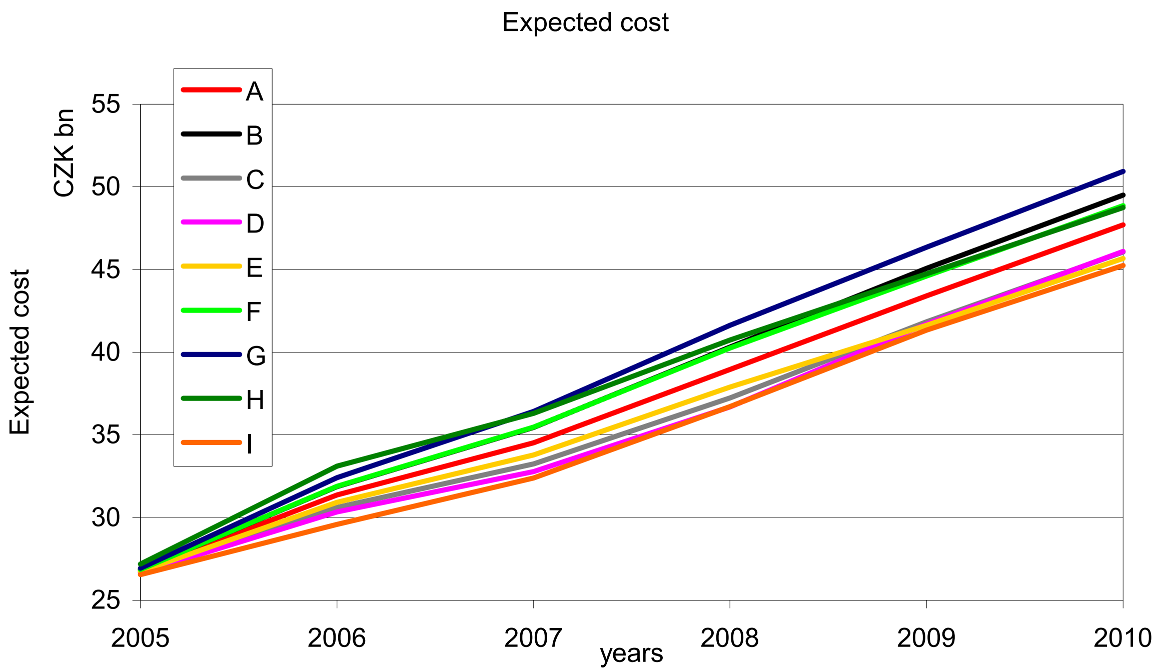
Issuance strategy	T-Bills	T-Notes	3Y T-Notes	5Y T-Notes	10Y T-Notes	15Y T-Bonds
A – basic	9,7	90,3	9,5	25,8	42,2	22,5
B – long term	9,5	90,5	4,6	4,6	45,4	45,4
C – short term	9,5	90,5	32,3	39,3	17,7	10,7
D - 100% 3Y	9,5	90,5	71,5	0,0	17,7	10,8
E - 100% 5Y	9,5	90,5	0,0	71,5	17,7	10,8
F - 100% 10Y	9,5	90,5	0,0	0,0	89,2	10,8
G - 100% 15Y	9,5	90,5	0,0	0,0	17,7	82,3
H - 100% 10Y no T-bills	0,00	100,0	0,0	0,0	90,3	9,7
I - 100% 3M	74,2	25,8	0,0	0,0	62,2	37,8
current portfolio	17,7	82,3	10,4	23,1	40,4	22,1

Note: There is 7Y T-note in the current portfolio. That's why the sum of the 3Y to 15Y T-note percentatges does not equal 100%.
Source: own calculations.

State's Expected interest cost on debt

The evolution of expected costs are shown in graph 2. If the issuance of T-bills and T-notes follows the basic strategy (A), the expected costs will increase from CZK 26.8 bn in 2005 to CZK 47.7 bn in 2010. The lowest expected costs are reached by issuing solely 3M T-bills (I). On the other hand, the highest expected costs are reached by issuing solely 15Y T-notes (G). The reason for this is that long yields are on average higher than short yields.

Graph 2

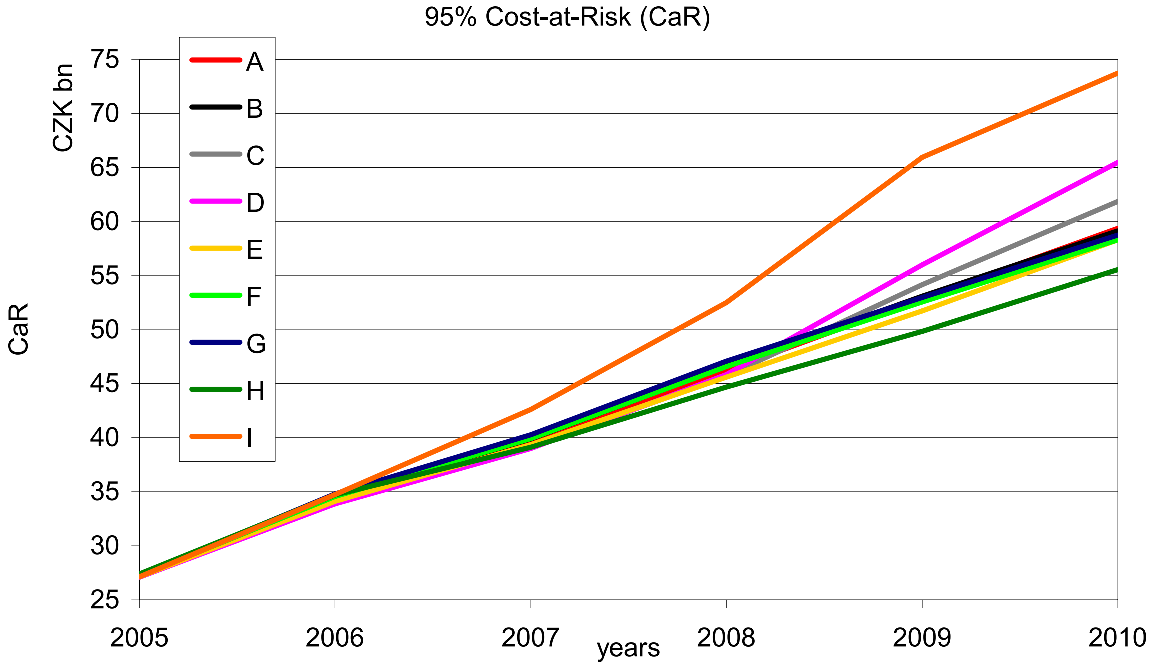


Source: own calculations.

CaR and relative CaR

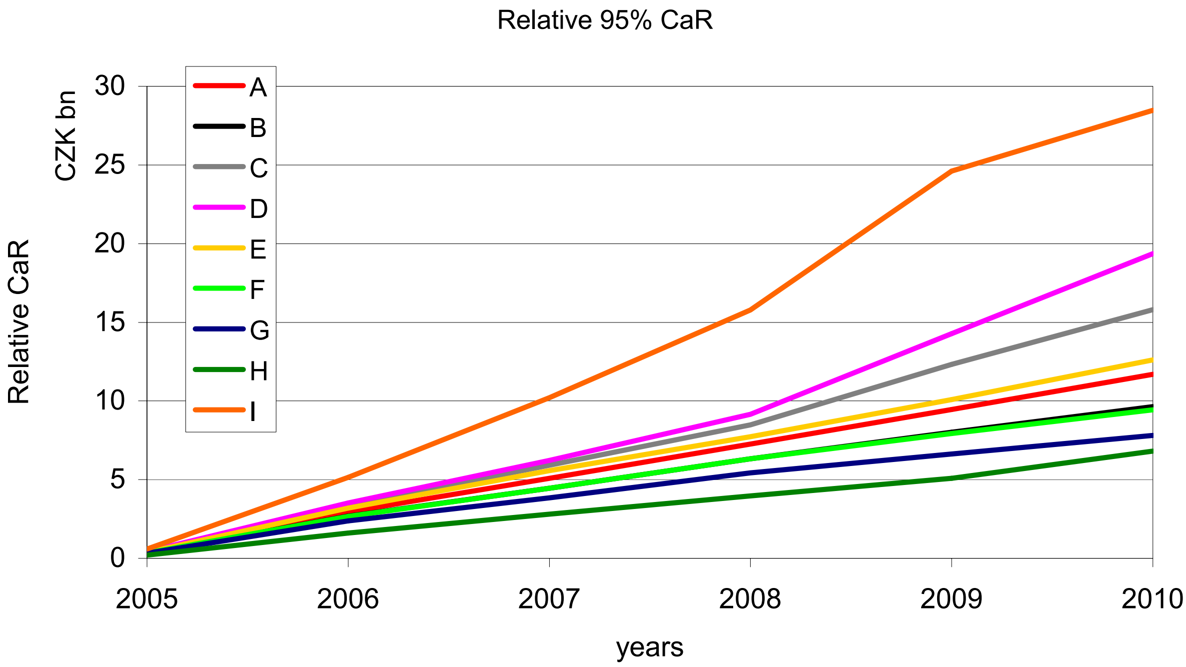
The risk of the issuance strategies is quantified by CaR and relative CaR. Evolution of CaR is shown in graph 3. The highest values of CaR are reached, if solely 3M T-bills are issued (I). It means that, in terms of interest costs, this issuance strategy is the most risky one. The least risky is issuing solely 10Y T-notes (H). The risk in the interest costs is partly due to the volatility of interest rates and partly due to the frequency of the state debt's portfolio refinancing. If solely 3M T-bills are issued, the refinancing frequency is highest among all the strategies. Generally, the volatility of interest rates is higher for the short end of the yield curve. The implication is the highest risk, if issuing solely 3M Tbills. In the long term (fifteen and more years) CaR would be smallest if issuing solely 15Y T-notes. For the basic strategy A CaR increases from CZK 27.2 bn in 2005 to CZK 59.4 bn in 2010. The last key figure we have computed is relative CaR, which is computed as the difference between CaR and expected costs. The evolution of relative CaR is shown in graph 3.

Graph 3



Source: own calculations.

Graph 4



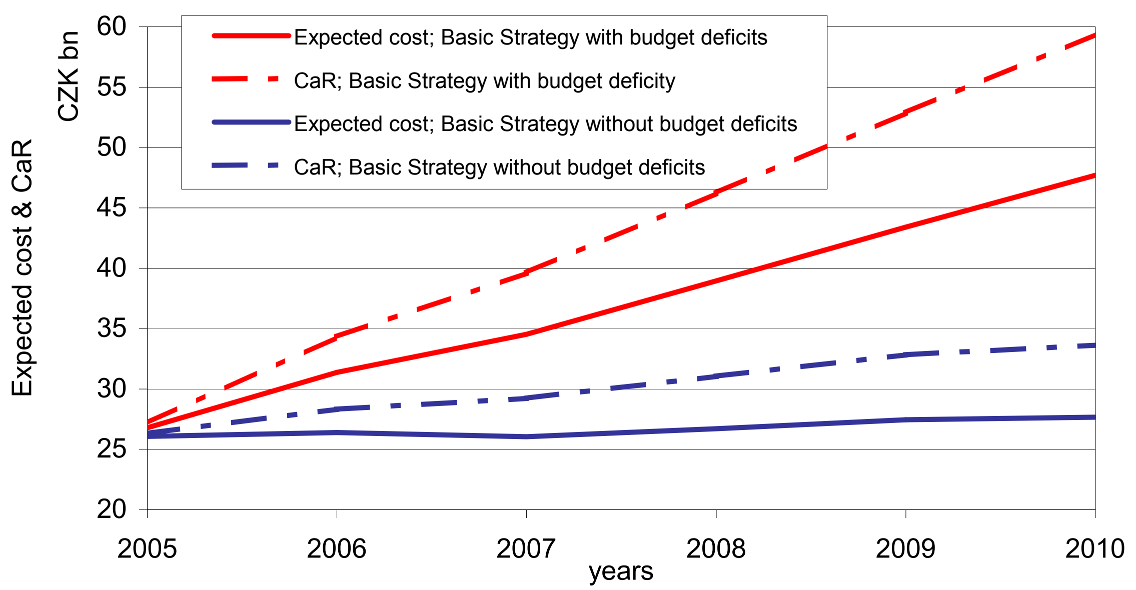
Source: own calculations.

Impact of budget deficits on the expected costs and CaR

The values of expected costs, CaR and relative CaR are derived from the budget defficts shown in table 1. In case there are budget deficits equal to zero the evolution of the expected costs and CaR is shown in graph 5. The redemptions of risky state guarantees are not taken into account and the state debt portfolio is kept at its current volume. The expected costs increase from CZK 26.1 bn in 2005 to CZK 27.7 bn in 2010. The reason for the expected cost rise is the rise in expected interest rates. It is important to realize that the rise in expected interest rates applies only for that part of the state debt portfolio, which is being refinanced in 2005 – 2010 (CZK 211.4 bn T-notes and CZK 109 bn T-bills). CaR increases form CZK 26.4 bn in 2005 to CZK 33.7 bn in 2010.

Graph 5

Impact of budget deficits on the expected costs and 95% CaR



Source: own calculations.

4 Conclusion

We have presented the future state debt quantitative modelling framework used by the Czech Ministry of Finance and resulting future expected cost and risk numbers. The expected interest cost, CaR and relative CaR are influenced by the chosen yield curve model, predictions of budget deficits and they don't take into account derivatives and buy backs used in managing the debt portfolio, nonmarketable instruments, risky state guarantees and potential currency risks. The model is crucial for consistent assessing the attractiveness of various issuance strategies and for estimating the probbality distribution of future interest costs of the state debt.