

# Optimal allocation of government debt for the Czech Republic: Managing vulnerability of debt service charges to macroeconomic shocks

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**Abstract:** Although debt sustainability issues are often analyzed in respect of the level of government debt, unexpected increases in debt services charges can substantially change the dynamics and accumulation of government debt. These unexpected increases could be a result of exposures to exchange rate, interest rate and refinancing risks that the government has assumed when allocating its debt across a spectrum of available financial (debt) instruments. Therefore public debt managers aim to minimize the vulnerability of public debt to macroeconomic shocks by carefully allocating debt through new issuance and buybacks across currencies, interest rates, maturities and markets, among others. In this paper, we build on the methodology proposed by Giavazzi and Missale (2004) to estimate the optimal debt allocation for the Czech Republic taking into account the structure of the Czech economy and the macroeconomic shocks that it is faced with. We develop policy recommendation to improve on the existing central government debt allocation and general government asset and liability management based on our estimations results.

**Keywords:** government debt allocation, risk management, macroeconomic shocks, Czech Republic.

**JEL Classification:** H63, E44

**AMS Classification:** 49K30

## 1. Introduction

The concept of fiscal sustainability is most often analyzed in the context of sustainable fiscal policies and the needed budgetary adjustments. However unsustainable fiscal stance can arise also as a result of risky government (public) debt allocations or misalignments of government assets and liabilities. Or alternatively, a better, more cost-efficient debt allocation can be implemented to support fiscal consolidation efforts of a government while taking on the same amount of risk.

IMF and World Bank (2001) include a comprehensive review of public debt management policies and approaches for policy makers, including formulation and properties of public debt management objectives, the underlying institutional framework and possible coordination issues, ensuing formulation of the debt management strategy, attributes of a sound risk management framework, and other important areas of public debt management. Melecký (2012a) presents an empirical analysis of possible drivers behind different formulations of public debt management strategies across a sample of countries. From a practical risk management perspective, Buera and Nicolini (2002) find that the size of financial transactions the government must undertake each period to replicate state contingent bonds is very large and increases dramatically with number of states. Further, Melecký (2012b) provides a review of policy approaches to choosing the currency structure of foreign-currency debt in view of the fact that historically the exchange rate risk is the most important risk for the debt managers in emerging market economies. Gerard and Gilson (2001) show in a simple two country model how an exchange rate regime can

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influence public debt structure. Melecky (2010) then develops empirical framework that debt managers could use when deciding on the currency allocation of public external debt building on a set of synchronization indicators of exchange rate volatility. Further, Concerning the Czech Republic, Matalik and Slavik (2005) describe historical development and the current state of public debt management in the Czech Republic. They conclude that public debt management should be included as part of the state treasury management. Overall there is a lack of empirical studies dealing with public debt management issues in the Czech Republic.

This paper uses the approached proposed by Giavazzi and Missale (2004) to estimate the optimal allocation of the Czech government's debt in the view of the government's fiscal consolidation plan and its probability of successful implementation. The considered instruments for allocation of the government debt are the domestic floating debt, domestic fixed rate debt, domestic inflation-indexed debt, and euro-denominated foreign debt. This government debt management problem has not been research much in the existing empirical literature concerning Central European economies, and the Czech Republic in particular. This paper thus attempts to fill in this gap.

We find that in view of the openness and structure of the Czech economy and the macroeconomic shocks it is facing, the Government should allocate most of its debt, about 57 percent, into domestic fixed rate bonds. The second biggest allocation, of about 40 percent, should be made towards foreign euro-denominated bonds. Further, about 3 percent of the debt should be optimally allocated into domestic floating rate notes, while zero allocation is suggested for inflation-indexed bonds. The comparison of our estimated optimal government debt allocation with the actual one followed by the Czech Ministry of Finance shows important differences. In sum, these differences may imply that the Ministry of Finance could, at the same level of volatility of debt service charges, lower its borrowing cost by making some changes in its debt allocation. Our preliminary results suggest that this would be best done, over a medium term, by increasing the allocations into foreign euro-denominated bonds while decreasing the allocation into domestic fixed-rate bonds.

The remainder of the paper is organized as follows. Section two discusses the adopted modeling approach. Section three describes the employed data series. Section four explains the calibration of key parameters for estimation of the optimal public debt allocation according to Giavazzi and Missale (2004). Section five discusses obtained results in the context of the actual government debt allocation applied by the Czech Ministry of Finance. Section six concludes.

## 2. The modeling approach

When analyzing the optimal allocation of government debt for the Czech Republic, we follow the approach of Giavazzi and Missale (2004). In view of the objective function for fiscal policy and debt management, including the size of expected fiscal consolidation  $E_t(A_{t+1} - \Delta B_{t+1}^T)$  and the probability of its failure  $\Pr$ , Giavazzi and Missale work out the optimal solution for the allocation of government debt across short-term floating-rate debt,  $s^*$ , foreign-currency denominated debt,  $q^*$ , inflation-indexed debt,  $h^*$ , and long-term fixed-rate debt,  $(1 - s^* - q^* - h^*)$ :

$$s^* = \frac{(\eta_y + B_t) \text{Cov}(y_{t+1} i_{t+1})}{B_t \text{Var}(i_{t+1})} + \frac{(\eta_x + B_t) \text{Cov}(\pi_{t+1} i_{t+1})}{B_t \text{Var}(i_{t+1})} - q^* \frac{\text{Cov}(e_{t+1} i_{t+1})}{\text{Var}(i_{t+1})} - h^* \frac{\text{Cov}(\pi_{t+1} i_{t+1})}{\text{Var}(i_{t+1})} + TP_t \frac{\sqrt{2\Pr}}{1 - \sqrt{2\Pr}} \frac{E_t(A_{t+1} - \Delta B_{t+1}^T)}{B_t \text{Var}(i_{t+1})} \quad (1)$$

$$q^* = \frac{(\eta_y + B_t) \text{Cov}(y_{t+1}, e_{t+1})}{B_t \text{Var}(e_{t+1})} + \frac{(\eta_\pi + B_t) \text{Cov}(\pi_{t+1}, e_{t+1})}{B_t \text{Var}(e_{t+1})} - s^* \frac{\text{Cov}(e_{t+1}, i_{t+1})}{\text{Var}(e_{t+1})} - h^* \frac{\text{Cov}(\pi_{t+1}, e_{t+1})}{\text{Var}(e_{t+1})} + FP_t \frac{\sqrt{2Pr}}{1 - \sqrt{2Pr}} \frac{E_t(A_{t+1} - \Delta B_{t+1}^T)}{B_t \text{Var}(e_{t+1})} \quad (2)$$

$$h^* = \frac{(\eta_y + B_t) \text{Cov}(y_{t+1}, \pi_{t+1})}{B_t \text{Var}(\pi_{t+1})} + \frac{(\eta_\pi + B_t) \text{Cov}(\pi_{t+1}, \pi_{t+1})}{B_t \text{Var}(\pi_{t+1})} - q^* \frac{\text{Cov}(e_{t+1}, \pi_{t+1})}{\text{Var}(\pi_{t+1})} - s^* \frac{\text{Cov}(\pi_{t+1}, i_{t+1})}{\text{Var}(\pi_{t+1})} + IP_t \frac{\sqrt{2Pr}}{1 - \sqrt{2Pr}} \frac{E_t(A_{t+1} - \Delta B_{t+1}^T)}{B_t \text{Var}(\pi_{t+1})} \quad (3)$$

where  $\eta_y$  and  $\eta_\pi$  are elasticity of government budget to GDP with respect to output and inflation, and  $B_t$  is government debt to GDP.  $\text{Cov}(\cdot)$  stands for covariance and  $\text{Var}(\cdot)$  for variance of corresponding variables.  $Pr$  denotes probability that the adopted stabilization plan fails, and  $E_t(A_{t+1} - \Delta B_{t+1}^T)$  is the planned reduction in debt-to-GDP ratio over period T.  $TP_t$ ,  $FP_t$ ,  $IP_t$  represents the term premium, the foreign exchange premium on Czech koruna vis-à-vis the euro, and the inflation premium respectively.

### 3. Data description

In order to estimate the optimal government debt allocation for the Czech Republic according to (1)-(3), we first focus on computing the unknown covariances and variances of real GDP, inflation, the interest rate and the nominal exchange rate. We use quarterly data series for the Czech Republic from the first quarter of 1996 to the fourth quarter of 2011. The data are obtained from the Czech National Bank (CNB), Eurostat, and the Czech Statistical Bureau (CSU). The computation of the individual data series is described in more detail in Table 1 including the data sources for the individual variable.

Variable	Notes	Source
Real GDP growth	Annualized percentage change in real GDP	ARAD – CNB
Inflation	Annualized percentage change in harmonized CPI (2005=100)	EUROSTAT
Interest rate	3Month PRIBOR	ARAD – CNB
Nominal exchange rate	Log of nominal exchange rate CZK/EUR	EUROSTAT
Government Budget	total government revenues-total government expenditures	CSU

**Table 1** Data description

Note: Data from 1996Q1 to 2011Q4.

### 4. Calibration of parameters

In the next step, we calibrate the remaining parameters of equations (1)-(3). The subject parameters, their description and numerical calibrations are presented in Table 2:

Parameter	Description	Value
$\eta_y$	Elasticity of gov. budget to GDP with respect to output	0.04
$\eta_\pi$	Elasticity of gov. budget to GDP with respect to inflation	-0.07
$B_t$	Government debt to GDP by end-2011	37.00
$TP_t$	Term premium	1.54
$FP_t$	Foreign Exchange Premium on CZK	-3.95
$IP_t$	Inflation premium	0.10
Pr	Probability that stabilization plan fails	2.00
$E_t(A_t - \Delta B_t^T)$	Planned reduction in debt-to-GDP ratio over T	1.00

**Table 2** Calibration of parameters in equations (1)-(3)

Source: Authors' calculations in percent

The semi-elasticities of the government budget to GDP ratio with respect to output and inflation were estimated as the respective correlations over 1996Q1-2011Q4. Note that the elasticity to inflation is negative which is somewhat puzzling and deserves further investigation which we leave for further research.<sup>3</sup> The government debt to GDP ratio,  $B_t$ , was set to 37 percent, the level at the end of 2011. The term premium was calculated as the average of the difference between the yield of 10-year government bond and the yield of 6-month money market rate (assumed to be equivalent to the 6-month Treasury bill rate). The foreign exchange premium on the Czech koruna vis-à-vis the euro is computed as the average of the difference between the percentage change in the CZK/EUR nominal exchange rate and the interest rate differential between the 3-month PRIBOR rate and 3-month EURIBOR rate. The PRIBOR rate was obtained from the CNB database and the EURIBOR from Eurostat.

The inflation premium is calculated as the average of the difference between actual CPI inflation at time  $t$  and the expected CPI inflation conditional on an information set dated  $t-1$ . The AR(1) process was used to generate expected inflation for simplicity. This is because data on inflation expectations are not readily available or inflation linked bonds traded. We leave more sophisticated treatment of expected inflation for further research. Note that another simple approximation of inflation expectations could be achieved by using the CNB inflation target at a given time, assuming perfect credibility of CNB's monetary policy and its inflation target. Alternatively, fast learning of the economic agents would need to be in place to ensure this approximation holds during a monetary policy-driven disinflationary period, as experienced by the Czech Republic.

The probability that a given stabilization (fiscal consolidation) plan may fail was set at 2 percent following Giavazzi and Missale (2004). In further research, we will consider more thoroughly the track record of the Czech government in adhering to its announced stabilization plans, most notably those involving significant consolidation.

The consolidation plan itself involving a planned reduction in debt-to-GDP ratio,  $E_t(A_t - \Delta B_t^T)$ , was set following Giavazzi and Missale to 1 percent annual reduction in government debt to GDP. Note that the Czech Republic is currently envisaging continuing, though declining, fiscal deficits and debt accumulation with the balance budget planned to be reached in 2015.

<sup>3</sup> This finding is robust to using annualized q-to-q inflation, y-to-y inflation or detrended inflation. The negative correlation of budget balance to GDP with inflation prevails.

## 5. Discussion of results

Employing the calibration discussed above and using the *fsolve* Matlab function to solve the equations (1)-(3) of three unknowns, we arrive at the estimation results that are presented in Table 3:

Considered Allocation	Estimated Optimal	Actual, December 2011
$s^*$	3%	10%
$q^*$	40%	18%
$h^*$	0%	0%
$(1 - s^* - q^* - h^*)$	57%	72%

**Table 3** Debt allocation of government debt for the Czech Republic

Source: Authors' calculations; MoF development of the government debt.

Our estimates suggest that in view of the historical macroeconomic developments, the structure of the Czech economy and the macroeconomic shocks it is facing, the Government should allocate most of its debt, about 57 percent, into domestic fixed rate bonds. This is to support its objective of fiscal consolidation and achievement of targeted outcomes while bearing in mind possible failures in exact implementation of the planned consolidation. The second biggest allocation, of about 40 percent, should be made towards foreign euro-denominated bonds. About 3 percent of the debt should be allocated into domestic floating rate notes, while zero allocation should be made towards inflation-indexed bonds.

The last column of Table 3 shows the actual allocation of Czech government's debt (in securities) across the considered categories by end-2011. It is interesting to observe that much more weight, 72 percent, is given to the allocation into domestic fixed-rate bonds which suggest more conservative (risk-averse) debt management preferences and possible additional objective of domestic debt market development (IMF and WB, 2001). Similarly, less weight is given by the Ministry of Finance to allocation into foreign currency bonds, about 18 percent, in comparison to the 40 percent allocation into euro-denominated bonds suggested by our estimates.

Although the presented research should be further developed and the robustness of the acquired results properly assessed, the comparison of our estimated optimal government debt allocation and the actual one followed by the Czech Ministry of Finance shows important differences. In sum, these differences could imply that the Ministry of Finance could achieve better outcomes in terms of possibly lower cost at the same level of risk by making some changes in its debt allocation. Our very preliminary results suggest that this would be best done, over a medium term, by increasing the allocations into the euro-denominated bonds on account of a decreased allocation into domestic fixed-rate bonds.

## 6. Conclusion

This paper acknowledges that unexpected increases in debt services charges due to risky allocation of government debt can substantially change the dynamics and accumulation of government debt. The risky allocation can derive from an excessive exposure of the government to exchange rate, interest rate and refinancing risks. This paper thus

aimed to exploit the approach of Giavazzi and Missale (2004) in order to provide some insight and guidance to public debt managers in the Czech Republic to minimize the vulnerability of government debt to macroeconomic shocks while achieving adequate efficiency in terms of borrowing costs. Based on our preliminary estimates, we found that the Czech government should allocate most of its debt, about 57 percent, into domestic fixed rate bonds -- as it currently does but to a much larger extent. Further, it should allocate about 40 percent of its debt into foreign euro-denominated bonds and about 3 percent of its debt into domestic floating rate notes. Zero allocation is suggested for inflation-indexed bonds. Our preliminary results imply that the Ministry of Finance could lower its borrowing cost, at the best possible cost-risk trade-off, by increasing its debt allocations into euro-denominated bonds while decreasing its debt allocation into domestic fixed-rate bonds, over the medium term.

## Acknowledgements

Financial support from the Czech Science Foundation GA402/10/1046 is gratefully acknowledged.

## References

- [1] Buera, F. and Nicolini, J. P.: Optimal Maturity of Government Debt without State Contingent Bonds. Universidad Torcuato Di Tella, Department of Economics Working Papers 016, 2002.
- [2] Gerard, M. and Gilson, N.: Public debt structure and exchange rate regime. Dipartimento di Economia Politica dell'Università di Milano Bicoc Working Paper, 2001.
- [3] Giavazzi, F. and Missale, A.: Public Debt Management in Brazil. National Bureau of Economic Research, Inc., Cambridge, NBER Working Paper No.10394, 2004.
- [4] IMF and the World Bank: Guidelines for Public Debt Management. Washington D.C., 2001.
- [5] Matalik, I. and Slavik, M.: Debt Management in the Czech Republic (formation in the 1990s and the current state). *Prague Economic Papers* 1 (2005), 33-50.
- [6] Melecky, M.: Formulation of Public Debt Management Strategies: An Empirical Study of Possible Drivers. *Economic Systems* 36 (2012), 218-234.
- [7] Melecky, M.: Choosing The Currency Structure Of Foreign-Currency Debt: A Review Of Policy Approaches. *Journal of International Development* 24 (2012), 133-151.
- [8] Melecky, M.: Currency Allocation of Public External Debt and Synchronization Indicators of Exchange Rate Volatility. *Comparative Economic Studies* 52 (2010), 104-129.