Bank Capital and Shocks Transmission: A Principal Components Analysis and Vector Error Correction Model

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Abstract

The recent financial turmoil has clearly highlighted the potential role of financial factors on amplification of macroeconomic developments and stressed the importance of analyzing the relationship between banks' balance sheets and economic activity. This paper assesses the impact of the bank capital channel in the transmission of shocks in Europe on the basis of bank's balance sheet data. The empirical analysis is carried out through a *Principal Component Analysis* and in a *Vector Error Correction Model.*

Key Words: *Bank Capital Channel, Shocks Transmission, Principal Component Analysis, Non-stationary panel.*
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1. INTRODUCTION

The recent financial turmoil has clearly highlighted the potential role of financial factors on amplification of macroeconomic developments and stressed the importance of analysing the relationship between banks' balance sheets and economic activity (Mehan and Moran, 2009; Pariès and al.,2010). The theory of bank capital channel developed (Blum and Hellwig, 1995; Van den Heuvel, 2002; Chami and Cosimano, 2001; Chen, 2001), the structures of bank balance sheets and their procyclicality determine the spread and amplification of shocks.

Many empirical studies on this channel have been performed. In the United States, Van den Heuvel (2004, 2008) shows the role of regulatory capital. Hubbard and al. (2002) show that the cost of loans granted by the various intermediaries varies and depends on their own financial situation (level of capitalization, for example). Markovic (2005) extends this result to the case of Britain, while Angeloni et al. (2002), Gambacorta (2004) and others, analysing individual cases in European countries. Bouvatier and Lepetit (2007), and Badarau-Semenescu and Levieuge (2010) are interested in several European countries. The results of these studies are not unanimous[3]. The magnitude and sign of the estimated model coefficients depend on the variables, estimate method and sample used to measure the impact of this channel on credit supply.

Although our paper is within this framework, we adopt an original approach. A Principal Components Analysis (PCA) and a Vector Error Correction Model (VECM) are used as complements. First, the PCA is performed to reduce the dimensionality of the sample by finding a new set of "optimal variables", which nevertheless contains most of sample information[4]. This preprocessing allows feed the model with fewer variables[5]. In a second step, the reduced variables

[3] For example, Van den Heuvel (2004) focuses on capital requirements, Bouvatier and Lepetit (2007) interested in the role of loan loss provision, etc.

[4] The resulting variables are uncorrelated and are ordered by factor the total information that each contains.

[5] In the practice of multivariate modelling, analysis often face a number of variables much larger than the "optimum number" needed. Some specialized techniques used to select variables: the use

obtained by the PCA named Principal Components are used in the VECM. As series are integrated of the same order and cointegrated, estimating a VAR in first differences is inappropriate; so it should be preferable to set the model as a VECM (Engle and Granger, 1987; Johansen, 1988). Moreover, a VECM can highlight relationships of short and long term.
The rest of paper is as follow: data and methodology are discussed in section 2; section 3 presents the assessment of the bank capital channel through PCA and VECM. Section 4 concludes.

2. DATA AND METHODOLOGY

Annual data available in Bankscope are used for the period 2002 to 2009. Our sample consists of an unbalanced panel of 181 commercial banks established in 14 European countries: Austria, Belgium, Denmark, Finland, France, Germany, Ireland, Italy, Netherlands, Portugal, Spain, Sweden, Switzerland and United Kingdom.
Based on bank capital channel studies, variables retained for this paper are:
NLTA is the endogenous variable (used by Kashyap and Stein, 1995) corresponding to net loans over total assets. Using this variable improves expected response from forward increase in output (Driscoll, 2002). *EXCESS_CAP* appreciate bank capital level due to regulatory requirements (Gambacorta and Mistrulli, 2004). *EQTA* represents the equity over total assets. *LLPTA* is loan loss provisions over total assets. *PBTA* is profit before tax over total assets. NIM is the net interest margin. *NIR* is the net interest revenue. *DTA* is customer deposits over total assets. *LA_DSTF* is the liquid assets over deposits and short term funding. *ROA*, return on assets. *PIBR* is the real GDP growth. *R3M* is the short-term interest rate used as monetary indicator. *INF* is the inflation rate. *INTERACT1*, interactive variable between EXCESS_CAP*R3M. *INTERACT2*, is the product between EXCESS_CAP*PIBR.

3. ASSESSEMENT OF THE BANK CAPITAL CHANNEL

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of quality criteria or the use of nested models. But methods of dimensionality reduction like PCA can also be used.

3.1. PCA: extraction of main variables

Applying the PCA technique to the set of variables previously discussed allows us to identify four principal components, which explain together 80.86% of the global data dispersion. The information contained in the 14 original variables can thus be summarized by the 4 principal components that simultaneously satisfy the Kaiser (1960) criteria[6].

The main results of the principal components are reported in Table 1 above[7]. The first component (Fac1) gives the direct influence of the bank capital on loan supply. The second component (Fac2) shows the influence of bank performance. The third component (Fac3) denotes the role of bank activity. The last one (Fac4) deals with macroeconomic indicators.

Table 1: Results of the principal components after varimax rotation method

Variables	**Fac1**	**Fac2**	**Fac3**	**Fac4**
DTA			75	
NIM			82	
R3M				85
INF				68
ROA		93		
NIR			-30	
PIBR				58
PBTA		95		
EQTA	76			

[6] To facilitate the interpretation, we use an orthogonal rotation of the principal components initially extracted, because the extraction algorithm automatically maximizes the variance explained by the first component extracted, making more difficult the interpretation of results (Badarau-Semenescu & Levieuge, 2010). For that, we use varimax method. An orthogonal rotation is always preferable because such a solution indicates that each factor provides a unique solution, not shared by another factor.

[7] Each number corresponds to the contribution (positive or negative) of the variable on the principal components.

LLPTA		-72		
LA_DSTF			-69	
INTERACT1	96			
INTERACT2	82			
EXCESS_CAP	93			
Cumulative %	**26.52**	**47.69**	**62.07**	**80.86**

3.2. VECM estimation

Define a VECM for our sample and let Z be a vector of endogenous variables in time period t such as $Z_t = (\mathrm{NLTA_{it}}, \mathrm{Fac1_{it}}, \mathrm{Fac2_{it}}, \mathrm{Fac3_{it}}, \mathrm{Fac4_{it}})$. The vector error correction representation is given as:

$$\Delta Z_t = \Gamma_1 \Delta Z_{t-1} + ... + \Gamma_{p-1} \Delta Z_{t-p+1} + \Pi Z_{t-1} + \varepsilon_t \quad (1)$$

The Γ_i are k*k dimensional coefficient matrices and $\Pi = \alpha\beta'$, where α and β are k*r dimensional matrices. The α represents the speed of adjustment to equilibrium and β is the matrix of long-run coefficients, such that the term $\beta' Z_{t-1}$ in (1) represents the r cointegrating relationships.

To test for the presence of unit roots, the tests are organized into groups depending on whether tests the dependence or independence of individuals, root tests for homogeneity or heterogeneity defined by Maddala & Wu (1999), Breitung (2000), Hadri (2000), Choi (2001), Levin & al. (2002), Im & al. (2003). The results (not reported here but available upon request) show that series follows an I(1) process indicating the need to test for cointegration among the variables above.

The Johansen (1988) procedure is used to test the presence and number of cointegration relations in the system. Table 2 reports the results of the Johansen trace test for cointegration. On the basis of this test, the null hypothesis is rejected for r=0 and r<=1 (at the 1 levels) suggesting the presence of two cointegrating relationships.

Table 2: Johansen's trace test

Null Hypothesis	Eigenvalue	Trace statistics	5% p-value
r=0	0.3343	334.58	0.0001
r<=1	0.1319	113.63	0.0000
r<=2	0.0449	36.77	0.0008
r<=3	0.0214	11.80	0.0610
r<=4	0.0001	0.06	0.8350

3.3. Results analysis

Based on the Johansen's trace test (Table 2), we will only be interested in the first cointegration relationship integrating loans supply (see Long run relationship1 on Table 3). In this long run equation, we denote a positive correlation between credit supply, the bank performance (Fac2) and macroeconomic indicators (Fac4) respectively, which is consistent with the findings of a large literature on bank's procyclicality behavior. In fact, these conclusions are in line with the existence of bank capital channel (for example, Gambacorta and Mistrulli, 2004). Furthermore, we observed a negative correlation with banking activity certainly linked to the decline in deposits and short-term funding. According to this relationship, a 10 per cent rise in the bank performance, will lead in the long run to a 4 per cent rise in loan supply.

In this short-term dynamics, there is a positive correlation between bank capital and loans. This finding is consistent with the existence of bank capital channel as proposed by Van den Heuvel (2002 and 2006): when the value of their capital falls, banks cut back lending in line with capital adequacy requirements or to finance the cost of issuing new capital.

The degree of error-correction is negative and significant showing that the divergence of the credit supply from his long run level (given by Long run relationship1) tends to be adjusted back to the equilibrium level with a speed of adjustment of 1% per year.

Table 3: The cointegrating relationships

Variables	Long Run Relationship (1)	Long Run Relationship (2)
NLTA(-1)	1,00	0,00
FAC1(-1)	0,00	1,00
FAC2(-1)	-0,43 **[-9,01]**	-0,28 **[-2,39]**
FAC3(-1)	0,710417 **[7,72]**	0,31 **[1,38]**
FAC4(-1)	-0,0030 **[-0.04]**	-0,4 **[-2,17]**

Error Correction Model	D(NLTA)	D(FAC1)	D(FAC2)	D(FAC3)	D(FAC4)
Degree of correction factor (1)	**-0,01** **[-2.21]**	0,046 **[2,84]**	0,08 **[4,31]**	-0,09 **[-2,36]**	-0,28 **[-14,48]**
Degree of correction factor (2)	0,004 **[1,63]**	-0,10 **[-8,66]**	0,04 **[3,38]**	-0,01 **[-0,29]**	0,051 **[3,84]**
D(NLTA(-1))	0,09 **[2,13]**	-0,41 **[-2,28]**	-0,44 **[-2,26]**	0,65 **[1,58]**	-0,27 **[-1,23]**
D(NLTA(-2))	0,04 **[0,79]**	-0,57 **[-2,84]**	-0,93 **[-4,27]**	-0,17 **[-0,36]**	-0,59 **[-2,47]**
D(FAC1(-1))	0,01 **[1,62]**	0,21 **[6,66]**	-0,04 **[-1,15]**	-0,09 **[-1,20]**	-0,01 **[-0,39]**
D(FAC1(-2))	-0,01 **[-1,22]**	0,24 **[8,50]**	-0,1 **[-3,30]**	-0,06 **[-0,86]**	-0,07 **[-2,08]**
D(FAC2(-1))	0,03 **[3,50]**	0,05 **[1,40]**	0,12 **[2,98]**	0,02 **[0,26]**	-0,09 **[-1,91]**
D(FAC2(-2))	-0,03 **[-3,95]**	0,014 **[0,43]**	-0,21 **[-5,70]**	-0,15 **[-1,94]**	0,011576 **[0,29]**
D(FAC3(-1))	0,006 **[2,10]**	0,004 **[0,41]**	0,02 **[1,45]**	0 **[-0,17]**	0,03 **[2,41]**
D(FAC3(-2))	0,00 **[-0,17]**	0,014 **[0,91]**	-0,01 **[-1,16]**	-0,01 **[-0,63]**	-0,07 **[-5,97]**
D(FAC4(-1))	-0,01 **[-2,43]**	0 **[-0,17]**	-0,03 **[-1,76]**	-0,02 **[-0,53]**	0,10 **[6,50]**
D(FAC4(-2))	0,01 **[2,60]**	-0,02 **[-1,87]**	-0,0040 **[-0,33]**	0,10 **[3,57]**	-0,23 **[-15,87]**

3. CONCLUSION

This paper has explored the existence of the bank capital channel in the transmission of shocks in Europe. To this end, an original approach is employed, studying the combination of several variables through a PCA. The principal components extracted are used to estimate a VECM. Within this VECM framework, we have identified two cointegration vectors that we interpret as long and short-run supply relationships.
Variables related to bank capitalization are the first principal component. They therefore contribute most to the explanation of the credit supply.

The main implications of our results is that bank capital channel in Europe seems to be working only in short run.

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