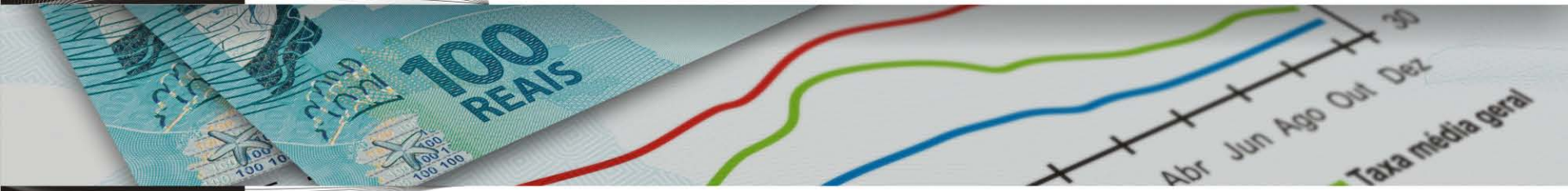
VI Seminário sobre Riscos, Estabilidade Financeira e Economia Bancária do Banco Central do Brasil



Credit Default and Business Cycles: An Empirical Investigation of Brazilian Retail Loans

Arnildo Correa, Jaqueline Marins, Myrian Neves and Antonio Carlos Magalhães

São Paulo, August 12, 2011

Motivation

- The 2004 Basel II Accord introduced a menu of approaches for determining capital requirements, including the internal ratings-based (IRB) approach.
  - It allowed banks to compute capital charges based on their own estimates of Probability of Default (PD) and Loss Given Default (LGD).

- Under the IRB approach, capital requirements are an increasing function in the PD and LGD parameters.

- A recent concern with this risk-sensitiveness of regulatory capital is that it might amplify fluctuations in the business cycles.

$$\underbrace{\text{Recession} \Rightarrow \uparrow \text{PD}, \uparrow \text{Corr}, \uparrow \text{LGD} \Rightarrow \uparrow \text{K}, \uparrow \text{VaR}}_{\text{First part}} \Rightarrow \underbrace{\downarrow \$\text{Supply} \Rightarrow \uparrow \text{Recession}}_{\text{Second part}}$$

- Discussion about capital buffers.

This paper

- The paper aims to understand the relationship between credit default and business cycles. In particular, the first part of the argument.
  - To what extent recessions increase credit default.
  - What are the impacts of recessions on the losses of lender institutions.

- We use data from the retail sector.

- We explore the time series and the individual data evidence.

- We take into account the unobserved individual effects.

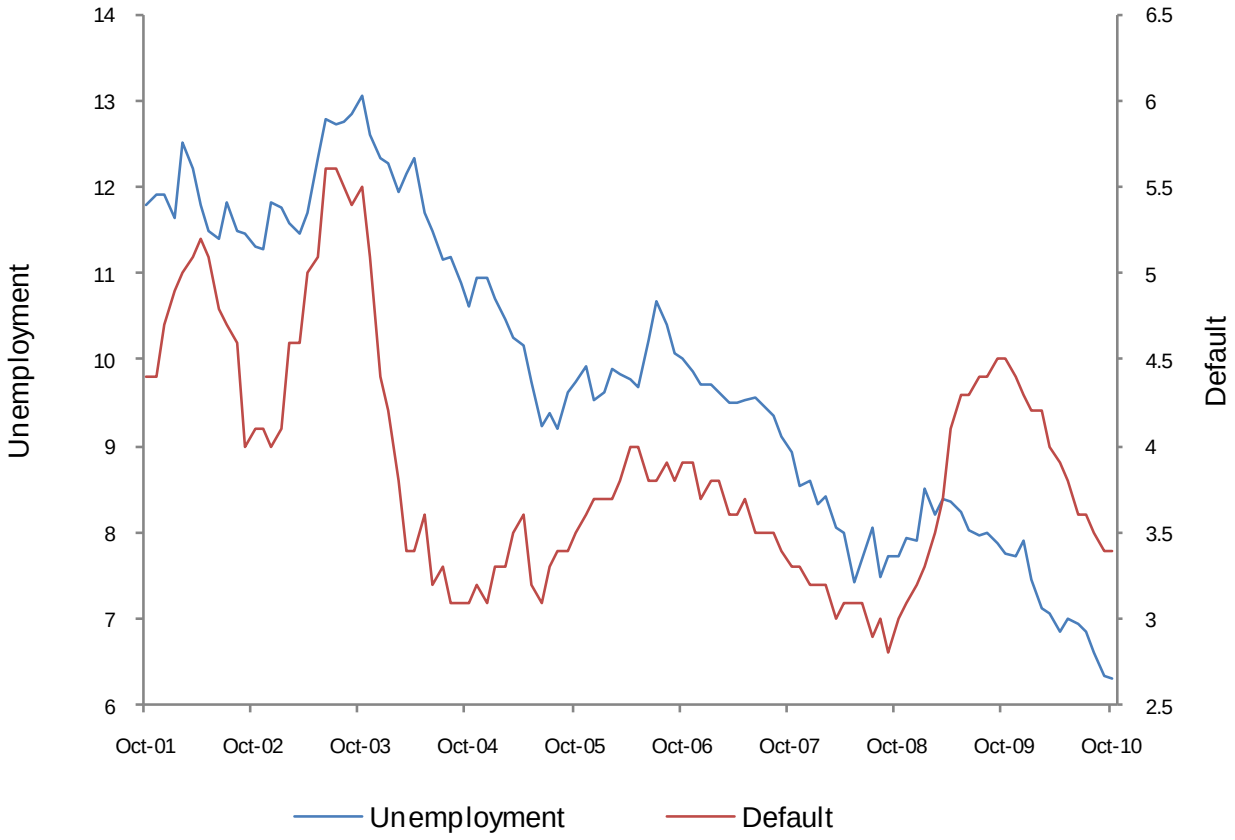
The literature

- Kashyap and Stein (EP, 2004)
- Koopman and Lucas (JAE, 2005)
- Koopman, Lucas and Klassen (JBF, 2005)
- Koopman, Lucas and Monteiro (JE, 2008)
- Repullo and Suarez (2008)
- Repullo, Saurina and Trucharte (2010)
- Andersen (JFS, 2011)

- Cowan and Cowan (JBF, 2004)

Evidence from time series

Figure: Credit default and unemployment rate – 2001:10 - 2010:10



VAR model

- We estimate a Vector Autorregressive (VAR) model:

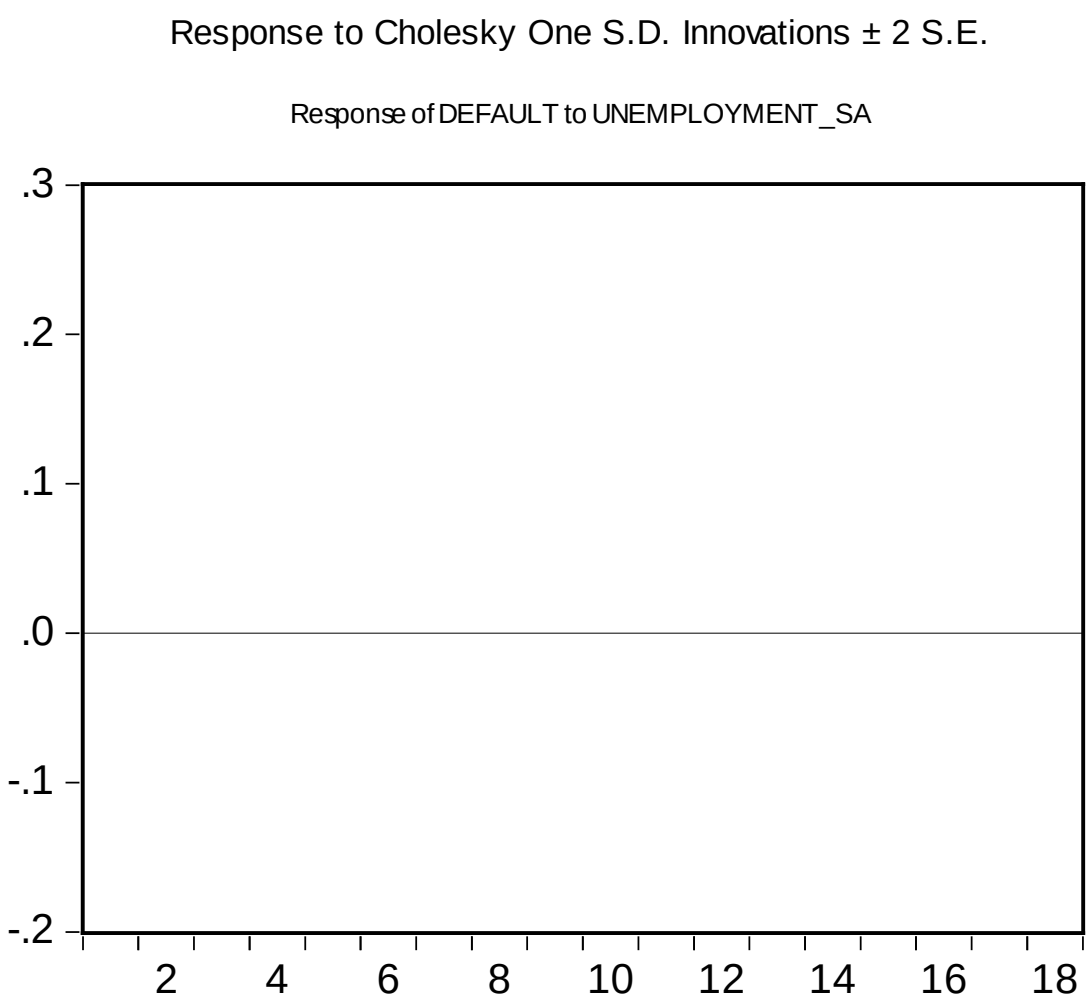
$$\mathbf{B}\mathbf{y}_t = \mathbf{c} + \sum_{s=1}^{P} \mathbf{A}_s \mathbf{y}_{t-s} + \boldsymbol{\varepsilon}_t,$$

where $\mathbf{y}_t = \begin{bmatrix} u_t \\ i_t \\ D_t \end{bmatrix}$.

- We use Cholesky decomposition with the following ordering:

Unemployment $\rightarrow$ Selic $\rightarrow$ Default

VAR (5): Impulse response funtions



Microdata

- Data from the Credit Information System (SCR) of the Central Brank of Brazil.
- Two modalities of retail credit: Consumer Credit and Vehicle Financing.
- Two institutions: A and B.
- They represent 31% of Consumer Credit and 38% of Vehicle Financing.
- Period: 2003 – 2008.
- Frequency: Semi-annually.
- No. of transactions: 730 thousand in Consumer Credit and 2.5 million in Vehicle Financing.

Probit model

- Return or potential wage:

$$y^*_{i,j,t} = \mathbf{x}'_i\boldsymbol{\beta} + \mathbf{m}'_{i.t}\boldsymbol{\gamma} + \mathbf{z}'_{i,t}\boldsymbol{\theta} + c_i + d_j + u_{i,j,t},$$

where $\mathbf{m}'_{i,t}$ are macroeconomic and/or sectoral variables measuring business cycles.

- As usual, we assume that $u_{i,j,t} \sim N(0,1)$

- We observe: $$y_{i,j,t} = \begin{cases} 1, & \text{if } y^*_{i,j,t} \leq \alpha \\ 0, & \text{if otherwise} \end{cases}$$

Probit model

- The probability of default is given by

$$\begin{aligned}\Pr[y_{i,j,t}=1|\mathbf{w}_{i,j,t},c_i] &= \Pr[y^*_{i,j,t}\le\alpha\,|\,\mathbf{w}_{i,j,t},c_i]\\ &= \Pr[\mathbf{x}_i'\boldsymbol{\beta}+\mathbf{m}_{i.t}'\boldsymbol{\gamma}+\mathbf{z}_{i,t}'\boldsymbol{\theta}+c_i+d_j+u_{i,j,t}\le\alpha\,|\,\mathbf{w}_{i,j,t},c_i]\\ &= \Pr[u_{i,j,t}\le\alpha-\mathbf{x}_i'\boldsymbol{\beta}-\mathbf{m}_{i.t}'\boldsymbol{\gamma}-\mathbf{z}_{i,t}'\boldsymbol{\theta}-c_i-d_j]\\ &= \Phi(\alpha-\mathbf{x}_i'\boldsymbol{\beta}-\mathbf{m}_{i.t}'\boldsymbol{\gamma}-\mathbf{z}_{i,t}'\boldsymbol{\theta}-c_i-d_j),\end{aligned}$$

where $\Phi(.)$ is the standard normal cumulative distribution function and $\mathbf{w}_{i,j,t}=(\mathbf{x}_i',\mathbf{m}_{i,t}',\mathbf{z}_{i,t}',d_j)'$

Probit model

- Problem: The parameters c_i appear in the likelihood function and they are unobserved.

- We assume: $c_i \mid \mathbf{w}_{i,j,t} \sim N(0, \sigma_c^2)$

- Then, we have:

$$f(y_{i,j,1},\ldots,y_{i,j,T} \mid \mathbf{w}_{i,j}; \boldsymbol{\Psi}) = \int_{-\infty}^{+\infty} \left\{ \left[\prod_{t=1}^{T} f(y_{i,j,t} \mid \mathbf{w}_{i,j,t}, c_i; .) \right] \left(\frac{1}{\sigma_c} \right) \phi\left(\frac{c}{\sigma_c} \right) \right\} dc,$$

where $\phi(.)$ is the density function of the standard normal distribution and $\boldsymbol{\Psi}$ are the parameters.

Probit model

- Variables measuring business cycles:
  - Aggregate unemployment
  - Regional unemployment
  - GDP

- Other controls:
  - Risk rating;
  - Interest rate;
  - Market size (population);
  - Borrower's gender;
  - Borrower's occupation;
  - Age;
  - Fixed effects for banks.

Consumer credit – Marginal effect

	(1)	(2)	(3)	(4)	(5)
Regional unemployment	0.0107***		-0.0003	-0.0003	-0.0004
Aggregate unemployment		0.0330***	0.0337***	0.0389***	0.0100***
GDP				-0.0071***	-0.0023***
Rating A	0.1944***	0.2151***	0.2109***	0.2101***	0.0140***
Rating B	0.5041***	0.5257***	0.5182***	0.5173***	0.1653***
Rating C	0.6426***	0.6477***	0.6476***	0.6470***	0.2941***
Rating D	0.9285***	0.9318***	0.9312***	0.9308***	0.6126***
Male	0.0149***	0.0143***	0.0151***	0.0151***	0.0083***
σ_c	0.6285***	0.6111***	0.6067***	0.6039***	0.1888
ρ	0.2832***	0.2719***	0.2690***	0.2672***	0.4356
Percent correctly predicted - Total	83.77	88.81	83.78	83.78	83.78
Percent correctly predicted - Default	76.36	73.47	76.36	76.36	76.24
Percent correctly predicted - Non Default	87.84	97.24	87.86	87.86	87.91
Log-likelihood value	-432515.16	-482208.97	-431699.89	-431657.92	-
No. obs.	1406843	1566423	1406843	1406843	1406843

Vehicle financing – Marginal effect

	(1)	(2)	(3)	(4)	(5)
Regional unemployment	0.0024***		0.0011***	0.0011***	0.0013***
Aggregate unemployment		0.0059***	0.0048***	0.0067***	0.0062***
GDP				-0.0058***	-0.0061***
Rating A	0.0013***	-0.0008**	-0.0011***	-0.0015***	-0.0054***
Rating B	0.0925***	0.0893***	0.0872***	0.0863***	0.0739***
Rating C	0.2245***	0.2249***	0.2210***	0.2198***	0.1911***
Rating D	0.8106***	0.8105***	0.8112***	0.8124***	0.7427***
Male	0.0024***	0.0023***	0.0024***	0.0024***	0.0032***
σ_c	0.2981***	0.2917***	0.2915***	0.2842***	0.0745
ρ	0.0815***	0.0784***	0.0783***	0.0747	0.1655
Percent correctly predicted - Total	87.85	95.88	87.85	87.85	87.85
Percent correctly predicted - Default	57.96	52.8	57.96	57.96	57.96
Percent correctly predicted - Non Default	90.07	99.08	90.07	90.07	90.07
Log-likelihood value	-254211.74	-283792.62	-253573.23	-252951.29	-
No. obs.	1750841	1928644	1750841	1750841	1750841

Transition probabilities

- We estimate the transition probabilites by the historical method.

Table: Univariate transition probabilities – recession and boom

	Consumer Credit - Recession						Vehicle Financing - Recession					
	Final Rating						Final Rating					
Intial Rating	AA	A	B	C	Default		AA	A	B	C	Default	
AA	40.03%	35.15%	3.35%	17.41%	4.07%	AA	77.40%	12.62%	6.85%	1.66%	1.47%	
A	2.02%	61.06%	14.84%	8.58%	13.50%	A	0.02%	84.40%	6.50%	3.40%	5.68%	
B	0.13%	9.52%	49.76%	6.44%	34.16%	B	0.11%	22.46%	45.64%	7.59%	24.19%	
C	0.04%	0.74%	1.85%	56.45%	40.92%	C	0.03%	23.45%	8.41%	14.82%	53.30%	
Default	0.00%	0.26%	0.68%	0.32%	98.74%	Default	0.01%	4.08%	1.73%	1.66%	92.52%	
	Consumer Credit - Boom						**Vehicle Financing - Boom**					
	Final Rating						Final Rating					
Initial Rating	AA	A	B	C	Default		AA	A	B	C	Default	
AA	48.97%	43.36%	2.45%	2.04%	3.17%	AA	88.92%	1.81%	3.05%	2.88%	3.33%	
A	1.25%	77.38%	11.57%	2.30%	7.50%	A	10.28%	75.61%	5.89%	4.06%	4.16%	
B	0.07%	8.77%	60.24%	4.44%	26.48%	B	9.29%	17.95%	44.94%	10.96%	16.87%	
C	0.14%	3.24%	9.03%	46.93%	40.67%	C	10.50%	11.01%	6.37%	35.17%	36.95%	
Default	0.01%	0.52%	2.91%	0.80%	95.76%	Default	2.92%	3.35%	1.81%	2.65%	89.28%	

Note: Average of semi-annual transition frequencies from rating i (initial rating) to rating k (final rating) in periods of recession and booming. Period: Jan/2003 to Jul/2008.

Value at Risk experiment

- The model structure is the following:

$$L = \sum_{i=1}^{N} EAD_i * LGD_i * Y_i$$

where:

- N is the # of transactions (50,000 in our simulation)
- EAD_i is the exposure at default (equal to R$1 in our simulation)
- LGD_i is the loss given default (See Silva, Marins and Neves (2009))
- Y_i is a Bernoulli variable indicating default

Value at Risk experiment

Table: Simulated credit VaR

Consumer Credit			
Percentiles	**95.0%**	**99.0%**	**99.9%**
Booming	18.85%	18.89%	18.91%
Recession	21.55%	21.61%	21.62%
Vehicle Financing			
Percentiles	**95.0%**	**99.0%**	**99.9%**
Booming	12.27%	12.31%	12.32%
Recession	12.82%	12.88%	12.90%

Note: Percentiles of the simulated potential losses distribution. The VaR experiment is based in a portfolio composed by 50 thousand transactions sampled from portfolios of the two banks. Results are based in one hundred simulations in five runs.

- Difference: 14% in Consumer Credit and 4% in Vehicle Financing.

Conclusions

- VAR estimations suggest that after a positive shock in the unemployment rate credit default increases, but the increase seems to be modest.
- Estimations based on microdata also provide evidence that the impact of an increase in the unemployment rate (both aggregate and sectoral) or in the GDP growth rate lies between 1 and 3 percentage points.
- VaR experiments show that potential losses in recessions are 4%-14% higher when compared to the losses during booming periods.
- There is a relationship between credit default and business cycles, but less strong than suggested in previous studies that use corporate data.