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Performance Efficiency Evaluation of U.S. Credit Unions Around the 2009 Global Recession: A Data Envelopment Analysis Approach

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This paper examines the impact of the latest economic recession on performance efficiency of U.S. credit unions using Data Envelopment Analysis (DEA), a non-parametric method. We find that larger credit unions and credit unions with lower loss loan provisions tend to have higher efficiency. Our results reveal that, compared to the pre-recession period, the recession and the post-recession periods affected the efficiency of Federal Credit Unions (FCUs) and Federally Insured State-Chartered Credit Unions (FISCUs) differently. FISCUs have significantly higher efficiency than FCUs before the recession but FCUs exhibit higher efficiency during the recession and post-recession periods.

Keywords: Credit Union; Data Envelopment Analysis; Recession; Performance Efficiency

JEL Classification: G21; G01; C14: L25

I. Introduction

Credit unions (hereafter CUs) are important financial institutions for the U.S. economy despite their small size ($198.5 billion on average) and market shares (7.1%) relative to banks. They not only serve individual customers, but also provide financing to businesses, specifically to small business firms. This industry rose the total membership to over 103 million by year 2015 and it is also reported that over 73% of CUs experienced increasing in total assets[1].

Previous literature on financial institutions mostly focuses on evaluating the performance and efficiency in large institutions, such as commercial banks (hereafter CBs). Little research has been done on the performance efficiency of CUs, primarily due to the cooperative feature of CUs (Bauer, 2008). CUs are member-owned cooperatives that build capital by retaining earnings. They do not issue equity. This kind of cooperative nature in CUs makes the traditional methods of examining performance efficiency difficult. Some recent studies (e.g., Smith, 2012; Anderson and Liu, 2013) focus on the difference of performance by examining the efficiency between small CUs and large depository CBs. Different from prior studies, in this paper we use a non-parametric Data Envelopment Analysis (DEA) to estimate the performance efficiency of U.S. credit unions around the 2009 Great Recession. The DEA technique evaluates the performance of decision-making units (DMUs) to successfully transform inputs into outputs relative to their peers (Charnes *et al.,* 1978; Hsiao *et al*., 2010; Harris *et al.*, 2013).

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[1] From *Credit Union Reports*, Credit Union National Association.

Credit unions in U.S. can be chartered by the federal government and regulated by the National Credit Union Administration (NCUA), or chartered by state governments. Therefore, we also use Panel Fixed Effects, Tobit, Generalized Linear Model (GLM), and System Generalized Method of Moments (GMM) regressions to investigate whether Federal Credit Unions (FCUs) and Federally Insured State-Chartered Credit Unions (FISCUs) react differently to market wide economic shocks. In addition, we examine the impact of assets size, loan loss provision, assets/liability management level, and productivity ratio on CUs' performance efficiency. This study contributes to the literature on CUs performance efficiency around the latest recession and on comparisons of efficiency between FCUs and FISCUs. To the best of our knowledge, this study is also the first attempt to examine recession impacts on performance efficiency of CUs using a DEA approach.

Our findings are consistent with the unique characteristics of the CU industry. The results from univariate analyses show that the efficiency of CUs increases from the pre-recession period to the post-recession period, implying that CUs did weather the recession. However, the results from multivariate analyses reveal that the recession has a significant negative impact on CU efficiency. When looking at the comparison of changes in efficiency between FCUs and FISCUs, we document that, on average, being FCUs implies higher efficiency during the recession and post-recession periods while FISCUs have a significantly higher operational efficiency than FCUs before the recession.

The remainder of this paper is organized as follows. In the next section, we survey related literature and present our research questions. Section III describes the data and sample selection. We explain our methodological approach in Section IV and present our empirical results in Section V. Section VI reports the results from robustness tests and Section VII concludes.

II. Literature and Proposed Hypotheses

Ownership structure and capitalization methods distinguish CUs from other financial intermediaries, such as CBs, in that CUs are mutually owned and not-for-profit institutions. Members of CUs are both the owners of the financial institution and the consumers of its output or suppliers of its input (Smith *et al.*, 1981; Smith, 1984). Bruce (2009) reports that, while the financial crisis has not left CUs unscathed, CUs appear to be healthier than their bank counterparts since not-for-profit credit union members benefit from both their own investment and depositors' funds. CU lending has been steadier than bank lending through business cycles, including the recent financial crisis, than bank lending (Anderson and Liu, 2013; Burger and Dacin, 1992; Smith, 2012; Smith and Woodbury, 2010). The regulatory and technological environment of CUs has changed dramatically since the 1980s' deregulation stream. The Dodd-Frank Wall Street Reform and the Consumer Protection Act subject CUs to similar consumer protection provisions and reporting rules as CBs (Wheelock and Wilson, 2013).Thus, CUs tend to take less risk during a bubble and are less likely to experience the effects of financial crises as seriously as CBs when the bubble bursts. Moreover, CUs gain from the failure of CBs as some commercial bank customers move to CUs for safety considerations.

CUs in the U.S. can be chartered by the federal government or by state governments. The National Credit Union Share Insurance Fund (NCUSIF) provides insurance coverage to all FCUs and to some FISCUs. While state-chartered CUs are primarily regulated by state supervisory agencies (SSAs), the NCUA also cooperates with SSAs to assess the financial and operational conditions of FISCUs. In general, FISCUs are considered to have advantages compared with

FCUs. According to the National Association of State Credit Union Supervisors[2], in contrast to FCUs, FISCUs are subject to state laws and regulations that meet the needs of the citizens of the state. Legislators and governors allow FISCUs a greater opportunity to affect credit union policy and generally provide more input into their governance than their federal counterparts. Moreover, the "Field of Membership" (FOM) that governs CUs' membership allows "for the mixing and matching of communities and Select Employee Groups for state-chartered credit unions".[3] The question is whether such advantages translate into higher performance efficiency and persist around economic downturns.

Two major performance theoretical models exist for CUs. One model, proposed by Smith *et al.*, (1981) and Smith (1984), argues that the performance should be examined by the benefits from receiving higher deposit rates and paying lower loan rates than the market since the goal of CUs is not to minimize costs but to maximize utility. Bauer (2008) extends Smith *et al.* (1981) model to examine the abnormal CU performance by constructing return vectors. Bauer *et al.* (2009) use this methodology and argue that this method and return vectors are well-specified and powerful with small changes in observed ex-post event performance.

The other theoretical model of CU performance efficiency is based on minimizing operating costs, thus maximizing the owner/customer's benefits, which corresponds to the maximization of service provisions that include quantity, price, and other components. Under this framework, most empirical studies focus on technical efficiency. Fried *et al.* (1993) conduct a performance evaluation of CUs in terms of price, quantity, and variety of services offered to members subject to resource availability and operating environment. They use parametric and non-parametric estimators (Free Disposal Hull, hereafter FDH) methods to detect a small but statistically significant portion of the performance variation. The study also finds that large CUs are more efficient than small CUs. Fried and Lovell (1994) enhance the FDH methodology to measure the efficiency and evaluate the performance of CUs. Frame and Coelli (2001) examine efficiency by using a parametric transcendental logarithmic (translog) cost function using data from CUs with more than $50 million of total assets. They find that CUs with residential common bonds have higher costs than those with occupational or association bonds.

Several studies have examined the impacts of mergers, acquisitions, and diversifications on performance efficiency of CUs. Most of these studies are under the frame of minimizing cost to maximize profit function. For example, Fried *et al.* (1999) investigate the impacts of mergers by using DEA to estimate efficiency and find that acquiring firms experience no deterioration in service provision and on average, acquired firms receive an immediate improvement that last three years following a merger. However, the aggregate findings indicate roughly that 50% of acquiring firms and 20% of acquired firms experience a decline following the merger. The performance change is also small.

Goddard *et al.* (2008) find that larger CUs are better in diversifying non-interest income than small ones by considering ROA and ROE ratios using data from 1993 to 2004. Wheelock and Wilson (2013) examine the scale efficiency and change in technology efficiency by constructing a cost analog of the Malmquist Productivity Index. They find that large CUs become less efficient over time and cost-productivity falls on average, especially in small ones. Wheelock and

[2] NASCUS (2008) Quick guide. Accessed from http://www.nascus.org/pdf/quick_guide/QG-State-Charter.pdf.

[3] A Select Employee Groups is a CU business partner that provides membership eligibility to the CU for its employees at no cost and without having to start up its own CU.

Wilson (2011) find increasing return to scale among CUs of all sizes, suggesting that further consolidation and growth are better for CUs.

In recent years, DEA has become one of the popular measurement methodologies for performance efficiency in financial institutions. Simply speaking, based on multiple inputs and outputs (decision making units, DMUs), DEA produces the relative efficiency for each DMU relative to the generated productivity frontier by all DMUs. The relative efficiency of an institution is determined as the ratio of a weighted sum of outputs to a weighted sum of inputs under assumptions on returns to scale as well as model orientation. DEA identifies the most proficient input-output combinations and develops a best practice efficiency frontier against the peers. However, studies on performance efficiency on CUs using DEA are very limited. Berger and Humphrey (1997) review 130 studies and find that cost efficiency is more important than market concentration in explaining financial institution profitability. Nonetheless, both measures only weakly explain performance variation. Regressions of efficiency on sets of explanatory variables have been unable to explain more than just a small portion of its total variation. From the survey, Berger and Humphrey (1997) conclude that DEA is an appropriate method to evaluate CU performance efficiency used within a profit frontier framework, as it is popular in the commercial bank literature.

The impact of recession on CBs is well documented (Fahlenbrach *et al.*, 2012, Fang *et al.*, 2013). However, there are few studies examining the impact of recession on CUs performance efficiency (Wheelock and Wilson, 2011; Bauer, 2008). One argument is that CUs may benefit from the financial shocks because CUs do not rely on stock or bond financing since they are financed with member deposits (Birchall and Ketilson, 2009). Smith and Woodbury (2010) analyze 15 years of quarterly call report data from banks and CUs during the period 1986 to mid-2009. Their report shows that commercial loan performance for both CBs and CUs are impacted by the business cycle. CUs delinquency and charge-off rates tend to be more sensitive to the business cycle than those of banks, though when aggregated, loan performance is more similar. They find that CUs' loan portfolios appear to be about 25% less sensitive to macroeconomic shocks than bank loan portfolios.

Given the existing studies, in this paper, we aim to fill the gap in the literature by addressing the following empirical questions:

1. *What is the impact of the 2007-2009 recession on CU performance efficiency?*
2. *Do the performance efficiencies of FCUs and FISCUs differ around the recession?*

On one hand, we expect the efficiency of CUs to be affected positively by the recession because of the increase in CU's assets due to investors moving to CUs for flight to safety and the CUs' advantages from not being reliant to the financial markets although five of the largest corporate credit unions invested in problematic mortgage-backed securities. On the other hand, we expect the efficiency of CUs to be affected negatively by the economic downturn marked with the high number of business failures, home foreclosures, and unemployment. In addition, the increase in CUs' assets due to the sudden shift in investors' behavior could lead to suboptimal management and affect CUs' efficiency negatively. Moreover, since FCUs and FISCUs are governed under different policies and regulations, we expect them to react differently to economic shocks.

III. Data

A. Data Source and Sample Selection

We use quarterly call report data from the NCUA during year 2000-2013. Following Wheelock and Wilson (2013), we omit observations with reported non-positive loans or investments, or with the calculated values for price of capital (X_1), price of labor (X_2), savings pricing (Y_5) or loan price (Y_6) outside the interval (0, 1), as well as those with non-positive capital or labor. We drop any quarter that does not have complete data items. Based on FDIC classification, we divide the sample into two groups to capture the performance efficiency difference between FCUs and FISCUs. This sample selection yields a revised sample of 836 FCUs and 896 FISCUs. Following Brunnermeier (2009), we divide the study period into three sub-periods: pre-recession refers to 2000q1 through 2007q4, recession period refers to 2008q1 through 2009q2, and post-recession refers to 2009q3 through 2013q2.

B. Descriptions of Variables

We construct two input variables and six output variables. The description of each input and output variables is provided in Table 1. Following Frame and Coelli (2001) and Wheelock and Wilson (2011), we identify two input variables, the price of financial capital (X_1) and the price of labor (X_2). The price of capital (X1) is identified as capital expenses divided by the total shares and deposits, where capital expenses include gross occupancy expense, office operations expense, advertising expense, travel and conference expense, loan expenses, operating expenses fees, professional and outside services, other operating expenses, and miscellaneous operating expenses (Wheelock and Wilson, 2011). The price of labor is defined as employees and officers' compensation and benefits divided by number of full time and half- or part-time employees. The first four output quantities are real estate loans (Y_1), commercial loans (Y_2), consumer loans (Y_3), and investments (Y_4). Investments include total investments, cash on deposit, and cash equivalent. These measures are based on NCUA performance report. These four variables capture the vast majority of CU assets. We consider two additional outputs, savings pricing (Y_5) and loan prices (Y_6) to ensure an institution is not unfairly considered as less efficient due to more costly output composition.

Pursuant to previous studies, we consider measures of capital adequacy, liquidity, asset quality and management, and productivity. That is, we include the following controlling variables in our models: assets, capital ratio, loan loss provision, assets to total shares and deposit ratio, productivity ratio and past performance efficiency. We also present the description of each of these variables in Table 1.

Table 1: Description of Variables

	Proxy	*Description*
Inputs		
X_1	Price of capital	Capital expenses / Total shares and deposits
X_2	Price of labor	{Labor expenses / (Number of full time employees + Number of half- and part-time employees)} / Total operating expenses Cost = Capital × X_1 + Labor × X_2
Outputs		
Y_1	Real estate loan	(Amount of first mortgage real estate loans + Amount of other real estate loans) / Total loans and leases
Y_2	Commercial loans	(Amount of commercial loans + Amount of agricultural loans to members; for years 2004–2006, Member business loans, total amount outstanding) / Total loans and leases
Y_3	Consumer loans	{Total loans and leases - (Amount of real estate loans +Amount of commercial loans)} / Total loans and leases
Y_4	Investment	(Total investments, Cash on deposit and Cash equivalent) / Total loans and leases
Y_5	Saving price	(Dividends on shares + Interest on deposits) / Total shares and deposits
Y_6	Loan price	Interest and fee income on loans, total / Total loans and leases
Variables in Regressions		
ESCORE		Efficiency score estimated using Data Envelopment Analysis (DEA)
Size		CU size = Natural logarithm of Total Assets
Capital ratio		Net worth / Total assets
Loan loss provision		Loan loss provision ratio = Provision for loan and lease / Total loan
Asset/liability		Asset/liability management = Total loans / Total shares and deposits
Productivity ratio		Members / Potential members
Funding cost		Cost of funds / Average assets
Corporate CU		Corporate credit union = 1 (0 otherwise)
Lag ESCORE		Lag value of efficiency score = Lag (ESCORE) We also define *Lag2 ESCORE* as the value of ESCORE lagged twice.
FCU		*FCU* = 1 if the credit union is a Federal Credit Union (0 if Federally Insured State-Chartered Credit Union)
Recession		*Recession* = 1 during the recession period (0 otherwise)
Post		*Post-recession* =1 after the recession period (0 otherwise)

Note: This table presents the two inputs and six outputs used to estimate credit union efficiency scores using Data Envelopment Analysis (DEA), and the variables used in the regression analyses.

IV. Methodology

A. Data Envelopment Analysis (DEA)

In the first stage, we construct an overall performance efficiency measurement using DEA as proposed by Charnes *et al.* (1978) to measure the aggregate change in technical process, pure efficiency, and scale efficiency. In the second stage, we use regression models to investigate the effect of the recession on CUs' efficiency generated from previous step.

To measure the performance efficiency of CUs, we construct a model of cost function. Following Wheelock and Wilson (2011) and Frame and Coelli (2001), we model CUs as service providers which seek to minimize non-interest costs subject to labor, capital, and the level and type of output they produce as in Bauer (2008), Fried *et al.* (1993), Fried *et al.* (1999) and Wheelock and Wilson (2013). The DEA method evaluates the performance of decision-making units (DMUs) compared to their peers (Charnes *et al*., 1978; Harris *et al.,* 2013; Hsiao *et al.*, 2010). Prior empirical studies provide evidence that banks with higher efficiency scores present higher performance efficiency. Similarly, empirical studies using DEA to evaluate the efficiency of CUs suggest that credit unions have a lot of room to improve with efficiency scores (e.g., Fried *et al.*, 1993). We estimate CU efficiency using Charnes *et al.* (1978) model of DEA to capture efficiency as the minimum consumption of inputs for a given level of outputs.

Following Hsiao *et al.* (2010), we define the input-oriented efficiency measure, *ESCORE*, as the reciprocal of the inefficiency measure, θ_j, for credit union j, CU_j, as follows:

$$\begin{aligned} & \theta_j = Max\ \theta \\ s.t. & \frac{X_{ij}}{\theta} \geq \sum_{j=1}^{N} \lambda_j X_{ij},\ i = 1, \dots, I \\ & Y_{rj} \leq \sum_{j=1}^{N} \lambda_j Y_{rj}, r = 1, \dots, R \\ & \lambda_j \geq 0, \end{aligned} \tag{1}$$

where θ_j is the estimated inefficiency for CU_j, X_{ij} is the input i for CU_j, and Y_{rj} is the output r for CU_j.

Table 2: Comparison of FCU and FISCU Inputs and Outputs

Panel A: Mean values and t-*statistics of mean differences (FCU)*						
	Pre (1)	Recession (2)	Post (3)	(2) - (1)	(3) - (2)	(3) - (1)
W_1	0.014	0.013	0.012	-7.8***	-5.0***	-17.4***
W_2	0.011	0.009	0.009	-7.4***	-1.3	-11.4***
Y_1	0.144	0.210	0.222	24.6***	3.8***	39.1***
Y_2	0.014	0.031	0.039	14.7***	6.4***	28.5***
Y_3	0.842	0.759	0.740	-25.4***	-5.3***	-42.3***
Y_4	0.176	0.639	0.835	28.7***	9.8***	49.4***
Y_5	0.021	0.014	0.007	-44.8***	-48.4***	-125.3***
Y_6	0.079	0.062	0.058	-23.9***	-5.9***	-41.0***
Panel B: Mean values and t-*statistics of mean differences (FISCU)*						
	Pre (1)	Recession (2)	Post (3)	(2) - (1)	(3) - (2)	(3) - (1)
W_1	0.013	0.012	0.013	-7.5***	4.5***	-3.2***
W_2	0.057	0.051	0.049	-2.4**	-1.1	-4.7***
Y_1	0.163	0.221	0.227	21.6***	2.0**	31.6***
Y_2	0.020	0.038	0.047	12.2***	5.0***	22.7***
Y_3	0.816	0.741	0.726	-20.9***	-3.5***	-32.6***
Y_4	0.130	0.601	0.846	21.2***	6.5***	23.1***
Y_5	0.016	0.013	0.007	-23.5***	-42.8***	-96.2***
Y_6	0.065	0.055	0.058	-13.3***	3.2***	-9.1***

Panel C: t-*statistics of mean differences in DEA inputs and outputs (FCU - FISCU)*			
	Pre (1)	Recession (2)	Post (3)
W_1	9.6***	4.0***	-6.1***
W_2	-51.2***	-20.7***	-27.6***
Y_1	-14.0***	-3.0***	-2.2**
Y_2	-9.7***	-4.5***	-6.4***
Y_3	15.0***	4.1***	4.2***
Y_4	7.9***	1.4	-0.3
Y_5	48.9***	9.3***	3.0***
Y_6	30.1***	7.1***	-1.1

, * These symbols indicate statistical significance at the 5% and 1% levels, respectively.

Table 2 presents the means and mean-differences in inputs and outputs used to estimate CU performance efficiency to compare the inputs and outputs across the three sub-periods for FCUs in Panel A, FISCUs in Panel B, and between FCUs and FISCUs in Panel C. On average, both FCUs and FISCUs exhibit statistically significant decreases in both capital and labor prices (W_1 and W_2) from the pre-recession period to the recession period ((2) – (1)), and from the pre-recession period to the post-recession period ((3) – (1)) at the 1% level. In term of the outputs, real estate loans, commercial loans, and investments (Y_1, Y_2, and Y_4) appear to decrease across the sub-periods while consumer loans, savings pricing, and loan prices (Y_3, Y_5, and Y_6) increase. The increase in consumer loans might be attributed to the significant decreases in real loans and commercial loans since we calculate consumer loans as total loans minus total real loans and commercial loans. Both decreases and increases are statistically significant at the 1% level.

The *t*-statistics of mean-differences between FCUs and FISCUs, reported in Panel C, imply that the price of capital (W_1) is higher for FCUs compared to FISCUs in the pre-recession and recession periods, but lower after the recession. In contrast, the price of labor (W_2) appears to be lower for FCUs over all three sub-periods. Real estate loans (Y_1) and commercial loans (Y_2) are lower for FCUs while consumer loans (Y_1) and savings pricing (Y_3 and Y_5) are higher. The mean difference in investments (Y_4) between FCUs and FISCUs is statistically significant and positive only during the pre-recession period. On average, loan prices (Y_6) are higher for FCUs before and during the recession.

Following Hsiao *et al.* (2010), we consider two DEA test statistics to examine the equality of efficiency scores among the three sub-periods and between FCUs and FISCUs. Under the assumption that the inefficiency score, θ_j, is exponentially distributed, we consider the following test statistic:

$$T_{exp} = \left[\sum_{j\in N_1} \frac{\theta_j - 1}{N_1}\right] \div \left[\sum_{j\in N_2} \frac{\theta_j - 1}{N_2}\right] \quad (2)$$

which is evaluated by the *F*- distribution with ($2N_1$, $2N_2$) degrees of freedom. N_1 and N_2 are the number of observations (CU-quarters) pertaining to each of any two compared groups, respectively.

If θ_j is assumed to be half-normally distributed, the test statistic is given as:

$$T_{hn} = \frac{\sum_{j\in N_1}(\theta_j - 1)^2 / N_1}{\sum_{j\in N_2}(\theta_j - 1)^2 / N_2} \quad (3)$$

which is evaluated by the *F*-distribution with (N_1, N_2) degrees of freedom.

In addition to these two-DEA based tests, we report the conventional *t*-statistics tests as well.

B. Research models

To estimate the effect of the recession and the post-recession periods on CU performance efficiency, we first test the following basic model on our unbalanced panel of CUs:

$$ESCORE_{i,t} = \beta_1 ESCORE_{i,t-1} + \beta_2 Recession_{i,t} + \beta_3 Post_{i,t} + \beta_4 Controls_{i,t} + u_i + \varepsilon_{i,t} \quad (4)$$

where $ESCORE_{i,t}$ denotes the performance efficiency score of CU i at time t; $ESCORE_{i,t-1}$ is the lag of the variable *ESCORE; Recession* $_{i,t}$ is a dummy variable with the value of 1 in the recession period, 0 otherwise; *Post* $_{i,t}$ is a dummy variable with the value of 1 in the post-recession period, 0 otherwise; $Controls_{i,t}$ represents selected CU characteristics as control variables; u_i represents time-invariant fixed effects,[4] and finally $\varepsilon_{i,t}$ is the error term.

Next, to investigate whether the impact of the recession and the post-recession periods on CU performance efficiency differs for FCUs and FISCUs, we consider the variable *FCU* that takes the value of 1 if the CU is federally charted (0 if state-charted), and its interactions with the variables *Recession* and *Post*, respectively. Therefore, we consider the following model:

$$ESCORE_{i,t} = \alpha + \beta_1 ESCORE_{i,t-1} + \beta_2 FCU_{i,t} + \beta_3 Recession_{i,t} + \beta_4 Post_{i,t} + \beta_5 Recession \times FCU_{i,t} + \beta_6 Post \times FCU_{i,t} + \beta_7 Controls_{i,t} + \varepsilon_{i,t} \quad (5)$$

In Table 3, we present the mean values of the selected control variables and the comparisons of their mean differences for FCUs and FISCUs over each of the three sub-periods and between FCUs and FISCUs.

[4] The null hypotheses of the Breusch-Pagan test and Hausman test are rejected at the 1% level of statistical significance. Therefore, we control for CU fixed effects in the panel regressions.

Table 3: Comparison of Financial Characteristics

Panel A: Mean values and t-*statistics of mean differences around recession (FCU)*						
Variable	Pre (1)	Recession (2)	Post (3)	(2)- (1)	(3) - (2)	(3) - (1)
Size	18.947	19.355	19.495	23.1***	7.4***	41.4***
Capital ratio	0.089	0.112	0.104	30.8***	-12.4***	25.1***
Loan loss provision	0.003	0.006	0.006	17.9***	1.7*	29.5***
Productivity ratio	0.471	0.279	1.023	-6.1***	1.0	0.7
Asset/Liability	0.732	0.747	0.670	4.3***	21.1***	24.9***
Funding cost	0.020	0.013	0.007	-52.2***	52.5***	140.5***
Panel B: Mean values and t-*statistics of mean differences around recession (FISCU)*						
Variable	Pre (1)	Recession (2)	Post (3)	(2) - (1)	(3) - (2)	(3) - (1)
Size	18.234	18.638	18.815	14.0***	5.4***	26.0***
Capital ratio	0.107	0.123	0.114	17.2***	-8.6***	12.4***
Loan loss provision	0.003	0.005	0.006	11.3***	6.9***	26.7***
Productivity ratio	0.344	0.248	0.230	-23.7***	-3.5***	28.5***
Asset/Liability	0.769	0.785	0.699	5.0***	-24.6***	-30.3***
Funding cost	0.014	0.012	0.007	-23.6***	-47.6***	-101.8***

Panel C: t-*statistics of mean differences (FCU – FISCU)*			
Variable	Pre (1)	Recession (2)	Post (3)
Size	51.5***	23.2***	31.1***
Capital ratio	-29.8***	-10.6***	-17.6***
Loan loss provision	0.4	4.1***	-0.8
Productivity ratio	4.1***	5.6***	1.0
Asset/Liability	-19.3***	-9.0***	-10.5***
Funding cost	57.2***	9.1***	5.5***

Note: This table presents the means of credit union selected financial characteristics and provides comparisons of these characteristics for the sample Federal Credit Unions (FCUs) and Federally Insured State-Chartered Credit unions (FISCUs). We divide the study period into three sub-periods: pre-recession (1) from 2000q1 through 2007q4, recession period (2) from 2008q1 through 2009q2, and post-recession (3) from 2009q3 through 2013q2. Means for each measure are shown in panels A and B, along with *t*-statistics of group mean differences among the three sub-periods. Panel C presents the *t*-statistics of group mean differences between FCUs and FISCUs across the three sub-periods.
*, *** These symbols indicate statistical significance.

As shown in panels A and B of Table 3, FCUs and FISCUs present similar trends in most of the selected financial characteristics used as control variables. Size and loan loss provision increase during and after the recession, and are larger after the recession compared to those before the recession. From Panel C of Table 3, FCUs are larger on average than FISCUs. They have lower capital ratio, lower asset/liability management, but higher funding cost and higher productivity ratio than FISCUs. During the recession, FCUs' loan loss provision is higher than that of FISCUs.

V. Results

A. Univariate Results

Table 4 presents summary statistics on credit union efficiency and univariate results from comparing the efficiency of FCUs to that of FISCUs and across the study three sub-periods. The results in Panel A show that, from the pre-recession period, the efficiency of credit unions increased on average during and after the recession. Overall, the mean (median) efficiency score of FCUs is lower at 0.22 (0.16) than for FISCUs at 0.34 (0.30).

However, it is noticeable that the efficiency of FCUs presents better improvement compared to that of FISCUs across the sub-periods. On average, the efficiency score of FCUs increased by 40% (0.15 to 0.21) from the pre-recession period to the recession, and by more than 52% (0.21 to 0.32) from the recession period to the post-recession period. For FISCUs, the efficiency score increased only by 12.5% (0.32 to 0.36) from the pre-recession period to the recession, and by only about 3% (0.36 to 0.37) from the recession period to the post-recession period.

The latter results are consistent with the statistics test results of equality of efficiency reported in Panel B. Although, the DEA-based test results are not statistically significant, except for comparing the efficiency scores during and after the recession, the *t*-statistics reflect statistically significant differences in efficiency scores at the 1% level across the three sub-periods. We find non-conclusive evidence in comparing the efficiency of FCUs to that of FISCUs: the DEA-based tests are not statistically significant while the *t*-statistics are negative and reveal statistically significant differences between FCUs and FISCUs efficiency scores (i.e. FCUs are less efficient than FISCUs). In the next section, we report our findings from regression analyses to shed some light on this issue.

Table 4: Descriptive Statistics and Comparisons of Efficiency Scores

Panel A: Efficiency scores of FCU and FISCU

	FCU				*FISCU*			
	Obs.	Mean	Median	St. dev.	Obs.	Mean	Median	St. dev.
Whole Period	24,217	0.22	0.16	0.19	37,659	0.34	0.30	0.19
Pre (1)	12,062	0.15	0.10	0.16	24,501	0.32	0.29	0.19
Recession (2)	3,659	0.21	0.15	0.19	4,519	0.36	0.33	0.20
Post (3)	8,496	0.32	0.27	0.20	8,639	0.37	0.34	0.20

Panel B: Statistics test results of equality of efficiency scores

	t-statistics		
	(2) - (1)	(3) - (2)	(3) - (1)
FCU	17.5***	27.7***	64.5***
FISCU	11.4***	2.8***	18.6***
	Pre (1)	Recession (2)	Post (3)
FCU - FISCU	-92.4***	-34.4***	-17.2***
	Exponentially distributed test statistics (T_{exp})		
	(2) - (1)	(3) - (2)	(3) - (1)
FCU	0.4	2.3***	0.8
FISCU	0.2	1.9***	0.5
	Pre (1)	Recession (2)	Post (3)
FCU - FISCU	0.4	0.5	0.7
	Half-normally distributed test statistics (T_{hn})		
	(2) - (1)	(3) - (2)	(3) - (1)
FCU	1.3***	2.8***	1.5***
FISCU	0.3	1.8***	0.5
	Pre (1)	Recession (2)	Post (3)
FCU - FISCU	0.2	0.2	0.3

Note: This table reports summary statistics on efficiency scores of the sample Federal Credit Unions (FCUs) and Federally Insured State-Chartered Credit Unions (FISCUs) from 2000q1 through 2013q2 in Panel A. Credit union efficiency is estimated by Data Envelopment Analysis (DEA). We divide the study period into three sub-periods: pre-recession (1) from 2000q1 through 2007q4, recession period (2) from 2008q1 through 2009q2, and post-recession (3) from 2009q3 through 2013q2. Panel B shows the statistics test results of mean difference of efficiency scores across the three sub-periods and between FCUs and FISCUs. In addition to *t*-statistics, we report two DEA-based test statistics: T_{exp} and T_{hn}, based on exponentially distribution and on half-normally distribution of inefficiency scores, respectively.

*** This symbol indicates statistical significance at the 1% level.

B. Panel Fixed-Effects and Tobit Regression Results

In Table 5, we present the results from panel fixed-effects regressions of credit union efficiency score on selected financial variables as described by Equation (4). As expected, the previous quarter efficiency score is statistically and positively related to the current efficiency score. We find that, however, the recession impacts FCUs and FISCUs differently. While the coefficient on *Recession* for FCUs is not statistically significant, the recession has a negative and statistically significant impact on FISCUs and on the whole sample after controlling for CU financial variables. On one hand, compared to the pre-recession period, the recession decreases the efficiency score of FISCUs and the whole sample significantly at the 1% level by 0.02 and 0.01, respectively. On the other hand, during the post-recession period, the efficiency score of FCUs increases by 0.02 but that of FISCUs decreases by 0.01, both at the 1% level of statistical significance. Goddard *et al.* (2015) report that the probability of credit unions survival increases with size. We find that, larger credit unions appear to be more efficient, which is contrary to the findings reported in Harris *et al.* (2013) for CBs. The signs and significances of the coefficients on other control variables are consistent with those on CB efficiency in Harris *et al.* (2013).

Table 5: Results from Panel Fixed-Effects Regressions

	FCU	FISCU	Whole Sample[a]
Lag ESCORE	0.74***	0.70***	0.76***
	(45.98)	(35.69)	(63.77)
Recession	0.000	-0.02***	-0.01***
	(0.14)	(-13.14)	(-11.99)
Post	0.02***	-0.01***	0.00***
	(13.21)	(-6.44)	(3.65)
Size	0.03***	0.05***	0.04***
	(7.25)	(13.13)	(14.95)
Capital ratio	-0.11***	0.00	-0.04**
	(-3.72)	(0.29)	(-2.51)
Loan loss provision	-0.41***	-0.04	-0.10*
	(-4.92)	(-0.85)	(-1.70)
Funding cost	-1.24***	0.41***	-0.41***
	(-11.31)	(5.13)	(-6.11)
Productivity ratio	-0.00***	-0.00	-0.00***
	(-8.89)	(-0.04)	(-5.16)
	(-4.74)	(-7.38)	(-7.44)

Table 5 - Results From Panel Fixed-Effects Regressions: Continues

	FCU	FISCU	Whole Sample[a]
Corporate CU	0.00	0.01***	0.01**
	0.37)	(3.95)	(2.34)
Intercept	-0.54***	-0.83***	-0.69***
	(-6.22)	(-12.40)	(-13.63)
CU fixed effects	Yes	Yes	Yes
Quarter fixed effects[b]	No	No	No
Observations	15,045	25,380	40,425
(Within) R-squared	0.78	0.61	0.71
Number of CUs	850	916	1,766

Note: This table presents the results from panel fixed-effects regressions of efficiency score (*ESCORE*) of the sample Federal Credit Unions (FCUs) and Federally Insured State-Chartered Credit Unions (FISCUs) on the selected variables defined in Table 1 for the period 2000q1-2013q2. All regressions include CU fixed effects. We report *t*-statistics calculated from robust standard errors in parentheses.

[a] Controlling for CU fixed effects do not allow us to include the time-invariant variable *FCU* in this model.

[b] When controlling for quarters, the *Recession* variable and most quarters are dropped due to collinearity.

*, **, *** These symbols indicate statistical significance at the 10%, 5% and 1% levels, respectively.

We follow Hsiao *et al.* (2010) and Harris *et al.* (2013) to use Tobit regressions to test Equation (4) on the sub-samples of FCUs and FISCUs, and to test Equation (5) on the whole sample. In the whole sample model, we include the variable *FCU* and its interactions with *Recession* and with *Post*, respectively. We report the results from these Tobit regressions in Table 6.

Table 6: Results from Tobit Regressions

	FCU	FISCU	Whole Sample
Lag ESCORE	0.92***	0.93***	0.93***
	(169.90)	(285.04)	(322.46)
FCU			-0.025***
			(-22.13)
Recession	0.01***	-0.01***	-0.01***
	(5.80)	(-14.97)	(-14.28)
Recession × FCU			0.02***
			(13.76)
Post	0.03***	0.00***	0.00
	(18.13)	(3.28)	(0.91)
Post × FCU			0.03***
			(27.15)
Size	0.01***	0.01***	0.01***
	(11.55)	(25.33)	(29.43)

Table 6: Results from Tobit Regressions: Continues

	FCU	FISCU	Whole Sample
Capital ratio	-0.07***	0.02***	0.00
	(-3.83)	(3.01)	(0.37)
Loan loss provision	-0.41***	-0.03	-0.11**
	(-6.60)	(-0.50)	(-1.97)
Funding cost	-0.16*	0.25***	0.19***
	(-1.87)	(6.53)	(3.38)
Productivity ratio	-0.00***	0.01***	-0.00***
	(-4.51)	(4.05)	(-3.06)
Asset/Liability	-0.04***	-0.01***	-0.02***
	(-12.76)	(-3.03)	(-11.84)
Corporate CU	0.00	0.00	0.01***
	(0.97)	(0.88)	(3.28)
Intercept	-0.11***	-0.12***	-0.11***
	(-8.69)	(-22.16)	(-23.23)
Observations	15,045	25,380	40,425
F-statistic	6,843***	35,528***	36,143***
$FCU + Recession \times FCU = 0$			p-value = 0.008
$FCU + Post \times FCU = 0$			p-value < 0.001
$Recession + Recession \times FCU = 0$			p-value < 0.001
$Post + Post \times FCU = 0$			p-value < 0.001

Note: This table presents the results from Tobit regressions of efficiency score of the sample Federal Credit Unions (FCUs) and Federally Insured State-Chartered Credit Unions (FISCUs) on the selected variables defined in Table 1 for the period 2000q1-2013q2. The dependent variable, *ESCORE,* is bounded between 0 and 1. In the Whole Sample model, we include the variable *FCU* and its interactions with *Recession* and with *Post*, respectively. We report *t*-statistics calculated from robust standard errors in parentheses. We perform Wald tests to check for statistical significance of the full effects of *FCU*, *Recession*, and *Post* when considering the interaction variables. We report the respective *p*-values at the bottom of the table.
*, **, *** These symbols indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

The results reported in Table 6 for the sub-samples of FCUs and FISCUs are similar to those reported in Table 5, except that the positive coefficient on *Recession* becomes statistically significant at the 1% level. This result, compared to the pre-recession period, implies that the recession affects positively the efficiency of FCUs. The coefficient on *Recession* is still negative and statistically significant for FISCUs, suggesting that the recession impacts FCUs and FISCUs differently.

From the whole sample model in Table 6, the negative and statistically significant coefficient (-0.025) on *FCU* implies that, on average and holding all else constant, FCUs are less efficient than FISCUs before the recession. The negative and statistically significant coefficient (-0.01) on *Recession* indicates that the recession decreases the efficiency of FISCUs by one percentage point,

a result that is not depicted with the univariate analyses. The coefficient on the interaction term denoted *Recession* × *FCU* is positive (0.02) and statistically significant at the 1% level. This result emphasizes that FCUs fare better during the recession than before the recession, and that the impact of the recession on FCUs is more positive than on FISCUs. Similarly, the coefficient on the interaction term *Post* × *FCU* is positive (0.03) and statistically significant at the 1% level. Thus, FCUs fare also better after the recession than before the recession, and that the post-recession impacts FCUs more positively than FISCUs.

Specifically, we also perform four Wald tests to determine whether (1) the sum of the coefficients on *FCU* and *Recession* × *FCU* (-0.025 + 0.02 = -0.005)*, (2)* the sum of the coefficients on *Recession* and *Recession* × *FCU* (-0.01 + 0.02 = 0.01)*, (3)* the sum of the coefficients on *FCU* and *Post* × *FCU* (-0.025 + 0.03 = 0.005), and (4) the sum of the coefficients on *Post* and *Post* × *FCU* (0.00 + 0.03 =0.03) are statistically and significantly different from 0 at the 1% level. We report the results from these tests at the bottom of Table 6. We find that the full effects of *FCU, Recession*, and *Post* when considering the interaction terms are all statistically significant. For instance, the sum of the coefficients on *Recession* and *Recession* × *FCU* (-0.01 + 0.02 = 0.01) is statistically significant at the 1% level (p-value < 0.001), suggesting that the recession impacts positively the efficiency of FCUs.

Overall, the results in Table 6 show that the recession and the post-recession periods impact the efficiency of CUs, but their effects are more positive for FCUs than FISCUs.

VI. Robustness Tests

A. Generalized Linear Model (GLM) regression results

Some researchers (e.g., Papke and Wooldridge, 2008; Ramalho *et al.,* 2010) criticize the use of log-odd estimations such as Tobit when the fractional dependent variable is naturally bounded in the interval [0, 1] rather than censored at the bounds. Efficiency scores outside of this interval are not feasible (i.e. there is no negative efficiency or efficiency greater than one), thus the zeros and the ones are true values rather than censored ones. Therefore, we retest Equation (4) and Equation (5) using GLM regressions as proposed by Papke and Wooldridge (2008). The results are reported in Table 7.

Table 7: Results From Generalized Linear Models (GLM)

	FCU	FISCU	Whole Sample
Lag ESCORE	4.89***	4.35***	4.61***
	(109.41)	(105.17)	(152.29)
FCU			-0.35***
			(-31.62)
Recession	0.18***	-0.08***	-0.08***
	(13.78)	(-13.37)	(-12.59)
Recession × FCU			0.233***
			(17.71)
Post	0.36***	-0.01	-0.01*
	(24.33)	(-1.12)	(-1.91)
FCU × Post			0.39***
			(36.05)
Size	0.04***	0.08***	0.06***
	(6.51)	(17.18)	(16.83)
Capital ratio	-0.82***	-0.16**	-0.30***
	(-5.23)	(-2.55)	(-3.27)
Loan loss provision	-4.67***	-0.09	-1.15**
	(-8.90)	(-0.21)	(-2.14)
Funding cost	0.84	1.92***	1.32***
	(1.17)	(4.72)	(3.65)
Productivity ratio	0.00***	0.03***	0.00*
	(4.85)	(3.80)	(1.74)
Asset/Liability	-0.21***	-0.11***	-0.19***
	(-6.54)	(-8.89)	(-10.39)
Corporate CU	0.03	-0.01	0.02
	(0.88)	(-0.77)	(0.86)
Intercept	-3.27***	-3.53***	-3.20***
	(-25.90)	(-49.27)	(-55.91)
Observations	15,045	25,380	40,425

Table 7: Results From Generalized Linear Models (GLM): Continues

	FCU	FISCU	Whole Sample
$FCU + Recession \times FCU = 0$			p-value < 0.001
$FCU + Post \times FCU = 0$			p-value < 0.001
$Recession + Recession \times FCU = 0$			p-value < 0.001
$Post + Post \times FCU = 0$			p-value < 0.001

Note: This table presents the results from GLM regressions of efficiency score (*ESCORE*) of the sample Federal Credit Unions (FCUs) and Federally Insured State-Chartered Credit Unions (FISCUs) on the selected variables defined in Table 1 for the period 2000q1-2013q2. In the Whole Sample model, we include the variable *FCU* and its interactions with *Recession* and with *Post*, respectively. We report *z*-statistics calculated from robust standard errors in parentheses. We perform Wald tests to check for statistical significance of the full effects of *FCU*, *Recession*, and *Post* when considering the interaction variables. We report the respective *p*-values at the bottom of the table.
*, **, *** These symbols indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

In Table 7, for the sub-sample of FCUs, the positive coefficients on *Recession* (0.18) and *Post* (0.36) are statistically significant. For the sub-sample of FISCUs, the negative coefficient on Recession (-0.01) is also statistically significant, while the coefficient on *Post*, though still positive, is not significant. When we analyze the whole sample, both the interaction terms of *FCU* with *Recession* and with *Post* remain positive and significant at the 1% level. These results are consistent with those from the panel fixed-effects and Tobit regressions.

B. Dynamic panel regression results

Since we include the previous quarter efficiency score, *Lag ESCORE*, in our models, we also replicate the previous analyses using Arrellano-Bover/Blundell-Bond dynamic panel Generalized Method of Moments (System GMM) regressions on our unbalanced panel of CUs to control for potential endogeneity. Table 8 shows that we have the results from system GMM regressions with one lag of the dependent variable only when we limit the study period to prior 2012 (Panel A). We suspect that this issue is due to the omitted first two quarters of 2012. For the entire study period (Panel B), the system GMM regressions include two lagged values of the dependent variable.

Table 8: Results From System GMM Regressions

	Panel A (Year < 2012)[a]			*Panel B (Entire study period)*		
	FCU	FISCU	Whole Sample	FCU	FISCU	Whole Sample
Lag ESCORE	0.11***	0.11***	0.09***	0.34***	0.22***	0.18***
	(3.77)	(3.11)	(3.79)	(5.84)	(3.79)	(4.33)
Lag2 ESCORE				0.24***	0.10***	0.12***
				(5.46)	(5.14)	(4.91)
FCU			-0.29***			-0.27***
			(-12.83)			(-11.56)
Recession	0.05	0.01	0.06***	0.03	-0.00	0.01
	(1.35)	(1.44)	(3.63)	(0.63)	(-0.01)	(0.89)
Recession × FCU			0.05*			0.05**
			(1.81)			(2.33)
Post	0.08**	0.02*	0.08***	0.12***	0.02	0.08**
	(2.43)	(1.79)	(4.21)	(2.59)	(1.39)	(2.19)
FCU × Post			0.06**			0.09*
			(2.28)			(1.74)
Size	0.01	0.07***	0.09***	-0.08***	0.06***	0.07***
	(0.22)	(8.83)	(11.42)	(-2.59)	(6.31)	(8.89)
Capital ratio	0.02	-0.14***	0.01	-0.03	-0.16***	-0.05
	(0.32)	(-5.46)	(0.29)	(-0.33)	(-5.77)	(-1.41)
Loan loss provision	-0.24	-0.61***	-0.28**	-1.16*	-0.74***	0.55***
	(-0.67)	(-4.30)	(-2.24)	(-1.93)	(-4.05)	(-2.91)
Funding cost	-2.73***	0.28**	-1.21***	-0.07	0.83***	-0.06
	(-7.78)	(2.25)	(-8.82)	(-0.08)	(3.24)	(-0.17)
Productivity ratio	0.00	-0.01	0.00	0.00	-0.03	0.00
	(0.24)	(-0.80)	(0.64)	(0.24)	(-1.61)	(0.60)
Asset/Liability	-0.46***	-0.04	-0.22***	-0.44***	-0.03	-0.20***
	(-4.68)	(-1.46)	(-9.29)	(-3.28)	(-0.59)	(-4.73)
Corporate CU	-0.02***	0.01***	-0.00	-0.02***	0.02***	-0.00
	(-3.12)	(3.34)	(-0.43)	(-4.09)	(5.45)	(-1.26)

Table 8: Results from System GMM Regressions: Continues

	Panel A (Year < 2012)[a]			*Panel B (Entire study period)*		
	FCU	FISCU	Whole Sample	FCU	FISCU	Whole Sample
Intercept	0.41	-0.99***	-1.10***	1.81***	-0.80***	-0.89***
	(0.74)	(-6.97)	(-8.21)	(3.47)	(-5.33)	(-7.48)
Observations	14,361	24,695	39,056	9,044	14,949	23,993
Number of CUs	850	916	1,766	850	916	1,766

Note: This table presents the results from Arrellano–Bover/Blundell–Bond dynamic panel (System GMM) regressions of efficiency score (*ESCORE*) of the sample Federal Credit Unions (FCUs) and Federally Insured State-Chartered Credit Unions (FISCUs) on the selected variables defined previously in Table 1. Panels A and B report the results for the period before 2012 and the entire study period, respectively. In the Whole Sample models, we include the variable *FCU* and its interactions with *Recession* and with *Post*, respectively. We report *z*-statistics calculated from robust standard errors in parentheses. We perform Wald tests to check for statistical significance of the full effects of *FCU*, *Recession*, and *Post* when considering the interaction variables. As in tables 6 and 7, all the *p*-values are less than 0.001 (unreported to save space).

[a] Estimation with only one lag of efficiency score was not feasible on the entire study period, probably because the entire study period does not include the 2012 quarters 1 and 2.

*, **, *** These symbols indicate statistical significance at the 10%, 5%, and 1% levels, respectively.

VII. Conclusion

This study contributes to the literature on performance efficiency and the comparison of performance efficiency between the two different types of credit unions using a non-parametric Data Envelopment Analysis (DEA). We construct a measurement of efficiency using a DEA approach, test the impact of the 2007-2009 recession on a sample of U.S. credit unions, and compare the efficiency scores of FCUs and FISCUs over the pre-recession, recession, and post-recession periods.

We find that larger credit unions and credit unions with lower loan loss provision are more efficient. Overall, our results from Panel Fixed-Effects and Tobit regressions imply that, despite the CUs' non-direct reliance to the financial markets, the sluggish economy during and after the recession decreased their performance efficiency. Despite investors' flight to safety, that could have improved their performance, CUs were certainly affected by the increased number of business failures and home foreclosures, and the higher unemployment rate.

We also provide evidence that FISCUs were more efficient than FCUs before the recession. This latter finding is consistent with the FISCUs' advantages from the involvement of state government and the flexibility of state regulations, noted by NASCUS (2008). However, we further document that the recession impacted FCUs and FISCUs differently. During and after the recession, FCUs appeared to be more efficient than their state-charted counterparts. Both FISCUs and FCUs are insured by NCUSIF and NCUA has adopted a 12-month examination cycle to detect problems in order to protect FCUs and FISCUs from failures. However, it could be the case that FCUs were more closely monitored by NCUA than FISCUs, which are primarily overseen by the state supervisory authorities.

Our findings still hold when replicating the analyses using Generalized Linear Model (GLM) and System Generalized Method of Moments (GMM) regressions. These outcomes indicate that

not-for-profit and cooperative CUs play important role for the participants, federal and state governance, and policy makers. We acknowledge that the changes in CUs' performance efficiency around the 2009 global recession reported in this study could also be due to policy changes triggered by the recession rather than the recession itself. Areas for further research would include the impact of regulatory changes on CU performance, further analysis of differences between credit unions, and comparisons of CU performance with microfinance institutions and other financial institutions.

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