“New Approach to Financial and Economic Stability in the United States from a Banking Perspective”

Abstract

This work analyzes the relationships between the banking sector and the economy as a whole in the United States between 1990 and 2016. To do so, a methodology that has never before been applied to these studies is used, namely, canonical correlation analysis. This analysis will allow us to obtain composite indicators on the real and financial state of the economy, among other composite indicators. This study’s main contribution and originality is centered on this new way of addressing financial and economic stability. Its contributions to macroprudential policy, as well as the financial and economic stability measures it creates, are valuable.

Keywords: Financial Stability; Economic Stability; Banking; Canonical Analysis.

JEL: C40; E44; E61; G10; G21

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1. INTRODUCTION

The crisis that began in the United States in 2008 and spread to the rest of the developed world triggered a process of developing and implementing regulatory measures used in an attempt to anticipate and, if necessary, mitigate the adverse effects that could cause new financial crises. In particular, the United States implemented the Dodd–Frank Wall Street Reform and Consumer Protection Act[1], from the Financial Stability Oversight Council. Its mission is to identify and attempt to mitigate systemic risk by designing actions and recommendations for regulatory agencies, such as the Federal Reserve, the Office of the Comptroller of the Currency, and the United States Congress.

One of the most novel aspects of this regulation is related to macroprudential policies that are used in an attempt to identify and mitigate risk that could arise in the banking system as a whole, establishing measures to quantify them, such as positions on bank capital, and, when applicable, mitigating potential adverse effects through requirements such as countercyclical capital, established in Basel III[2]. Countercyclical capital seeks to limit procyclicality in the banking system and essentially provides it with a certain level of financial stability. While this is a fundamental element of this work, it has not received sufficient attention within the existing literature on the subject, as there are not many works focused on analyzing their interaction with various relevant economic variables, including monetary variables, or specifics on the public or private sector.

This work presents an original statistical model that uses a set of composite indicators related to US banking and economic systems between 1990 and 2016, describing economic and financial conditions, and, as a result, helps propose appropriate macroprudential policies. This is done by applying canonical correlation analysis, which has not been used to date in previous works with similar characteristics.

2. LITERATURE REVIEW

[1] Specifically, Subtitle A (section 111 part a) of Title I of the aforementioned act establishes the Financial Stability Oversight Council.

[2] See point IV, letter A, number 137 in Basel III, which states: "The countercyclical buffer aims to ensure that banking sector capital requirements take account of the macro-financial environment in which banks operate."

As Houben et al. (2004) indicated, the financial system supports real economic activity in three main ways: i) by efficiently allocating financial resources among activities; ii) by evaluating and managing financial risk; and iii) by absorbing economic shocks. Thus, financial stability is often considered to be of utmost importance for economic growth because most transactions in the real economy are made through the banking system. According to the Federal Reserve (2018)[3], “Financial stability is about building a financial system that can function in good times and bad, and can absorb all the good and bad things that happen in the US economy at any moment (…).”

The literature includes many works on financial stress and financial stability. In terms of financial stress, Dumičic (2016) wrote about the processes of accumulation and the materialization of systemic risk in Croatia. The author used principal component analysis, based on economic and banking variables, to construct two composite indicators: an accumulation of systemic risk index, based on increasing credit, and an index on the consequences derived from the previous index (the materialization of systemic risk), which identifies an increase in delinquent loans as associated with a worsening real economy[4]. In our work, financial and banking stability indicators are also developed. Here, delinquent loans are also highly significant, which is widely reflected in the “recognition of bank losses” dimension; unlike Dumičic’s (2015) work, the possible interaction between financial variables and a country’s or region’s economic conditions is not studied.

Other works that cover designing financial stress measures include Illing and Liu (2003), Holló (2012), Jakubík et al. (2013) and Nagy et al. (2016). In all of these studies, financial stress is measured using composite indicators; our statistical model includes the relationship between the economic and banking systems, an aspect that we consider essential, but it is not considered in these works.

Aikman et al. (2015) provide a framework to assess the accumulation of vulnerabilities in the US financial system. Thus, using principal component analysis, they collect data that are used to calculate a wide range of economic and financial indicators, which they standardize and group into 14 components and, then, group them into the following three categories: i) investor risk tolerance; ii) nonfinancial instability and; iii) vulnerability of the financial sector. This last category is largely led by the credit cycle, suggesting its potential use in providing valuable

3 https://www.federalreserve.gov/faqs/what-is-financial-stability.htm.

4 That is, the materialization of cumulative risk that appears when the economy worsens.

information to guide US macroprudential policy. Our work, like the one referenced, also proposes a statistical model aimed at setting macroprudential policy; our work is differentiated by providing an in-depth analysis of the banking sector. Geršl and Heřmánek (2006) create an aggregate indicator of bank stability. They set partial indicator weights based on opinions from financial experts, and they do not analyze other economic variables or use an objective mathematical system, as opposed to experts with a subjective view. Gadanecz and Jayaram (2008) conclude that composite indicators are more appropriate than individual variables in defining reference values (threshold) used to identify whether or not a financial system is stable. Therefore, with the variable grouping demonstrated by the different indicators, we try to reproduce the relationships that occur between the US's banking and economic systems between 1990 and 2016.

Smaga (2013) complains that, first, the risk derived from the accumulation of asset bubbles is widely disregarded and, second, that the financial system's instability has a negative impact on the real economy (and vice versa).

Fidanoski et al. (2017) share this opinion and conclude that because the concept of macroeconomic stability is too broad and complex, providing an adequate measure of it constitutes a real challenge. They confront this challenge by breaking it down into three components: financial, economic, and price stability. Specifically, they use the autoregressive distributed lag (ARDL) approach developed by Pesaran and Shin (1999), using an econometric model to define the relationship between macroeconomic stability and economic growth in Macedonia's economy between the first quarter of 2006 and the third quarter of 2016. They concluded that due to the structural complexity of the financial system and its relationship with macroeconomic sectors, in particular the monetary sector, adequately measuring financial stability must be based on compound economic indicators rather than individual indicators.

As other authors have previously suggested, we conduct a broader analysis in our work, which also includes the impact of the financial system, more specifically, the banking system, on the real economy, using one index for economic stability and another for financial stability.

Muraru (2015) finds that the interaction between the financial sector and the real economy became more significant after the onset of the economic and financial crisis in the United States in the fall of 2008. Therefore, the author develops a financial conditions or financial stability index, using a three-fold methodology: a) weighted averages based on the impulse-response functions of an autoregressive vector calculated for the financial indicators selected and GDP; b) principal component analysis and; c) dynamic factor models.

Manolescu and Manolescu (2017) published a similar work in which the authors define the financial stability index, which they relate to macroeconomic indicators in the Romanian economy, using a vector autoregression (VAR) model. The index aims to analyze the relationships between the main indicators of the banking sector and the most significant macroeconomic indicators. The financial stability index summarizes the state of equilibrium and the evolution of different financial variables.

After we reviewed the literature, we noticed a gap in studying the relationships between the banking system and the real economy. Although some works include the banking sector when analyzing financial stability, a study analyzing the banking sector with regard to monetary and financial-economic variables has never been conducted. Canonical correlation analysis is used to obtain dimensions related to the variables that are not mathematically arbitrary, which will allow us to set up the analysis. We believe it may be useful in understanding the interactions between the banking and economic systems as well as in setting macroprudential policies.

3. METHODOLOGY

Canonical correlation analysis (CCA) is a multidimensional exploratory statistical method that is developed as an extension of principal component analysis (PCA), as both methods rely on the same mathematical background (matrix algebra and analysis) and illustrate results using similar graphic representations. With this model, we will find dimensions that will allow us to mathematically, rather than arbitrarily, analyze the relationships between two groups of different variables, while only one group is considered using PCA.

Thus, the main purpose of CCA is to explore the sample correlations between two sets of quantitative variables, in our case, a set of macroeconomic variables and another set of variables representing the banking system.

2.1. Experimental Setup

To achieve the objectives defined in this work, we used quarterly data for 27 economic variables and 11 banking variables (see Appendix A) directly from the Federal Reserve's (FED) website[5] and from the United States Federal Deposit Insurance Corporation (FDIC)[6], between 1990 and 2016, both inclusive.

Specifically, the banking system's representative variables were grouped into the following three categories: solvency, liquidity, and regulatory. These categories can be used to describe the US banking system during the period analyzed.

The selected economic variables cover various aspects such as monetary policy, tax environment, the state of the stock market and housing market, the country's credit system, the foreign sector, and debt servicing.

Once the variables have been selected, applying the CCA model will show us the relationships between the two groups of variables so we can define the economic and financial stability composite indices. Finally, it will allow us to understand the interaction between these composite indices.

We defined two matrices in our model, "X" and "Y," from the (n x p) and (n x q) dimensions, respectively. The "X" and "Y" columns correspond to banking (X) and economic (Y) variables, and

[5] https://www.federalreserve.gov/data.htm
[6] https://www.fdic.gov/bank/statistical/

the rows correspond to the time evolution of macromagnitudes, where the j-th column of matrix "X," banking variables, is expressed as X^j, and the k-th column of "Y," economic variables, is expressed as Y^k. Without loss of generality, columns "X" and "Y" are assumed to be standardized (mean 0 and variance 1). In addition, it is assumed that p ≤ q (essentially, the group containing the least number of variables is expressed as X).

S_{XX} and S_{YY} express the sample covariance matrices for the sets of variables X and Y respectively, and $S_{XY} = S_{YX}$ expresses the sample cross-covariance matrix between X and Y.

To the extent that classic CCA assumes that p ≤ n and q ≤ n, the "X" and "Y" matrices are full-column range p and q, respectively. Then, CCA becomes a problem that can be solved using an iterative algorithm.

The first step of CCA is to find two vectors, a^1 and b^1, that maximize the correlation between linear combinations:

$$U^1 = Xa^1 = a_1^1 X^1 + a_2^1 X^2 + \cdots + a_p^1 X^p$$

and

$$V^1 = Yb^1 = b_1^1 Y^1 + b_2^1 Y^2 + \cdots + b_q^1 Y^q$$

assuming that vectors a^1 and b^1 are normalized, that is: $var(U^1) = var(V^1) = 1$.

The following must be solved:

$$\rho_1 = cor(U^1, V^1) = \max_{a^1, b^1}\{cor(Xa^1, Yb^1)\}$$

subject to the following restriction:

$$var(Xa^1) = var(Yb^1) = 1$$

The resulting variables U^1 and V^1 are the first canonical variables, and ρ_1 is the first canonical correlation.

The higher order canonical variables and correlations can be found as a step-by-step problem.

For $s = 1, \cdots, p$, we can successively find positive correlations $\rho_1 \geq \rho_2 \geq \cdots \rho_p$ with corresponding vectors $(a^1, b^1), \cdots, (a^p, b^p)$, maximizing:

$$\rho_s = cor(U^s, V^s) = \max_{a^s, b^s}\{cor(Xa^s, Yb^s)\}$$

with the additional restriction:

$$cor(U^s, U^t) = cor(V^s, V^t) = 0 \quad 1 \leq t < s \leq p$$

Canonical correlations are calculated using the positive values of the square roots of the eigenvalues of $P_X P_Y$, which are the perpendicular projection matrices in the X and Y columns, defined as:

$$P_X = X(X^T X)^{-1} X^T = \frac{1}{n} X S_{XX}^{-1} X^T$$

$$P_Y = Y(Y^T Y)^{-1} Y^T = \frac{1}{n} Y S_{YY}^{-1} Y^T$$

$$\rho_s = \sqrt{\lambda_s}$$

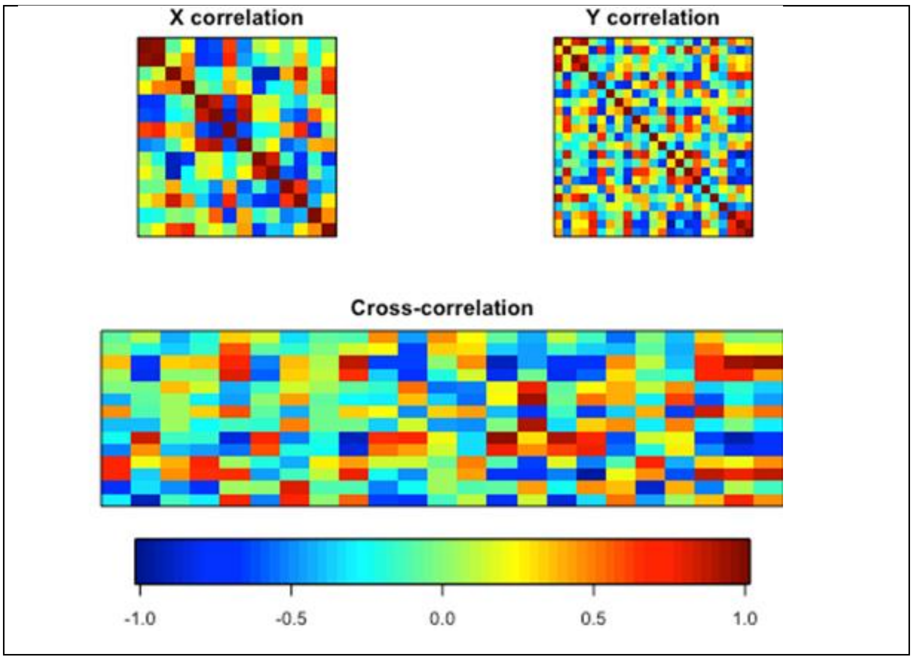
The $U^1, \cdots, U^p$ vectors are the standardized eigenvectors corresponding to the eigenvalues in descending order ($\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p$) of $P_X P_Y$.

The $V^1, \cdots, V^p$ vectors are the standardized eigenvectors corresponding to the same eigenvalues ($\lambda_1 \geq \lambda_2 \geq \cdots \geq \lambda_p$) of $P_Y P_X$.

2.1.1. Conducting the Experiment

As indicated above, 38 variables (see Appendix A) were grouped into two categories to conduct this empirical study (banking and economic variables), to which canonical analysis (CCA) was applied, first to find the existing correlation between the banking variables in matrix X and that corresponding to the economic variables from matrix Y; next, the cross-correlation was calculated. Figure 1 shows the correlations found.

Figure 1. (X and Y) Correlations and Cross-Correlation.



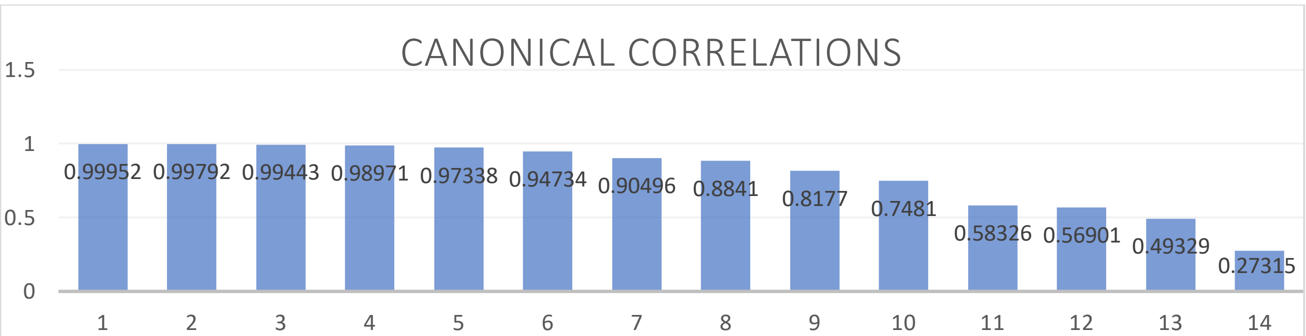
Source: Created by the authors

The presence of a wide range of colors indicates a high correlation, supporting the opportunity to conduct CCA. In light of the results, calculating is clearly justified, given the high correlation between banking variables and economic variables and between the two matrices.

As with PCA, choosing a small value for the d-dimension ($1 \leq d \leq p$) is recommended. In practice, this value is generally 2, 3, or 4. Note that small canonical correlations are irrelevant (see Figure 2): they do not express linear relationships between columns X and Y and can be discarded. For large p-values (see Figure 2), an empirical approach is suggested to choose the dimension based on jointly examining the two graphic representations: the canonical correlations graph and variable scatter plots (Figures 3 and 4). A clear gap between two consecutive values on the canonical correlations graph versus the dimension suggests selecting the largest range for "d." We evaluate the variable scatter plots according to the (U^s, U^{s+1}) axes for the first values of s and discard the axes for which all the points that represent X or Y variables are within the radius circle of 0.5 (Figures 3 and 4) (that is, the correlations between the X^j or Y^k variables and the U^s or V^s canonical variables are less than 0.5).

Figure 2 shows the number of dimensions and their canonical correlations. The first four will be analyzed because as seen in Appendix C, many of the variables are within the radius circle of 0.5 in dimension five. In contrast, many variables are outside the radius circle of 0.5 in the first four dimensions, indicating a high correlation with the dimension, as will be seen in the analysis.

Figure 2. Depiction of the Dimensions



2.1.2. Analysis and Discussion of the Results

The following figures represent the dimensions found. Each dimension is interpreted by analyzing the correlation between that dimension and the original variables (see Appendix B).

The variable figure is interesting because it enables us to discern the correlation between the two sets of X and Y variables. The coordinates of the X^j and Y^k variables on the axis defined by U^s are Pearson's correlation coefficients between the variables and U^s. As X^j and Y^k variables are assumed to have the same variance, their projections in the plane defined by the (U^s, U^t) axes are within a radius circle of 1 centered on the origin, called a correlation circle.

In this figure, two circumferences corresponding to the radiuses of 0.5 and 1 are drawn to show the most distinct patterns in the ring defined between these two circumferences. Variables with a strong relationship are portrayed in the same direction from the origin. The greater the distance from the origin, the stronger the relationship is (see Figures 3, 4, and 5).

The greater the distance from the origin, the stronger the relationship is. The greatest explanatory power is present in dimensions 1, 2, and 3, and as we depict dimensions beyond 1, 2, 3, and 4, the variables end up in the inner circle in greater numbers, minimizing the significance of the analysis. Therefore, although they are depicted, only dimensions 1, 2, 3, and 4 are analyzed (*see Appendix C*).

This unit depiction can help clarify how the correlation between variables is interpreted. This unit depiction is possible using the axes defined by (U^s, U^t): the coordinate of the i-th unit on axis U^s is U_i^s (the i-th coordinate of the s-th canonical variable). The relationships between the two figures (variables and units) drawn on coinciding axes can show associations between variables and units (left part of Figures 3, 4, and 5).

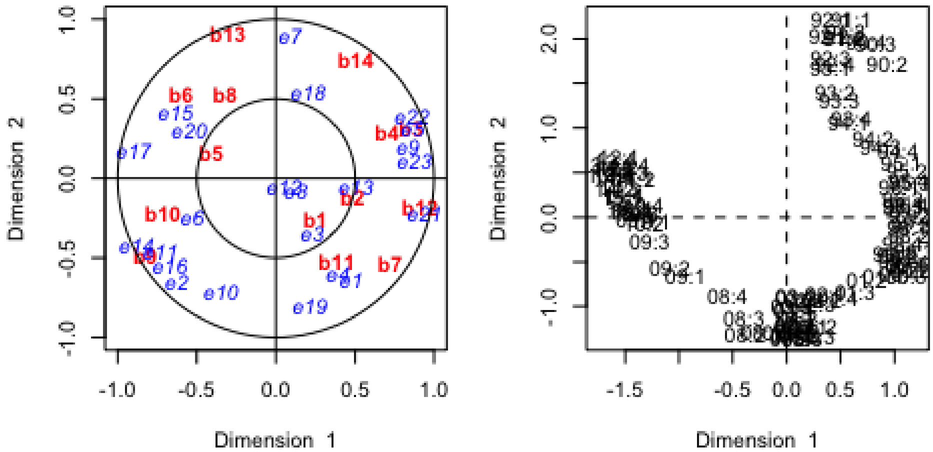
3. ANALYSIS OF RESULTS

The results are analyzed by first interpreting each dimension and naming it, depending on the variables it groups, for both banking and economic variables. Subsequently, this dimension is analyzed as a whole, and finally, a quadrant analysis is conducted representing the dimensions two by two. In the last section, time evolution is analyzed.

3.1. Analyzing Dimension 1: Economic Conditions

Dimension 1 can be defined as the "**economic conditions**" in the United States, with higher dimension values signifying improved conditions (see Figure 3).

Figure 3. Depiction of Dimensions 1 and 2



Banking variables are grouped in dimension 1 representing a period of good progress in the banking business because, for example, the interest margin has a positive correlation and defaults have a negative correlation (percent of noncurrent loans and leases). Capital to assets and regulatory capital have a negative correlation. It is assumed that when loans to assets increase, bank solvency decreases; therefore, they have a negative correlation. In addition, the loss allowance coverage ratio has a positive correlation, indicating the banking business's good performance, as there is more coverage.

From the perspective of economic-financial conditions, the dimension has a negative correlation with unemployment and a positive correlation with wages received to available income, level of wages to income, and income tax to national income. With high dimension values, public finances improve and, therefore, a positive correlation with government surplus and a negative correlation with debt to GDP.

Additionally, the velocity of M2 money has a positive correlation, indicating more economic transactions, in contrast to the negative correlation with the growth of M1, indicating a less expansive monetary policy (with the need for less accommodating monetary policy measures).

Economic stability has positive values while greater instability has negative values, noting that consumer prices (CPI), housing prices, share prices, and corporate profits to GDP all have a negative correlation with dimension 1, assuming that greater financial instability is present.

Joint Analysis of Dimension 1

Dimension 1 has a positive correlation with the net interest margin, b4, indicating that the banking business is doing well, and with b7, loss allowance to noncurrent loans and leases. However, bank solvency suffers when dimension 1 increases because both b9 and b10 (solvency measures) are negatively correlated with the dimension. For the economic variables, an increase in public surplus, e5, as well as the velocity of M2 money, e21, and wages to available income, e9, are positively correlated, indicating the economy's progress. On the other hand, an increase in residential property prices, e2, and shares, as well as unemployment, e15, and public debt are negatively correlated, worsening economic conditions and thus negatively affecting the banking sector.

Quadrant Analysis of Figure 3

- *Quadrant 1* indicates that e14 (consumer price index), b9 (equity capital to assets), e11 (private domestic sectors; consumption of fixed capital, structures, equipment, and intellectual property products, current cost basis/national income), e16 (total share prices for all shares for the United States, index 2010), and e2 (residential property prices) are all correlated with each other. In addition, price indices correlate with each other, along with the ratio of capital to assets and the depreciation of fixed capital. A possible explanation for this result is that an increase in demand causes prices to increase, leading to, in turn, greater consumption of fixed capital. These variables are negatively correlated with dimension 1, showing high values.

  B10 (total risk-based capital ratio (PCA)) and e6 (nonfinancial corporate business; corporate profits before tax/GDP) are also negatively correlated with each other and with dimension 1. This correlation occurs due to increased company profits stemming from times of expansion, which results in reduced regulatory ratios and increased bank risk due to increased credit to finance new business projects.

- *Quadrant 2* indicates that b6 (percent of noncurrent loans and leases), e15 (unemployment rate: ages 15-64) and e20 (M1 for the United States, growth rate in the previous period) are highly correlated with each other and are negatively correlated with dimension 1, with values over -0.5. This correlation between variables is apparent, as higher unemployment increases bankruptcy, and in turn, monetary authorities attempt to recover the economy through expansionary policies that generate an increase in M1.

- *Quadrant 3* indicates that e22 (long-term government bond yields: 10-year), e9 (households and nonprofit organizations; wages and salaries received/national income), e23 (3-month or 90-day rates and yields: interbank percent.), b4 (net interest margin) and b3 (cost of earning funding assets) are correlated with each other. These correlations occur because increasing rates increase the banking margin and, in turn, financing costs, but without damaging their margins to decrease them.

  The correlation for wages earned to income explains that bank profitability is related to good economic conditions and, in turn, higher wages to total income. All the previous variables are positively correlated with dimension 1, with that dimension's correlation being very high.

  In addition, b14 (insured deposits as a percent of total deposits) is positively correlated with dimension 1, with a value around 0.5.

- *Quadrant 4* indicates that b12 (net loans and leases to total assets) and e21 (velocity of M2 money stock, ratio) are highly correlated because increased transactions in the economy lead to increased credit. Both are very highly positively correlated with dimension 1.

  Variables b11 (risk-weighted assets to total assets), e4 (financial obligations ratio), and e1 (credit-to-GDP gaps (current-trend) - United States - credit from all sectors to the private nonfinancial sector) are positively correlated with dimension 1 and also correlated with each other, but the correlation with dimension 1 is approximately 0.5. Their correlation explains how increased risk in general, an increase in the banking variable risk-weighted assets, is related to deviations in the credit trend with respect to GDP and a higher financial obligations ratio that increases credit risk.

  B7 (loss allowance to noncurrent loans and leases (coverage ratio)) is also positively correlated with dimension 1, greater than 0.5.

3.2. Analyzing Dimension 2: Financial Risk

This dimension **financial risk** represents the risk in the US banking business, with higher negative values representing increased risk (see Figure 3). In contrast, loss allowance has a positive correlation, indicating that the dimension's higher positive values signify greater loss allowance.

Additionally, in dimension 2, deposit financing is positively correlated with deposits to assets and negatively correlated with risk-weighted assets, which leads to the conclusion that financing deposits signifies a lower level of asset risk. In turn, the fact that loss allowance and risky assets are inversely correlated may be overlooked, leading to the assumption that increased risk is not demonstrated by increased loss allowance.

Economic variables are negatively correlated with credit-to-GDP gaps as well as home prices, share prices, and financial obligation ratios. Additionally, the velocity of M1 money, the most liquid monetary supply, is negatively correlated, as well as a decrease in corporate profits to national income.

Balance on current account to GDP, as well as the value of credit debt to the market value of nonfinancial companies are positively correlated. A higher balance on current accounts signifies lower economic risk because it improves competition. On the other hand, the value of credit debt to the market value of nonfinancial companies correlates with a fairly low value of 0.54; if the risk increases, the value of the debt worsens, and therefore, the ratio decreases, thereby increasing risk.

Joint Analysis of Dimension 2

In this dimension, the relationship between banking and economic variables indicates an increased risk represented by economic variables (e1, e2, e4, e10, e16, and e19), which, among other variables, identify share prices, housing, or credit increases, indicate the same as bank variable b11, risk-weighted assets to total assets. Therefore, banks increasing their risk, without being represented by their loss allowance (b8), is positively correlated with the dimension. B13 is positively correlated with the dimension, indicating decreased risk because bank financing is based mostly on deposits; b14, representing insured deposits, is also positively correlated.

Quadrant Analysis of Figure 3

- <u>Quadrant 1</u>: e16 (total share prices for all shares for the United States, index 2010) and e2 (residential property prices; long series) are correlated and are negatively correlated with dimension 2, approximately -0.5. Their correlation is an indication of the relationship between increasing real estate and share prices.

Additionally, e10 (nonfinancial business; proprietors' income/national income) is negative correlated, which is also stronger in dimension 2.

Furthermore, e10 (Nonfinancial business; proprietors' income/national income) is negatively correlated with dimension 1, with values of -0.5.

- *Quadrant 2:* B8 (loss allowance to loans and leases), b6 (percent of noncurrent loans and leases) and to a greater extent b13 (total deposits as a % of total assets) are positively correlated with dimension 2.
- Quadrant 3: E7 (balance on current account/GDP) shows a strong positive correlation with dimension 2, while e18 (nonfinancial corporate business; credit market debt as a percentage of the market value of corporate equities, percent) is also positively correlated, but more moderately at approximately 0.5. B14 (insured deposits as a percent of total deposits) is also significantly correlated with dimension 1.

  Note the negative correlation of e7 (balance on current account/GDP) and e19 (velocity of M1 money stock, ratio), which occurs because increased spending is related to increased demand and a slight decrease in balance on current accounts is due to an increase in imports.

- *Quadrant 4*: Variables b11 (risk-weighted assets to total assets), e4 (financial obligations ratio), and e1 (credit-to-GDP gaps (current-trend) - United States - credit from all sectors to private nonfinancial sector) are correlated. These variables are correlated because they indicate risk in the banking and financial systems.

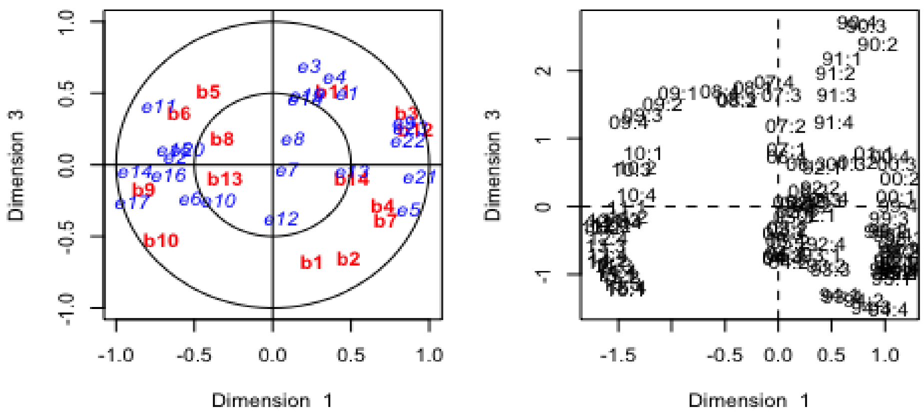
  They are also negatively correlated with dimension 2, with negative values of approximately -0.5.

  B7 (loss allowance to noncurrent loans and leases (Coverage ratio)) is also negatively correlated with dimension 2, with values greater than -0.5. Variable e19 (velocity of M1 money stock, ratio) is negatively correlated, very close to -1, with dimension 2.

3.3. *Analyzing Dimension 3: Profitability of the Banking System*

Dimension 3 can be identified as "**profitability of the banking system,**" where lower values signify higher levels of profitability (see Figure 4).

Figure 4. Dimensions 1 and 3



Dimension 3 is negative correlated with profitability and the regulatory ratio. Therefore, the dimension's higher values signify less regulatory solvency and profitability. Risk-weighted assets to total assets, as well as unpaid assets, are positively associated with dimension 3. Unpaid assets are negatively correlated with the profitability variables, as more defaulted loans clearly hurt profitability.

Regarding economic variables, e1 ((credit-to-GDP gaps (actual-trend) - United States - credit from all sectors to private nonfinancial sector) is strongly correlated with b11 ((risk-weighted assets to total assets), reflecting that when credit-to-GDP gaps increase in relation to their trend, the risk assumed by banks in their balances increases, showing a greater volume of risk-weighted assets to total assets.

In addition, e4 (financial obligations ratio) is strongly correlated with b11 (risk-weighted assets to total assets), that is, when the bank assets increase in risk, the financial obligations ratio increases, with a higher payment percentage for debts to available income.

Joint Analysis of Dimension 3

Bank profitability, b1 and b2, are negatively associated with this dimension, and e4, financial obligations ratio, as well as b11, risk-weighted assets to total assets, are positively associated, in addition to credit-to-GDP gaps, e1. Therefore, profitability is associated with a lower solvency and not necessarily with times of greater risk because at that time, more are unpaid (remember that b5, net charge offs, is positively correlated with the dimension).

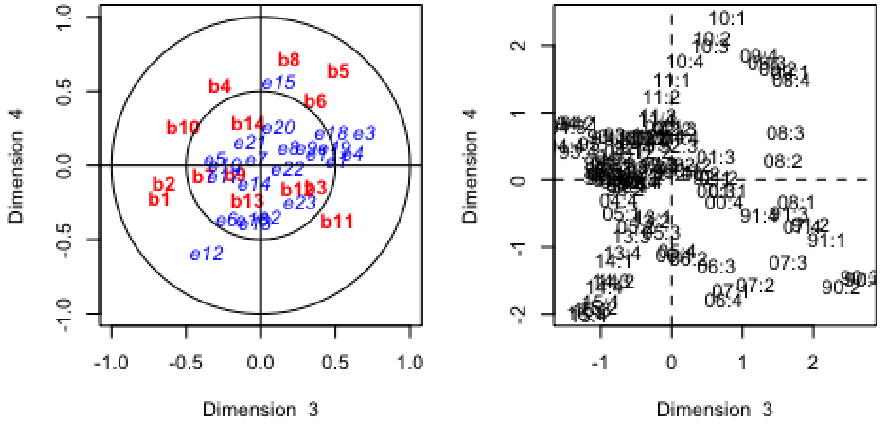
Quadrant Analysis of Figure 4

- *<u>Quadrant 1</u>*: B10 (total risk-based capital ratio (PCA)) is negative.
- *<u>Quadrant 2</u>:* B5 (net charge offs to loans and leases) is positive.
- *<u>Quadrant 3</u>:* E1 (credit-to-GDP gaps (actual-trend) - United States - credit from all sectors to the private nonfinancial sector), e3 (mortgage debt service ratio), and e4 (financial obligations ratio) are positively correlated with the dimension. The strong correlation between e3 and e4 demonstrates the fact that mortgages constitute a very significant portion of payments regarding household debt. B11 (risk-weighted assets to total assets) is positively associated with the dimension and is negatively correlated with e1 (credit-to-GDP gaps (current-trend) - United States - credit from all sectors to private nonfinancial sector).
- <u>Quadrant 4</u>: B1 (return on assets) and b2 (return on equity), which are correlated with each other, are negatively associated with this dimension.

3.4. Analyzing Dimension 4: Recognition of Bank Losses

Dimension 4 represents the **"recognition of bank losses"** and is correlated with b5, net charge offs to loans and leases, as well as b8, loss allowance to loans and leases. Additionally, regarding economic variables, the negative correlation with unemployment, e15, results in fewer unpaid loans when unemployment is lower. Corporate taxes to national income are negatively correlated with the dimension because fewer profits mean lower taxes and, therefore, less capacity to repay debt (see Figure 5).

Figure 5. Dimensions 3 and 4



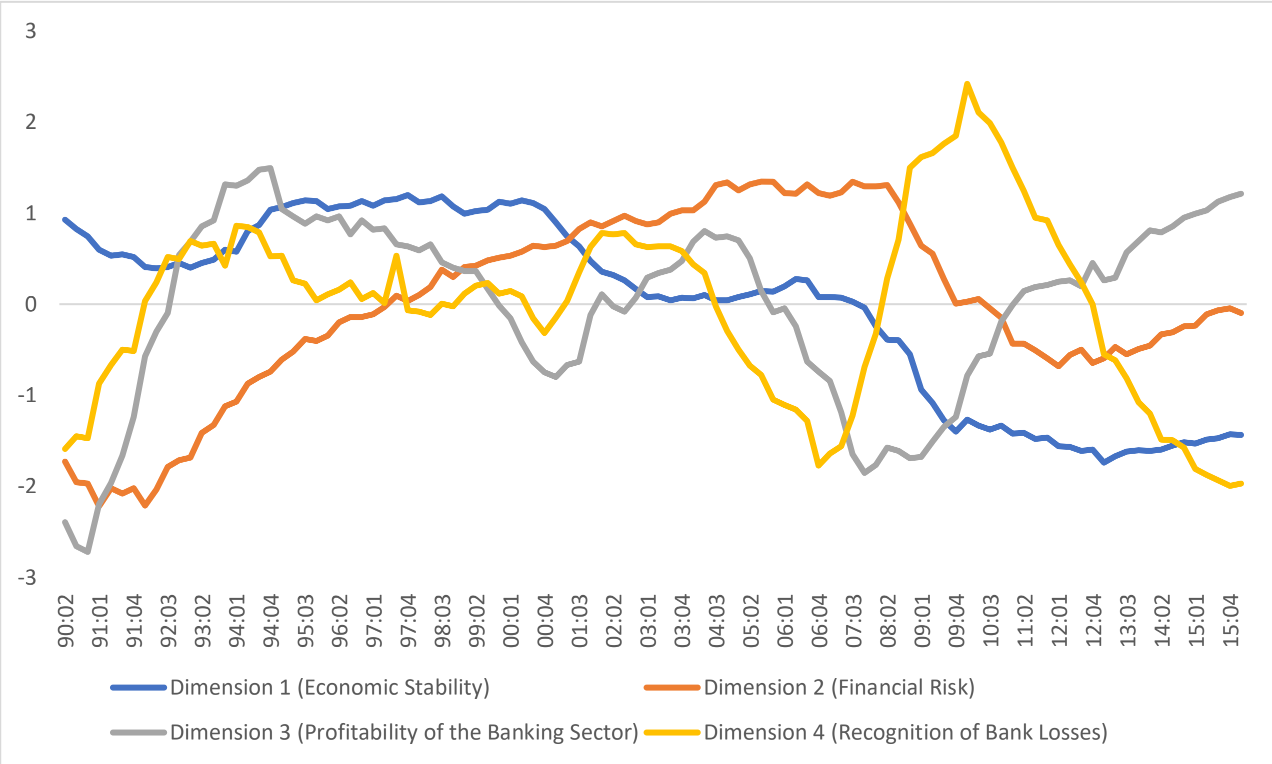
Quadrant Analysis of Figure 5

- ❖ <u>*Quadrant 1*</u>: E12 (taxes on corporate income/national income) is negatively correlated with the dimension.
- ❖ <u>*Quadrant 2:*</u> B4 (net interest margin) and b5 (net charge offs to loans and leases) are positively correlated.
- ❖ <u>*Quadrant 3*</u>*:* B8 (loss allowance to loans and leases), e15 (unemployment rate: ages 15-64: all persons for the United States, percent), and b5 (net charge offs to loans and leases) are positively correlated with the dimension.

3.5. Time Analysis

In the time representation of dimensions 1 through 4, the values for dimensions 2 and 3 have been inverted to directly portray the concepts they represent, risk, and bank profitability.

Figure 6. Time Representation of the Dimensions



<u>Dimension 1 (Economic Stability) and Dimension 2 (Financial Risk)</u>

At the beginning of the 1990s, dimension 2 has very high values, that is, low levels of banking and economic risk. As the years progress, economic and banking risk start to increase, peaking before 2008 with the onset of the crisis. High levels of risk remain in the years prior to the onset of the crisis. Observing recovery from that point, baseline levels from the 1990s are never attained.

Dimension 1 also starts with very positive values at the beginning of the 1990s, due to good banking performance and economic conditions. The situation begins to worsen at the end of the 1990s, reaching a low point at the beginning of 2008. To reach the baseline values from the 1990s, recovery must continue, and values from 2009 have been stagnant, resulting in a slowdown of the recovery.

<u>Dimension 3 (Profitability of the Banking Sector) and Dimension 1 (Economic Stability)</u>

At the beginning of the 1990s, economic conditions were positive based on dimension 1, and profitability decreased, based on dimension 3. Profitability begins to increase in 2000, then decreases in 2007 and starts increasing once again after 2010. These results contrast with the increase in profitability to pre-crisis levels, but with worse economic conditions, as defined by dimension 1.

Dimension 3 (Profitability of the Banking Sector) and Dimension 2 (Financial Risk)

Profitability increases along with risk throughout the 1990s, with the highest values for both dimensions appearing in 2004, 2005, and 2006. Profitability gradually decreases in those years, but in conditions of high economic risk. In 2007, 2008, and 2009, low profitability with high risk is observed, and after these years, profitability increases by mitigating economic risk to some extent. After 2013, however, economic risk and profitability sharply increase.

A joint analysis of the established dimensions leads us to find results that could define the financial cycle in the economy in a new way, demonstrated by dimension 2 (financial risk). This variable increases after the 1990s, reaching its peak from 2005 to 2008, after which it starts to decrease until 2012; from then on, it starts to increase again.

The economic stability dimension worsens in the 2000s, while financial risk continues to increase (financial risk is reduced and exceeds economic stability). This event is a global risk for the economy that emerges in 2008. Therefore, financial risk increases to a greater extent when there was less economic stability. After 2007, financial risk decreases but still does not reach baseline levels observed in the 1990s, in which economic stability was greater than financial risk.

Recognition of bank losses experiences strong growth from 2000 to 2002, in order not to reflect risk in subsequent years, demonstrating the highest values after 2008, with the onset of the crisis.

In addition, dimension 3, profitability of the banking sector, increases above financial risk as of 2010. In 1997, it starts to decline, indicating the large concentration of risk during that period. One explanation for the large increase in dimension 3 after 2012 is dimension 4's sharp decrease. This increase in bank profitability occurs in a context of increased financial risk and slightly improved economic stability.

Conclusions

CCA was used to obtain four dimensions: economic stability, financial risk comparable to financial instability, profitability of the banking sector, and finally, recognition of bank losses.

In dimension 1, the economic variables that have a positive correlation are national income corresponding to wages, government surplus, velocity of M2 money, and 10-year bond yield. On the other hand, unemployment, share prices, consumption of fixed capital, public debt, and housing prices are negatively correlated. Therefore, economic stability can be determined by price and monetary stability because M1 is negatively correlated. Additionally, as the velocity of M2 money is greater in times of monetary stability determined by economic stability, the unit of money defined as M2 (monetary base and deposits) is spent more quickly, indicating confidence in the economy.

Banking variables, specifically capital ratios, are negatively correlated with this dimension when the economy is stable. Thus, we conclude that banking entities tend to hold less capital, creating vulnerabilities. Increases in loans to assets along with the interest margin are positively correlated with this dimension, unpaid loans are negatively correlated, while coverage of failed loans was positively correlated. Therefore, economic stability is demonstrated through a lower default rate, but another vulnerability is added, namely, higher bank balances.

For dimension 2, financial risk, the financial obligations ratio, along with housing prices and credit-to-GDP gaps, as well as risk-weighted assets to total assets, contribute to increased financial risk and decrease financial stability. However, bank financing through deposits is inversely correlated with financial risk as well as balance on current accounts. We conclude that the financial risk dimension is based largely on banks' assumptions of greater risk because banks are financed not only through deposits but also other types of financing, contributing to external capital inflows that compensate for current account deficits.

Since the 1990s, the US economy's financial risk dimension continued to increase until 2008, when it decreased until 2013, increasing thereafter. The economic stability dimension was high during the period of study, until 2000, declining since then and never increasing above financial risk. Thus, growth has occurred based on higher values in the financial risk dimension (lower financial stability) and lower levels of economic stability in the last decade.

Finally, the recognition of bank losses dimension, which includes loss allowance, has the lowest values when financial risk was highest, in 2006. Therefore, there is a need to use expected loss allowance to alleviate procyclicality and stabilize the economy.

Future works could apply this analysis to different countries and to sectors beyond the financial system as well as establish the relationships among the composite indicators found with economic growth.

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Appendix

Appendix A

Codes	Economic and Banking Variables
e1	Credit-to-GDP gaps (actual-trend) - United States - Credit from All sectors to Private non-financial sector.
e2	Residential property prices.
e3	Mortgage debt service ratio.
e4	Financial obligations ratio.
e5	General government; operating surplus, net/Gross domestic product.
e6	Nonfinancial corporate business; corporate profits before tax /GDP.
e7	Balance on current account/GDP.
e8	Nonfinancial corporate business; net dividends paid/Nonfinancial corporate business; corporate profits before tax.
e9	Households and nonprofit organizations; wages and salaries received /national income
e10	Nonfinancial business; proprietors' income /national income
e11	Private domestic sectors; consumption of fixed capital, structures, equipment, and intellectual property products, current cost basis/national income
e12	Taxes on corporate income/national income
e13	Personal current taxes/national income

Codes	Economic and Banking Variables
e14	Consumer Price Index: Total All Items for the United States, Index 2010=100,
e15	Unemployment Rate: Aged 15-64: All Persons for the United States, Percent.
e16	Total Share Prices for All Shares for the United States, Index 2010.
e17	Federal Debt: Total Public Debt as Percent of Gross Domestic Product, Percent of GDP.
e18	Nonfinancial Corporate Business; Credit Market Debt as a Percentage of the Market Value of Corporate Equities, Percent.
e19	Velocity of M1 Money Stock, Ratio.
e20	M1 for the United States, Growth Rate Previous Period.
e21	Velocity of M2 Money Stock, Ratio.
e22	Long-Term Government Bond Yields: 10-year.
e23	3-Month or 90-day Rates and Yields: Interbank Percent.
b1	Return on Assets
b2	Return on Equity
b3	Cost of Earning Funding Assets
b4	Net Interest Margin
b5	Net Charge offs to loans and leases
b6	Percent of Loans and Leases Noncurrent
b7	Loss Allowance to non current Loans & Leases (Coverage ratio)
b8	Loss Allowance to Loans and Leases
b9	Equity Capital to Assets
b10	Total Risk-Based Capital Ratio (PCA)
b11	Risk-Weighted Assets to Total Assets
b12	Net Loans & Leases to Total Assets
b13	Total Deposits as a % of Total Assets
b14	Insured Deposits as a Percent of Total Deposits

Appendix B

Codes	Banking Variables	Dimension 1	Dimension 2	Dimension 3	Dimension 4
b1	Return on Assets	0.2504347	-0.2530805	-0.67767490	0.21868560

b2	Return on Equity	0.4822078	-0.1191799	-0.64800738	-0.11897381
b3	Cost of Earning Funding Assets	0.8536969	0.3210595	0.36955754	-0.14358939
b4	Net Interest Margin	0.7022275	0.2869240	-0.27475480	0.53287513
b5	Net Charge offs to loans and leases	-0.4092303	0.1686879	0.52023411	0.63370674
b6	Percent of Loans and Leases Noncurrent	-0.5984607	0.5345453	0.36571850	0.43235818
b7	Loss Allowance to non current Loans & Leases (Coverage ratio)	0.7217187	-0.5270313	-0.38177107	-0.06752274
b8	Loss Allowance to Loans and Leases	-0.3217221	0.5327428	0.19036665	0.71382047
b9	Equity Capital to Assets	-0.8242089	-0.4821237	-0.17118337	-0.04854188
b10	Total Risk-Based Capital Ratio (PCA)	-0.7129112	-0.2226129	-0.51883285	0.26530768
b11	Risk-Weighted Assets to Total Assets	0.3849299	-0.5151315	0.51580754	-0.36982439
b12	Net Loans & Leases to Total Assets	0.9109103	-0.1813242	0.24732000	-0.15536011
b13	Total Deposits as a % of Total Assets	-0.3039404	0.9123471	-0.08952015	-0.22398748
b14	Insured Deposits as a Percent of Total Deposits	0.5029738	0.7465355	-0.08408684	0.28832347

Codes	Economic Variables	Dimension 1	Dimension 2	Dimension 3	Dimension 4
e1	Credit-to-GDP gaps (actual-trend) - United States - Credit from All sectors to Private non-financial sector	0.47422234	-0.63240133	0.50858949	0.030813715
e2	Residential property prices; long series.	-0.62716071	-0.65108167	0.06077114	-0.343926332
e3	Mortgage debt service ratio	0.22938202	-0.34213315	0.69729428	0.227993725
e4	Financial obligations ratio	0.39147037	-0.59837763	0.61894382	0.092380910

Codes	Economic Variables	Dimension 1	Dimension 2	Dimension 3	Dimension 4
e5	General government; operating surplus, net/Gross domestic product	0.86495226	0.31863850	-0.31165644	0.045348793
e6	Nonfinancial corporate business; corporate profits before tax /GDP	-0.52938872	-0.24214828	0.23199251	-0.357582368
e7	Balance on current account/GDP	0.08910250	0.89828751	-0.03133398	0.055051136
e8	Nonfinancial corporate business; net dividends paid/Nonfinancial corporate business; corporate profits before tax	0.12470969	-0.07257365	0.18494277	0.121233582
e9	Households and nonprofit organizations; wages and salaries received /national income	0.83391178	0.20807952	0.30677628	0.125140890
e10	Nonfinancial business; proprietors' income /national income	-0.34782465	-0.71149984	-0.24590598	0.004996908
e11	Private domestic sectors; consumption of fixed capital, structures, equipment, and intellectual property products, current cost basis/national income	-0.72963838	-0.45698102	0.41379803	0.085337677
e12	Taxes on corporate income/national income	0.04988575	-0.05634602	-0.36674064	-0.590280910
e13	Personal current taxes/national income	0.50382990	-0.05171873	-0.03990991	-0.386623552
e14	Consumer Price Index: Total All Items for the United States, Index 2010=100,	-0.88119758	-0.41616121	-0.04551283	-0.110767826
e15	Unemployment Rate: Aged 15-64: All Persons for the United States, Percent.	-0.63431229	0.41783650	0.11869861	0.576230579
e16	Total Share Prices for All Shares for the United States, Index 2010.	-0.66953710	-0.54772797	-0.05936958	-0.353957317
e17	Federal Debt: Total Public Debt as Percent of Gross Domestic Product, Percent of GDP.	-0.89964926	0.18123281	-0.25239235	-0.071171158

Codes	Economic Variables	Dimension 1	Dimension 2	Dimension 3	Dimension 4
e18	Nonfinancial Corporate Business; Credit Market Debt as a Percentage of the Market Value of Corporate Equities, Percent.	0.20363047	0.54063738	0.47130639	0.233431178
e19	Velocity of M1 Money Stock, Ratio.	0.21515575	-0.79596791	0.49483722	0.126807920
e20	M1 for the United States, Growth Rate Previous Period.	-0.54854500	0.30357371	0.11783109	0.264309749
e21	Velocity of M2 Money Stock, Ratio.	0.93851721	-0.22348767	-0.07296941	0.164249720
e22	Long-Term Government Bond Yields: 10-year.	0.85901259	0.39347709	0.17987820	-0.012390683
e23	3-Month or 90-day Rates and Yields: Interbank Percent.	0.87549922	0.11696640	0.26201618	-0.246811040

Appendix 3