

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

Abstract

This paper examines the impact of the latest economic recession on performance efficiency of U.S. credit unions. We construct a measurement of performance efficiency of credit unions from 2000 to 2013 using Data Envelopment Analysis, a non-parametric method. Our results from Tobit regression models reveal that the recession has a significant negative impact on Federal Credit Unions (FCUs) and Federally Insured State-Chartered Credit Unions (FISCUs) compared to the pre-recession period. We document that both FCUs and FISCUs exhibit their highest performance efficiency during the post-recession period. However, FISCUs have significantly higher operational efficiency than FCUs over the whole study period.

Keywords: Credit union; Performance efficiency; Data envelopment Analysis

JEL Classification: C14; G01; G21

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1. Introduction

Credit unions (hereafter CUs) are important financial institutions for the U.S. economy. They serve not only individual customers, but also provide financing to businesses, specifically to small business firms. However, there is little research on their performance efficiency compared to that of commercial banks (hereafter CBs). This shortage of research is primarily due to the cooperative feature of CUs, which makes the methods for examining performance efficiency difficult. CUs are member-owned cooperatives that build capital by retaining earnings. They do not issue equity.

We use a non-parametric Data Envelopment Analysis (DEA) to investigate the performance efficiency of U.S. credit unions. The DEA technique evaluates the performance of decision-making units (DMUs) to successfully transform inputs into outputs relative to their peers (Harris et al., 2013). Berger and Humphrey (1997) argue that a considerable lack of information on what the main determinants of efficiency are both across firms within the financial industry and across branches within a single firm.

There is also a lack of studies on comparison of performance efficiency across types of institutions. Although, some recent studies (e.g., Smith, 2012 and Anderson and Liu, 2013) examine CUs efficiency from different perspectives, few studies focus on this gap. Different from prior studies, we examine the persistence of performance of efficiency of CUs around the latest recession and compare our findings with evidence from CBs. In the U.S., credit unions can be chartered by the National Credit Union Administration (NCUA) or by state governments. We examine whether Federal Credit Unions (FCUs) and Federally Insured State-Chartered Credit

Unions (FISCUs) react differently to economic shocks and whether CUs are more sensitive than CBs to such shocks. Further, we use Tobit regression models to examine the impact of loan loss provision, assets size, and assets/liability management level and productivity ratio on CUs' performance.

CUs differ from other financial intermediaries in that they are not-for-profit and mutually-owned institutions. Ownership structure and capitalization methods are two basic differing factors for CUs and CBs. Members of CUs are both the owners of the organization and the consumers of its output or suppliers of its input (Smith, 1984; Smith, Cargill, and Meyer, 1981). Compared with CBs, one argument is that CUs fare better in financial shocks. While the financial crisis hasn't left CUs unscathed, they appear to be healthier than their bank counterparts (Bruce, 2009). The reason for this is that for-profit bank shareholders are only liable for losses of their own investment while not-for-profit credit union members profit from both own investment and depositors' funds. Therefore, CUs tend to take less risky investment during a bubble. On the other hand, conflicts of interest between shareholders and bondholders do not exist in CUs. Thus, CUs tend to take less risk during a bubble and are less likely to experience the effects as seriously as CBs when the bubble goes bust. Moreover, CUs gain from the failure of CBs as some commercial bank customers move to CUs for safety considerations.

FISCUs have advantages compared to FCUs based on Article XI of the Banking Law. Compared to federally-chartered credit unions, state-chartered credit unions are subject to state laws and regulations that are enacted to meet the particular needs of the citizens of the state. The state system allows for a local voice. Legislators and governors allow state-chartered credit unions a greater opportunity to affect credit union policy and generally provide more input into their governance than their federal counterparts. Moreover, Field of Membership (FOM) laws

and regulations allow for the mixing and matching of communities and Select Employee Groups for state-chartered credit unions.

Our results are consistent with the unique characteristics of the CU industry. We find that the latest recession has a significant negative impact on performance efficiency. Both FCUs and FISCUs exhibit significant higher performance efficiency during the post-recession period. We document that FISCUs have a significantly higher operational efficiency than FCUs during the whole study period. In addition, the higher efficiency scores of credit unions more likely lead to higher performance efficiency as evidenced from commercial banks. Further, we find that CUs experience an increase in assets contrary to CBs.

Our study contributes to the literature on CUs operating efficiency around the latest recession and on comparison of performance efficiency between FCUs and FISCUs, as well as CUs and CBs. 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.

The remainder of this paper is organized as follows. In the next section, we provide additional background as motivations of the study, survey related literature, and present our hypotheses. Section 3 describes the data and sample selection. We explain our methodological approach in Section 4 and present our empirical results in Section 5. Section 6 concludes.

2. Background, related literature, and proposed hypotheses

2.1 Background and motivations of the study

CUs experience a rapid growth of financial market share. First, CUs are one of the most numerous depository financial institutions. Anderson and Liu (2013) report that at the end of September 2012, approximately 2,710 credit unions were chartered by 47 states and Puerto Rico,

and approximately 4,320 credit unions were chartered by the federal government, making a total of 7,030 CUs. Second, they have also become important in home-mortgage and small-business lending. Moreover, CUs were less affected by recessions than commercial banks and savings institutions in the 1980s and early 2000s (Saunders and Cornett, 2001). Finally, CUs have been steadily growing their number of employees. Over the past two decades, CUs have more employees (actual employees) than all other depository institutions combined. CUs had 96 million members, representing more than half of American families, and provided 16.7% of outstanding consumer credit. The share of employees in the CUs was about 8% in 1990, but has grown to over 14% in mid-2010 (Anderson and Liu, 2013; Bauer, 2011b; Wheelock and Wilson, 2011).

In addition, like other depository financial institutions, CUs experience a high merger activity in recent years. Meanwhile, previous studies indicate that commercial banks exhibited their worse performance in the global recession of 2009 due to risk increases in asset adequacy, managerial ability, and profitability (Fahlenbrach et al., 2012; Fang et al., 2013). However, there are few studies that focus on performance efficiency of credit unions. From 2008 through 2012, 481 Federal Deposit Insurance Corporation (FDIC) insured banks were either liquidated or merged with healthier institutions. CUs had 136 involuntary liquidations or assisted mergers at the hands of the National Credit Union Share Insurance Fund (their version of the FDIC). Currently, there are 6,940 FDIC institutions compared to 6,815 U.S. credit unions (Gold, 2013). Bauer (2011a) claims that managers tend to take on more risks in an effort to make more money if they are given option compensation. Most of such incentives do not hold for credit unions because credit union managers by contrast cannot be given stock based compensation (Dong et al., 2010).

Credit unions and commercial banks are important parts of the financial system and are aggressive competitors. Both types of institutions are chartered by the federal or state governments, which aim to fostering competition between the institutions. Empirical studies document the characteristic of CUs and CBs well. The main results of these studies are (1) rates on deposits at banks and credit unions move together, (2) credit union lending to small businesses partly displaces bank lending, and (3) credit union lending has been steadier 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 and CBs 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 provision and reporting rules as CBs (Wheelock and Wilson, 2013).

Berger (1997) surveys 130 studies that apply frontier efficiency analysis to financial institutions in 21 countries. They find that depository financial institutions (banks, credit unions) in these studies experience an average efficiency of around 77% (median 82%). Moreover, CUs and CBs have similar trends over time. CUs in the aggregate held \$1 trillion in assets and community banks held \$13 trillion. The number of credit unions has decreased 36%, while total assets have increased 160%. The number of banks has decreased 30%, while their total assets have increased 140% (Anderson and Liu, 2013).

In summary, both industries have experienced similar trend growth since 1998. The comparison between the two types of institutions is important. Specifically, with the expansion CU products, the roles and efficiency of the two competitors in the market are interesting to study.

2.2 Related literature and proposed hypotheses

The theoretical models of performance efficiency of CUs are well documented. Two major performance theoretical models exist. One is proposed by Smith et al. (1981) and Smith (1984). They model the CUs' owner/customer receiving benefit from the CUs by receiving higher deposit rate and paying lower loan rate 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 vector. Bauer argues that his methods and return vectors are well specified and powerful with small changes in observed ex post event performance. Bauer et al. (2009) employ the methodology proposed by Bauer (2008) to examine the mergers impacts on CU performance.

The other theoretical model of CU performance efficiency is based on minimizing operating cost, thus maximizing the owner/customer's benefits, which is the maximization of service provision that includes 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 employ parametric and non-parametric estimators (Free Disposal Hull, hereafter FDH) methods. They explained 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.

Further, several studies in the literature examine 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. 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. Also, the performance change was small.

Goddard et al. (2008) find that large CUs are better in diversifying non-interest income than small ones by 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 overtime and cost-productivity fell on average especially in small ones. Wheelock and Wilson (2011) find increasing return to scale among CUs of all sizes, suggesting that further consolidation and growth are better for CUs.

There are few studies to examine the impacts of recession on CUs performance efficiency. On the contrary, the impacts of recession on CBs are well documented. One argument is that CUs may benefit from the financial shocks since they are not reliable on the stock financing as they are financed by member deposits (Ferris, 2008; Birchall and Ketilson, 2009). Smith and Woodbury (2010) analyze 15 years of quarterly call report data from banks and credit unions during the period 1996 to 2010. Their report shows that commercial loan performance for

both banks and credit unions is 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. Smith and Woodbury (2010) analyze call report data from banks and credit unions from 1986 to 2009. They find that CUs loan portfolios appear to be about 25% less sensitive to macroeconomic shocks than bank loan portfolios. However, in their study, they don't examine the performance efficiency of CUs and CBs, and they didn't examine the difference between these two institutions either.

DEA is one of the popular measurement methodologies of performance efficiency in both CUs and CBs. It is a weighted sum of outputs to inputs that can be used to compute the relative efficiency of an institution in relation to other institutions. It identifies the most proficient input-output combinations and develops a best practice efficiency frontier against the peers. However, there are few studies on comparison of performance efficiency between FCUs and FISCUs, CUs and CBs employing DEA. Berger and Humphrey (1997) survey 130 studies and find that cost efficiency is more important than market concentration in explaining financial institution profitability. However, both influences 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. In the survey, Berger and Humphrey (1997) argue that DEA is an appropriate method to evaluate CU performance efficiency employed within a profit frontier framework, as it is popular in the commercial banking literature.

Overall, CUs and CBs are important financial institutions and they experience a rapid growth in financial market shares. The comparison of performance efficiency between these two competitors is an interesting issue. Also, the comparison of performance efficiency of FCUs and FISCUs is interesting as well. The impacts of recession on operational performance of CUs are

less documented. Although the efficiency of CBs is well documented, performance efficiency comparison between CUs and CBs is not. Therefore, we propose the following hypotheses.

We expect the latest subprime recession to affect CUs performance efficiency. We posit that the performance efficiency declines during recession and experiences an increase during post-recession for both FCUs and FISCUs. We presume FISCUs to experience higher performance efficiency than FCUs. We expect that higher efficiency score more likely leads to higher performance efficiency as proposed in CBs.

3. Data and methodology

3.1 Data source and sample selection

We use quarterly call report data from the National Credit Union Administration (NCUA) from 2000 through 2013, which include 14 years and 55 quarters. Following Wheelock and Wilson (2013), we omit observations with reported non-positive loans or investments, or with the calculated values for cost of capital(W_1), cost of labor(W_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 doesn't have complete data items.¹ 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 whole sample 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.

¹ There is no labor expense available for 2012q1 to 2012q2, so we cannot get the efficiency scores because of these missing items.

We construct six output variables and two input variables. The description of each variable and its calculation are provided in Table 1. Following Frame and Coelli (2001) and Wheelock and Wilson (2011), we identify the two input variables, the prices of labor and financial capital. A loan price is identified as the total income and fees divided by total capital, which indicates that a higher price is associated with better performance. A labor price is defined as employees and officer's compensation and benefits divided by number of full time plus half or part time employees. The four output quantities identified 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 case equivalent. These measures are based on NCUA performance report. These four variables capture the vast majority of assets. For example, real estate loans are important assets for CUs, which account for around 35.5% of total assets in 2010 (Saunders and Cornett, 2001). Savings pricing (Y_5) and loan prices (Y_6) are created to ensure an institution is not unfairly considered as less efficient due to more costly output composition.

Insert Table 1 here

Pursuant to previous studies, we analyze several measures of capital adequacy, liquidity, asset quality, management and productivity. That is, we include the following controlling variables in our model: assets, capital ratio, loan loss provision, assets to total shares and deposit ratio, productivity ratio and Lag of performance efficiency. Descriptive statistics of these variables are provided in Table 2.

Insert Table 2 here

As shown in Table 2, both FISCUs and FCUs samples have significantly higher assets (t -statistics = 43.79 and 26.05, respectively) and capital ratios (t -statistics = 11.94 and 19.95,

respectively) in the pre-recession compared to the pre-recession period.² Over these two sub-periods, CUs have the highest level in asset and capital ratio in the post-recession, but the lowest during the pre-recession period. The mean differences of these two variables are significant at 1% level. These results indicate that the asset size and capital adequacy of credit unions increased during the whole sample period (even in the recession period). On the other hand, FISCUs have a higher capital ratio compared with FCUs in the two sub-periods while FCUs has higher assets than FISCO. It indicates the FISCUs exhibit a higher capital adequacy requirements while FCUs have a higher asset level. The mean difference between the two groups in assets and capital ratios are significant at 1% level.

Referring to credit risk, on average, loan loss provision to total loan ratio which access the quality of its assets and how well it protects itself from losses caused by problematic loans. The higher this ratio is, the better the bank is handling itself in regards to loans. It is statistically higher during post-recession period compared to pre-recession period in both groups. For instance, the loan loss provision increases by .03% for FISCUs and statistically different from pre-recession period. It indicates that the expense set aside as an allowance for bad loans (customer defaults, or terms of a loan have to be renegotiated) went up after the recession. Moreover, compared with FISCUs, FCUs has a higher loan loss ratio which indicate the FCUs has a higher expense set aside as an allowance for bad loans.

In terms of asset management, we use total loan to total shares and deposit ratio. On average, FISCUs and FCUs experience a significant decrease in this ratio after the crisis.

Comparing FCUs with FISCUs, the latter has a statistically higher mean ratio than the former in post-recession period compared with pre-recession period. It indicates that the asset management risk declines after the crisis.

² We report the results of comparison of financial ratios for each type of CUS only between pre-recession and post-recession periods. We do the comparisons of FCUs and FISCUs among pre-recession, recession, and post-recession periods.

For earnings, we use fund cost to average assets ratio. On average, FISCUs and FCUs experience a significant decrease in earnings after the crisis. For instance, the mean *fundcost* decreases from .014 to .007 for FISCUs. It indicates less input costs for credit unions after the recession. FCUs have a higher fund cost than FISCUs in both pre and post-recession periods. The mean difference is statistically significant between FCUs and FISCUs in all the financial ratios except for loan loss and productivity ratio during post-recession period. More interestingly, FCUs have a higher productivity ratio³ than that of FISCUs, which means FISCUs have less actual membership to potential membership which indicate the member penetration percentage. It implies FISCUs are more likely to have a larger increase of membership than FCUs in the future.

As expected, the results show that both FCUs and FISCUs experience very significant increase in asset size and capital ratio, which may be attributed to the comparative safety in CUs than CBs. Further, it might be attributed to the capital adequacy requirements. We find significant decrease in funding cost and increase in loan loss provision.

4. Methodology

4.1 Data Envelopment Analysis and test statistics

Based on the previous analysis, in the first stage, we construct a performance efficiency measurement using DEA proposed by Charnes et al. (1978) that captures efficiency as the minimum consumption of inputs for a given level of output. In the second stage, we use regression models to examine the impacts of the crisis on CUs efficiency and compare our

³ Members report the number of credit union members. Report the actual number of members, not the number of accounts. Report the number of potential credit union members. Include current members in this estimate. The estimate of potential members must be reasonable and supportable. Based on the Financial Performance Report (FPR) Ratios for FCU released on March 31, 2013.

findings with impacts on CBs (Harris et al., 2013). Table 3 presents descriptive statistics on the inputs and outputs used to examine the CUs efficiency and compares the inputs and outputs of CUs before and after the crisis period.

Insert Table 3 here

To measure the performance efficiency of CUs, we must construct a model of cost function. Following Wheelock and Wilson (2011) and Frame and Coelli (2001), we model CUs as service providers which are seeking 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) to their peers (Charnes et al., 1978; Harris et al., 2013; Hsiao et al., 2010). Empirical studies provide evidence that the banks with higher efficiency scores indicate higher performance efficiency. Similarly, empirical studies using DEA to evaluate the efficiency of credit unions 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 that minimize inputs for a given level of output.

Following Hsiao et al. (2010), the input-oriented efficiency measure is the reciprocal of the inefficiency measure θ_j for CU_j , as following:

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

where θ_j is the estimated inefficiency for CU_j , X_{ij} is input i for CU_j , Y_{rj} is the output r for CU_j . Based on previous studies, we construct six outputs and two inputs. Four outputs include real estate loans, consumer loans, commercial loans, and investments. The other two additional outputs are price dimension of price of loan and price of saving. The two inputs variables include capital price and labor price. Descriptive statistics are provided in Table 3.

Insert Table 3 here

Table 3 provides the means and mean-differences of the inputs and outputs used to estimate CUs performance efficiency to compare the inputs and outputs in pre-recession, recession, and post-recession periods for FCUs and FISCUs. On average, both FISCUs and FCUs exhibit very significant decrease on both capital and labor price for post-recession period compared to that of pre-recession at 1% level. The comparison between recession and post-recession indicates that FISCUs have highest inputs in capital and labor. Further, FCUs have significant higher inputs in capital than FISCUs while FCUs have a very significant lower labor input than FISCUs. For instance, the mean labor price for FISCUs is .057 compared to .015 for FCUs.

On the other hand, in terms of the six outputs, on average, both FCUs and FISCUs have a similar trend and the results indicate a high statistically significant increase in real estate loans (Y_1), commercial loans (Y_2), and investments (Y_4) at 1% level. Consumer loans (Y_3) experience a significant decrease in both FCUs and FISCUs. It might be attributed to the high increase in real loans and commercial loans since we calculate consumer loans by using total loans minus total real loans and commercial loans.

The most impressive change is in two additional price dimension outputs. Especially, the decrease is in mean saving price (Y_5). For instance, for FISCUs, it decreased by 44% from 0.016

to 0.009 and the difference is statistically significant at 1% level. There is a similar situation in FCUs where the decline is about 55%. In addition, both saving price (Y_5) and loan price (Y_6) decreased in both FCUs and FISCUs compared to in pre-recession period.

Overall, both FCUs and FISCUs experience an increase in real estate loans, commercial loans, and investments. Especially, investments jumped about 540% (from 0.132 to 0.845) compared to pre-recession period in FISCUs while they increased by 356% (from 0.183 to 0.835) in FCUs as well. Investments experience an impressive increase even during recession. The results show that FCUs have a very significant lower output in real estate loans and commercial loans at 1% while FCUs have a significant higher loan price and saving price than FISCUs.

As expected, on average, the univariate test indicates both FCUs and FISCUs input cost has a very significant decrease during post-recession. The saving price (dividend income and interest income of deposit) and loan price (interest and fee income on loans) experience significant decrease post-recession. The changes in inputs and outputs stay consistent in both FCUs and FISCUs. Impressively, FISCUs have a very significant higher expense in labor compared to FCUs.

As Hsiao et al. (2010), we consider the available two DEA test statistics to examine the equality of efficiency scores among the three sub-periods and also the FCU group compared to FISCO group. Under the assumption that θ_j is exponentially distributed, we consider the following test statistic:

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

which is examined by the F- distribution with (N_1, N_2) degree of freedom. N_1 and N_2 are the periods before and after the crisis period.

The test statistic for assumption of half-normally distribution θ_j is given as:

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

In addition to the above tests, we report the conventional t -statistics tests. The results are reported on Table 4.

4.2 Research models

We use Tobit regression and Panel regression models with fixed effects to capture the relationship between recession and CUs performance efficiency after controlling for Size (ln (assets)), Capital ratio, Loan loss provision, assets to total deposit ratio, productivity ratio and lag efficiency performance. The research model is proposed as following:

$$\begin{aligned} ESCORE_{i,t} = & \alpha + \beta_1 fcu_{i,t} + \beta_2 (Recession)_{i,t} + \beta_3 (Post-Recession)_{i,t} \\ & + \beta_4 Control\ variables_{i,t} + \beta_5 ESCORE_{t-1} + \varepsilon_{i,t} \end{aligned} \quad (4)$$

where $ESCORE_{i,t}$ denotes performance efficiency score of CU i at time t ; Dummy variable FCU equals 1 for FCU; otherwise it takes a value of 0, denotes FISCU. We include several controlling variables in the model. The descriptive statistics of dependent variables and independent variables are provided in Panels A and B of Table 4.

Insert table 4 here

Based on the previously reviewed literature, we expect that the latest subprime recession has a negative impact on CUs performance efficiency. Compared to that of pre-recession period, performance efficiency would decline during recession and experience an increase during post-recession in both FISCUs and FCUs. We expect FISCUs to experience higher performance efficiency than FCUs. We expect that higher efficiency score more likely leads to higher performance efficiency as documented for commercial banks. We expect that the recession has

lesser impact on performance efficiency of CUs compared to CBs. We expect both FCUs and FISCUs have a scale effect, which means that the large CUs has a higher efficiency than the small ones. On the contrary, fund cost and asset to liability, previous performance have positive impact on the future operating efficiency.

5. Empirical results

5.1 Univariate results

As expected, the results in Table 4 indicate that the performance efficiency of post-recession period exhibit the highest efficiency scores among the three sub-periods in both FCUs and FISCUs. This result is consistent with the inputs and outputs results in Table 3. The post-recession period exhibits the highest outputs in real estate loans, commercial loans and investments with the lowest inputs. Moreover, FISCUs experience a stable increase even during the recession period. On the contrary, FCUs experience a decrease in performance during the period 2006 to 2009. In addition, very interestingly, the number of observations for FCUs decline from 24,896 to 8,657 across recession and FCUs experience a decrease from 13,442 to 8,492. The mean efficiency scores of FCUs increase from 0.171 to 0.318 and for FISCUs from 0.324 to 0.371. Both standard deviation of FCUs and FISCUs increase indicates that the deviation of mean efficiency scores increases. As shown in panel B of Table 4, the three equality statistics all indicate the mean difference in efficiency scores across three sub-periods is statistically significant at 1% level. For instance, the mean efficiency score of FISCU is statistically different at the 1% level of significance. (t -statistics =18.59).

Overall, on average, the mean efficiency score post-recession is about 0.047 higher compared to pre-recession for FISCUs; while the mean efficiency score is about 0.147 higher

than that of pre-recession for FCUs. FCUs have a lower efficiency score in the three sub-periods compared to FISCUs. As expected, our results indicate that FISCUs exhibits higher performance efficiency than FCUs. Both groups experience an increase in efficiency even under recession shock. It seems to indicate that, for CUs, recession is not as bad as for CBs.

5.2 Tobit and Panel with fixed effects regression results

In Table 5, we present Tobit regression results controlling for several variables. We report the results for the whole sample, FISCUs and FCUs respectively.

Insert table 5 here.

First of all, on average, controlling for other variables in the model, FCUs have a lower performance efficiency compared to the base group-FISCUs which is significant at 1% level. The result is consistent with our univariate results in Table 4. The soundness of this finding is that FISCUs have more flexible laws and regulations which provide more opportunity to put more inputs than FCUs. For instance, we find that FISCUs have a much higher labor inputs than FCUs.

Second, both FISCUs and FCUs (separately and considering the whole sample) are lower in performance efficiency during the recession compared to the base period-pre-recession period. This finding is consistent with our expectation. Third, controlling for other variables in the model, on average, both FISCUs and FCUs experience an increase in operating efficiency during post-recession compared to pre-recession period, which is also consistent with our expectations. For instance, performance efficiency scores increase by .2% compared with pre-recession period for FCUs.

In terms of controlling variables, on average, the results are consistent with our expectations on assets, loan loss, and asset/liability ratio. Assets have a very significant relationship with efficiency scores in both FCUs and FISCUs. It implies that scale effects exist, which means the large CUs have higher efficiency than the small ones, which is not the case with CBs (Harris et al., 2013). The difference between Harris et al., (2013) and our study might be because, in our sample, the average asset size of CUs is less than \$18 million while the average size of the CBs in their study is around \$97.29 million and \$135.67 million. Moreover, interestingly, previous efficiency has a very significant positive relationship with performance.

We report results of Panel regression models with fixed effects in Table 6. Generally speaking, on average, the results are similar with Tobit regression. Overall, Tobit regression results support our expectations that FISCUs have a higher efficiency around recession. Recession has negative relationship with performance efficiency of CUs.

Insert table 6 here.

6. Conclusions and implications

In the study, we examine the impacts of the latest recession on performance efficiency of credit unions during 2000q1 through 2013q2 by constructing a measurement of performance efficiency using a non-parametric DEA approach. We compare the efficiency over the pre-recession, recession, and post-recession periods between FCUs and FISCUs.

Overall, our results indicate that FISCUs have higher performance efficiency than FCUs during the three sub-periods. Recession decreases performance efficiency. Both FCUs and FISCUs have a higher efficiency during post-recession period than that of pre-recession.

Higher efficiency scores are more likely to lead to higher performance efficiency. Our study contributes to the literature on performance efficiency of credit unions around recessions. We also contribute to the comparison of performance efficiency among different types of institutions by DEA.

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Table 1 Variable description

	Proxy	Description and calculation
Inputs		
Y ₁ (I)	real estate loan	(amount of first mortgage real estate loans + amount of other real estate loans)/total loans and leases
Y ₂ (I)	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 lease
Y ₃ (I)	consumer loans	{total loans and leases, amount-(amount of real estate loan +amount of commercial loan)}/total loans and lease
Y ₄ (I)	investment	(total investments, cash on deposit and cash equivalent)/total loans & leases
Y ₅ (I)	saving price	dividends on shares + interest on deposits]/total shares and deposits
Y ₆ (I)	loan price	interest and fee income on loans, total/ total loans & leases
Outputs		
W ₁ (O)	price of capital	capital expenses/ Total shares and deposits
W ₂ (O)	price of labor	{labor expenses/(number of full time employees+1/2 part time employees)}/total operating expenses
Cost		Cap* W ₁ + Lab* W ₂
Control variables in regression		
Assets		Ln(Assets)
Capital ratio		net worth/total assets
Loan loss provision ratio		provision for loan and lease /total loan
Asset/liability management		total loans /total shares and deposits
productivity ratio		members/potential members
Funding cost		cost of funds/average assets
LAG(EFFICIENT SCORE)		Lag (EFFICIENT SCORE)
D1		Crisis Dummy

Table 2 Comparison of financial ratios

This table reports descriptive statistics on credit union financial ratios and compares the financial ratios of Federal Credit Unions (FCUs) and Federally insured State-Chartered Credit unions (FISCUs). We divide the whole sample into three sub-periods: pre-recession from 2000q1 through 2007q4, recession period from 2008q1 through 2009q2 and post-recession from 2009q3 through 2013q2. Means for each measure are shown in Panels A and B. Tests of significance are *t*-statistics for differences in group mean. In Panel C, tests of significance are *t*-statistics in group mean between FCUs and FISCUs among three sub-periods. The symbols *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

<i>Panel A FISCU Comparison of mean difference between pre-recession and post-recession</i>			
Variables	FISCU_Pre_recession(1)	FISCU_post (2)	Difference (2)-(1) <i>t</i> -statistics
assets	18.236	18.814	26.05***
capratio	0.107	0.114	11.94***
loanloss	0.003	0.006	26.82***
pratio	0.343	0.230	-28.34***
asset/liability	0.770	0.699	-30.61***
fundcost	0.014	0.007	-102.2***
<i>Panel B FCU Comparison of mean difference between pre-recession and post-recession</i>			
Variables	FCU_Pre_recession	FCU_post	Difference (2)-(1) <i>t</i> -statistics
assets	18.894	19.495	43.79***
capratio	0.092	0.104	19.95***
loanloss	0.003	0.006	23.97***
pratio	0.454	1.023	0.75
asset/liability	0.737	0.669	-27.39***
fundcost	0.019	0.007	-139.57***
<i>Panel C Comparison of mean difference between FCU and FISCU</i>			
Variables	PRE	RECESSION	POST
assets	46.25***	39.1***	31.1***
capratio	-25.45***	-20.8***	-17.59***
loanloss	2.34**	1.97**	-0.9
pratio	3.92***	1.06	1.04
asset/liability	-17.16***	-15.06***	-10.48***
fundcost	53.15***	5.87***	5.48***

Table 3 Comparison of FCU and FISCU efficient scores inputs and outputs

This table provides descriptive statistics on the two inputs and six outputs used to measure credit union efficiency. The two inputs are cost of capital (W1) and cost of labor (W2). The four outputs identified are Real estate loans (Y1), Commercial loans (Y2), Consumer loans (Y3), and investments (Y4). The two additional inputs, Savings pricing (Y5) and loan prices (Y6) are created to ensure an institution is not unfairly considered as less efficient due to more costly output composition. Means for each measure are shown in Panels A and B. Tests of significance are t-statistics for differences in group mean. We divide the whole sample into three sub-periods: pre-recession from 2000q1 through 2007q4, recession period from 2008q1 through 2009q2 and post-recession from 2009q3 through 2013q2. In Panel C, tests of significance are *t*-statistics in group mean between FCUs and FISCU among pre-recession, recession, and post-recession periods. The symbols ** and *** indicate statistical significance at the 5% and 1% level, respectively.

Panel A FISCU comparison of inputs and outputs

Variables	FISCU_PRE(1)	FISCU_RECESSION(2)	FISCU_POST(3)	(2)-(1) t-statistics	(3)-(2) t-statistics	(3)-(1) t-statistics	Pr > t
w1	0.013	0.012	0.013	6.99***	4.57***	-3.77***	<.0001
w2	0.057	0.050	0.049	4.82***	-1.04	-4.73***	<.0001
y1	0.164	0.225	0.227	-35.25***	2.05**	31.15***	<.0001
y2	0.021	0.044	0.047	-23.72***	4.96***	22.27***	<.0001
y3	0.815	0.731	0.726	35.78***	-3.55***	-32.05***	<.0001
y4	0.132	0.761	0.845	-28.9***	6.54***	23.12***	<.0001
y5	0.016	0.009	0.007	75.45***	-42.9***	-96.74***	<.0001
y6	0.065	0.057	0.058	13.73***	3.3***	-9.3***	<.0001

Panel B FCU comparison of inputs and outputs

Variables	FCU_PRE(1)	FCU_RECESSION(2)	FCU_POST(3)	(2)-(1) t-statistics	(3)-(2) t-statistics	(3)-(1) t-statistics	Pr > t
w1	0.014	0.012	0.012	-11.36***	-4.98***	-22.63***	<.0001
w2	0.015	0.009	0.009	-13.38***	-1.29	-14.51***	<.0001
y1	0.151	0.218	0.222	21.91***	3.79***	35.41***	<.0001
y2	0.015	0.036	0.039	13.95***	6.39***	27.49***	<.0001
y3	0.834	0.745	0.740	-22.89***	-5.34***	-38.83***	<.0001
y4	0.183	0.776	0.835	28.2***	9.83***	48.73***	<.0001
y5	0.020	0.009	0.007	-42.19***	-48.43***	-126.76***	<.0001
y6	0.080	0.059	0.058	-24.92***	-5.87***	-43.13***	<.0001

Table 3 (continued)

Panel C Comparison of inputs and outputs between FCU and FISCU

Variables	PRE	RECESSION	POST	Pr > t
w1	14.94***	-2.73***	-6.19***	<.0001
w2	-42.52***	-34.56***	-27.64***	<.0001
y1	-9.49***	-3.29***	-2.18**	<.0001
y2	-8.86***	-7.52***	-6.44***	<.0001
y3	10.96***	5.48***	4.24***	<.0001
y4	8.72***	0.65	-0.31	<.0001
y5	46.45***	4.76***	3.00***	<.0001
y6	31.94***	2.60***	-1.06	<.0001

Table 4 Descriptive statistics of credit union efficiency

This table reports summary statistics on credit union efficiency and provides univariate statistics test results of equality of the efficiency scores during 2000q1 to 2013q2 in Federal Chartered (FCU) and State-Chartered credit union (FISCU). We divide the whole sample into three sub-periods: pre-recession from 2000q1 through 2007q4, recession period from 2008q1 through 2009q2 and post-recession from 2009q3 through 2013q2. We also report mean difference of efficiency scores between FCU and FISCU across the three sub periods. Credit union efficiency is calculated by data envelopment analysis (DEA). We report two DEA test results: *Texp* based on the exponentially distribution and *Thn* based on the half-normally distribution. We report the *t*-test statistics as well. The symbols *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

<i>Panel A Efficiency scores of FCU and FISCU</i>						
Year	State Chartered Credit Unions			Federal Chartered Credit Unions		
	mean	median	sd	mean	median	sd
2000	0.305	0.267	0.179	0.144	0.101	0.144
2001	0.313	0.276	0.186	0.123	0.091	0.124
2002	0.308	0.270	0.180	0.113	0.074	0.131
2003	0.336	0.291	0.185	0.131	0.088	0.142
2004	0.334	0.291	0.181	0.342	0.297	0.191
2006	0.356	0.317	0.193	0.290	0.250	0.202
2007	0.356	0.319	0.191	0.196	0.131	0.182
2008	0.360	0.328	0.198	0.219	0.153	0.191
2009	0.368	0.335	0.198	0.201	0.137	0.187
2010	0.365	0.333	0.202	0.324	0.268	0.191
2011	0.364	0.328	0.203	0.335	0.280	0.191
2013	0.394	0.361	0.204	0.394	0.346	0.181
Total	0.343	0.306	0.192	0.232	0.174	0.195
pre(1)	0.324	0.286	0.188	0.171	0.109	0.172
recession(2)	0.367	0.334	0.202	0.286	0.240	0.202
post(3)	0.371	0.336	0.204	0.318	0.271	0.198
	pre(1)	recession(2)	post(3)	pre(1)	recession(2)	post(3)
Observations	24,898	13,211	8,657	13,442	12,155	8,496
<i>Panel B-Statistics test results of equality of the efficiency scores</i>						
	(2)-(1) t-statistics	(3)-(2) t-statistics	(3)-(1) t-statistics	Exponentially distributed <i>t</i> -stat.(Texp)	Half-normally distributed <i>t</i> -stat.(Thn)	
FISCU	11.46***	2.76***	18.59***	2.953	3.319	
FCU	56.30***	27.74***	56.30***	2.708	4.246	
	pre(1)	recession(2)	post(3)			
FCU-FISCU	-80.60***	-31.99***	-17.19***	20.090***	47.500***	

Table 5 Tobit regression results

This table reports Tobit regression models results which are two-side censored since the efficiency scores is bounded between 0 and 1. We divide the sample into three sub-periods: pre-recession period from 2000q1 through 2007q4; recession from 2008q1 to 2009q2 and post-recession from 2009q3 through 2013q2. The sample is an unbalanced panel data. We report regression results of whole sample, FISCU and FCU respectively. The dummy variables denote FCU equals 1 for FCU; a value 0 denotes FISCU. We control for several credit union level variables: Asset size is the natural log of total credit union assets. Loan loss provision is used to measure the expense recorded in order to maintain the allowance for loan losses account. Total loan to total deposits ratio and fund cost are used to measure asset/liability management. Pratio denotes membership to potential membership ratio which is to measure productivity of CU. Berger et al. (2000) points out that the profit of bank tends to persist over time. We assume for credit union, the profit supposed to be persisting as well. Therefore we include the lag of efficiency scores to control auto-correlation.

$$ESCORE_{i,t} = \alpha + \beta_1 fcui_{i,t} + \beta_2 (Recession)_{i,t} + \beta_3 (Post-Recession)_{i,t} + \beta_4 Control\ variables_{i,t} + \beta_5 ESCORE_{i,t-1} + \varepsilon_{i,t}$$

where *ESCORES* denotes efficiency scores of credit union *i* at time *t*.

The symbols *, **, *** represent statistical significance at the 10%, 5%, and 1% level, respectively.

Variables	Whole Sample	FISCU	FCU
Intercept	-0.089*** (0.004)	-0.124*** (0.004)	-0.048*** (0.009)
FCU	-0.006*** (0.001)		
Recession	-0.010*** (0.001)	-0.014*** (0.001)	-0.002 (0.002)
Post	0.007*** (0.001)	0.002** (0.001)	0.014*** (0.002)
Assets	0.006*** (0.000)	0.008*** (0.000)	0.005*** (0.001)
Capratio	-0.002 (0.005)	0.020*** (0.006)	-0.039*** (0.012)
Loanloss	-0.106*** (0.028)	-0.032 (0.031)	-0.261*** (0.056)
Fundcost	-0.163*** (0.031)	0.273*** (0.031)	-0.695*** (0.078)
Pratio	-8.48e-07 (8.96e-06)	0.005*** (0.001)	-2.50e-06 (1.05e-05)
Asset/liability	-0.012*** (0.001)	-0.007*** (0.002)	-0.022*** (0.003)
L.score	0.944*** (0.002)	0.933*** (0.002)	0.944*** (0.003)
Observations	43054	26664	16390
LR chi2	108267	72376	35835
CU fixed effects	no	no	no

Table 6 Panel regression with fixed effects

This table reports results from Panel regression with fixed effects. We divide the sample into three sub-periods: pre-recession period from 2000q1 through 2007q4; recession from 2008q1 to 2009q2 and post-recession from 2009q3 through 2013q2. The sample is unbalance panel data. We report regression results of whole sample, FISCU and FCU respectively. The dummy variables denote FCU equals 1 for FCU; otherwise it takes value 0, denotes FISCU. We control several credit union level variables: Asset size is the natural log of total credit union assets. Loan loss provision is used to measure the expense recorded in order to maintain the allowance for loan losses account. Total loan to total deposits ratio and fund cost are used to measure asset liability management. Pratio denotes membership to potential membership ratio which is to measure productivity of CU. Berger et al. (2000) points out that the profit of bank tends to persist over time. We assume for credit union, the profit supposed to be persisting as well. Therefore we include the lag of efficiency scores to control auto-correlation.

$$ESCORE_{i,t} = \alpha_i + \beta_1 fcui_{i,t} + \beta_2 (Recession)_{i,t} + \beta_3 (Post-Recession)_{i,t} + \beta_4 Control\ variables_{i,t} + \beta_5 ESCORE_{i,t-1} + \varepsilon_{i,t}$$

where *ESCORES* denotes efficiency scores of credit union *i* at time *t*.

Variables	Whole Sample	FISCU	FCU
Intercept	-0.696*** (0.047)	-0.805*** (0.063)	-0.527*** (0.083)
FCU	-0.009*** (0.002)		
Recession	-0.013*** (0.001)	-0.016*** (0.001)	0.000 (0.002) ***
Post	0.003*** (0.001)	-0.008*** (0.001)	0.024 (0.002)
Assets	0.043*** (0.003)	0.051*** (0.004)	0.034*** (0.005)
Capratio	-0.061*** (0.010)	-0.029*** (0.010)	-0.120*** (0.012)
Loanloss	-0.137*** (0.043)	-0.053 (0.054)	-0.402*** (0.081)
Fundcost	-0.412*** (0.066)	0.403*** (0.078)	-1.262*** (0.114)
Pratio	-1.21e-06*** (2.36e-07)	-0.000 (0.003)	-3.63e-06*** (3.98e-07)
Asset/liability	-0.028*** (0.004)	-0.036*** (0.005)	-0.039*** (0.008)
L.score	0.754*** (0.012)	0.699*** (0.020)	0.744*** (0.016)
Observations	43054	26664	16390
R-squared	0.693	0.604	0.772
CU fixed effects	yes	yes	yes