Global macro-financial shocks and corporate sector expected default frequencies in the euro area

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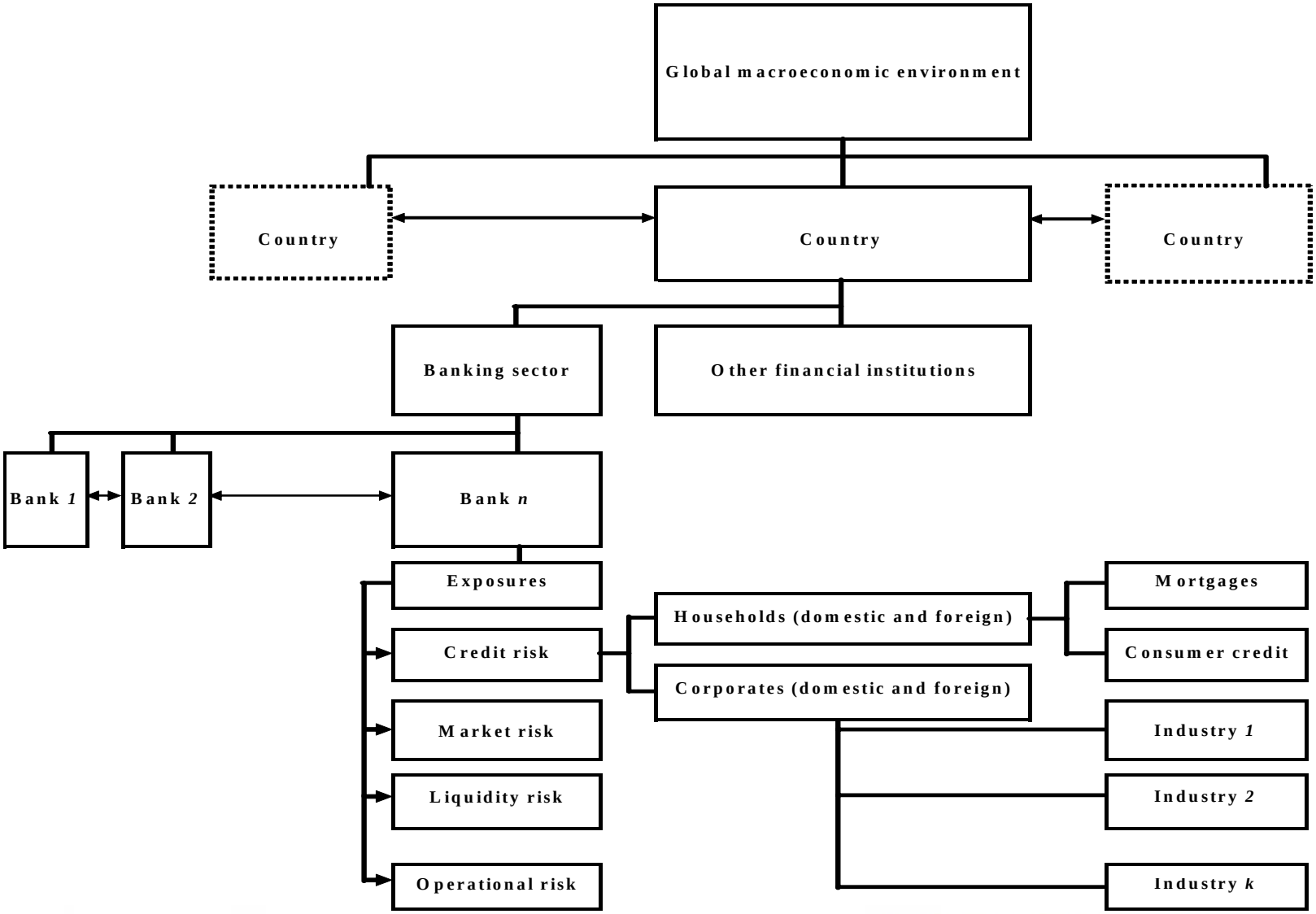
Background: financial sector stress testing



Motivation

- The world has become more financially integrated and firms and banks are operating in the global marketplace
- Large euro area banks are active in corporate lending in many countries of the euro area; corporate borrowers are often large firms with global exposures
- A framework linking indicators of corporate sector credit quality to a global macroeconomic model is useful:
  - For large banks to calculate their capital buffers
  - For central banks and supervisors to assess resilience at systemic level

Previous Literature on Macro-VARs & PDs

- **Pesaran et al. (2004): Conditional loss distributions of a credit portfolio in different regions of the world**
- **Alves (2005) and Shahnazarian and Åsberg-Sommer (2007): Corporate sector EDFs in a macroeconomic VAR model**
- **Jacobson et al. (2005): Interactions between firms' balance sheets & the evolution of the economy**
- **Drehmann et al. (2005): Non-linear VAR for corporate sector credit risks**
- **Aspachs et al. (2006): Interaction between bank equity value & bank PDs and the UK macroeconomy**

Our approach in a nutshell

- **To quantify the impact of domestic and global macroeconomic shocks on the aggregate and the sectoral EDFs of the euro area**

- **Combination of:**

1) A structural default model (Moody's KMV based on the Merton (1974) approach)

2) An internal ECB macro-econometric model (Global VAR by Dées et al. (2007))

- **Construct a linking equation to the GVAR model, which isolates the EDF from the global system**

- **The GVAR model + the linking equation of the EDF => <u>Satellite GVAR model</u>**

Benefits of the Satellite approach

- **Can combine a complex global macro model with a simple equation for EDFs in one country, with possibly different time series length**
- **Isolates the credit risk assessment from the macro assessment, thus avoiding inference of complex and controversial feedbacks**
- **Can easily experiment with various specifications for the satellite equation (e.g. non-linearities, heterogeneity…), without messing up the features of the macro model**

A Primary of Global VAR (GVAR)

- **Macroeconomic policy analysis and financial risk management require taking account of the increasing interdependencies that exist across markets and countries**
- **Also financial stability issues need to be considered from a global perspective; this invariably means that many different channels of transmission must be taken into account**
- **The GVAR provides a convenient and intuitive solution to the modeling of complex high dimensional systems**
- **Other possibilities: structural models and common factor models**

A Primary of Global VAR (GVAR)

- **The GVAR approach models the interlinkages using trade-weighted observable macroeconomic aggregates and financial variables**

- **The GVAR is composed of individual country VARX* models in which the core domestic variables are related to country-specific foreign variables**

$$x_{it} = a_{i0} + a_{i1}t + \Phi_i x_{i,t-1} + \Lambda_{i0} x^*_{i,t}$$

$$+\Lambda_{i1} x^*_{i,t-1} + \Psi_{i0} d_t + \Psi_{i1} d_{t-1} + \varepsilon_{it}$$

for *t=1,2,…,T* and *i=0,1,2,…, N*.

The Satellite model for EDFs

- **Formulate an equation where the endogenous variables of the GVAR are exogenous variables to the Satellite model**
- **The endogenous variable z_t in the Satellite model is the EDF for corporate sector *j***

$$z_{jt} = b_{j0} + b_{j1} x_t + \varepsilon_t$$

- **In practice, the x_t variables in the Satellite model are the domestic variables of the euro area block of the GVAR, expressed in first differences**

Satellite-GVAR: Four steps

- 1) Estimate the GVAR
- 2) Subject the GVAR to shocks to generate impulse response functions (GIRs)
- 3) Separately, estimate the parameters of the Satellite model (we use 5 out of 7 factors)
- 4) Simulate the reactions of the endogenous variable of the Satellite model (EDFs) with the estimated parameters of the Satellite model and the shocks from the GVAR

Data

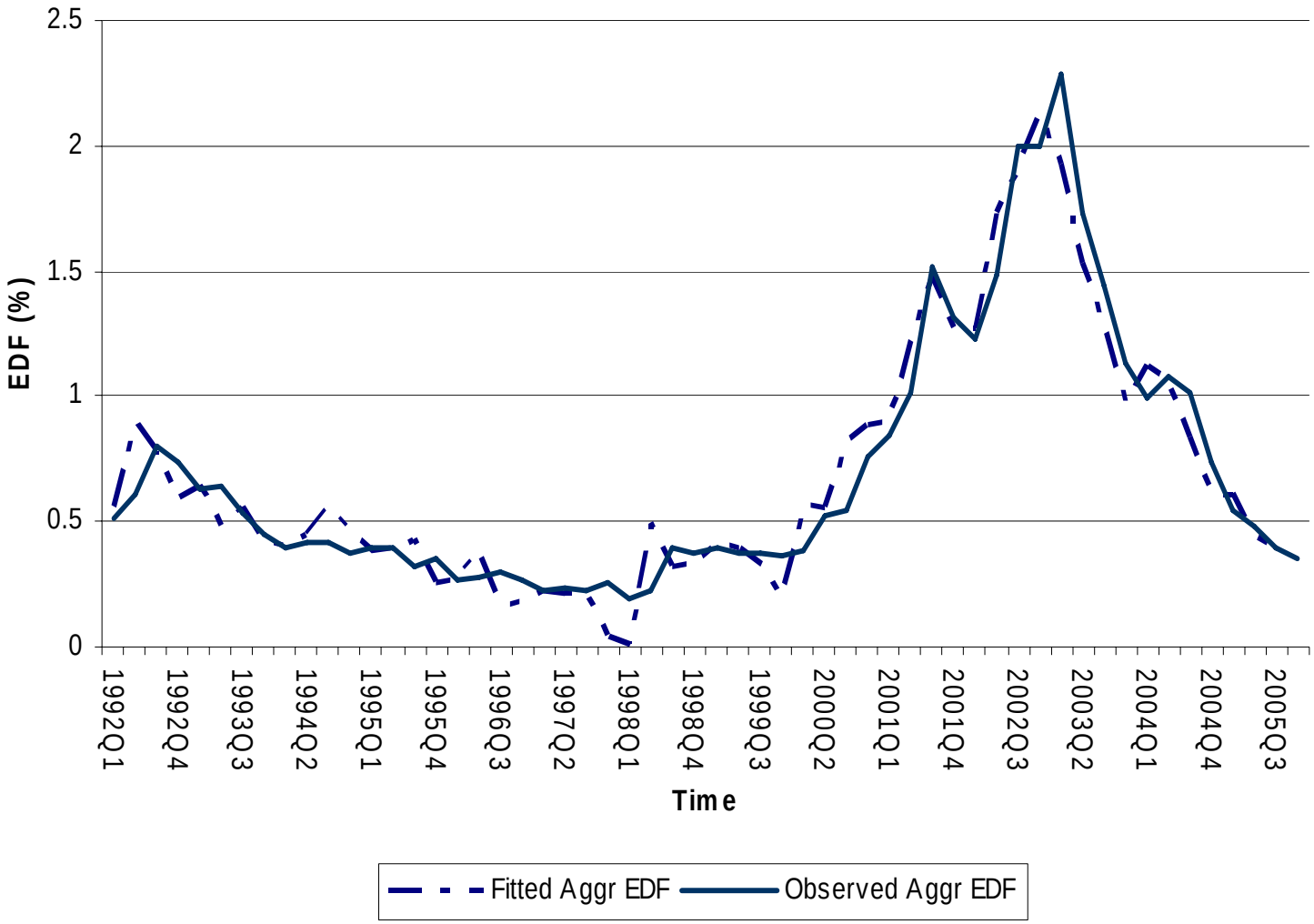
- GVAR data includes 33 countries with the euro area comprising 8 of the 11 countries that joined in 1999
- For each country in the GVAR, the variables include GDP, CPI, Equity price, USD FX, SR & LR interest rates. Oil price is a common (global) variable for all countries. Sample period 1979 Q1-2005 Q4
- Data on aggregate and 7 sectoral corporate EDFs in the euro area 1992-2005. Source: Moody's KMV
- The most parsimonius specification of the Satellite equation includes 5 of the 7 "risk factors" (exogenous variables) from the GVAR

Estimation of the Satellite model

$$EDF_t = \alpha + \beta_1 \Delta GDP_t + \beta_2 \Delta CPI_t + \beta_3 \Delta EQ_t + \beta_4 \Delta EP_t + \beta_5 \Delta IR_t$$

		Const	GDP	INFL	EQUITY	EP	IR
Aggr	beta	0.853	-0.350	-0.054	-0.018	-0.028	-0.010
	Pval	0.000	0.040	0.823	0.020	0.077	0.228
BaC	beta	0.663	-0.285	0.161	-0.014	-0.012	-0.007
	Pval	0.000	0.006	0.268	0.003	0.198	0.146
Cap	beta	1.167	-0.465	-0.097	-0.022	-0.034	-0.011
	Pval	0.000	0.030	0.749	0.025	0.089	0.268
CCy	beta	0.679	-0.266	0.018	-0.015	-0.017	-0.006
	Pval	0.000	0.022	0.915	0.005	0.120	0.270
CNC	beta	0.520	-0.117	-0.100	-0.010	-0.012	-0.003
	Pval	0.000	0.235	0.485	0.026	0.206	0.558
EnU	beta	0.160	-0.047	0.031	-0.005	-0.002	0.000
	Pval	0.000	0.080	0.421	0.000	0.332	0.737
Fin	beta	0.168	-0.030	0.081	-0.003	-0.002	-0.001
	Pval	0.000	0.118	0.005	0.001	0.196	0.404
TMT	beta	2.385	-1.179	-0.831	-0.062	-0.135	-0.038
	Pval	0.006	0.108	0.433	0.066	0.052	0.272

Satellite model: goodness of fit



Summary: Satellite-GVAR results

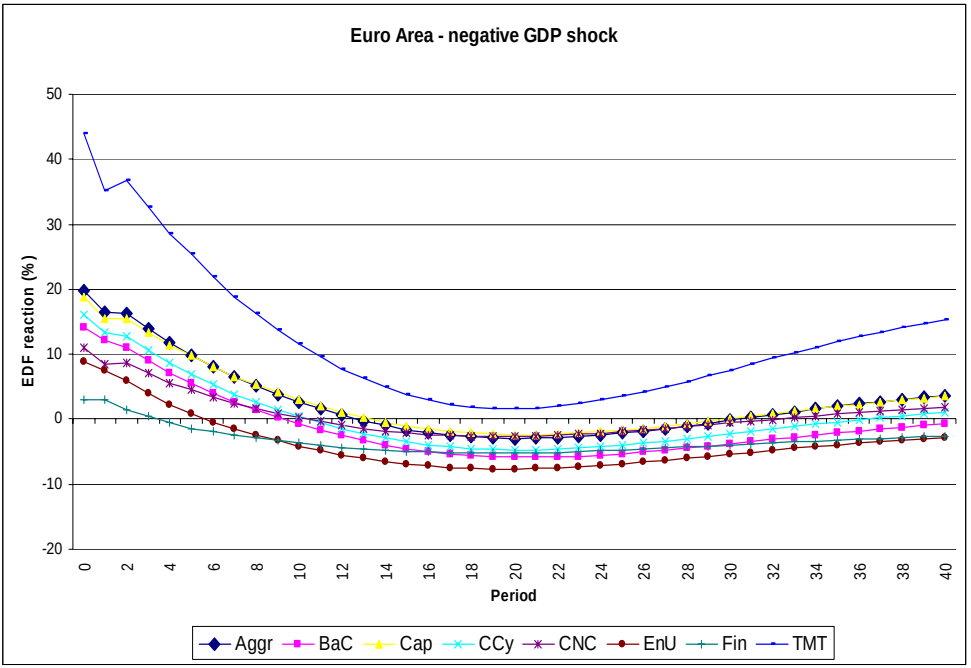
- **On the aggregate Euro Area EDF level, the EDF reactions are most sensitive to shocks to:**

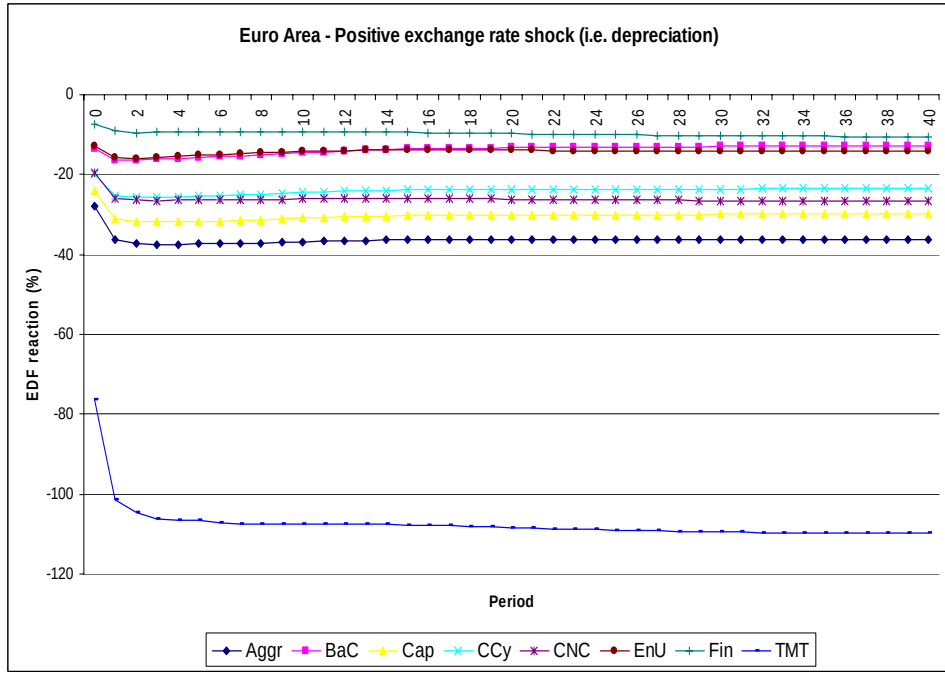
  1) Global and euro area GDP
  2) Global equity prices
  3) Interest rates (short and long)
  4) Exchange rates
  5) Oil prices

- **In general, most sectoral EDFs react similarly to the benchmark (i.e., the aggregate EDF case)**

- **BUT the technology sector EDF is more affected than the other EDFs in our sample period**

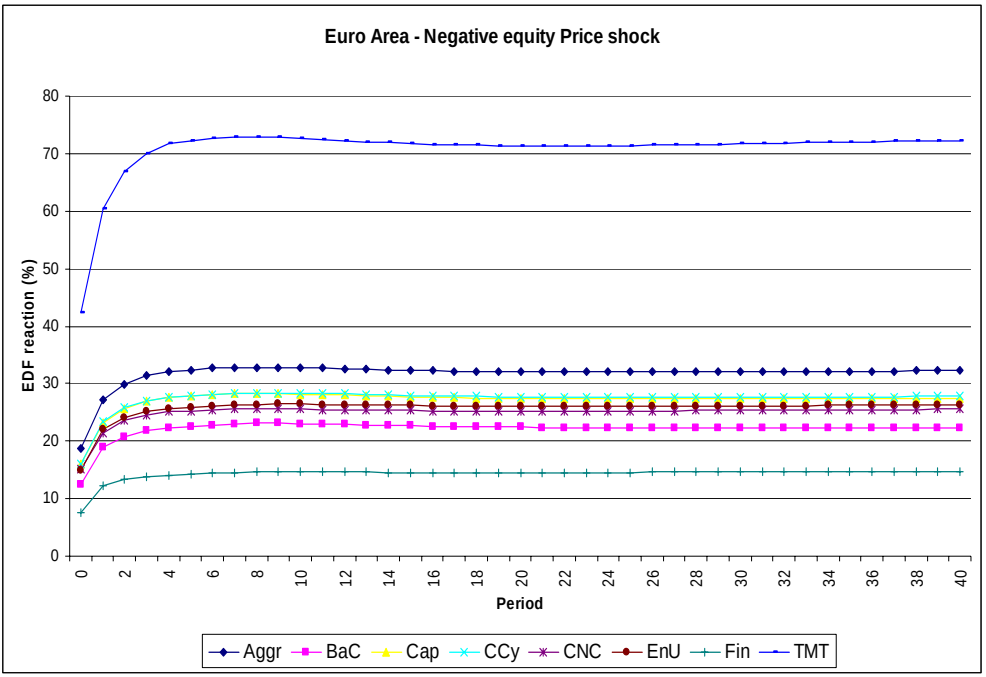
Satellite-GVAR reactions

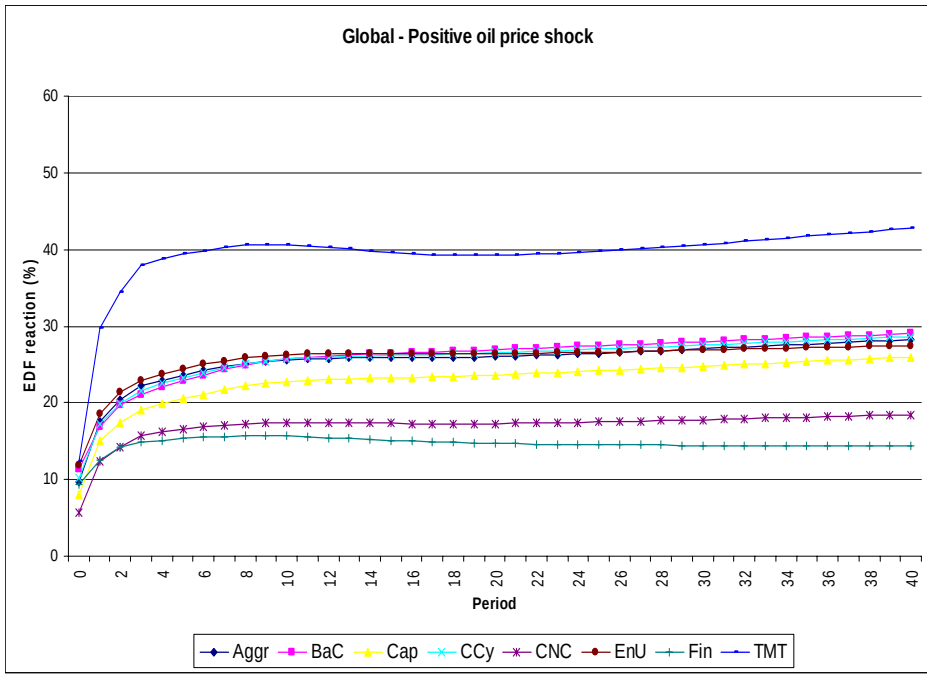




Note: graphs show deviations from the baseline profile

Satellite-GVAR reactions





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Bootstrap simulation exercise

- **The Satellite-GVAR model, given a shock, is rejected if the EDF reaction falls outside the 90% confidence interval range at least once in the 40 quarters**
- **The results show that the model representing the aggregate EDFs is within the 90% confidence interval for all types of shocks.**
- **By contrast, for some sectors the model fit appears less satisfactory**

Future extensions

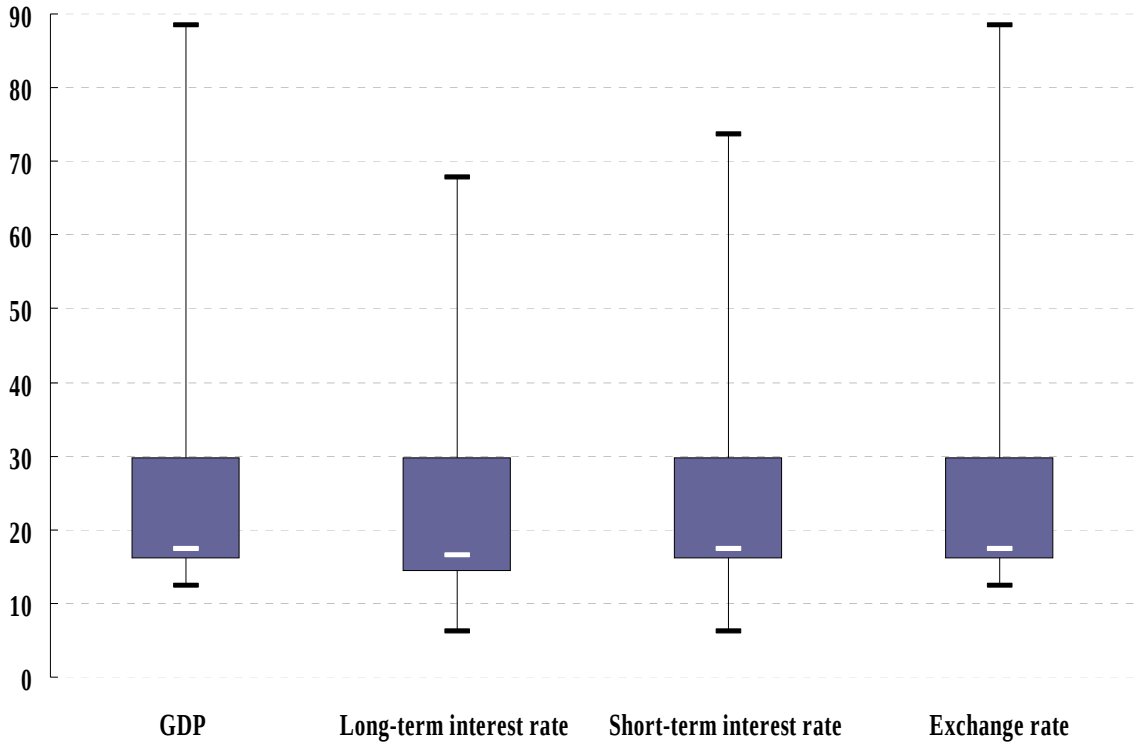
- **Exploit the distribution of sectoral EDFs (instead of only median EDFs) to find out possible effects of firm *heterogeneity***
- **Further efforts to estimate a *non-linear* satellite equation**

Application: LCBGs credit portfolio losses

- **Data inputs: loan exposures, recovery rates, expected default rates and PD volatilities**
- **Use publicly available exposure data from 15 large EU banks, and Moody's KMV Expected Default Frequencies (EDF), shocked by the GVAR**
- **Losses estimated using the CreditRisk+ (CR+) model. This calculates the losses over a fixed one-year horizon for a given confidence interval and for a portfolio of individual exposures of which each has a low probability of defaulting**

Results: a single shock scenario

- Distribution of changes in banks' credit portfolio Value at Risk as a percentage of Tier 1, following various macro shocks
- An useful estimate for banks' economic capital, and the distribution of losses in the banking system




Thank you