

## **Support for the SME supporting factor? Empirical evidence for France and Germany\***

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\*The views expressed are those of the authors and do not necessarily reflect those of the ACPR, Deutsche Bundesbank and ECB.

## Introduction (I)

### The SME Supporting Factor

- In Basel II/III, capital requirements should be sensitive to risk: main difference with Basel I and reason why BCBS used asymptotic single risk factor (ASRF) framework for calibration of capital charges
- Basel III has affected capital requirements for credit exposures to SMEs through higher capital ratios and a tighter capital definition
- Do these regulatory adjustments treat SMEs “unfairly” considering that SMEs did not cause the recent financial crisis?
- **SME Supporting Factor (SF):**
  - Art. 501 CRR
  - Capital reduction factor for loans to small and medium enterprises (SMEs) of 0.7619
  - Aim is to allow credit institutions to counterbalance the rise in capital resulting from the capital conservation buffer and to provide an adequate flow of credit to this particular group of companies.
  - SME definition: turnover < 50 mln Euros (≠ free SME definition of COREP reporting)
  - Loans are only eligible if “amount owed” does not exceed 1.5 mln Euros

## Introduction (II)

### Contribution

#### – Main subject of this study: asset correlation (AC)

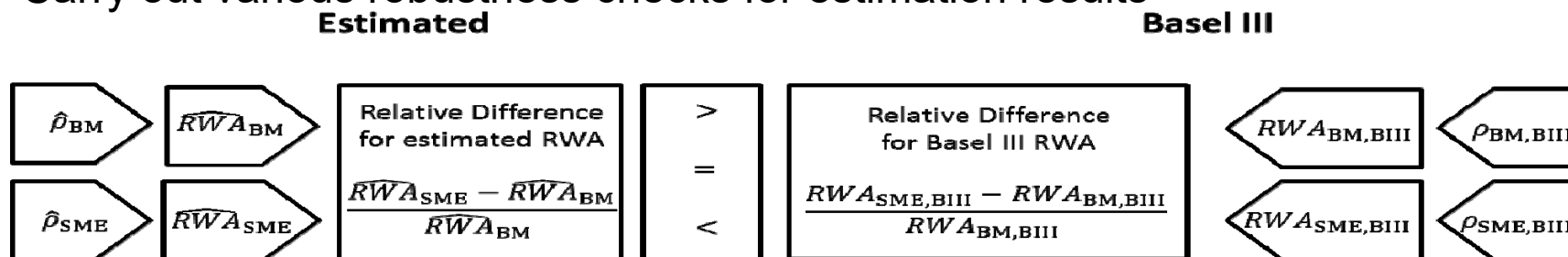
- Key measure of systematic risk in the ASRF
- Empirical AC estimates may reflect the adequate risk level and inform the calibration of regulatory AC

#### – Contribution

- Assess the systematic risk of DE/FR SME loans (dependence on (1) firm size and (2) exposure) in a common asset value credit risk model
- Perform Likelihood Ratio test
- Unique data sample of SME lending for DE and FR (significant coverage of SME market) over a full economic cycle
- Compare estimation results with capital requirements for SME lending under Basel III and CRR/CRD IV framework
- Answer the request of Art. 501 CRR to assess the consistency of own funds requirements with riskiness:
  4. The Commission shall, by 28 June 2016, report [...] to the European Parliament and to the Council, together with a legislative proposal, if appropriate.
  5. For the purpose of paragraph 4, EBA shall report on the following to the Commission:
    - (a) an analysis of the evolution of the lending trends and conditions for SMEs over the period referred to in paragraph 4;
    - (b) an analysis of effective riskiness of Union SMEs over a full economic cycle;**
    - (c) the consistency of own funds requirements laid down in this Regulation for credit risk on exposures to SMEs with the outcomes of the analysis under points (a) and (b).**

## Framework

- Step 1: Estimate AC from historical default rates of selected size (and rating buckets) using a GLMMix Single Factor Estimator
- Step 2: Compare the size-dependence of IRB regulatory risk-weights with the size-dependence of empirical risk-weights (i.e. risk weights based on estimates of AC and PD)
- Focus on “relative calibration”: Does the regulatory capital for SMEs appropriately reflect the systematic risk **relative** to other size classes?
- Use IRB capital requirements (based on the ASRF model) directly for a comparison because they are the economically relevant measure
- Large corporates serve as benchmark (BM), i.e. we assume that their IRB risk weights are “correctly” calibrated
- Carry out various robustness checks for estimation results



## Results

### AC Estimations – GLMMix Single Factor (I)

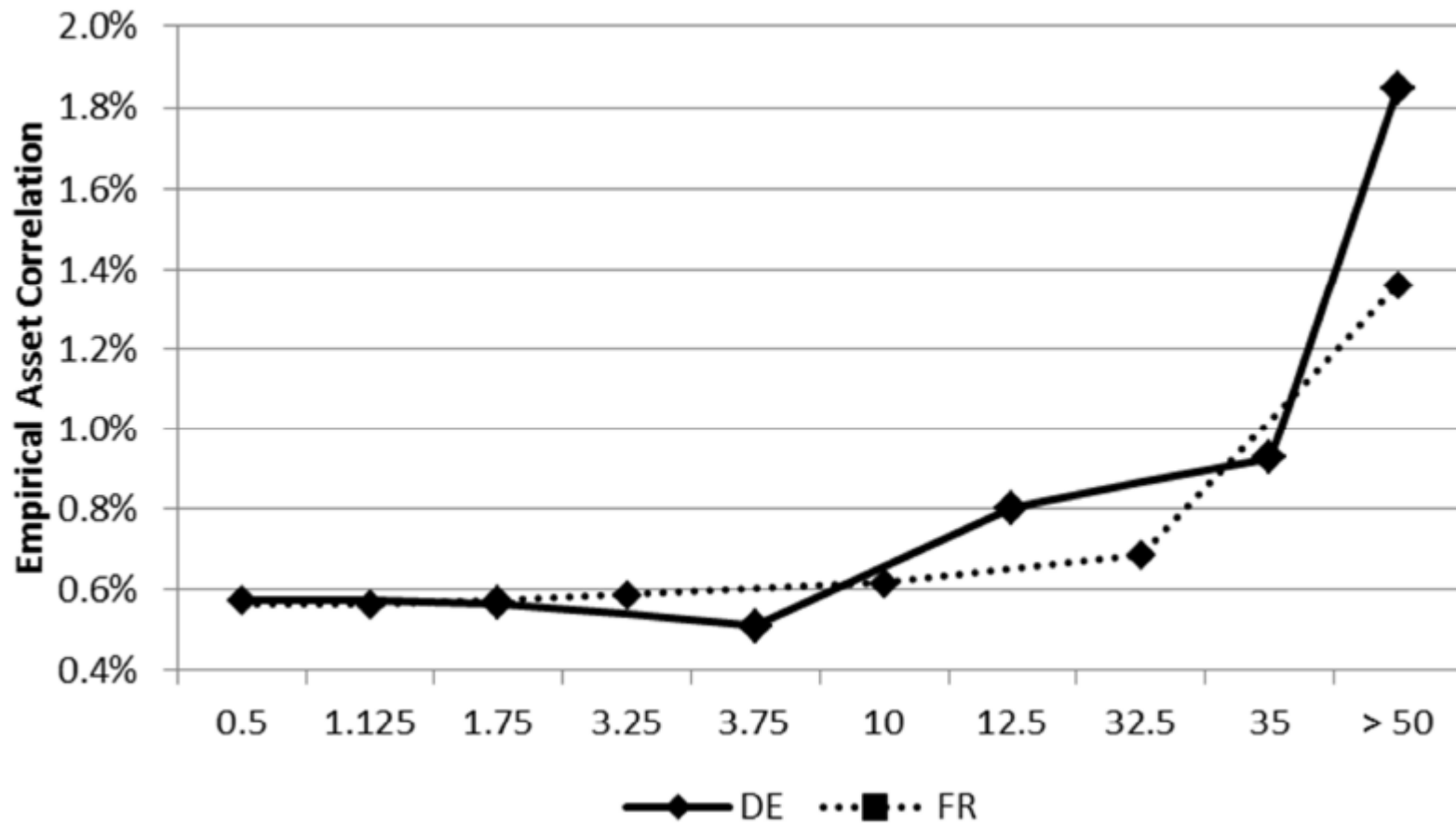
	Turnover in mln €	Retail		Corporate		
		0.75 - 1.5	1.5 - 5	5 - 15	15 - 50	BM
France	Estimates	0.56	0.59	0.62	0.69	1.36
	st. errors	(0.15)	(0.15)	(0.18)	(0.22)	(0.54)
	Likelihood Ratio test statistics	134.9***	149.9***	150.1***	161.1***	---

	Turnover in mln €	Retail		Corporate			
		0 - 1	1 - 2.5	2.5 - 5	5 - 20	20 - 50	BM
Germany	Estimates	0.57	0.57	0.51	0.80	0.92	1.84
	st. errors	(0.19)	(0.19)	(0.18)	(0.28)	(0.36)	(0.67)
	Likelihood Ratio test statistics	40.0***	42.9***	61.3***	61.3***	44.2***	---

- Results across DE and FR are consistent and robust for 3 estimators
- Loans to large corporates face a considerable higher systematic risk than SMEs
  - Structural difference
  - AC more than 50% lower for SMEs; difference is statistically significant
  - For SMEs AC do not vary significantly with turnover; AC is rather constant

## Results

### AC Estimations – GLMMix Single Factor (II)



# Results

## Average Total Differences using IRBA – DE

	Turnover (in EUR mln)		Retail		Corporate				
			0 - 1	1 - 2.5	2.5 – 5	5 - 20	20 - 50	BM	
IRBA	A	Regulatory	Basel III	-53.7%	-53.4%	-22.1%	-18.5%	-7.4%	0.0%
	B		CRR/CRD IV	-64.7%	-64.5%	-40.7%	-37.9%	-29.5%	0.0%
	C	Estimated		-51.8%	-52.8%	-55.8%	-42.0%	-36.9%	0.0%
	C-A	Average total difference Basel III		1.9 pp	0.6 pp	-33.6 pp	-23.5 pp	-29.5 pp	0.0 pp
	C-B	Average total difference CRR/CRD IV		12.9 pp	11.6 pp	-15.1 pp	-4.1 pp	-7.5 pp	0.0 pp

- Results for FR are very much comparable (see Annex)
- Total differences for Basel III are relevant for
  - SME loans in the IRB corporate portfolio
  - But not for SME loans in the retail portfolio
- CRR/CRDIV (conservative Assumption: SME SF is applied to all SME loans)
  - SME SF compensates some part of these differences (IRB corporate)
  - Overstates effect for IRB retail

## Results

### Average Total Differences using SA – DE

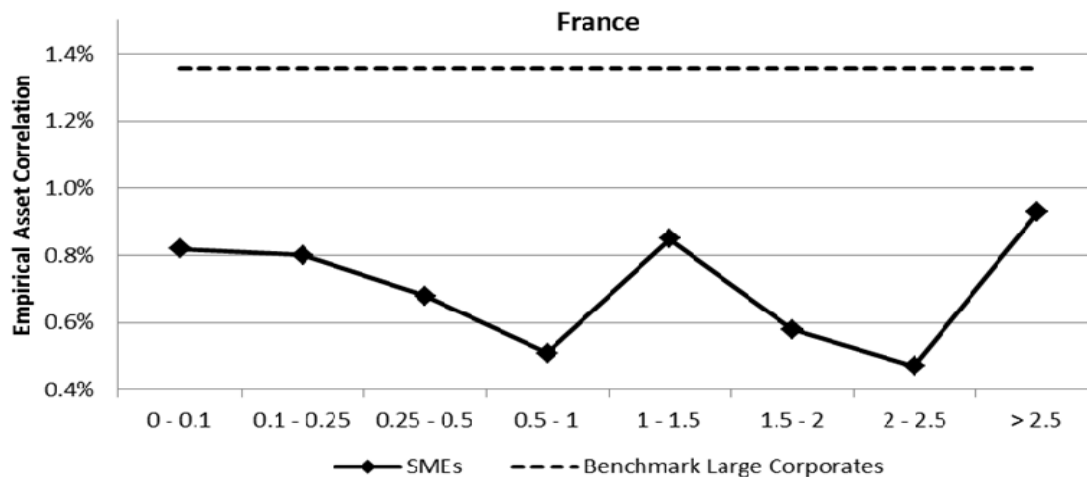
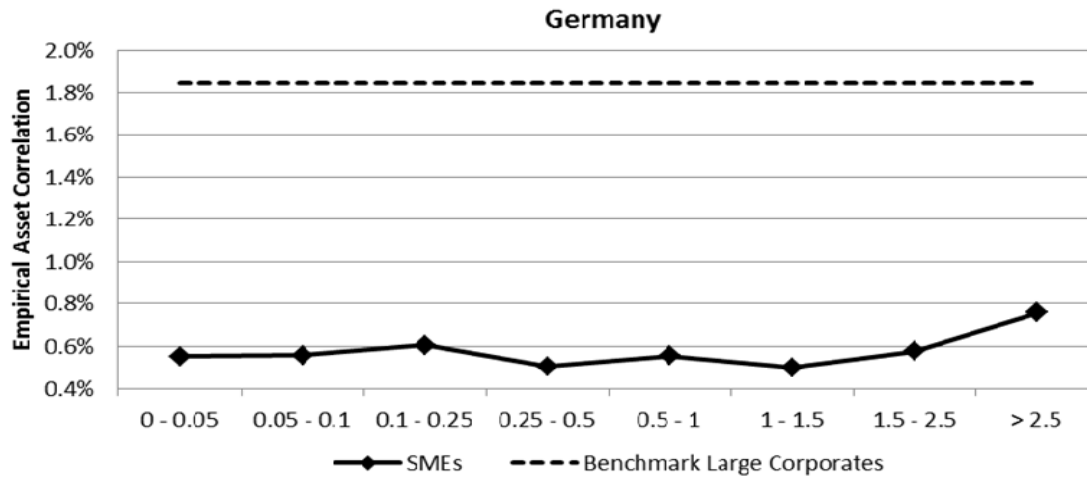
	Turnover (in EUR mln)		Retail		Corporate				
			0 - 1	1 - 2.5	2.5 - 5	5 - 20	20 - 50	BM	
SA	A	Regulatory	Basel III	-25.0%	-25.0%	0.0%	0.0%	0.0%	0.0%
	B		CRR/CRD IV	-42.9%	-42.9%	-23.8%	-23.8%	-23.8%	0.0%
	C	Estimated		-51.8%	-52.8%	-55.8%	-42.0%	-36.9%	0.0%
	C-A	Average total difference Basel III		-26.8 pp	-27.8 pp	-55.8 pp	-42.0 pp	-36.9 pp	0.0 pp
	C-B	Average total difference CRR/CRD IV		-8.9 pp	-9.9 pp	-32.0 pp	-18.2 pp	-13.1 pp	0.0 pp

- Results for FR are very much comparable (see Annex)
- Total differences for Basel III are relevant for
  - All SME loans
- CRR/CRDIV (conservative assumption on application of SME SF)
  - SME SF **only partially** compensates these differences for loans in the corporate portfolio
  - Full adjustment of retail risk weights by SME SF



# Results

## Dependence of exposure



- Art. 501 CRR: SME SF applicable to all SME loans with an amount owed of less than 1.5 mln €
- Only SME are considered (turnover < 50 mln €)
- **Result: No relevant impact of exposure on systematic risk**
- Likelihood Ratio test shows that all AC estimates are significantly different from BM large corporates

## Summary

### – Key findings:

- Results across DE and FR are consistent, robust for 3 estimators and significant for each rating class
  - Loans to large corporates face a considerable higher systematic risk than SMEs
  - Structural difference
  - AC more than 50% lower for SMEs
  - For SMEs AC do not vary significantly with turnover; AC is rather constant
- Potential for a decrease of Basel III capital requirements for IRBA corporates and SA
- SME SF effectively compensates the difference between estimated and Basel III capital requirements
- No relevant impact of exposure on systematic risk
- Before drawing policy conclusions the following caveats should be considered:
- Basel is an international framework; only two large industrial countries are considered
  - SA was calibrated more conservatively than the IRBA since it is much less risk sensitive. This can at least partly explain large total differences

# Annex

## Annex

### Relation to the literature

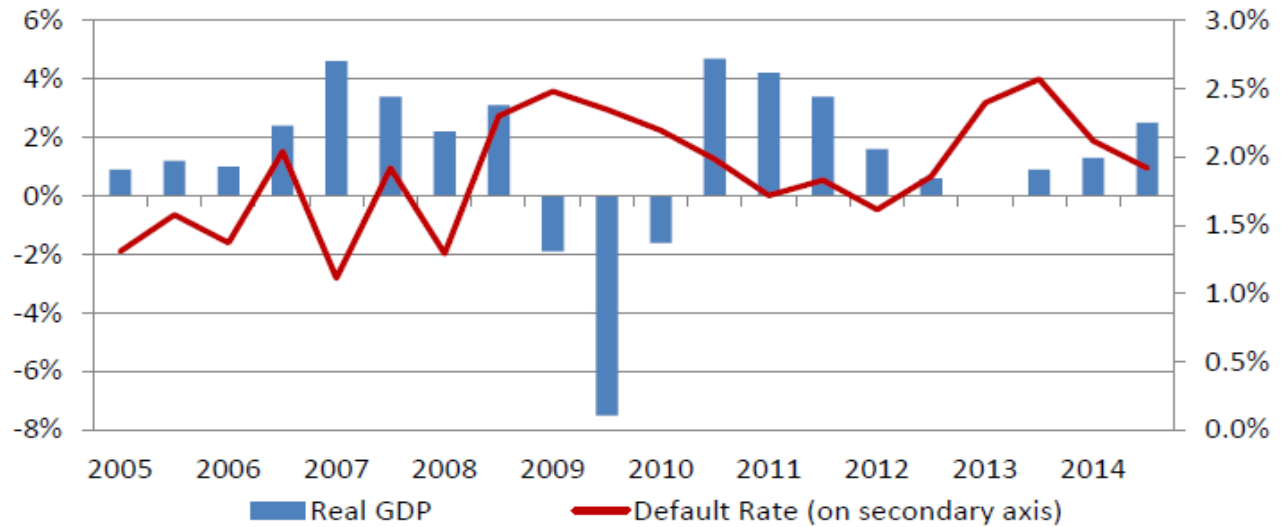
- Two strands of empirical literature
  - Uses historical default rates to determine default or asset correlations (Dietsch/Petey, 2004; Dietsch/Fraisse, 2013, Bams et al. 2014; Düllmann/Koziol, 2014) and estimate lower values than in Basel II
  - Uses equity prices (Hahnenstein, 2004; Lopez, 2004; Düllmann et al., 2010; Lee/Jiang/Chiu/Chang, 2012)
- Previous empirical work shows on the dependence of ACs on creditor credit quality and size show a tendency towards lower ACs for SMEs as compared to large corporates.
- Empirical work encompasses both studies within the single-factor framework used in Basel II/III (e.g. our study) and those using more granular models (esp. multifactor). Expanding strand of literature using other multifactor models casts general doubts about the adequacy of regulatory capital requirements to consistently reflect portfolio credit risk (e.g. Dietsch/Fraisse, 2013).
- Our study extends Düllmann/Koziol (2014) in terms of data set and by using a more refined estimation technique (GLMMix instead of ML).

## Annex Data (I) – General Features

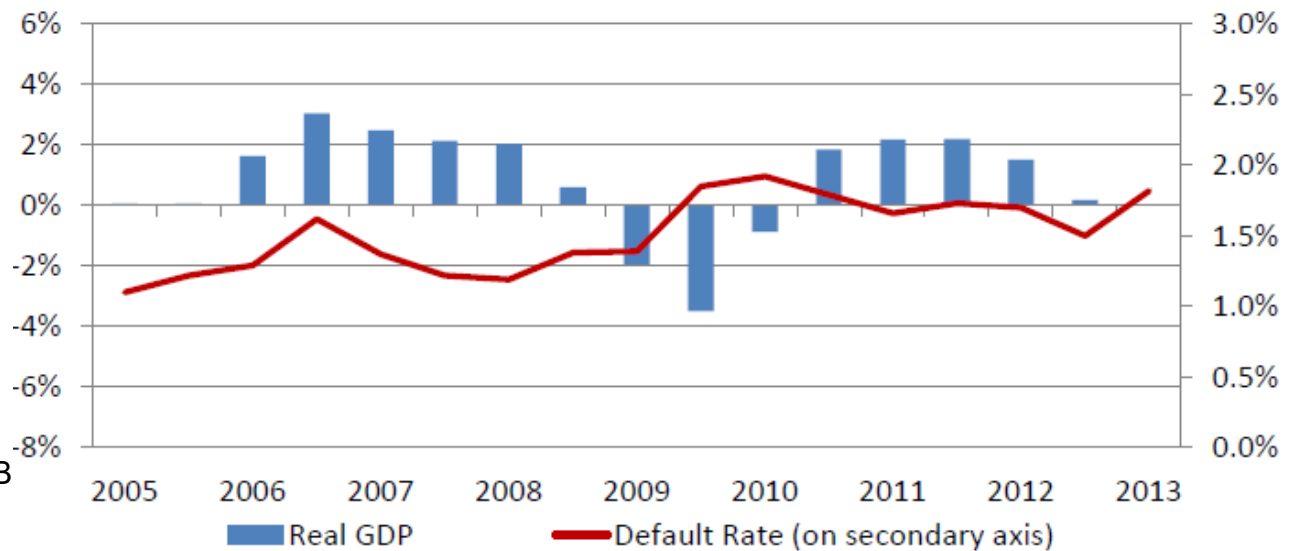
Country	France	Germany
Sources	French Credit Register and Banque de France (BdF) rating system	Data provided by significant proportion of German banks. Use of IRBA ratings mapped to a consistent master scale
Time period	Q4 2004 to Q4 2013 (20 observations)	Jan 2005 to Dec 2014 (20 observations)
Data frequency	Quarterly aggregated to semi-annual	Semi-annual
Credit exposure amount	>EUR 25 000	All; measured in terms of “amount owed” as defined in Art.501 CRR
Default definition	Two criteria: legal failure (bankruptcy) and bank default, which corresponds to severe banking problems	Basel II/III default definition
Firm’s size classes definition	Restricted to firms with turnover over € 0.75 mln; Five size classes turnover measured in € mln: 0.75 to 1.5, 1.5 to 7.5, 7.5 to 15, 15 to 50, And over 50.	Six size categories turnover measured in € mln: [0;1], (1;2.5], (2.5; 5], (5;20], (20;50], And over 50.
Number of rating grades	4, from 10 in the master scale	5, from 6 in the master scale

## Annex Data (II) – Default Rates and GDP

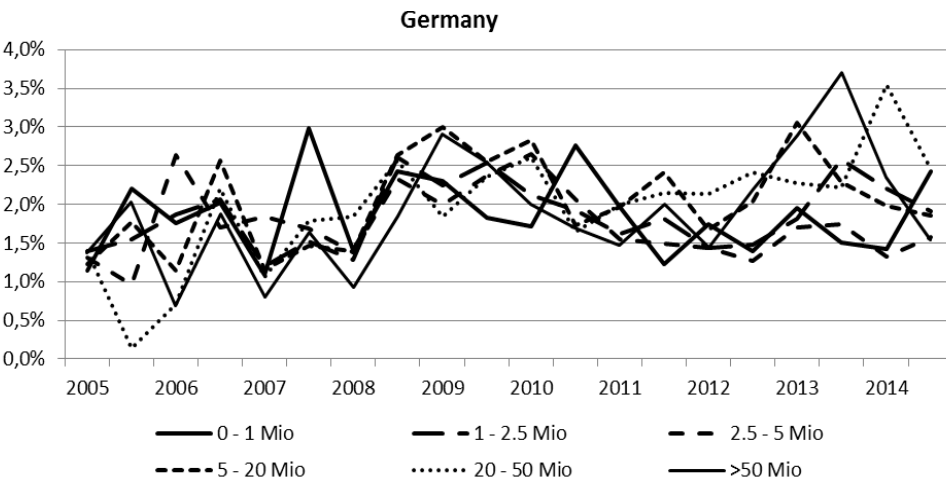
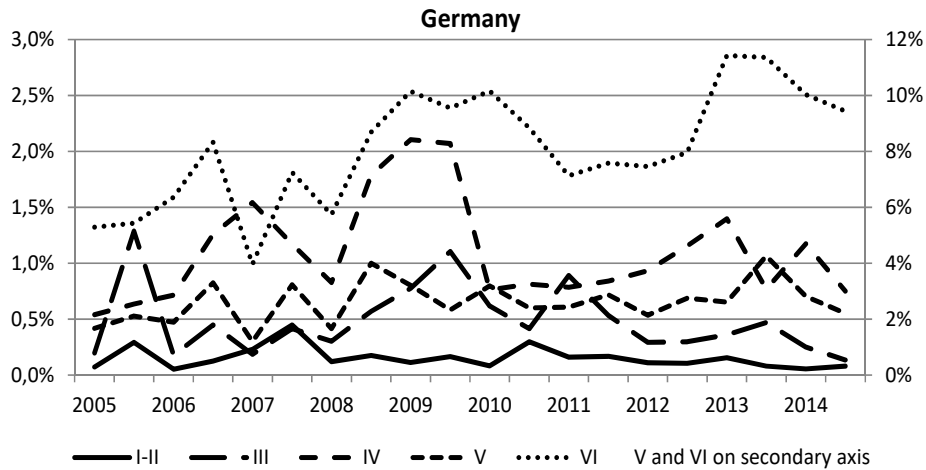
–Germany



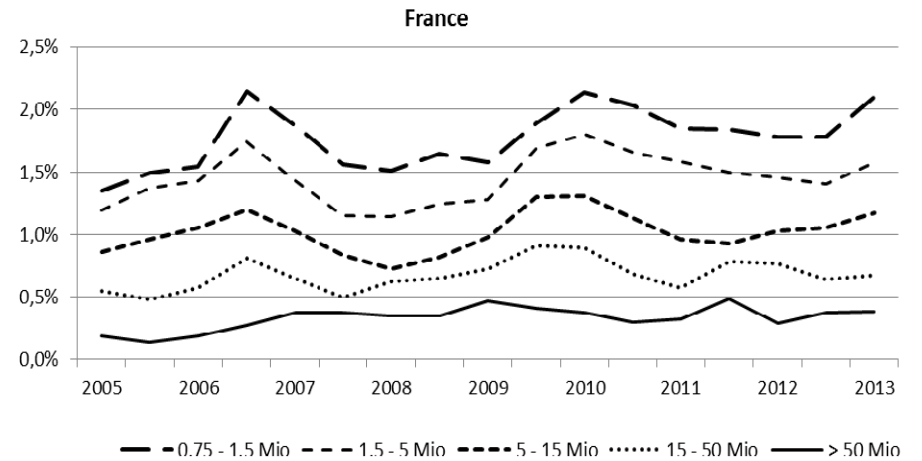
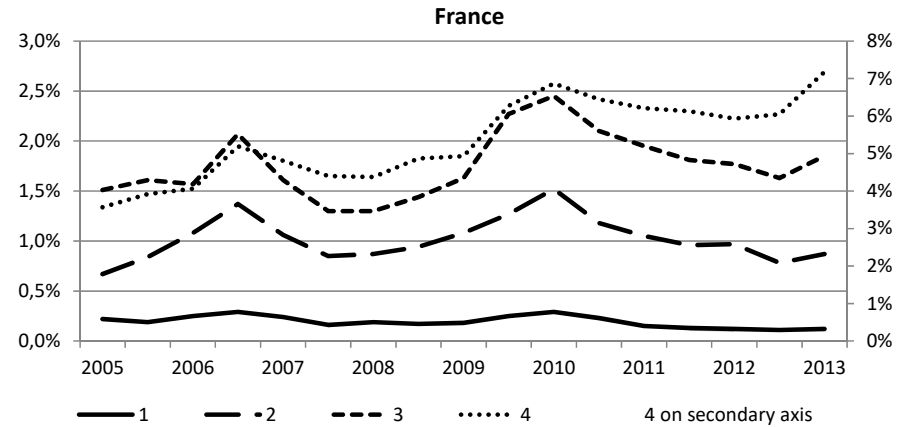
–France



# Annex Data (III) – Default Rates Germany



# France



## Annex Data (IV) – SME Loans eligible for Supporting Factor

France	Turnover in mln €	Retail	Corporate			
		0,75 - 1,5	1,5 - 5	5 - 15	15 - 50	all
	% of loans	96%	90%	67%	44%	86%

Germany	Turnover in mln €	Retail		Corporate			
		0 - 1	1 - 2.5	2.5 - 5	5 - 20	20 - 50	all
	% of loans	69%	68%	63%	55%	45%	64%

### – Assumption for the analysis of CRR/CRDIV CR

- SME Supporting Factor is applied to all SME loans (<50 mio €)
- Conservative; likely to overstate beneficial impact of SME SF on regulatory risk weights

### – Empirical justification for the 1.5 mln € threshold (Art. 501)?



## Annex Model and Estimation Methodology (I)

- The framework : the ASRF model
- Portfolio-level losses may be defined as the sum of individual losses on defaulted loans:

$$L = \sum_{i=1}^n u_i \mathbf{1}_{D_i}$$

- where  $u_i$  is the LGD of borrower  $i$  and  $\mathbf{1}_{D_i}$  is the default indicator variable of this borrower.
- In a structural credit risk model (Merton, 1974), default occurs if the ability-to-pay  $Y_i$  of borrower  $i$  falls below an default threshold  $\gamma_i$ .  $Y_i$  can be decomposed into the return of a systematic factor  $x$  and an idiosyncratic (borrower) part  $\varepsilon_i$ :

$$Y_i = \sqrt{\rho_i} x + \sqrt{1 - \rho_i} \varepsilon_i$$

- The factor loading  $\sqrt{\rho_i}$  can be interpreted as the sensitivity against systematic risk or as the square root of the asset correlation  $\rho_i$ .
  - Thus, the unconditional default probability of borrower  $i$  is defined as:
- $$P(L_i = 1) = P(Y_i < \gamma_i) = \Phi(\gamma_i)$$
- where  $\Phi$  denotes the cumulative distribution function of a standard normal distribution.
  - The threshold value is fixed such that the unconditional probability of default is equal to  $\bar{p}$ . Then, the borrower default when:

$$\frac{w x + \varepsilon_i}{\sqrt{1 - w^2}} < \Phi^{-1}(\bar{p})$$

## Annex Model and Estimation Methodology (II)

- Estimation of risk parameters (default thresholds and factor sensitivity) using Generalized linear Mixed Model (GLMMix)
  - Correspondence between the conditional default probability entailed in the loss variable and the specification of a GLMMix (Frey and McNeil, 2003).
    - Default threshold  $\Phi^{-1}(\bar{p}_j)$  is the fixed effect.
    - Systematic risk factor is a latent factor and it corresponds to the random effect, what allows taking account for the serial dependence of defaults.
  - In this framework, the default rate is modeled as:
$$P(\text{Default} | b_t) = \Phi(\mu_0 + x'_{it} \mu_r + z'_{it} \gamma_t)$$
  - In this specification, dynamic defaults history is explained by:
    - A fixed effect : firm's rating
    - A general latent systematic risk factor which represents the "state of the economy"

## Annex Risk Weight Formulas

Empirical risk-weight formula:

$$RW(LGD,PD,M, \rho) = 1.06 \cdot 12.5 \cdot LGD \cdot \left[ \Phi \left( \frac{\Phi^{-1}(PD) + \sqrt{\rho} \Phi^{-1}(0.999)}{\sqrt{1 - \rho}} \right) - PD \right] \cdot f(PD,M)$$

Basel II risk-weight formula:

$$RW(LGD,PD,M) = 1.06 \cdot 12.5 \cdot LGD \left[ \Phi \left( \frac{\Phi^{-1}(PD) + \sqrt{\rho(PD,S)} \Phi^{-1}(0.999)}{\sqrt{1 - \rho(PD,S)}} \right) - PD \right] f(PD,M)$$

where

$$\rho(PD,S) = \frac{1 - e^{-50PD}}{1 - e^{-50}} \cdot 0.12 + \left( 1 - \frac{1 - e^{-50PD}}{1 - e^{-50}} \right) \cdot 0.24 - 0.04 \left( 1 - \frac{\min\{50, \max\{S, 5\}\} - 5}{45} \right)$$

Other retail: turnover < 2.5 m €; S:= turnover; M:= maturity

## Annex Results – Original PD estimations

	Turnover in mio €	Retail		Corporate			Weighted Avg.
		0.75 - 1.5	1.5 - 5	5 - 15	15 - 50	> 50	
France	<b>Low Risk 1</b>	0.25%	0.22%	0.14%	0.10%	0.04%	0.20%
	<b>2</b>	1.07%	1.15%	0.92%	0.62%	0.33%	1.03%
	<b>3</b>	1.68%	2.04%	1.83%	1.12%	0.60%	1.80%
	<b>High Risk 4</b>	5.97%	5.64%	4.18%	3.09%	2.03%	5.38%

	Turnover in mio €	Retail		Corporate				Weighted Avg.
		0 - 1	1 - 2.5	2.5 - 5	5 - 20	20 - 50	> 50	
Germany	<b>Low Risk I-II</b>	0.60%	0.48%	0.48%	0.39%	0.41%	0.43%	0.50%
	<b>III</b>	1.57%	1.76%	1.67%	1.58%	1.76%	1.49%	1.63%
	<b>IV</b>	3.73%	4.27%	3.93%	3.70%	4.49%	3.78%	3.88%
	<b>V</b>	7.94%	10.60%	8.53%	9.07%	11.17%	10.35%	8.78%
	<b>High Risk VI</b>	24.23%	28.72%	25.42%	27.03%	27.07%	30.59%	25.33%

- PDs will be used as averages per rating categories across all size classes

## Annex Robustness: AC estimates (ML estimator)

	Turnover in mio €	Retail		Corporate	
		0.75 - 1.5	1.5 - 5	5 - 50	> 50
<b>France</b>	<b>(low risk) 1</b>	0.53	0.51	0.54	2.01
	p-value	(0.00)	(0.00)	(0.01)	(0.07)
	<b>2</b>	0.61	0.60	1.31	6.26
	p-value	(0.00)	(0.00)	(0.00)	(0.03)
	<b>(high risk) 3</b>	0.79	0.94	0.81	3.02
	p-value	(0.00)	(0.00)	(0.00)	(0.01)

	Turnover in mio €	Retail		Corporate		
		0 - 1	1 - 2.5	2.5 - 5	5 - 50	> 50
<b>Germany</b>	<b>(lows risk) I-III</b>	0.85	0.68	0.75	0.61	1.79
	p-value	(0.01)	(0.01)	(0.03)	(0.02)	(0.02)
	<b>IV</b>	0.58	0.74	0.52	0.53	2.10
	p-value	(0.01)	(0.02)	(0.06)	(0.03)	(0.04)
	<b>(high risk) V-VI</b>	0.47	0.42	0.42	0.85	1.93
	p-value	(0.01)	(0.01)	(0.02)	(0.01)	(0.02)

## Annex Robustness: Var-Cov-Ma (GLMMix multi-factor)

France	Var-Cov-Matrix for Turnover Buckets (in mln €)		Retail	Corporate			
			0,75 - 1,5	1,5 - 5	5 - 15	15 - 50	> 50
	Retail	0,75 - 1,5	2.2%	2.4%	0.8%	-0.9%	-3.3%
Corporate	1,5 - 5	2.4%	2.7%	1.0%	-1.1%	-3.9%	
	5 - 15	0.8%	1.0%	0.7%	0.4%	-0.3%	
	15 - 50	-0.9%	-1.1%	0.4%	2.1%	4.4%	
	> 50	-3.3%	-3.9%	-0.3%	4.4%	10.3%	

Germany	Var-Cov-Matrix for Turnover Buckets (in mln €)		Retail		Corporate			
			0 - 1	1 - 2.5	2.5 - 5	5 - 20	20 - 50	>50
	Retail	0 - 1	0.6%	0.4%	0.4%	0.4%	0.2%	0.5%
1 - 2.5		0.4%	1.0%	0.5%	0.5%	0.6%	0.7%	
Corporate	2.5 - 5	0.4%	0.5%	0.5%	0.6%	0.5%	0.7%	
	5 - 20	0.4%	0.5%	0.6%	0.7%	0.8%	1.0%	
	20 - 50	0.2%	0.6%	0.5%	0.8%	1.0%	1.2%	
	>50	0.5%	0.7%	0.7%	1.0%	1.2%	1.7%	

## Annex

### Results: Average Total Differences using IRBA – FR

	Turnover (in EUR mln)			Retail	Corporate			
				0.75 - 1.5	1.5 - 5	5 - 15	15 - 50	BM
IRBA	A	Regulatory	Basel III	-54.5%	-22.1%	-19.6%	-8.7%	0.0%
	B		CRR/CRD IV	-65.3%	-40.6%	-38.7%	-30.4%	0.0%
	C	Estimated		-43.5%	-42.4%	-40.8%	-36.7%	0.0%
	C-A	Average total difference Basel III		11.0 pp	-20.3 pp	-21.2 pp	-28.0 pp	0.0 pp
	C-B	Average total difference CRR/CRD IV		21.8 pp	-1.8 pp	-2.1 pp	-6.2 pp	0.0 pp

- Total differences for Basel III are relevant for
  - SME loans in the IRB corporate portfolio
  - But not for SME loans in the retail portfolio
- CRR/CRDIV (conservative Assumption: SME SF is applied to all SME loans)
  - SME SF compensates some part of these differences (IRB corporate)
  - Overstates effect for IRB retail

## Annex Average Total Differences using SA – FR

	Turnover (in EUR mln)			Retail	Corporate			
				0.75 - 1.5	1.5 - 5	5 - 15	15 - 50	BM
SA	A	Regulatory	Basel III	-25.0%	0.0%	0.0%	0.0%	0.0%
	B		CRR/CRD IV	-42.9%	-23.8%	-23.8%	-23.8%	0.0%
	C	Estimated		-43.5%	-42.4%	-40.8%	-36.7%	0.0%
	C-A	Average total difference Basel III		-18.5 pp	-42.4 pp	-40.8 pp	-36.7 pp	0.0 pp
	C-B	Average total difference CRR/CRD IV		-0.6 pp	-18.6 pp	-17.0 pp	-12.9 pp	0.0 pp

- Total differences for Basel III are relevant for
  - All SME loans
- CRR/CRDIV (conservative assumption on application of SME SF)
  - SME SF **only partially** compensates these differences for loans in the corporate portfolio
  - Full adjustment of retail risk weights by SME SF



# Annex

## Calculation of total average differences

	Estimated					Risk Weights	Basel III				
	Retail	Corporate					Retail	Corporate			
	0,75 - 1,5	1,5 - 5	5 - 15	15 - 50	> 50		0,75 - 1,5	1,5 - 5	5 - 15	15 - 50	> 50
Low Risk 3	1.7%	1.7%	1.8%	1.9%	3.1%		19.1%	36.3%	37.3%	42.1%	46.0%
4	6.0%	6.2%	6.4%	6.8%	10.6%		49.1%	77.4%	79.8%	90.4%	98.8%
5	9.2%	9.4%	9.7%	10.3%	16.0%		59.8%	91.4%	94.3%	107.6%	118.1%
High Risk 6	20.1%	20.6%	21.2%	22.6%	34.1%		70.9%	121.9%	126.6%	147.1%	162.8%

	Estimated					Relative Differences in Capital Requirements by Rating and Turnover class	Basel III				
	Retail	Corporate					Retail	Corporate			
	0,75 - 1,5	1,5 - 5	5 - 15	15 - 50	> 50		0,75 - 1,5	1,5 - 5	5 - 15	15 - 50	> 50
Low Risk 3	-45.3%	-43.8%	-42.1%	-37.8%	0.0%		-58.6%	-21.2%	-18.9%	-8.5%	0.0%
4	-43.4%	-42.0%	-40.2%	-36.0%	0.0%		-50.3%	-21.6%	-19.3%	-8.6%	0.0%
5	-42.6%	-41.2%	-39.5%	-35.3%	0.0%		-49.4%	-22.6%	-20.2%	-8.9%	0.0%
High Risk 6	-40.9%	-39.5%	-37.8%	-33.7%	0.0%		-56.5%	-25.1%	-22.3%	-9.7%	0.0%

	Total Differences of Capital Requirements in BASEL III				
	Retail	Corporate			
	0,75 - 1,5	1,5 - 5	5 - 15	15 - 50	> 50
Low Risk 3	13.3%	-22.6%	-23.1%	-29.3%	0.0%
4	6.9%	-20.3%	-20.9%	-27.4%	0.0%
5	6.8%	-18.6%	-19.3%	-26.4%	0.0%
High Risk 6	15.5%	-14.4%	-15.5%	-24.1%	0.0%

	Estimated				
	Retail	Corporate			
	0,75 - 1,5	1,5 - 5	5 - 15	15 - 50	> 50
	-43.5%	-42.4%	-40.8%	-36.7%	0.0%

	Basel III				
	Retail	Corporate			
	0,75 - 1,5	1,5 - 5	5 - 15	15 - 50	> 50
	-54.5%	-22.1%	-19.6%	-8.7%	0.0%

	Average total difference				
	Retail	Corporate			
	0,75 - 1,5	1,5 - 5	5 - 15	15 - 50	> 50
	11.0%	-20.3%	-21.2%	-28.0%	0.0%