SAULO CARDOSO MAIA

VALUE CREATION IN BRAZILIAN CREDIT UNIONS

LAVRAS – MG

2019

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Tese apresentada à Universidade Federal de Lavras, como parte das exigências do Programa de Pós-Graduação em Administração, área de concentração em Gestão de Negócios, Economia e Mercado, para a obtenção do título de Doutor.

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CRIAÇÃO DE VALOR EM COOPERATIVAS DE CRÉDITO BRASILEIRAS

Tese apresentada à Universidade Federal de Lavras, como parte das exigências do Programa de Pós-Graduação em Administração, área de concentração em Gestão de Negócios, Economia e Mercado, para a obtenção do título de Doutor.

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Aos meus filhos, Gabriel e Mateus.

À minha esposa, Sueli.

Aos meus pais, Sálvio e Adelina.

Dedico

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RESUMO GERAL

Este trabalho teve como objetivo avaliar a criação de valor pelas cooperativas de crédito brasileiras aos seus membros. Pesquisadores engajados no desenvolvimento de modelos econômicos declaram que cooperativas de crédito criam valor para seus membros oferecendo juros sobre operações de crédito e depósitos que sejam vantajosos em comparação com alternativas de mercado. No entanto, poucos estudos empíricos dizem respeito à função objetivo com benefícios líquidos a tomadores de empréstimo e poupadores apresentada nos modelos teóricos. Neste sentido, este estudo busca contribuir para o campo de estudos com uma pesquisa empírica que avalia o desempenho de cooperativas de crédito em relação aos benefícios e valor para os membros. Especificamente, avalia o valor de cooperativas de crédito Brasileiras com base em um modelo dinâmico que considera a intertemporalidade dos benefícios a tomadores de crédito e poupadores. O modelo envolveu a comparação entre taxas de juros do mercado e das cooperativas de crédito, bem como a estimação de risco individual ao longo do tempo, de 2010 a 2018. Em um capítulo específico, o trabalho estima os riscos individuais por meio de regressão logística com dados em painel avaliando a probabilidade de falha. O sistema de indicadores PEARLS foi a base para estimar o risco, mas variáveis complementares qualitativas e macroeconômicas também foram verificadas e mostraram-se efetivas no modelo de estimação. Dentre os indicadores PEARLS, a qualidade das operações de crédito foi a variável mais significativa para explicar risco, seguida do indicador de solvência, crédito externo, depósitos e crescimento no capital social dos membros. O modelo também evidenciou que pequenas cooperativas e aquelas com critérios de associação mistos apresentam maior risco. Além disso, os resultados também mostraram uma influência significativa da variação real do PIB sobre o risco. De forma geral, cooperativas de crédito brasileiras apresentaram 1.1% de probabilidade de falha. Todavia, foram observadas algumas instituições com alto risco. Embora a maioria das cooperativas de crédito tenha superado um período crítico de crise, o setor não ficou imune à recessão. Uma vez calculado o risco, em um capítulo subsequente o trabalho examinou os benefícios e valor das cooperativas de crédito considerando o período de 2013 a 2017. Os resultados evidenciaram que as cooperativas de crédito vêm criando valor, particularmente aos tomadores de crédito. Os benefícios aos poupadores são menos significativos. A estrutura intertemporal mostrou que a soma do valor das cooperativas de crédito foi positiva em todos os semestres. Ademais, a média e a mediana do valor em relação ao patrimônio líquido foi maior que 1 também para todos os semestres. De modo geral, a média do valor intrínseco em relação ao total do patrimônio líquido foi 2.25, considerando todo o período estudado. Os resultados demonstraram que as cooperativas de crédito foram valiosas para os seus membros especialmente quando as taxas de juros do mercado estavam mais desfavoráveis, visivelmente durante a recessão econômica.

Palavras-chave: Cooperativas de Crédito. Criação de Valor. Função Objetivo. Risco. PEARLS.

GENERAL ABSTRACT

This work aimed at assessing the value creation by Brazilian credit unions for their members. Researchers engaged in developing economic models state that credit unions create value to members by offering advantageous interest rates on loans and savings compared to market alternatives. However, few empirical studies regard the borrower-saver net benefit objective function presented in theoretical models. In this sense, this study seeks to contribute to the field with empirical research that evaluates the performance of credit unions regarding benefits and value for members. Specifically, it assesses Brazilian credit union values based on a dynamic model that considers the inter-temporality of borrower-saver benefits. The model involved comparison between market and credit unions interest rates, as well as individual risk estimation over time, from 2010 to 2018. In one of its chapters, the work estimates individual risks through panel data logistic regression evaluating the probability of failure. The PEARLS ratios system was the basis to estimate risk, but complementary qualitative and macroeconomic variables were also verified and proved to be effective at the estimation model. Among the PEARLS ratios, quality of loans was the most significant variable to explain risk, followed by solvency indicator, external credit, deposits, and growth in member shares. Besides, the model evidenced that small and mixed bond credit unions have higher risk. Furthermore, results also showed significant influence of real percentage change in GDP on risk. Overall, Brazilian credit unions presented a 1.1% of probability of failure in that period. However, some highly risky individuals were observed. Although most credit unions have overcome a critical period of recession, the sector was not immune to it. Having calculated the risk in a subsequent chapter, this work examined benefits and value of credit unions considering the period from 2013 to 2017. The findings evidenced that credit unions have been providing benefits, particularly to borrowers, while benefits to savers were less significant. The inter-temporal framework showed that the sum of credit union values was positive in each semester. Moreover, mean and median values scaled by equity were higher than 1 for each semester. Overall, the mean of intrinsic value to equity was 2.25, considering the entire period studied. Results demonstrated that credit unions were valuable to their members, especially in periods when market interest rates were more unfavorable during the economic recession.

Keywords: Credit Unions. Value Creation. Objective Function. Risk. PEARLS.

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LISTA DE SIGLAS

ABCUL	Association of British Credit Unions Limited
AC	Acre
AE	Adjusted Equity
AIC	Akaike Information Criterion
AL	Alagoas
AM	Amazonas
ANN	Artificial Neural Networks
AP	Amapá
AUC	Area under the ROC Curve
BA	Bahia
BCB	Banco Central do Brasil
BIC	Bayesian Information Criterion
BRL	Brazilian Real
CAMELS	CAMELS Rating System
CE	Ceará
CECREMGE	Central das Cooperativas de Economia e Crédito de Minas Gerais Ltda
CF	Cash Flow
CMN	Conselho Monetário Nacional
COSIF	Plano Contábil das Instituições do Sistema Financeiro Nacional
CV	Credit Union Value
DEA	Data Envelopment Analysis
DF	Distrito Federal
ES	Espírito Santo
FASB	Financial Accounting Standards Board
FATES	Fundo de Assistência Técnica, Educacional e Social
FE	Fixed Effects
FGV	Fundação Getúlio Vargas
GAAP	Generally Accepted Accounting Principles
GDP	Gross Domestic Product
GEE	Generalized Estimation Equation
GO	Goiás
IASB	International Accounting Standards Board
IBRE	Instituto Brasileiro de Economia

ICC	Indicador do Custo de Crédito
IGP-DI	Índice Geral de Preços – Disponibilidade Interna
ILCU	Irish League of Credit Unions
LM	Lagrange Multiplier
LR	Likelihood-ratio
MA	Maranhão
M&A	Mergers and Acquisitions
MG	Minas Gerais
MS	Mato Grosso do Sul
MT	Mato Grosso
PV	Present Value
NGL	Net Gain on Loans
NGS	Net Gain on Savings
NMB	Net Monetary Benefits
NMBB	Net Monetary Benefits to Borrowers
NMBS	Net Monetary Benefits to Savers
PA	Pará
PA	Population Average Model
PB	Paraíba
PE	Pernambuco
PEARLS	PEARLS Monitoring System
PI	Piauí
POLS	Pooled Ordinary Least Squares
PR	Paraná
RE	Random Effects
RF	Random Forests
RJ	Rio de Janeiro
RN	Rio Grande do Norte
RO	Rondônia
ROA	Return on Assets
ROC	Receiver Operating Characteristic Curve
RR	Roraima
RS	Rio Grande do Sul
SELIC	Sistema Especial de Liquidação e de Custódia

SC	Santa Catarina
SE	Sergipe
SP	São Paulo
SVM	Support Vector Machine
TB	Total Benefits
TL	Total Amount of Loans
TO	Tocantins
TV	Terminal Value
USD	U.S. Dollar
VIF	Variance Inflation Factor
WADR	Weighted Average Dividend Rate
WALR	Weighted Average of Loans Rates
WAMLR	Weighted Average of Market Loan Rates
WOCCU	World Council of Credit Union

CONTENTS

CHAPTER 1 GENERAL INTRODUCTION

1 BACKGROUND AND MOTIVATION

Credit unions are financial cooperative organizations in which members provide both offers and demands for funds. These cooperatives mediate transactions between savers and borrowers. As stated by Bressan (2009), by offering financial services to their members, these organizations are important to the development of several countries. The credit union sector has considerable relevance at national and international levels. The statistical report from Word Council of Credit Unions (WOCCU, 2016) gathered data from 68,000 cooperatives that serve around 235 million people in 109 countries on six continents. Financial data also demonstrate how the operations of those organizations are significant. WOCCU (2016) reported USD 1.7 trillion in assets, USD 1.2 trillion in loans, and USD 1.4 trillion in savings and shares. Data from the Brazilian Central Bank (BCB, in Portuguese) indicate a significant presence of credit unions in the country. According to BCB (2017), first level credit unions held, as of December 2016, USD 47.3 billion in assets.

Despite the significant figures, the sector is still far from reaching its full potential to grow up and increase its economic contribution. According to BCB (2015) in 2014 over 50% of Brazilian municipalities were served by the cooperative sector. Nevertheless, BCB considers the sector as inclusive, since approximately 43% of all cooperative members do not have an account at any other financial organization. Besides, credit unions are supposed to provide better interest rates to members when compared to other financial institutions, such as, banks.

According to WOCCU (2015), there are about 2 billion people worldwide that have no access to banking services, out of which 55% are women, 54% belong to classes with the lowest income in the population, and 54% are young adults, that is, aged 15 to 24. Credit unions can help reduce economic distortions as there are many benefits associated with them. Bressan, Bressan, and Silva Júnior (2015) claim that credit unions are important means of inclusion in the financial system, and have an important social function to perform financial intermediation between members.

Among the benefits attributed to credit unions, the academic literature (RUBIN et al., 2013; SMITH; CARGILL; MEYER, 1981; TAYLOR, 1971; WALKER; CHANDLER, 1977) highlights better interest rates on savings and loans than other financial institutions. The vocation of credit unions to practice a differentiated financial intermediation by offering better interest

rates, both to savers and borrowers this is the aspect this paper focuses on Brazilian Credit Unions have been used as object of study.

In Brazil, most credit unions are organized into three levels: singular, central and confederations. Singular cooperatives provide services directly to their members, people or organizations; moreover, they may receive transfers from other financial institutions and carry out investments in the financial market. At the second level, central cooperatives provide services and assistance to affiliated singular cooperatives and are responsible for their supervision, regardless of BCB supervision. In turn, confederations provide services to central cooperatives and their affiliates. There are also credit unions organized in two levels, and independent credit unions that do not belong any system. Besides, there are two big cooperative banks owned by central cooperatives. The cooperative banks provide access to check clearing house and bank reserves, which, according to the Brazilian regulation, credit unions cannot access directly (BCB, 2015).

In some countries, credit unions are at an advanced stage. For example, in Australia, the credit union movement is considered well developed because of assets, membership and penetration rate (MCKILLOP; WILSON, 2011). WOCCU (2016) reported 4.2 million credit union members, which correspond to 17.5% of Australia's population. According to McKillop and Wilson (2011), there is a selected group of countries where credit unions are at a mature stage, namely, United States, Canada, Australia, France, and Korea. In those countries, such mature stage is characterized by large asset size, conduct deregulation accompanied by increased prudential regulation, a loose common bond, diversified product portfolios, professionalization of management, centralized services, adoption of electronic technologies and a deposit insurance scheme.

In spite of the fact that these peculiar organizations have demonstrated relevant presence in many countries, studies point out that they have not received so much attention by the academic community (BAUER, 2008; RUBIN et al., 2013). Fried, Lovell, and Eeckaut (1993) attribute this low interest to their small size and small share in financial sector, or probably because of their unconventional organizational form.

Although credit unions have a mutuality nature, there are still few studies on the economic benefits they actually generate and on how they are capable of creating value to their members. Many studies (BAUER; MILES; NISHIKAWA, 2009; BOSSLER; SCHILD, 2016; BROWN; DAVIS, 2009; FREITAS; CASTRO AMARAL; BRAGA, 2008; MAIA et al., 2013), both national and international, generally focus on the financial and economic performance of the

institutions, on the accounting issues, and on the risk or organizational aspects. This kind of research is important and should continue to be developed, because they can contribute to the development of the sector. However, researchers could also consider aspects of the economic benefits of credit unions to their members, as well as to the regions, states and countries in which they operate. This project aims to address these aspects, specifically regarding the economic value creation to credit unions members. Although credit unions can also provide qualitative benefits, this study will only evaluate quantitative benefits.

2 RESEARCH QUESTIONS

By developing a practical way to assess the performance of credit unions based on the main models available in literature, this study seeks to assess credit union value creation to their members.Credit union managers have many motivations to generate positive results. First, the institutions must be economically viable. This means that they must generate enough revenue to cover their expenses, as well as to guarantee the institution's solvency. Second, the economic-financial situation in a financial institution is especially relevant, because of the need to show credibility to its target audience. Third, the surplus can be understood as indicative of management performance. Besides, managers must be motivated to make efforts to cause the cooperative to reach a certain level of output. Negative results can be interpreted as mismanagement. Results smaller than the previous year can be interpreted as involution in performance.

In addition to having to show good performance to shareholders, managers also need to follow a strong regulatory requirement that tends to force credit unions to present good earnings: the minimum equity index required by the central banks, in line with Basel Accords, which demands a minimum capital to risk ratio. (BROWN; DAVIS, 2009; FERRI; LIU; MAJNONI, 2001; LAURENT; SESTIER; THOMAS, 2016; MAIA et al., 2013). The capital requirement will be affected, among other factors, by earnings accumulated over time. Indeed, credit unions have a differentiated prudential regime, which is simpler than that applied to banks; nevertheless it is subject to minimum capital requirements.

Although cooperative managers have enough motivation to generate a certain level of earnings, there are still practical and market limitations. If the cooperative adopts a strategy to maximize its earnings, they will be generated to the most extent by the members themselves. Regarding assets and revenues, the members of the cooperative are the main generators of income

by paying interest on credit loans. To achieve a higher profit, the cooperative will have to raise interest rates, harming the borrowing members. In turn, when it comes to liabilities and expenses, to generate a higher profit, the cooperative will have to reduce the interest rates paid to saving members, who will be also prejudiced. Therefore, the surplus, although relevant as presented above, is not the best measure of credit union performance, regarding value creation to their members.

The economic performance of a cooperative can be understood as the extent of the economic activity of its members, who operate together, rather than individually. Thus, the goal of a cooperative is to engage in economic activities that are more advantageous for its members (RUBIN et al., 2013; TAYLOR, 1971). Therefore, the bottom line of income statement, is not the main objective of a cooperative, but the net income, especially because the earnings are generated mainly by members themselves. They are economically benefited by credit unions through access to financial services.

On one hand, if a credit union provides, in a certain period, financial services with better interest rates than the market, it creates value for their members even though the net profit is equal to zero. On the other hand, if a credit union distributes a positive net profit in certain period, but charges prices higher than those found in the market, the created value might be near zero or even less.

The credit union creates economic value for their members as long as they ensure access to financial market instruments with better prices than those found in other financial institutions, while maintaining equity. Therefore, there are limitations in models that assess credit union performance by mainly taking into account net profit ratios, only.

It is necessary to develop more suitable ways to evaluate the performance of cooperatives and the value they generate for their members by taking into account their particular characteristic of being owned by clients. Smith, Cargill, and Meyer (1981), supported by Rubin et al. (2013), stated that models applied to firms based on profit maximization cannot be directly applied to credit unions, since their members are owners, customers, and suppliers. Rubin et al. (2013) highlight the fact that, since Smith's work in 1980s, little effort has been made to develop specific theoretical models for credit unions, considering their peculiarities.

Taking the context above into account, it is possible to identify some limitations in models and ways of evaluating the performance of credit unions, especially considering the member's perspective. For example, the Statement of Income, which, for credit unions, is also called

the Statement of Surpluses and Losses, does not adequately evidence value creation for their owners, because it focuses on net income, without considering the potential gains that come from differences of interest rates in relation to other financial institutions. In this study, value creation refers to the creation of economic value, based on the difference between the firm's value at the end and at the beginning of a given period. As the next chapter details, the value of a credit union is assumed as the present value of future economic benefits flowing to members.

Therefore, inferring the value creation from credit unions to their members through the existing evaluation models is, at the best, a limited analysis. Consequently, investigations about determinants of credit unions performance are also limited since they are based on inappropriate measures. Hence, there is space for improvement in cause and effect analysis related to the creation of value by those organizations. In other words, a wide empirical assessment of the credit unions value creation using models suitable for the context in which the cooperatives operate would allow more fitting investigations about the external and internal factors that make a credit union more or less worth to their owners. Moreover, it would enable the possibility of properly evaluate the variables that influence the value creation by the credit unions. This work aims to contribute in this sense.

From the aspects sustained above, the following specific questions have raised:

a) how do credit unions create value?;

b) how to properly measure credit unions value creation in context of Brazil?;

c) to which extent have Brazilian credit unions been creating value?;

3 OBJECTIVES

The general and specific objectives are presented below. They are strongly related to the questions presented above.

3.1 General objective

The general objective of this study is to assess the value creation by Brazilian credit unions to their members.

3.2 Specific objectives

Specifically, this research aims to:

a) estimate the risk of credit unions to include it in the model of value creation measurement;

b) investigate how to properly measure credit union value creation in the Brazilian context;

c) investigate to which extent Brazilian credit unions have been creating value;

4 JUSTIFICATION

The findings of this doctoral thesis can help enrich current knowledge on credit unions and value creation, both in theoretical and practical terms, related to the way different organizations create value and to the variables that influence it.

4.1 Theoretical contributions

This thesis enriches the discussion on credit union value creation, both in theoretical and empirical fields. In the theoretical sense, this study develops a way to measure performance, and provides some general discussions on value creation. In an empirical sense, this work performs a cause and effect variable study and provides an econometric analysis. They can contribute to confirm or refute theories about the response of credit unions performance to specific internal and external factors, which can support future studies that seek to delve into the theme.

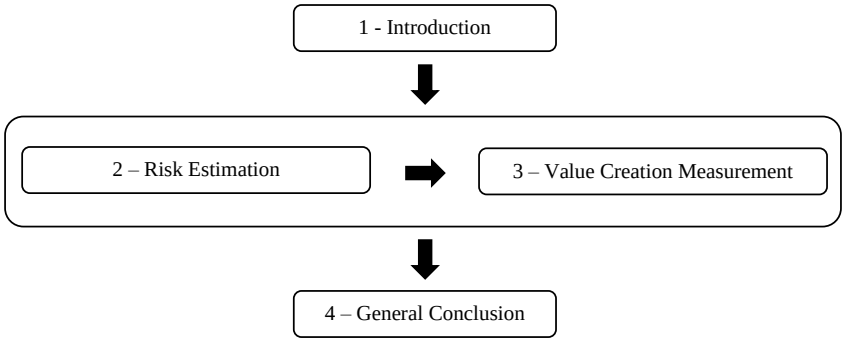
4.2 Practical contributions

In a practical sense, the main audiences of this thesis are credit unions, credit union members, and policymakers. Credit unions can use the findings towards refining their activities and to take decisions like growing, investments, mergers and acquisitions, demutualization, valuation, and communication of performance to the membership. Members can use this thesis to better understand how and to what extent those organizations benefit them, besides the variables that diminish or increase potential benefits. This thesis is also potentially useful to the government, central banks, and regulators, since it provides information on risk assessment and the impact of credit unions on financial system efficiency, which includes possible contributions to spread reduction, depending on how and to which extent studied organizations do this financial intermediation.

5 THESIS OVERVIEW

The objectives presented in section 3.2 are approached in sequence, since the achievement of one depends on the results of the previous one. To meet these purposes, this thesis is organized into 5 chapters, as explained below. First, this general introduction, which contains the research questions, objectives and contributions. Chapter 2 addresses the specific objective (a) by presenting an estimation of credit union risk to be used in the following chapter. Chapter 3 specifically approaches objectives (b) and (c), presenting a theoretic review on credit union value creation, explaining how to measure it in the Brazilian context, and then, detailing how to empirically implement this measure. Finally, Chapter 4 presents general conclusions and final considerations, including suggestions for future research. Figure 1.1 provides an overview of thesis.

Figure 1.1 – Thesis structure



Source: by the author (2019)

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CHAPTER 2 RISK ESTIMATION

RESUMO

Este capítulo aborda o primeiro objetivo específico da tese, que é estimar o risco das cooperativas de crédito para incluí-lo no modelo de mensuração de criação de valor. Primeiramente, apresenta uma revisão da literatura sobre diferentes modelos de mensuração de risco para as organizações em questão. A estimação do risco foi baseada principalmente no sistema de indicadores PEARLS, com o auxílio de variáveis qualitativas e macroeconômicas. O modelo econométrico utilizado é baseado em regressão logística com dados em painel. Os resultados apontam que as principais variáveis que impactam o risco das cooperativas de crédito estão relacionadas a solvência, estrutura financeira, qualidade das operações de crédito e crescimento. Finalmente foi calculada a estimativa de risco para cada cooperativa de crédito com base nos parâmetros e variáveis apontados pelo modelo econométrico. Em geral, as cooperativas de crédito apresentaram baixa probabilidade de falência, com uma média geral no período estudado igual a 1,1%. No entanto, foram observadas algumas cooperativas com alto risco. Ademais, embora a maioria das cooperativas de crédito tenha superado o período crítico da recente crise econômica no Brasil, o setor não ficou imune à recessão.

Palavras-chave: Cooperativas de Crédito. Risco. Estimação. PEARLS. Logit.

ABSTRACT

This chapter approaches the first specific objective of this thesis, which is to estimate the risk of credit unions to include in the model of value creation measurement. First, it presents a literature review on diverse models of risk measurement for the studied organizations. The risk estimation was based mainly on the PEARLS ratio system along with qualitative and macroeconomic variables. This chapter also relies on a panel data logistic regression. The findings indicate that the main variables that impact credit union risk are related to solvency, financial structure, quality of loans, and growth. Finally, this chapter calculated the risk estimation of each credit unions based on the parameters and variables according to the econometric model. Overall, credit unions have presented low probability of failure, with a general mean equal to 1.1% in the studied period. However, some highly risky individuals were observed. In addition, although most of credit unions have overcome the critical period of the recent economic crisis in Brazil, the sector was not immune to it.

Keywords: Credit Unions. Risk. Estimation. PEARLS. Logit.

1 INTRODUCTION

The previous chapter has provided an overview of this thesis, as well as its objectives and general structure. This chapter approaches the first specific objective, which is to present a risk estimation for each credit union, in order to be applied in the next chapter and compose the model of value creation measurement. Based on the literature, we develop procedures to calculate a risk of failure r to compose the discount rate p in the next chapter (see equations (3.50) and (3.51)).

The risk component of function p must be established to indicate the probability of credit union failure. McKillop and Wilson (2011) observes that there are many studies on determinants of bank failure, but literature on credit union failure is limited. Rubin et al. (2013) assert that it is dependent on equity to loans ratio. The Basel Accords corroborate the importance of this ratio to the economic sustainability of financial organizations. However, it should not be the only factor to be considered. Other features are also determinant to the survival of a financial institution. Some of the key financial ratios are liquidity, quality of assets, and profitability. Therefore, the probability of failure of a credit union involves a set of financial characteristics that must be taken into account to compose a robust index.

A system of ratios that provides a customized and objective basis to evaluate credit union probability of survival is the PEARLS Monitoring System. PEARLS is a management tool that provides standardized evaluation ratios and formulas grouped into areas. It consists of a set of financial ratios used by WOCCU since 1990 to monitor the performance of credit unions. The system also aims to standardize diverse criteria used by credit unions to evaluate their operations, to compare organizations objectively, and to provide a framework for supervision (RICHARDSON, 2009).

As highlighted by Rubin et al. (2013), equity is really important for financial organizations. The minimum equity index required by central banks around the world, in line with the Basel Accords, corroborate the relevance of equity to reduce failure risk (BROWN; DAVIS, 2009; FERRI; LIU; MAJNONI, 2001; LAURENT; SESTIER; THOMAS, 2016). Capital requirement will be affected, among other factors, by retained earnings accumulated over time. Therefore, the strong regulatory requirement tends to force credit unions to achieve a good level of equity, as required in Brazil. A differentiated regime is simpler than the one applied to banks, but credit unions are subject to minimum capital requirements anyway. The great importance that Basel

Accords and signatory central banks give to the equity-to-loans ratio justifies its utilization as risk component of rate q, even though it should not be the only factor to be considered.

It is reasonable to consider that many other ratios, besides equity-to-loans, may help to indicate the probability of failure. Indicators of liquidity, profitability, asset quality, and growth can be very informative regarding risk evaluation. In this sense, PEARLS gathers a set of specific ratios to assess credit unions, as it will be explained in the next section. Subsequently, a review on previous models to estimate risk is provided. The model used in this chapter is later detailed in Section 3 (Methodology), and then applied in Section 4 (Findings).

2 LITERATURE REVIEW

2.1 The PEARLS Monitoring System

As shown in Frame 2.1, PEARLS is an acronym to six key areas of credit union operations: **P**rotection, **E**ffective financial structure, **A**sset quality, **R**ates of return and cost, **L**iquidity, and **S**igns of growth. It consists of objective indicators coming from accounting system and permits to assess and compare credit union performance. Besides its utility as a management tool, the framework provided by PEARLS may be used by supervisory organizations to conduct periodic operational analyses. These evaluations allows to spot trends and detect areas of concern among credit unions (RICHARDSON, 2009).

PEARLS was initially based on CAMEL ranking system (Capital adequacy, Asset quality, Management, Earnings, and Liquidity), a similar ratio system applied to bank assessment in United States. Many modifications were needed to the case of credit unions. Specifically, PEARLS has two main advantages in comparison with CAMEL. Because PEARLS is basically composed by financial ratios from balance sheet, it is more objective if compared to CAMEL, which has subjective judgment components. Besides, CAMEL does not consider growth rates while PEARLS does (RICHARDSON, 2009).

Methods based on PEARLS have been used to solvency assessment and credit union monitoring in academic literature or supervisory organizations. In Ireland, the system is used by the Irish League of Credit Unions (ILCU) in a compliance division to monitor and supervise their 402 affiliates with the support of a system based on PEARLS ratios (GLASS; MCKILLOP; RASARATNAM, 2010). According to Jones (2008), the Association of British Credit Unions (ABCUL) have introduced PEARLS financial monitoring system into British credit unions.

Frame 2.1 – PEARLS Components

Area	Overview
Protection	Protection is related to credit risk. The ratios mainly regard the allowance for loan losses and loan charge-offs in relation to loans delinquency. Basically, the ratios show to what extent discretionary accounting suits the risk level in lending activity and, consequently, how proper the evaluation of the main assets - the loans - is. The main of six ratios is: P1=Loan Losses Allowances/Delinquency>12 months, which should be 100%.
Effective Financial Structure	It is related to the structure of sources and applications of funds. Here are analyzed the proportions of the main assets, liabilities and capital in balance sheet. An effective financial structure requires, besides capital adequacy, assets mainly financed by savings deposits, generating sufficient income to pay market rates on savings and cover operating costs. Among nine ratios, E1 (Net Loans/Total Assets) and E5 (Savings Deposits/Total Assets) can be highlighted, because they indicate the major assets and liabilities. WOCCU recommends both should be between 70% and 80%.
AAsset Quality	Asset Quality is composed by three ratios that affects the organization profitability: Delinquency Ratio (A1), Percentage of Non-Earnings Assets (A2) and Financing of Non-Earning Assets (A3). The ideal target to the delinquency ratio is to maintain it up to 5% of total outstanding loans. In addition, the institution must monitor the proportion of non-earning assets (e.g. fixed assets) to total assets and ensure that they are financed by no-cost capital.
Rates of Return and Cost	It is composed by return-and-cost ratios covering the main lines of income statement. The ratios start from loan income, include financial and administrative costs ratios, and finish with ROA (Net Income/Average Assets). This area permits to analyze the main components of earnings by evaluating investment yields and operating expenses.
Liquidity	Liquidity is an essential component of any financial organization. It regards the necessary short-term liquid funds available to face withdrawals. Effective liquidity becomes much more important, as long as the credit union changes its financial structure from more stable member shares to more volatile deposit savings. On the other hand, because idle liquid funds are not profitable, they should be reduced as close to zero as possible. The target to L1 (Short-Term Investments+Liquid Assets-Short-Term Payables/Savings Deposits) is 15-20%.
Signs of Growth	The indicators of this area measure the percentage of growth in each of the most important accounts on the financial statements, as well as growth in membership. This area reflects membership satisfaction. Real growth (after subtracting inflation) accompanied by sustained profitability, maintains asset values and is essential to the credit union long-run viability. Ratio S11 (Growth in Total Assets) is a critical indicator since many of the formulas in PEARLS are linked to it.

Source: The author (2019), based on Richardson (2009) and WOCCU (2017)

In Brazil, PEARLS has proved to be effective in predicting credit union solvency. According to Oliveira and Bressan (2015), BCB's analysts estimate that there is around 90% of

similarity between PEARLS and the Score System adopted by the Brazilian financial authority. Bressan et al. (2010) have proposed a set of indicators based on PEARLS applied to Brazilian credit unions. Their study has been the main basis for a series of subsequent studies on the topic (BRESSAN et al., 2011a,b; GOZER et al., 2014a,b, 2015; OLIVEIRA; BRESSAN; BRESSAN, 2014).

Bressan et al. (2011a) have developed a Logit model based on PEARLS ratios to estimate the probability of solvency in credit unions from Minas Gerais State. The study used 9,456 observations from 112 organizations. The ratios of PEARLS were statistically significant to explain the probability of credit union insolvency. The correct prediction rate was 94.97% overall, 72.32% to insolvent individuals, and 96.14% to solvent ones.

In a similar, but broader study, with 35.485 observations from 510 credit unions of Sicoob all over Brazil, Bressan et al. (2011b) found similar results. The correct prediction rate was 86.86% overall, 50.75% to insolvent individuals, and 93.14% to solvent ones. The prediction accuracy was lower, but all selected ratios were statistically significant at the level of 1%. In both studies, the authors highlighted some groups of ratios as specially relevant to explain the probability of insolvency: P(Protection), E(Effective financial structure), A(Asset quality) and R(Rates of return and cost).

There are also studies in Brazil that use PEARLS to assess the performance and the solvency of central credit unions. Oliveira, Bressan, and Bressan (2014) use the system to evaluate and compare the performance of 14 central cooperatives of Sicoob. After, Bressan et al. (2015) analyzed the same central cooperatives to check which of the ratios are relevant to explain the solvency of the central cooperatives. According to the results, the main indicators are in groups P(Protection), E(Effective financial structure) and R(Rates of return and cost). The authors conclude that the Logit model based on PEARLS system is valid to be used in solvency and risk analysis of central as well as singular, or first level, credit unions.

Gozer et al. (2014a) use a different approach with artificial neural networks (ANN) algorithms and a selection of PEARLS ratios, to inquire the solvency situation of 62 credit unions from Paraná State. Among the studied organizations, 31 were initially identified as solvent and 31 as insolvent. The six different algorithms achieved a correct classification ratio, of insolvent and solvent individuals, from 83.9% to 91.9% of accuracy. The most relevant groups of ratios in Gozer et al. (2014a) were P(Protection), E(Effective financial structure), A(Asset quality) and R(Rates of return and cost), the same groups highlighted in previous studies (BRESSAN et al.,

2011a,b), although some indicators inside the groups are different. Therefore, ratios from those four groups apparently play a special role in solvency prediction of credit unions.

The studies shown above demonstrate that PEARLS is a valid way to evaluate the probability of credit union solvency. They also point out that the system is not used as a whole with all ratios. The studies select the ratios according to the power of explanation of explanatory variables seeking to achieve the best possible adjustment and accuracy rate. The studies also face some limitations regarding the availability of variables to calculate every ratio. In summary, the literature demonstrates that PEARLS is a well-grounded way to predict probability of survival of credit unions, even though some adaptations are necessary.

2.2 Previous models to estimate risk of credit unions

The risk assessment of credit unions has studied approaches regarding the econometric techniques. Crapp and Stevenson (1987) developed a method to select variables and specify their relative importance to failure. The model was then applied to estimate the probability of failure of Australian credit unions. The analysis was based on Cox (1972) proportional-hazard regression model. The study used stepwise procedures for selecting the variables. Failure was defined as the phenomenon where a credit exits the industry due to financial distress. The authors grouped ratios as follows: asset quality, financial risk, managerial efficiency, growth, and economic consequences. According to the results, the most relevant variables were income capacity, operating efficiency, and loan growth[1] . Credit unions with high operating expenses and/or high loan growth without a compatible increase in income capacity were shown to have more probability of failure.

Pille and Paradi (2002) developed data envelopment analysis (DEA) models to predict potential financial failure of credit unions in Canada. They compared the DEA models with equity to asset ratio and with the Canadian government regulator's method. The models were considered similar, regarding the predictability of failure. The authors considered failures according to the regulator‘s indication or when a credit union was the weak partner in a merger. The failure prediction was more reliable in the first year before the event. On average, lower scores were observed in insolvent credit unions up to three years before failure. This means that periods longer than three years were not significant to predict failure.

[1] Income capacity = total income/total assets; group: managerial efficiency. Operating efficiency = operating expenses/total assets; group: managerial efficiency. Loan growth = loan change/loans at start;group: growth

Ely (2014) focused on the impact of bond types and multiple bond fields of membership in credit unions. As a result, the author found that risk is higher when the field of membership is broader. However, the risk declines as asset size grows. The study employed two measures of insolvency risk: the probability of bankruptcy and the probability of exhausting regulatory capital. The probability of bankruptcy, a Z-score, was defined as the number of standard deviations below the mean of Return on Assets (ROA) at which the institution would deplete its equity. The probability of exhausting regulatory capital was defined as the number of standard deviations below mean ROA at which the institution would breach regulatory capital requirements. To check the influence of kind of membership on probability of insolvency, the authors used a difference-in-differences approach. Size, mix of assets, industry environment, and economic environment were used as control variables.

Goddard, McKillop, and Wilson (2014) have studied the reduction in number of credit unions in the United States through merger and acquisitions (M&A) and failure. Consolidation via M&A was the main cause of reduction. As part of the study, they have investigated the causes of failure. The empirical model was Cox (1972) proportional hazard model. According to the study, the main factors positively associated with the probability of survival are size, growth, capitalization, and return on assets. High proportion of liquid assets low loans-to-asset ratios and low profitability are at higher risk of exit, both through acquisition or failure.

In Brazil, Araujo (2011) used logistic regression to assess the relationship between accounting ratios and risk of insolvency in Brazilian credit unions. The accounting ratios were relevant to estimate the risk of insolvency. The authors characterized insolvency based on interruption of sending balance sheets to BCB, which means operational discontinuity, combined with negative or decreasing equity. The interruption of sending financial statements to BCB is also used in other works to characterize insolvency.

Araujo (2011) found that there are differences in predictability of ratios regarding insolvency according to the period before the insolvency event. Two years before, reduction in liquid assets and unbalance between operational incomes are more relevant. Closer to the event, one year before, the risk of insolvency was more related to the proportion of bad debt, reductions of loans volume and reduction of operational margin with increasing of operational expenses, both in relation to total of assets.

Besides using accounting ratios, Araujo (2011) points out some additional aspects. One important observation is the influence of Basel index related to minimum capital. This index

was considered superior to the capital adequacy, because not only does it consider the absolute value of asset, but also a weighted value according to the risk. Another important aspect is the necessity of segregating and pairing credit unions according to the system they belong to, the bond type, size, and location. This is important to reduce the heterogeneity in samples of insolvent and solvent institutions. Moreover, Araujo (2011) verifies that ratios from income statement were more relevant than those from balance sheet in relation to the risk of insolvency.

Researchers from Brazil have also used the proportional hazard model (COX, 1972) to analyze solvency. Braga et al. (2006) employed it to assess the solvency of Brazilian credit unions with a sample from Minas Gerais State. As criteria for insolvency, they defined the compulsory percentage of liquidity required by the Minas Gerais Central Credit Union (CECREMGE). The explanatory variables were gathered in 5 groups of ratios: capitalization, solvency, cost and expense, return, and growth. It turns out they are similar to some groups from PEARLS. Braga et al. (2006) concluded that the most relevant indicators for insolvency prediction were general liquidity, salary and benefit expenses, and loan/equity ratio.

Carvalho et al. (2015) used a set of accounting ratios to investigate the factors that affect the market exit of Brazilian singular credit unions. Models of survival analysis supported the study. Cox, Wibull, Gompertz, and Competitive risk presented similar coefficient and significance to each variable. By the way, Cox and Competitive Risk overcame the other ones, judging by Akaike Information Criterion (AIC). The market exit defined by the authors did not include only insolvency problems, but also the possibility of mergers or incorporations.

Overall, the results from Carvalho et al. (2015) revealed that the volume of deposits and treasury investment are important to the probability of credit union survival. Moreover, high proportions of other revenues and service revenues are related to higher probability of discontinuity. Size demonstrated to be a decisive factor to credit unions survival, indicating the influence of scale economies. However, it is important to ponder that the gain of scale through mergers does not guarantee survival, as evidenced by Ralston, Wright, and Garden (2001) in a study with credit unions from Australia and the United States.

Discriminant analysis, logistic regression, and artificial neural networks are well- established techniques in literature about bankruptcy prediction (PRADO et al., 2016). However, newer advanced algorithms or machine learning techniques have shown to be very accurate to predict bankruptcy and default events. They have demonstrated superior predictability of business failure if compared to the more traditional methods. Some examples are support vector machine

(SVM), bagging, boosting, AdaBoost, random forests (RF), spline-rule ensembles, which has been applied to companies in general, banks and credit unions (BARBOZA; KIMURA; ALTMAN, 2017; DE BOCK, 2017; GOZER et al., 2015, 2014b; JONES; JOHNSTONE; WILSON, 2017).

Literature discusses performance of models. Gozer et al. (2014b) compare artificial neural networks and support vector machine to predict insolvency of credit unions. Results evidence that SVM is a superior classifier than ANN, and the interruption of sending financial statements to BCB is used to characterize insolvency. The study shows that there is no need to include all the ratios proposed by PEARLS system, since a selection of 10 ratios proposed by market analysts provided similarly good results.

Guenther and Schonlau (2016) have compared support vector machine (SVM) and logistic regression. The authors have dedicated their work to develop a new command to implement support vector machine in Stata, but even so they observed some caveats. Logistic regression achieved an accuracy of 80.5% when predicting net income households above 2,000 Euros in Germany. To the same sample, SVM achieved 82.3% of accuracy, a modest improvement. According to the authors' experience, this modest increase for binary outcomes of SVM relative to logistic regression is typical. Guenther and Schonlau (2016) noticed SVM can be very powerful, but it has to be well adjusted, otherwise, it may result in much worse mean square errors than linear regression. Therefore, it is preferable to work with Gaussian/logistic regression than with an improperly adjusted SVM model (GUENTHER; SCHONLAU, 2016).

Barboza, Kimura, and Altman (2017) have tested machine learning models to predict bankruptcy using a big database of North-American firms with more than 10,000 firm-years observations from 1985 to 2013. On average, the accuracy of machine learning models outperformed in 10% the traditional models like discriminant analysis, logistic regression, and artificial neural networks.

Jones, Johnstone, and Wilson (2017) have examined the predictability of 16 classifying methods using a large sample of US corporate companies collected from Standard and Poor's Capital IQ service. The sample includes 26,169 firm-years observations of non-failed companies and 3,960 firm-year observations for the bankrupt group. They tested more common techniques, such as discriminant analysis and logistic regression, more advanced ones, like neural network and support vector machine, and the so-called "new age" learning methods, which include boosting, AdaBoost, and random forests. Results of Jones, Johnstone, and Wilson (2017) are

in line with Barboza, Kimura, and Altman (2017). They indicate that the "new age" classifiers provide better predictions than earlier ones. However, more traditional classifiers such as logit and discriminant analysis provide reasonable bankruptcy predictions.

Table 2.1 – Overall performance of classifiers in different studies (AUC)

Model	**(1)**	**(2)**
Fully Nonlinear Classifiers		
Generalised Boosting	0.9312	0.9297
Ada Boost	0.9275	
Random Forests	0.9188	0.9292
Bagging		0.9248
Neural Networks	0.8344	0.9008
SVMs	0.8299	0.8517
Partially Nonlinear Classifiers		
Logistic_MARS	0.8641	
Probit_MARS	0.8623	
Probit_GAM	0.8213	
Logistic_GAM	0.8167	
Standard Form Classifiers		
Logistic	0.8039	0.9010
Probit	0.7879	
Discriminant Analysis	0.7777	0.6368

Source: by the author (2019), adapted from:
(1) Jones, Johnstone, and Wilson (2017)
(2) Barboza, Kimura, and Altman (2017)

As described in Table 2.1, machine learning models have proved to be accurate to classify failure in a binary outcome. However, their capability to provide consistent individual probabilities of failure has some caveats. Mease, Wyner, and Buja (2007) show that even boosting algorithms, such as Adaboost, that perform very well for classifications, might be problematic to estimate the conditional probability function $P[y = 1|x]$. Table 2.1 shows that logistic regression provides reasonable results even if compared with non-linear classifiers, which are more complicated to be interpreted and usually rely on logistic regression - a well-known statistical regression model - to estimate conditional probability (DE BOCK, 2017; MALLEY et al., 2012).

Previous literature shows that different methods and set of variables have been used to assess credit union risk. Moreover, different characterization of solvency, failure or survival have been used. Therefore, PEARLS ratios stand out as a recurrent system of variables. It has been usually applied with adaptations, due to restrictions on data availability and selection of variables

aiming at the best possible adjustment. As prediction methods, the studies have mainly applied logistic regression and Cox proportional hazard, but there are also studies using artificial neural network analysis, data envelopment analysis (DEA), difference-in-differences, and survival analysis with methods other than Cox, particularly, Wibull, Gompertz, and Competitive risk. Non-linear methods have shown higher accuracy, but there are caveats regarding conditional probability and complexity of analysis. Failure has been usually related to financial disruption, to regulatory supervision, and to mergers or acquisitions.

In this study, the logistic regression will support the risk estimation, because it is a widely accepted method in bankruptcy literature and provides reasonable results, even if compared with newer non-linear models which are more complicated to interpret and mostly rely on logistic regression to estimate conditional probability. In this study, information on probability of failure is necessary to estimate risk and compose the discount rate. In this sense, the logistic regression itself will directly provide estimation of conditional probability.

3 METHODOLOGY

3.1 Research hypothesis

This chapter relies on some assumptions to achieve its objective, which is to estimate the risk of each credit unions in order to be applied in the next chapter and compose the model of value creation measurement. In this case, risk is assumed to be the probability of failure of credit unions, that is, their risk to discontinue their activities due economic/financial difficulty. Based on previous literature, we have established the following assumptions:

a) quantitative characteristics, such as economic-financial ratios and size, provided good basis to assess risk of credit unions failure;

b) qualitative characteristics, such as kind of bond, technology, and whether or not a credit has incorporated another, contribute to explain probability of failure;

c) external environment, mainly represented by macroeconomic scenario, also influences risk of credit union failure.

The first assumption is based on the fact that many studies have demonstrated the capacity of economic-financial ratios to predict companies failure, including financial institutions, such as banks and credit unions. Specifically, in Brazil studies as Araujo (2011), Bressan et al. (2010,

2011a,b, 2015), Carvalho et al. (2015) and Gozer et al. (2014a,b, 2015) have evidenced the ratios coming from accounting figures are capable to predict failure. In the cited studies, the use of PEARLS system (RICHARDSON, 2009) prevails to provide relevant economic-financial indicators to predict failure.

The second assumption is based on studies that have shown qualitative characteristics of credit unions that influence their operations, and consequently influence risk. For example, Araujo (2011) and Lima (2008) both demonstrate that kind of bond significantly influences Brazilian credit union operations and their indicators. International studies also highlight the impact of qualitative characteristics on credit union operation. For example, Goddard, McKillop, and Wilson (2008) have studied financial performance of US credit unions and, among their significant, variables is the kind of bond (single or multiple). Previously, Ward and McKillop (2005) also demonstrated that the bond type impacts UK credit unions performance. Bauer, Miles, and Nishikawa (2009) studied the impact of mergers on credit union performance, and found gains to target credit union members, even though they found no gains to acquiring ones.

Third, external factors also have been evidenced to influence credit union operations. For example Goddard, McKillop, and Wilson (2008), included in their study variables to capture impact of external environment on financial performance of credit unions. They found gross state product and population were significant to explain financial performance. From the study, it is possible to conclude that macroeconomic scenario influences credit union performance.

In summary, based on previous literature, there are reasonable foundations to state that economic-financial ratios (more specifically, PEARLS ratios), qualitative characteristics, and macroeconomic scenario influence operations of credit unions, and consequently, may influence their risk of failure. Therefore, to achieve its objective, this chapter assumes the hypothesis that PEARLS ratios, along with qualitative characteristics and macroeconomic conjuncture, are capable to explain credit unions probability of failure.

3.2 Data collection and sample

This study uses financial data of Brazilian credit unions. The data were collected from BCB's public available database, using semi-annual periods from 2010 to 2018. To compose the economic and financial ratios, we took into account the restrictions of publicly available balance sheets and the Brazilian regulation. The individual accounting data of Brazilian credit unions were obtained from credit unions' semi-annual trial balance sheets, available on BCB's

website (BCB, 2019a). The accounts composing the trial balance sheets are standardized by the official chart of accounting of Brazilian financial institutions (in Portuguese, "*Plano Contábil das Instituições do Sistema Financeiro Nacional*" (COSIF)). COSIF is determined by BCB and must be employed in the accounting of all financial institutions in Brazil, including credit unions.

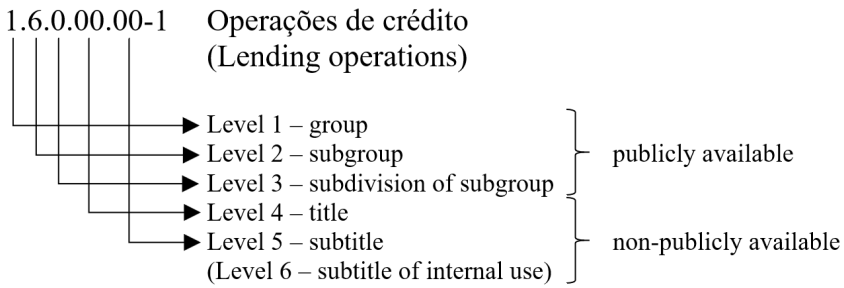
Figure 2.1 – COSIF groups

ASSETS		LIABILITIES	
1	CIRCULANTE E REALIZÁVEL A LONGO PRAZO (Current and long-term assets)	**4**	CIRCULANTE EXÍGIVEL A LONGO PRAZO (Current and long-term liabilities)
		5	RESULTADOS DE EXERCÍCIOS FUTUROS (Deferred income)
		6	PATRIMÔNIO LÍQUIDO (Equity)
2	PERMANENTE (Permanent assets)	**7**	CONTAS DE RESULTADO CREDORAS (Credit income statement accounts)
		8	(-) CONTAS DE RESULTADO DEVEDORAS (Debit income statement accounts)
3	COMPENSAÇÃO (off-balance sheet accounts)	**9**	COMPENSAÇÃO (off-balance sheet accounts)

Source: by the author (2019), based on BCB (1987)

The main restriction regarding data refers to the analytic level of accounts that are publicly available. The official accounting chart is organized into 9 overall groups (see Figure 2.1) with 6 analytic levels of accounts (see Figure 2.2). The publicly available trial balance sheets only present the accounts up to the third level, as the Figure 2.2 demonstrates. Therefore, some indicators that require accounts beyond level 3 only can be calculated from internal data provided by the credit unions or BCB.

Figure 2.2 – COSIF levels



Source: by the author (2019), based on BCB (1987)

The sample of Brazilian credit unions is composed by a total of 910 single credit unions after excluding capital and loans cooperatives. Single credit unions in Brazil are classified

according to the complexity of their operations and size (CMN, 2015). There are three categories: plenary, classic, and capital and loans credit unions.

Essentially, plenary credit unions are authorized to realize many types of operations, including deposits, loans, gold, commodities, and stock market. Classic credit unions can operate with deposits and loans, but cannot operate with gold, commodities and stock markets. In turn, capital and loans credit unions cannot raise funds from deposits, in addition to following the same restrictions of classic ones.

Since 2016, BCB's database have included the identification of those three categories for each credit union. The capital and loans credit unions were excluded from the sample because they do not raise funds from deposits and, thus, have different operational characteristics. Besides, they would not allow to compare deposit interest rates, which is inherent to the objectives of this study. To categorize capital and loans credit unions, first the classification was replicated to the same credit unions existent in periods before 2016. After, the following procedures were done:

a) all free admission and entrepreneurs credit union were not considered, since none of them were classified as capital and loans by BCB;

b) credit unions with less than 3% of deposits in relation to total liabilities in more than 70% of periods.

The final sample is distributed over time from 2010 to 2018 according to the Table 2.2.

Table 2.2 – Number of credit unions in Brazil from 2010 to 2018

Year	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**2018**
Authorized by BCB	1377	1328	1269	1209	1163	1113	1078	1023	973
(−) Non-single (1)	39	39	39	38	39	37	37	37	37
(=) Single credit unions	1338	1289	1230	1171	1124	1076	1041	986	936
(−) No enough data (2)	89	49	32	30	26	21	26	26	18
(−) Capital-loans (3)	368	366	351	319	296	273	258	249	244
(=) Final sample	881	874	847	822	802	782	757	711	674

Source: by the author (2019), based on BCB (2019a)
(1) Confederations and central credit unions
(2) Less than two years of available balance sheets
(3) Credit unions classified as "capital and loans"

The accounting data from Brazilian financial institutions, which were in nominal values of Brazilian currency Real (BRL), have been updated to values at 2018 December. The adjustment

for inflation was made through the inflation index General Price Index - Internal Availability (IGP-DI), provided by Instituto Brasileiro de Economia (IBRE) of Fundação Getúlio Vargas (FGV). This index is employed in the calculation of Brazilian gross domestic production (GDP) and national accounts, and in price corrections and contractual values (FGV, 2019). It was chosen because of its broad national scope and period of collection, from the beginning to the end of each month.

The main software application employed in this research is Stata (STATACORP, 2017a), which has been used to perform all the econometric estimations. Also, Microsoft Excel has been used to organize data before putting them into Stata.

3.3 Econometric Model

Literature shows that logistic regression provides good results even if compared to the most updated non-linear methods and has the advantage of being more interpretable. Besides, the objective here is not to advance in methodology to estimate probability of failure, but to use a reliable probability estimation in order to compose a discount rate as part of a model to obtain value creation. Concerns about specification and the usefulness of the outcomes reinforce the motivation to use the well-known logistic regression. After concluding that even the most sophisticated models may be biased because problems of specification Martin Feldstein asserts:

> The applied econometrician, like the theorist, soon discovers from experience that a useful model is not one that is "true" or "realistic" but one that is parsimonious, plausible, and informative (FELDSTEIN, 1982, p. 829).

Previous literature shows that issues about which is the best set of variables, the most suitable definition of failure and the best model of failure prediction for credit unions are neither deeply addressed nor conclusive. Nevertheless, previous studies indicate good options that can be chosen. This study will rely on PEARLS ratios, but it will not be restricted to them. Other financial ratios indicated in previous studies (e.g. (ARAUJO, 2011)) will be applied. Important qualitative characteristics of credit unions as kind of bond, region, and age will be also considered. Besides, the Basel index, available in BCB's website, since 2014 will be tested as predictor. Another important aspect, which is not considered in many studies on bankruptcy of credit unions, is the macroeconomic context, which will be taken into accounting and tested.

This chapter employs a logistic regression model (logit) to estimate the risk of credit unions insolvency in order to compose the discount rate to be used to calculate value creation.

Frame 2.2 – Overview of the solvency probability estimation

Predictors	**Failure characterization**	**Periods before failure**	**Statistical model**
PEARLS ratios, additional financial ratios, qualitative characteristics, Basel index and macroeconomic variables	Interruption of balance sheets releasing and negative or decreasing equity	1 year and 2 years	Logistic regression

Source: by the author (2019)

Logistic regression models are useful in situations with a binary response variable. A binary response variable is that with only two possible values, 0 or 1. In this study, the variable response is the credit union failure. If the cooperative fails, the variable is equal to 1, otherwise its value is 0.

Agresti (2002) provides a historical overview of the evolution of methods for categorical data analysis, including logistic regression. According to the author's summary, one could find the base for logistic regression in the 1930's but the term logit was later introduced by the physician and statistician Joseph Berkson (BERKSON, 1944) for the transformation of a binomial parameter for analyzing of binary data. The model is a very common technique applied in studies about companies failure including credit unions and has been widely used in the last decades, especially with advanced statistical computational packages.

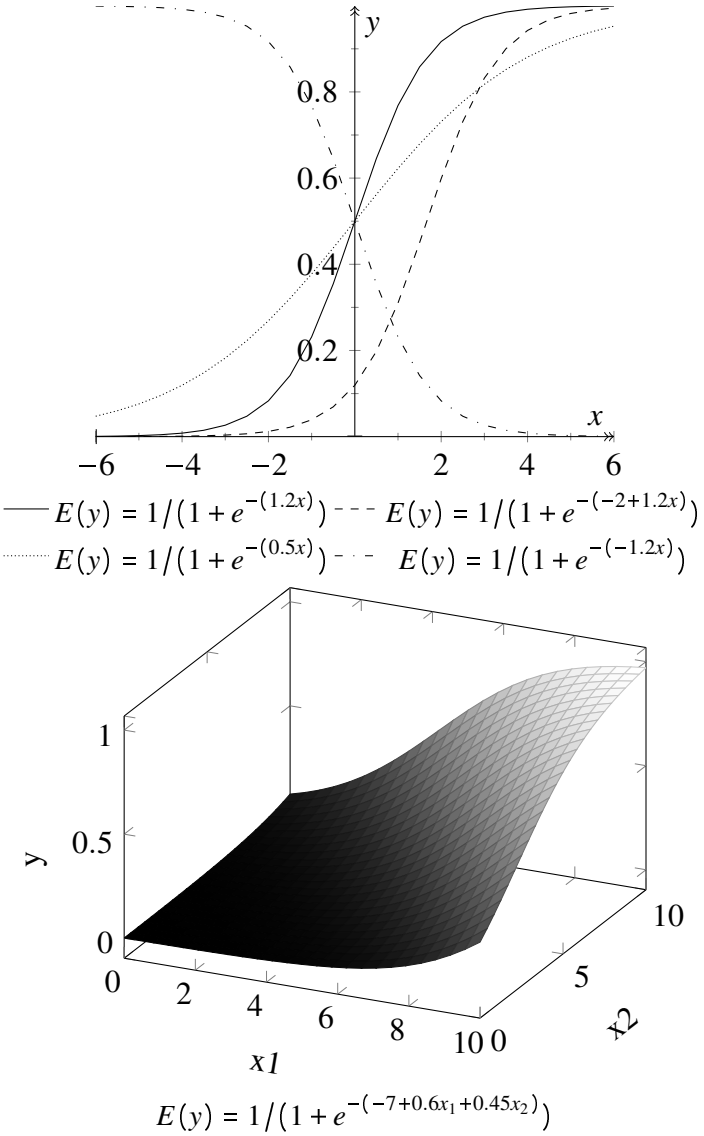
The aim of using logit model in this study is to predict the probability of credit union failure, given the values of explanatory variables. This probability will be denoted by the logistic response function, also called cumulative distribution function (GUJARATI, 2006; MONTGOMERY; PECK; VINING, 2006).

The logistic response function has the form:

$$P_i = E(y_i = 1|\boldsymbol{x_i}) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + \ldots + \beta_k x_{ki})}} \tag{2.1}$$

Where y=1 if the event has occurred; otherwise y=0; x_k are the variables that explain the probability of the event occurrence. In this work, the event is the credit union failure. Credit unions were considered failed if they had discontinued balance sheets publication besides presenting negative or decreasing equity. The sub section 3.5 details the characterization of failure.

Figure 2.3 – Examples of logistic response functions



Source: by the author (2019) using PGFPlots package

The logit model has a convenient form: geometrically, the cumulative distribution function provides a sigmoid curve, as shows the Figure 2.3. It gives the model some important characteristics: (GUJARATI, 2006; JAEGER, 2008; MONTGOMERY; PECK; VINING, 2006)

a) logit models estimate probabilities situated between 0 and 1;

b) logit models capture the fact that the changes in probabilities around 0.5 do not have the same importance than those closer to 0 or 1;

c) the probabilities do not vary linearly in relation to x.

d) the logistic response function can be easily linearized;

e) the linearization in parameter does not imply that the predictors must be linear. Thus, it is possible to include predictors like x^2 or x^3;

f) it is possible to include as many predictors as necessary, according to the underlying theory;

g) it enables to predict the probability of y - 1 given the values of x_k.

As equation (2.1) evidences, P_i falls between 0 and 1 and is related with x_k in a non-linear form. These are two important characteristics to a probability model. On the other hand, this causes an estimation problem, since P_i is not only linear in x_k , but also in the parameters β_k. This means that it is not possible to undertake the ordinary least squares procedures, but the equation can be linearized as follows.

To simplify the transformation, from equation (2.1) the probability of the event occurrence can be written as:

$$P_i = \frac{1}{1 + e^{-Z_i}} \tag{2.2}$$

Where $Z_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + ... + \beta_k x_{ki}$.

If P_i is the probability of the event occurrence, then the probability of non-occurrence is:

$$1 - P_i = 1 - \frac{1}{1 + e^{-Z_i}} \tag{2.3}$$

The equation results in:

$$1 - P_i = \frac{1 + e^{-Z_i}}{1 + e^{-Z_i}} - \frac{1}{1 + e^{-Z_i}} = \frac{e^{-Z_i}}{1 + e^{-Z_i}} = \frac{1}{(1 + e^{-Z_i})e^{Z_i}} = \frac{1}{1 + e^{Z_i}} \tag{2.4}$$

Taking the ratio between the probability of occurrence (P_i) and the probability of non-occurrence ($1 - P_i$) the called odds ratio is obtained. It represents the odds that an outcome will occur, compared to the odds that the outcome will not occur. For instance, if the probability of raining tomorrow is 80%, the odd ratio of the event occurrence (Y=1) is 4 by 1 (0.8/0.2). In other words, the chance of raining tomorrow is 4 times higher than the chance of not raining.

The follows operations can be performed from the odds ratio:

$$\frac{P_i}{1 - P_i} = \frac{\frac{1}{1 + e^{-Z_i}}}{\frac{1}{1 + e^{Z_i}}} = \frac{1 + e^{Z_i}}{1 + e^{-Z_i}} = \frac{(1 + e^{Z_i})e^{Z_i}}{(1 + e^{-Z_i})e^{Z_i}} = \frac{(1 + e^{Z_i})e^{Z_i}}{(e^{Z_i} + 1)} = e^{Z_i} \tag{2.5}$$

The natural logarithm of the odds ratios, summarized in (2.5) provides a very useful result:

$$L_i = ln\left(\frac{P_i}{1-P_i}\right) = ln(e^{Z_i}) = Z_i = \beta_0 + \beta_1 x_{1i} + \beta_2 x_{2i} + ... + \beta_k x_{ki} + \varepsilon_i \tag{2.6}$$

L is called the logit (or log-odds), which is the natural logarithm of the odds ratio. That is why models like (2.6) are called logit models. The parameters β_k represent the changes in log of odds ratio (L) of the event occurrence ($y = 1$) caused by a unitary variation in x_k (GUJARATI, 2006; JAEGER, 2008; MONTGOMERY; PECK; VINING, 2006).

Estimating the probability (P_i) of the event occurrence is just a matter of replacing the estimated parameters β_k in the equation (2.1) and linking them to the values of explanatory variables x_k:

$$\hat{P}_i = \frac{1}{1 + e^{-(\hat{\beta}_0 + \hat{\beta}_1 x_{1i} + \hat{\beta}_2 x_{2i} + ... + \hat{\beta}_k x_{ki})}} \tag{2.7}$$

The result of equation (2.7) will provide the probability of failure. In order to simplify the explanation, the model was exposed in a specification to cross section data. But in this study, the information on credit union will be expressed as longitudinal or panel data. In this case, it is necessary to adapt the binary model to panel data. There are different possibilities for binary regression models with panel data. Pooled regression, fixed effects model and random effects model are the basic distinctions.

We can start with the Pooled Ordinary Least Squares (POLS) regression, which ignores the individual heterogeneity and fits the model as a cross-section (GREENE, 2018). In this case, a binary response function is (ANDRESS; GOLSCH; SCHMIDT, 2013; CAMERON; TRIVEDI, 2010; WOOLDRIDGE, 2010):

$$P(y_{it} = 1 | \boldsymbol{x}_{it}) = G(\boldsymbol{x}_{it}' \boldsymbol{\beta}), \quad i = 1, 2, ..., N, \qquad t = 1, 2, ..., T, \tag{2.8}$$

Where $G(.)$ is a suitable transformation function that ensures the right-hand side of the equation provides values within the proper limits of probabilities (i.e., $0 \leq P(y_{it} = 1 | \boldsymbol{x}_{it}) \leq 1$). The specialized literature (e.g., CAMERON; TRIVEDI, 2010; WOOLDRIDGE, 2010) explains that the logit model is a special case of equation (2.8) with:

$$G(z) = \Lambda(z) \equiv e^z / (1 + e^z) \tag{2.9}$$

It turns out that the Pooled Logit model is the usual cross-section model with the form:

$$P(y_{it} = 1 | \boldsymbol{x}_{it}) = \Lambda(\boldsymbol{x}_{it}^{\prime}\boldsymbol{\beta}) \tag{2.10}$$

Cameron and Trivedi (2013) advise that, specially in case of short panels (large N and small T, which is the case of this study), any correlation of errors over time for a given individual should be controlled through panel-robust standard errors that are cluster-robust error with clustering on the individual. As Andreß, Golsch, and Schmidt (2013) demonstrate, computing robust standard errors generate larger standard errors and consequently may imply a change in the conclusion regarding significance of covariates. Nonetheless, estimated coefficients remain the same. In summary, POLS with robust standard errors is preferable to "conventional" POLS, but neither of them accounts for unobserved heterogeneity at unit level. A cluster-robust estimation to correct error correlation over time for a given individual in logistic regression is available in Stata. Appendix A provides procedures used to compute it.

The POLS estimation treats panel data as a long cross section, which is consistent if the POLS is the true model and the disturbance term u_{it} and x_{it} are not correlated. However, the assumptions involved in that case are unlikely to be met in realistic applications (GREENE, 2018). The POLS ignores possible heterogeneity across individuals. Consequently, the estimation would lead to inconsistent parameters. Individual-effect models (fixed effects (FE) or random-effect (RE) models) may accommodate the panel complications. Population-average (PA) model is also an alternative to POLS.

Besides POLS, we also performed the PA model estimated through generalized estimation equations (GEE) approach. Wooldridge (2010) explains that in GEE approach to binary outcome models, the binary response probabilities are specified only conditional on x_i, which results in $E(y_{it}|x_{it}) = E(y_{it}|x_i)$ for all t. Following Cameron and Trivedi (2010), we estimated the PA model in Stata by using the `xtlogit` command with the `pa` option. The PA model may assume different pattern of time-series correlations assumed for observations on the i^{th} individual. We used the default option of correlations, the exchangeable model, which assumes that the correlations are the same, regardless of how many years apart the observations are (CAMERON; TRIVEDI, 2010). The model was estimated with panel-robust standard errors.

After performing POLS and PA models, we proceeded to RE and FE approaches, which explicitly take into account the panel structure (ANDRESS; GOLSCH; SCHMIDT, 2013).

The logit individual-effects models (FE and RE) specify that (CAMERON; TRIVEDI, 2010; WOOLDRIDGE, 2010):

$$P(y_{it} = 1|\boldsymbol{x}_{it}, \boldsymbol{\beta}, \alpha_i) = \Lambda(\alpha_i + \boldsymbol{x}_{it}'\boldsymbol{\beta}) \tag{2.11}$$

Where α_i is a non-observed effect and may be an FE or an RE. In addition to the equation (2.11), a standard assumption is that the outcomes are independent conditional on $(\boldsymbol{x_i}, \alpha_i)$ (WOOLDRIDGE, 2010). This assumption is analogous to the linear model assumption that conditional on $(\boldsymbol{x_i}, \alpha_i)$, the outcomes are serially uncorrelated. If the individual specific effect α_i is assumed to be fixed, then both α_i and β are unknown parameters to be estimated (HSIAO, 2014). In fixed effect models, the unobserved, individual-specific heterogeneity may be correlated to x_{it} (GREENE, 2018). In turn, a RE model treats the individual-specific effects α_i as an unobserved random variable. In this case the usually called random effect logit model adds to (2.11) the assumption (CAMERON; TRIVEDI, 2010; WOOLDRIDGE, 2010):

$$\alpha_i|\boldsymbol{x_i} \sim Normal(0, \sigma_\alpha^2) \tag{2.12}$$

The assumption (2.12) implies that α_i and $\boldsymbol{x_i}$ are independent and that α_i has a normal distribution. More details on how the logit models are estimated may be found on the literature exploring advanced panel data topics (e.g., CAMERON; TRIVEDI, 2010; GREENE, 2018; HSIAO, 2014; WOOLDRIDGE, 2010). Stata commands to implementation and specification tests of logit panel data models are displayed in Appendix A. Considering the options of logistic regression for longitudinal data, as briefly recalled in this subsection, the models tested in this study were POLS, PA, RE, and FE logit models.

The final model for risk assessment was estimated by a random-effects logistic regression. Its form is:

$$\begin{aligned} ln\left(\frac{P_{it}}{1-P_{it}}\right) =& \beta_0 + \beta_1 P6_{it} + \beta_2 E5_{it} + \beta_3 E6_{it} + \beta_4 A5_{it} + \beta_5 R9x_{it} + \beta_6 S7_{it} + \\ &+ \beta_7 logta_{it} + \beta_8 bondm_{it} + \beta_9 gdpcent_{it} + \alpha_i + \varepsilon_{it} \end{aligned} \tag{2.13}$$

Where ln = the natural logarithm; P = probability of failure; $1 - P$ = probability of non-failure; $P6$ = solvency ratio; $E5$ = deposits/total assets; $E6$ = external credit/total assets; $A5$ = loans classified between level D and level H/total classified loans portfolio; $R9$ = administrative

expenses/average total assets; $S7$ = growth in member share capital; $logta$ = natural logarithm of total assets; $bondm$ = binary variable (bondm=1 for credit union with mixed bonds association criteria, otherwise bondm=0); $gdpcent$ = GDP real % change; α_i = unobserved individuals' effect, constant over time; ε = error component for other unobserved variables influencing P, varying over individuals and time. [2]

Once the model has fit, the probability of failure was obtained by using the Stata command `predict, pu0`, which returns the estimated probability of a positive outcome (P) given the values of explanatory variables for each individual over time.

The next subsection defines specification tests and how the best fit model was selected. Subsection 4.2 in Findings provides results of model selection and specifications test.

3.4 Model selection and specification tests

Procedures were taken to suitably observe three crucial aspects for the accuracy of the model: selection of variables, choice of type of panel data logit model, and specification tests.

There are many variables that could be selected to compose the model, as the Subsection 3.6 shows. For the selection of variables, two opposing strategies may be chosen: simple-to-general or general-to-simple. In the former, researchers start from a simple model and include variables towards a more complex model, whereas in the latter, researchers start from large elaborate models and reduce variables and structure (GREENE, 2018; VERBEEK, 2017).

According to Greene (2018), seeking to maintain simplicity, model builders would start with small specifications. "However, a markable disadvantage of the simple-to-general strategy is that just about any criterion do decide whether to add a variable to a current model would be contaminated by the biases caused by incomplete specifications at the early stages. Verbeek (2017) observes that, in the long run, the general-to-simple approach implies less risks of specification errors and would result in the correct specification.

Due the significant number of candidate variables, mainly from PEARLS, a general-to-simple approach has been applied to select variables. In this sense, a backward strategy was implemented. For Montgomery, Peck, and Vining (2006) backward is a kind of stepwise procedure that is often a good variable selection procedure, although it has some caveats. On the one hand, a backward strategy is usually less adversely affected by the correlative structure

[2] Calculation of ratios P6, E5, E6, A5, R9, and S7, as well as other unselected PEARLS ratios, is detailed in Subsection 3.6.

of the explanatory variables than is forward procedure. Besides, it favors the inclusion of all variables, so that nothing “obvious” could be missed. On the other hand, neither forward nor backward strategies guarantee the selection of the best subset selection, yet there might be other equally good ones. In any case, both procedures are efforts to find an optimal subset of regressors (MONTGOMERY; PECK; VINING, 2006). Greene (2018) agrees that downward reduction is an attractive strategy when models elaboration involves many variables.

To select models in Stata, we used the `stepwise` command with the `pr` option and 5% of significance level. By using these options, the command first fits the full model on all explanatory variables. Then, while the least-significant term is “insignificant”, the program removes it and re-estimates it. As a result, the final model only contains statistically significant terms after testing each one inside the previous larger models. By default, the removal test is based on the probability of the Wald test. The technique was not applied indistinctly and some interventions after judgement were necessary. For example, variables with many missing observations were excluded. Furthermore, metrics as the receiver operating characteristic (ROC) curve (HANLEY; MCNEIL, 1982) supported models assessment. More details are presented in Section4.2.

To verify if the POLS is applicable and which is the best type of panel data model (FE or RE), there are some specific tests that are usually undertaken. In a linear panel data modeling process, F of Chow and Breush-Pagan’s Lagrange Multiplier (LM) test respectively indicate if FE or RE are preferred to POLS. Posteriorly, the Hausman test indicates if FE or RE is preferable. However, in this chapter, the FE logit regression was discarded, due to the presence of many time-unvarying observations. Consequently the remaining decision was between POLS and RE. Moreover, the LM test (`xttest0` in Stata) is not applicable after running a panel data logistic regression. For that reason, other tests were considered: the Wald test and the likelihood-ratio (LR) test for the panel-level variance component.

The Wald test analyzes the null hypothesis that the parameters are simultaneously equal to zero (IDRE, 2019). If the p-value is less than 0.05, so the null hypothesis is rejected, which indicates the coefficients are not simultaneously equal to zero. The LR test compares two models, the fit of one model to the fit of other (IDRE, 2019). After running a logit RE model in Stata (command `xtlogit` with option “re”), a LR test is automatically reported. In that case, the LR test formally compares panel (logit) estimation with the pooled (logit) estimation. Specifically, the test verifies if the proportion (ρ, labelled "rho") of total variance contributed by the panel-level variance is statistically equal to zero. If the null hypothesis of rho=0 is not rejected (that is,

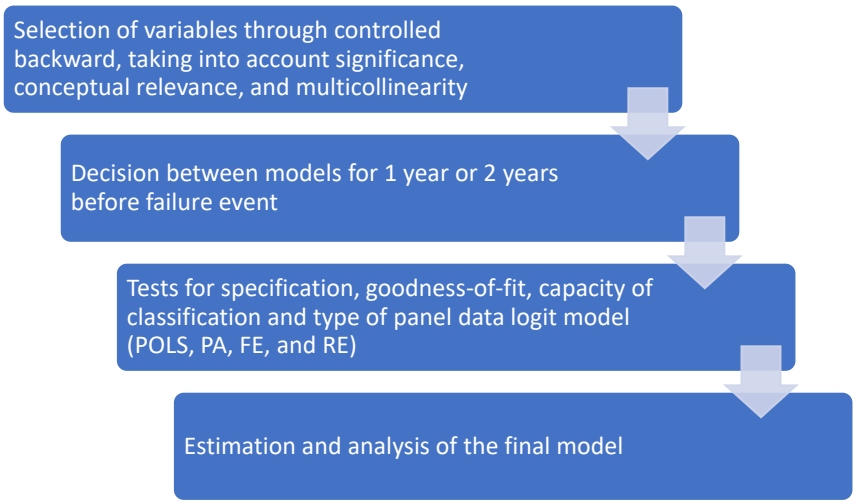
p>0.05), the panel-level variance is not important and the RE model does not differ from the POLS.[3]

When disturbances are not identically distributed over individuals or there is serial correlation in errors, cluster-robust standard errors produces a consistent estimator (STATACORP, 2017c; WOOLDRIDGE, 2015). Those are common problems in panel data modelling. Based on that, the final model was then estimated with cluster-robust standard errors. The parameters remained significant, though.

Before interpreting the results, we checked the stability of quadrature technique, which is particularly concerning large panels [4] . The RE model is estimated by using quadrature and its accuracy does not only depend on good data, but also on the number of integration points (STATACORP, 2017c). We checked the quadrature approximation and achieved stability by increasing the number of integration points to 30.

Figure 2.4 provides an overview of the process to build the final model.

Figure 2.4 – Overview of the process to build the panel data logit model



Source: by the author (2019)

3.5 Dependent variable

To carry out the logistic regression, it is necessary to define the dependent variable, which is a binary variable. The binary variable assumes value 1 if the credit union has failed and 0, otherwise. In line with the literature review in the Subsection 2.2, the failure status has been

[3] For more details on the LR test for RE versus POLS models see StataCorp (2017c, p. 272).

[4] For more details on quadrature technique in RE estimation see StataCorp (2017c, p.10) and StataCorp (2017c, p.275).

defined as the definitive discontinuity of balance sheets publication in BACEN's database along with one of the following situations:

a) negative adjusted equity;

b) decreasing adjusted equity in the last semester before the interruption;

c) decreasing adjusted equity in two or more semesters in the last two years before the definitive discontinuity of balance sheets publication.

The definitive discontinuity of balance sheets publication is a strong indication of credit union failure, although it is not enough to say that a credit union has had financial problems. The definitive discontinuity of balance sheets evidences the interruption of credit union operation. That is, it is not only an accounting indicator but a factual situation that indicate discontinuity. However, it should not be directly assumed as a failure. The organization may have stopped its activities due to different reasons: failure, acquisition, dissolution or liquidation.

Since the objective of this chapter is to assess credit unions' risk, the characterization of failure must not include interruptions caused by reasons other than economic-financial problems. For example, a credit union may have been incorporated by others because of strategic reasons without necessarily having faced a challenging financial situation. In this case, it should not be considered a failure case even though the organization has been closed and stopped issuing balance sheets.

To separate failed and non-failed interrupted credit unions three additional criteria have been established, as it has been mentioned above. Those criteria do not have to be cumulative. That is, only one of them is enough to characterize failure since balance sheet publication has definitively discontinued.

The first of them is negative adjusted equity, which is the worst situation. Adjusted Equity (AE) is the result of current equity plus total revenues minus total expenses. Frame 2.3 shows the COSIF accounts that compose AE:

If a credit union has negative AE it means that total liabilities are greater than total assets. A negative AE preceding the interruption of balance sheets publication is clear evidence of failure. However, even an organization with positive equity may be at a bad financial-economic situation. Then, two additional criteria have been considered: a decreasing AE in the last semester or in any two or more semesters in the last two years before the balance sheet definitive discontinuity.

Frame 2.3 – Adjusted Equity (AE) calculation

COSIF account	Official account title	Free translation
a. 6.0.0.00.00-2	Patrimônio líquido	Equity
b. 7.0.0.00.00-9	Contas de resultado credoras	Credit income statement accounts
c. 8.0.0.00.00-6	(-) Contas de resultado devedoras	Debit income statement accounts
Formula: $AE = a + b + c$		

Source: by the author (2019)

If the credit union has presented one of these two situations preceding balance sheets definitive interruption a failure status is also characterized.

Using decreasing AE as additional criteria to identify failed credit unions has allowed to include those ones that would not have presented negative AE but had been presenting negative net income and eventually stopped operations. Reporting negative net income before stopping operations is a strong indication that the organization was not economically viable and the interruption was caused by an incapacity to continue activities with good economic conditions.

3.6 Independent variables

As Frame 2.2 exposes, the failure prediction in this work is based on PEARLS ratios, additional financial ratios, qualitative characteristics, Basel index, and macroeconomic variables. PEARLS ratios system is the main reference and is composed of ratios of variables obtained from financial statements of credit unions. To calculate the PEARLS ratios we primarily based on the available documentation on the PEARLS system (KIDNEY, 2016; RICHARDSON, 2009). Nevertheless, some adaptations were necessary.

While we have concerned to maintain the essence of the structure of PEARLS system we also have made some necessary adaptations to Brazilian context based on previous works applying COSIF accounts to compose PEARLS ratios (ARAUJO, 2011; BRESSAN et al., 2010, 2011a,b, 2015; CARVALHO et al., 2015; GOZER et al., 2014a,b, 2015). As a consequence, some original indicators were modified and extra indicators were included, as we explained below.

The next frames present the PEARLS ratios constructs adapted to Brazilian case and respective COSIF accounts used to compose them. Frame 2.4 presents the ratios in group P - Protection. It is worth noting that the group Protection concerns the adequacy of accounting in relation to the level of risk of loans. Notably, it includes ratios checking the adequacy of allowances for loan losses and charge-off of delinquent loans. Therefore, the group deals with

the suitable accounting of the loan risk, not the level of risk itself, which is assessed in section A - Asset Quality. It is important to keep that in mind just to avoid including asset quality ratios in section P - Protection.

The use of the PEARLS system in the Brazilian context requires some adaptations that are detailed in Frame 2.4. The original P1 ratio from PEARLS (see Richardson (2009)) refers to the volume of allowance in relation to delinquency greater than 12 months and the goal is 100%. In Brazilian case that is not applicable because BCB demands 100% of the allowance for delinquency > 6 months anyway, as determined by the National Monetary Council (CMN, 1999b). Further, according to the norm, all loans with delinquency > 12 months must be fully written off. For that reason, we did not employ the original P1 ratio because otherwise, it would be invariably equal 100%. Instead, we followed previous works of Brazilian researchers (BRESSAN et al., 2010, 2015; GOZER et al., 2014a,b) to formulate the ratio. Like the previous works, we composed the ratio by dividing the total allowances by total loans. However, we made a minor adjustment by using total loans from the assets group (COSIF group 1.6.0) instead of the control group (COSIF group 3.1.0), which produces equivalent results. The group 3.1.0 may contain allowances for other assets even though usually insignificant if compared to the loan portfolio. In any case, using group 1.6.0 ensures that the formula for P1 ratio includes only loans and their allowances.

P2 ratio refers to the allowances for loan losses concerning the delinquent loans up to 12 months. It can be obtained by combining accounting data and non-bookkeeping control from BCB's IF.data (BCB, 2018). Regarding P2 just a simple adjustment to the original ratio is necessary by using delinquency 15 days - 12 months instead of 1-12 months to take into account the characteristic of IFData. Hence, P2 provides a valuable assessment on the number of allowances for loan losses to face Delinquent Loans outstanding from 15 days-12 months.

The ratios P3, P4 and P5 (RICHARDSON, 2009) concern to loans charge-off. The P3 ratio is a binary yes/no indicator that points if all loans delinquent greater than 12 months are written off, which is mandatory in Brazil. The ratio P4 refers to the amount of loans charged-off from the loan portfolio in a given period. P5 refers to the accumulated amount of charge-offs that have been recovered through successful collection efforts. Both P4 and P5 could be calculated using the off-balance account COSIF 3.0.9.60.00-0 - Loans written-off as losses, which is non-publicly available.

Frame 2.4 – Adapted PEARLS ratios - Protection

(it continues)

P - Protection		
P1 = Allowance for loan losses/Gross loan portfolio		
Purpose: To measure the allowance volume in relation to total gross loans portfolio.		
COSIF account	**Official account title**	**Free translation**
a. 1.6.9.00.00-8	(-) Provisões para operações de crédito	Allowance for loans losses
b. 1.6.0.00.00-1	Operações de crédito	Lending operations
Formula: $P1 = \|a\| / (b + \|a\|)$		
Goal: Dependent on A1		
P2 = Allowance for loan losses/Loan delinquency 1-12 months		
Purpose: To measure the adequacy of allowances after deducting all delinquent loans > 12 months.		
COSIF account	**Official account title**	**Free translation**
a. 1.6.9.00.00-8	(-) Provisões para operações de crédito	Allowance for loans losses
Non-bookkeeping control: *b*. Total loans in arrears over 15 days - IF.data (BCB, 2018)		
Formula: $P1 = \|a\| / b$		
Goal: 35%		
P3 = Complete charge-off of delinquent loans > 12 months		
To measure the total charge-off of all delinquent loans > 12 months.		
Non-bookkeeping control: total delinquent loans > 12 months		
Formula: If (a) = 0(zero) then Yes, else No		
Goal: Yes - charge-off 100% of all loans delinquent > 12 months.		
P4 = Loan charge-off in the period/Average loan portfolio		
To measure the amount of loans charged-off from the loan portfolio in the period		
COSIF account	**Official account title**	**Free translation**
a. 3.0.9.60.00-0	(-) Créditos baixados como prejuízo	Loans written-off as losses
b. 1.6.0.00.00-1	(-) Operações de crédito	Lending operations
Formula: $P4 = (\text{Total debits in the account } a \text{ from } t \text{ to } t-1) / ((b_t + b_{t-1})/2)$		
Goal: Minimize		
P5 = Accumulated loan recoveries/accumulated loan charge-offs		
To measure the accumulated amount of charge-offs that have been recovered from collection efforts.		
COSIF account	**Official account title**	**Free translation**
a. 3.0.9.60.00-0	(-) Créditos baixados como prejuízo	Loans written-off as losses
b. 1.6.0.00.00-1	(-) Operações de crédito	Lending operations
Formula: $P5 = (\text{Total credits in the account } a \text{ from } t \text{ to } t-1) / ((b_t + b_{t-1})/2)$		
Goal: > 75%		
P6 = Solvency		
Purpose: To measure the degree of protection for member deposits and shares in the event of liquidation of the credit union's assets and liabilities.		
COSIF account	**Official account title**	**Free translation**
a. 1.0.0.00.00-7	Circulante e realizável a longo prazo	Current assets and long-term receivables
b. 2.0.0.00.00-4	Permanente	Non-current assets
c. 4.0.0.00.00-8	Circulante e exigível a longo prazo	Current and long-term liabilities
d. 4.1.0.00.00-7	Depósitos	Deposits
e. 6.1.1.00.00-4	Capital social	Capital
Formula: $P6 = (a + b - (c - d)) / (d + e)$		
Goal: Min 1.11		

Frame 2.4 - Adapted PEARLS ratios - Protection

(conclusion)

P - Protection		
P7 = Loans from level D to H - Estimated allowance/Equity		
Purpose: To measure the non-provisioned portion of loans at levels D to H against equity.		
COSIF account	**Official account title**	**Free translation**
a. 3.1.5.00.00-5	Operações de risco nível D	Loans at risk level D
b. 3.1.6.00.00-8	Operações de risco nível E	Loans at risk level E
c. 3.1.7.00.00-1	Operações de risco nível F	Loans at risk level F
d. 3.1.8.00.00-4	Operações de risco nível G	Loans at risk level G
e. 3.1.9.00.00-7	Operações de risco nível H	Loans at risk level H
f. 6.0.0.00.00-2	Patrimônio líquido	Equity
g. 7.0.0.00.00-9	Contas de resultado credoras	Credit income statement accounts
h. 8.0.0.00.00-6	(-) Contas de resultado devedoras	Debit income statement accounts
Formula: $P7 = ((1-0.1)a + (1-0.3)b + (1-0.5)c + (1-0.7)d + (1-1)e)/(f+g+h)$		
Goal: the lower the better. A low ratio would indicate the equity could support loan losses at risk levels related to arrears greater than 60 days.		

Source: by the author (2019)

P6 is called solvency ratio, which aims to measure the degree of protection that the credit union offer for member savings and shares in the event of liquidation of the credit union's assets and liabilities (RICHARDSON, 2009). We have adapted the ratio P6 to Brazilian case as follows. The original PEARLS proposes to suppress the actual allowances and later include allowances according to suggested percentual. Instead, we have maintained the actual allowances that are deducting the assets and must be in line with CMN (1999b). This makes the ratio more suitable to Brazilian case and more conservative because the allowances for risk assets required by CMN are indeed more conservative than what is defined in PEARLS. While PEARLS recommends 100% of allowances for delinquent loans greater than 12 months, CMN demands 100% of allowances for delinquent loans greater than 6 months. Similarly, while PEARLS recommends 35% of allowances for delinquent loans from 1 to 12 months, CMN demands 10%-70% of allowances for delinquent loans from 61-180 days. The provision follows a progressive level of allowances according to risk assessment and days in arrears as table 2.3 shows.

Additional indicators could be included in groups P and A based on previous Brazilian literature. Bressan et al. (2010) use the classified loan portfolio (COSIF 3.1.0) to calculate two ratios coded as P3 and P4. P3 ratio (BRESSAN et al., 2010) enables to verify the percentage of higher risk loans (levels D-H, Table 2.3) concerning the total loan portfolio. It is a pertinent measurement because it indicates the quality of the loan portfolio by revealing the portion of loan portfolio classified at the highest risk levels. The Bressan et al. (2010)'s P3 ratio could

Table 2.3 – The progressive system of allowances for delinquent loan in Brazil

Risk level	**Allowances(%)**	**Days in arrears**
AA	0	-
A	0.5	up to 14
B	1	15-30
C	3	31-60
D	10	61-90
E	30	91-120
F	50	121-150
G	70	151-180
H	100	over 180

Source: by the author (2019), based on CMN (1999b)

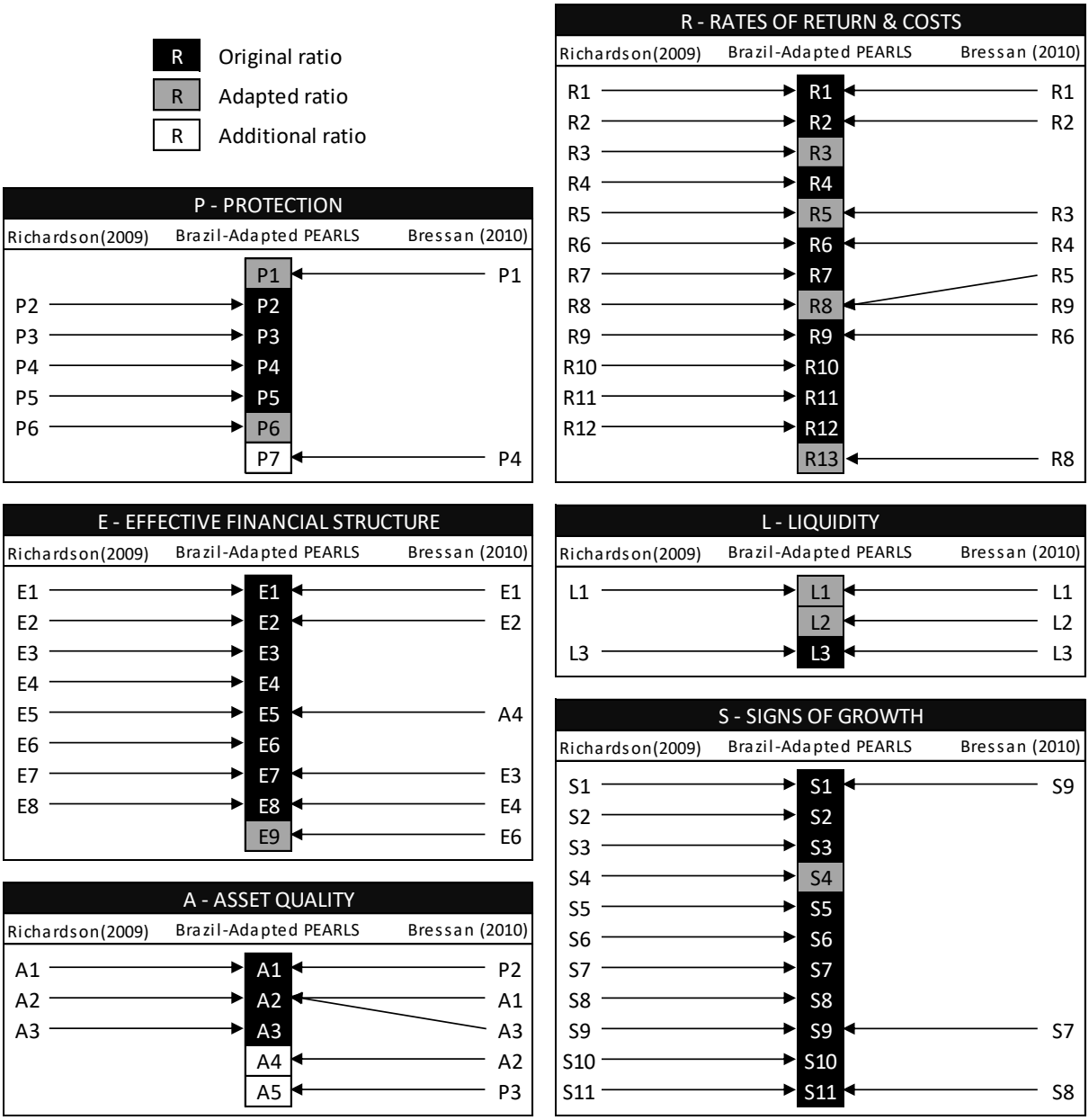
be relocated to section A because is more related to the quality of assets than to the level of protection. In turn, the P4 ratio (BRESSAN et al., 2010) is a Protection indicator. It also deals with risk levels AA-H, but it is related to the allowances to loan losses according to risk levels rather than the quality of loans itself. The ratio aims to measure the non-provisioned portion of loans at levels D to H compared to equity value. Percentages of allowances in Bressan et al. (2010)'s P4 ratio (recoding to P7) are by CMN Resolution nº 2682/99 (CMN, 1999b).

To keep the original coding consistent, we propose relocating Bressan et al. (2010) P3 to group A - Asset Quality and recoding Bressan et al. (2010)'s P4 to P7 to become an additional indicator and preserve P3 and P4 according to Richardson (2009). This arrangement combines and conciliates the two ratios set, which enriches the PEARLS system. Figure 2.5 shows this and other adaptations that have been done and will be detailed hereafter.

The next section of ratios is E - Effective Financial Structure. The frames 2.5, 2.6, and 2.7 present the ratios in the group and respective COSIF accounts that enable their calculation. According to Richardson (2009), the purpose of the group Effective Financial Structure is to measure the composition of the most important accounts on the balance sheet. An effective financial structure is essential to achieve safety, soundness, and profitability. The ratios measure the structure of assets (E1, E2, E3, and E4), liabilities (E5 and E6) and capital (E7, E8, and E9). In this group, most of the ratios may be found from the values of accounts on publicly available trial balance sheets.

The indicators E1, E2 E3 and E4, which concern to asset structure, are directly related to the indicators R1, R2, R3, ad R4, which concern to rates of returns from the respective assets. In ratio E1, net loans are obtained directly from the COSIF group 1.6.0.00.00-1, which considers

Figure 2.5 – Brazil-adapted PEARLS



Source: by the author (2019), based on Richardson (2009) and Bressan et al. (2010)

gross loans less allowances. According to PEARLS, E2 and E3 measure the percentage of total assets invested in liquid and long-term investments respectively. In line with Richardson (2009) the ratio E2 is composed of interbank investments, securities and financial instruments. Also in line with the WOCCU's documentation of PEARLS, E3 is composed of long-term investments in shares and quotas. Singular credit unions usually detain quotas of central second level credit unions and shares of cooperative banks. Regarding the indicator E4, it originally aims to measure the percentage of total assets invested in non-financial investments, like supermarkets, pharmacies, residential housing developments, etc. The credit unions in Brazil cannot operate

in those activities and must focus in financial services. However, they may have assets not for own use, typically from guarantees received on loans in default. Thus, we adapted E4 ratio and composed it with assets not for own use.

The adapted ratio E4 measures the percentage of total assets applied in the COSIF account 1.9.8.10.00-9 - Bens não de uso próprio (Assets not for own use). That account is used to register assets owned by the institution, not used to perform its activity, including those received in payment (e.g. properties, vehicles). Note the account is COSIF level 4. Due to the limitation of publicly available trial balance sheets, which only provides accounts up to level 3, it is not possible to directly access the values of the account, unless through non-public data. However, a reasonable proxy for assets not for own use may be obtained from the level 3 account 1.9.8.00.00-2 - Outros valores e bens (Other assets). It also includes two other accounts regarding materials in inventory. Nevertheless, it is substantially composed by assets not for own use, as we confirmed by checking notes to the financial statements of credit unions with great values in the account 1.9.8.00.00-2. Exaggerated values in that account indicate difficulties in receiving loans and high level of delinquency. Further, they are non-earnings unproductive assets and difficult to liquidate. Therefore, the ideal value of E4 is 0%, in line with WOCCU's best practice (RICHARDSON, 2009).

The next two ratios (E5 and E6) indicate liabilities as sources of funding. Indicator E5 refers to the portion of assets financed by deposits. It can be directly obtained by accounts from publicly available balance sheets, according to accounts in Frame 2.6. Indicator E6 measures the percentage of total assets financed by external sources, that is, obligations with other financial institutions outside the credit unions. WOCCU best practice (RICHARDSON, 2009) suggests this ratio should be no more than 5%. Similarly to asset structure indicators (E1-E4), the liabilities structure indicators E5 and E6 have corresponding R indicators, R5 and R6, which indicate the financial cost of the respective funding.

The last three ratios in group E (E7, E8, and E9) indicate the structure of own capital about total assets. The E7 ratio measures the number of assets financed by member capital. Like assets and liabilities structure indicators, E7 has a correspondent R indicator, R7, which indicates the explicit financial cost of shares. E8 measures the number of assets financed by institutional capital, which has no explicit financial cost. The institutional capital is composed of legal and non-distributable reserves plus the retained portion of the current year's surplus. Concerning E9 an adaptation has been necessary. WOCCU defines it as "Net Capital". It is the level of

Frame 2.5 – Adapted PEARLS ratios - Effective Financial Structure (Assets)

E - Effective Financial Structure (Assets)		
E1 = Net loans/Total assets		
Purpose: To measure the percentage of total assets invested in the loan portfolio.		
COSIF account	**Official account title**	**Free translation**
a. 1.6.0.00.00-1	Operações de crédito	Lending operations
b. 1.0.0.00.00-7	Circulante e realizável a longo prazo	Current assets and long-term receivables
c. 2.0.0.00.00-4	Permanente	Permanent assets
Formula: $E1 = a/(b+c)$		
Goal: 70-80%		
E2 = Liquid investments/Total assets		
Purpose: To measure the percentage of total assets invested in liquid investments.		
COSIF account	**Official account title**	**Free translation**
a. 1.2.0.00.00-5	Aplicações interfinanceiras de liquidez	Interbank investments
b. 1.3.0.00.00-4	Títulos e valores mobiliários e instrumentos financeiros derivativos	Securities and derivative financial instruments
c. 1.4.0.00.00-3	Relações interfinanceiras	Interbank accounts
d. 1.0.0.00.00-7	Circulante e realizável a longo prazo	Current assets and long-term receivables
e. 2.0.0.00.00-4	Permanente	Permanent assets
Formula: $E2 = (a+b+c)/(d+e)$		
Goal: Max 18%		
E3 = Long-term investments/Total assets		
Purpose: To measure the percentage of total assets invested in long-term investments (participation in subsidiaries or affiliates).		
COSIF account	**Official account title**	**Free translation**
a. 2.1.5.00.00-8	Ações e cotas	Shares and quotas
b. 1.0.0.00.00-7	Circulante e realizável a longo prazo	Current assets and long-term receivables
c. 2.0.0.00.00-4	Permanente	Permanent assets
Formula: $E2 = a/(b+c)$		
Goal: Max 3%		
E4 = Assets not for own use/Total assets		
Purpose: To measure the percentage of total assets applied in assets not for own use.		
COSIF account	**Official account title**	**Free translation**
a. 1.9.8.10.00-9	Bens não de uso próprio	Assets not for own use
b. 1.9.8.99.00-6	(-) Provisão para desvalorização de outros valores e bens	Allowances for impairment of other assets
c. 1.0.0.00.00-7	Circulante e realizável a longo prazo	Current assets and long-term receivables
d. 2.0.0.00.00-4	Permanente	Permanent assets
Formula: $E4 = (a-\|b\|)/(c+d)$		
Goal: 0%		

Source: by the author (2019)

institutional capital after deducting allowances for risk assets to meet the standards of P1 and P2. However, the balance sheets of credit unions in Brazil must present Equity after deduction of proper allowances with respect to regulation (CMN, 1999b). Thus the Equity is deducted of risk

Frame 2.6 – Adapted PEARLS ratios - Effective Financial Structure (Liabilities)

E - Effective Financial Structure (Liabilities)		
E5 = Deposits/Total assets		
Purpose: To measure the percentage of total assets financed by deposits.		
COSIF account	**Official account title**	**Free translation**
a. 4.1.0.00.00-7	Depósitos	Deposits
b. 1.0.0.00.00-7	Circulante e realizável a longo prazo	Current assets and long-term receivables
c. 2.0.0.00.00-4	Permanente	Permanent assets
Formula: $E5 = a/(b+c)$		
Goal: 70-80%		
E6 = External credit/Total assets		
Purpose: To measure the percentage of total assets financed by external borrowing.		
COSIF account	**Official account title**	**Free translation**
a. 4.4.0.00.00-4	Relações interfinanceiras	Interbank accounts
b. 4.6.0.00.00-2	Obrigações por empréstimos e repasses	Borrowed funds
c. 1.0.0.00.00-7	Circulante e realizável a longo prazo	Current assets and long-term receivables
d. 2.0.0.00.00-4	Permanente	Permanent assets
Formula: $E6 = (a+b)/(c+d)$		
Goal: Max 5%		

Source: by the author (2019)

loans anyway. Besides, as already exposed, the level of allowances in Brazil is more conservative than PEARLS recommends.

Taking into account the aforementioned aspects we have adapted the ratio E9 to represent a broad indicator of leverage composed by total assets divided by total adjusted equity. It is based on Bressan et al. (2010)'s E6 ratio. The higher the indicator the higher is the leverage. That is, credit unions presenting high values of E9 concerning the average industry are operating with a higher proportion of liabilities against equity. Extreme ratios indicate a bad situation. Values between 6 and 12 are considered normal (BRESSAN et al., 2010).

Frame 2.8 presents Asset Quality ratios. The indicators in this section measure the quality of assets composed by delinquency rate, non-earnings asset, and financing of non-earnings assets. Asset quality is related to productivity and profitability of assets. Non-productive or non-earning assets are those that do not generate income Richardson (2009). For example, delinquent loans or fixed assets are considered low-quality assets. According to Richardson (2009), the delinquency ratio (A1) is the most important measurement of institutional weakness. High delinquency ratio usually impacts all other key areas of credit unions operations. Properly monitoring delinquency informs credit unions of the severity of problems in loans before a crisis develops. WOCCU

Frame 2.7 – Adapted PEARLS ratios - Effective Financial Structure (Capital)

E - Effective Financial Structure (Capital)		
E7 = Member share capital/Total assets		
Purpose: To measure the percentage of total assets financed by member shares.		
COSIF account	**Official account title**	**Free translation**
a. 6.1.1.00.00-4	Capital social	Capital
b. 1.0.0.00.00-7	Circulante e realizável a longo prazo	Current assets and long-term receivables
c. 2.0.0.00.00-4	Permanente	Permanent assets
Formula: $E7 = a/(b+c)$		
Goal: Max 20%		
E8 = Institutional capital/Total assets		
Purpose: To measure the percentage of total assets financed by institutional capital.		
COSIF account	**Official account title**	**Free translation**
a. 6.1.3.00.00-0	Reservas de capital	Capital reserves
b. 6.1.5.00.00-6	Reservas de lucro	Profit reserves
c. 6.1.7.00.00-2	Sobras ou perdas acumuladas	Retained surplus or losses
d. 1.0.0.00.00-7	Circulante e realizável a longo prazo	Current assets and long-term receivables
e. 2.0.0.00.00-4	Permanente	Permanent assets
Formula: $E8 = (a+b+c)/(d+e)$		
Goal: Min 10%		
E9 = Total equity/Total assets		
Purpose: To measure the percentage of total assets financed by total adjusted equity.		
COSIF account	**Official account title**	**Free translation**
a. 6.0.0.00.00-2	Patrimônio Líquido	Equity
b. 7.0.0.00.00-9	Contas de resultado credoras	Credit income statement accounts
c. 8.0.0.00.00-6	(-) Contas de resultado devedoras	Debit income statement accounts
d. 1.0.0.00.00-7	Circulante e realizável a longo prazo	Current assets and long-term receivables
e. 2.0.0.00.00-4	Permanente	Permanent assets
Formula: $E9 = (a+b+c)/(d+e)$		
Goal: Min 10%		

Source: by the author (2019)

recommends considering outstanding delinquent loan balances instead of accumulated delinquent loan payments.

The calculation of the ratio A1 requires to sum all delinquent loan balances from a non-bookkeeping control and confront it with total gross loan portfolio (RICHARDSON, 2009). For that purpose, we can find the number of gross loans in arrears in a non-bookkeeping control from BCB's IF.data (BCB, 2018). Alternatively, gross loans in arrears could be found on credit unions' balance sheets in COSIF group 3 (off-balance accounts, recall Figure 2.1), according to Bressan et al. (2010)'s ratio P2. However, it would require internal data of balance sheets in analytical accounts beyond COSIF level 3 that are not publicly available.

Frame 2.8 – Adapted PEARLS ratios - Asset Quality

(it continues)

A - Asset Quality		
A1 = Total loan delinquency/Gross loan portfolio		
Purpose: To measure the total percentage of delinquency in the loan portfolio.		
Non-bookkeeping control: IF.data (BCB, 2018)		
a. Total loans in arrears over 15 days		
COSIF account	**Official account title**	**Free translation**
b. 1.6.0.0.00.00-1	Operações de crédito	Lending operations
Formula: $A1 = a/b$		
Goal: <= 5%		
A2 = Non-earnings assets/Total assets		
Purpose: To measure the percentage of total assets not producing income.		
COSIF account	**Official account title**	**Free translation**
a. 1.1.0.0.00.00-6	Disponibilidades	Cash and cash equivalents
b. 1.8.0.0.00-00-9	Outros créditos	Other receivables
c. 1.8.3.0.00.00-8	Rendas a receber	Income receivables
d. 1.9.0.0.00.00-8	Outros valores e bens	Other assets
e. 1.0.0.0.00.00-7	Circulante e realizável a longo prazo	Current assets and long-term receivables
f. 2.0.0.0.00.00-4	Permanente	Permanent assets
Formula: $A2 = (a + (b - c) + d + f)/(e + f)$		
Goal: <= 5%		
A3 = Institutional capital, transitory capital and liabilities with no explicit financial cost/ Non-earnings assets		
Purpose: To measure the percentage of non-earnings assets financed with institutional capital, transitory capital and liabilities without interest.		
Institutional capital: *a*. numerator for E8 ratio		
COSIF account	**Official account title**	**Free translation**
b. 4.9.3.0.00-00-8	Obrigações sociais e estatutárias	Social and statutory liabilities
Non-earnings assets: *c*. numerator for A2 ratio		
Formula: $A3 = (a + b)/c$		
Goal: > 100%		
A4 = Permanent assets/Total adjusted equity		
Purpose: To measure the percentage of total adjusted equity applied in permanent assets.		
COSIF account	**Official account title**	**Free translation**
a. 2.0.0.0.00.00-4	Permanente	Permanent assets
b. 6.0.0.0.00.00-2	Patrimônio Líquido	Equity
c. 7.0.0.0.00.00-9	Contas de resultado credoras	Credit income statement accounts
d. 8.0.0.0.00.00-6	(-) Contas de resultado devedoras	Debit income statement accounts
Formula: $A4 = a/(b + c + d)$		
Goal: <=50%		

The ratio A2 measures the percentage of assets allocated to non-earning assets. Credit unions should keep this ratio as low as possible and WOCCU best practice recommends a maximum of 5% of total assets. However, credit unions that need to improve their poor physical image can temporarily increase the non-earnings asset ratio. The ratio begins to increase as long

Frame 2.8 - Adapted PEARLS ratios - Asset Quality

(conclusion)

A - Asset Quality		
A5 = Loans classified between level D and level H/Total classified loans portfolio		
Purpose: To measure the portion of loans at level of risk greater than 61 days of delinquency.		
COSIF account	**Official account title**	**Free translation**
a. 3.1.5.00.00-5	Operações de risco nível D	Loans at risk level D
b. 3.1.6.00.00-8	Operações de risco nível E	Loans at risk level E
c. 3.1.7.00.00-1	Operações de risco nível F	Loans at risk level F
d. 3.1.8.00.00-4	Operações de risco nível G	Loans at risk level G
e. 3.1.9.00.00-7	Operações de risco nível H	Loans at risk level H
f. 3.1.0.00.00-0	Classificação da carteira de créditos	Total classified loans portfolio
Formula: $A5 = (a+b+c+d+e)/f$		
Goal: the lower the better.		

Source: by the author (2019)

as public confidence increases a new members join and deposit their savings with the credit unions (RICHARDSON, 2009). Some examples of non-earnings as defined by WOCCU are: fixed assets, cash on hand, non-interest bearing monetary checking accounts, accounts receivable, assets in liquidation, prepaid expenses and other deferrals.

The ratio A3 concerns the percentage of non-earnings assets financed with institutional capital, transitory capital, and liabilities without interest. Transitory capital includes monetary, educational and social reserves, revalued assets and undistributed income (RICHARDSON, 2009). The account Social and Statutory Liabilities refers to liabilities with no explicit financial cost and are included in ratio A3. It includes the Fund for Technical, Educational, and Social Assistance, in Portuguese, Fundo de Assistência Técnica, Educacional e Social (FATES). It is a legal fund that comes from earnings and has no interest cost although it is recorded in liabilities. Therefore, it fits the WOCCU's concept of transitory capital. WOCCU recommends financing 100% of all non-earnings asset with the credit union's institutional capital, transitory capital and liabilities without explicit financial cost.

We have included two extra ratios to section A - Asset Quality: A4 and A5. Following Bressan et al. (2010) we composed the ratio A4 with permanent assets divided by total equity. This ratio is similar to A2, but it is more specific and focuses on the percentage of total equity applied in fixed assets. It is regulated by the CMN Resolution nº 2669/99 (CMN, 1999a) and its value should not be greater than 50%. Another additional ratio (A5) has been included. A5 comes from the recoded Bressan et al. (2010)'s P3 ratio. It measures the portion of loans classified at risk levels D to H (recall Table 2.3) concerning the total loan portfolio. Them, it is a

relevant asset quality ratio that indicates the general quality of loans, which is the main asset item of credit unions' balance sheet.

The next group of indicators is R - Rates of Returns and Costs, detailed in Frame 2.9. The indicators in this group assess the return of assets and cost of liabilities and capital. They enable to analyze the main components of earnings by evaluating investment yields and operation expenses. The indicator is directly related to assets, liabilities and capital indicators in section E - Effective Financial Structure. Therefore, they are composed of income and costs (numerators) and assets, liabilities, and capital (denominators). Originally, thirteen ratios compose the group R. The first four indicators (R1, R2, R3, and R4) concern to return of assets. The second group of indicators (R5 and R6) concern to financial cost of liabilities. The R7, in turn, measures the explicit financial cost of shares. The indicators R8, R9, R10, R11, R12, and R13 are other critical ratios concerning to gross margin, administrative expenses, loan losses provisions expenses, non-recurring earnings/losses, return on assets (ROA) and return on equity (ROE) respectively.

Frame 2.10 presents the indicators of group L - Liquidity, which is an essential component for any financial organization. Liquid assets must be adequate to face abrupt outflows of resources in short-term stress scenarios. Also, an adequate stable source of funding is necessary to face long-term liquidity risk. In spite of that, excess liquid assets reduce profitability. Therefore the institution has to pursue a suitable level of cash and equivalents in a trade-off between liquidity and profitability. WOCCU documentation of PEARLS (RICHARDSON, 2009) composes the group Liquidity with three indicators: L1, L2, and L3. L1 confronts short-term and liquid assets, less short-term payables, to deposits. L2 confronts liquidity reserves to deposits. Finally, L3 confronts non-earning liquid assets to total assets. We have adapted indicators L1 and L2 according to Bressan et al. (2010). Two reasons motivated the change. First, in an analysis by Araujo (2011) on the original indicators through econometric treatment and verification of applicability to Brazil the indicators were not selected to the final model of credit unions solvency risk. Second, the adapted L1 and L2 (BRESSAN et al., 2010) have been significant in empirical studies about solvency risk in credit unions (BRESSAN et al., 2011a; GOZER et al., 2014a,b). Regarding L3 ratio we followed the original WOCCU's original purpose because it does not imply any adaptation or restriction.

The last group of indicators is S - Signs of Growth. According to richardson2009, the strong growth of assets accompanied by sustained profitability is essential to maintain asset values. The PEARLS system group Signs of Growth has eleven indicators divided into five key

Frame 2.9 – Adapted PEARLS ratios - Rates of Return and Costs

(it continues)

R - Rates of Return and Costs		
R1 = Net loan income/Average loan portfolio		
Purpose: To measure the yield on the loan portfolio.		
COSIF account	**Official account title**	**Free translation**
a. 7.1.1.00.00-1	Rendas de operações de crédito	Loan income
Gross loan portfolio: *b*. denominator for P1 ratio		
Formula: $R1 = a_t / ((b_{t-1} + b_t)/2)$		
Goal: Entrepreneurial rate that covers financial, operating expenses and contributes to maintain capital levels		
R2 = Liquid investment income/Liquid investments		
Purpose: To measure the yield on liquid investments.		
COSIF account	**Official account title**	**Free translation**
a. 7.1.4.00.00-0	Rendas de aplicações interfinanceiras de liquidez	Interbank investments income
b. 7.1.5.00.00-3	Rendas com títulos e valores mobiliários e instrumentos financeiros derivativos	Income from securities and derivative financial instruments
c. 8.1.5.00.00-0	(-) Despesas com títulos e valores mobiliários e instrumentos financeiros derivativos	Expenses from securities and derivative financial instruments
d. 7.1.9.86.00-5	Ingressos de depósitos intercooperativos	Intercooperative deposits income
Liquid investments: *e*. numerator for E2 ratio		
Formula: $R2 = (a_t + (b_t - \lvert c_t \rvert) + d_t) / ((e_{t-1} + e_t)/2)$		
Goal: Highest rates possible without undue risk.		
R3 = Long-term investment income/Average long-term investments		
Purpose: To measure the yield on long-term investments.		
COSIF account	**Official account title**	**Free translation**
a. 7.1.8.00.00-2	Rendas de participações	Participations income
b. 2.1.0.00.00-3	Investimentos	Investments
Formula: $R3 = a_t / ((b_{t-1} + b_t)/2)$		
Goal: Highest rates possible without undue risk.		
R4 = Assets not for own use income/Average assets not for own use		
Purpose: To measure the yield on assets not for own use.		
COSIF account	**Official account title**	**Free translation**
a. 7.3.1.50.00-4	Lucros na alienação de valores e bens	Profits in disposal of assets
b. 7.3.9.20.00-7	Rendas de alugueis	rental income
c. 7.3.9.90.10-9	Desvalorização de outros valores e bens	Other assets impairment
d. 8.3.1.50.00-1	(-) Prejuízos na alienação de valores e bens	Losses in disposal of assets
f. 8.3.9.90.10-6	(-) Desvalorização de outros valores e bens	Other assets impairment
Assets not for own use: *g*. numerator for E4 ratio		
Formula: $R4 = (a_t + b_t + c_t - \lvert d_t \rvert - \lvert f_t \rvert) / ((g_{t-1} + g_t)/2)$		
Goal: Highest rates possible without undue risk.		
R5 = Financial cost: interest cost on deposits/Average deposits with costs		
Purpose: To measure the cost of deposits.		
COSIF account	**Official account title**	**Free translation**
a. 8.1.1.00.00-8	(-) Despesas de captação	Money market funding expenses

Frame 2.9 - Adapted PEARLS ratios - Rates of Return and Costs

(it continues)

R - Rates of Return and Costs		
R5 = Financial cost: interest cost on deposits/Average deposits with costs		
Purpose: To measure the cost of deposits.		
COSIF account	**Official account title**	**Free translation**
b. 4.1.3.00.00-6	Depósitos interfinanceiros	Interbank deposits
c. 4.1.4.00.00-9	Depósitos sob aviso	Savings deposits
d. 4.1.5.00.00-2	Depósitos a prazo	Savings deposits
e. 4.3.2.00.00-1	Recursos de letras imobiliárias, hipotecárias, de crédito e similares	Real estate credit notes, mortgage notes, credit and similar notes
Formula: $R5 = \|a_t\| / ((b_{t-1} + b_t + c_{t-1} + c_t + d_{t-1} + d_t + e_{t-1} + e_t)/2)$		
Goal: Rates that protect the nominal value of the savings deposits (>Inflation.)		
R6 = Financial cost: interest cost on external credit/average external credit		
Purpose: To measure the cost of external credit.		
COSIF account	**Official account title**	**Free translation**
a. 8.1.2.00.00-1	(-) Despesas de obrigações por empréstimos e repasses	Borrowed funding expenses
External credit: *b*. numerator for E6 ratio		
Formula: $R6 = \|a_t\| / ((b_{t-1} + b_t)/2)$		
Goal: Same or lesser cost than R5		
R7 = Financial cost: Total interest(dividend) cost on shares/average member shares		
Purpose: To measure the cost of member shares		
COSIF account	**Official account title**	**Free translation**
a. 8.1.9.55.00-2	(-) Despesas de juros ao capital	Interest on capital
b. 6.1.1.00.00-4	Capital social	Capital
Formula: $R7 = \|a_t\| / ((b_{t-1} + b_t)/2)$		
Goal: Same or greater than R5.		
R8 = Gross margin/Average total assets		
Purpose: To measure the gross income margin generated, expressed as a yield on all assets,		
Loan interest income: *a*. numerator for R1 ratio		
Liquid investment income: *b*. numerator for R2 ratio		
Interest cost on deposits: *c*. numerator for R5 ratio		
Interest cost on external credit: *d*. numerator for R6 ratio		
COSIF account	**Official account title**	**Free translation**
e. 1.0.0.00.00-7	Circulante e realizável a longo prazo	Current assets and long-term receivables
f. 2.0.0.00.00-4	Permanente	Permanent assets
Formula: $R8 = (a_t + b_t - (\|c_t\| + \|d_t\|))/((e_{t-1} + e_t + f_{t-1} + f_t)/2)$		
Goal: To generate sufficient income to cover all operating expenses and allowances for loan losses and provide for adequate increases in institutional capital.		
R9 = Administrative expenses/Average total assets		
Purpose: To measure the expenses associated with the management of Credit Union assets.		
COSIF account	**Official account title**	**Free translation**
a. 8.1.7.00.00-6	Despesas administrativas	Administrative expenses
Average total assets: *b*. denominator for R8 ratio		
Formula: $R9 = (\|a_t\| / b)$		
Goal: <5%		

Frame 2.9 - Adapted PEARLS ratios - Rates of Return and Costs

(conclusion)

R - Rates of Return and Costs		
R10 = Provision for loan losses/Average total assets		
Purpose: To measure the cost of losses from risk assets such as delinquent loans.		
COSIF account	**Official account title**	**Free translation**
a. 8.1.8.30.30-9	(-) Provisões para operações de crédito	Loan losses provisions
Average total assets: *b*. denominator for R8 ratio		
Formula: $R8 = (a_t / b)$		
Goal: Dependent on delinquent loans.		
R11 = Non-recurring income or expenses/Average total assets		
Purpose: To measure the net amount of non-recurring income and expenses.		
COSIF account	**Official account title**	**Free translation**
a. 7.3.0.00.00-6	Receitas não operacionais	Non-operating income
b. 8.3.0.00.00-3	(-) Despesas não operacionais	Non-operating expenses
Average total assets: *c*. denominator for R8 ratio		
Formula: $R8 = (a_t - \lvert b_t \rvert) / c)$		
Goal: Minimum possible.		
R12 = Net income/Average total assets (ROA)		
Purpose: To measure the adequacy of earnings and also, the capacity to build institutional capital.		
COSIF account	**Official account title**	**Free translation**
a. 7.0.0.00.00-9	Contas de resultado credoras	Credit income statement accounts
b. 8.0.0.00.00-6	(-) Contas de resultado devedoras	Debit income statement accounts
c. 8.1.9.55.00-2	(-) Despesas de juros ao capital	Interest on capital
Average total assets: *d*. denominator for R8 ratio		
Formula: $R12 = (a_t - (\lvert b_t \rvert - \lvert c_t \rvert)) / d)$		
Goal: Minimum possible.		
R13 = Net income/Average equity (ROE)		
Purpose: To measure the return on equity (ROE).		
COSIF account	**Official account title**	**Free translation**
a. 7.0.0.00.00-9	Contas de resultado credoras	Credit income statement accounts
b. 8.0.0.00.00-6	(-) Contas de resultado devedoras	Debit income statement accounts
c. 8.1.9.55.00-2	(-) Despesas de juros ao capital	Interest on capital
d. 6.0.0.00.00-2	Patrimônio líquido	Equity
Formula: $R13 = (a_t - (\lvert b_t \rvert - \lvert c_t \rvert)) / ((d_{t-1} + d_t) / 2))$		
Goal: > money market interest rate (Selic)		

Source: by the author (2019)

areas: total assets, loans, savings deposits, shares, and institutional capital. Growth of itself is not sufficient but PEARLS has the advantage of linking growth to profitability, as well as to the other components and evaluating the strength of the system as a whole (RICHARDSON, 2009). The growth in total assets (S11) is one of the most important ratios, not only because total assets is a key denominator for many formulas in the PEARLS ratios (RICHARDSON, 2009) but also because its growth represents somehow the overall development and growth of the credit union. The frame 2.11 details the indicators of the group S - Signs of Growth.

Frame 2.10 – Adapted PEARLS ratios - Liquity

L - Liquidity		
L1 = Cash and cash equivalents/Demand deposits		
Purpose: To measure the adequacy of liquid cash reserves to satisfy demand deposit withdrawal.		
COSIF account	**Official account title**	**Free translation**
a. 1.1.0.00.00-6	Disponibilidades	Cash and cash equivalents
b. 4.1.1.00.00-0	Depósitos à vista	Demand deposits
Formula: $L1 = a/b$		
Goal: 5-15%		
L2 = Short-term assets/Total deposits		
Purpose: To measure the adequacy of short-term assets to satisfy total deposit withdrawal.		
COSIF account	**Official account title**	**Free translation**
a. 1.1.0.00.00-6	Disponibilidades	Cash and cash equivalents
b. 1.2.0.00.00-5	Aplicações interfinanceiras de liquidez	Interbank investments
c. 1.3.0.00.00-4	Títulos e valores mobiliários e instrumentos financeiros derivativos	Securities and derivative financial instruments
d. 1.4.5.00.00-8	Centralização financeira - cooperativas	Financial centralization - cooperatives
e. 4.1.0.00.00-0	Depósitos	Deposits
Formula: $L2 = (a+b+c+d)/e$		
Goal: > 50%		
L3 = Non-earnings liquid assets/Total assets		
Purpose: To measure the percentage of total assets that are invested in non-earning liquid accounts.		
COSIF account	**Official account title**	**Free translation**
a. 1.1.0.00.00-6	Disponibilidades	Cash and cash equivalents
b. 1.0.0.00.00-7	Circulante e realizável a longo prazo	Current assets and long-term receivables
c. 2.0.0.00.00-4	Permanente	Permanent assets
Formula: $L3 = a/(b+c)$		
Goal: <= 1%		

Source: by the author (2019)

Most of the indicator in this last group can be calculated from balance sheets. The unique exception is the ratio S10, which requires non-bookkeeping control of internal data. To calculate the ratio using publicly available data, a proxy could be the growth of members with loans (found in IF.data (BCB, 2018)) weighted by the growth in loans concerning member shares. The notes to financial statements are another alternative, which usually provides information on membership size. The limitation of this option is that likely not all credit unions release the number of member in notes to financial statements or even do not have a website to publish it.

Besides PEARLS ratios, that are the basis to the logit panel data, other independent variables have been included in the model. The Basel index has been considered as an index of capital structure. However, it has been removed because it is just available in its source (BCB, 2018) after 2015, which would substantially reduce the observations to be included in the model. Nonetheless, some PEARLS ratios (E7, E8, E9) provide a similar assessment. The age and

Frame 2.11 – Adapted PEARLS ratios - Signs of Growth

S - Signs of Growth	
S1 = Growth in loans to members	**S2 = Growth in liquid investments**
Purpose: To measure the growth of loan portfolio.	**Purpose:** To measure the growth of liquid investments.
Loan portfolio: *a.* numerator for E1 ratio	**Liquid investments:** *a.* numerator for E2 ratio
Formula: $S1 = (a_t / a_{t-1}) - 1$	**Formula:** $S2 = (a_t / a_{t-1}) - 1$
Goal: Dependent on E1.	**Goal:** Dependent on E2.
S3 = Growth in long-term investments	**S4 = Growth in assets not for own use**
Purpose: To measure the growth of long-term investments.	**Purpose:** To measure the growth of assets not for own use (ANOU).
LT investments: *a.* numerator for E3 ratio	**ANOU:** *a.* numerator for E4 ratio
Formula: $S3 = (a_t / a_{t-1}) - 1$	**Formula:** $S4 = (a_t / a_{t-1}) - 1$
Goal: Dependent on E3.	**Goal:** Dependent on E4.
S5 = Growth in deposits	**S6 = Growth in external credit**
Purpose: To measure the growth of deposits.	**Purpose:** To measure the growth of external credit.
Deposits: *a.* numerator for E5 ratio	**External credit:** *a.* numerator for E6 ratio
Formula: $S5 = (a_t / a_{t-1}) - 1$	**Formula:** $S6 = (a_t / a_{t-1}) - 1$
Goal: Dependent on E5.	**Goal:** Dependent on E6.
S7 = Growth in member share capital	**S8 = Growth in institutional capital**
Purpose: To measure the growth of member share capital.	**Purpose:** To measure the growth of institutional capital.
Member share capital: *a.* numerator for E7 ratio	**Institutional capital:** *a.* numerator for E8 ratio
Formula: $S7 = (a_t / a_{t-1}) - 1$	**Formula:** $S8 = (a_t / a_{t-1}) - 1$
Goal: Dependent on E7.	**Goal:** Dependent on E8.
S9 = Growth in equity	**S10 = Growth in membership**
Purpose: To measure the growth of equity.	**Purpose:** To measure the growth of membership of the credit union.
Adjusted equity: *a.* numerator for E9 ratio	**Membership:** *a.* non-bookkeeping control
Formula: $S9 = (a_t / a_{t-1}) - 1$	**Formula:** $S10 = (a_t / a_{t-1}) - 1$
Goal: Dependent on E9.	**Goal:** >15% per year
S11 = Growth in total assets	
Purpose: To measure the growth of total assets.	
Total assets: *a.* denominator for E1 ratio	
Formula: $S11 = (a_t / a_{t-1}) - 1$	
Goal: > inflation + 10% per year.	

Source: by the author (2019)

size of credit unions were also included. The former has been converted into natural logarithm because of its high scale and skewness on the left. The latter was converted into quartiles (by semester) given a lack of structured data on the exact starting date for all the oldest institutions (started before 1988).

Further, some qualitative variables of credit unions characteristics have been also tested: kind of bond, technology (assumed as the existence of website), age, and a dummy for credit

unions that have incorporated other at least once. The qualitative variables could be found on BCB's list of institutions in operation in the country (BCB, 2019b). Also, some macroeconomic/-sectorial variables have been checked: default rate by state, SELIC interest rate and GDP real percentage change. These last three variables have been retrieved from BCB's public module of the Time Series Management System (BCB, 2019c).

4 FINDINGS

4.1 Exploratory analysis

The data is composed of a total of 910 individuals in 18 semesters from the first semester of 2010 to the second semester of 2018. Since credit unions have started or stopped during the period, the dataset is an unbalanced panel. This is inherent to the Logit analysis to be done because the failed individuals are essential to perform the analysis. Nonetheless, most of the individuals (71.43%) have data in all 18 periods (see panel data patterns in Appendix B, Figure A.1).

Table 2.4 presents an overview of the sample used in this chapter in terms of numbers of credit unions over the studied period. It also shows the distribution across the country in its five geographic regions. Table 2.4 only shows the final sample, according to Table 2.2 in Methodology.

Table 2.4 – Regional distribution of single credit unions in Brazil from 2010 to 2018

Year	Total	Region				
		SE	S	NE	CW	N
2010	881	311	334	101	91	44
2011	874	310	336	96	89	43
2012	847	303	331	88	84	41
2013	822	293	323	84	82	40
2014	802	287	319	79	79	38
2016	782	277	311	81	77	36
2016	757	274	298	78	74	33
2017	711	264	275	69	70	33
2018	674	256	256	64	69	29

Source: by the author (2019)

Notes: Although this table is quite comprehensive it does not include 100% of the credit unions in Brazil. For more details on the sample please see the Subsection 3.2 in Methodology.
(SE) Southeast, (S) South, (NE) Northeast, (CW) Central-West, (N) North

As can be noticed, the regions Southeast and South have the majority of credit unions headquarters. The regions Northeast, Central-West and North have much fewer credit unions. This reflects in part the economy of the regions. In spite of that, more credit unions could help to improve the economy of less developed regions. A detailed view on the number of credit unions by the state in the last three years can be found in Table 2.5.

Table 2.5 – Sample of single credit unions by state in the last three years

State	**2016**	**2017**	**2018**
AC	4	4	3
AL	8	8	6
AM	4	4	2
AP	1	1	1
BA	30	27	26
CE	6	5	5
DF	13	12	11
ES	20	18	18
GO	33	32	32
MA	6	7	7
MG	151	149	148
MS	10	10	10
MT	18	16	16
PA	5	5	4
PB	11	9	8
PE	9	5	5
PI	2	2	2
PR	101	90	75
RJ	19	18	16
RN	4	4	3
RO	17	17	17
RR	1	1	1
RS	94	86	86
SC	103	99	95
SE	2	2	2
SP	84	79	74
TO	1	1	1
Total	757	711	674

Source: by the author (2019)
Note: this table does not include 100% of the credit unions in Brazil. For more details please see the Subsection 3.2 in Methodology

As Table 2.5 shows, the states with the most credit unions in the sample are: Minas Gerais, São Paulo, Santa Catarina, Paraná, and Rio Grande do Sul. It is relevant to highlight that the sample does not include all credit unions in Brazil, according to methodology, mainly

because capital-loan credit unions were not included. Due to that selection, Table 2.5 does not indicate the states necessarily in the same order of total credit unions. For example, the state of São Paulo has many capital-loan credit unions and would overcome Minas Gerais if they were included in the sample. Nevertheless, the table provides a good overview of the Brazilian credit union by states and the sample reflects the fact that most credit unions are located in the three states of the South region (Paraná, Santa Catarina, and Rio Grande do Sul), besides Minas Gerais and São Paulo in the Southeast region. The distribution fairly reflects aspects as population, number of municipalities, and economy of the states.

The data reveals the number of credit unions in Brazil have decreased from 2010 to 2018. The sample has an amount of 674 credit unions in the second semester of 2018, against 881 during the second semester of 2010. It means a reduction of 207 credit unions. An amount of 152 credit unions have been classified as failed individuals according to the procedures described in the methodology.

There are different kinds of credit unions according to the bond between members. Table 2.6 shows the evolution of the number of credit unions from 2010 to 2018 segregated by kind of bond. The number of credit unions has decreased in all kinds of bond except for free admission. Credit unions can change their bond. The table evidences a movement of change to free admission, which is now the kind of bond with more institutions, followed by employees and rural producers. Free admission, employees, and rural producers credit unions gather 80% of the credit unions at 2018.

Table 2.6 – Single credit unions in Brazil segregated by kind of bond from 2010 to 2018

Year	**Free admission**	**Rural**	**Employees**	**Enterprisers**	**Professional activity**	**Mixed bonds**
2010	204	288	137	50	132	70
2011	224	271	137	45	131	66
2012	251	244	135	41	130	46
2013	271	233	126	38	111	43
2014	285	220	118	37	98	44
2015	309	196	109	36	88	44
2016	330	139	105	58	80	45
2017	351	102	97	47	68	46
2018	368	82	87	42	65	30

Source: by the author (2019)
Note: this table does not include 100% of the credit unions in Brazil. For more details about the sample please see the Subsection 3.2 in Methodology

Another interesting exploratory analysis is the size. Brazilian credit unions are very diverse regarding their total assets, loans, liabilities, deposits, adjusted equity (equity plus revenues minus expenses) and operational revenues. Table 2.7 shows descriptive statistics of the Brazilian credit unions at the end of 2018. As can be noticed, there are very small and considerably big organizations. The smallest one had near a BRL 1.1 thousand in assets while the biggest one had BRL 5.8 billion. The median indicates 50% of credit unions had more than BRL 49 million in assets. It is also noticed that total assets are mainly composed of loans and funding mainly comes from deposits. Besides, adjusted equities were between BRL -7.5 million and BRL 1.5 billion.

Table 2.7 – Descriptive statistics of credit unions in Brazil at 2018 December

Variable (BRL Million)	**Min**	**Max**	**p5**	**p50**	**p95**	**Mean**	**SD**	**CV**
Total assets	0.00118	5819	1.985	49.01	682.1	162.2	349.7	2.155
Loans	0	2916	1.082	27.02	359.2	86.03	185.1	2.151
Deposits	0	3686	0.710	27.35	416.5	96.81	204.3	2.110
Adjusted Equity	-7.579	1509	0.372	8.297	116.5	27.81	67.02	2.410
Operational Revenues	0	490.4	0.306	5.066	77.39	17.21	35.69	2.074

Source: by the author (2019)

After the brief description of qualitative aspects of the studied subjects, the next exploratory analysis is on the dependent variable used to perform the model of risk assessment. Among 910 studied credit unions, 152 have been classified as failed. Table 2.8 shows the number of failed credit unions according to their last semester of balance sheets publication. It is not clear if there is an increasing tendency in the number of failed credit unions. However, there was a remarkable increase in the number of failures in three semesters between the first semester of 2016 and the first semester of 2017.

It is reasonable to believe that the macroeconomic scenario has impacted on the number of failures. The panel data logit enables to verify this issue. To control the impact of the sector and economic conjuncture on the risk of credit unions failure the following independent variables have been verified: general default rate by state, GDP and SELIC interest rate.

Figure 2.6 shows the evolution of the variables over time from 2010 to 2018, by half-year.

The figure shows the economic crisis in Brazil especially from 2015 to 2017 when the change of GDP had been negative and SELIC interest rate had raised to 14.25% yearly. It is also noticed an increase in the default rate by state in the critic period of crisis followed by a decrease

Table 2.8 – Number of failed credit unions in their last semester of balance sheet publication

Semester	**n**
Total	152
2010h2	2
2011h1	5
2011h2	10
2012h1	10
2012h2	7
2013h1	10
2013h2	7
2014h1	9
2014h2	6
2015h1	11
2015h2	5
2016h1	20
2016h2	15
2017h1	18
2017h2	4
2018h1	13

Source: by the author (2019)

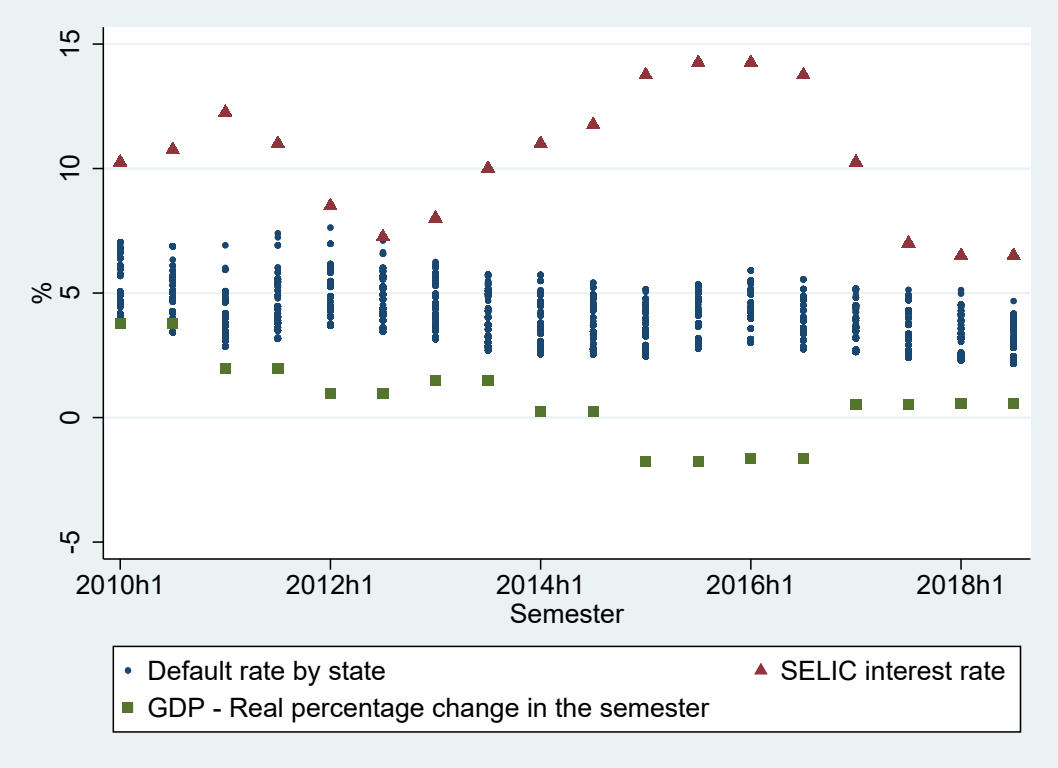
after that. The numbers suggest a connection between the number of failures increase (Table 2.8) and the economic crisis, which should be confirmed through the econometric model.

As reported in the Methodology, the PEARLS ratios are the main basis to assess the credit union risk. Some of the PEARLS ratios could not be calculated for this study due to unavailable information. IFData has data on delinquency after 2014 June. In consequence, ratios P2 and A1 have not been used to avoid too much missing data of them. Also, ratios P3, P4, P5, E4, R2, R4, R7, R8, R10, R12, R13, S4, and S10, have not been used due to lack of their required non-public data. They include COSIF accounts beyond level 3 (see Frame 2.2) or require non-public managerial data. Despite the impossibility to calculate all PEARLS ratios, the remaining ratios have been considered still capable to portray the economic and financial status of the credit unions. Most of them (33 of 48, recall Figure 2.5) have been calculated and covered all the six groups of PEARLS.

4.2 Model estimation and discussions

As reported in the Methodology, the PEARLS ratios are the main basis to asses credit union risk. Some of the PEARLS ratios could not be calculated for this study due to unavailable

Figure 2.6 – Risk assessment - sectorial and macroeconomic variables



Source: by the author (2019), data retrieved from BCB (2019c)
Note: SELIC interest rate is in nominal terms (without discounting inflation)

information. IFData has data on delinquency after 2014 June. In consequence, ratios P2 and A1 have not been used to avoid too much missing data of them. Also, ratios P3, P4, P5, E4, R2, R4, R7, R8, R10, R12, R13, S4, and S10, have not been used due to lack of their required non-public data. They include COSIF accounts beyond level 3 (see Frame 2.2) or require non-public managerial data.

Despite impossibility to calculate all PEARLS ratios, the remaining ratios still form a good basis to assess the economic and financial status of the credit unions. Most of them (33 of 48, recall Figure 2.5) have been calculated and covered all the six groups of PEARLS.

Following the methodology procedures, the next step was the selection of variables through the backward selection to obtain a relevant subset of variables. First, the "full" models were tested with the inclusion of all available PEARLS ratios and the additional variables seeking to select the best subset. Then, the backward selection took into account the significance and gradually eliminated variables below a significant level until achieving a model with only significant variables.

A preliminary elimination of not significant variables with many missing values was necessary. Two initial backward selections, for 1 and 2 years before failure, both returned results for 9,916 observations. The total number of observations is 14,413, but the command `stepwise` only takes observations with non-missing values of all variables specified. Thus we inspected variables with many missing values. We found the variables R3, R6, S3, and S6 had a large number of missing values (1,605; 3,469; 1,731; and 4,052 respectively). Besides, those four variables were not selected by the preliminary selection. They were then ignored and a new backward selection was done seeking to cover as many observations as possible (see A.1).

However, a multicollinearity problem for the independent variables was detected, as evidenced by the variance inflation factor (VIF) (see Table A.2 and Table A.3 in Appendix B). Previous experiences indicate that if VIF exceeds 5 or 10, it is a sign that related coefficients are poorly estimated because of multicollinearity (MONTGOMERY; PECK; VINING, 2006; GUJARATI, 2006). We set a limit of VIF=5 above which variables should be analyzed. To cope with multicollinearity through the elimination of correlated variables, four criteria were taken into account: VIF, correlation, significance for failure prediction, and concept behind each of the variables.

First, we have coped with multicollinearity in the model for 1 year before failure. Variables E5 and E9 presented the two highest VIF. They have a high correlation of (-0.96) (TABLE A.4, APPENDIX B). Both ratios are indicatives of financial leverage, as shown in Frames 2.6 and 2.7. E5 is deposits divided by total assets, and E9 is total equity divided by total assets. E5 indicates “third parts” capital and E9 indicates “own” capital. That explains their high negative correlation. While E5 was significant at 0.1% and E9 was significant at 1%, the positive sign of E5 A.1 makes more sense because more leveraged organizations take a greater risk a priori. Therefore only E5 was chosen to stay in the model.

Variables E1 and E2 presented also presented VIFs above 5. They are highly correlated (TABLE A.4, APPENDIX B). E1 and E2 respectively refer to net loans and liquid investment, both divided by total assets. Naturally, they have a highly negative correlation. Those institutions with a high (low) proportion of net loans volume at the same time have a low (high) proportion of liquid investments. Thus, in a certain way, the variables measure pretty much the same thing. Therefore, the exclusion of one of them will not adversely affect the model. As both are significant at 0.1% the remaining criterion the remaining criterion to exclusion was conceptual.

E1 was chosen to stay in the model to detriment of E2 because E1 refers to the main asset of credit unions, which is loans.

E6 is the next variable to be analyzed. It presented a VIF above the set limit. It refers to external credit about total assets and is significant at 0.1%. That is, it indicates the proportion of funding from external sources, which are usually riskier and more expensive than internal sources (i.e. members' deposits and shares). Not surprisingly, E6's coefficient is positive and significant, which denotes it increases the probability of failure. Besides, it is moderately correlated to E1, E2, E9. As the last two variables were previously excluded after analysis, a new VIF statistic was done after the exclusions. In the absence of E2 and E9, the ratio E6 is no longer a problem. Therefore, the variable was preserved, based on its significance and conceptual importance.

The next two variables whose removing from the model should be considered are P1 and A5, as they presented VIFs above the set limit and are highly correlated. According to Richardson (2009), P1 is one of the most important ratios since it measures the amount of allowance for loan losses divided by the gross loan portfolio. A5 is equally important because it indicates the quality of loan portfolio (2.8). The choice between P1 and A5 should be done with special caution. They are highly correlated, and both have conceptual relevance and statistic significance.

Based on the extreme similarity of P1 and A5, an extra analysis was done with univariate logistic regression (robust POLS) to assess how each of the ratios could individually explain the probability of failure. Besides, P1 and A5 were separately included in regression with the remaining variables to verify their contribution in the model. Both univariate and multivariate regressions (TABLES A.5 and A.6, APPENDIX B) evidence a slight advantage for A5 compared to P1 regarding many criteria (Pseudo R^2, AIC, BIC, log-likelihood, and area under the ROC curve). Therefore, A5 is preferred for P1.

The final robust POLS logit model for 1 year before failure assumed its final form. Having dropped the variables P1, E2 and E9 to treat multicollinearity, the variables E1 and L3 became not significant. They were then also dropped without worsening the model. After that, the PEARLS variables included in the model for 1 year before the event are: P6, E5, E6, A5, R9, S7, and S11. The additional significant variables are the log of total assets, a dummy for mixed admission criteria, age(quartile 3), and GDP real percentage change.

Similar procedures were done to cope with multicollinearity in the model for 2 years before failure. In summary, A5 was preferred to P1 and, R9 was preferred to E8 and, L2 and

L3 became not significant. After exclusions, the PEARLS variables included in the model for 2 years before the event are: P6, E5, E6, A2, A5, R9, S7, S9. The additional significant variables are the log of total assets, a dummy for mixed admission criteria, age(quartile 2 and quartile 3), and GDP real percentage change. As can be noticed the models for 1 year and 2 years are very similar.

The selected models (1 year and 2 years) both formed a sample with 13,500 observations (93.7% of the total). Table 2.9 shows the results of the selection for 1 year and 2 years before the failure event. In general, the coefficients are very similar both regarding their signs and values. The model for 2 years before failure includes more variables. It also has a greater pseudo R^2. However, the model for 1 year before failure is preferable given the Akaike's Information Criterion (AIC) and Bayesian Information Criterion (BIC). Also, log-likelihood also suggests the model for 1 year before the event as a better choice. Moreover, according to the goodness-of-fit Hosmer-Lemeshow test, only the model for 1 year before failure matches the expected event in subgroups of the model population. Further, the area under the ROC curve is larger in the model for 1 year before failure.

After comparisons the model for 1 year before failure is the one to be used. It is expected that a model assessing the risk near the event would return better results. From this point, subsequent analysis refers only to the chosen option. Figure 2.7 shows the area under the ROC curve. A large area under the curve (i.e. near 1) means the model has a good predictive ability. A model with null predictive ability would present the ROC curve as a 45-degree line (BRESSAN, 2009). In Figure 2.7, the curve itself and the value under it equal 0.9022 indicate the model has a good predictive ability.

The overall rate of classification is estimated to be 97.8%, with 99,74% of the non-failed individuals correctly classified (specificity), and only 11.74% of the failed individuals (sensitivity) correctly classified (TABLE A.2, APPENDIX B). Classification favors the larger group (STATACORP, 2017b), which is evident here. In our case, the smaller group corresponds to 2,25% of the total observations. By default, the classification uses a cutoff of 0.5, but it can vary to obtain a more balanced classification. In our case, the point where cutoff equalizes specificity and sensitivity is around 0.0225, based on the proportion between larger and smaller groups. It can be confirmed in Figure 2.8, which shows the intersection between specificity and sensitivity curves.

Table 2.9 – POLS logit with selected variables for 1 year and 2 years before failure

Variable	Failed 1 year		Failed 2 years	
	Coefficient	**Std. err.**	**Coefficient**	**Std. err.**
P6	−2.316	(0.500)	-2.768^{***}	(0.506)
E5	-0.446^{***}	(0.051)	-0.538^{***}	(0.061)
E6	1.820^{***}	(0.421)	1.800^{***}	(0.435)
A2			1.694^{*}	(0.821)
A5	3.499^{***}	(0.641)	4.277^{***}	(0.756)
R9	-4.402^{***}	(1.309)	-7.007^{***}	(1.617)
S7	-2.618^{*}	(1.178)	-2.506^{***}	(0.692)
S9			-0.106^{***}	(0.029)
S11	-0.937^{*}	(0.442)		
Log of total assets	-0.558^{***}	(0.059)	-0.633^{***}	(0.062)
Mixed admission criteria	1.783^{***}	(0.252)	1.537^{***}	(0.264)
Age quartile 2			0.553^{*}	(0.228)
Age quartile 3	0.571^{*}	(0.237)	0.790^{**}	(0.278)
GDP - real % change	-0.387^{***}	(0.051)	-0.380^{***}	(0.051)
Constant	7.616^{***}	(1.082)	9.850^{***}	(1.103)
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$				
Observations		13500		13500
Pseudo R^2		0.287		0.304
AIC		2065.7		3364.9
BIC		2155.8		3470.0
Log-likelihood		-1020.9		-1668.4
Hosmer-Lemeshow Prob>χ^2		0.0553		0.0240
Area under the ROC curve		0.9022		0.8976

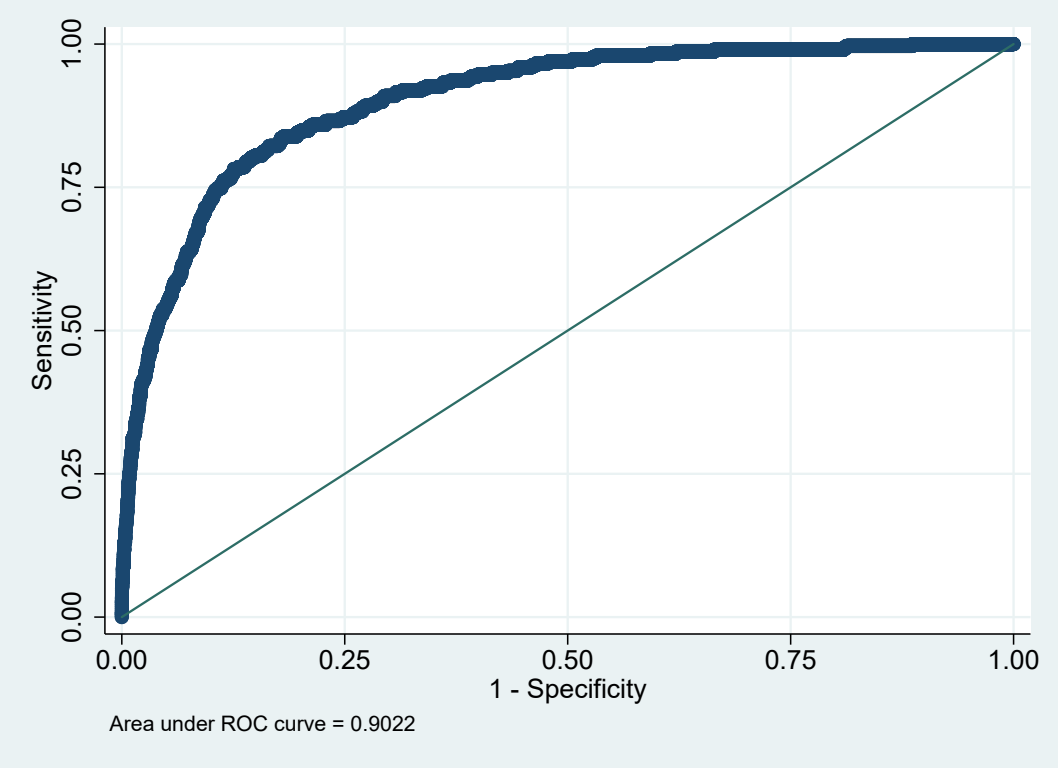
Source: by the author (2019)

Note: P6: Solvency; E5: Deposits/Total assets; E6: External credits/Total assets; A2: Non-earnings assets/Total assets; A5: Loans classified between level D and level H/Total classified loans portfolio; R9: Administrative expenses/Average total assets; S7: Growth in member share capital; S9: Growth in equity; S11: Growth in total assets.

The modified cutoff resulted in a lower percentage of correctly classified individuals in total, but it provided a more balanced classification compared to the default cutoff (0.5). Based on the proportion between failed and non-failed individuals and the support of Figure 2.8 we set a cutoff of 0.0225 and obtained a balanced result. Table 2.10 shows that considering the changed cutoff the model has correctly classified 83.13% of the individuals, with 82.21% of failed individuals correctly classified, and 83.15% of non-failed ones correctly classified.

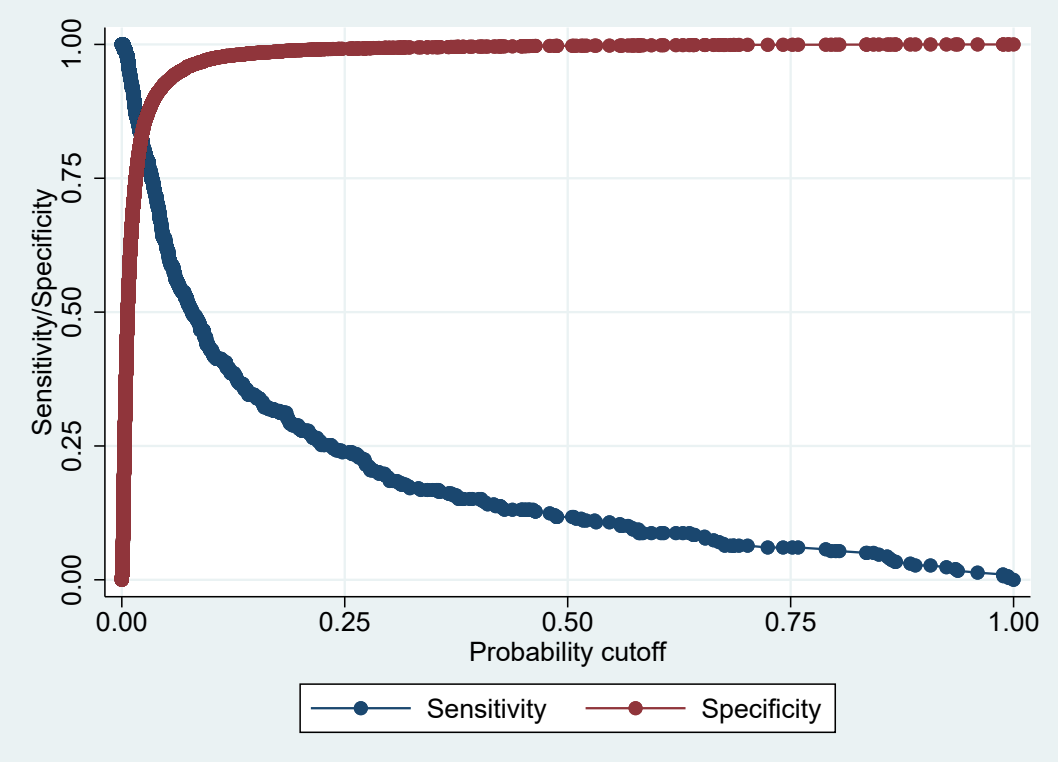
Having estimated the POLS logit model with robust standard errors, the next step is to verify if panel data logistic regression would overcome it by accounting for unobserved

Figure 2.7 – Area under the ROC curve - robust POLS logit 1 year before failure



Source: by the author (2019)

Figure 2.8 – Sensitivity and specificity versus probability cutoff



Source: by the author (2019)

Table 2.10 – Logit classification - cutoff = 0.0225

Model	**True**		**Correctly**
	Failed	**Non-failed**	**classified**
Failed	245	2224	82.21%
Non-failed	53	10978	83.15%
Total	298	13202	83.13%

Source: by the author (2019)
Note: For more details see the Figure A.3, Appendix B, with the classification output

heterogeneity at the unit level (recall subsection 3.3 in Methodology). Table 2.11 shows different estimations with robust pooled regression (POLS), population-average (PA), fixed effects (FE) and random effects (RE) models. The regressor "lnsig2u" refers to the panel-level variance component in RE model.

Table 2.11 – Comparisons between logistic regressions - POLS, PA, FE, and RE

	POLS	PA	FE	RE
P6	-2.31^{***}	-2.23^{***}	-7.72^{***}	-4.66^{***}
E5	-0.45^{***}	-0.45^{***}	-0.21	-0.71^{***}
E6	1.82^{***}	1.85^{***}	0.01	2.58^{***}
A5	3.50^{***}	3.30^{***}	3.32^{***}	5.14^{***}
R9	-4.40^{***}	-3.69^{**}	-0.17	-4.80^{**}
S7	-2.62^{*}	-2.24^{*}	-0.78	-2.21^{**}
S11	-0.94^{*}	-0.64	-0.41	-0.08
Log of total assets	-0.56^{***}	-0.54^{***}	1.99^{***}	-0.95^{***}
Mixed bonds	1.78^{***}	1.64^{***}	1.81^{***}	2.65^{***}
Age (quartile 3)	0.57^{*}	0.56^{*}	-1.22	0.58
GDP real % change	-0.39^{***}	-0.41^{***}	-0.80^{***}	-0.76^{***}
Constant	7.62^{***}	7.39^{***}		14.11^{***}
lnsig2u				2.03
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$				
Observations	13500	13500	1441	13500
Pseudo R^2	0.287		0.399	
AIC	2065.7		634.6	1810.2
BIC	2155.8		692.6	1907.8
Log-likelihood	-1020.9		-306.3	-892.1

Source: by the author (2019)
Note: P6: Solvency; E5: Deposits/Total assets; E6: External credits/Total assets; A5: Loans classified between level D and level H/Total classified loans portfolio; R9: Administrative expenses/Average total assets; S7: Growth in member share capital; S11: Growth in total assets.

Table 2.11 shows that the coefficients are very similar, especially between POLS and PA. The sign of coefficients is the same for all models, except for two variables (log of total assets and mixed bond) in the FE model. The decision of which model should be chosen was done based on the metrics below the coefficients. Note that POLS, PA, and RE formed a sample of 13500 observations. The FE model, in turn, is based only on 1441 observations. That reduction is because the fixed-effect model does not consider variables with time-invariant values, notably, dummies. In this case, it includes the dependent variable. As a consequence, the model is restricted to around 10% of observations compared to the other models. Because of this big restriction, the model was discarded.

Comparative metrics are not available for PA, whose results are very similar to POLS. The decision is then between models POLS and RE. The sign of their coefficients is the same although they differ in values. The statistics AIC, BIC, and log-likelihood indicate the random-effects model is preferred to pool. The Wald test indicates the parameters are not simultaneously equal zero. And the most determinant, the LR test (recall Subsection 3.4 in Methodology) returned a p-value < 0.001, which means the proportion of panel-level variance component (rho) contributes to the total variance. Consequently, the RE differs from the POLS model. Therefore, the random-effects model is preferable.

A final selection was done in the model based on significance and signs of variables. Note the RE model in Table 2.11 has two insignificant variables: S11 and Age (quartile 3). In addition, R9 has a controversial negative sign, indicating that higher administrative expenses imply less probability of failure. It is moderately correlated to the log of total assets. While the log of assets is a proxy of size, R9 indicates scale. The lower the R9 is, the better. Therefore its sign should be positive, indicating the higher administrative expenses would increase the probability of failure. Simulations evidenced that log of total assets and R9 interfere in parameters of each other. A simulation with a univariate regression with only R9 returned a positive sign, confirming expectation and its controversial influence in the model. Hence, R9 was removed.

It has been observed that the variables S11, Age(quartile 3), and R9 do not add to the model. A new estimation has been performed without them to verify their contribution (see Table A.7 in Appendix B. For example, in POLS model, the area under the ROC curve is nearly the same, and the goodness-of-fit test Hosmer-Lemeshow presents better result without the variables. Moreover, for the RE model, AIC, BIC, and log-likelihood are very similar with and without the variables. Therefore, they were removed. Finally, the model for risk assessment assumed

its definitive form for this study. In summary, it is a random-effects panel data logistic model to predict the risk of failure considering one year before the event. The dependent variable is a binary variable equal 1 if the credit unions have failed and 0 otherwise. The explanatory variables are the PEARLS ratios P6, E5, E6, A5, S7, and S11 (as detailed in the Subsection 3.6) besides the variables log of total assets, mixed bonds, and GDP real % change. Equation (2.14) specifies the final model:

$$\begin{aligned} ln\left(\frac{P_{it}}{1-P_{it}}\right) =& \beta_0 + \beta_1 P6_{it} + \beta_2 E5_{it} + \beta_3 E6_{it} + \beta_4 A5_{it} + \beta_5 R9x_{it} + \beta_6 S7_{it} + \\ &+ \beta_7 logta_{it} + \beta_8 bondm_{it} + \beta_9 gdpcent_{it} + \alpha_i + \varepsilon_{it} \end{aligned} \tag{2.14}$$

Table 2.12 details the results of the final model:

Table 2.12 – Final model for risk of failure estimation - random-effects logistic regression

Variable	**Coefficient**	**Std-err (1)**	**p-value**
P6	-4.090^{***}	1.223	0.001
E5	-1.065^{**}	0.405	0.009
E6	2.688^{***}	0.810	0.001
A5	5.280^{***}	1.131	0.000
S7	-2.275^{*}	1.074	0.034
Log of total assets	-0.820^{***}	0.126	0.000
Mixed bonds	2.622^{***}	0.551	0.000
GDP real % change	-0.752^{***}	0.08	0.000
Constant	11.168^{***}	1.944	0.000
lnsig2u	2.117^{***}	0.189	0.000
Observations	13,500	Groups	907
Observation per group (average)	14.9		
Integration points	30(2)		
Wald χ^2	141.16	p-value	0.0000
Log likelihood	-898.86		

Source: by the author (2019)
Note: P6: Solvency; E5: Deposits/Total assets; E6: External credits/Total assets; A5: Loans classified between level D and level H/Total classified loans portfolio; S7: Growth in member share capital.
(1) Cluster-robust standard errors
(2) Results of quadrature check are in Table A.8, in Appendix B

Positive (negative) coefficients in Table 2.12 indicates the variable increases (decreases) probability of failure. Not surprisingly, P6 harms probability of failure, which means the higher

is the solvency the lower is the probability of failure. As detailed in Frame 2.4, Subsection 3.6, P6 is a ratio that measures the degree of protection, on the size of assets, for members' deposits and shares. The indicator was also significant to explain failure in the study performed by Araujo (2011).

The variables E5 and E6 are both indicators of liabilities structure. The former has a negative sign and the latter has a positive sign. While E5 measures the number of deposits concerning total assets, E6 measures the amount of external credit concerning total assets. Despite both concern to financial structure in liabilities they presented low correlation (TABLE A.4, APPENDIX B), and did not cause multicollinearity problems, as previously analyzed. Nonetheless, their opposite signs are compatible with one should expect. E5 parameter is negative, which means the higher is the level of deposits concerning assets, the lower is the probability of failure. A great amount of deposits means the trust of members in the institution. Besides, it provides funding with relatively low cost if compared to other sources, like loans from other financial institutions.

In other studies, the proportion of deposits concerning total assets was also verified to explain the probability of credit unions failure. The study of Bressan et al. (2011a) with credit unions from Minas Gerais State indicates a significant positive sign. In turn, a more comprehensive study of Bressan et al. (2011b) with Brazilian credit unions does not select the indicator in the adopted selection methodology using BIC. Similarly, the study of Araujo (2011) has not preserved the indicator in the final model, which was selected through the stepwise procedure, despite its significance. Differently, the study developed by Carvalho et al. (2015) evidenced, in many tested models, that deposits diminish the probability of failure of credit unions in Brazil. Therefore, the findings in this study confirm the evidence provided by Carvalho et al. (2015) regarding the influence of deposits on credit unions success.

The results for deposits are related to the funding structure. Unlike deposits, external credit provides a more expensive source of credit. Moreover, high levels of external credit might indicate the need to draw on funding from sources other than members' resources. It may also be associated with difficulties to face deposits withdraw or other operational difficulties such as low or negative profitability and loans default, or even a riskier or less conservative behavior of managers. Consequently, from the exposed reasons, it is reasonable to state that higher levels of external credit indicate more risk, which is compatible with the positive sign of E6.

A5 is the slope coefficient with the highest value, denoting the strongest impact in the probability of failure. A5 is an indicator of asset quality. It measures the portion of loans at risk levels from D to H (CMN, 1999b). Loans equal to or above level D present high risk (recall Table 2.3. Then, the lower the A5, the better. Also recall A5 is highly correlated to P1 (TABLE A.4, APPENDIX B), which was removed from the model just due to multicollinearity and indicates a high level of allowances for loans losses because of low quality. High values of A5 indicate high risk, which explains its positive sign with a high value.

The indicator measuring the proportion of operations from risk D to H was also tested in other studies (e.g. (BRESSAN et al., 2011a,b; GOZER et al., 2014a)), but none of them has selected it in the final model, likely due differences in selection methodology. However, a very similar indicator was observed to be significant to explain the probability of failure. For example, Bressan, Bressan, and Silva Júnior (2015) and Gozer et al. (2014a,b) evidence that P1 (highly correlated to A5), positively impacts the probability of failure. Therefore, at least three studies using a correlated indicator but different statistical modeling found similar evidence regarding the impact of loans quality to risk. It is strongly evidenced that the lower the quality of loans, the higher the risk. Therefore, from the pieces of evidence in this and previous studies, it can be concluded that loans quality is central to credit unions survival.

S7 measures the growth in members' share capital. The negative sign of the coefficient indicates that the growth in members' share capital decreases the probability of failure. Members' capital is the cheapest and most stable source of funding for credit unions. It is part of equity, and then is an internal source of funds. It indicates the growth of membership through the entrance of new members, growth of old membership's capital, or even distribution of surplus (net income) to capital. Consequently, it indicates good financial situation and trust of members in the institutions, signalizing credibility, and good management. On the other hand, a decrease in S7 indicates the withdrawal of capital (with or without leaving of members) or even covering of losses, which denotes bad financial situation. In Brazil, other researches on credit unions failure using Logit (BRESSAN et al., 2011a,b; CARVALHO et al., 2015; GOZER et al., 2014a,b) have not selected the indicator S7 among final explanatory variables. Therefore, more research investigating the impact of the indicator would be welcome to confront the results in this study.

Table 2.12 shows that variables other than PEARLS ratios also contribute to explain the probability of credit unions' failure. Log of total assets, mixed bonds, and GDP real % change were the selected additional variables. Log of total assets is a proxy of size. Its negative

significant parameter indicates big credit unions have been less likely to fail. On the contrary, small credit unions have a low scale and may have difficulties to generate enough revenues to cover their expenses. Therefore, small size is associated with a high probability of failing. This result agrees with previous studies that indicate the influence of size on credit unions risk (ELY, 2014; GODDARD; MCKILLOP; WILSON, 2014; PILLE; PARADI, 2002).

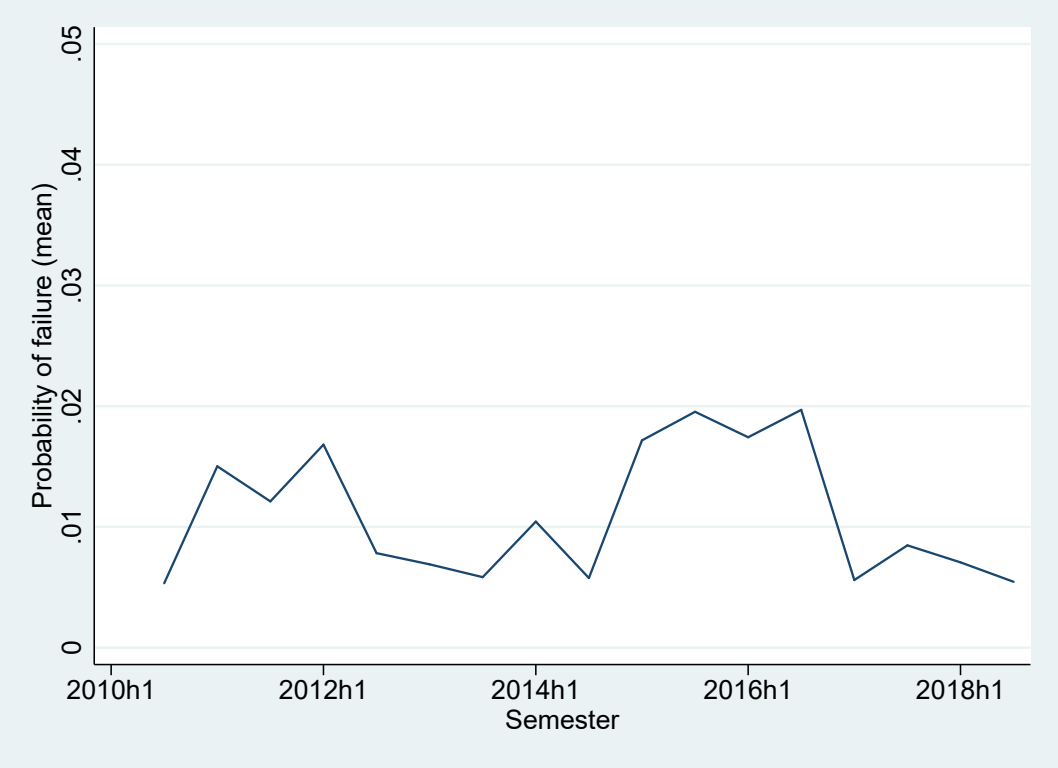
Mixed bonds have a positive sign, which means credit unions in this category have more chance to fail. This is in line with previous studies (ELY, 2014; FRAME; KARELS; MCCLATCHEY, 2003; FREITAS; CASTRO AMARAL; BRAGA, 2008) showing that when membership is broader, the risk is higher. Credit unions classified as mixed bond allow the entrance of different types of members from a combination of different economic activities. Their interest is not necessarily aligned and this kind of mixed bond may increase the chance of conflicts, with a consequence to risk. Other kinds of bond, as rural, professionals, employees, entrepreneurs, did not evidence additional risk.

Finally, the impact of macroeconomic conjuncture on credit unions risk was captured by the variable GDP real % change. Indeed, Brazil has passed by a strong economic crisis, whose apex was around 2015 and 2016, as Figure 2.6 shows. In that period, the SELIC interest rate was high, default rates increased and GDP decreased. Not coincidentally, 2016 was the year with most credit unions failures, as exposed in Table 2.8. The panel data logistic regression allowed to verify the impact of GDP, which is a time-variant variable, on credit unions operations. The econometric model confirmed that positive (negative) change in GDP decreases (increases) probability of failures. This evidence corroborates the study of Cordeiro et al. (2018), which demonstrates that the economic recession in 2015 and 2016 negatively impacted the performance of Brazilian credit unions.

Having fitted and analyzed model results, it was possible to perform an estimation of failure probability. The mean of the probability of failure for all studied credit unions from 2010 to 2018 was 1.10%. Figure 2.9 shows how the risk of failure has varied over time.

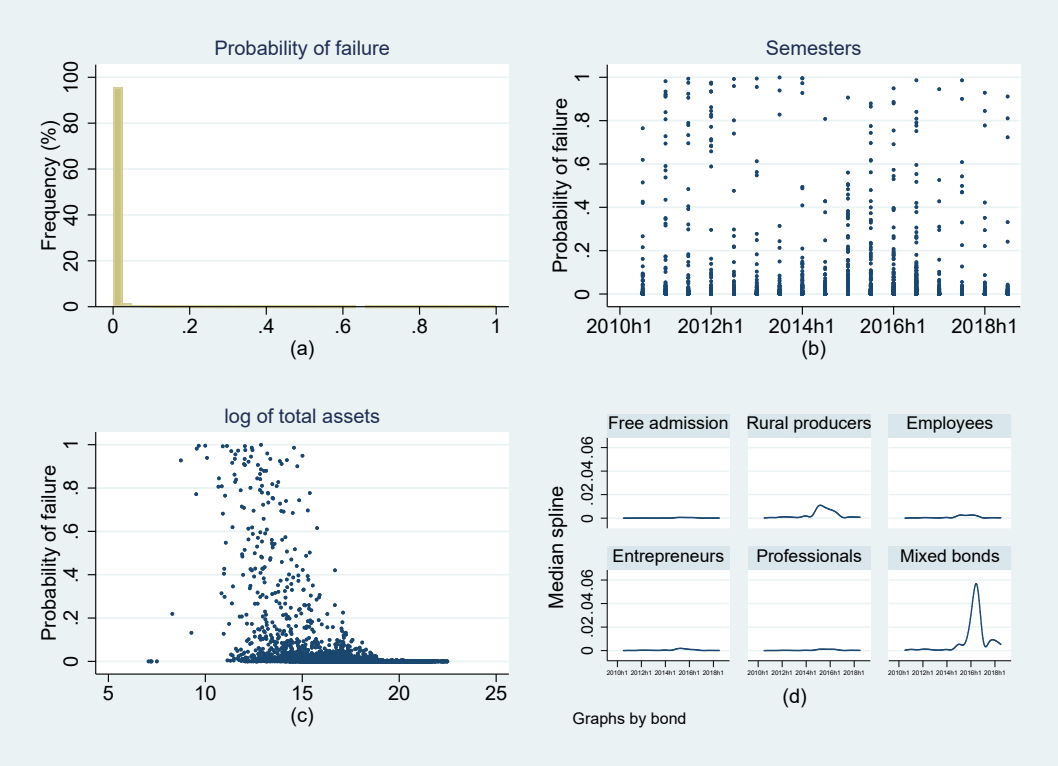
From Figure 2.9 it is possible to notice that the mean of the probability of failure increased to near 2% in 2015 and 2016 and posteriorly stayed below 1%. The evolution is in line with the number of failed credit unions over time and macroeconomic conjuncture, as exposed above. The mean of the probability of failure can be considered low. But a more detailed analysis reveals some credit unions with a high probability of failure, although most of them are at low risk. Figure 2.10 provides more detailed views of the credit unions' probability of failure.

Figure 2.9 – Evolution of probability of credit unions failure from 2010 to 2018 (mean)



Source: by the author (2019)

Figure 2.10 – Different views of credit unions' probability of failure from 2010 to 2018



Source: by the author (2019)

Figure 2.10 (a) is a frequency histogram of the probability of failure in the whole period from 2010 to 2018. The figure shows that most credit unions (around 95%) have a low probability of failure. A more detailed view of the distribution of probabilities is exposed in Figure 2.10 (b). The figure shows that, although most credit unions are at low risk, there are some of them with a high probability of failure (e.g. above 40%). For example, both in the first and the second semesters of 2018 there are three credit unions with a probability of failure higher than 60%. Figure 2.10 (b) also evidences the number of credit unions with a probability of failure higher than 20%, or even 40%, increased in 2015 and 2016.

The probability of failure can also be analyzed from different points of view regarding the characteristics of credit unions. For example, Figure 2.10 (c) reveals how the size, measured by the log of total assets, influences risk. It can be noticed that, in general, the higher the size, the lower the risk. Although there are small credit unions with a low probability of failure, they tend to be riskier than the big ones. Indeed, Figure 2.10 (c) shows no highly risky credit unions with a log of total assets higher than 20, that is, higher than 485 million BRL. Another possible analysis is on kind of bond since the econometric model revealed mixed bond admission criteria is statistically significant. Figure 2.10 (d) shows the evolution in the probability of failure by kind of bond. Mixed bond credit unions have a strong increase in their average risk in 2015 and 2016, while other kinds of credit unions did not observe the same increase. Combination of credit unions with mixed bonds may affect the risk due to members with different backgrounds. Figure 2.10 (d) evidence that the risk of rural producers credit unions slightly increased in the same period, although it was not enough to be statistically significant. The little momentous increase of rural credit unions risk may be related to changes in commodities prices, but further investigation would be necessary to check this possibility.

The probability of failure calculated in this subsection will be used to compose a discount rate in the next chapter. Each credit union has a vector of calculated probabilities over time, which defines the evolution of its risk. Individual figures are not shown here not only because of the large amount of data, but also to avoid disclosing individual risks. Nonetheless, they correspond to what Figure 2.10 displays.[5]

[5] More details on failure distribution can be found in Table A.9, Appendix B

5 CONCLUSION

This chapter has provided an estimation of the risk of credit unions from 2010 to 2018. The calculation will be employed in the model of value creation measurement in the next chapter. To estimate the individual risk over time, logistic regression has been employed in a panel dataset. The response variable is a binary dummy indicating if the credit union will be failed or not within one year. The explanatory variables have been mainly based on PEARLS ratios system, along with additional qualitative and macroeconomic variables, assuming the hypothesis that they can explain credit unions probability of failure.

After many simulations and specifications tests, the following PEARLS ratios were significant and selected to explain probability of failure: P6 (solvency), E5 (deposits in relation to total assets), E6 (external credit in relation to total assets), A5 (quality of loans), and S7 (growth in members' share capital). Also, the following variables were significant: size (measured by the log of total assets), mixed bonds, and real % change in GDP. It is worth to recall that other variables were also significant but were not selected mainly because of multicollinearity problems. Based on the methodology, procedures were done to select and qualify a chosen model that supported the calculation of the probability of failure.

The impact of PEARLS ratios on risk is compatible with their concept. For example, higher levels of solvency decrease the probability of failure. Further, high levels of deposits concerning total assets contribute to diminishing risk, unlike external credit, which increases risk. Moreover, as expected, the quality of loans is a crucial indicator to assess credit unions risk. Besides, positive growth in members' capital decreases the chances to fail, which denotes the trust of members on the institution signalize a good economic-financial position.

The additional variables added to the risk assessment. Size, here measured by the log of total assets, play an important role do diminish the probability of failure. Very small credit unions, for example with the log of assets lower than 15(equivalent to 3.2 million BRL), in general, have the highest probability to fail. On the other hand, large credit unions (e.g. more than 500 million BRL of assets) present a very low risk. Besides small-sized, credit unions categorized as mixed bond present a higher risk than other categories, which may be related to the conflict between different groups of members.

Finally, the econometric model indicates that the country's macroeconomics influences the probability of failure. In summary, the higher the GDP growth lower is the risk for credit

unions. Indeed, there was an increase in failures in 2015 and 2016, years with a marked economic crisis.

The statistic confirmed what previous descriptive analysis had indicated the influence of GDP growth on the occurrence of failed credit unions.

Overall, credit unions are at low risk, although some of them present a high risk, which is in line with the occurrence of failures during the studied period. The mean of the probability of credit unions failure increased to near 2% during the crisis, but at the end of 2018 decreased to around 0.05%. Off course, this does not mean all credit unions have a low risk. There were still few credit unions at high risk at the end of 2018, as it has been demonstrated. Despite that, the general financial position of the studied organizations in the sector can be considered favorable regarding the risk of failure.

The chapter aimed to provide a risk assessment of each studied credit union over time. Having calculated individual risk from 2010 to 2018, in the next chapter it will be possible to include it in a discount rate to evaluate in which extend credit unions have created (or not) value. Beyond its main objective, we believe the results in this chapter may help decision-makers to undertake policies to prevent credit union failure because. The studied variables exploring financial-economic position, along with qualitative and macroeconomic factors, help to confirm or clarify the causes of failures. In this sense, the study also contributes to the literature on risk evaluation. The chapter may be useful for researchers interested in similar procedures to evaluate the risk of credit unions or even other financial institutions.

We must recognize some limitations in this chapter. Maybe the principal limitation is the model cannot be generalized since it is restricted to the sample in this study. Also, the model cannot be used to predict if the credit union will fail or not, this is not the objective. It simply provides a probability of failure, given the explanatory variables, to be used in a value creation model that takes risk into account. In this sense, although consistent methodological procedures were undertaken to achieve a well-fitted model, it cannot be considered the unique possible valid model, even within the scope of this study.

As the reader could note, some decisions had to be taken based on clear criteria. The decisions implied the exclusion of some significant variables, that could be included in different combinations of models. Therefore, other valid models could also work. Consequently, although the results of the model were satisfactory, further studies on credit unions risk are strongly recommended to test different variables and improve accuracy.

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CHAPTER 3 MEASURING CREDIT UNIONS VALUE CREATION

RESUMO

Este capítulo aborda três objetivos específicos da tese. Apresenta uma revisão teórica sobre como as cooperativas de crédito criam valor e a forma adequada de sua mensuração. Além disso, propõe uma forma de mensuração adaptada às especificidades do Brasil. Posteriormente implementa a mensuração da criação de valor das cooperativas de crédito. De acordo com a revisão de literatura as cooperativas de crédito criam valor aos seus membros essencialmente por meio da oferta de operações de crédito e depósitos com taxas de juros mais atrativas que nas demais opções existentes no mercado. A mensuração da criação de valor é feita a partir do cálculo dos benefícios obtidos com a diferença de taxas de juros em relação ao mercado. O modelo de mensuração utilizado é baseado no fluxo de benefícios descontados por uma taxa que leva em consideração a preferência temporal ponderada pelo risco de cada cooperativa. Os resultados apontam que de forma geral as cooperativas têm gerado valor aos seus membros associados, especialmente os tomadores de crédito.

Palavras-chave: Cooperativas de Crédito. Criação de Valor. Mensuração. Função objetivo. Risco

ABSTRACT

This chapter approaches three specific objectives of the thesis. It presents a theoretical review of how credit unions create value and a suitable way of measuring it. Besides, it proposes a way of measurement adapted to Brazil's particularities. Subsequently, it implements a measurement of credit unions value creation. According to the literature review, the credit unions create value to their members essentially by providing loans and deposits with better interest rates than those of other market options. The value creation measurement comes from the benefits obtained with the difference of interest rates plus eventual surplus in the period. The model of measurement has been based on the cash flow of benefits discounted by a rate that takes into account the time preference weighted by the risk of each credit union. The findings evidence that overall credit unions have been creating value to their members, especially to borrowers.

Keywords: Credit Unions. Value Creation. Valuation. Objective function. Risk

1 INTRODUCTION

This chapter approaches three specific objectives, as explained in the thesis overview (section 5) in Chapter 1. That is, it investigates how credit unions create value, how to properly measure credit unions value creation in the context of Brazil and to which extent Brazilian credit unions have been creating value.

Because of their nature, credit unions have inherent characteristics that influence their potential to create value. According to Fried, Lovell, and Eeckaut (1993), the not-for-profit cooperative structure of credit unions gives them certain advantages but also certain disadvantages. On the one hand, their cooperative nature restricts their size, which limits their ability to gain benefits of scale and scope economies. On the other hand, their not-for-profit status, as well as their ability to operate only with their members, primes them a tax advantage, which affords an offsetting cost reduction.

Indeed, these advantages and disadvantages can be observed up to date. Although credit unions have been growing, they still have limited size if compared to big financial institutions, which might limit their capacity to reduce cost via scale and scope economies. However, because their status of cooperatives they have some important prerogatives. In Brazil, they have two important advantages related to tax and compulsory deposits. Their operations with members, called cooperative acts, are exempt from tax. Moreover, unlike banks, the obligation of compulsory deposits in Central Bank is not applicable to credit unions.

This kind of differences in credit unions operations compared to banks is good reasons to investigate their capacity to create value. As long as they have some inherent advantages and disadvantages, issues about how those characteristics may influence their potential to benefits their members become intriguing sources of research inquiry. This chapter will address some aspects of credit union value creation hoping to contribute to this field.

The chapter will be organized in five sections including this introduction. In section 2 the first specific objective is treated. It presents the literature review about value creation and credit unions particularities. It also addresses the classic studies that show the foundations of how credit unions create value.

In section 3.3 the perspectives derived from the literature review are then used to develop an empirical model of measurement, which will have two variants suitable for Brazil. The section corresponds to the second specific objective, that is, to investigate how to properly measure credit unions value creation.

Since models have been developed, they will be empirically implemented and results will be presented in section 4, which will present the findings. The value creation of credit unions in Brazil will be measured. Finally, section 5 will provide conclusions. The value creation measurement of this chapter will be the base of the dependent variable in Chapter 4.

2 LITERATURE REVIEW

In this section, the literature review about credit unions value creation is presented. First, a brief review of value creation is provided. Subsequently, a second subsection summarizes the foundations on the nature of credit unions. Finally, another subsection shows the particularities about the value creation by studied organizations.

2.1 Value

Before studying how credit unions create value and how to measure it properly, it is necessary to do a brief review of value and value creation to establish a basic platform to sustain this work. According to Porter and Kramer (2011), value benefits relative to costs. This may look simple, but the concept of value may have many ramifications. Bowman and Ambrosini (2000) distinguish between "use value" and "exchange value". The use-value is subjective. It refers to the customers' perceptions of the product. That is, it is subject to consumers' judgments and their satisfaction with the product. It is related to specific qualities of the product that are perceived by customers about their needs. The taste and texture of an apple and the style and potency of a car are some examples. These qualities are subjective and depend on the judgment of each customer. The exchange value, in turn, is objective. It refers to the monetary amount paid when the exchange of the good happens, that is, it is the price, the amount paid by the buyer to the seller for the perceived use-value. The exchange, or sale, occurs when the customer realizes that the product provides more surplus than other achievable alternatives (BOWMAN; AMBROSINI, 2000). In this work, the objective aspects of value measurement will be treated. Then, it is closer to the exchange value than perceived use-value.

In the finance literature, some key concepts are applied: book value, market value, fair value, and intrinsic value. Book value refers to the accounting equity value of a firm. It can be easily obtained from the balance sheet in companies' financial statements or databases that gather them. It is largely used as an efficiency or solvency analysis component. It is composed of the investment of shareholders and retained profits. Even though it does not come only from

objective measurements but also from subjective accruals, it is a direct and consistent figure, understood as the net asset after deducting the liabilities. Although it does not reflect exactly the market or intrinsic value of the firm, it is strongly related to them and is often found in accounting or financial studies and analysis, among which to indicate if the market value is under or over evaluated or even to do performance assessments (BARTH; BEAVER; LANDSMAN, 1998; BEAVER; RYAN, 2005; COLLINS; PINCUS; XIE, 1999; DUTTA; REICHELSTEIN, 2005; HILLIER; HODGSON; NGOLE, 2016; LAUX; LEUZ, 2009).

The market value of the firm is obtained by the current share prices times the number of shares. It is how much the investors are valuing the company. Thus, it is related to exchange value. The market value is usually the reference in mergers and acquisitions to determine the price by which the target will be taken over. It is subject to momentary variations, that is, changes in market timing, ergo more volatile than book value. It reflects not only historic worth but also market prospection and anticipation regarding future performance and potential dividends returns. Market value is also a common topic in finance literature (DUTTA; REICHELSTEIN, 2005; HALL; JAFFE; TRAJTENBERG, 2005; HOLDEN; KIM, 2017; JACOBS; SINGHAL; SUBRAMANIAN, 2010; LAUX; LEUZ, 2009).

Fair value is often found in accounting and finance literature. It is the price of exchange, when available, or a reasonable proxy of asset's liquidation value. In this sense, it is a measurement basis for financial report standards. This measurement basis is part of Generally Accepted Accounting Principles (GAAP), both in the Financial Accounting Standards Board (FASB) and International Accounting Standards Board (IASB) financial standards. It is close to the notion of market value. Studies have been using fair value concept to address issues like valuation, value- relevance, financial standards, market efficiency or measurement (CANNON; BEDARD, 2017; HOLDEN; KIM, 2017; HOLTHAUSEN; WATTS, 2001; LAUX; LEUZ, 2009; WHITTINGTON, 2008).

Intrinsic value concept is found in noteworthy finance papers (BOENING; WILLIAMS; LAMASTER, 1993; LEE; MYERS; SWAMINATHAN, 1999; LIU; NISSIM; THOMAS, 2002; MA; WHIDBEE; ZHANG, 2011; SUBRAMANYAM; VENKATACHALAM, 2007). It is the present value from the expected dividend flow of an asset share. At the company level, it is the present value of a company based on the discounted operating cash flow. To measure intrinsic value, one may also use earnings instead of cash flow. It is also possible to combine with market value. It is calculated in the long-term horizon. As the infinite flow of outcomes assessment is

not observable, the studies implement a finite set of flows with a terminal value. The terminal value might be a perpetual series or another reference. To cite an example, Subramanyam and Venkatachalam (2007) use market value in the final period of operating cash flow as a terminal value. Differently, Ma, Whidbee, and Zhang (2011) use a perpetual series.

Like book value, intrinsic value is used to inquire about over or under evaluations in market value. To do this analysis, it is necessary to compound the ratio prices of shares relative intrinsic value. If the price to intrinsic value ratio is too high, there is an over-evaluation or even a bubble. Bubbles may occur when economic activity is high and the market is overconfident. On the other hand, a low price to intrinsic value ratio, that means an under evaluation, may happen after a crisis has decreased the confidence of marketing.

A low price relative to intrinsic value or book value usually indicates good opportunities to buy undervalued assets or even to take over target companies as a whole. Ma, Whidbee, and Zhang (2011) found evidence that acquirer companies do that to take advantage of market timing. This demonstrates that for long-term horizon approaches, intrinsic value is more appropriate than market value. The former is more consistent for long-term analysis, whereas the latter is more subject to short-term effects. In the long run, market value and intrinsic value converge. However, since prices may diverge from value, the measurement of intrinsic value is very important (LEE; MYERS; SWAMINATHAN, 1999).

It is noticed that book value, fair value, market value, and intrinsic value are different possibilities to measure the value of a company. In this study, we are going to use the intrinsic value as a reference to investigate value creation in credit unions. First, because of its relevance and consistency, as can be found in the aforementioned literature. Second, because this study will focus not only on the short-term horizon but also in long term run when the intrinsic value is more suitable. Finally, because there is a lack of studies trying to verify the intrinsic value of credit unions. Third, because there are more limitations in using the other kind of value to verify the monetary benefits from credit unions to their members.

The other types of value are not available or not appropriate to verify the credit union value. Market value is not observable to credit unions because they do not participate in the stock market. Their equity shares are from members and are not negotiable. Regarding fair value accounting, although interferes in the firm's value as a whole, is more about assets measurement basis. The book value will be useful in some aspects of the study. For example, to define risk and discount rate. But it will not be the main reference to value creation, because, especially

in credit unions, case does not reflect the benefits flow to members and the perspective view of value creation.

Due to the objectives of this work, the notion of intrinsic value will be approached. Value in this study will be the present value of monetary benefits flow to credit union members. The monetary benefits can be divided into two main streams: benefits as owners and as users. As owners, members obtain benefit from credit unions via earnings. As users, they gain benefits via better interest rates than those found in another alternative in the market, typically in banks. Specifically, the value for members as users will be based on differences in rates in relations to the best market alternative. More details about this will be provided in section 2.4. Having defined value for the study, the next section addresses value creation.

2.2 Value creation

According to Lepak, Smith, and Taylor (2007), although value creation is a central concept in business and organizations research, there is not a strong consensus on what it is and how it can be achieved. As the authors explain, the approach depends on the parties or targets for which value is created. On the one hand, researchers evolved in strategic management, marketing or entrepreneurship may focus on value to business owners, stakeholders or customers. On the other hand, scholars who are addressing human resource management or organizational behavior are more interested in value creation to employees, teams, and organizations. In turn, researchers from sociological or economics disciplines will be likely to emphasize value creation in terms of society. The concept thus may vary according to the purpose of research.

A relatively recent concept, creating shared value, has been very reverberated in academia since it was highlighted by Porter and Kramer (2011). The article published on Harvard Business Review received enough citations to place it in the top 1% of the academic field of Economics and Business in Web of Science collection. The connections between societal and economic progress are the focus of shared value. The paper points out that social problems can create internal costs for firms. Therefore, what defines markets is not just conventional economics but also societal needs. Looking at decisions and opportunities through the lens of creating shared value could generate greater innovation and growth for companies besides greater benefit for society (PORTER; KRAMER, 2011).

Porter and Kramer (2011, p. 66) define shared value as “policies and operating practices that enhance the competitiveness of a company while simultaneously advancing the economic

and social conditions in the communities in which operates". It is not a case of sharing the value created, but increasing the total value created both for company and society. It assumes that principles of value, which is benefit relative do cost and not just benefits alone, must be used when social and economic progress are addressed. Besides, it is intrinsic the interdependence between the competitiveness of a company and the health of the communities around it.

There are three main ways by which companies can create shared values opportunities: reconceiving products and markets, redefining productivity in the value chain and enabling local cluster development. In these key ways, companies can create economic value by creating societal value. First, reconceiving products and markets implies companies providing products and services that meet societal needs and discovering new opportunities by exploring it. Second, redefining productivity in the value chain includes energy and other resources use, logistics, procurement, distribution, employee productivity, and location. Just to cite an example, when a company in the food sector helps its farmers' suppliers to improve productivity and quality both sides gain and environmental impact shrink. Third, the company is not autonomous, that is, the surrounding supporting companies and infrastructures affect its success. Then, firms create shared value by supporting local clusters development (PORTER; KRAMER, 2011).

Credit unions have the potential to create shared value through the three presented ways. Porter and Kramer (2011) have not cited any type of cooperative. However, they mentioned some examples related to the financial market that are strongly close to credit unions case specifically in the first way, reconceiving products and markets. One example is mobile banking services that help poor save money and the ability of small farmers to produce and sell their harvest. Another one is microfinance, that serves unmet financing needs in developing countries.

It is also possible to identify connections to the second way, redefining productivity in the value chain, especially in resources use, procurement, distribution, and location. Porter and Kramer (2011) explain the resource topic is not only about those identified by environmentalists, but it applies to all resources. Regarding resources use, credit unions can create shared value by increasing technology and enabling better resource utilization. To evidence this potential it can be cited the recent achievement of SICOOB, one of the biggest credit unions groups in Brazil, which was awarded in 2016 e-finance prize[6]. The prize highlights the most important projects in information and communication technology implemented by the main organizations that make up the financial sector in Brazil.

[6] Financeiros (2016).

About procurement, a credit union can help its members, who are at the same time its clients and suppliers, to improve their economic activity not only via lower-cost credit but mainly by providing technical assistance in their activities. In Brazil, credit unions must set apart a portion of their results to a fund called Fund of Technical, Educational and Social Assistance (FATES). This fund has to be used to assist members. If it is well applied it can help members to improve their activities, for example, to increase the productivity of farmers by providing technical assistance or consulting. This fund is a legal obligation, but cooperatives could go beyond the requirement. A good example is an extra social fund created by Sicredi Pioneira, recognized as the first Brazilian credit union. In 2016 it sponsored regional entities to develop a total of 175 educational, cultural and sportive projects.[7]

Distribution and location are also observed in the credit unions sector as ways to create shared value. Regarding distribution, Porter and Kramer (2011) have cited microfinance again, which has created a new model of distributing financial services to small business. This is typical in credit unions lending activity since local small business is common credit unions, borrowers. Concerning location, is a remarkable way by which the studied organizations can create shared value. Porter and Kramer (2011) signalized the possibilities of gain by establishing deep roots in local communities in which a company operates. Credit unions usually have strong connections to places where they are. Establishing relationships with local farmers, companies, and consumers as well as providing direct employment to local people are inherent characteristics of them.

Some contributions to local clusters development can be found as examples of the third way. Puga (2000) have studied supporting activities to small firms in the USA, Italy, and Taiwan. The study emphasizes the role played by credit unions in Italian industrial districts as a good way to financially support local small firms and stimulate development. Deller and Sundaram-Stukel (2012) evidence that credit unions in the USA provide complementary services in markets underserved by banks. Mook, Maiorano, and Quarter (2015) show similar evidence from Canada, where they have found that credit unions are more likely to be situated in low-income regions than banks. These studies help to demonstrate that credit unions can support local development.

It is noticed that value creation is an adherent theme to credit unions research. Due to their principles, objectives and organizational form, they can create value in most of the ways suggested by Porter and Kramer (2011). It could be observed here in some practical examples

[7] RS (2016).

as well as in some studies that demonstrated it, even though they did not mention the shared value concept. This helps to demonstrate the relevance of credit unions to their members and communities and the pertinence of studying their value creation.

A key issue in a value creation study is how to estimate it. To establish the model of measurement we will rely on the valuation concept of value. According to Koller, Goedhart, and Wessels (2010, p. 18), value creation is “the change in value due to company performance” and value itself is the "sum of the present values of future expected cash flows". It is in line with Damodaran (2012, p. 271) definition, according to which “the value of a firm is the present value of expected future cash flows generated by the firm”.

Based on the concept above and the peculiar characteristics of the studied organizations, in this work, the value created credit unions is the present value of the benefits from the difference of interest rates on deposits and loans to the average market. The credit union’s value is based on the discounted present value, which is the sum of expected future cash flows discounted by a rate that represents the risk and cost of capital over time, which is in line with intrinsic value. Therefore, we assume the value for members is the present value of future benefits flows. The flow of benefits will be based on credit union literature provided in sections 2.3 and 2.4. The benefits will be calculated in terms of members perspective.

Addressing value creation in credit unions context requires not only thinking about the concept from the owners’ point of view but also customers or users point of view. This is because members of credit unions are both owners and customers. Thinking about value creation just from a shareholder point of view is at the best to negligence the basics characteristics of those organizations. Therefore, a broader view about value creation is necessary, where customers and marketing approach is necessary, without losing the focus on the owners. To do that, this work will use cash flow approach (DAMODARAN, 2012; KOLLER; GOEDHART; WESSELS, 2010) combined with specific aspects of credit unions literature, that are provided in next section.

2.3 The nature of credit unions

Credit unions are organizations formed by an organized group of people with common interests and/or located in the same geographic region, that promote the intermediation between savers and borrowers through the mutuality. Their objective is to facilitate access to market financial services with more advantageous prices than those practiced by other kinds of financial organizations, especially the banks.

The credit unions belong to two kinds of organizations: financial organizations and cooperatives. While financial organizations are typically for-profit companies, cooperatives have not the same propensity. They can be understood as social organizations with economic purposes (BIALOSKORSKI NETO, 2006). There are so many kinds of cooperatives and credit unions are part of the cooperative sector. As a financial organization, they belong to the financial system. In Brazil, credit unions are subject to the rules of the National Monetary Council (CMN in Portuguese) and BCB. They are considered monetary financial organizations because they get deposits and have the capacity of creating scriptural money. They offer services similar to banks, but in a different way, generally with a closer relationship with the clients, since they are also their owners.

As Hillier et al. (2008) describe, credit unions have backgrounds, philosophies, and operating procedures that differ significantly from other financial and banking intermediaries, with some unique agency relationships. Its philosophy is developed through mutual collaboration, with the primary purpose of providing services to members, the equitable treatment of them, and a broad notion of community service where the relationship between stakeholders is based on cooperative principles. This approach is reflected in its modus operandi, which is based on one vote per member, regardless of the capital invested.

According to Hillier et al. (2008), credit unions traditionally have restrictive conditions of adhesion, usually based on geographical boundaries and joint professional activities. Its main focus is on providing credit in the form of personal loans or for specific purposes such as rural credit, for example, harder to obtain in banks and significantly cheaper than in other financial institutions.

Bressan (2009) notes that credit unions are important instruments of inclusion in the financial system with notable importance in the international financial system as well. It has been also demonstrating its growth potential in Brazil. The author reports the important participation of credit unions worldwide, with notable participation in the financial system of countries such as Germany, the Netherlands, and the USA. In Brazil, there is a potential to grow, since the segment is still modest compared to that of more developed countries, considering the proportion concerning the National Financial System.

Credit unions represent an instrument for the inclusion of small enterprises in the financial system, as well as an alternative to provide financial services to people with less access to the traditional banking companies and communities lacking banking infrastructure. These financial

institutions are able to reduce the transfer of resources from smaller municipalities to large centers, whereas they recycle the funds raised by returning them in the form of loans to the agents of the geographical regions where they are installed, unlike large financial conglomerates with a national presence, which contribute to the concentration of resources in large centers.

For Taylor (1971), the most peculiar characteristic of a cooperative, which distinguishes it from other firms, is its subsidiary nature. This means that they exist not to generate profits for themselves, but to meet the economic and social goals of the people who form the society. Therefore, the goal of a cooperative is to engage in economic activities more advantageously for its members. With credit unions, it should not be any different. Therefore, as cooperative organizations, credit unions must be evaluated according to their ability to generate value to their members. Nevertheless, they are also financial organizations and must meet both the challenges imposed by the market and the requirements imposed by the institutions that regulate their activities. Perhaps one of the main challenges for the credit unions is to conciliate their double-nature: cooperative and financial organization.

As credit organizations, credit unions must guarantee solvency and credibility. They are agents of the financial system where and have to pass trust. Thence, they must present performance that is sufficient to remain in the market and give credibility to their activities. To be able to contribute to country's development, credit unions must have a strong financial structure, with a protection mechanism to their members (BRESSAN, 2009). At the same time, credit unions have to generate value otherwise they would not have reason to exist. It was collected in the classic and recent literature the need subsidies to construct a theoretical foundation about how credit unions do it.

2.4 How credit unions create value

Credit unions have interesting relations with their members, different from other kinds of companies and even other kinds of cooperatives. Regarding cooperatives in general, most of them represent producers or consumers. An example of cooperatives of producers is a cooperative of farmers. An example of a cooperative of consumers is a cooperative in which the members come together to buy basic need products. In both cases, the members aim to better prices. Higher prices in the former example and lower ones in the second. The credit unions are an interesting combination of both situations. It can be thought as a "seller" cooperative since it supplies loans. It can also be considered as a "buyer" cooperative since it demands savings. In

the most cooperatives the members interact with them by just on side of the market. But in credit unions, members are both providers and consumers of resources. As a result, credit unions can be treated as the "purest" form of cooperatives (TAYLOR, 1971). Because of that, credit unions have implications in the way they interact with members.

In other kinds of companies or even cooperatives, this dynamic does not occur. For example, in a cooperative of coffee producer, the cooperators are just on the provider side. It is the same case in a health cooperative in which doctors are the members and patients are clients. The same in a transport cooperative in which members are providers of transport services. On the other hand, in a cooperative of medical service users, the members are just consumers.

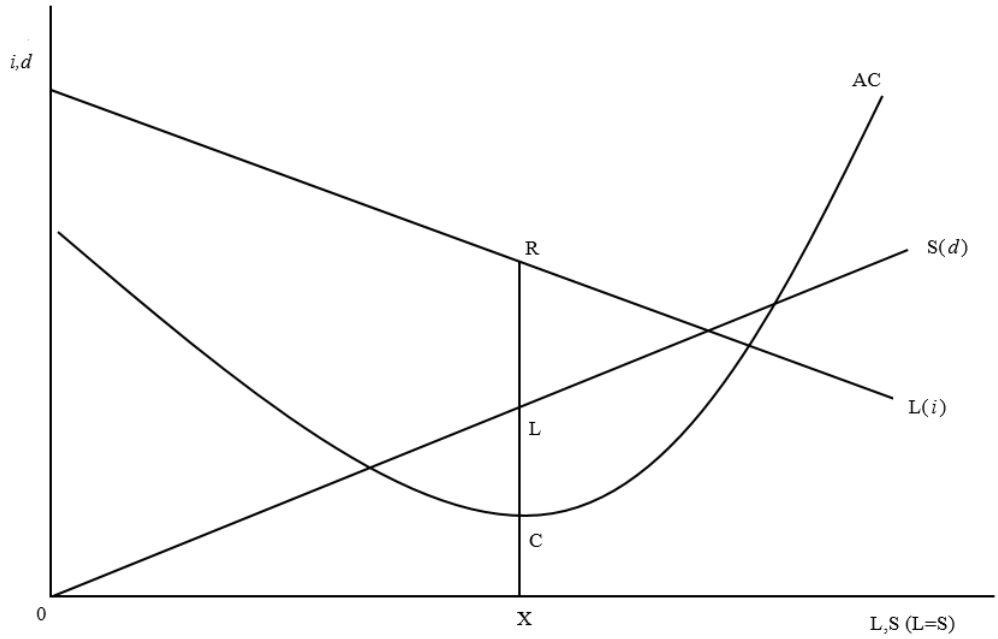
In credit unions, the financial resources obtained by the borrowing members come from the resources of saving members. There may be inherent conflicts of interest between borrowers and savers. Borrowers aim at credit at the lowest possible rate, while savers aim to apply their resources at the highest possible rate. A supplying member can become a consumer and vice versa, in such a way that there are peculiar relations in a credit union and implications for its objective.

Smith, Cargill, and Meyer (1981) cite two factors that affect the credit union objective. First, the value of a credit union should be maximized by respecting both borrowers and savers. Second, any conflict that may arise between borrowers and savers should be minimized. Increasing the earnings imposes direct costs to members (by increasing operating margin) and decisions have to be made in a way that costs are supported and shared by both savers and borrowers somehow. Maximizing returns simultaneously for borrowers and savers is economically impracticable. The borrowers members aim to minimize interest rates paid on loans while savers members aim to maximize the remuneration received by their savings. From this, a conflict between borrowers and savers arises (PATIN; MCNIEL, 1991a).

Nevertheless, the entity should seek to optimize the returns for borrowers and savers, since it is not feasible to maximize the returns for both. Maximizing value for savers means minimizing value to borrowers, and vice versa. Optimizing implies pursuing the best possible for both. The fact is that groups inside the credit unions have different objectives, which implies the conflict among members. However, this relations are not always conflictual. To investigate this issue, Taylor (1971) exposed an initial model of credit union equilibrium. In his model, he assumes that the assets of a credit union only consist of loans to its members and the liabilities

only consist of savings. It is also assumed that operational costs are U shaped. Besides, the reserve constitution is assumed as not existent. The model is shown in Figure 3.1.

Figure 3.1 – Taylor's Credit Union Model



Source: Adapted from Taylor (1971, p. 214)

Origin and application of resources are measured along the horizontal axis. They consist of loans, which comprise the assets, and savings, that comprise the liabilities. Since assets are equal to liabilities, they can be measured on a common axis. Returns and costs on assets and liabilities are represented on the vertical axis, where *i* is the interest rate charged to borrowers and *d* is the rate of remuneration to savers. The AC curve represents the indirect average costs, assumed to have optimized long-term behaviour. The long-term S(savings) function represents the savings resources offering, dependent on the rate of remuneration (vertical axis). That is, the higher the remuneration the greater the volume of resources saved. Similarly, the L (loans) function is the volume of loans demanded by members, dependent on the interest rates charged (vertical axis). In this case, the higher the rate, the lower the demand for loans.

As Taylor (1971) explains, the output equilibrium will most likely be at 0X. At this point the price for borrowers is in RX, the return to savers in LX, and the RL difference is sufficient to cover the overhead costs of the cooperative.

Evaluating Taylor's Model, Spencer (1996) indicates that credit unions create value to their members not as owners but as customers. Thus, a measure of value creation for cooperative members could be equal to (*i*-*d*) - low interest rates (*i*) for borrowers and high interest rates

(*d*) for savers - as well as minimizing (*i-d*) to cover costs, as in point 0X in Figure 3.1. It is a reasonable indicator of the value creation maximization to members. Cooperatives will have incentives to expand until to the point where (*i-d*) can be reduced (SPENCER, 1996).

That is, the credit union should grow to the point where there is maximum gain in scale, where it is possible to charge the lowest possible rate to borrowers and at the same time offer the highest possible remuneration to the savers, conciliating the two sides. It means that the cooperatives seek an optimum size rather them maximize it. This assertion interfere in the assessment of cooperative merger operations. It also implies that to achieve the optimal level of value creation, credit unions must to optimize their overhead costs.

Taylor (1971) indicates that the credit union's size influences the relations between members. According to the author, when the cooperative is small and members engage in more social interactions, mutual aid is a more important aspect. As the organization grows, members become less familiar and the cooperative takes a more business-oriented attitude. Conflicts of interest can be mitigated by economies of scale.

The Taylor's model was later improved by the author. But according to Spencer (1996), a limitation of the valuable Taylor's work is that it does not consider the impact of reserve accumulation, which is important when there is growth or decrease in assets. Because of that, there would be a lower prediction of reserves and their benefits arising for future members. That was the motivation to Spencer (1996) extend Taylor's model. The influence of reserves, highlighted by Spencer (1996), and other important aspects were later approached by more recent works (BAUER, 2008; RUBIN et al., 2013). But before to verify them is important to analyse other classical studies that sought to elucidate how credit unions generate value to their members.

Among the basic models that were developed, we highlight Patin and Mcniel (1991a); Patin and Mcniel (1991b); Smith, Cargill, and Meyer (1981); Smith (1984); Smith (1986); and Walker and Chandler (1977) because they strongly collaborate on the notion of economic benefits to the members, and therefore, are in line with the objectives of this study. These papers served as a basis for further studies, which will also be addressed.

According to Walker and Chandler (1977) the benefits of credit unions can be divided into monetary and non-monetary. The financial counselling, convenience of saving and loan repayment through payroll deduction, shares insurance, free credit life insurance, check cashing

are examples of non-monetary benefits. The monetary benefits relate to better interest rates charged by credit unions in relation to the market, both for savers and for borrowers.

In this sense, Walker and Chandler (1977) introduced the concept of the net monetary benefits to members of credit unions, based on market interest rate comparison. The net monetary benefits to members of credit unions are the difference between loans and savings interest rates offered by credit unions and the next best alternative available to members in the market. In other words, it is the benefits members gain by gaining higher savings fees or paying lower loan rates because they are negotiating with the cooperative rather than negotiating with the next best available alternative in the market.

On the side of savers, the net monetary benefits can be measured by the increasing in interest rates on financial investments in relation to the best available alternative in the market. On the side of borrowers, the net monetary benefits obtained refers to the reduction in interest rates paid on credit operations as a consequence of borrowing funds with the cooperative instead of using the next best available alternative in the market. Thus, the benefits provided by credit unions take into account the opportunity gain to members when operating with their credit unions.

In an equation form, the net monetary benefits received by credit unions members is defined by (WALKER; CHANDLER, 1977):

$$NMB_S = D_C - S_O \tag{3.15}$$

Where NMB_S is the net monetary benefits received by savers; D_C is the dividend rate paid on savings by the credit union and S_O is the best alternative interest rate on savings available to credit unions members.

$$NMB_B = L_O - L_C \tag{3.16}$$

Where NMB_B is the net monetary benefits to borrowers; L_O is the effective loan interest rate available at the lowest cost non credit union lender and L_C is the effective interest rate charged on a credit union loan.

Therefore, according to Walker and Chandler (1977) the credit union create value to members through the difference between interest and dividend rates of the cooperative and the

best next alternatives in the market. The authors observe that the credit union can control D_C and L_C but cannot control S_O and L_O, which are determined by market.

Smith, Cargill, and Meyer (1981) has presented a somewhat more elaborated model. The authors state that there are two basic requirements for modeling the behavior of credit unions. First, a specification of the objective function should focus on credit union value for its members. This amount should include the prices and amounts of the transactions. Second, the analysis must explicitly consider the possibility of conflict between members and conflict resolution should be good for both savers and borrowers. The authors disagree with models that ignore the fact that the credit union owners are the consumers and simply consider that credit unions should maximize profit, as well as other financial intermediaries. The view of Smith, Cargill, and Meyer (1981) is that, as recognized by most authors, the maximization of profit is improper as the credit union objective.

The fact is that the cooperative should seek profit for the members and not for itself. The final line of the income statement is not the most important indicator for credit unions, although it should not be ignored. Because their customers are their owners, maximizing earnings implies offering higher-cost credit and/or lower-yielding applications than desirable. That is, the profit to members comes from themselves. Therefore, the objective function of the cooperative should be related to its gain concerning the available market alternatives, especially the banking organizations and other financial intermediaries. However, it is important to emphasize that credit unions cannot fail to have solvency and investment capacity to continue in the competitive financial market. Nevertheless, net profit in the income statement is not the credit unions objective.

Smith, Cargill, and Meyer (1981) have specified the generalized objective function of the credit union as follows:

$$\begin{aligned} \underset{r_L, r_S}{\text{maximize}} \quad & \lambda NGL + \sigma NGS + \pi \\ \text{subject to} \quad & L - S = D, \\ & \pi = r_L L - r_S S - r_{DM} D - C_L L - C_S S - \overline{E} \geqq 0 \end{aligned} \tag{3.17}$$

Where NGL is the Net Gains on Loans, that is the difference between credit union loans rate and next best marketing interest rate times the amount of credit union loans; NGS is the Net Gains on Savings, that is savings rate difference times the amount of credit union savings; and π is the operating surplus, if any, available for distribution to members. The decision variables are

the rate on loans, r_L; and the dividend rate on savings, r_S. The parameters λ and σ are scaled such their values fall between zero and one. They indicate if the credit unions are borrower-oriented or saver-oriented. If $\lambda = \sigma$, the cooperative is neutral. The first constraint regards the balance sheet, where L is the number of loans; S is the amount of savings and D represents a money market investment if $S > L$ or a debt issue if $L > S$. The second constraint reflects a non-negative operating surplus in the income statement, where r_{DM} is the exogenous rate for D; C_L and C_S are costs on loans and savings, and $\overline{E}$ is the sum of all fixed expenditures; for example, rental of office and cost of providing member services other than financial operations. $\overline{E}$ might also include reserve accounts for contingencies, bad debts on loans, and future distribution of retained surplus.

The value creation for borrowers members is *NGL*. For the saver members, the value creation is *NGS*. A limitation is that this measurement just approaches pecuniary gain. That is, it does not consider non-pecuniary benefits generated by the credit union. Besides, there is also a natural problem of aggregation, since not all members have the same alternatives. This problem can be mitigated somehow due to the principle of the common bond among members (SMITH; CARGILL; MEYER, 1981). However, it is noted that in so big credit unions the bond among members tends to diminish (GHATAK; GUINNANE, 1999; GHATAK, 2000; HULME; MONTGOMERY, 1994).

The weakening of the common bond is noticed. In Brazil, after the regulation of free admission credit unions, a link of which between the members is given only by the geographic region, decreased the link among members, since there are members of the most varied profiles and economic activities. These aspects should be taken into account when considering a market alternative, especially regarding different interest rates on loans. Knowing the exact gain of each member would require discovering the alternative available to each one, according to their economic activity and the financial organizations present in their region. But when the objective is to verify the general model, the problems of aggregation appointed by (SMITH; CARGILL; MEYER, 1981) are inherent to the research.

Following the previous valuation approaches (SMITH; CARGILL; MEYER, 1981; WALKER; CHANDLER, 1977), Smith (1984) has continued to develop the objective function of the credit unions. The author highlighted that the credit union purpose is to provide financial services for its members. Therefore, the objective function should be specified in terms of

services flow during a relevant period. A measure of this flow for such an individual member using the comparison with market rates is (SMITH, 1984):

$$NGL^j = (r^j_{LM} - r_L)L^j \tag{3.18}$$

$$NGS^j = (r_S - r^j_{SM})S^j \tag{3.19}$$

Where NGL^j and NGS^j are the Net Gain on Loans and Net Gain on Savings for the j^{th} member; r^j_{LM} and r^j_{SM} are the best market interest rates on loan or saving available to the member for an equivalent loan or saving; r_L and r_S are the credit union's rates on loan and saving; and L^j and S^j are the amounts of the member's loan or saving.

There are some assumptions in the formulation above. First, the rates of r_L and r_S are not overwritten for the j^{th} member. Smith (1984) claims that credit unions generally offer all members the same rate for a transaction made at the same time. The different degrees of loss on credit operations are managed with additional guarantees or co-signers rather than the explicit risk premium on the interest rate on loan. Second, it is assumed that there is always an alternative interest rate, so members can always deposit or borrow at another organization in the absence of the credit union. Besides, the equations just capture pecuniary gains. Other aspects of the transaction, such as waiting time, convenience, courtesy, and disclosure of information, are neglected. Thus, the pecuniary measure of net gains may be zero, or even negative, and members may still want to operate in the credit union if those other aspects are sufficiently valued (SMITH, 1984).

Considering that the credit union has J members, the individual net gains can be aggregated as follows (SMITH, 1984):

$$NGL = \sum_{j=1}^{J} (r^j_{LM} - r_L)L^j \tag{3.20}$$

$$NGS = \sum_{j=1}^{J} (r_S - r^j_{SM})S^j \tag{3.21}$$

Smith (1984) suggests two additional useful assumptions to be added to construct a practical model for the objective function of credit unions. First, the model could assume that all members have the same alternatives, that is, $r^j_{LM} = r_{LM}$ and $r^j_{SM} = r_{SM}$ for all J members. This

assumption is not too problematic for deposits since other financial organizations are usually open to all depositors. Regarding loans, it is different, because the organizations that provide SM for them necessarily consider the history and the capacity of individual payment. However, as discussed previously, the fact that there are criteria of association, with a common bond among the members, can confer bigger homogeneity to the membership within the cooperative than in the general population. Smith (1984) also justifies the premise of alternatives equivalence by assuming that managers have a typical or average member type in mind when making decisions. Then r_{LM} and r_{SM} can represent the options available to the typical member.

The second assumption is that the sum of individual loans and savings can be written as a function of the interest rates of the credit union and market (SMITH, 1984):

$$\sum_{j=1}^{J} = L^j = L(r_{LM}, r_L), \qquad \frac{\partial L}{\partial r_{LM}} > 0, \qquad \frac{\partial L}{\partial r_L} < 0 \tag{3.22}$$

$$\sum_{j=1}^{J} = S^j = S(r_{SM}, r_S), \qquad \frac{\partial S}{\partial r_{SM}} < 0, \qquad \frac{\partial S}{\partial r_S} > 0 \tag{3.23}$$

The signs of partial derivatives in the equation (3.22) indicate that lower credit union rates and higher market rates will attract more loans to credit unions. The opposite happens to savings. As the equation (3.23) shows, higher credit unions rates and lower market rates will contribute to more savings to credit unions. In summary, the total amounts of loans and savings are a function of credit unions and market rates. Better rates in the credit union and worse rates in the market will attract operations to cooperative, otherwise, operations will be removed from the credit union.

Smith (1984) points out the need to consider any preferential treatment or dominance of the cooperative by savers or borrowers. The author adds variations of the model with components that consider the level of preference of the cooperative by savers or borrowers. However, in an empirical study (SMITH, 1986) demonstrates, through statistical tests, that credit unions, in general, are neutral, at least in the United States, at the time the study was made, with data referring to the period between 1976 and 1979. Further studies (PATIN; MCNIEL, 1991a,b) in 1984 and 1985, also with cooperatives in the United States, have confirmed that the vast majority of cooperatives are neutral, although there are some cooperatives borrowers or savers orientated.

In Brazil, Bressan et al. (2013) have done similar tests for the period from 2000 to 2008 with data from Sicoob credit unions, following the methodology proposed by Patin and Mcniel (1991a) to measure the net monetary benefits to savers and borrowers. According to the study, the majority (87.3%) of credit unions are oriented to borrowers. However, the domination index is near zero for most cases, which leads to the conclusion that credit unions in Brazil mostly approach to neutrality. Besides, Bressan et al. (2013) noticed that the credit unions have been more attractive than the market alternatives, both for savers and borrowers, respectively in 92% and 77.8% of the observations. The study was not intended to explain the variables that determine the ability of credit union to create value for members.

Next, the study of Patin and Mcniel (1991a) will be addressed to demonstrate the way the authors proposed to measure the value created by credit unions to members. The study relied on previous works (SMITH; CARGILL; MEYER, 1981; SMITH, 1984; WALKER; CHANDLER, 1977), which had developed models based on members' opportunity when operating with their credit union. The gains, as in previous studies, are divided into two groups: monetary benefits to savers and monetary benefits to borrowers, which are described below.

Monetary benefits to savers (PATIN; MCNIEL, 1991a):

$$NMBS = (WADR - WAMDR)TS \tag{3.24}$$

Where $NMBS$ is the net monetary benefits provided to savers; $WADR$ is the weighted average of the dividend rates paid by the credit union on all savings instruments offered; $WAMDR$ is the weighted average of the best alternative market dividend rates available on similar types of savings instruments and TS is the total amount of credit unions members' savings.

Monetary benefits to borrowers (PATIN; MCNIEL, 1991a):

$$NMBB = (WAMLR - WALR(1 - R))TL \tag{3.25}$$

Where $NMBB$ is the net monetary benefits to borrowers; $WAMLR$ is the weighted average of market loan rates charged by alternative organizations on similar debt instruments to those offered by the credit union; $WALR$ is the weighted average of loans rates charged by credit unions for all types of loans to members, R is the proportion of interest income on loans refunded to credit unions borrowers and TL is the total amount of loans to credit union members.

Calculating the difference d between *NMBS* and *NMBB* enables to compare empirically the benefits allocated to each group (PATIN; MCNIEL, 1991a):

$$d = NMBS - NMBB \tag{3.26}$$

Such a credit union allocates more net monetary benefits to its savers (borrowers) if d is higher (lower) than zero. Value $d = 0$ indicates that the cooperative allocates equivalent benefits to both groups. The equation 3.26 has been used by researchers to verify if credit unions are savers-oriented or borrowers-oriented (BRESSAN et al., 2013; MCKILLOP; FERGUSON, 1998).

A simple sum of benefits to savers and borrowers is enough to calculate the total benefits (TB) created (PATIN; MCNIEL, 1991b):

$$TB = NMBS + NMBB \tag{3.27}$$

Despite the simplicity and similarity of previous models, Patin and Mcniel (1991a)'s model has an important aspect: it takes into account the weighted average of interest rates. That is, it considers the different rates according to different modalities of operations and their respective proportions. This feature is essential for the accuracy of the model, especially for credit loans, which may have different modalities with relevant differences between rates. For example, interest rates for retail operations are usually much higher than for rural credit operations. Using the weighted average, as in equations (3.24) and (3.25), is a way to mitigate the problems of aggregation pointed out by (SMITH; CARGILL; MEYER, 1981) and existent in equations (3.18), (3.19), (3.20), (3.21), (3.22), (3.23). This is important especially when there are different kinds of debt operations and rates and the common bond is weak as has been discussed above in this section and pointed out in literature (GHATAK; GUINNANE, 1999; GHATAK, 2000; HULME; MONTGOMERY, 1994).

The calculation of weighted average rates (*WADR*, *WAMDR*, *WALR* and *WAMLR*) is detailed in (PATIN; MCNIEL, 1991a) to United States case. The calculation shall be adapted to peculiarities of each country, given the specificities of debt and savings instruments. Generically, the weighted average of interest rates on deposits or savings may be represented as follows:

$$WADR = \sum_{i=1}^{I} \frac{S_i}{TS} rS_i \tag{3.28}$$

Where $WADR$ is the weighted average dividend rate paid by the credit union to savers; S_i is the amount of savings in modality i; TS is the total amount of credit unions members' savings and rS_i is the average rate paid by the credit union to the modality i.

The weighted average of loans rates may be calculated similarly, as follows:

$$WALR = \sum_{i=1}^{I} \frac{L_i}{TL} rL_i \tag{3.29}$$

Where $WALR$ is the weighted average loans rate charged by the credit union from borrowers; L_i is the number of loans in modality i; TL is the total amount of credit unions loans and rL_i is the average rate charged by the credit union to the modality i.

Note that the (Patin and Mcniel (1991a))'s model the opportunity cost of operating with the credit union rather than operating with another financial organization. Therefore, it is based on the credit union objective function present in previous works (SMITH; CARGILL; MEYER, 1981; SMITH, 1984, 1986; TAYLOR, 1971; WALKER; CHANDLER, 1977). In other words, it is based on the idea that the credit union goal is to return to members the greatest possible additional benefit concerning market options. According to Rubin et al. (2013), in terms of theoretical research, few efforts were made in the two decades following Smith's work during the 1980s, regarding economic models for credit unions. More recently it is possible to identify more empirical studies that were based on the aforementioned objective function (BAUER, 2008; BAUER; MILES; NISHIKAWA, 2009; BROWN; DAVIS, 2009).

Bauer (2008) established two methods, one parametric and another one non-parametric, to detect abnormal credit unions performances, and demonstrated by simulations that both were correctly specified and have explanatory power. This methodological basis was then used in Bauer, Miles, and Nishikawa (2009) to analyze the effect of mergers on the performance of credit unions in the United States. The results showed that there are generally gains for target cooperative members and regulators, but there are no gains for acquirer institutions. In turn, Brown and Davis (2009) studied the practice of capital management by credit unions in Australia. The evidence has indicated the occurrence of capital management to meet capital requirements in line with the Basel Accords, with improvements in short-term return rates.

Despite their empirical and methodological importance, the studies mentioned above have not advanced concerning economic modeling for credit unions. Those articles were influenced by Smith's studies in the 1980s, still considered the "state of the art" from a theoretical perspective (RUBIN et al., 2013). This perception demonstrates the lack of theoretical economic studies on

these peculiar organizations. However, the study of Rubin et al. (2013) may be considered, if not the most, one of the most advanced studies regarding the development of economic models for credit unions value creation.

The study of Rubin et al. (2013) brings an important advance comparing to previous studies that have addressed the objective function of credit unions and value creation. It enables a dynamic analysis. This analysis allows considering the variation of rates and amounts in more than one period. That is, through an inter-temporal structure, it addresses issues such as optimal capital retention and rate policies for borrowers and savers over time.

Rubin et al. (2013) take into account the level of reserve formation over time and the impact on benefits to associates. Each year credit unions determine the amount of income retention for shareholders' equity. Allocation of reserves reduces the risk of bankruptcy and implies a lag in the allocation of benefits. The authors explain that the optimal level of reserves will depend on the risk and term preferences of the associates. Thus, credit unions must make their decisions on the level of reserves and deposits and loans interest rate to maximize the benefits to members.

According to Rubin et al. (2013)'s objective function, the credit union controls the functions $d_{cu}(t)$, $l_{cu}(t)$, and $E(t)$ to maximize:

$$\int_0^\infty [U(B) + V(S)]e^{-p(E,L)t}dt \tag{3.30}$$

subject to

$$L + I = D + E \tag{3.31}$$

and

$$\frac{dE}{dt} = [l_{cu}L + rI - d_{cu}D - c(L,D)]\tau \tag{3.32}$$

Where $U(B)$ and $V(S)$ are the borrower and saver utility function; B and S are the borrower and saver benefit. As specified in the equation (3.17) formulated by Smith, Cargill, and Meyer (1981), the borrower benefit B is the amount of credit union loans times the difference between credit union loans rate and the next best marketing interest rate, $L(l_m - l_{cu})$, where L is the total amount of loans, l_m is the market loan rate and l_cu is the credit union loan rate. Similarly, the saver benefit S, also as in equation (3.17), is the amount of credit union savings times the

savings rate difference $D(d_{cu} - d_m)$. The function $p(E,L)t$ indicate the discount rate of a typical credit union member, where the discount rate p depends on the credit union equity E concerning the number of loans L over time t.

The first constraint, equation (3.31), refers to the balance sheet, where the sum of loans L and investment balance I is equal the sum of deposits D and equity E. Of course, the credit union has other assets and liabilities, like pieces of equipment and current payables as wages, but they may be overlooked in the analysis since they are not as relevant in financial organizations as are deposits, loans, investments and equity, the main components of a credit union balance sheet.

The second constraint, equation (3.32), refers to the income statement, where $\frac{dE}{dt}$ is the variation of the equity E in momentum t, that is, the earnings of credit union; coming from loans interest income $l_{cu}L$; plus investments interest income rI; minus deposits interest expense dcuD; minus operating costs $c(L,D)$; deduct tax, where τ is one minus the applicable income tax rate. The loans interest income comes from credit union loan interest rate l_{cu} times the loan volume L. Similarly, investments interest income comes from investments interest rate r times the investment volume I. In turn, the deposits interest expense comes from credit union deposits interest rate d_{cu} times the volume of the deposits. The operating costs c is a function of loans L and deposit D volume.

The equations (3.30), (3.31) and (3.32) compose the core of Rubin et al. (2013)'s model. In equation (3.30) the credit union chooses functions $d_{cu}(t)$, $l_{cu}(t)$, and $E(t)$ over time to maximize the sum of members' benefits, discounted by the rate p. In other words, the credit union's managers should control deposits interest rate, loans interest rate and the level of equity over time to maximize value creation for members. The main differential feature of the model if compared with earlier studies is its inter-temporal structure, which contemplates the optimal equity retention and inter-temporal rate policy, not addressed by earlier studies. In this sense, it considers the discounted present value of the future sum of benefits to members, which is in line with the concept of value assumed in this study, as explained in section 2.2.

Despite the advancement of the model over those developed previously, Rubin et al. (2013) recognize that some simplifying assumptions are implied in the formulation. There is only one type of deposit and credit operation, but the structure could be extended to include multiple deposit products and credit operations, as has been seen in equations (3.24), (3.25) developed by Patin and Mcniel (1991a), as well as in equations (3.28) and (3.29) synthesized in this work based on the mentioned study. Rubin et al. (2013) also cite other omitted credit unions, such

as multi-member utility functions, non-cash credit unions activities, employee motivation, and deposit insurance. The division of equity in special regular reserves and indivisible results are ignored, as well as regulatory requirements concerning shareholders' equity. Possible conflicts between members are also not considered (RUBIN et al., 2013).

Rubin et al. (2013) justify the absence of these factors by explaining that the focus of the model is the basis of the inter-temporal operation of credit unions, as described in equations (3.30), (3.31) and (3.32). One may consider that even with these simplifications, the model has a considerable number of components. Therefore, the inclusion of additional assumptions could give it a very high degree of complexity. On the other hand, the authors emphasize that a series of extensions can be made to the model, with the exclusion and inclusion of assumptions aiming to improve it.

An important extension to Rubin et al. (2013)'s work, as mentioned by themselves, is the adaptation to credit unions outside the United States. Also, there are several testable hypotheses, originating from the model, that may be verified empirically. The present chapter will seek to use the basis constructed in Rubin et al. (2013) and in previous works such as (BAUER; MILES; NISHIKAWA, 2009; PATIN; MCNIEL, 1991a,b; SMITH; CARGILL; MEYER, 1981; SMITH, 1984, 1986) including studies developed in Brazil (e.g., BRESSAN et al., 2013), to develop a dynamic model that enables to measure the value creation of credit unions to members in the Brazilian context. Besides, the empirical measurement will be conducted to verify the assumptions involved and take advantage of the model. The results of empirical measurements will guide tests in the next chapter where the variables that determine credit union value creation will be verified. We hope to develop a procedure that may be able to contribute to the advancement of studies about credit unions.

3 METHODOLOGY

3.1 Research hypothesis

This chapter relies on the assumption that credit unions create value to their members. The value is assumed to be the benefits to borrowers and savers coming from difference of interest rates in relation to options found in the market, which is support by many previous works (BAUER, 2008; BRESSAN et al., 2013; PATIN; MCNIEL, 1991a; SMITH; CARGILL; MEYER, 1981; SMITH, 1984, 1986; SPENCER, 1996; TAYLOR, 1971). The studies agree that

credit union generates value by providing financial services with better conditions than other financial organizations, rather than generating net income to be distributed since credit unions are oriented to the user instead of investors.

The model of measurement is based on (RUBIN et al., 2013), that gathered the relied on the previous studies to develop a dynamic model. The dynamic model considers the benefits to members over time, applying a discount rate. In this sense, it is a discounted flow of future benefits, which reflects the intrinsic value (BOENING; WILLIAMS; LAMASTER, 1993; LEE; MYERS; SWAMINATHAN, 1999; LIU; NISSIM; THOMAS, 2002; MA; WHIDBEE; ZHANG, 2011; SUBRAMANYAM; VENKATACHALAM, 2007) of credit unions. Further, it has a close connection to the literature on valuation (e.g. (DAMODARAN, 2012; KOLLER; GOEDHART; WESSELS, 2010)), which usually address discounted cash flow as a way to estimate firm's value.

In summary, based on previous literature, there are reasonable foundations to state that credit unions create value to their members and value comes from the benefits of advantageous operations of loans and deposits. Therefore, to achieve its objective, this chapter assumes the hypothesis that credit unions create value to their members. Value creation refers to the flow of benefits to member, from difference of interest rates times the volume of operations, adjusted at present value. The discount rate is based on the SELIC interest rate adjusted by individual risk over time, which was calculated in the previous chapter.

3.2 Data collection and sample

Similarly to the previous chapter, in this chapter data mainly comes from public trial balance sheets available on BCB's website (BCB, 2019a). Besides, it also relies on average market interest rates on loans and deposits retrieved from Time Series System of the Central Bank of Brazil (BCB, 2019c). The market rates indicators will be detailed in Subsection 3.3. The main index used to measure market interest rates on loans is available only after 2013. Consequently, the period used to analysis is from the first semester of 2013 to the second semester of 2018. The dataset is a panel data with 692 individuals, of which 89.74% for each semester. Failed credit unions have not been included in this chapter because it aims to calculate the value of organizations based on a discounted cash flow that assumes infinite operations. Credit unions starting in the period of analysis are included.

Results have been presented in shorter period due characteristics of formulas. For example, results of benefits to savers and borrowers are available only after the second semester of

2013, because they require means of deposits and loans, which need figures of one semester before. Therefore, there are no results for the first semester of 2013. Results of value measurement are only available from 2013 to 2017, also because of the structure of the formula. As it will be detailed below in Subsection 3.3, the formula of value requires sequences of discounted cash flows, which requires three terms with two future semesters. Because of that, there are no results of value measurement for 2018.

Similarly to procedures done in the previous chapter, the accounting data from credit unions, which were in nominal values of Brazilian currency Real (BLR), have been updated to values at 2018 December. The adjustment for inflation was done through the inflation index General Price Index - Internal Availability (IGP-DI), provided by Instituto Brasileiro de Economia (IBRE) of Fundação Getúlio Vargas (FGV).

3.3 Measuring value for borrowers and savers

This section develops a procedure to measure credit value creation. It takes into account previous theoretical models, includes some additional assumptions and converts the gathered knowledge into practical procedures that culminate in measurement template. First, we convert Rubin's model into the measurable equation, second, we gather more information from previous studies, third, we include some additional assumptions and perspectives, and then we address Brazilian particularities.

Based on the understanding that the development of a practical measurement for credit unions value creation should depart from the most advanced knowledge in terms of theoretical models, we have taken as kick-off the model developed by Rubin et al. (2013). It has gathered most of the theory available in previous works. The previous studies had already assumed that credit unions create value to their members through the benefits coming from credit unions rates differences concerning the market.

Despite the sophistication of Rubin et al. (2013)'s model, which integrates most of the theoretical framework previously developed and has been done significant advancement, some practical adaptations are needed for its use in an empirical study. At least three adaptations will be necessary: to do a conversion of the continuous function model to the summation of discrete periods; to deal with the impossibility of effectively calculate the benefits in infinite time and to take into account the constraints adapting them in an empirical situation.

3.3.1 From a continuous to a discrete approach

The continuous function over time is not applicable in practice because credit union accounting figures, as in any organization, are obtained periodically (e.g., monthly, quarterly or annually). Therefore, the observations are in discrete time and the infinitesimal rate and benefits are unobservable. For this reason, it is necessary to convert the continuous function of time, represented by definite integral, to the summation of periods, discrete t. This also implies adapting the continuous discount rate component $e^{(rate\ X\ time)}$ to periodically capitalized rate.

To replace the continuous-time model in equation (3.30), provided by Rubin et al. (2013), by discrete intervals, we propose:

$$CV = \sum_{t=1}^{\infty} \frac{B_t + S_t}{(1 + p(E,L))^t} \tag{3.33}$$

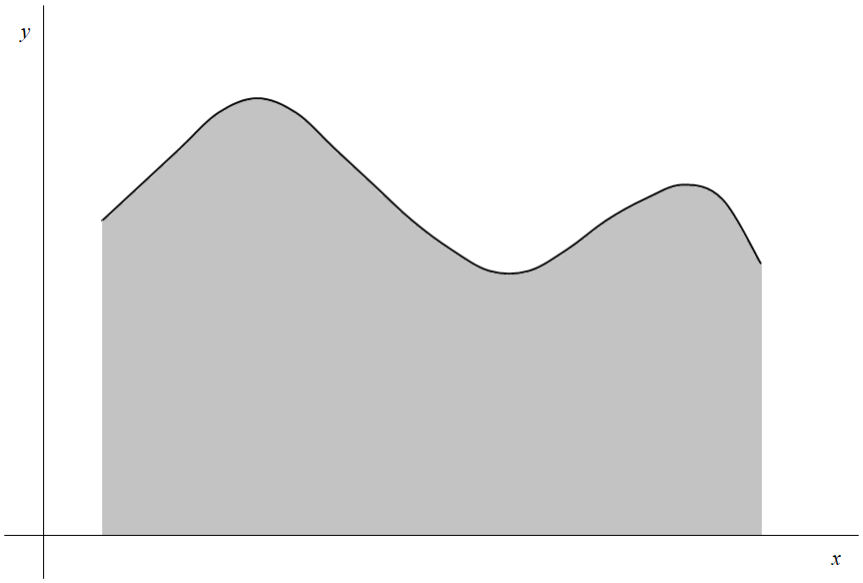
Where CV is the credit union value and the other components are as in equation (3.30). B_t is the borrower's benefits in time t, S_t is the savers benefits in time t and p is the discount rate according to equity E concerning the amount of loans L. The equations (3.30) and (3.33) are analogous. The unique difference is that the former assess the value of credit unions through a continuous treatment and the latter does it by using a discrete treatment. The equivalence between discrete and continuous time models is a common belief in economic theory. Therefore, one can be used to approximate the other and for implementation of continuous-time models is often necessary to discretize (PROTTER, 2013). The notion of the definite integral, or Riemann Integral, as the "limit of a sum" (LEITHOLD, 1994, p. 326) helps to demonstrate the equivalence of the integral and sum when the length of the periods tends to zero:

$$\int_a^b f(x)dx = \lim_{|\Delta|\to 0} \sum_{i=1}^{n} f(\xi_i)\Delta_i x \tag{3.34}$$

In Figure 3.2 the area below the curve may be calculated by an integral. In the specific case of this study, the area below the curve would represent the sum of credit unions benefits in infinitesimally periods, as in equation (3.30).

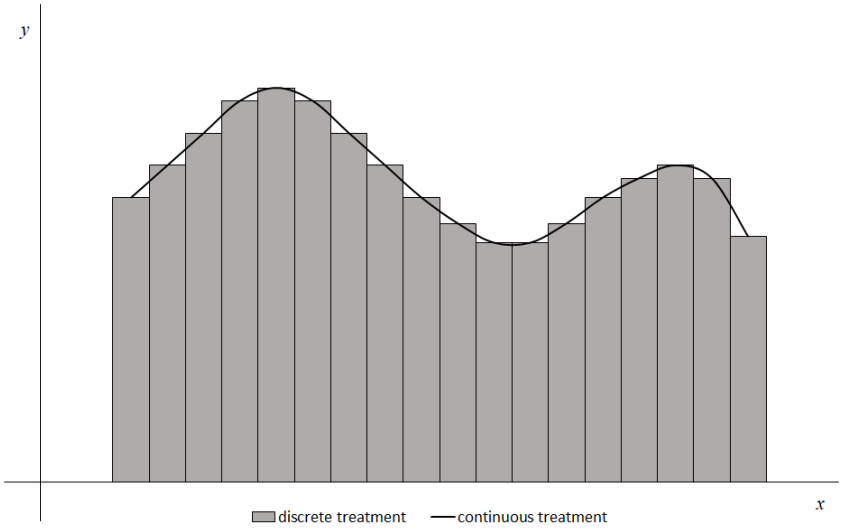
However, the financial figures are inherently discrete. Therefore, in this case, a discrete treatment represents reality. It enables the implementation of generalized models. Figure 3.3 shows that the discrete treatment is a reasonable approximation of continuous treatment. It is

Figure 3.2 – Continuous Treatment



possible to notice that the sum of the rectangles' area is quite similar to the area below the curve in the previous figure. It means that the value of the discrete and continuous treatment is similar.

Figure 3.3 – Discrete Approximation



The finer the rectangles, that is, the shorter the periods, the better the approximation. That is, if we make the rectangles infinitely fine their area will be similar to the area below the curve.

In equation (3.30), the term e $e^{-p(E,L)t}$ represents a discount rate under a continuous compounding regime where the periods have infinitesimal lengths. In equation (3.33) the denominator $(1+p(E,L))^t$ refers to the discount rate under a discrete-time regime and the result can be calculated for each discrete period t. Making some simple operations is possible to realize

how equivalent they are. An initial capital subject to a continuous compounding interest may be represented by (BARROS, 2009; PETTERS; DONG, 2016):

$$C_t = C_0.e^{r.t} \tag{3.35}$$

Where C_t is the final capital; C_0 is the initial capital; e is the Euler's mathematical constant; r is the rate and t is the time. The continuous compounding happens when the periods of compounding are infinitely small. Equation (3.35) comes from:

$$C_t = C_0(1+r)^t \tag{3.36}$$

Taking m as the number of compounding period, the amount C_t is obtained by:

$$C_t = C_0\left(1+\frac{r}{m}\right)^{t.m} = C_0\left[\left(1+\frac{r}{m}\right)^m\right]^t \tag{3.37}$$

Being $a = \frac{m}{r}$, then $\frac{1}{a} = \frac{r}{m}$ and $m = a.r$. Thus, equation (3.37) may be written as:

$$C_t = C_0\left[\left(1+\frac{1}{a}\right)^{a.r}\right]^t \tag{3.38}$$

Since:

$$\lim_{a\to\infty}\left(1+\frac{1}{a}\right)^a = e \tag{3.39}$$

Then:

$$C_0\left[\lim_{a\to\infty}\left(1+\frac{1}{a}\right)^a\right]^{r.t} = C_0.e^{r.t} \tag{3.40}$$

That is, as the number of compounding periods tends to infinity, an instantaneous compounding is performed. Under this condition, the amount C_0 approximates to equation (3.35), that is originated from (3.36), as demonstrated in equations (3.37), (3.38), (3.39) and (3.40). The similarity between equations (3.30) and (3.33) follows the same process even though both represent a present value of future flows instead of a future value. In a cash flow system the present value is given by (CIPRA, 2010):

$$PV = CF_0 + \frac{CF_1}{1+i} + \ldots + \frac{CF_n}{(1+i)^n} = \sum_{t=0}^{n}\frac{CF_t}{(1+i)^t} \tag{3.41}$$

Where PV is the present value; CF is the cash flow; i is the rate and n is the number of analyzed periods. Using the process from equation (3.36) to (3.40) is enough to convert equation (3.41) into a cash flow under a continuous discount regime. If the continuous discount cash flow spreads across time to perpetuity, then the present value would be:

$$PV = \int_0^{\infty} CF.e^{-i.t}dt \tag{3.42}$$

Notice the equations (3.30) and (3.42) have the same structure, as well as the equations (3.33) and (3.41). In summary, Rubin et al. (2013)'s model is a present value under a continuous discounting approach and what we have done up to equation (3.33) was just putting it into a discrete discounting approach. This adequacy is necessary for the practical implementation of the model, considering that the accounting figures of credit unions, as in any organization, are not continuous in time but are released periodically.

3.3.2 Replacing infinite time

Although the equation (3.33) circumvents the issue of a continuous function, it still needs adaptations. The infinite component ∞ is another feature that should be adapted to enable a practical implementation. Since the infinite values of future cash flows are unobservable, it is necessary to develop an alternative form to obtain the value in the future. Based on the literature about cash flow valuation, in this section, we show a form to replace the infinity component by a terminal value using perpetuity and expected growth.

Damodaran (2012) explains that to determine the value of a firm using cash flow, first, it is necessary to choose between a going or a liquidation approach. In a going approach one assumes that the firm continues to deliver cash flows in perpetuity, that is, is not expected to shut down at some point in time. Differently, in a liquidation approach one assumes that the business will be liquidated, eventually. In this study, the going approach will be used. It will be assumed that the studied organizations do not have any predictable or deliberated liquidation point in time. That is, the organizations are intended to continue over time. For this reason, a liquidation approach will not be addressed.

In a going approach, the main problem is that the cash flow cannot be estimated forever. Therefore, is necessary to stop the cash flows sometime in the future and then compute a terminal value that reflects the value of the firm at that point (DAMODARAN, 2012). Alternatively, the infinite flow should be replaced by a terminal value with perpetual series, which is that

whose payments and receipts extend ad *ad aeternum*. Including a terminal value requires caution, because it may strongly influence the value and be biased (LIU; NISSIM; THOMAS, 2002). Notwithstanding, many remarkable studies about firms evaluation research demonstrate that terminal value with perpetual series has been used oftentimes in firms' value estimation. Those studies include implementation of recognized techniques such as discounted cash flow (DECHOW; HUTTON; SLOAN, 1999; GALDI; TEIXEIRA; LOPES, 2008; LEE; MYERS; SWAMINATHAN, 1999; MA; WHIDBEE; ZHANG, 2011) and Ohlson's model (OHLSON, 1990, 1991, 1995). The terminal value is added in cash flow to provide the value of the firm as follows (DAMODARAN, 2012):

$$V = \sum_{t=1}^{t=n} \frac{CF_t}{(1+i)^t} + \frac{TV}{(1+i)^n} \tag{3.43}$$

Where V is the value of the firm; CF_t is the cash flow at time t; i is the rate; TV is a perpetual series that represents the terminal value. A perpetual series is calculated by equation[8]:

$$PV = \frac{CF}{i} \tag{3.44}$$

Where the PV is the present value; CF is the cash flow; i is the rate. In the equation above the cash flow will be constant. However, it is necessary to consider if there will be some growth rate of the cash flows. In this case, it is necessary to include the expected growth rate (KOLLER; GOEDHART; WESSELS, 2010; DAMODARAN, 2012):

$$P = \frac{CF}{i-g} \tag{3.45}$$

Where g is the expected growth rate of cash flows. Koller, Goedhart, and Wessels (2010) recommend that the cash flow-based firm value be projected in more details in the early years. However, from a certain point, projecting the earnings year by year becomes unimportant. From this point, the value based on perpetuity can be used. The estimation of terminal value should be done carefully since it is usually a significant part of the total value (KOLLER; GOEDHART; WESSELS, 2010). An important component of the terminal value is the rate of growth g. As Damodaran (2012) states, since the firm has grown it is difficult to maintain a high rate of growth. Therefore, it will be at best equal to the growth rate of the economy in which the firm operates.

[8] Morin and Dabadghao (2012).

A stable growth rate that is sustained in perpetuity enables the estimation of future cash flows as a terminal value (DAMODARAN, 2012).

From the considerations above, replacing the infinite cash flow in equation (3.33) by a finite cash flow with a terminal value, as in equation (3.43), the calculation of credit union value in this study will be:

$$CV = \sum_{t=1}^{n} \frac{B_t + S_t}{(1 + p(E,L)_t)^t} + \frac{TV}{(1 + p(E,L)_n)^n} \tag{3.46}$$

Where

$$TV = \frac{B_n + S_n}{p(E,L)_n - g} \tag{3.47}$$

$$B = L_{cu}(l_m - l_{cu}) \tag{3.48}$$

$$S = D_{cu}(d_{cu} - d_m) \tag{3.49}$$

Notice that the infinite component was replaced by a terminal value, which provides an observable equation. The equations above can be used as a general model of measurement for credit union value creation subject to constraints regarding credit unions operations in equations (3.31) and (3.32). So far there have been no structural changes from Rubin's model. The changes related to the terminal value and the discrete function are simply towards the implementation of the equation (3.30). The number of periods "n" was defined to be equal to three. (MA; WHIDBEE; ZHANG, 2011) explain that truncating the horizon inevitably introduces estimations errors, but the value "CV" is not sensitive to the choice of "n" if "n" equal or greater than three (LEE; MYERS; SWAMINATHAN, 1999).

To find benefits to borrowers B the market rate l_m has been given by the official BCB's index "Average Cost of Outstanding Loans, in Portuguese "Indicador do Custo de Crédito (ICC)" provided by the Time Series System of the Central Bank of Brazil (BCB, 2019c). According to BCB (2018), the ICC index is divided into two groups modalities of credit: earmarked and non-earmarked (or "free application"). The earmarked loans operations must be designated for particular purposes (e.g. real estate financing, rural credit). Non-earmarked loans are funding

by deposits or equity, do not have to be designated for specific purposes and are usually more expensive than earmarked ones.

The difference in interest rates should not be given by total loans, but consider only non-earmarked resources. Earmarked loans are generally cheaper for borrowers because they come from particular funding and are usually provided by public banks. Especially rural or free-admission credit unions also provide earmarked loans, coming from specific funding, for rural financing, but usually with less volume than public banks. Besides, earmarked loans have standardized interest rates. Consequently, the difference in rates in this modality is little or null. Therefore, only the non-earmarked ICC index (market rate) will be considered for comparisons. Consequently, also only non-earmarked loans of credit unions will be considered.

Earmarked and non-earmarked loans in credit unions are not directly segregated in assets side of public available trial balance sheets. However, it is possible to segregate them from the liabilities side. On the side of liabilities, the funding for earmarked loans is identifiable from external credit accounts as well their cost in expenses accounts. Assuming that the credit union does not gain any spread in earmarked operations (as it should be, because they are controlled by BCB), we can assume that average expenses are the same as loans income for those operations. Similarly, the outstanding earmarked loans can be found from the balance of external credit accounts used to record earmarked funding. Frame 3.1 details calculation of the average interest rate or credit union comparable to ICC - non-earmarked.

Frame 3.1 – Calculation of the average interest rate of credit unions loans

Average interest rate of credit unions - non-earmarked loans		
Purpose: To measure average interest rates of credit unions comparable to ICC non-earmarked index		
COSIF account	**Official account title**	**Free translation**
a. 7.1.1.00.00-1	Rendas de Operações de Crédito	Loan income
b. 8.1.2.00.00-1	(-) Despesas de obrigações por empréstimos e repasses	Borrowed funding expenses
c. 1.6.0.00.00-1	Operações de crédito	Lending operations
d. 1.6.9.00.00-8	(-) Provisões para operações de crédito	Allowance for loans losses
e. 4.4.3.00.00-2	Repasses financeiros	Financial transfers
f. 4.6.0.00.00-2	Obrigações por empréstimos e repasses	Borrowed funds
Formula: $l_{cut} = (a_t - \lvert b_t \rvert)/(((c_t + \lvert d_t \rvert - e_t - f_t) + (c_{t-1} + \lvert d_{t-1} \rvert - e_{t-1} - f_{t-1}))/2)$		

Source: by the author (2019)

Briefly, the difference in loans interest rate will come from non-earmarked operations. The marked rates are obtained from the ICC index (BCB, 2018), while the comparable credit unions rates are obtained from trial balance sheets. The difference is then multiplied by the

average amount of non-earmarked loans of credit unions to find the benefits to borrowers (B) (3.48). [9]

Regarding savers benefits, given by the equation (3.49), the market rate has been given by the average of savings deposits rates in Brazil. It is provided by the Time Series System of the Central Bank of Brazil (BCB, 2019c). In turn, credit unions' savings deposits interest rates have been calculated from trial balance sheets according to Frame 3.2. The benefits to savers are then calculated from the difference between market and credit unions rates, times the amount of savings deposits, according to the denominator of the formula for d_{cu} in Frame 3.2.

Frame 3.2 – Calculation of the average interest rate of credit unions savings deposits

Average interest rate of credit unions savings deposits		
Purpose: To measure average interest rates of credit unions savings deposits		
COSIF account	**Official account title**	**Free translation**
a. 8.1.1.00.00-8	(-) Despesas de captação	Money market funding expenses
b. 4.1.4.00.00-9	Depósitos sob aviso	Savings deposits
c. 4.1.5.00.00-2	Depósitos a prazo	Savings deposits
d. 4.3.2.00.00-1	Recursos de letras imobiliárias, hipotecárias, de crédito e similares	Real estate credit notes, mortgage notes, credit and similar notes
Formula: $d_{cut} = (\lvert a_t \rvert)/(((b_t + c_t + d_t) + (b_{t-1} + c_{t-1} + d_{t-1}))/2)$		

Source: by the author (2019)

3.4 Defining the growth rate

Koller, Goedhart, and Wessels (2010) demonstrate value estimation is highly sensitive to the growth rate. According to the authors, it is difficult for most companies to grow faster than the economy for long periods. Because of that, they suggest the expected long-term rate of consumption growth for the industries products plus inflation. Damodaran (2012) also calls attention to growth rate as a critical input especially for high-growth firms and adds that long term growth rate is particularly difficult to estimate in emerging marks, like Brazil.

According to Damodaran (2018), predicting the growth of financial services firms is challenging despite the have historically been viewed as stable investments. Some of the valuation issues affecting financial services firms are the differences are leverage and regulation. As financial firms are usually high leveraged small swings in an asset can cause large shifts in

[9] The average amount of non-earmarked loans is the denominator of l_{cu} in Frame 3.1. ICC was converted from yearly to half-yearly basis due to data periodicity of this study.

equity value (DAMODARAN, 2018). Moreover, changes in regulatory limits and constraints can strongly influence growth (DAMODARAN, 2018).

Besides the aforementioned inherent problems to predict the growth of credit unions due to financial sector characteristics, another challenge is the business life cycle. Firms pass through different life cycles: start-up, young growth, mature growth, mature, and decline. The time spent in each stage varies. According to Damodaran (2018), the estimation of growth becomes easier in a mature phase, when operating history can be used. Unlikely, estimation of young growth firms is more difficult.

Based on Damodaran (2018)'s life cycle classification, in general, credit unions in Brazil seem to be in an intermediary stage between young growth and mature. For most of them, revenues and assets are growing, while there is already some operation history. How quickly will revenues and assets growth fade is uncertain for credit unions in Brazil? In other words, it is difficult to know how growth will change as they become bigger.

In addition to financial sector characteristics and life cycle phases, placement in emerging markets as Brazil also complicates expectations of future growth. As Damodaran (2018) observes, economic crises that visit emerging countries at regular intervals may affect growth rates. Indeed, Brazil has recently experienced a serious economic crisis, and currently, there is not a stable growth expectation yet. Therefore, growth rates should be defined with caution, given the non-mature stage of credit unions, issues inherent to the financial sector, and emerging market implications.

Small changes in growth rate can change the terminal value dramatically, especially when the growth rate approximates to the discount rate (DAMODARAN, 2012, 2018; KOLLER; GOEDHART; WESSELS, 2010). As the cited valuation experts assert, no firm can grow forever at a rate higher than the growth rate of the economy in which operates. Therefore, the maximum growth rate should be the growth rate in the economy. According to (DAMODARAN, 2018), setting the stable-growth rate to be less than or even equal the growth of the economy is a recommended procedure. Besides consistent, it ensures a growth rate lower than the discount rate.

Based on the literature and context of the studied organizations, the growth rate to be applied in terminal value in equation (3.47) will be the expected growth rate for the Brazilian economy. The data will be retrieved from the most updated analysts' average market exceptions in the BCB's report "Focus Market Readout" (BCB, 2019b).

Based on the literature and context of the studied organizations, the growth rate to be applied in terminal value in equation (3.47) will be the expected growth rate for the Brazilian economy. The data will be retrieved from the most updated analysts' average market exceptions in the BCB's report "Focus Market Readout" (BCB, 2019b).

3.5 Defining the discount rate

The discount rate p in Rubin et al. (2013) contemplates the time preference rate and the risk involved in future benefits. It is given by:

$$p = \frac{q}{s(E,L)} \tag{3.50}$$

Where q is a constant rate of time preference and the function $s(E,L)$ is the instantaneous probability of survival of the credit union according to the level of equity E in relation to the amount of loans L. The retention of earnings in equity both postpones benefit distribution and helps to protect the credit union against failure. When the ratio of equity to loans is low, members perceive a higher chance of failure and consequently have future benefits discounted at a relatively high rate. As reserves increase, the increase in credit union safety reflects a lower discount rate. As $E \to 0$ or $L \to \infty$, $s \to 0$. Contrariwise, as $E \to \infty$ or $L \to 0$, $s \to 1$. That is, the lower (higher) the proportion of equity concerning the volume loans, the lower (higher) will be the probability of survival of the cooperative, and the higher (lower) will be the discount rate (RUBIN et al., 2013).

To implement the model, it is then necessary to define the numerator and the denominator of the function p, which will provide the discount rate to the equation (3.46). The numerator q, which is the time preference rate, will be the basic official interest rate of the respective country. In the case of Brazil, it is the SELIC rate, whose historic series is easily found on BCB's website. As credit unions are financial organizations, opportunity cost related to benefits are strongly related to the interest rate from central banks. Therefore, q is directly observable and no complex procedures are necessary to establish it.

Differently, the denominator s is not directly observable and requires some procedures to be obtained. The s component adjusts the rate q according to the risk. In this work, following previous literature (BLANCHARD, 1985; RUBIN et al., 2013), s is the probability of credit union survival. This probability comes from the risk of credit union failure, which has been calculated in Chapter 2.

The probability of survival of the credit union i at the time t is given by:

$$s_{it} = 1 - r_{it} \tag{3.51}$$

Where r is the probability of credit unions failure, as calculated in Chapter 2.

As the equation (3.50) shows, higher the survival probability, lower is the risk. The values of variables s and r in equation (3.51) fall between 0 and 1. A risk r equal 0 would return a probability of survival equal to 1. Consequently, the discount rate p would be exactly the time preference rate q. That is, the discount rate would not contain a risk component, only the time preference.

However, zero-risk status does not occur. As far as the risk r increases, the probability of survival s decreases, assuming a value lower than 1. Consequently, a component of risk is added to the equation (3.50). In summary, the discount rate p comes from the official interest rate composing the denominator q and the risk component coming from Chapter 2, composing the probability of survival s. The higher is the risk and official interest rates, the higher is the discount rate, and the lower is the credit union value.

4 FINDINGS

This section presents the results of the empirical application of the models developed in this chapter. The results will be the base to the dependent variable, the value created, in Chapter 4. The equation (3.46) detailed in the Methodology provided the basis to measurement value created by credit unions for their members.

As established in the Methodology, the benefits to borrowers and savers provide the basis to find credit union value. The benefits to borrowers come from the difference between the market interest rate and credit union interest rate, times the volume of credit union deposits or loans [10].

Borrowers and savers benefits are then included in a discounted cash flow calculation that provides the present value of future benefits [11] . For that purpose, a discount rate is put into effect and growth rate is also required to calculate terminal value. The next subsections present

[10] Recall equations (3.48) and (3.49), where benefits to borrowers $(B) = L_{cu}(l_m - l_{cu})$, and benefits to savers$(S) = D_{cu}(d_{cu} - d_m)$

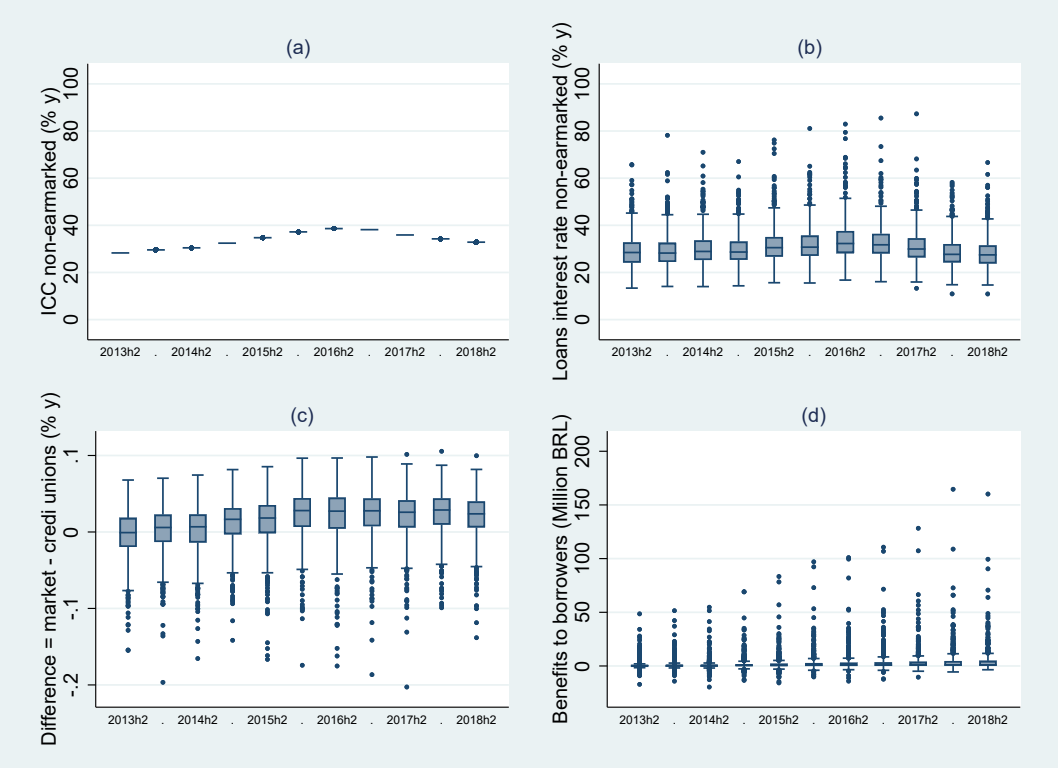
[11] Recall equation (3.46).

the results of the calculation of borrowers and savers benefits as well as the discount rate and growth rate. Finally, the discounted value over time is presented.

4.1 Benefits to borrowers

As it was explained previously, three variables comprise benefits to borrowers (*B*): amount of credit union loans, credit union loans interest rates, and market loans interest rate. It is interesting to have a look at these three variables, besides the benefits. Figure 3.4 presents those four variables.

Figure 3.4 – Distribution of credit unions regarding benefits to borrowers from 2013 to 2018



Source: by the author(2019)

Figures 3.4 (a) and 3.4 (b) show the market rate and credit unions rate respectively. Both are on the same scale and yearly basis to facilitate interpretation. According to the Methodology, both refer to non-earmarked. That is, they comprise modalities of credit under which financial institutions can take discretionary decisions (e.g. regarding time, interest rates, amounts, and purpose). The market interest rate has a unique value for each period, which reflects the average of the credit market. The credit unions' loans interest rate varies over time and individuals. The boxes plots, or "dispersion diagrams" provide a graphic notion of distribution indications the

median (horizontal line inside box), 25th and 75th quartiles (box's lower and upper hinges), and outside values (dots).

Figures 3.4 (a) and 3.4 (b) reveal the median of credit unions interest rate is slightly lower the market rate. It indicates most of the credit unions charge lower interest rates than the average of the credit market for non-earmarked operations. However, there are also many cases of credit unions charging rates above the market average. Also, the graphs indicate a correlation between credit unions and market interest rates. Both increased when SELIC achieved its top values within the period (2015 and 2016) when the median of credit unions rates remained below market rates index.

Figures 3.4 (c) just reflects the difference between market and credit union loans interest rates exposed in 3.4 (a) and 3.4 (b). It confirms that most of the rates are favorable to credit unions members if compared to the average market, but there are more expensive rates. Figure 3.4 (d) results from values in Figures 3.4 (c) times the volume of credit unions loans. That is, Figure 3.4 (d) shows the monetary benefits to borrowers. There are not only positive values, which means some credit unions are more expensive to borrowers than is the average market. However, as Figure 3.4 (d) shows, most of them generate benefits to borrowers.

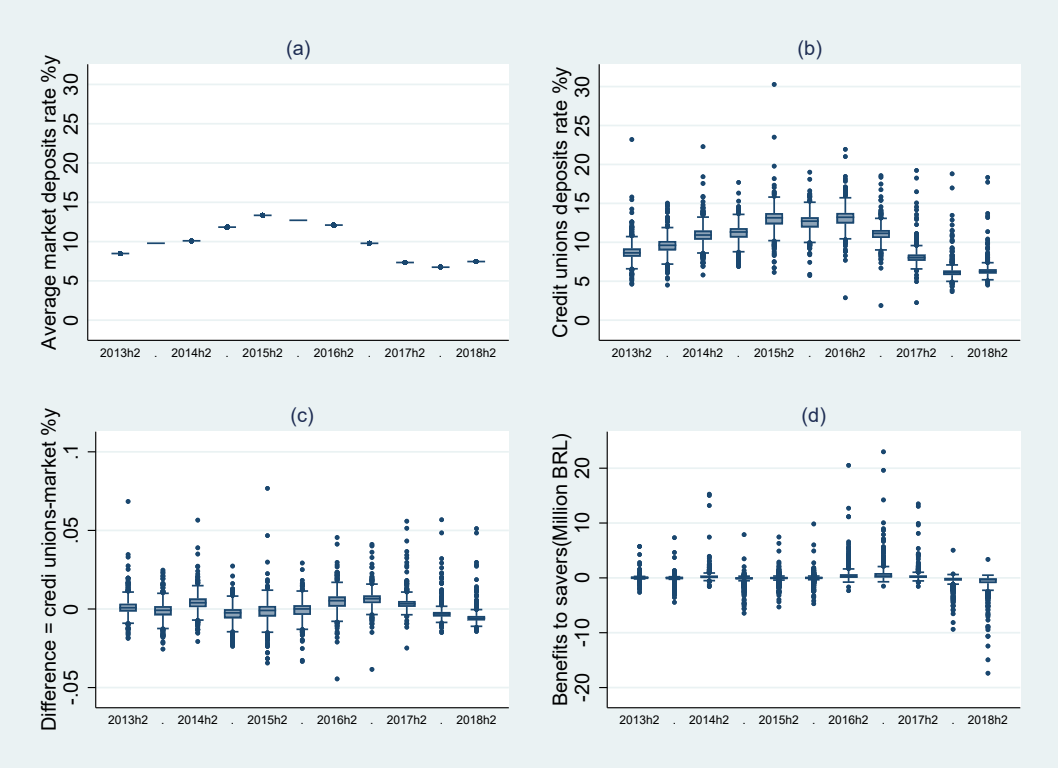
The evidenced benefits to savers provided by Brazilian credit unions confirm the theorists' models addressing economic benefits do members (PATIN; MCNIEL, 1991a,b; RUBIN et al., 2013; SMITH; CARGILL; MEYER, 1981; SMITH, 1984, 1986; TAYLOR, 1971; WALKER; CHANDLER, 1977). In this sense, credit unions do create value to members not as owners, but as customers (SPENCER, 1996). The results of this study comprehensively confirm previous studies indicating that credit unions in Brazil usually charge lower interest rates on loans than other financial institutions (e.g., DAL MAGRO; MICHELS; SILVA, 2017; BRESSAN et al., 2013; DA SILVA et al., 2017; SOUSA DE ABREU et al., 2018).

The benefits to borrowers shown in Figure 3.4 (d) are the basis to calculate the value for members, which will be presented in Subsection 4.5.

4.2 Benefits to savers

Benefits to savers are found like benefits borrowers. Three variables comprise benefits to savers S: amount of credit unions savings deposits, credit unions savings deposits interest rates, and market savings deposits interest rate. Figure 3.5 presents benefits do savers and its components.

Figure 3.5 – Distribution of credit unions regarding benefits to savers from 2013 to 2018



Source: by the author(2019)

Figures 3.5 (a) and 3.5 (b) show the market rate and credit unions rate for savers respectively, both in the same scale. While the former shows the average market in each semester from 2013 to 2018, the latter shows the distribution of credit unions' interest rates on savings deposits in the same period. The figures reveal the median of credit unions' rates, given by the line inside the boxes, follows the market rate. As a consequence, the difference of credit unions (median) and market rates is zero, as Figure 3.5 (c) shows. It can be noticed that the medians of rates differences (lines inside the boxes in Figure 3.5 (c)) alternate between positive and negative values near zero.

Figures 3.5 (d) shows the distribution of credit unions regarding benefits to savers (S) in million BRL. It results from the difference of rates shown in Figure 3.5 (c) times the amount of credit union's savings deposits. Likely differences of rates, benefits for savers vary around zero with some extreme observations that come from the largest credit unions. Hereupon, in the last two semesters, extreme negative values indicate the largest credit unions were providing lower interest rates on deposits than the average of the market. However, they were providing higher rates in the previous semesters, as positive extreme values indicate. Most credit unions,

nevertheless, present benefits to savers near zero as a consequence of the very similar rates of market and credit unions interest on deposits.

The findings on benefits to savers differ somehow from the classic literature while confirms some empirical studies in Brazil. While data evidenced significant benefits to borrowers provided by Brazilian credit unions, the benefits to savers are more limited to confirm the theorists' models addressing economic benefits do members (PATIN; MCNIEL, 1991a,b; RUBIN et al., 2013; SMITH; CARGILL; MEYER, 1981; SMITH, 1984, 1986; TAYLOR, 1971; WALKER; CHANDLER, 1977). This is not the first study indicating benefits to savers are lower than those to borrowers. The investigations done by Bressan et al. (2013) and Bressan, Braga, and Bressan (2012) and by Bressan, Braga, and Bressan (2012) reveal that while credit unions in Brazil provide better saving and loan rates in comparison to banks, they are borrower-dominated in the sense of Patin and Mcniel (1991a,b). That is, they provide more benefits to borrowers than to savers. This study confirms the borrower-orientation of Brazilian credit unions.

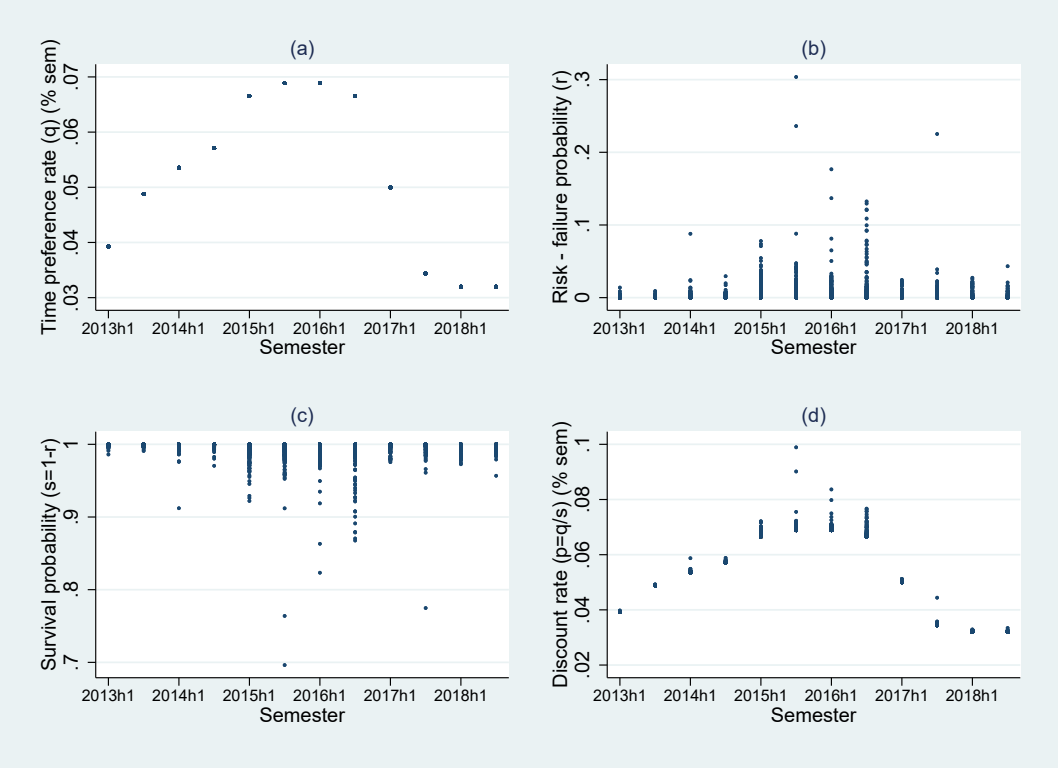
4.3 Discount rate

Figure 3.6 shows the discount rate from 2013 to 2018, according to Methodology, along with its components. All of them are on a half-yearly basis. Figure 3.6 (a) shows the time preference rate. According to the Methodology, it comes from the SELIC rate. As can be noticed it considerably increased achieving its apex in 2015 and 2016, and decreased to near 3% in the second half of 2018.

Figures 3.6 (b) and 3.6 (c) show the probability of failure and survival respectively. The probability of failure comes from Chapter 2, and the probability of survival is one minus it. Probability of survival varies over individuals and time. As can be noticed, it also increased in 2015 and 2016 reflecting the economic crises. Also, during the crises variance of risk across individuals increased. Nonetheless, as the failed credit unions are not considered in this chapter to evaluate the value, the graphs only show non-failed credit unions. For those surviving credit unions, the graphs show the maximum (minimum) probability of failure (survival) was near 30%(70%) in the second half of 2015. But most credit unions have stayed at a survival probability higher than 90% most of the time.

Finally, 3.6 (d) shows the discount rate from 2013 to 2018, which will be used in the value measurement. It simply reflects the time preference rate individually adjusted according to survival probability. Consequently, in general, it also increased especially in 2015 and 2016, and

Figure 3.6 – Discount rate from 2013 to 2018



Source: by the author(2019)

after decreasing. From the discount rate in Figure 3.6 (d), we can infer how the value will be properly adjusted according to general market interest rate (coming from SELIC) and individual risk varying over time. The overall mean of half-yearly discount rate from 2013 to 2018 is 5.17%, with a minimum of 3.19% in the second half of 2018 and a maximum of 9.89% in the second half of 2015.

4.4 Growth rate and interest rate for terminal value

The growth rate was defined in the Methodology as the expected growth for the Brazilian economy. As the growth rate will be used to compose the terminal value in the value measurement, we tried to obtain the growth rate as much in the future as possible. The final available estimation is for 2022. According to the median of analysts' expectation (BCB, 2019b), the future growth of Brazilian GDP is expected to be 2.5% in 2022. The percentage of growth was then adjusted to a half-yearly basis to take into account the semi-annual periodicity of data used in this study.

The final interest rate was also estimated from market analysis (BCB, 2019b). According to their median analysis, SELIC is expected to be 7.5% yearly at the end of 2022, the final year for which market expectations are available. The expected interest rate was converted to a

half-yearly basis and adjusted by the last individual risk, following the individual risks according to the previous subsection. The minimum final individually adjusted discount rate is 3.68% half-yearly. As a result, in the terminal value, the discount rate is properly higher than the growth rate. According to the referential literature (DAMODARAN, 2018, 2012; KOLLER; GOEDHART; WESSELS, 2010), growth rate must be lower than the discount rate, because the latter is partially a consequence of the former. Therefore, the theoretic requirement regarding discount rate and growth is met.

4.5 Value to borrowers and savers

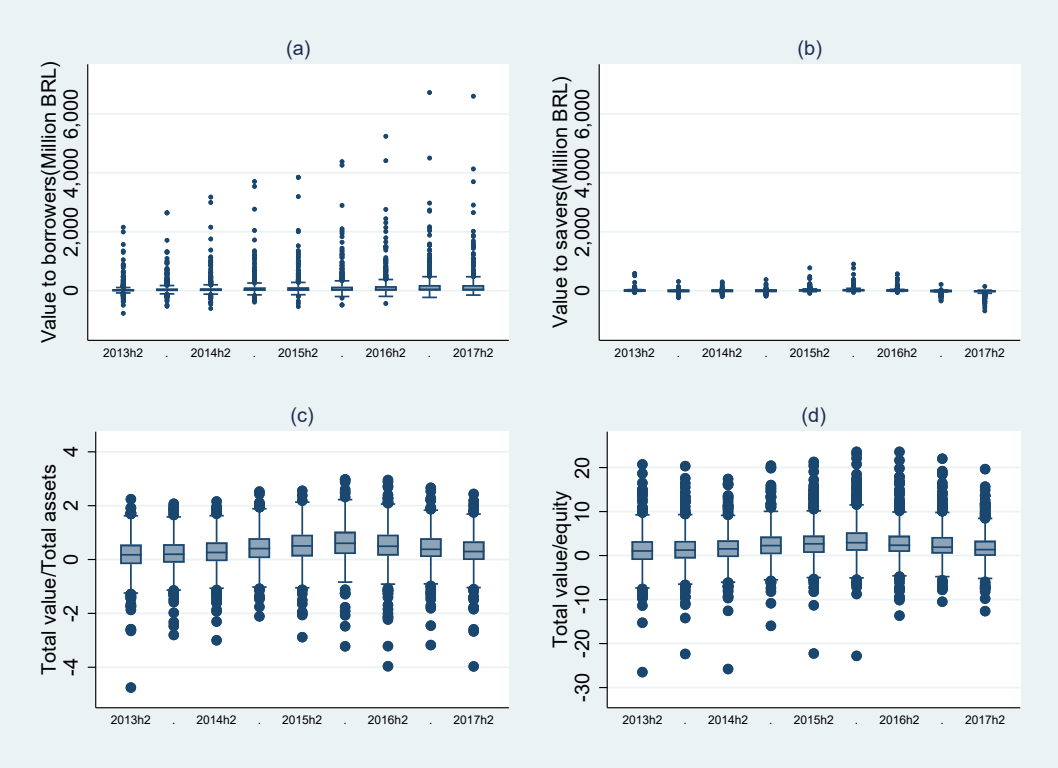
The value of credit unions has been calculated according to the equation 3.46 in Methodology. It is a present value of discounted cash flow of benefits to borrowers and savers. Based on the literature (DAMODARAN, 2018; MA; WHIDBEE; ZHANG, 2011; RUBIN et al., 2013), we included a sum of three semesters (t) plus a terminal term to calculate the value. In this sense, the value of credit unions calculated in this subsection represents their intrinsic value, as it has been exposed in the literature review (BOENING; WILLIAMS; LAMASTER, 1993; LEE; MYERS; SWAMINATHAN, 1999; LIU; NISSIM; THOMAS, 2002; MA; WHIDBEE; ZHANG, 2011; SUBRAMANYAM; VENKATACHALAM, 2007)[12]. In summary, value comes from the benefits to borrowers (Subsection 4.1) and savers (Subsection 4.2) considering the discount rate according to the Subsection 4.3 and terminal value using growth and discount rates according to the Subsection 4.4.

Figure 3.7 summarizes the distribution of absolute value for borrowers and savers as well as relative total value from 2013 to 2017. Figure 3.7 (a) and Figure 3.7 (b) show the absolute value for borrowers and savers respectively, in million BRL. In turn, Figure 3.7 (c) and Figure 3.7 (d) show the total value (sum of value to borrowers and savers) scaled by total assets and equity respectively.

Findings reveal that in general credit unions have more value to borrowers than to savers. Figure 3.7 (a) show that exists a big variability on values to borrowers, which is mainly because of credit unions' size. It also indicates most credit unions have generated positive values to borrowers and it presents an apparent growing trend. In the same scale, Figure 3.7 (b) shows that value for savers is lower and near zero. These results are in line with subsections 4.1 and 4.2 that demonstrate benefits to borrowers and savers. While there is a big heterogeneity in absolute

[12] Recall Subsection 2.1 on concepts of value

Figure 3.7 – Value to members from 2013 to 2017



Source: by the author(2019)

values, Figure 3.7 (c) and Figure 3.7 (d) show that total value scaled by total assets or equity is less dispersed.

Tests indicate that values both to borrowers and savers are greater than zero in the studied period (Tables 3.1 and 3.2). The normal distribution has been not met. Then, non-parametric sign tests were undertaken for each semester. Value to borrowers is higher than zero in all periods. The evidence indicates that credit unions consistently generate value to borrowers over time.

Value to savers is not as prominent as value to borrowers. Table 3.2 shows that value for savers alternate between positive and negative values. There are semesters with negative value and in the first semester of 2015 a two-sided test indicate that value to savers is not statistically differenced to zero. Despite the oscillation near zero, the total value to savers for all the period from 2013 to 2018 is positive. Nonetheless, it has been evidenced that credit unions are more advantageous to borrowers than to savers.

An analysis taking into account both value to borrowers and savers provides a notion of total credit union value for all members. Table 3.3 provides more details about total value, both to borrowers and savers, scaled by total equity. Value is positive in all semesters and curiously has achieved its peak in the first semester of 2016 when SELIC interest rate reached its maximum

Table 3.1 – Value to borrowers from 2013 to 2017 scaled by equity

Semester	obs	mean	sd	median	p-value(1)
2013h2	654	0.707	3.937	0.731	0.000
2014h1	657	1.756	3.885	1.562	0.000
2014h2	659	1.742	3.545	1.687	0.000
2015h1	658	2.599	3.582	2.332	0.000
2015h2	655	2.392	3.525	2.252	0.000
2016h1	653	2.611	3.695	2.255	0.000
2016h2	653	2.481	3.972	2.035	0.000
2017h1	643	2.868	3.857	2.273	0.000
2017h2	638	2.439	3.612	1.956	0.000
Total	5870	2.175	3.788	1.895	0.000

Source: by the author (2019)
(1) Ho: median=0 Ha:median>0

Table 3.2 – Value to savers from 2013 to 2017 scaled by equity

Semester	obs	mean	sd	median	p(1)
2013h2	654	0.469	1.102	0.392	0.000
2014h1	657	-0.410	1.035	-0.283	1.000
2014h2	659	-0.171	1.187	-0.082	1.000
2015h1	658	-0.079	0.853	-0.005	0.623
2015h2	655	0.550	1.084	0.463	0.000
2016h1	653	0.801	1.201	0.663	0.000
2016h2	653	0.464	0.703	0.366	0.000
2017h1	643	-0.355	0.540	-0.328	1.000
2017h2	638	-0.660	0.624	-0.605	1.000
Total	5870	0.070	1.071	0.036	0.000

Source: by the author (2019)
(1) Ho: median=0 Ha:median>0

value in the analyzed period, and when a change in GDP was negative (recall Figure 2.6 in the previous chapter). Note that in the intermediary semesters the mean is higher, and also is the median.

Table 3.3 provides more details on credit unions value concerning book value over time, estimated according to the Methodology. The general mean is 2.24, and it varied between 1.17 and 3.4 in the period of analysis. These figures indicate the ratio of intrinsic value divided to book value. It means that, in general, the value of credit unions to members overcome the equity in balance sheets.

Table 3.3 – Descriptive statistics of value/equity from 2013 to 2017

Semester	obs	min	max	mean	sd	cv	median	p(1)
2013h2	653	-26.48	20.72	1.173	4.245	3.620	1.048	0.000
2014h1	656	-22.36	20.33	1.345	4.010	2.983	1.249	0.000
2014h2	658	-25.79	17.41	1.570	3.862	2.460	1.520	0.000
2015h1	657	-15.97	20.44	2.520	3.826	1.518	2.266	0.000
2015h2	654	-22.25	21.27	2.943	3.992	1.356	2.664	0.000
2016h1	652	-22.80	23.58	3.414	4.243	1.243	2.921	0.000
2016h2	652	-13.65	23.57	2.946	4.153	1.410	2.345	0.000
2017h1	642	-10.49	22.02	2.516	3.772	1.499	1.901	0.000
2017h2	637	-12.63	19.64	1.781	3.434	1.928	1.355	0.000
Total	5861	-26.48	23.58	2.245	4.026	1.794	1.912	0.000

Source: by the author (2019)
(1) Ho: median=0 Ha:median>0

Overall, findings are in line with literature on credit unions. In a nutshell, the main theorists (SMITH; CARGILL; MEYER, 1981; RUBIN et al., 2013; TAYLOR, 1971) agree that the objective of credit unions is to maximize benefits to members by offering better interest rates on loans and savings than those that could be found in the money market. The investigation outcomes evidence that in average credit unions have been achieving its objective.

Concerns on the equilibrium between benefits to borrowers and savers (PATIN; MCNIEL, 1991b; SMITH; CARGILL; MEYER, 1981; TAYLOR, 1971) have been addressed. Findings are in line with results of Bressan et al. (2013) and Bressan, Braga, and Bressan (2012), which studied Brazilian credit unions of the Sicoob group from 2000 to 2008 and found they were more oriented to borrowers. In this study, findings also indicate more benefits to borrowers than to savers.

The market of savings is more homogeneous, that is, there are not so many kinds of categories of products and rates closely follow SELIC. On the other hand, the market of loans has higher rates and many kinds of purposes. The less competitive market of savings if compared to the market of loans could partially explain the lower difference of rates for savers.

This study has implemented an observable model based on the generalized model developed by Rubin et al. (2013). The model has proved to be feasible to estimate credit unions' value and put the benefits into a dynamic evaluation which considers the present value of future benefits. Having estimated value of credit unions over time now raises the issue on which are the

main variables that determine the value creation by credit unions to their members, which will be addressed in the next chapter.

5 CONCLUSION

This chapter has provided an estimation of Brazilian credit unions' value to borrowers and savers from 2013 to 2017. The estimated value will be employed in a panel data regression as a response variable to investigate which are the main variables that determine the value of credit unions to their members. The value of credit unions to members is assumed to be the present value of benefits to borrowers and savers. In turn, the benefits come from the difference in interest rates on loans and deposits times the respective volume of operations.

Overall, findings indicate that credit unions in Brazil create value to their members. The value creation is more evident to borrowers than to savers. Value to borrowers is positive in each semester from the second semester of 2013 to the second semester of 2017. Differently, value to savers is positive if considering the whole period, but there are semesters in which value is negative or statistically equal zero. The sum of value to borrowers and savers is positive in each semester.

It has been interesting to notice that semesters with higher mean and median of total value coincide with periods when market interest rates were higher. That is, when the economic scenario was worse, value increased. It suggests that credit unions are more valuable to members especially when the credit market is more unfavorable to borrowers. As a consequence, they also might benefit the economy when credit is more expensive and restrict. This and other factors influencing the value of credit unions to members will be verified in more details in the next chapter. The outcomes of this chapter will be used to formulate a dependent variable to investigate cause and effect relationships that could explain what variables make credit unions create more or less value.

Although this chapter is part of a sequential procedure, its findings are useful by themselves. Scholars, policymakers, credit unions, and their members can benefit from this study. The contribution of scholars is mainly related to the empirical applications of a recent developed model of measurement, which can also be used with other objectives. Policymakers can find pieces of information to implement politics in fields as financial system efficiency, economic development, social policy, and regulation. Findings are especially relevant for members of credit unions, who can observe if they create value and how they have been doing it. Finally, credit

unions can also benefit from the study to controllership and make decisions mainly regarding interest rates on loans and deposits in favor of their operations and their members.

Limitations of the chapter are mainly related to the limitation of publicly available data. For example, the study does not consider value created by the difference of fees on services, which would require more detailed accounting and operational data. Further, it does not considers net income distributed to members. Consequently, the value may have a downward bias. Any future study aiming to include net income in value creation using a similar model should include only distributed (not retained) surplus. That is because retained surplus, even in the form of share capital, do not fit the concept of benefits to members that could be included in a discounted cash flow formulation. Similarly, interest rates on a capital only could be included if they were higher than the discount rate because they keep retained at long-term.

A quick search of publicly available financial statements of credit unions reveals that distributing surplus in form of cash (in members accounts, for example) sometimes occurs, but it does not seem to be a common practice of the average Brazilian credit union. Most of them convert most of the surplus to reserves and member's share capital. Nonetheless, a future study including surplus distribution would be relevant to verify its impact on credit unions' value.

Another interesting study would be on the impact of credit unions operation on the Brazilian financial system regarding interest rates on loans. They could have influenced the market, despite their market share is still small. Findings demonstrated that credit unions interest rates, in general, were cheaper than other financial institutions, especially in the most critical period of economic crisis. Therefore, it is reasonable to believe that without the credit unions market interest rates could be even higher in periods of crisis.

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CHAPTER 4 GENERAL CONCLUSION

The overall objective of this project was to assess the value creation by credit unions to their members. This approach, focused on benefits to members instead of to credit unions themselves, has been widely discussed by the literature for more than 40 years. Since the precursor theoretical article on credit unions economics (TAYLOR, 1971), many researchers have sustained the notion that credit unions must create value for members by offering pecuniary benefits that come from better interest rates on loans and savings than those offered by traditional financial institutions like banks.

Despite the recognized pertinence of the objective function of credit unions established by theorists (RUBIN et al., 2013; SMITH; CARGILL; MEYER, 1981; TAYLOR, 1971), most empirical studies have not adopted it as a guide to measuring performance. Instead, most empirical studies have assessed credit unions performance by focusing only on measurements that are more suitable to for-profit non-cooperative institutions. That is, studies have been insisting on applying measurements, like net income or profitability to evaluate credit unions performance. However, the metric recommended by the most recognized theoretical works to assess credit union value to the member is different. Performance of credit unions should take into account the value for members.

That credit unions value is evaluated basically from the pecuniary benefits generated to members is fairly a consensus. Nevertheless, the field lacks studies that empirically investigate such form of performance appraisal. This thesis contributes to the literature in this sense. Specifically, it investigates to which extent Brazilian credit union have been creating value to their members.

The study evaluates credit union value based on a dynamic model as provided by Rubin et al. (2013), which based on previous well-known static models (SMITH; CARGILL; MEYER, 1981; WALKER; CHANDLER, 1977; TAYLOR, 1971). The model is based on the flow of benefits to members over time discounted by a rate. The discount rate takes into account risk and time preference. Thus, two main efforts have been made to calculate value: discount rate and the discounted benefits over time.

Regarding the first effort, the study had to face a limitation: as credit unions do not participate in the stock market there is no individual risk estimation available, as a beta for the Capital Asset Pricing Model. Then, to calculate discount rate, individual time-varying risk has been estimated based on PEARLS ratios system and macroeconomic conjuncture. In a nutshell,

a logistic regression considering failed and non-failed credit unions have proved to be capable to provide a reasonably accurate risk estimation.

Among the main indicators of risk, the most significant for the sample is the quality of loans. Credit union failure is strongly related to delinquent loans. However, other financial indicators are also important: solvency, the proportion of deposits and external credit concerning assets and growth in members' share capital. Besides PEARLS ratios, size, kind of bond, and change in GDP also influenced failure rates. Overall, Brazilian credit unions present a low risk. They also were resilient, although not immune, to a recent economic recession.

Having estimated risk, the study calculated benefits to the member to find credit unions value. Data revealed that credit unions benefit members and the present value of discounted benefits is significant. The value for borrowers is outstanding, but for savers, it is nearly null. Considering value for both savers and borrowers, credit unions in Brazil do create value to their members. The findings consistently confirm affirmation that credit unions contribute to the financial system since they provide reduced spreads in a country where credit market is extremely expensive and highly concentrated.

A reviewer concerned to credit unions will find very few studies dedicated to assessing credit unions value in terms of their capacity to generate economic benefits to their members. The lack of research in this area is even greater when it comes to dynamic evaluation models. Therefore, this study aimed to contribute to reducing this deficiency. Future studies could improve the discussion mainly through research in other countries or cross-country comparisons, alternative ways to calculate risk, and cause-effect investigation on which variables make credit unions more or less valuable to members.

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APPENDIX A – Stata procedures

This Appendix presents command for Stata that have been used in this study and have not been detailed over the text.

Pooled logit model with cluster-robust standard errors to correct for error correlation over time for a given individual:

```
. logit y x1 x2 ... xk, vce(cluster id) nolog
```

Population-average with exchangeable errors and panel-robust VCE

```
. quietly xtlogit y x1 x2 ... xk, pa corr(exchangeable) vce(robust)
```

Logit random-effects:

```
. xtlogit y x1 x2 ... xk, re nolog
```

Conditional Logit fixed-effects:

```
. xtlogit y x1 x2 ... xk, fe nolog
```

`nolog` option suppresses display of the iteration log

Example to display a table to compare estimates:

```
. global xlist x1 x2 ... xk
. quietly logit y x1 x2 ... xk, vce(cluster id)
. estimates store POOLED
. quietly xtlogit y x1 x2 ... xk, pa corr(exchangeable) vce(robust)
. estimates store PA
. quietly xtlogit y x1 x2 ... xk, re
. estimates store RE
. quietly xtlogit y x1 x2 ... xk, fe
. estimates store RE
. estimates table POOLED PA RE FE, equations(1) b(%8.3f) se(%8.3f)
> p(%4.3f) stats(N ll)
```

The table will show the parameters (b), standard errors (se) and p-values (p) of each covariate. The statistics will include samples size (N), the log likelihood (ll) of each model. Optionally, using `star` would show coefficients with asterisks to denote significance. In this case `se` and `p` must be suppressed.

Comparing fixed and random effect using Stata through Hausman test:

a) estimating the random effect model: `xtreg y x1 x2 ... xk, re` ;

b) storing the random effect estimation: `estimates store random_effects` ;

c) estimating the fixed effect model: `xtreg y x1 x2 ... xk, fe ;`

d) applying the Hausman test: `hausman . random_effects .`

Installing the `xtserial` test:

```
. findit xtserial
. net sj 3-2 st0039
. net install st0039
. net get st0039
```

APPENDIX B – Outputs Chapter 2

This Appendix presents outputs of Chapter 2 that have not been detailed over the text.

Figure A.1 – Panel data patterns in Chapter 2 (Stata output)

```
       id:  58338, 68389, ..., 97489280            n =         910
        t:  2010h1, 2010h2, ..., 2018h2            T =          18
            Delta(t) = 1 halfyear
            Span(t)  = 18 periods
            (id*t uniquely identifies each observation)

Distribution of T_i:   min  5%  25%  50%  75%  95%  max
                         1   5   16   18   18   18   18

     Freq.  Percent    Cum. |  Pattern
 ---------------------------+--------------------
       650     71.43   71.43 |  111111111111111111
        22      2.42   73.85 |  1111111111111.....
        21      2.31   76.15 |  11111111111111...
        21      2.31   78.46 |  111111111111111.
        20      2.20   80.66 |  11111111111111....
        17      1.87   82.53 |  11111.............
        15      1.65   84.18 |  1111111...........
        13      1.43   85.60 |  1111..............
        13      1.43   87.03 |  111111............
       118     12.97  100.00 | (other patterns)
 ---------------------------+--------------------
       910    100.00         |  XXXXXXXXXXXXXXXXXX
```

Source: by the author (2019)

Table A.1 – Robust POLS logit with selected variables for 1 year and 2 years, before multicollinearity analysis b

Variable	Failed 1 year		Failed 2 years	
	Coefficient	**Std. err.**	**Coefficient**	**Std. err.**
P1	-7.097^{***}	(1.975)	-5.553^{**}	(1.994)
P6	-3.147^{**}	(0.983)	-4.350^{***}	(1.017)
E1	-7.361^{***}	(1.539)		
E2	-6.721^{***}	(1.545)		
E5	5.593^{***}	(1.364)	1.904^{*}	(0.787)
E6	7.576^{***}	(1.352)	3.906^{***}	(0.799)
E8			1.302^{***}	(0.311)
E9	3.746^{**}	(1.226)		
A2			8.204^{***}	(1.561)
A5	7.041^{***}	(1.134)	7.278^{***}	(1.326)
R9	-8.250^{***}	(2.207)	-9.146^{***}	(2.434)
L2			-0.240^{*}	(0.101)
L3	-4.717^{*}	(2.147)	-7.464^{***}	(2.097)
S7	-2.652^{***}	(0.784)	-2.119^{**}	(0.788)
S9			-0.104^{***}	(0.0220)
S11	-1.252^{**}	(0.483)		
Log of total assets	-0.675^{***}	(0.0764)	-0.817^{***}	(0.0790)
Mixed admission criteria	1.706^{***}	(0.313)	1.492^{***}	(0.312)
Age quartile 2			0.568^{*}	(0.249)
Age quartile 3	0.620^{*}	(0.258)	0.919^{**}	(0.297)
GDP - Real % change	-0.449^{***}	(0.0565)	-0.432^{***}	(0.0550)
Constant	11.94^{***}	(1.997)	12.62^{***}	(1.747)
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$				
Observations		12860		12860
Pseudo R^2		0.306		0.328
AIC		1766.5		2917.8
BIC		1893.4		3052.1
Log-likelihood		-866.3		-1440.9
Hosmer-Lemeshow Prob>χ^2		0.045		0.044

Source: by the author (2019)

Table A.2 – Variance inflation factor (VIF) for selected PEARLS ratios (1 year before failure)

Variable	VIF	1/VIF
Mean VIF	14.29	
e9	69.64	0.014
e5	62.37	0.016
e1	7.350	0.136
e2	7.280	0.137
e6	6.200	0.161
p1	5.640	0.177
a5	5.060	0.198
l3	1.720	0.581
s11	1.720	0.581
s7	1.720	0.582
r9	1.690	0.593
p6	1.100	0.908

Source: by the author (2019)

Table A.3 – Variance inflation factor (VIF) for selected PEARLS ratios (2 years before failure)

Variable	VIF	1/VIF
Mean VIF	2.28	
p1	5.650	0.177
a5	5.060	0.198
e8	2.450	0.407
r9	2.120	0.471
a2	1.870	0.534
s9	1.770	0.565
s7	1.770	0.566
l3	1.740	0.574
e5	1.670	0.598
p6	1.110	0.900
e6	1.100	0.911
l2	1.010	0.994

Source: by the author (2019)

Table A.4 – Correlation between selected PEARLS ratios

	p1	p6	**e1**	**e2**	**e5**	**e6**	e8	**e9**
p1	1							
p6	-0.17	1						
e1	-0.19	0.05	1					
e2	-0.07	0.03	**-0.86**	1				
e5	0.25	-0.18	-0.23	0.12	1			
e6	0.00	-0.01	0.42	-0.37	0.01	1		
e8	-0.25	0.20	0.07	0.06	**-0.61**	-0.04	1	
e9	-0.27	0.19	0.11	-0.00	**-0.96**	-0.27	**0.65**	1
a2	0.49	-0.14	-0.17	-0.36	0.16	-0.07	-0.25	-0.20
a5	**0.89**	-0.07	-0.19	-0.06	0.21	-0.05	-0.22	-0.21
r9	0.34	-0.23	-0.04	-0.19	0.31	-0.17	**-0.61**	-0.30
l2	0.01	-0.00	-0.03	0.02	-0.01	-0.01	-0.01	-0.01
l3	0.32	-0.11	-0.13	-0.19	0.17	-0.12	-0.33	-0.16
s7	-0.02	-0.01	0.02	-0.01	-0.00	0.01	0.00	-0.00
s9	-0.01	0.01	0.03	-0.01	-0.00	0.02	0.00	0.00
s11	-0.03	-0.01	0.00	0.00	-0.01	0.01	0.00	0.01

	a2	**a5**	r9	l2	l3	s7	s9	s11
a2	1							
a5	0.41	1						
r9	0.43	0.30	1					
l2	0.01	0.01	0.04	1				
l3	**0.60**	0.26	0.48	0.01	1			
s7	-0.02	-0.02	0.00	0.00	0.00	1		
s9	-0.03	-0.00	0.01	-0.03	-0.00	**0.66**	1	
s11	-0.01	-0.03	0.01	0.00	0.02	**0.65**	0.39	1

Source: by the author (2019)
Note: Bold headers for VIF > 5. Bold values for correlation > 0.5

Table A.5 – Univariate robust POLS logistic regressions to compare P1 an A5 (1 year before failure)

Variable	**P1**		**A5**	
	Coefficient	**Std. err.**	**Coefficient**	**Std. err.**
Slope coefficients	6.427^{***}	(0.788)	-5.553^{***}	(0.478)
Constant	-4.415^{***}	(0.111)	-4.587^{***}	(0.114)
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$				
Observations		14404		14404
Pseudo R^2		0.098		0.103
AIC		2635.0		2621.1
BIC		2650.2		2636.1
Log-likelihood		-1315.5		-1308.5
Area under the ROC curve		0.7674		0.7739

Source: by the author (2019)

Table A.6 – Multivariate robust POLS logistic regressions to compare P1 an A5 (1 year before failure)

Variable	P1		A5	
	Coefficient	**Std. err.**	**Coefficient**	**Std. err.**
p1	2.894^{***}	(0.836)		
p6	-2.356^{***}	(0.475)	-2.233^{***}	(0.473)
e1	-0.857	(0.566)	-0.851	(0.587)
e5	-0.474^{***}	(0.0589)	-0.486^{***}	(0.0592)
e6	1.970^{***}	(0.451)	2.125^{***}	(0.461)
a5			3.332^{***}	(0.656)
r9	-4.495^{**}	(1.367)	-4.578^{***}	(1.371)
l3	0.429	(1.322)	0.444	(1.331)
s7	-2.732^{*}	(1.138)	-2.575^{*}	(1.071)
s11	-1.222^{**}	(0.462)	-1.095^{*}	(0.449)
Log of total assets	-0.574^{***}	(0.0594)	-0.566^{***}	(0.0589)
Mixed admission criteria	1.796^{***}	(0.251)	1.811^{***}	(0.253)
Age quartile 3	0.523^{*}	(0.240)	0.571^{*}	(0.239)
GDP - Real % change	-0.390^{***}	(0.0502)	-0.389^{***}	(0.0512)
_cons	8.643^{***}	(1.165)	8.137^{***}	(1.171)
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$				
Observations	13500		13500	
Pseudo R^2	0.278		0.288	
AIC	2095.2		2065.0	
BIC	2200.3		2170.1	
Log-likelihood	-1033.6		-1018.5	
Area under the ROC curve	0.8966		0.9047	
Hosmer-Lemeshow Prob>χ^2	0.0887		0.0612	

Source: by the author (2019)

Figure A.2 – Logit classification - cutoff = 0.5 (Stata output)

```
Logistic model for f1

              -------- True --------
Classified |         D             ~D  |       Total
-----------+--------------------------+-----------
     +     |        35             34  |          69
     -     |       263          13168  |       13431
-----------+--------------------------+-----------
   Total   |       298          13202  |       13500

Classified + if predicted Pr(D) >= .5
True D defined as f1 != 0
--------------------------------------------------
Sensitivity                     Pr( +| D)   11.74%
Specificity                     Pr( -|~D)   99.74%
Positive predictive value       Pr( D| +)   50.72%
Negative predictive value       Pr(~D| -)   98.04%
--------------------------------------------------
False + rate for true ~D        Pr( +|~D)    0.26%
False - rate for true D         Pr( -| D)   88.26%
False + rate for classified +   Pr(~D| +)   49.28%
False - rate for classified -   Pr( D| -)    1.96%
--------------------------------------------------
Correctly classified                        97.80%
--------------------------------------------------
```

Source: by the author (2019)

Figure A.3 – Logit classification - cutoff = 0.0225 (Stata output)

```
Logistic model for f1

              -------- True --------
Classified |         D             ~D  |       Total
-----------+--------------------------+-----------
     +     |       245           2224  |        2469
     -     |        53          10978  |       11031
-----------+--------------------------+-----------
   Total   |       298          13202  |       13500

Classified + if predicted Pr(D) >= .0225
True D defined as f1 != 0
--------------------------------------------------
Sensitivity                     Pr( +| D)   82.21%
Specificity                     Pr( -|~D)   83.15%
Positive predictive value       Pr( D| +)    9.92%
Negative predictive value       Pr(~D| -)   99.52%
--------------------------------------------------
False + rate for true ~D        Pr( +|~D)   16.85%
False - rate for true D         Pr( -| D)   17.79%
False + rate for classified +   Pr(~D| +)   90.08%
False - rate for classified -   Pr( D| -)    0.48%
--------------------------------------------------
Correctly classified                        83.13%
--------------------------------------------------
```

Source: by the author (2019)

Table A.7 – Comparisons between logistic regressions - POLS and RE, with and without insignificant variables

	POLS	POLS	RE	RE
P6	-2.32^{***}	-1.72^{***}	-4.66^{***}	-4.03^{***}
E5	-0.45^{***}	-0.48^{**}	-0.71^{***}	-1.06^{**}
E6	1.80^{***}	2.01^{***}	2.58^{**}	2.69^{***}
A5	3.50^{***}	3.56^{***}	5.14^{***}	5.25^{***}
R9	-4.40^{***}		-4.80^{*}	
S7	-2.62^{*}	-3.23^{**}	-2.21^{*}	-2.28^{*}
S11	-0.94^{*}		-0.08	
Log of total assets	-0.56^{***}	-0.43^{***}	-0.95^{***}	-0.82^{***}
Mixed bonds	1.78^{***}	1.76^{***}	2.65^{***}	2.61^{***}
Age (quartile 3)	0.57^{*}		0.58	
GDP real % change	-0.39^{***}	-0.36^{***}	-0.76^{***}	-0.75^{***}
Constant	7.62^{***}	4.65^{***}	14.11^{***}	11.14^{***}
lnsig2u			2.03^{***}	2.09^{***}
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$				
Observations	13500	13500	13500	13500
Pseudo R^2	0 .287	0 .271		
AIC	2 065.7	2 104.2	1 810.2	1 818.0
BIC	2 155.8	2 171.8	1 907.8	1 893.1
Log-likelihood	- 1020.9	- 1043.1	- 892.1	- 899.0
Area under the ROC curve	0 .9022	0 .8967		
Hosmer-Lemeshow p-value	0 .0553	0 .0973		
Wald p-value	0 .0000	0 .0000		
LR test p-value			0 .0000	0 .0000

Source: by the author (2019)

Table A.8 – Quadrature check for integration stability - final RE logit model

	Fitted 30 points	**Comparison 20 points** **Relative Difference**	**Comparison 40 points** **Relative Difference**
Log likelihood	-898.85583	-898.8433 -0.00001394	-898.85667 9.30E-07
P6	-4.0897586	-4.086033 -0.00091095	-4.0894834 -0.00006729
E5	-1.0653487	-1.0634396 -0.001792	-1.0653909 3.96E-05
E6	2.6884449	2.6804672 -0.00296738	2.6889286 0.00017993
A5	5.2802194	5.2771023 -0.00059034	5.2801328 -0.0000164
S7	-2.2746705	-2.2751067 0.00019177	-2.2747014 0.0000136
Log of total assets	-0.8197822	-0.81863187 -0.00140328	-0.81985311 0.00008643
Mixed bonds	2.6223606	2.6201498 -0.00084304	2.622383 8.54E-06
GDP real \% change	-0.7519340	-0.75135645 -0.00076817	-0.75193796 5.19E-06
Constant	11.168273	11.152061 -0.00145156	11.169293 0.00009137
lnsig2u	2.1167223	2.1137629 -0.00139808	2.1166554 -0.0000316

Source: by the author (2019)
Note: test obtained through the command `quadchk, nooutput` (STATACORP, 2017)

Table A.9 – Descriptive statistics of probability of failure from 2010 to 2018

t	N	min	max	mean	sd	p50	p99
2010h2	872	1.62e-10	0.765	0.00534	0.0453	0.000048	0.128
2011h1	877	4.55e-09	0.982	0.0150	0.0972	0.000157	0.694
2011h2	872	6.05e-09	0.994	0.0121	0.0872	0.000141	0.484
2012h1	861	2.06e-08	0.975	0.0168	0.106	0.000281	0.772
2012h2	844	5.16e-08	0.993	0.00783	0.0653	0.000275	0.216
2013h1	832	9.99e-09	0.994	0.00691	0.0609	0.000170	0.138
2013h2	820	3.55e-11	0.999	0.00584	0.0584	0.000156	0.071
2014h1	811	8.16e-10	0.995	0.01044	0.0753	0.000359	0.168
2014h2	801	1.70e-09	0.808	0.00577	0.0404	0.000325	0.092
2015h1	788	9.61e-09	0.907	0.01720	0.0669	0.001485	0.383
2015h2	778	5.31e-09	0.879	0.01954	0.0849	0.001569	0.561
2016h1	776	7.54e-12	0.949	0.01743	0.0827	0.001256	0.530
2016h2	756	5.86e-11	0.986	0.01970	0.0895	0.001042	0.553
2017h1	727	7.11e-10	0.945	0.00560	0.0467	0.000156	0.092
2017h2	711	3.68e-11	0.986	0.00847	0.0679	0.000165	0.330
2018h1	699	3.65e-13	0.929	0.00707	0.0612	0.000165	0.221
2018h2	674	3.44e-11	0.911	0.00546	0.0568	0.000140	0.037
Total	13499	3.65e-13	0.999	0.0110	0.0732	0.000293	0.346

Source: by the author (2019)