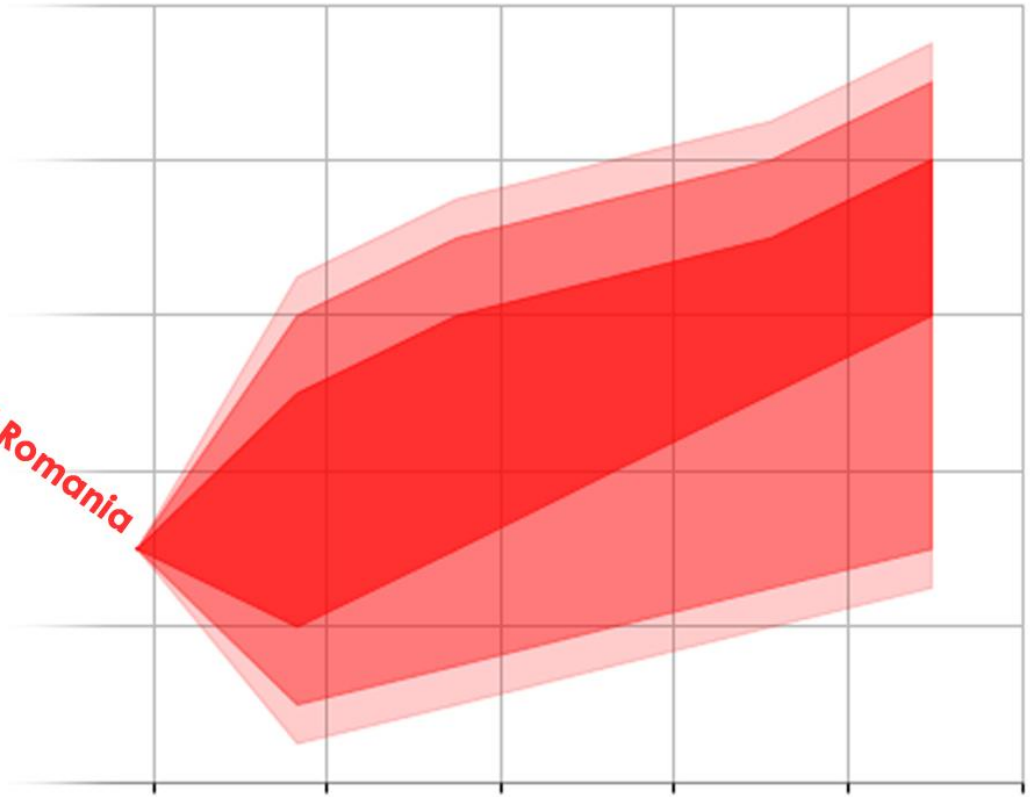
Academy of Economic Studies
Doctoral School of Finance and Banking (DOFIN)

Public Debt Sustainability: A Probabilistic Approach – The Case of Romania



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Dissertation Paper Outline

1. Motivation and Objectives
2. Problem overview
3. Literature review
4. Methodology and Data input
5. Empirical results
6. Limitations and Further research
7. Conclusions
8. References

Motivation and Objectives

- The economic and financial international crisis which errupted in 2008 had a **very important impact** on the public debt in some advanced economies in the European Union.

- **High correlation** between the public debt and the possibility of default ⇨ public debt evolution became crucial for many economies.

- **Key question**: What does sustainable/unsustainable public debt level mean?

- **Objective**: Unconventional debt sustainability analysis for the case of Romania

- No such study has been performed for the Romanian economy so far

Problem overview

- Debt sustainability has a **significant economic importance** but it cannot be simply defined neither can be measured directly ⇨ analogy with other economic concepts like price stability and full employment

- The determinants of public debt dynamics are typically more volatile in **emerging market economies** than in industrialised countries ⇨ the volatility makes more difficult to predict the future with confidence ⇨ assessing debt sustainability on a single future path of these variables is too simplistic.

- **DSA approaches** → three forward looking approaches based on analysis time horizon (short, medium and long term)

  Medium term:

  - Conventional approach (IMF, ECB, European Commission)
  - Stochastic approach

Literature review

- In the past ⇨ **Hamilton and Flavin (1986)** ⇨ focus on budget intertemporal relation and No Ponzi game condition
- This approach has been criticized by **Bohn (1998)** who proposed a sustainability test ⇨ whether the primary deficit to GDP ratio is a positive linear function of the debt to GDP ratio
- **Roubini (2001)** ⇨ "As long as the debt ratio to GDP is stabilized over the medium term, it is considered as sustainable regardless of its level; i.e. a debt to GDP ratio of 150% is as sustainable as a debt to GDP ratio of 50%."
- **Ghosh et al. (2011)** affirm that the sustainability indicator introduced by Bohn is too weak ⇨ new framework for assessing debt sustainability in the advanced economies by determing a „debt limit" beyond which fiscal solvency is in doubt.
- **IMF** conventional framework on "sustainability assessment" (first release in 2002) versus unconventional debt sustainability analysis (**Celasun et al, 2006**)

Methodology and Data input

- Celasun et al (2006) ⇨ Stochastic debt sustainability analysis ⇨ puts more emphasis on **risk**
- Main differences between conventional approach and stochastic approach:

Conventional (deterministic) approach	**Stochastic approach**
• Diagnostic based on a **few isolated shocks**	Diagnostic based on a **large number of random shocks** drawn from a estimated joint distribution
• **Exogenous** fiscal policy	**Endogenous** fiscal policy
• Output of the method: large temporary shocks provide a probabilistic **upper bound** to the debt ratio while small permanent shocks delineate interval of most outcomes.	• Output of the method: frequency distributions of the debt ratio over time ⇨ **fan charts**
• Principal advantage: low data requirement	• Principal advantage: better reflection of country specificity and explicitly probabilistic output.

Methodology and Data input

The stochastic framework consists of three blocks:

1. **Panel fiscal reaction function**: characterizes the fiscal behaviour

2. **Unrestricted VAR model**: used to calibrate the joint distribution of shocks

3. **Simulated public debt-to-GDP ratio**: combines simulated economic scenarios (using the estimated VAR model) and estimated fiscal policy (based on the estimated fiscal reaction function) to produce annual debt paths

Methodology and Data input

- Law of motion for the evolution of public debt ⇨ The **foundation of the analysis**

$$PD_t = (1 + i_t)PD_{t-1} - PB_t + S_t \qquad (1)$$

- We assumed that $S_t = 0$ and we divided (1) by nominal GDP ⇨

$$pd_t = \frac{(1 + r_t)}{(1 + g_t)} pd_{t-1} - pb_t \qquad (2)$$

- To account for the **considerable share of public debt denominated in foreign currency** for a governement issuing debt in foreign currency ⇨

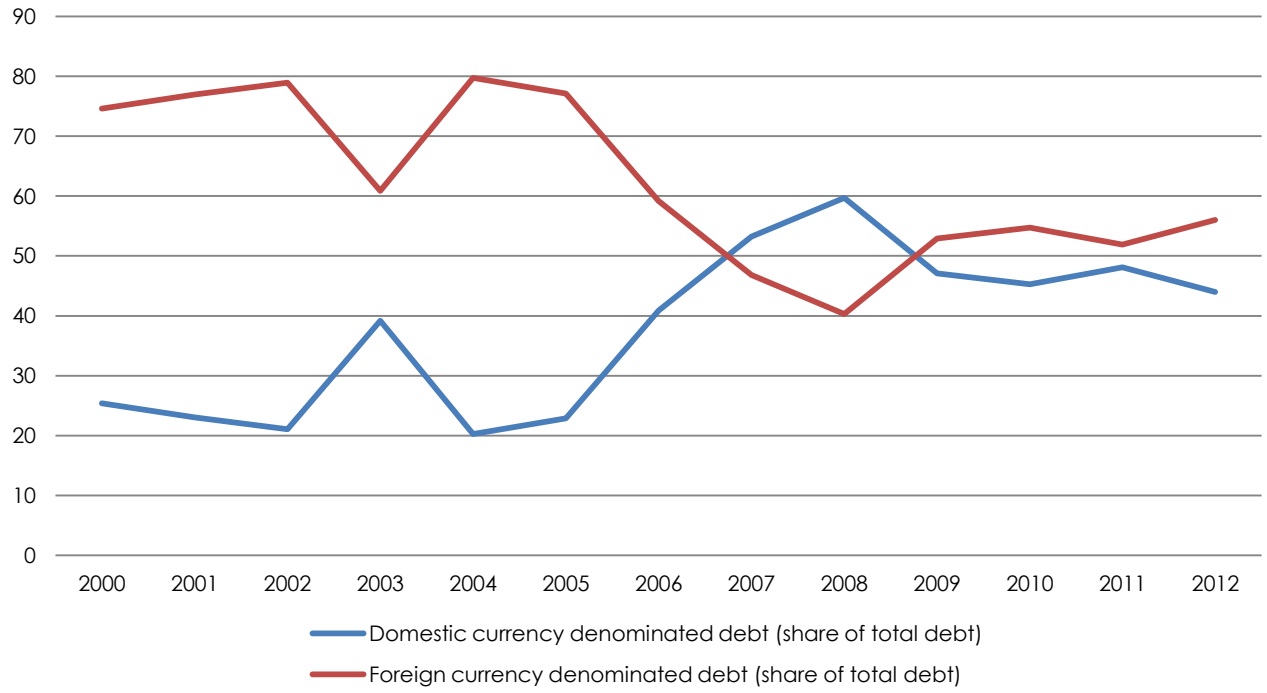
$$pd_t = \frac{[(1 + r_t^f)(1 + \Delta z_t)pd_{t-1}^f + (1 + r_t^d)pd_{t-1}^d]}{(1 + g_t)} - pb_t \qquad (3)$$

Methodology and Data input

- In case of equation (3) ⇨ the effective interest on government debt will be a weighted average of domestic and foreign rates and exchange-rate movements

$$\hat{r}_t = pd^d_{t-1} r^d_t + pd^f_{t-1} r^f_t \quad \Rightarrow \quad r_t = \hat{r}_t + \Delta z_t \, pd^f_{t-1} (1 + r^f_t)$$

- Structure of the public debt in Romania ⇨ **considerable share of foreign denominated debt**



Source: Compiled by the author based on data from the Annual Reports of the Financial Affairs Minister

Methodology and Data input

- **Fiscal reaction function** ⇨ response of the primary budget balance-to-GDP ratio to a set of macroeconomic and institutional variables ⇨ a positive response of the primary balance to lagged debt can be expected if buoyant debt dynamics are corrected

- Scarcity of relevant budgetary data ⇨ **panel data methods**

- **Annual data** ⇨ Period: 2000 - 2012

- **10 emergent states** from the European Union included in the panel ⇨ Bulgaria, the Czech Republic, Estonia, Latvia, Lithuania, Poland, Romania, Slovakia, Slovenia and Hungary

- **Independent variable** ⇨ Primary balance-to-GDP ratio (net lending/borrowing excluding interest)

- **Exogenous variables** (besides the public debt-to-GDP ratio) ⇨ lagged primary balance, output gap, inflation rate, foreign business shocks and other institutional variables.

Methodology and Data input

- Fiscal reaction function ⇨

$$pb_{i,t} = \alpha_0 + \delta\, pb_{i,t-1} + \rho\, pd_{i,t-1} + \sum_{k=0}^{1} \gamma_k\, og_{i,t-k} + X_{i,t}\beta + \eta_i + \varepsilon_{i,t}$$

- Methods of estimation ⇨
  - Pooled regression
  - Fixed effects ⇨ to account for heterogeneity

- Most exogenous regressors typically used in the literature were not found to be significant. Also, the use of exogenous variables as regressors would present the disadvantage of requiring making **assumptions on their out of sample trajectories** in order to be able to simulate debt paths until 2017.

- The estimated fiscal reaction function:

pb = -2.6252 + 0.47307*pb(-1) + 0.0569*pd(-1) + 0.3105*pot_gdp_gap - 0.2587*pot_gdp_gap(-1) + [CX=F]

- Fixed effect for Romania: 0.143881

Methodology and Data input

- The joint distribution of the macroeconomic shocks is estimated from the **statistical properties of the historical data**

- Unrestricted VAR model having as endogenous variables the real GDP growth, the domestic real interest rate, the foreign real interest rate and the real effective exchange rate; the variables are found to be stationary

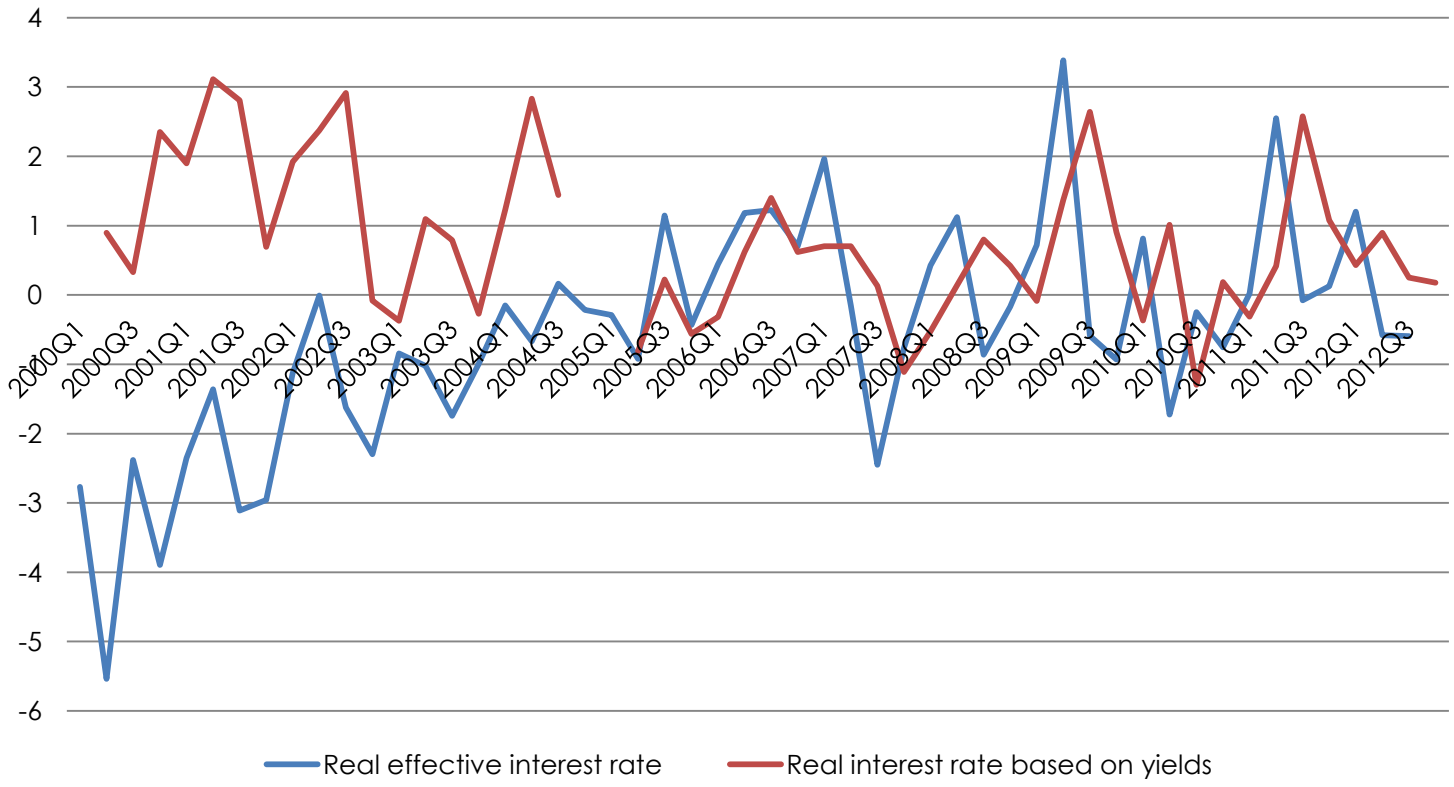
- Quarterly data ⇨ Period: 2000 – 2012 ⇨ for annual debt simulations the variables will be annualized

- Problem related to **domestic real interest rate series** ⇨ 2 alternative series ⇨

- **Real effective interest rates** obtained by dividing the value of interest payable at the value of the consolidated debt, deflated by CPI
- A series which combinines **the yields for Treasury Certificates** (2000Q1 – 2004Q3) and **long-term maturity bonds (10Y)** (2005Q2 – 2012Q4). To obtain the real values we deflated the nominal values by CPI.

Methodology and Data input

- Alternative proxies for domestic real interest rate, % per quarter (2000Q1 – 2012Q4)



Source: Compiled by the author based on data from NBR and EUROSTAT

Methodology and Data input

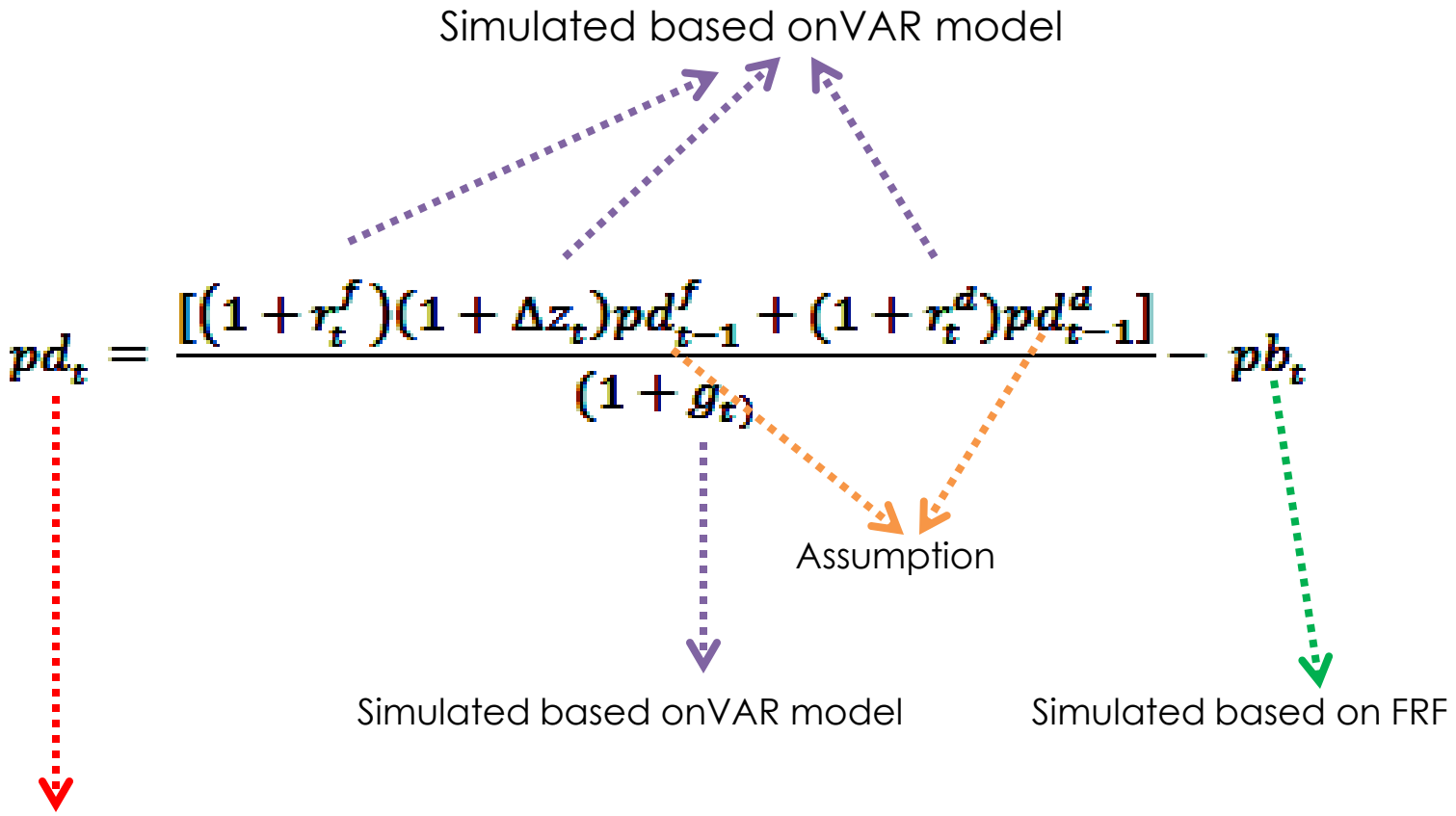
- Two VAR models were estimated due to the two different series representing the real domestic interest rate.
- Choice of the lag order ⇨ information criterions and number of observations in the sample ⇨ model with **one lag**
- The models were found to be **stable**
- **Steady state values (% per year)**

	VAR1 (using effective interest rate)	VAR2 (using interest rate based on yields)
gdp_growth_ro	3.0588059	3.5135029
real_ir_eff_ro	-1.4178892	-
real_ir_y_ro	-	3.3862052
real_ir_ger	1.8626339	1.9231182
reer	0.5820444	-0.3143646

Source: Author's calculations using R programme

Methodology and Data input

Projected public debt paths



Methodology and Data input

- Primary balance-to-GDP projections ⇨ using the variance of the country specific residuals from the estimated fiscal reaction function and a standard normal distributed vector we simulate a set of 1000 shocks ⇨

$$\varphi_{i,t+\tau} = \sigma^2_{(\eta_i + \varepsilon_{i,t})} v_{t+\tau} \qquad v \sim N(0,1) \;\; and \;\; \varphi_{i,t+\tau} \sim N(0, \sigma^2_{(\eta_i + \varepsilon_{i,t})})$$

- These shocks will enter in the estimated fiscal reaction function to generate forecasts of the primary balance ⇨

$$\widehat{pb_{i,t+\tau}} = \Lambda_{i,t+\tau} + \hat{\delta}\, pb_{i,t+\tau-1} + \hat{\rho}\, pd_{i,t+\tau-1} + \sum_{k=0}^{1} \widehat{\gamma_k}\, og_{i,t+\tau-k} + \varphi_{i,t+\tau}, \qquad \tau = \overline{1,5}$$

- The primary balance forecasts depend on **future realizations of the output gap** output gap at moment *t+τ* which enters in the forecast of the primary balance at moment *t+τ* ⇨ equals the growth differential between predicted GDP growth and the steady-state growth produced by the VAR model

Methodology and Data input

- We obtained the **1000 stochastic shocks** by multiplying a standard normal distributed vector with the Choleski factorization of the variance-covariance matrix of the residuals from the VAR model ⇨

$$\xi_{t+T} = W v_{t+T}$$
$$v_{t+T} \sim N(0,I)$$
$$\Omega = W'W$$

- The VAR generates forecast of *Y* consistent with the simulated shocks. As shocks occur each period, the VAR produces **joint dynamic responses** of all elements in *Y*.

- **Assumption** regarding the **weights of public debt denominated in national currency and foreign currency** ⇨ they remain constant across the forecasting period, at the 2012 level (44% of the total debt is denominated in domestic currency and the remaining 56% is denominated in foreign currencies).

Empirical results

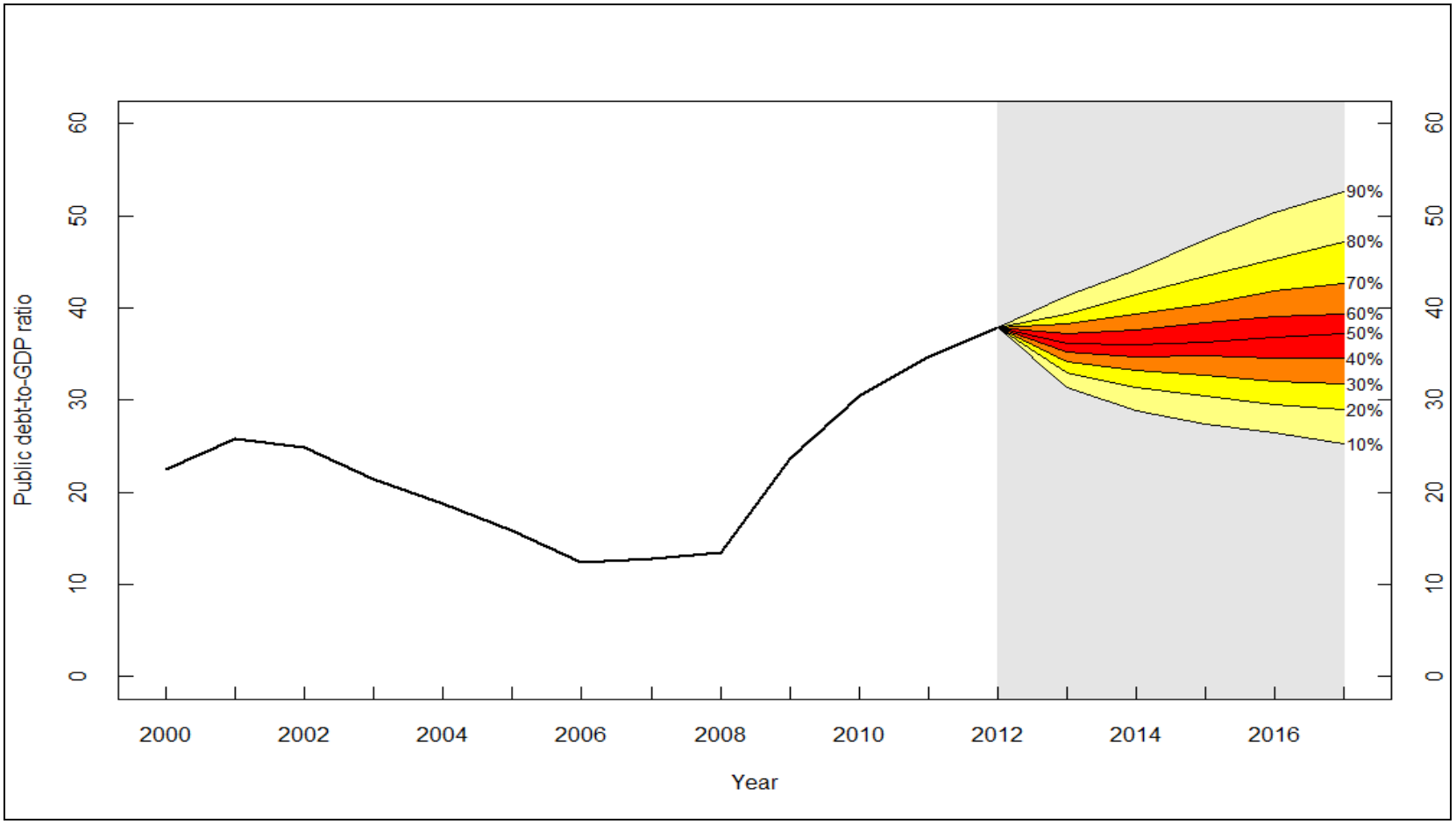
- The **fan charts** summarize the frequency distribution of the projected debt paths and serve to illustrate the overall range of risks to the debt dynamics.

- The **median projection** connects the median values of the frequency distributions for each year in the forecasting period (in a given year , 50% of the debt projections lie below and 50% above this reference value).

- **Stepwise shaded areas** capture the different deciles of the frequency distribution. The darkest shaded area reflects debt paths located in the 5^{th} and 6^{th} deciles of the distribution (representing a 20% confidence interval around the median projection). The overall colored cone reflects the 2nd to 9th deciles of the distribution and depicts a confidence interval of 80% around the median projection.

Empirical results

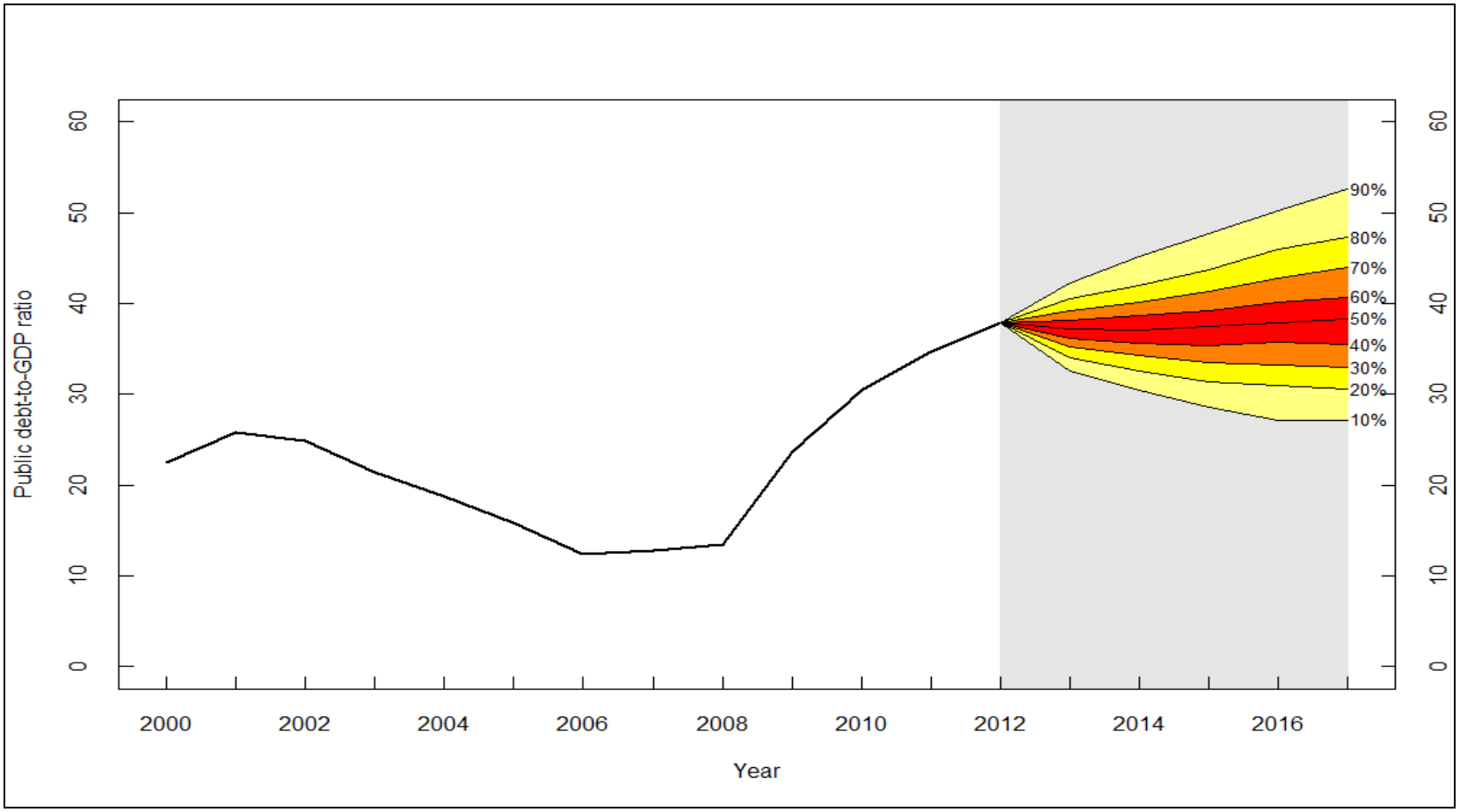
- Fan chart for public debt-to-GDP ratio in Romania based on VAR1



Source: Compiled by the author using R programme

Empirical results

- Fan chart for public debt-to-GDP ratio in Romania based on VAR1



Source: Compiled by the author using R programme

Empirical results

- When we draw our attention to the **median projections** ⇨ slightly increasing median debt path in the second graph whereas the first one shows a constant trend (at 2012 level).

- These median projections do not indicate that public debt gets out of control until the end of the forecasting horizon and can thus be qualified to be sustainable over the period from 2013 to 2017.

- When we also take into the consideration the **risks around the median projections** ⇨ The fiscal reaction function is apparently not responsive enough (with regard to public debt) to prevent increasing debt paths from covering a considerable share of the overall frequency distribution.

- Debt-to-GDP empirical distributions are **asymmetric and positively skewed** (having more data in the right tail than would be expected in a normal distribution; the median is greater than the mode of the distribution).

Empirical results

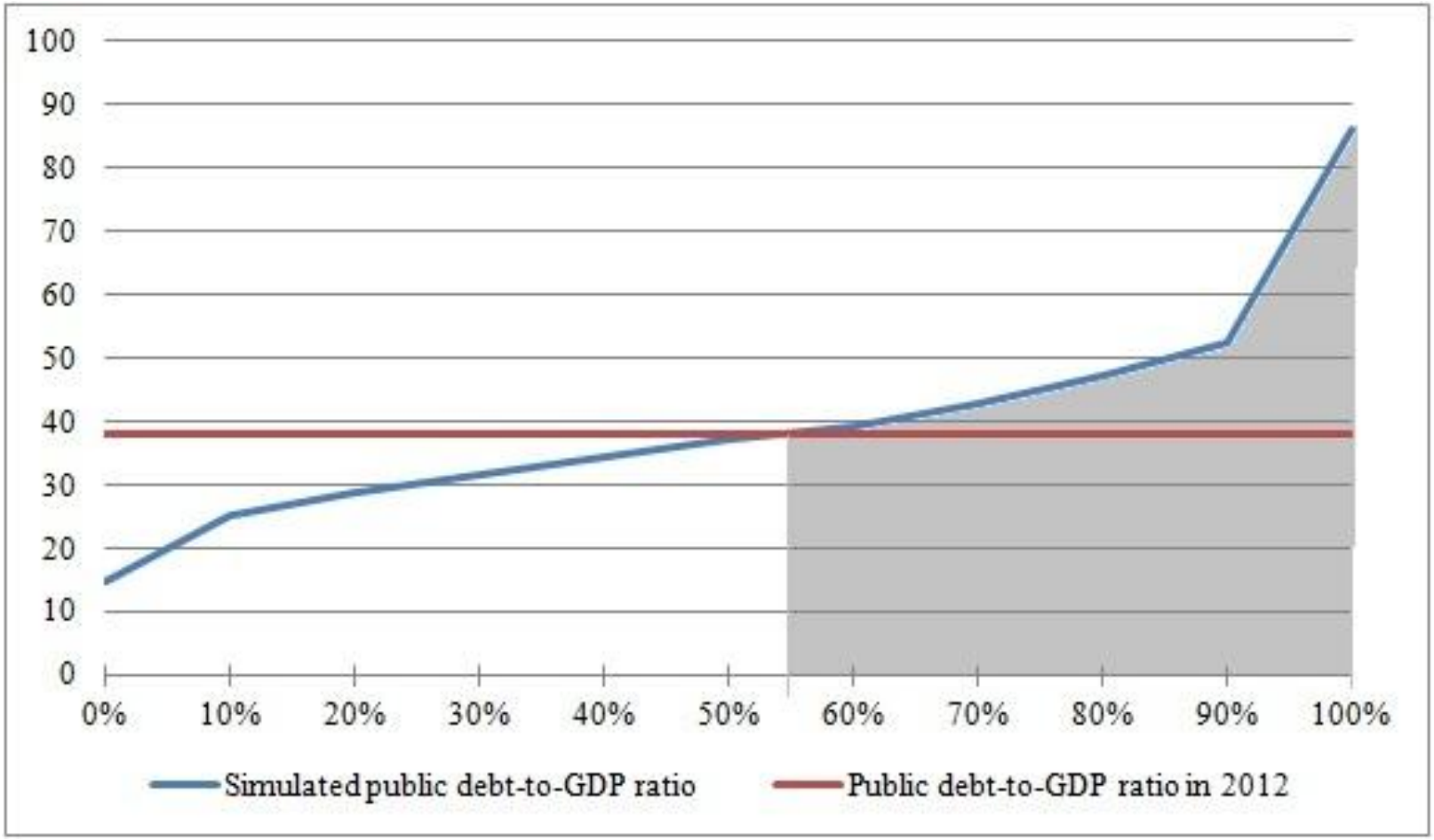
- So far: our debt sustainability analysis produced probability distributions of debt at different horizons, rather than a deterministic path for debt probabilistic ⇨ probabilistic interpretation of debt sustainability

- The prospect of a **downward trend** in the debt ratio in a deterministic setup corresponds to the probability that the debt ratio falls below its initial value in the stochastic setting.

- The simulated empirical distributions allow measuring the probability of particular events occurring

Empirical results

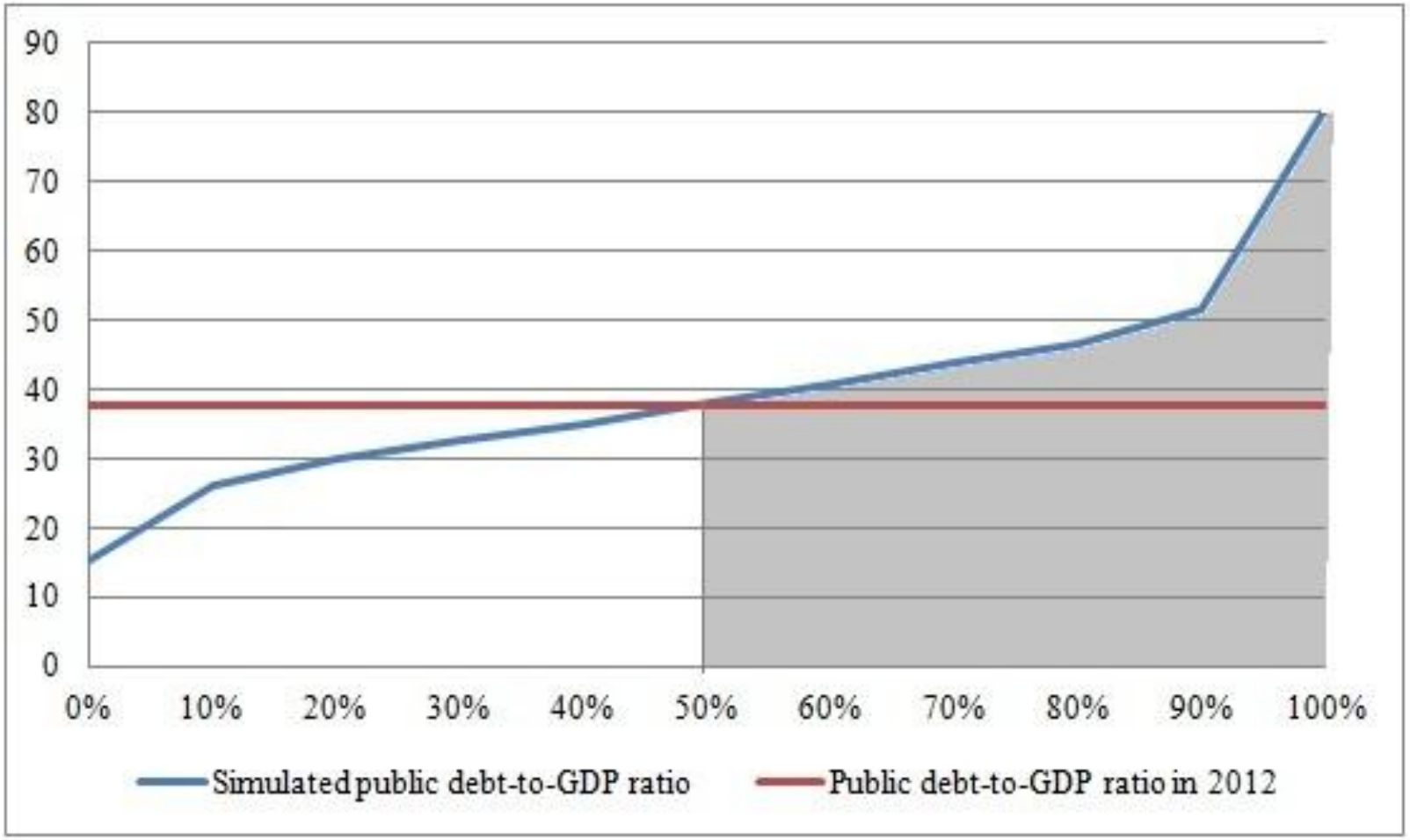
Probability of exceeding in 2017 the public debt value from 2012 (using VAR1)



Source: Author's compilation

Empirical results

Probability of exceeding in 2017 the public debt value from 2012 (using VAR1)



Source: Author's compilation

Empirical results

- When using VAR1 to simulate the public debt path, **the probability of exceeding the 2012 public debt-to-GDP ratio** is almost 45% and when VAR2 is used the probability increases with 5 percentage points.

- **To account for the overall risk profile**, we can calculate an indicator that combines the probability that debt declines over time with the risk that debt not rise beyond some specific amount over the same horizon. This indicator can take the following form:

$$I_S = P(d_{t+\tau} < d_t) \cdot [1 - P(d_{t+\tau} > (d_t + x))]$$

- Because the sustainability indicator is the product of these two probabilities, once these probabilities are set, a critical threshold is established. It is up to the policymaker to set a **critical threshold** depending on the degree of risk aversion and of the perceived need for a reduction in debt.

Limitations and Further research

- The stochastic debt sustainability analysis does not completely solve the problem with **limited data availability** (especially in the case of the emerging economies)

- Macroeconomic and fiscal shocks are drawn from a **joint normal distribution** ⇨ in reality shocks can be asymmetric or it can present fat tails ⇨ a possible solution might be to use a more realistic distribution (for example, Student's t distribution has fatter tails)

- The **parameters of the FRF and the VAR** model were estimated using historical data (2000 – 2012) and they were assumed to remain valid during the forecasting period (2013 – 2017)

- Future study direction ⇨ implementing the model in a much more realistic framework

Conclusions

- From the **fiscal reaction function** we concluded that budgetary policy reacts to lagged debt and the contemporaneous and lagged output gap

- Simulations for the public debt were made based on **two VAR models**: one using the real effective interest rate and another one using domestic real interest eate based on Treasury Certificates and long-term bond yields

- **The median projections** showed a slightly increasing median debt path. These median projections do not indicate that public debt gets out of control until the end of the forecasting horizon and can thus be qualified to be sustainable over the period from 2013 to 2017

- **The probabilistic sustainability indicator** indicated a high probability for a sustainable debt in the medium term

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Thank you for your attention!