ASSETS AND LIABILITIES DEPENDENCE: EVIDENCE FROM AN EUROPEAN SAMPLE OF BANKS

Trenca Ioan *, Zapodeanu Daniela **, Cociuba Mihail-Ioan **
** Babes-Bolyai University, Faculty of Economics and Business Administration, Department of Finance, Cluj-Napoca, Romania*
*** University of Oradea, Faculty of Economics, Department of Finance, Oradea, Romania*
ioan.trenca@econ.ubbcluj.ro
danizapodeanu@yahoo.com
cociuba@gmail.com

Abstract: *In this paper we analyzed the correlation between asset and liabilities using the canonical correlation method, in the case of correlation we analyze the interdependence between two variables, by using canonical correlation analyses we study the interdependence between two groups of variables, X consisting of p variables and Y with q variables from which the best linear combination can be constructed to maximize the correlation between X and Y. While on the financial markets the relation between variables may be linear or non-linear and although canonical correlation analyses only the linear combination of variables it is a more efficient tool than then simple correlation.*
The asset group which we analyze is composed of different types of loans, derivatives and other earning assets, while in the group of liabilities we have deposits (short and long term), interest bearing liabilities and trading liabilities. We find that the assets and liabilities in the banking sector are directly linked. In the context of the global financial crisis (2007-2008) and the afterwards financial recession this direct correlation between assets and liabilities created a vicious cycle in which the losses from assets had a direct impact on the liabilities which also influenced the levels of assets.
The behavior of different variables is important, especially in the financial markets, mainly due to the structure of financial markets. The banking sector and the systemic risk associated with it can affect the financial system and even the whole economy so the study of the correlation of assets and liabilities may give us insights on the causes of the financial crises. We use a panel of fifty-nine European banks for the 2004-2011 period and we analyses the correlation between assets and liabilities. We find that there exists a direct and strong connection between different classes of assets held by banks and the structure of liabilities. The impact of the economic crisis on the banking sector has shown that this kind of connection between the structure of assets and liabilities is not the best choice because a negative fluctuation in assets generates a negative impact on the structure of liabilities. The direct connection between assets and liabilities amplifies the systemic risk of the banking sector and can also have an impact on other markets due to their spillover effects.

Keywords: asset-liabilities interdependence, canonical correlation, bank profitability

JEL codes: G21

1. Introduction

Asset liabilities management is defined as the strategic management of the balance sheet (Rosen & Zenios 2006), it is the management of income and expenses with respect to maximizing earnings, adjusted to risk factors, given the long term interest of the shareholders (Uyemura et al. 1993) also ALM manages the risk due to

mismatches between assets and liabilities. (Al-Shubiri 2010) considers that the main goal of assets and liabilities management is the control of the net interest margin; usually the goal of assets and liabilities management is view from the context of enterprise risk management having as final objectives the level of profitability, liquidity and capital.

The assets liabilities management models are classified as: single period-static models, multiple period static model, single period stochastic model, multi period stochastic model (Zenios & Ziemba 2007). One of the first period-static model is presented in the seminal paper of (Markowitz 1952) which analyses assets allocation from a risk-return perspective, a model which incorporates the leptokurtic characteristic of financial series is developed by (Zenios 1995). One example of multiperiod stochastic models is the stochastic programming models of (Carino et al. 1994). (Alexiou & Sofoklis 2009) while investigating the effects of bank-specific and macroeconomic determinants of bank profitability in Greek bank, from a Structure-Conduct-Performance framework, finds that the banks specific variables influence banks profitability.

While in the case of macroeconomic factors the influence is ambiguous with some variables (inflation, GDP growth) having a positive connection with bank profitability. (Alper & Anbar 2011) found that for banks operating in Turkey there is a connection between bank-specific determinants and profitability and the significant macroeconomic factors influencing profitability are real interest rate.

In the case of South European countries (Athanasoglou et al. 2006) observed that financial reforms and the structure of credit institutions are the determinants of banks profitability. (DeYoung & Yom 2008) uses canonical correlation analyses to study the assets-liabilities dependency, while (Memmel & Schertler 2010).

This paper analyzes the structure of the assets and liabilities and the connections with the profitability in the banking sector on a panel of 30 European countries using the canonical correlations methodology. The remaining of the article is organized as follows: Section 2 presents the methodology, Section 3 presents the dataset and the results, Section 4 concludes.

2. Methodology

In his seminal paper „Relations between two sets of variates" Hotelling (1936) presents the theoretical framework of canonical correlation analyses, if in the case of correlation we analyze the interdependence between two variables when using canonical correlation analyses we study the interdependence between two sets of variables.

The canonical correlation analysis has the following mathematical background (Hotelling 1936), for two groups of variables, X consisting of p variables $X = [X_1, X_2, ..., X_p]$ and Y with *q* variables $Y = [Y_1, Y_2, ..., Y_q]$ from which the following linear combination can be constructed (Hardle & Simar 2007):

$$U = a'X = \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + ... + \alpha_p X_p \quad (1)$$

$$V = b'Y = \beta_1 Y_1 + \beta_2 Y_2 + \beta_3 Y_3 + ... + \beta_q Y_q \quad (2)$$

where $a' = [\alpha_1, \alpha_2, \ldots, \alpha_p]$ and $b' = [\beta_1, \beta_2, \ldots, \beta_q]$ are the canonical coefficients vectors and the linear combinations of a'X and b'Y are the canonical variables.

The linear combinations are build such as the two vector a' and b' will maximize the following correlation:

$$\rho(a, b) = \rho_{a^T X b^T Y} \quad (3)$$

For the X and Y variables we will define the mean μ_X, μ_Y and the variance-covariance matrix $\sum$ so that we will have:

$$\binom{X}{Y} \sim \left(\binom{\mu_X}{\mu_Y}, \begin{pmatrix} \sum_{XX} & \sum_{XY} \\ \sum_{YX} & \sum_{YY} \end{pmatrix} \right) \text{and}$$

$$Var(X) = \sum_{XX}$$

$$Var(Y) = \sum_{YY}$$

$$Cov(X,Y) = E(X - \mu_X)(Y - \mu_Y)^T = \sum_{XY} = \sum^T{}_{XY}$$

From equation 3 and using the definition of correlation as a ration between the covariance of the series and their standard deviations we have:

$$\rho(a,b) = \frac{Cov(a'X, b'Y)}{\sqrt{Var(a'X)Var(b'Y)}} = \frac{a'\sum_{XY} b}{\sqrt{a'\sum_{XX} a}\sqrt{b'\sum_{YY} b}} \qquad (4)$$

The maximum of the correlation is at $max_{a,b} = a^T \sum_{XY} b$ where the standard deviations of X and Y was normalized so that $a'\sum_{XX} a = 1$ and $b'\sum_{YY} b = 1$, in order to maximize equation 4 the singular value decomposition (SVD) will be applied on the matrix $K = \sum_{XX}^{1/2} \sum_{XY} \sum_{YY}^{1/2}$ so that the SVD is $K = \Gamma \Lambda \Delta^T$

Where

$$\Gamma = (\gamma_1, \ldots, \gamma_k)$$
$$\Delta = (\delta_1, \ldots, \delta_k) \qquad (5)$$
$$\Lambda = diag(\lambda_1{}^{1/2}, \ldots, \lambda_k{}^{1/2})$$

and the rank of (K) = k, $\lambda_1{}^{1/2} \geq \lambda_2{}^{1/2} \geq \cdots \geq \lambda_k{}^{1/2}$ are the eigenvalues of $N_1 = KK^T$, respectively $N_2 = K^T K$ and γ, δ are the eigenvectors of N_1,respectively N_2.

The first pair of canonical correlation vectors will be $a_i = \sum_{XX}^{1/2} \gamma_i$, respectively $b_i = \sum_{YY}^{1/2} \delta_i$, the variables of the canonical correlation are $\varphi_i = a_i^T X$ for the X series, respectively $\eta_i = b_i^T Y$ for the Y series.

The second pair of canonical correlation variables maximize the correlation between the two set, equation 4, from the all the possible option that are uncorrelated with the first pair of canonical variables. If p>q we will have a maximum number q of correlation between the two variables set.
The canonical variables have the following statistical properties (Johnson & Wichern 2002):

1. $Var(U_k) = Var(V_k) = 1$
2. $Cov(U_k, U_l) = corr(U_k, U_l) = 0, k \neq l$
3. $Cov(V_k, V_l) 0, k \neq l$
4. $Cov(U_k, V_l) = corr(U_k, V_l) = 0, k \neq l$

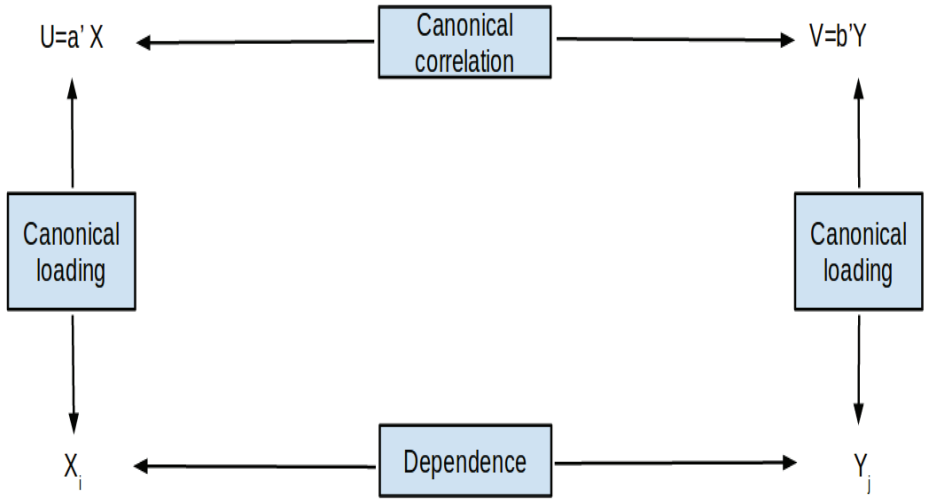
for k, l =1, 2, ..., p.

The canonical loadings are defined as the correlation between the canonical variables and the initial variables:

$$Corr(X_1, U_1) = Corr(X_1, \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \ldots + \alpha_p X_p)$$
$$Corr(X_1, U_1) = Corr(X_1, \alpha_1 X_1 + \alpha_2 X_2 + \alpha_3 X_3 + \ldots + \alpha_p X_p)$$

The interdependence between canonical variables can be interpreted (DeYoung & Yom 2008) in the following manner: if there is a strong canonical correlations between the canonical variables U and V and also a strong canonical loadings between X_i ,Y_j and U, V there will be a dependence between the X_i and Y_j variables (Figure 1).

Figure. 1 Assets and liabilities dependency



3. Data analyses

The dataset consists of annually financial information for a panel of 59 banks; the data are obtained from the Bankscope database and covers the period between 2004 until 2011.

When looking at a panel of individual banks (Figure 2.b.) we can observe that the Greek (Eurobank, National Bank of Greece, Alpha Bank) and Cypriot banks (Cyprus banks, Bank of Cyprus) have the lowest level of net income on assets, this is a widespread trend for the analyzed banks because for all of them net income has decreased. For most of the analyzed banks the level of loans has decreased from 2004 until 2011 (Fig. 2.a).

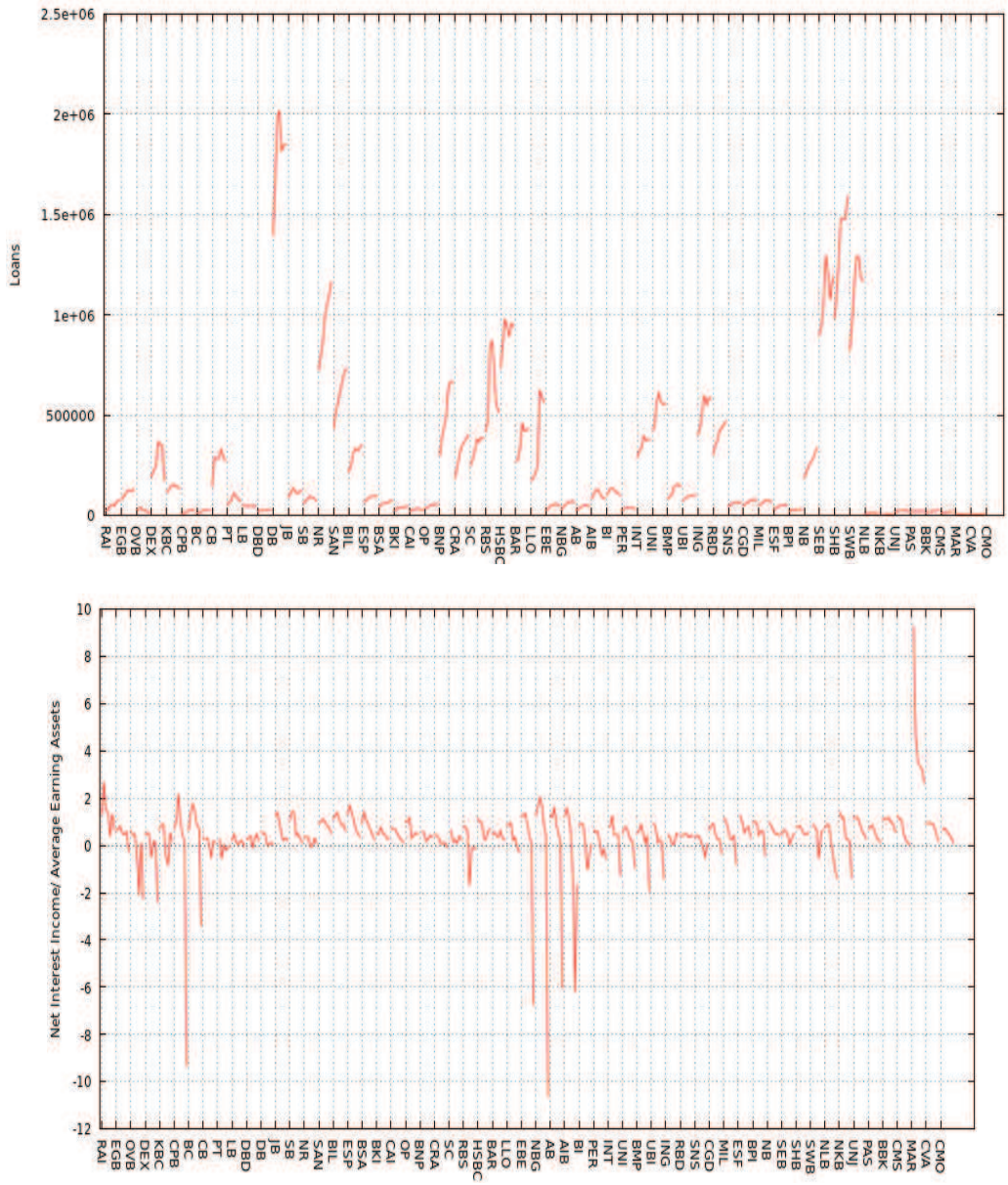


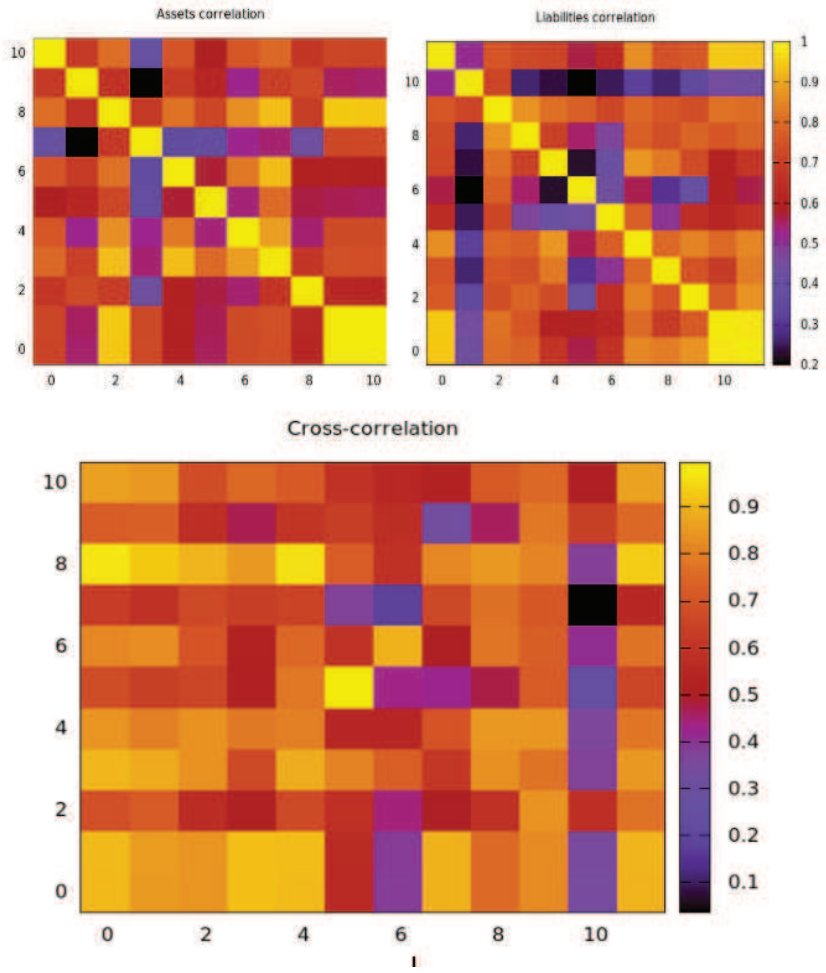
Figure 2 a) Total Loans, b) Net income/ Total Asset

In the asset group we analyse the impact of different types of loans, derivatives and other earning assets, while in the group of liabilities we have deposits (short and long term), interest bearing liabilities and trading liabilities.

The assets and liabilities in the banking sector (Fig.3) have mostly a direct connection, in the case of the assets structure this positive connection is stronger than in the case of liabilities, also the cross-correlation between assets and liabilities shows that these variables are positively correlated. In the context of the global financial crisis (2007-2008) and the afterwards financial recession this direct correlation between assets and liabilities created a vicious cycle in which the losses from assets had a direct impact on the liabilities which also influenced the levels of assets. In the case of all of the analysed

banks the level of profits and income have decreased, most of the banks suffering high losses due to the mismatch in maturity between assets and liabilities, high leverage and over indebtedness. This situation demanded a response from Central banks and State and in some cases large bail-out and debt restructuring programs were necessary in order to keep the banks from bankruptcy, but these restructuring programs also had a negative impact on the national economies.

Figure 3. Correlation between asset-liabilities



4. Conclusions

In this paper we analyzed the correlation between asset and liabilities using the canonical correlation method, while in the case of correlation we can observe the connection between two variables by using canonical correlation different types of assets and liabilities can by analyzed at the same time. In the financial markets the relation between variables may be linear or non-linear and although canonical correlation analyses only the linear combination of variables it is a more efficient tool than then simple correlation. The behavior of different variables is important, especially in the financial markets, mainly due to the structure of financial markets. The banking sector and the systemic risk associated with it can affect the financial system and even the hole economy so the study of the correlation of assets and liabilities may give us insights on the causes of the financial crises. We use a panel of fifty-nine European banks for the 2004-2011 period and we analyses the correlation between assets and liabilities. We find that there exists a direct and strong connection between different classes of assets held by banks and the structure of liabilities. The impact of the economic crisis on the banking sector has shown that this kind of connection between the structure of assets and liabilities is not the best choice because a negative fluctuation in assets generates a negative impact on the structure of liabilities. The direct connection between assets and liabilities amplifies the systemic risk of the banking sector and can also have an impact on other markets due to their spillover effects.

References

Al-Shubiri, F., 2010. *Impact of bank asset and liability management on profitability: Empirical investigation.* Journal of Applied Research in Finance (JARF), II(2).

Alexiou, C. & Sofoklis, V., 2009. *Determinants of bank profitability: Evidence from the Greek banking sector*. Ekonomski anali, 54(182), pp.93–118.

Alper, D. & Anbar, A., 2011. *Bank specific and macroeconomic determinants of commercial bank profitability: empirical evidence from Turkey*. Business and Economics Research Journal, 2(2), pp.139–152.

Athanasoglou, P., Delis, M. & Staikouras, C., 2006. *Determinants of bank profitability in the South Eastern European region*. Bank of Greece, Working Paper No. 47, pp.1–31. Available at: http://mpra.ub.uni-muenchen.de/10274/

Carino, D.R. et al., 1994. *The Russell-Yasuda Kasai model: An asset/liability model for a Japanese insurance company using multistage stochastic programming.* Interfaces, 1994(February), pp.29–49.

DeYoung, R. & Yom, C., 2008. *On the Independence of Assets and Liabilities: Evidence from U.S. Commercial Banks, 1990-2005*. Journal of Financial Stability, 4(3), pp.275–303.

Hardle, W. & Simar, L., 2007. *Applied multivariate statistical analysis*, Springer.

Hotelling, H., 1936. *Relations between two sets of variates*. Biometrika.

Johnson, R.A. & Wichern, D.W., 2002. *Applied multivariate statistical analysis*, Prentice hall Upper Saddle River, NJ.

Markowitz, H., 1952. *Portfolio section*. Journal of finance, 7, pp.77–91.

Memmel, C. & Schertler, A., 2010. *The dependency of the banks' assets and liabilities: evidence from Germany*. European Financial Management, 49(4), pp.602–619.

Rosen, D. & Zenios, S.A., 2006. *Enterprise-wide asset and liability management: issues, institutions, and models*. Handbook of Asset and Liability Management: Theory and Methodology, 1, p.1.

Uyemura, D.G., Van Deventer, D.R. & Foundation, B.A.I., 1993. *Financial risk*

management in banking: the theory & application of asset & liability management, Bankers Pub. Co.
Zenios, S.A., 1995. *Asset/liability management under uncertainty for fixed-income securities*. Annals of Operations Research, 59(1), pp.77–97.
Zenios, S.A. & Ziemba, W.T., 2007. *Handbook of Asset and Liability Management: Theory and Methodologies*, North Holland.