

Estimation of the impacts of macroeconomic variables on default rate (Internal stress-tests)



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1 Objectives

2 Methodology

3 Results

4 Application to Stress test

5 Conclusion

- **The context: Internal stress test**
- **Two main objectives:**
 - **Is there a specific link between probability of default and the evolution of macroeconomic variables?**
 - **Could we use this link to anticipate the future risk level and therefore, improve bank's risk management?**
- **To reach our aims:**
 - **Development of a statistical approach based on time series analysis: the Error Correction Model (ECM)**



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Limits and data available (1/2)

■ Some limits of this approach:

- The depth of historical data
- The representativeness of the business cycle
- The bank management in credit approval policy
- The homogeneity of risk data

■ Macroeconomic database :

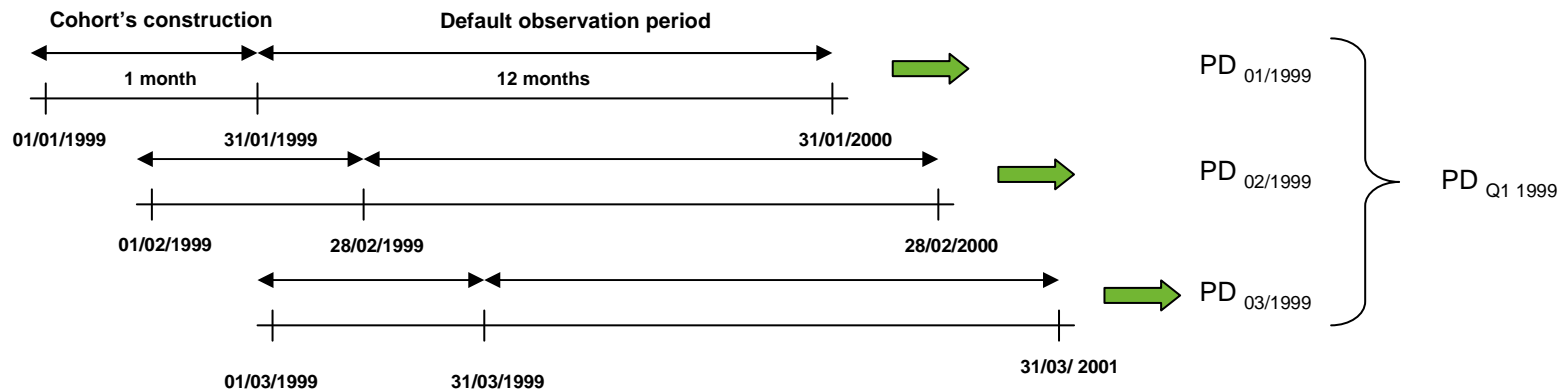
- 30 key quarterly macroeconomic variables provided by INSEE¹ from 1993 through 2010.
 - Unemployment rate
 - GDP,...
- Others variables specific to the portfolios analyzed
 - Number of new car's registration
 - Consumer hard goods

■ Internal risk data :

- Historical default rate (PD) of two retail banking portfolios:
 - Revolving credit
 - Repayment loan

(1) : Institut National de la Statistique et des Etudes Economiques

Limits and data available (2/2)



- **The quarterly probability of default is an average of 3 monthly PD**
 - A one year delay to determine the PD (PD_{Q1 2010} is observed on Q1 2011)
 - For the 2011-2012 stress test the historical PD's data is available until Q4 2009

- **The PD “point in time” is used rather than the PD “Through the Cycle”**

Error Correction Model (ECM) (1/3)

■ Principle:

□ **ECM are based on the assumption that the PD and macroeconomic factors exhibit an equilibrium relationship that determines both short- and long-run behaviour.**

- The long run relationship is positing between a dependant variable (PD) and independent variables with lag structure to be empirically determined
- The short run relationship, influenced by the deviation from the long run relationship, measures the adjustments between the variables

■ The default rate is modeled by a logistic function:

□ y_t is a macroeconomic index which is assumed to be related to the macroeconomic factors, according to the ECM specification

$$PD_t = \frac{1}{1 + \exp(-y_t)} \Leftrightarrow y_t = \ln\left(\frac{PD_t}{1 - PD_t}\right)$$

Error Correction Model (ECM) (2/3)

Preliminary step

- Stationarity test of all variables (macroeconomic and PD)
 - Dickey Fuller (Augmented), Phillips Perron, KPSS, ERS
 - Selection of macroeconomic variables which are integrated of the same order as PD
- Setting a priori sign for each macroeconomic factor's coefficient with respect to economic theory
 - 30 key macroeconomics variables

Long run relationship

- Estimation of the cointegrating vectors by regressing PD on macroeconomic factors
 - By OLS or GLS (in case of residual autocorrelation)
- Cointegration test: *residual based test*
 - 2 step method by Engle and Granger
 - Phillips Ouliaris test
- Selection of the long run relationship:
 - Statistical criterion
 - Economic consistency

Short run relationship

- Estimation of the short run relationship: $\Delta PD_t = \Phi_0 + \Phi_1 \hat{\varepsilon}_{t-1} + \Phi_2 \Delta X_{i,t} + \Phi_3 Z_{i,t} + \gamma_{i,t}$
 - $\hat{\varepsilon}_{t-1}$ the error term of long run relationship
 - $Z_{i,t}$ the stationary macroeconomic variables.
 - $\Delta X_{i,t}$ the macroeconomic variables which are integrated as PD's order
- $\hat{\Phi}_1$ Has to be both negative and statistically significant

Error Correction Model (ECM) (3/3)

- For more convenience, the ECM is transformed from 2 to 1 equation

- For instance:

$$\begin{cases} y_t &= \beta_1 GDP_{t-1} + \beta_2 Inflation_t + \varepsilon_t \\ \Delta y_t &= \theta_1 \hat{\varepsilon}_{t-1} + \theta_2 \Delta GDP_{t-2} + \theta_3 \Delta Inflation_{t-2} + \nu_t \end{cases}$$



$$y_t = (1 + \theta_1)y_{t-1} - \theta_1 * \beta_1 GDP_{t-2} - \theta_1 * \beta_2 Inflation_{t-1} + \theta_2 \Delta GDP_{t-2} + \theta_3 \Delta Inflation_{t-2} + \nu_t$$

- Some validation tools:
 - Adjusted Root means Square Error
 - Adjusted pseudo R²
 - Backtesting out of time



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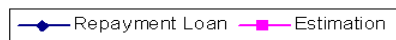
4 Application to stress test

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Repayment loan(1/2)

3 models proposed:

Macroeconomic factors		Repayment loan		
		Model 1	Model 2	Model 3
Household investment	1	T-1,T-3	T-1,T-3	T-1,T-3
Household investment	2	T-1		T-1
Unemployment rate	+	T-5	T-5	T-5
Real disposable personal income	1	T-4	T-4,T-5	T-4
Quarterly inflation rate	-		T-3	T-3
Statistical Criteria				
Pseudo R ²		0.860	0.867	0.888
Adjusted RMSE		0.0232	0.0226	0.0207

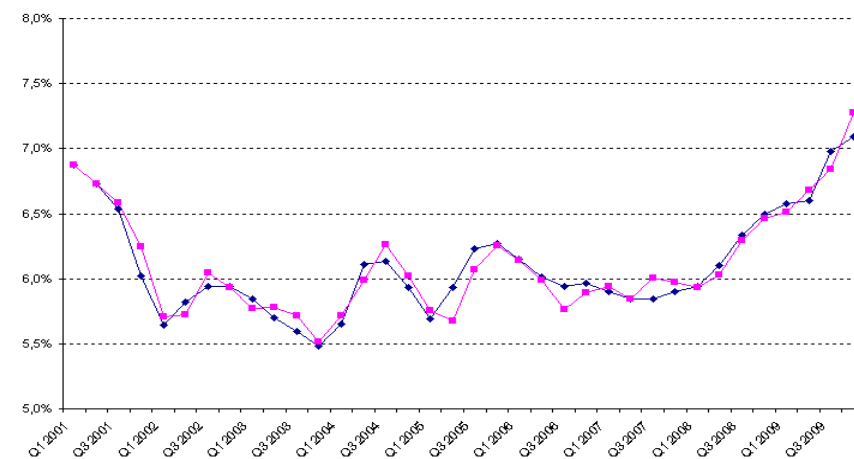


- (1) : included in growth rate
- (2) : included in first difference of growth rate

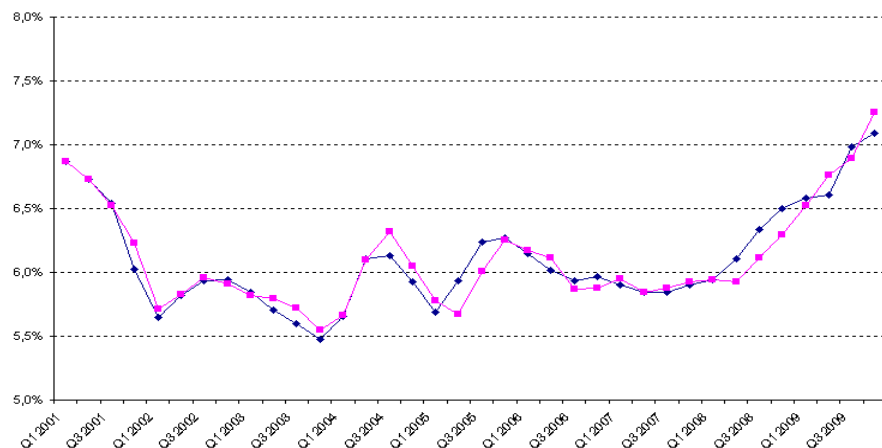
Model 1



Model 3

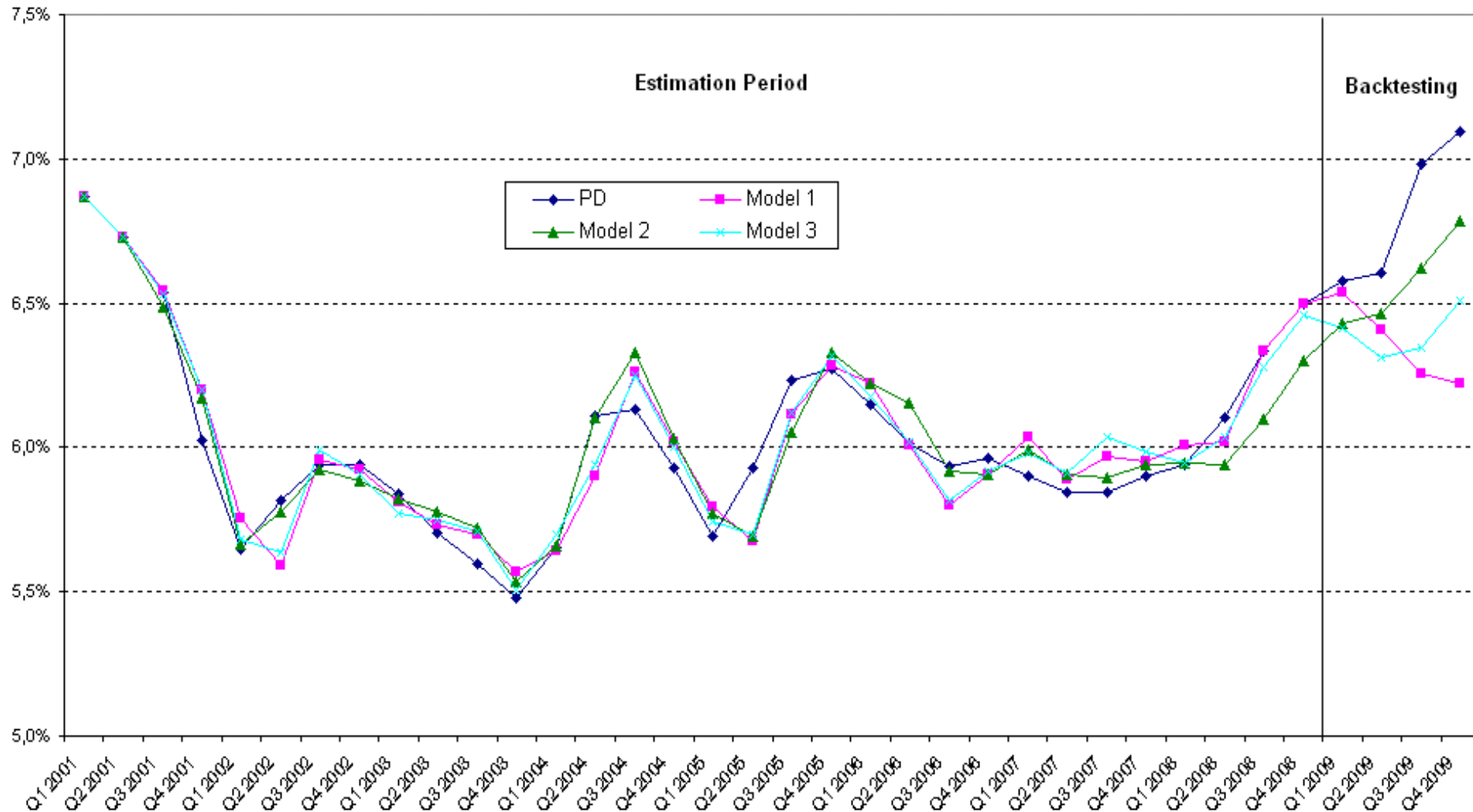


Model 2



Repayment loan(2/2)

Backtesting out of time

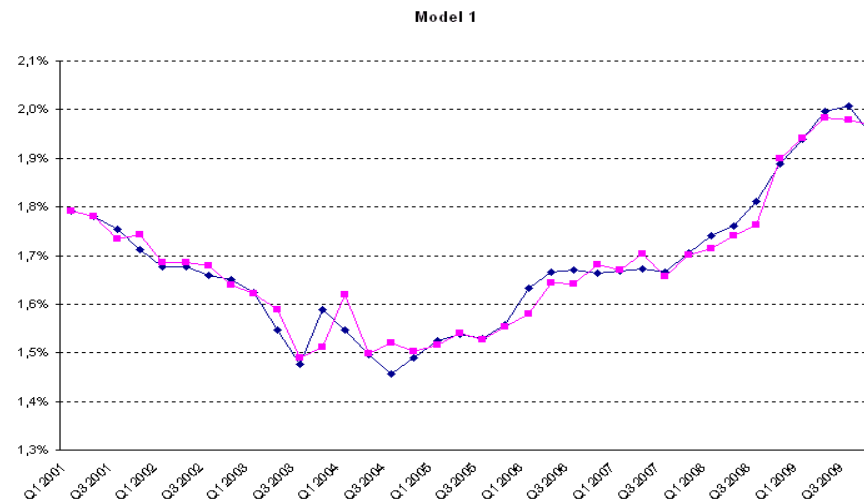


Revolving Credit (1/2)

3 Models proposed:

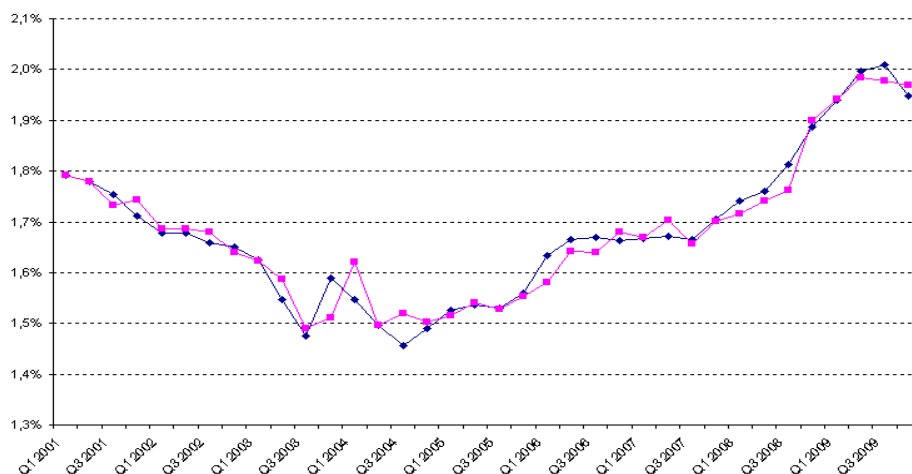
- (1) : included in growth rate
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Macroeconomics factors		Revolving Credit		
		Model 1	Model 2	Model 3
Household investment	1 -	T	T-1	
Outstanding Mortgage credit	1 -	T	T	T
Household debt ratio	1 +	T-1	T-1	T-1
10 Year interest rate	+	T	T-2	
New cars registration	1 +	T-4	T-1	T-1
Outstanding Mortgage credit	2 -	T	T	T
Unemployment rate	+			T-1
3 months interest rate	+			T-3
Hard goods consumption expenditure	1 -		T-2	T-2
Statistical Criteria				
Pseudo R ²		0.940	0.943	0.957
Adjusted RMSE		0.021	0.021	0.018



Model 2

—●— Revolving Credit —■— Estimation

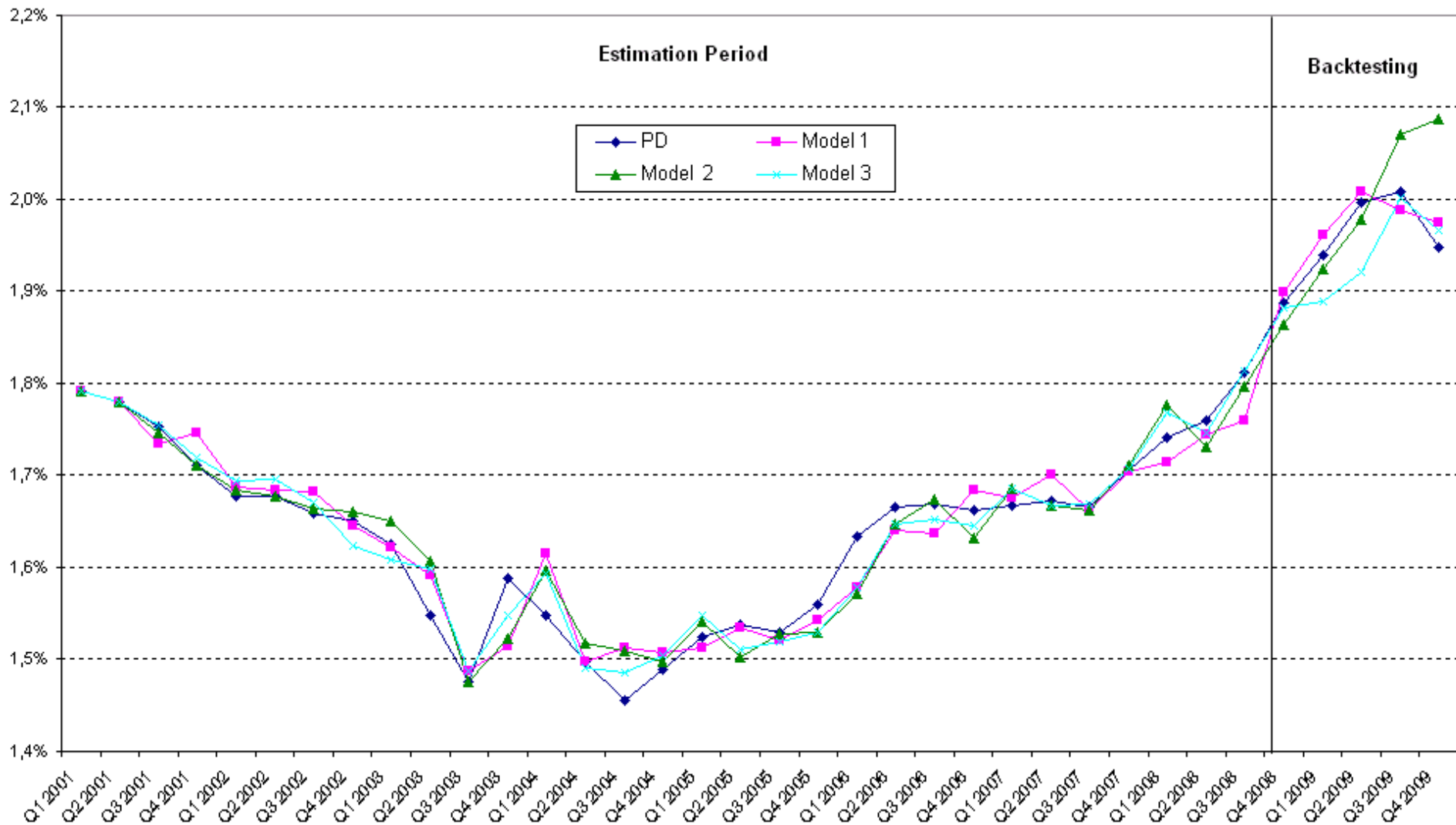


Model 3



Revolving credit(2/2)

Backtesting out of time





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- **2 Scenarios designed by the EBA (2011 stress test):**
 - **Baseline scenario: based on the average of the forecasts by the consensus of macro forecasters**
 - **Adverse scenario : based on a macro crisis scenario**

			Baseline		Adverse	
		2010	2011	2012	2011	2012
1	GDP	1,5%	1,6%	1,8%	0,4%	0,2%
	Household investment	-2,20%	0,0	0,0	-2%	-5,50%
	Corporate investment	-1,60%	2,8%	3,8%	0,50%	-1,50%
	Real disposable personal income	2,60%	0,0	0,0	1,50%	0,50%
	Outstanding consumer credit	1,0%	0,9%	1,8%	-1,0%	-3,0%
	Outstanding mortgage credit	8,2%	8,4%	7,9%	2,0%	-2,0%
	Outstanding corporate investment credit	-3,6%	2,0%	8,0%	-4,0%	-10,0%
	Housing price	6,3%	0,8%	1,1%	-3,4%	-12,4%
	Hard goods consumption expenditure	-0,1%	-1,0%	2,0%	-3,0%	-1,0%
	New cars registration	-3%	-2%	3%	-6%	-3%
2	Quarterly inflation	1,5	1,6	1,6	1,3	0,9
	Unemployment rate	9,3	9,5	9,2	9,6	9,8
	Corporate debt ratio	122%	123%	125%	118%	112%
	10 Year interest rate	2,9	2,7	2,9	3,5	3,5
	Household debt ratio	79,3%	82,1%	85,2%	78,9%	76,9%

(1) : included in growth rate

(2) : included in level

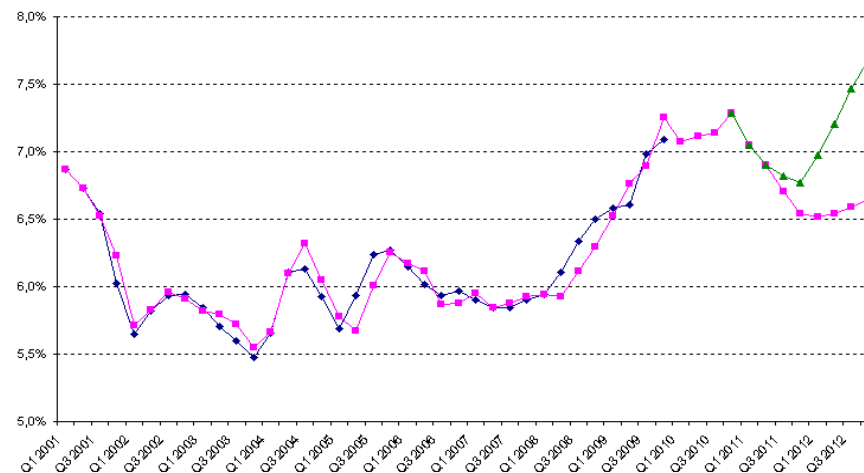
Repayment loan

Results under the stress scenario

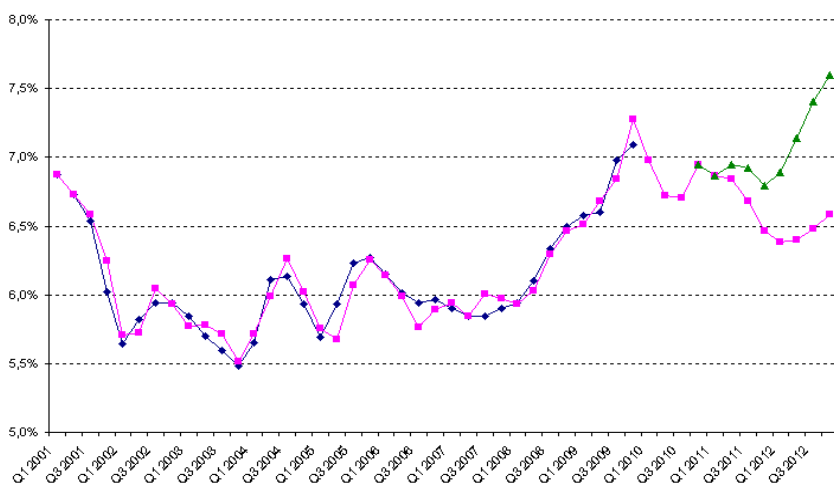
Model 1



Model 2



Model 3



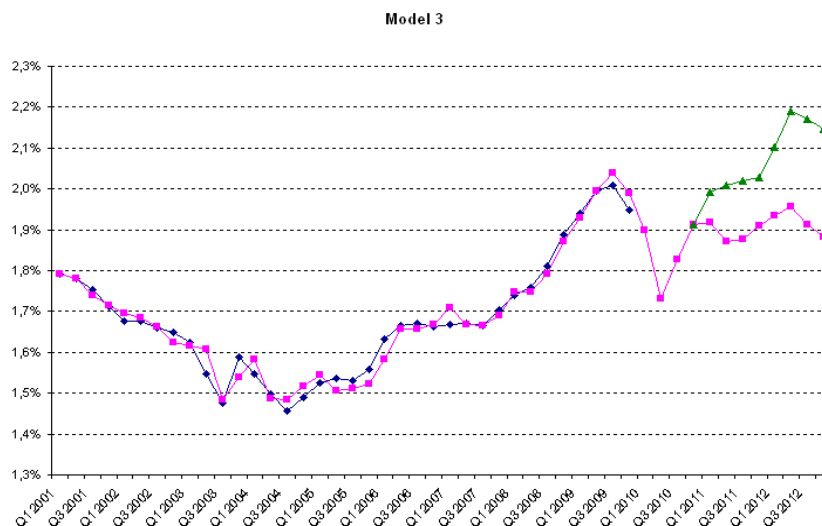
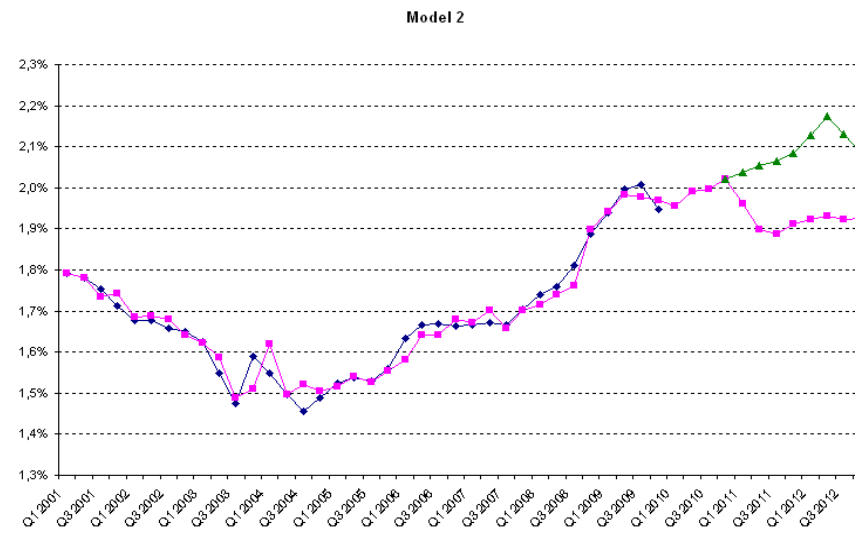
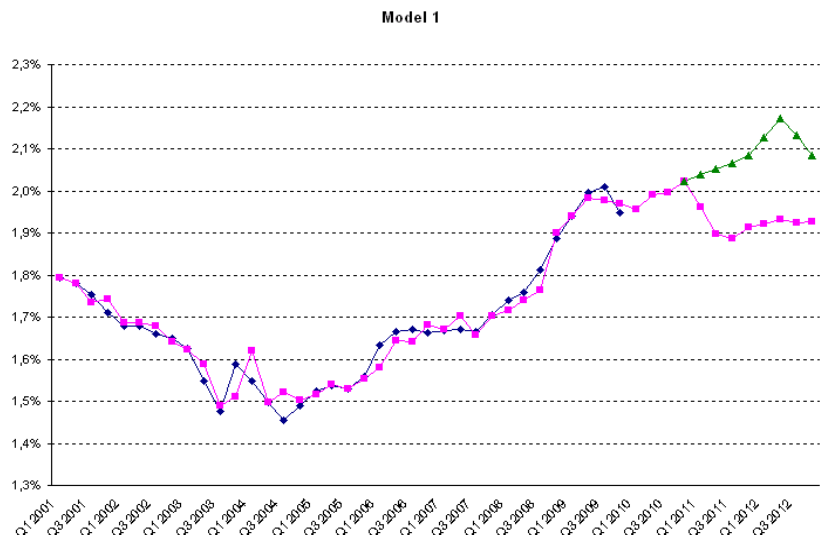
◆ Repayment Loan
 ■ Baseline
 ▲ Adverse

	Impact					
	Model 1		Model 2		Model 3	
	Baseline	Adverse	Baseline	Adverse	Baseline	Adverse
2011	-3,66%	0,79%	-10,18%	-7,07%	-6,88%	-2,20%
2012	-0,44%	9,34%	1,67%	13,57%	1,87%	11,83%
Overall	-4,09%	10,20%	-8,68%	5,54%	-5,14%	9,37%

	PD					
	Model 1		Model 2		Model 3	
	Baseline	Adverse	Baseline	Adverse	Baseline	Adverse
Q4 2010	6,80%		7,28%		6,95%	
Q4 2011	6,55%	6,85%	6,54%	6,77%	6,47%	6,79%
Q4 2012	6,52%	7,49%	6,65%	7,69%	6,59%	7,60%

Revolving credit

Results under the stress scenario



◆ Revolving ■ Baseline ▲ Adverse

	Impact					
	Model 1		Model 2		Model 3	
	Baseline	Adverse	Baseline	Adverse	Baseline	Adverse
2011	-5,435%	3,072%	-4,799%	2,500%	-0,186%	5,984%
2012	0,693%	0,016%	-2,034%	1,511%	-1,430%	5,853%
Overall	-4,779%	3,088%	-6,736%	4,049%	-1,613%	12,187%

	PD					
	Model 1		Model 2		Model 3	
	Baseline	Adverse	Baseline	Adverse	Baseline	Adverse
Q4 2010	2,02%		2,09%		1,91%	
Q4 2011	1,94%	2,08%	1,99%	2,14%	1,91%	2,03%
Q4 2012	1,93%	2,09%	1,95%	2,18%	1,88%	2,15%



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■ Quite satisfactory results:

- **A model for performing macroeconomic stress test**
- **The goodness of fit on the historical data**
- **The impacts measured:**
 - A slight increase or decrease under the baseline scenario
 - A sharp rise under the adverse scenario

■ Forthcoming:

- **Define additional tools to improve the choice of the best model**
 - Quantitative or qualitative?
 - Building of “global index”
- **Data enhancement**



QUESTIONS?

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