Is the Maastricht debt limit safe enough for Slovakia?

Fiscal Limits and Default Risk Premia for Slovakia

Moderné nástroje pre finančnú analýzu a modelovanie

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Aims

1. **Fiscal Limit:** the point at which, for economic or political reasons, taxes and spending can no longer adjust to stabilize debt.
   - The maximum level of debt that the government is able to service
   - Fiscal limit distribution is endogenous and arises from the **dynamic Laffer curve**

Is the Maastricht debt limit safe enough for Slovakia?

Inspiration: Models of **Bi (2011)** and **Bi and Leeper (2010, 2013)** augmented by Slovak economy particularities & expected challenges

2. Fiscal Limit distribution depends on economic and political environment
   - Function of the current state, expected fiscal policy & its credibility, long-term projections the distribution of exogenous disturbances $\Rightarrow$ **State-dependent & Stochastic**
   - Distribution (not a point) $\Rightarrow$ **Default is possible at any point on this distribution**

Effects of bad policies in bad times

3. **Default risk premia** are determined by the fiscal limit distribution, current state of the economy, distribution of disturbances and **investors' expectations about future**

The snowball effect

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Key Results

Maastricht debt limit (60%) is definitely not safe enough for Slovakia

- Economy in its equilibrium: 10% chance of default and 4 p.p risk premium (NB: no QE)
- Sudden fall of productivity by 8% of GDP: 30%-40% chance of default depending on preferred fiscal policy and 12-13 p.p. risk premium (snowball effect)
- **Fiscal policy matters** : Proper & credible decisions about transfers $\Longrightarrow$ Fall in chance of default and the risk premium

Safe Debt Limit : 50% of the GDP

. . . with the **debt target (equilibrium)** at **40%** of the GDP

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The Model I

Approach : small **nonlinear DSGE / RBC model** of a closed economy without monetary policy used to determine the fiscal limit distribution from the endogenous dynamic Laffer curve

1. Firms: homogeneous goods consumed by households (c_t) and government (g_t)

$$\text{linear production function:} \qquad a_t h_t = y_t = c_t + g_t \,, \tag{1}$$

$$\text{technology:} \qquad a_t = \rho_a a_{t-1} + (1-\rho_a)a + \mathscr{E}_t^a \,. \tag{2}$$

Business cycle distribution $\mathscr{E}_t^a$: substantially **heavy-tailed and non-symmetric**

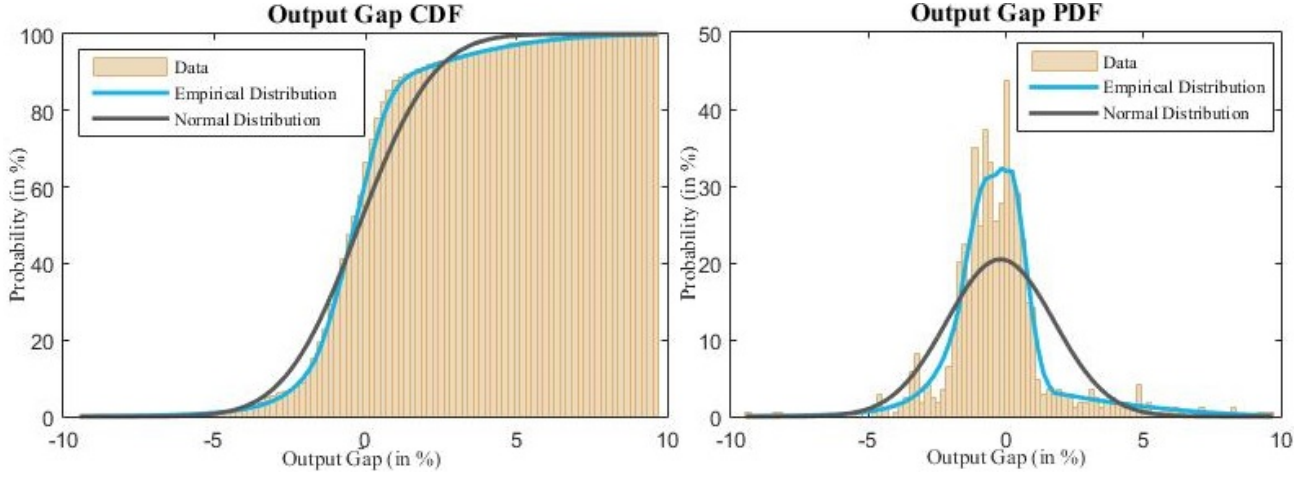

Figure 1 : Business cycle distribution in Slovakia, comparison with normal distribution

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The Model II

2. Government: government purchase g_t and transfers z_t financed by collecting distorting taxes and issuing non-state-contingent debts b_t (price q_t)

A) Government Purchase g_t : all non ageing-related primary expenditures, *stationary & procyclical*

$$g_t = \rho_g g_{t-1} + (1-\rho_g)g + \mathscr{E}_t^g, \quad \mathscr{E}_t^g \sim \mathcal{N}(0,\sigma_g^2), \zeta_g > 0 \qquad (3)$$

B) Transfers z_t: all ageing-related expenditures, *always explosive & countercyclical*, 2 regimes (NPC, risky)

$$z_t(r_t,a_t) = \begin{cases} \mu_t^{(1)} z_{t-1} + \zeta_z (a_t - a) + \mathscr{E}_t^z, & r_t = 1, \\ \mu_t^{(2)} z_{t-1} + \zeta_z (a_t - a) + \mathscr{E}_t^z, & r_t = 2, \end{cases} \qquad (4)$$

where both $\bar{\mu}^{(i)} > 1$, $\zeta_z < 0$ and $\mathscr{E}_t^z \sim \mathcal{N}(0,\sigma_z^2)$

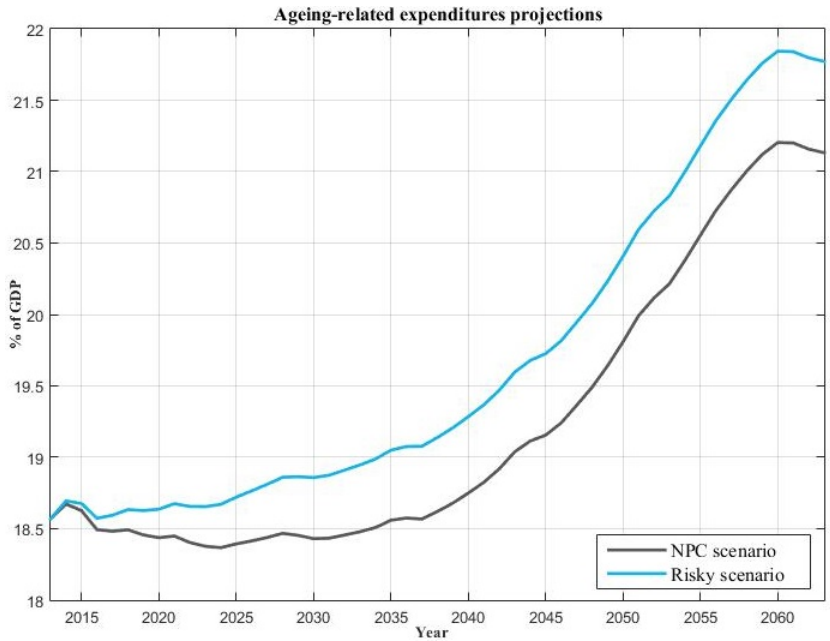

Figure 2 : Projections of ageing-related expenditures to 2060

C) Tax Rate τ_t levied on labour income: government raises the time-varying tax rate levied on labour when the debt level goes up

$$\tau_t = \tau + \gamma(b_t^d - b), \qquad \gamma > 0. \qquad (5)$$

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The Model III

D) Bond contract is not enforceable, partial default is possible & depends on the *effective fiscal limit* $\mathbf{b_t^*} \sim \mathscr{B}(\mathbf{a_t}, \mathbf{g_t}, \mathbf{r_t})$

post-default government liability $$b_t^d = (1-\Delta_t) b_{t-1}\,, \qquad \Delta_t = \delta_t \mathbf{1}_{b_{t-1} \geq b_t^*}\,, \qquad \delta_t \sim \Omega. \tag{6}$$

E) Budget Constraint $$\tau_t a_t h_t + q_t b_t = b_t^d + z_t + g_t \tag{7}$$

3. Households: choose the level of consumption c_t, labour supply and bonds b_t to maximise

$$\max \mathbb{E}_t \sum_{k=0}^{\infty} \beta^k U(c_{t+k}, h_{t+k})\,, \qquad U(c_t, h_t) = \log c_t + \phi \log(1-h_t)\,,$$

w.r.t. their budget constraint (τ_t, z_t, Δ_t are given)

$$\text{FOC:} \quad \phi \frac{c_t}{1-h_t} = -\frac{\partial U/\partial h_t}{\partial U/\partial c_t} = a_t(1-\tau_t)\,, \quad q_t = \beta \mathbb{E}_t \left[(1-\Delta_{t+1}) \frac{c_t}{c_{t+1}} \right]. \tag{8}$$

$$\text{Transversality condition:} \quad \lim_{j \to \infty} \mathbb{E}_t \left\{ \beta^{j+1} \frac{\partial U/\partial c_{t+j+1}}{\partial U/\partial c_t} \left(1-\Delta_{t+j+1}\right) b_{t+j} \right\} = 0 \tag{9}$$

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Fiscal Limit Concept

Two Pillars:

1. Iterate the government budget constraint (7) for the primary surplus $\omega_t = \tau_t a_t h_t - z_t - g_t$ assuming no default in the future:

$$b_{t-1} = \frac{\omega_t + q_t b_t}{1-\Delta_t} = \frac{\omega_t}{1-\Delta_t} + \frac{q_t}{1-\Delta_t}\mathbb{E}_t \frac{\omega_{t+1} + q_{t+1} b_{t+1}}{1-\Delta_{t+1}} = \ldots = \mathbb{E}_t \sum_{k=0}^{T} \left[\prod_{j=1}^{k} \frac{q_{t+j-1}}{1-\Delta_{t+j-1}} \right] \frac{\omega_{t+k}}{1-\Delta_t} + \mathbb{E}_t \prod_{j=0}^{T} \frac{q_{t+j}}{1-\Delta_{t+j}} b_{t+T}$$

   maximal b_{t-1} requires maximal current & expected future primary surpluses ⇒max. tax revenues

2. **Laffer curve:** (1) a (8) ⇒Bijection between (a_t, g_t) and the rate maximising tax revenues

$$\begin{aligned} \Theta_t^{\max}(a_t, g_t) &= (1+2\phi)\, a_t - \phi g_t - 2\sqrt{(1+\phi)\,\phi a_t\,(a_t - g_t)}, \\ \tau_t^{\max}(a_t, g_t) &= 1 + \phi - \sqrt{(1+\phi)\,\phi\,(a_t - g_t)/a_t} \end{aligned}$$

Fiscal Limit: sum of the expected discounted maximum fiscal surplus in all future periods conditional on the existing state

$$\mathscr{B}_t^* = \mathbb{E}_t \sum_{k=0}^{\infty} \beta^k \frac{u^{\max}(a_{t+k}, g_{t+k})}{u^{\max}(a_t, g_t)} \left[\Theta^{\max}(a_{t+k}, g_{t+k}) - g_{t+k}(a_{t+k}, \mathscr{E}^g_{t+k}) - z(r_{t+k}, a_{t+k}, \mathscr{E}^z_{t+k}) \right] \tag{10}$$

⇒state space determined by $\{a_{t+j}\}_{j=1}^{\infty}$, $\{g_{t+j-1}\}_{j=1}^{\infty}$, $\{r_{t+j}\}_{j=1}^{\infty}$, $\{z_{t+j-1}\}_{j=}^{\infty}$ & importance of shock processes

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Model Calibration & Solution

Procedure: MCMC method used to simulate the fiscal limit distribution conditional on current state and exogenous shock distributions

- discretise the state-space $\mathscr{S}_t = (a_t, g_t, r_t, z_t)$
- MCMC : at each point $s_t \in \mathscr{S}_t$ generate the draws of shocks $\{\mathscr{E}^a_{t+j}\}^{(i)}_{1\leq j\leq T}$, $\{\mathscr{E}^g_{t+j}\}^{(i)}_{1\leq j\leq T}$, $\{\mathscr{E}^z_{t+j}\}^{(i)}_{1\leq j\leq T}$ and $\{\mathscr{E}^r_{t+j}\}^{(i)}_{1\leq j\leq T}$ for 200 periods ($i = 1, \dots 10^6$) and calculate $\mathscr{B}^{(i)}_t(s_t)$ assuming that the tax rate is always at the peak of the dynamic Laffer curves
- aggregate & smooth the simulated results

Parameters:

- Equilibrium: calibration is based on long-term predictions and expert judgement
  - **transfers** (age-related expenses) $z = 18.6\%$GDP, $\bar{\mu}_1 = 1.0026$, $\bar{\mu}_2 = 1.0032$, **government purchase** (other expenses) $g = 16.4\%$ GDP
  - **debt** $b = 40\%$ GDP, $\beta = 0.95$, **tax rate** $\tau = 39.14\%$, labour supply $h = 1/4$, productivity $a = 1$
- Dynamics: Bayesian estimates of model parameters

Scenario	$\bar{\mu}_1$	$\bar{\mu}_2$	ζ_g	ζ_z	$p^{(1)}/p^{(2)}$	ρ_a	ρ_g	σ_g	σ_z
no policy change	1.0026	1.0032	0	0	1 / 0	0.7205	0.9229	0.0233	0.0277
– procyclical g.purchase	1.0026	1.0032	0.0219	0	1 / 0	0.7205	0.9229	0.0233	0.0277
– countercyclical transfers	1.0026	1.0032	0	-0.0159	1 / 0	0.7205	0.9229	0.0233	0.0277
risky scenario	1.0026	1.0032	0	0	0 / 1	0.7205	0.9229	0.0233	0.0277
– two regimes of transfers	1.0026	1.0032	0	0	0.75 / 0.75	0.7205	0.9229	0.0233	0.0277
– all features switched on	1.0026	1.0032	0.0219	-0.0159	0.75 / 0.75	0.7205	0.9229	0.0233	0.0277

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Fiscal Limit: Quantitative Analysis I

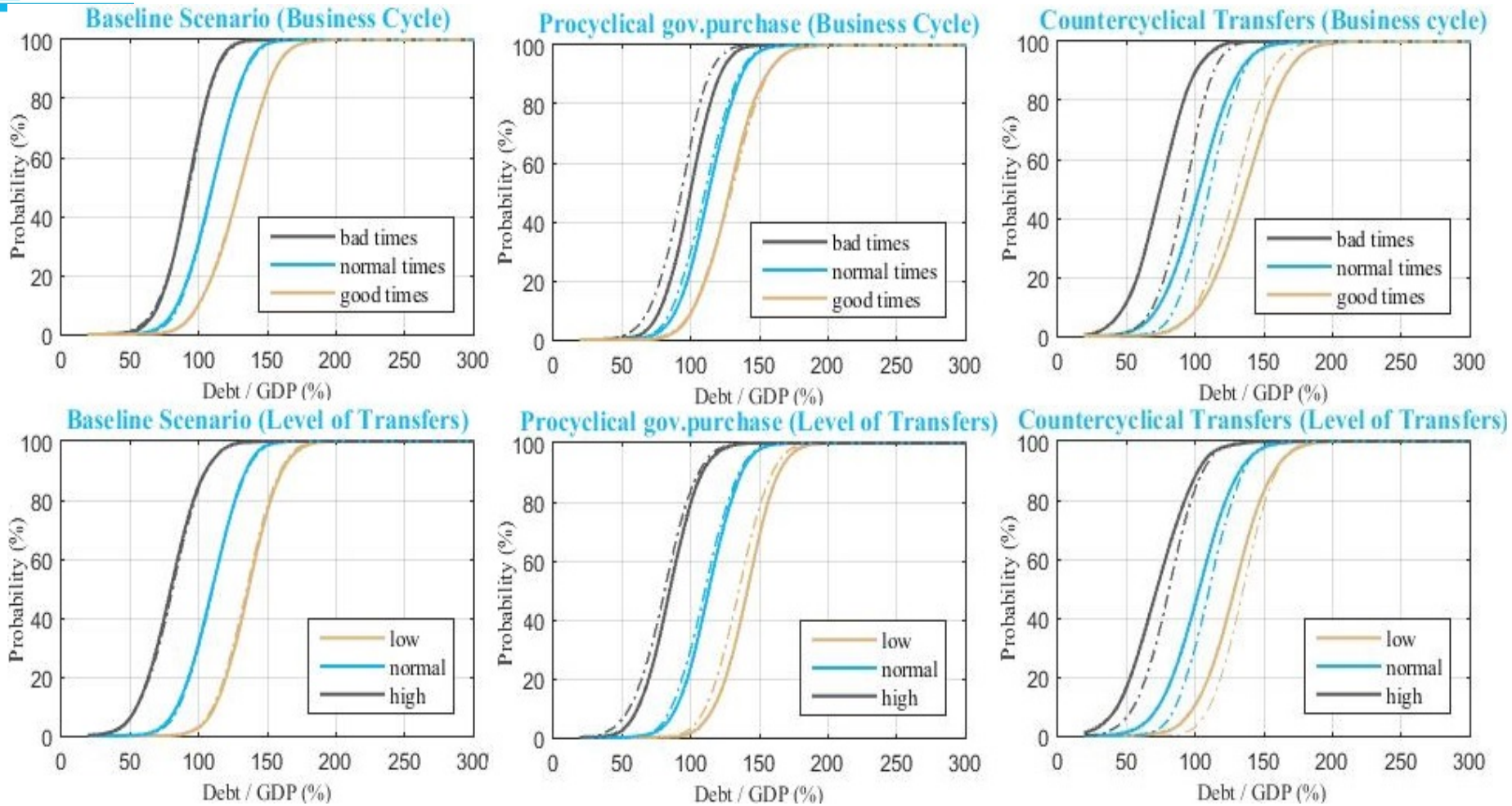

Figure 3 : CDF of the fiscal limit distribution for for various levels of technology and transfers: the NPC scenario under baseline setting with heavy-tailed business cycle (left), with procyclical government purchase (middle) or countercyclical transfers (right). Dashed lines correspond to the NPC regime with baseline setting.

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Fiscal Limit: Quantitative Analysis II

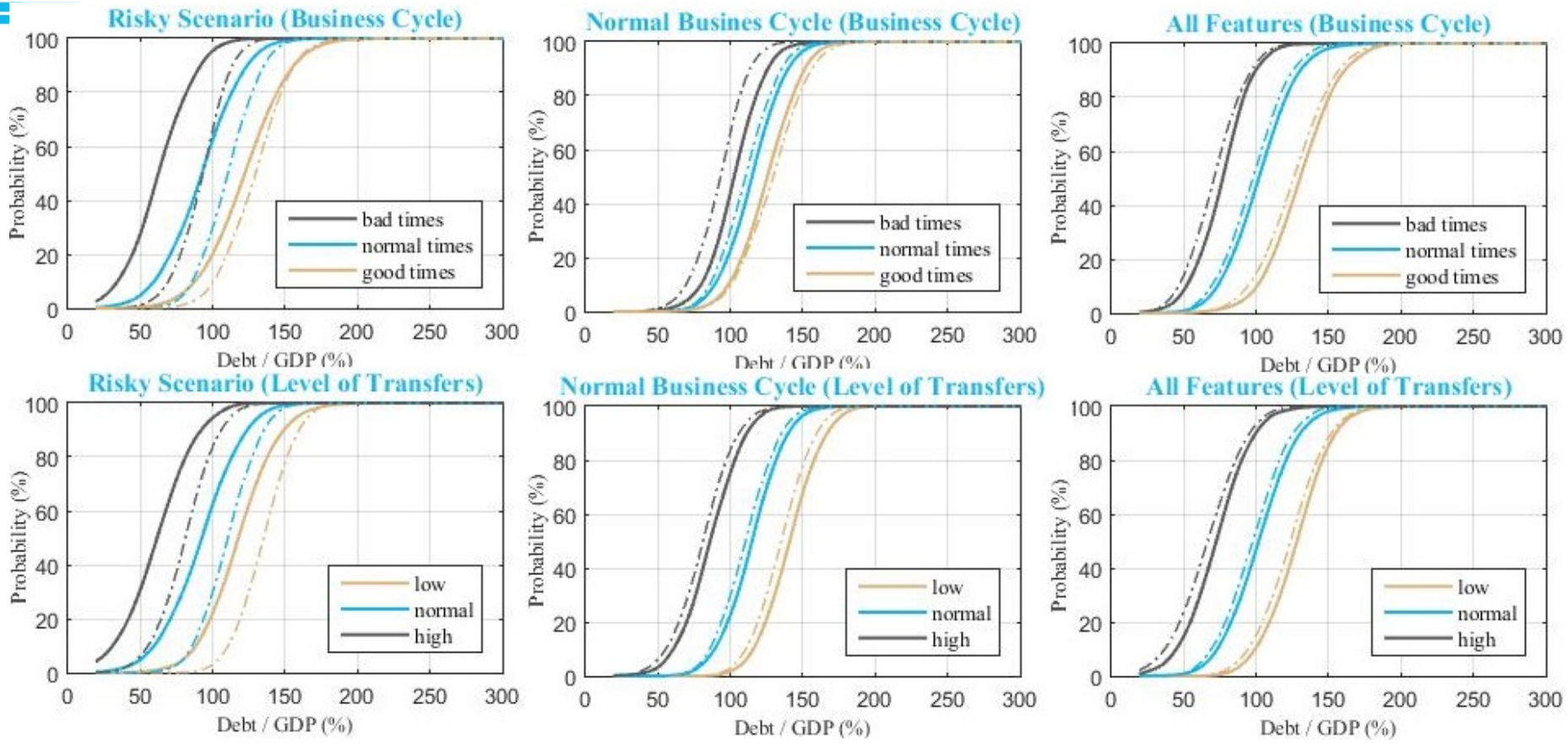

Figure 4 : Impact of model parameters on the fiscal limit distribution for various levels of technology and transfers: higher growth rate of transfers (left) or normally distributed business cycle (middle). Dashed lines correspond to the NPC regime with baseline setting with heavy-tailed empirically distributed business cycle. Right plots compare the distribution of the fiscal limit for the regime-switching, always explosive & countercyclical transfer, pro-cyclical government purchase under heavy-tailed left-skewed empirically distributed business cycle for transfers currently growing accordingly to either the NPC (thick lines) or risky (dashed) scenarios.

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Nonlinear Model

Aim: Assuming (5), (6), and (8), find the debt rule b_t, that solves

$$\frac{(1-\Delta_t)b_{t-1}+g_t+z_t-\tau_t a_t h_t}{b_t}=\beta \mathbf{E}_t\left\{[1-\Delta_{t+1}]\frac{c_t}{c_{t+1}}\right\}, \quad (11)$$

Determine the debt price q_t and the default risk premium r_t based on the debt rule b_t

$$r_t = 1/q_t - 1/q_t^{\Delta_t=0}. \quad (12)$$

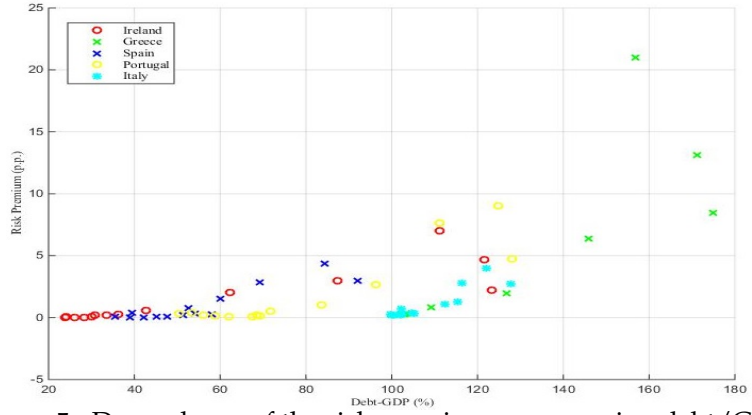

Figure 5 : Dependence of the risk premium on sovereign debt/GDP ratios for PIIGS countries (2004-2013)

Solution: monotone mapping method (Coleman, Davig), numerical solution (Sims)

Calibration: reuse values of parameters from the fiscal limit distribution model

- tax sensitivity $\gamma = 0.0724$ (OLS, effective tax rate incl. social insurance contributions)
- empirical distribution of the default rate Ω : defaults of emerging countries (1983-2011)

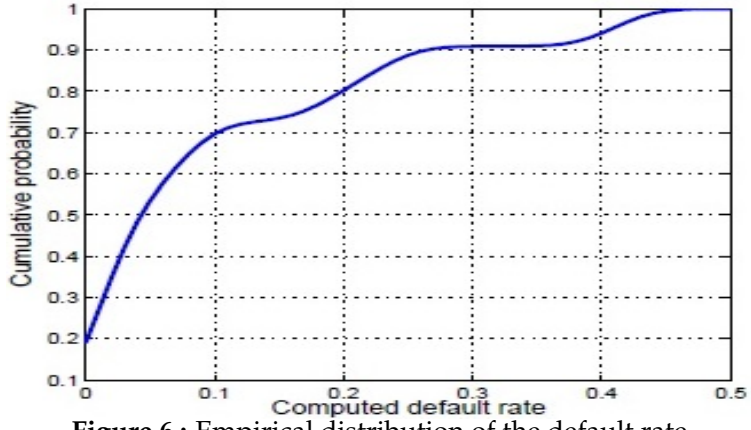

Figure 6 : Empirical distribution of the default rate

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Default Risk Premium Scenarios

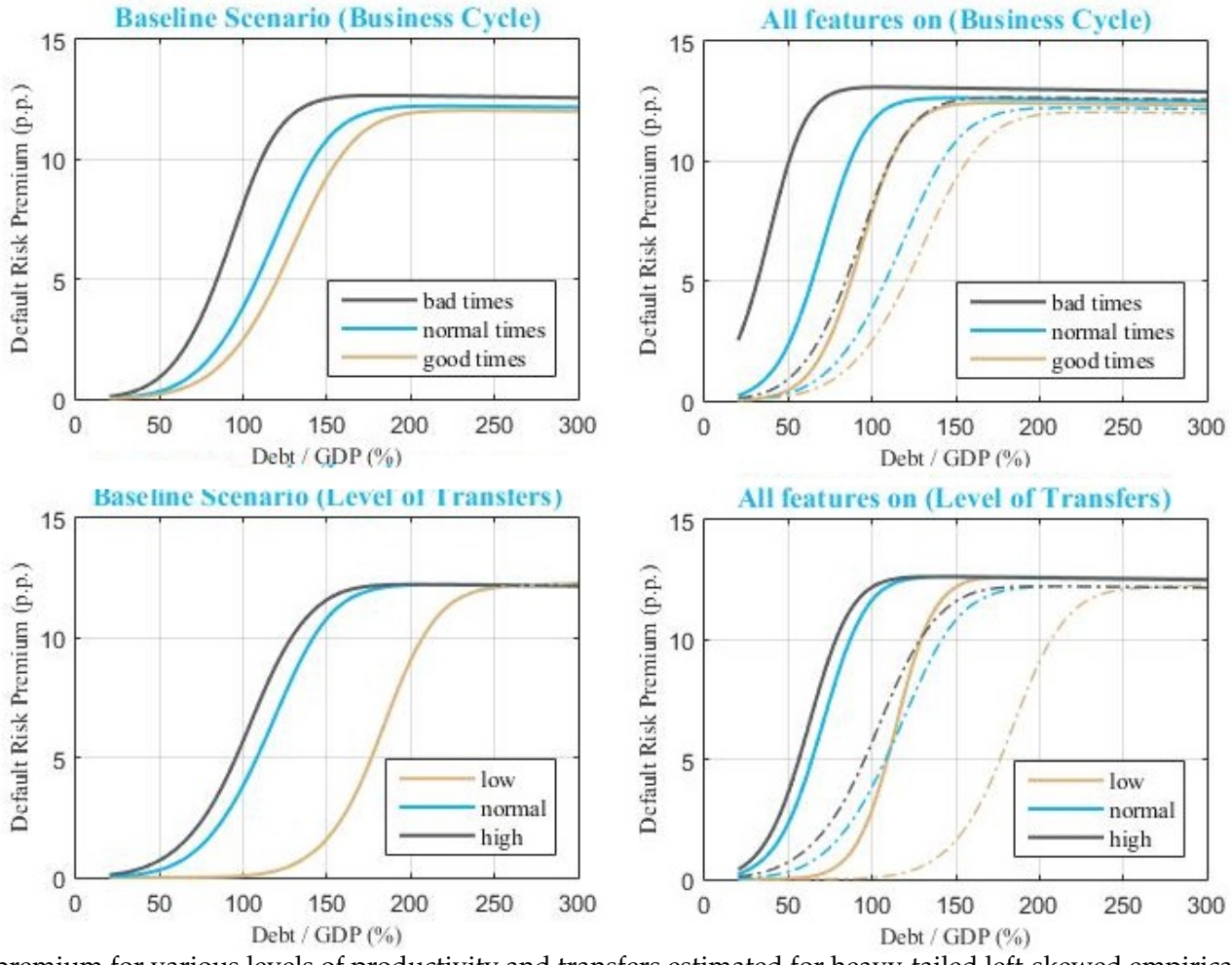

Figure 7 : Default risk premium for various levels of productivity and transfers estimated for heavy-tailed left-skewed empirically distributed business cycle. Left figures are obtained assuming the NPC regime with baseline setting. Right figures assume the regime-switching, always explosive & countercyclical transfers and pro-cyclical government purchase, and transfers grow accordingly to either the NPC (thick lines) or risky (dashed) scenarios.

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Conclusions

Determinants of the fiscal limit distribution and the public finance long-term sustainability

1. **Steeply growing age-related transfers** = time bomb for public finance
   - Current level and expected future policies (and their credibility) matter
   - Transfers in the role of automatic stabilizers need to be designed carefully
2. **High vulnerability of Slovak economy towards external factors**
   - Extreme situations are not rare, business cycle is very volatile fiscal limit

$\Longrightarrow$ Be aware of ***bad policies in bad times***

Maastricht debt limit (60%) is definitely not safe enough for Slovakia

- Economy in its equilibrium: 10% chance of default and 4 p.p risk premium (NB: no QE)
- Sudden fall of productivity by 8% of GDP: 30%-40% chance of default depending on preferred fiscal policy and 12-13 p.p. risk premium (snowball effect)
- **Fiscal policy matters** : Proper & credible decisions about transfers $\Longrightarrow$ Fall in chance of default and the risk premium

Safe Debt Limit : 50% of the GDP

. . . with the **debt target (equilibrium)** at **40%** of the GDP

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Model Extentions

Attempts that would get us nowhere

- One tax is not enough⇒introduce **consumption tax**
- Use a different **utility function** (vary Frisch elasticity, consumption-leisure non-separability)

Put in the pigeon hole

- Slovakia as an **open export-oriented economy**:
  - Incorporate the foreign demand, export and import of goods
  - Modify the production function (combine labour and import)
  - This should eliminate the non-desirable small elasticity of tax revenues w.r.t. output gap.
- **State-dependent transition matrix** (used in the MCMC algorithm)
  - Matrix components reflect the evolution of tax rate and transfers and thus introduce a deeper structure in the policy credibility.
  - This results in higher chance of default for low debt and more disperse distribution on its left tail.

Implemented . . . and evokes great white hope

- Use the default-free rate ($q^{\Delta=0}$) instead of the constant risk-free rate β in the formula for determining the fiscal limit distribution.
- **Fiscal limit distribution & discount bond price determined together**: iterative procedure, feedback effect of default risk premium on fiscal limit distribution.

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Literature Overview

1. Model

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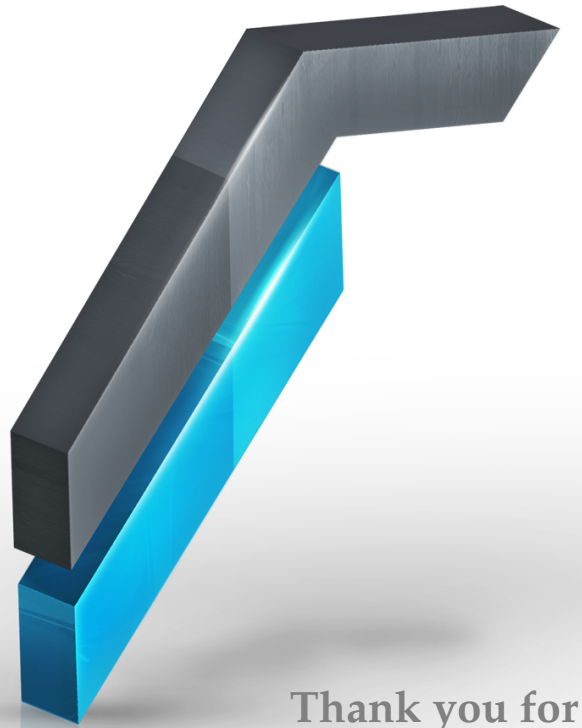

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