

Eurobanking -18 May 2009

Concentration Risk in Mortgage Portfolios

Michel DIETSCH

Caisse Nationale des Caisses d'Epargne et Université de Strasbourg

Jean-François FOUCHER

Caisse Nationale des Caisses d'Epargne

Adeline VANDAELE

Caisse Nationale des Caisses d'Epargne



**GROUPE
CAISSE D'EPARGNE**



Introduction and Objectives

- Credit Risk:
 - > Defined as **portfolio** potential assets losses due to extreme events
 - > Depends on the concentration of the portfolio

- Concentration risk in internal measurement of portfolio credit risk (Pillar 2 of Basel II – emphasized in 2008 by BCBS)

- What is concentration in retail banking:
 - > Not a name concentration (granular portfolio)
 - > Refers to a potential situation of correlated defaults in sub-portfolios
 - Even if loans are small or medium-sized exposures in retail banking, there can be concentration in portfolios due to strong dependences across exposures (highly correlated defaults)



Introduction and Objectives

- Potential for credit risk diversification exists if there is borrowers heterogeneity in the population
 - > Borrowers may differ because they are exposed to different systematic factors in addition to a general macroeconomic factor: geography, wealth, profession...
 - > Borrowers may be affected by a same set of risk factors but react more or less strongly to variations of these factors

- If this potential could be detected, bankers could manage the composition of their portfolios to benefit from diversification effects and to reduce economic capital charges
 - > Economic capital is capital that covers the insolvency risk of the bank at a risk level accepted by the banker

- Measuring the marginal contributions of separate groups of borrowers is crucial:
 - > to assess the importance of concentration/diversification effects within a loans portfolio
 - > to determine the level of economic capital and its allocation for that portfolio



Introduction and Objectives

- Most internal models measuring economic capital (asset correlations) as well as the formulas of regulatory charges in Basel II use an asymptotic single factor model (ASFR)
 - > What is measured in an ASFR model is the correlation to a latent (unobservable) risk factor assumed to represent general macroeconomic conditions

- But the ASFR model does not take into account borrowers heterogeneity, i.e. the dependence of borrowers financial health to other systematic risk factors

- Only a multi-factor framework allows to take into account mortgage dependence to additional risk factors
 - > But very few theoretical and empirical works on multi-factor approach in retail banking

- In this paper, we use a multi-factor framework to compute dependence structure between mortgages exposures, to measure the level of economic capital charges and to assess the potential for diversification

1. From the ASFR Framework to the multi-factor Framework
2. Multi-factor Model and Capital Allocation



1. From the ASFR Framework to the multi-factor Framework

2. Multi-factor Model and Capital Allocation



From the ASFR model ... (1/2)

- In the common structural model family (Merton), the default occurs when the value of the borrower's assets fall under a threshold given by the value of its debt
- This threshold can be related to the long term default probability (PD) of that borrower (its rating)
- In the ASFR model, the borrower defaults when:

$$w_i x + \sqrt{1 - w_i^2} \varepsilon_i < \Phi^{-1}(PD)$$

correlation ———
systematic factor ———
specific factor ———
latent variable ———
threshold ———



From the ASFR model ... (2/2)

- Extension of the ASFR framework to a multi-factor framework:
 - > Allows to introduce additional risk factors
 - > Allows to compute correlations within portfolios sub-segments and correlations between risk factors

- Generalized Linear Mixed Model (GLMM) econometric methodology
 - > to compute risk parameters describing dependence across exposures grouped in sub-portfolios

- Computation of portfolio's VaR and marginal contributions of mortgage sub-portfolios exposed to additional risk factors (using Tasche 2008 methodology) take into account borrowers heterogeneity effects on economic capital charges and capital allocation



... to the Multi-factor Framework: Methodology (1/3)

- Natural way to account for additional factors is to introduce additional macroeconomic variables
 - > Not possible or difficult to access specific time series for retail loans
 - > Difficult to obtain deep rating histories

- Alternative: expand the one-factor model by adding new latent factors that could be linked to observable characteristics of the firm:
 - > Geographic location of the mortgage loan measured by the belonging to different urbanization classes or classes of price per square meter
 - > Wealthiness
 - > Profession

- ... assumed to reinforce or attenuate the effect of the general systematic risk factor on portfolio means losses
 - > However, it is difficult to identify these factors due to the lack of a comprehensive theory about retail borrowers default

- Invites to use a random effect specification by segmenting ratings histories according to a combination of factors



... to the Multi-factor Framework: Methodology (2/3)

- Risk parameters estimation methodology = Generalized Linear Mixed Models
- In this framework, the PD is modeled as:

$$P(\text{default}|b_t) = \Phi[\mu_0 + x'_{ti} \mu_r + z'_{ti} \gamma_t]$$

rating of the borrower matrix of random effects

- Specification where dynamic defaults history is explained by
 - > A fixed effect: mortgage's rating (μ_r)
 - > Random effects (γ_t):
 - A general latent factor
 - Augmented by a set of factors corresponding to given segmentation of the portfolio: belonging of an urbanization class

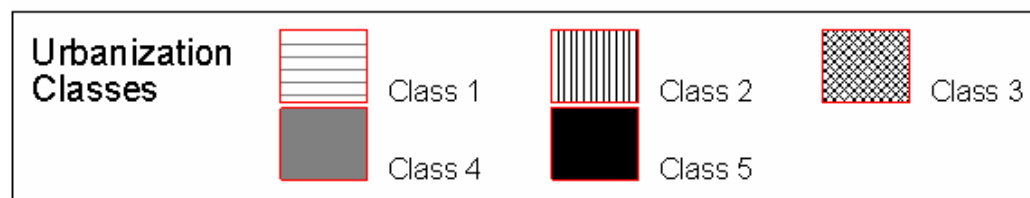
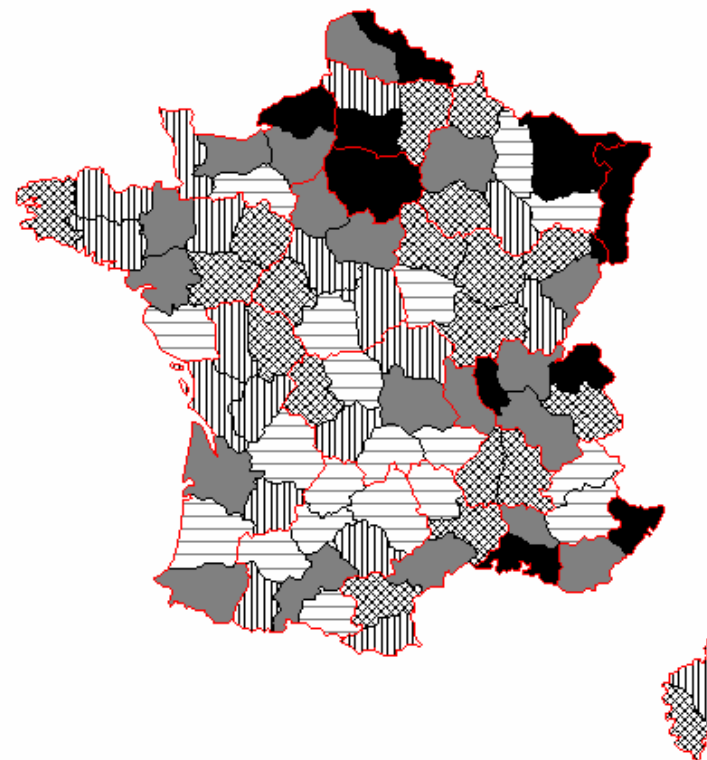


... to the Multi-factor Framework: Methodology (3/3)

- Additional factors add to the variance of the systematic factor
- GLMM estimates the dependence structure (covariance matrix):
 - > Covariance across exposures within additional factors
 - > Covariance between general ($q+1$) and additional ($1...q$) factors

$$G = \begin{bmatrix} \sigma_1^2 & 0 & \dots & \sigma_{1,q+1} \\ 0 & \ddots & 0 & \sigma_{2,q+1} \\ \vdots & \dots & \sigma_q^2 & \vdots \\ \sigma_{1,q+1} & \sigma_{2,q+1} & \dots & \sigma_{q+1}^2 \end{bmatrix}$$

- Complete ratings system of the Caisse d'Epargne Group
- Large portfolio of Mortgage loans, what allows to compute default rate by ratings and urbanization classes
- Urbanization rate grouped in 5 classes (location criterion)
- Ratings grouped in 8 rating grades plus default grade
- Period of the study : 2005 - 2008 (Monthly data)





Multi-factor Framework: Results (1/2)

- Covariance matrix of random effects, 5 urbanization classes and one general factor

	class 1	class 2	class 3	class 4	class 5	systematic risk factor
class 1	0,0036					0,0011
class 2		0,0015				-0,0021
class 3			0,0000			0,0000
class 4				0,0021		0,0058
class 5					0,0152	0,0089
systematic risk factor	0,0011	-0,0021	0,0000	0,0058	0,0089	0,0245



Multi-factor Framework: Results (2/2)

- Some urbanization classes characterized by:
 - > Low levels of covariance within urbanization classes
 - > Covariance levels follow a J-curve
 - Highest level in the most urbanized areas
 - > Negative covariance between systematic factor and urbanization risk factor
 - > Low levels of covariance between systematic factor and urbanization risk factor

- Urbanization risk factor seems to capture some borrowers heterogeneity



1. From the ASFR Framework to the multi-factor Framework

2. Multi-factor Model and Capital Allocation



VaR and marginal contributions: Methodology (1/3)

- To allocate economic capital, banks need a precise cartography of their portfolio credit risk, accounting for borrowers heterogeneity
- Potential for diversification can be managed by bankers only if borrowers heterogeneity is integrated in the computation of EC charges
- Estimates of portfolio risk parameters allow:
 - > To compute Portfolio Value-at-Risk (VaR) as a measure of economic capital
 - > To derive marginal contributions to the VaR of sub-portfolios exposed to additional systematic risk factors
 - > And to allocate capital and assess diversification potential



VaR and marginal contributions: Methodology (2/3)

- In a multi-factor context, loss variable is approximated by losses expectations conditional on the realization of general systematic and additional systematic risk factors
- The amount of losses depend on the sensitivity of the N exposures i ($i=1, \dots, n$) to a set of K systematic risk factors S_1, \dots, S_k which are common to all borrowers:

$$L(u) = \sum_{i=1}^n u_i g_i(S_1, \dots, S_k)$$



VaR and marginal contributions: Methodology (3/3)

- Properties of VaR allow to compute marginal contributions of sub-portfolios as partial derivatives of the portfolio VaR (Gouriéroux et al., 2000, Tasche, 1999)
- Computation of marginal contributions of sub-portfolios to economic capital charges (VaR) using the Tasche (2008) methodology



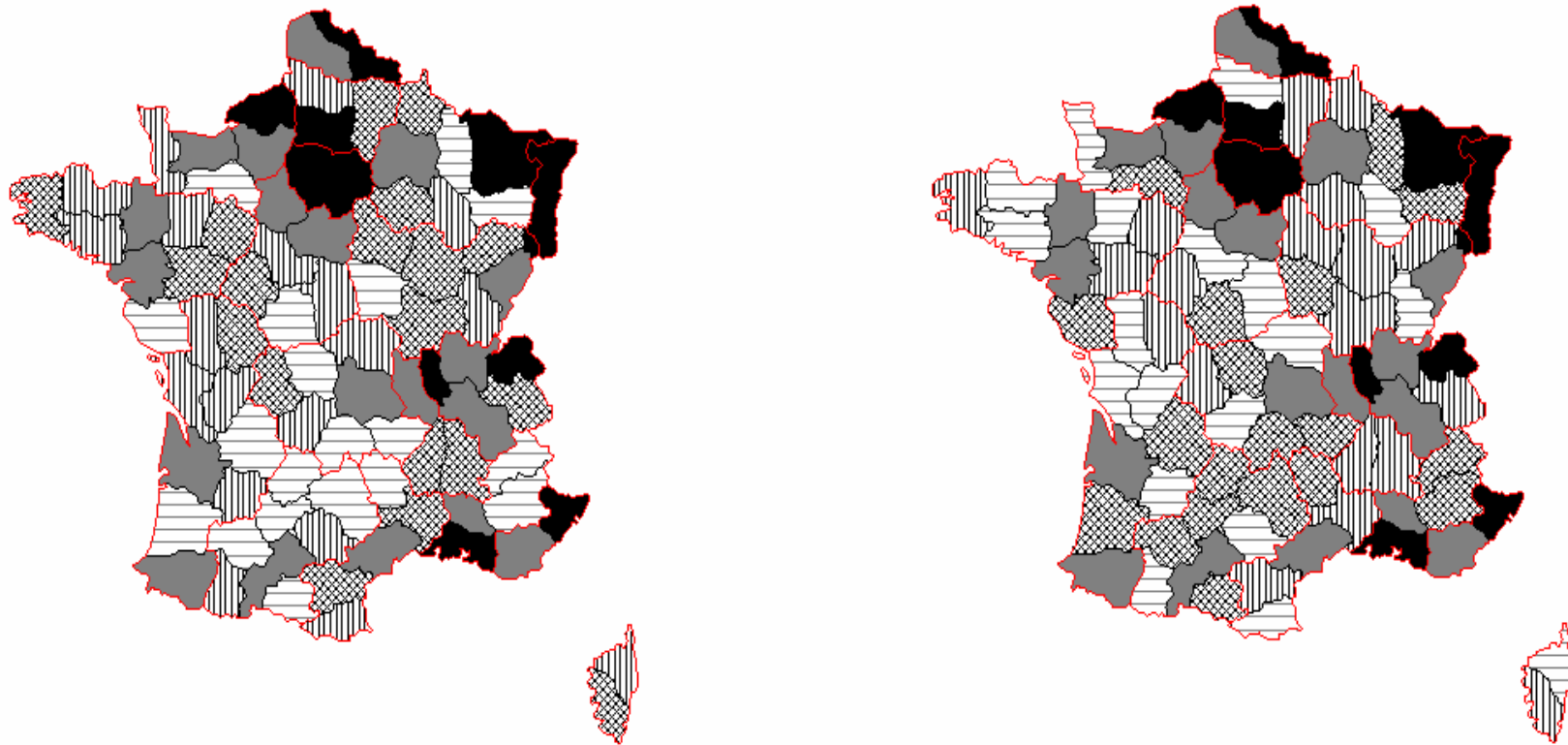
VaR and marginal contributions: Results (1/4)

- Table presents values of marginal contributions in terms of capital ratios by urbanization classes (all ratings taken together)
- Due to heterogeneity of portfolio risk parameters and exposures, marginal contributions of classes to capital charges vary across classes

Urbanization classes	Capital ratios given by a multi-factor model
Class 1	0,1266%
Class 2	0,1127%
Class 3	0,1221%
Class 4	0,1526%
Class 5	0,2226%



VaR and marginal contributions: Results (2/4)

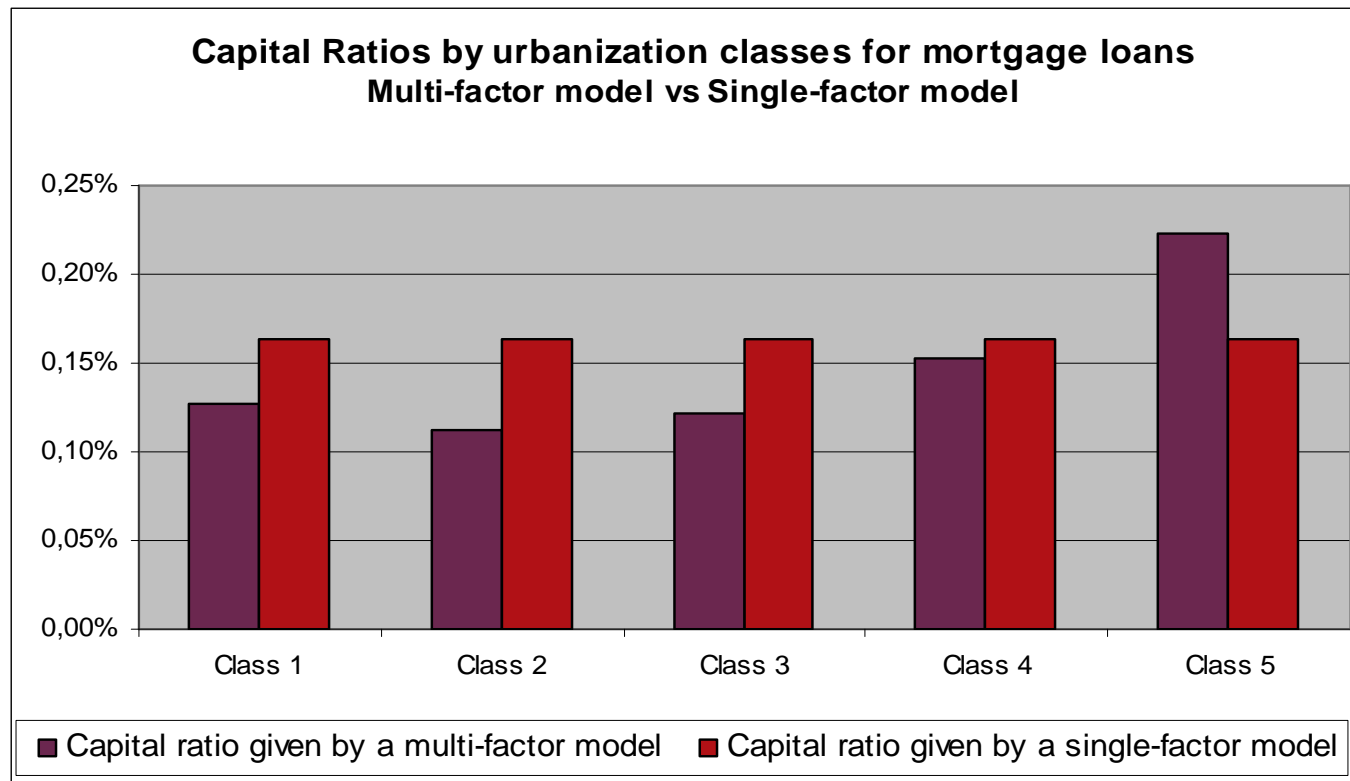


Urbanization Classes	Class 1	Class 2	Class 3	Class 4	Class 5

Capital ratios	0.11%	0.12%	0.13%	0.15%	0.22%



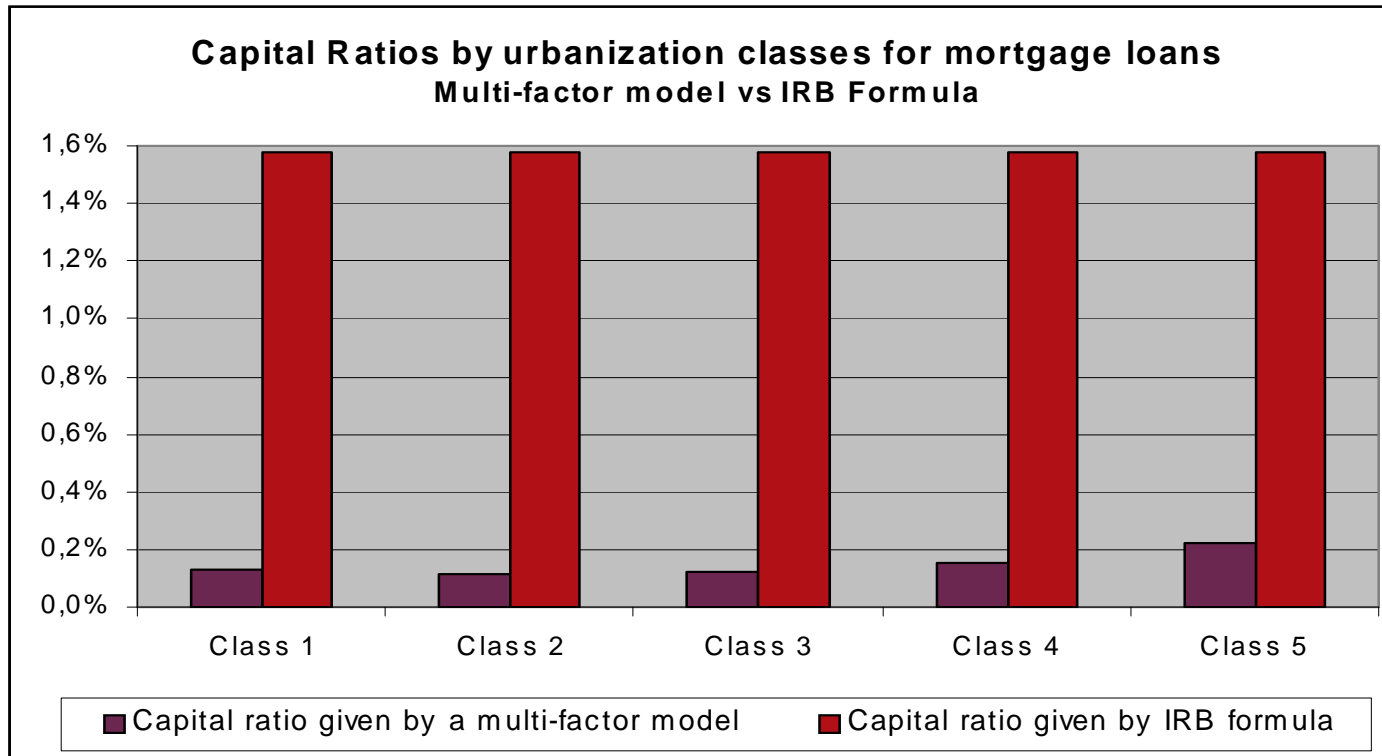
VaR and marginal contributions: Results (3/4)



- Taking account for additional risk factors induces:
 - > An *increase* of economic capital charges in some portfolio segments, relative to the capital charge computed by using a single factor model, the additional charges coming from the introduction of previously 'missing' factors in the credit portfolio risk measurement
 - > And – in this portfolio – a *decrease* of total economic capital charges, due to diversification effects coming from correlations between risk factors



VaR and marginal contributions: Results (4/4)



- Capital charges computed by using an internal model are far lower than Basel II IRBA charges



Conclusion

- Single-factor (regulatory) model of portfolio credit risk is insufficient to implement an optimal economic capital allocation policy and loans' pricing
- Multi-factor model allows to detect and manage potential concentration in retail loans portfolios
- However, the capacity to measure dependence structure across mortgage loans depends of the choice of additional systematic risk factors
- Active capital management needs additional research on the nature of risk factors in such portfolios