

## **TECHNICAL EFFICIENCY IN MEXICO'S POPULAR SAVINGS AND CREDIT SECTOR**

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Los objetivos del estudio son dos: determinar la escala de eficiencia técnica de las instituciones que forman parte del SACP e identificar los determinantes significativos de la ineficiencia de dichas instituciones. La escala de eficiencia se obtuvo con base en dos metodologías econométricas que la literatura financiera propone: el análisis de la envolvente (técnica no paramétrica) y el análisis de la frontera estocástica (modelo que incorpora una función parametrizada que contiene el término de error estocástico). Ambas metodologías emplean los enfoques de la intermediación y la producción que la misma literatura propone. Se observó que los determinantes significativos de la ineficiencia son el tipo de institución y variables institucionales.

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# **Technical Efficiency in Mexico's Popular Savings and Credit Sector**

Julia Paxton

## **I. INTRODUCTION**

In developing regions across the world, reforms of the 1990's have led to a restriction of available funds for rural development and rural finance. As state sponsored financial institutions have retreated from rural areas, a number of semi-formal financial institutions have taken their place, yet little is known about their efficiency in serving a rural clientele. Advances in efficiency frontier techniques that are generally applied to formal banks in developed countries are relevant techniques to estimate the relative efficiency of semi-formal financial institutions in developing countries.

With the decline of state sponsored rural finance in Mexico, the Popular Savings and Credit Institutions (PSCI) have come to serve an important role throughout Mexico. Because the PSCI do not belong to the formal financial sector and do not receive significant donor funds, information about them has been scarce. Nevertheless, these institutions serve over 2 million clients and have served partially to fill a tremendous void in the rural financial system.

A markedly heterogeneous sector, little is known about the relative efficiency of these institutions and the determinants of inefficiency. The objective of this study is to evaluate the technical and scale efficiency of the PSCIs in Mexico and to determine the significant determinants of inefficiency.

The structure of the paper is as follows. Section II presents an overview of the PSCS while Section III discusses how parametric (Stochastic Frontier Analysis) and non-parametric methods (Data Envelopment Analysis) used for the commercial banking sector are applied to this semi-formal banking sector. A description of the data and model specification are presented in Section IV, followed by the empirical results for technical efficiency using both methods in Section V. In a second stage of analysis presented in Section VI, the determinants of technical efficiency are analyzed to shed light on questions of whether institutional type, technological sophistication, and client outreach are significant determinants of inefficiency. A summary of important findings and key issues is offered in the Section VII.

## **II. THE POPULAR SAVINGS AND CREDIT SECTOR IN MEXICO**

### ***A. Emergence of the PSCI***

During most of the 20<sup>th</sup> century, the Mexican financial system suffered from financial repression which was manifested in numerous ways including credit targeting, interest rate ceilings, credit quotas, subsidization, and negative real interest rates during inflationary periods. As a result, the formal financial sector was not well developed and few Mexicans had access to financial services. In the rural sector, various government sponsored programs had granted subsidized credit to farmers and had disappeared after mismanagement, poor loan recovery, and corruption.

Financial liberalization measures taken in the late 1980's included prudential regulation and fiscal reforms, liberalization of interest rate controls and quotas, an opening up of the commercial banking sector to the private sector, the reform of the

development bank and national banks,<sup>1</sup> and granting the central bank (Banco de Mexico) increased autonomy.

Despite these reforms, banks in Mexico have reduced their lending in recent years due to liquidity constraints, high interest rates, legal constraints making debt collection difficult, high risk, and a "culture of non-payment". The tequila crisis of 1994-1995 hit the financial sector particularly hard and resulted in the financial deepening indicator of M4 to GDP falling from 60 percent in 1992 to 38 percent in 1996. Most of the growth in the Mexican economy of 4 percent annually during the period 1996-2000 was financed by international loans rather than domestic credit (Hernández and Villagómez, 2001).

The lack of financial market penetration is particularly pronounced in rural areas of Mexico where poverty is widespread. In 1999, 26 percent of the population lived in rural areas yet the value added from agriculture represented only five percent of GDP (World Bank, 2001). Historically, the public sector has provided farmers with credit. Nearly half of the rural population has had access to public sector agricultural credit in the 1970's and 1980's (Mansell Cartens, 1996). The cost of the subsidization of public rural finance institutions has been substantial, representing nearly 13 percent of the annual agricultural GDP (World Bank 1998).

Despite the enormous cost associated with the rural credit programs, they have not fulfilled their objective of developing the rural sector and reducing poverty. In fact, the rural subsidization has been characterized by excessive cost, widespread arrears and strategic default, a myriad of debt forgiveness programs, regulatory problems, and

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<sup>1</sup> including *Nacional Financiera* (NAFIN), *Banco Nacional de Crédito Rural* (Banrural), and *Fideicomisos Instituidos en Relación con la Agricultura* (FIRA)

inverted income distribution. As a result, government transfers to the rural sector decreased in the 1990's.

The inefficient use and contraction of public funds in the rural areas has led to a weak and vulnerable financial system. Currently, the principal institutions operating in many of the rural and peri-urban areas are the PSCI. These institutions vary dramatically in their legal framework, number of clients, and types of services offered. Since half of these institutions were initiated by the communities and are not subsidized, detailed information about their services, profitability, and costs have not been available. As industry standards have become increasingly competitive, the PSCI find themselves in the position of streamlining operations and becoming more efficient.

### ***B. Institutional Types in the PSCI***

While some the PSCI are bank-like in nature with automated processes, financial transparency, and a for-profit legal structure, others are quite small, non-profit organizations, relying on rudimentary processes and accounting practices. Often these small cooperatives offer various social and humanitarian services.

The most important institutional structure in the PSCS is the CAP (cooperative savings and loans). Created under the 1994 General Law of Cooperative Societies, cooperatives in Mexico take on numerous institutional forms. The flexibility of this law has allowed for small social and financial organizations to qualify as CAPs with minimal requirements. Most act completely independently and until recently, have been largely unregulated. Private cajas and cooperatives play a notable role in rural areas where no formal bank structures exist. They are primarily community sponsored and do not rely

on donor or government subsidization. In addition, they offer a variety of nonfinancial services ranging from education, training, health, nutrition, and social services at low or no cost to their members. Numerous cooperatives have failed, leaving clients with lost savings and apprehension to participate in financial institutions. Another shortcoming of many of these institutions is their relatively underdeveloped technological infrastructure.

A second type of PCSI is the savings and credit society (SAP), a non-profit legal structure created in 1991 to support savings and credit operations to members only. The SAPs have declined in numbers since their creation in 1991. In 1995, 20 SAPs were in existence and by 1999, only 9 were operating. The failure of several SAPs has damaged public confidence since many depositors lost their savings. The SAPs have no federal deposit insurance, loose prudential supervision and regulation, and limited access to rediscounted lines of credit. Despite the problems of some of the smaller, weaker SAPs, the stronger SAPs have fared quite well in Mexico. Even during the peso crisis, these SAPs performed well since their capital structure is based on member savings rather than foreign currency liabilities. Real deposits in the SAPs actually increased during the period 1995 - 1997.

The Mexican credit union system is undergoing a shift in its orientation. Traditionally, credit unions operated primarily in rural areas and differed from the traditional savings based credit union model in that they relied principally on government and commercial lines of credit. The rural credit unions have deteriorated significantly in recent years due to weak national and regional organization, inadequate regulation and poor internal management and reporting. Since 1994, the rural credit unions have steadily declined in terms of number of clients and portfolio quality. From 1994 to 1997,

the value of the loan portfolio decreased by 60 percent. In recent years, some new credit unions have emerged that are more bank-like in nature and follow a traditional model of savings and credit.

Cajas Solidarias are small rural banks that reach the most remote villages with both savings and credit. Started in 1989, Cajas Solidarias incorporated members who had previously participated in the government sponsored credit program "Crédito a la Palabra" (Credit at your word). One of the successes of Cajas Solidarias has been its savings program which has more than doubled each year from 1995 to 1998. While the Cajas Solidarias program has had better success than previous government programs, it still struggles against the "grant mentality" of many of its clients who are used to government debt forgiveness. Arrears have increased throughout the 1990's, resulting in a 31 percent arrears rate in 2001.

In addition to these institutional types, a variety of other legal structures operate on a small scale in the PSCS including Civil Associations, Social Solidarity Societies, Civil Societies, Women's Agricultural Industrial Units, Private Assistance Institutions, Sociedades Anónimas de Capital Variable, and Mutualist Societies.

### ***C. Efficiency Issues in the PSCS***

The marked heterogeneity of the PSCS raises several issues regarding the efficiency of the sector. What type of returns to scale are witnessed in the sector and does scale efficiency vary by institutional type? Which of these institutions use an efficient mix of inputs to produce a given level of output? Are factors relating to client composition and institutional characteristics significant determinants of technical

inefficiency? How widely dispersed are the efficiency measures within each institutional type? The answers to these questions are critical to the rural financial development policy in Mexico.

### **III. PARAMETRIC AND NONPARAMETRIC MEASURES OF BANKING EFFICIENCY**

All banks utilize various measures of efficiency ranging from descriptive cost ratios (i.e. administrative cost per dollar lent) to output measures (such as the number of deposit accounts per employee). Based on the pioneering work of Charnes, et al. (1978) and Aigner, Lovell, and Chu (1977), recent academic studies implement either parametric or non-parametric techniques, utilizing a vector of inputs and outputs to create an efficient frontier (for a literature survey, see Berger and Humphrey, 1997).

While both parametric and non-parametric techniques have been applied to the analysis of institutional efficiency in the banking sector, no consensus exists in the literature about the preferred method of analysis. In general, non-parametric analyses impose a more flexible structure on the frontier, but have the shortcoming of assuming no random error. Likewise, parametric estimations incorporate random error but necessarily impose a particular functional form. The use of one technique over another can lead to divergent results, however, research addressing the limitations of each approach will allow the parametric and non-parametric results to be increasingly comparable (Berger and Humphrey, 1997).

### ***A. Data Envelopment Analysis***

Data Envelopment Analysis (DEA) is a non-parametric technique that utilizes mathematical programming to create a multi-dimensional efficient surface based on empirical data. Stochastic Frontier Analysis (SFA) estimates technical efficiency based on a parameterized production function. A comparison of both techniques will allow for a more comprehensive analysis of efficiency among the PSCIs in Mexico.

Data Envelopment Analysis is a flexible performance measurement that is based on plotting inputs and outputs in multidimensional space. DEA is typically used to measure technical efficiency and scale efficiency. If input price data are available, then it is possible to estimate allocative efficiency and economic efficiency.

*technical efficiency*: the ability to produce maximum output from a given set of inputs

*scale efficiency*: the ability of the firm to produce at an optimal scale

*allocative efficiency*: the firm's ability to utilize inputs in their optimal proportions, given relative prices (also known as price efficiency)

*economic efficiency*: also known as overall efficiency, it is the combination of technical and allocative efficiency

In the Constant Returns to Scale Model (CRS DEA), it is assumed that there are  $k$  inputs ( $x$ ) and  $m$  outputs ( $y$ ) for  $n$  firms or Decision Making Units (DMUs) where  $u$  is the output weight and  $v$  is the input weight. Efficiency for  $DMU_0$  is measured by:

$$e_0 = \frac{\sum_{j=1}^m u_j y_{j0}}{\sum_{i=1}^k v_i x_{i0}} \quad (1)$$

Efficiency is maximized subject to:

$$\frac{\sum_{j=1}^m u_j y_{jh}}{\sum_{i=1}^k v_i x_{ih}} \leq 1 \quad h=1, \dots, n \quad (2)$$

$$u_j \geq 0 \quad \text{for } j = 1, \dots, m \quad (3)$$

$$v_i \geq 0 \quad \text{for } i=1, \dots, k \quad (4)$$

The efficiency score is bounded by one and weights must be positive and are determined so that the efficiency ratio of the individual DMU is maximized.

The linear programming specification of this problem can be written as:

*min*  $f_0$

*subject to:*

$$\sum_{h=1}^m L_{0h} x_{ih} \leq f_0 x_{i0} \quad i=1, \dots, f \quad (5)$$

$$\sum_{h=1}^n L_{0h} y_{ih} \geq y_{j0} \quad j=1, \dots, m \quad (6)$$

$$L_{0h} \geq 0 \quad (7)$$

This formulation seeks to find the minimum proportion for firm 0 ( $f_0$ ) so that the weighted combination of inputs for all firms does not exceed the proportion of  $f_0$  for firm 0 and that the weighted combination of output is equal to or exceeds the output firm 0 for each output. The Variable Returns to Scale Model (VRS DEA) does not make the assumption that all DMUs are operating at optimal scale. By calculating a CRS DEA along with the VRS DEA, technical efficiency scores for each method can be compared, and the difference will illustrate scale inefficiency. The CRS DEA model is modified to incorporate VRS by including a convexity constraint on the weight combinations of:

$$\sum_{h=1}^n L_{0h} = 1 \quad (8)$$

This type of analysis is particularly applicable to the measurement of banking efficiency since traditional efficiency indicators, including the standard cost ratios, cannot control for several factors at the same time. DEA provides a flexible framework for analyzing numerous simultaneous factors. DEA is capable of determining which firms or DMUs fall on the efficient frontier and can assign numerical efficiency values for how far from the frontier the other observations are radially (termed *X-inefficiency* in the economics literature).

### ***B. Stochastic Frontier Analysis***

Stochastic Frontier Analysis also incorporates the notion of an efficient frontier, however, the frontier is determined parametrically. The parametric specification allows

for the inclusion of a stochastic error term. Differing from the symmetric random error associated with traditional least-squares based approaches, the error term in Stochastic Frontier Analysis is comprised of two components: traditional random noise with a zero mean and a strictly non-negative inefficiency measure with a nonzero mean that captures the distance from the frontier.

Given the availability of input and output data, a production function can be specified using Stochastic Frontier Analysis<sup>2</sup>. The translog production function is frequently used in empirical studies due to its flexibility and ease of interpretation. A translog production frontier for firm  $i$  with two inputs (labor and capital) and a single output is given by:

$$\ln Q_i = \beta_0 + \beta_1 \ln K_i + \beta_2 \ln L_i + \beta_3 \ln K_i^2 + \beta_4 \ln L_i^2 + \beta_5 \ln K_i \ln L_i + v_i - u_i, \quad (9)$$

where  $v$  is a normally distributed error term with a zero mean and variance  $\sigma_v^2$ , and  $u_i$  is a random variable that follows a truncated normal distribution with mean  $\mu_u$  and variance  $\sigma_u^2$ .

To analyze possible sources of technical inefficiency, the inefficiency effect,  $u_i$ , in the stochastic frontier translog production function can be specified as:

$$(2) \quad u_i = \theta' Z_i + w_i, \quad (10)$$

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<sup>2</sup> With price vectors, additional information on allocative and economic efficiency can be captured using cost functions and profit functions. However, these prices were not available for this study.

where  $Z_i$  represents a vector of explanatory variables related to technical inefficiency for the  $i$ th firm, the  $\theta$ 's are the inefficiency parameters to be estimated, and  $w$  is an error term that follows a truncated normal distribution. The parameters in equations (1) and (2) are estimated jointly by maximum likelihood (Battese & Coelli, 1995; Kumbhakar and Lovell, 2000).<sup>3</sup>

### ***C. Empirical Studies of Financial Institutions***

Most of the empirical studies of financial institutions using frontier efficiency estimates focus on banks in developed countries. In a survey of empirical results, Berger and Humphrey (1997) present findings from 116 banking efficiency analyses that include both DEA and SFA. Fifty-seven percent of the studies focused on the U.S. banking sector while another 40 percent examined formal financial institutions in other developed countries. Only 3.5 percent of the studies were performed in developing countries (Tunisia, India, and Mexico) and each of these studies analyzed the formal banking system. No frontier efficiency studies to date<sup>4</sup> have analyzed semi-formal financial institutions that target low and middle income clients in developing countries, despite their critical role in financial development.

Table 1 summarizes the mean X-efficiency estimates (cost and productive efficiency values) by region for the 116 studies in Berger and Humphrey's overview. A unitary X-efficiency indicates that the institution is on the efficient frontier, which is merely a reflection of the most efficient institutions within a given data set and the

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<sup>3</sup> The variance parameters are estimated as  $\sigma^2 = \sigma_v^2 + \sigma_u^2$  and  $\gamma = \sigma_u^2 / (\sigma_v^2 + \sigma_u^2)$  (Battese & Corra, 1977). The specification for the log likelihood function can be found in Battese and Coelli (1993).

<sup>4</sup> published in academic journals or other sources known to the author

average dispersion of institutions from the best-practice frontier<sup>5</sup>. The studies encompass all types of parametric and non-parametric techniques and have a wide range of inputs and outputs. The average U.S. bank with a mean inefficiency of 21 percent is closer to an efficient frontier than banks are in other regions.

**TABLE 1**  
**SURVEY OF BANKING EFFICIENCY MEASURES BY REGION**

<b>Region</b>	<b>Number of Studies</b>	<b>Mean Efficiency Value</b>
U.S. banks	66	0.79
Developed country banks (non-U.S.)	46	0.75
Developing country banks	4	0.72
Mexican banks	1	0.72

source: Berger and Humphrey, 1997.

The study of Mexican banks by Taylor, et. al. (1997) sheds light on the changing Mexican financial landscape. Using panel data from 1989 to 1991 for 13 commercial banks, the authors find that banks could increase their DEA efficiency relative to their competitors over time by shifting the input mix. DEA efficient banks were not necessarily the most profitable and the average bank had an X-inefficiency of 28 percent. When studying the semi-formal banking sector in Mexico, it is hypothesized that the X-inefficiency scores will even more pronounced given the variations in technology, outreach, and institutional objectives among institutions and also due to the fact that many more institutions, and therefore outliers, are included in the study.

Comparisons of institutional types have been difficult since most studies have not been able to utilize a common efficiency frontier for distinct banking legal entities. In

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<sup>5</sup> Therefore, caution must be exercised when comparing values across institutions since it may be possible that institutions lying on the efficient frontier in one data set might be inefficient in another milieu where banking efficiency is stronger.

many studies to date, banks, credit unions, and savings and loans have not shown dramatically divergent efficiency scores (Berger, et. al., 1997). However, Altunbas and Chakravarty (1998) find that institutional type (including commercial, savings, cooperative and "other") is an important determinant of X-inefficiency among financial institutions in Europe.

#### **IV. DATA AND MODEL SPECIFICATION**

##### ***A. Data***

Confidential financial information from June 30, 2001 was obtained from 350 PSCIs in a census performed by Banco de Ahorro Nacional y Servicios Financieros (BANSEFI). The data are self-reported and do not contained detailed cost information. Nevertheless, relevant information about overall inputs and outputs, institutional types, and client outreach were obtainable.

Table 2 shows the number of institutions by legal structure that fit into each of these size ranges. Most institutional types are dominated by micro, small, and medium sized institutions<sup>6</sup>. The SAPs stand out as having a greater proportion of very large institutions with an average of over 100,000 clients per institution. In contrast, the Cajas Solidarias have just 1150 clients per institution on average. The CAPs have all sizes of institutions and represent one of the most diversified categories of PSCIs.

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<sup>6</sup> *MICRO: 1 - 500 clients SMALL: 501 - 1500 clients MEDIUM: 1501 - 5000 clients LARGE: 5001 - 15,000 clients VERY LARGE: over 15,000 clients*

**TABLE 2**  
**OUTREACH INDICATORS BY INSTITUTIONAL TYPE AND SIZE**

Institutional Type and number of observations	# Members	% Female	% Children	% Rural Clients
<b>CAP</b>				
AVERAGE MICRO (37)	263.32	0.55	0.12	na
AVERAGE SMALL (35)	931.97	0.55	0.29	0.57
AVERAGE MEDIUM (56)	2793.52	0.56	0.31	0.43
AVERAGE LARGE (37)	9035.22	0.57	0.35	na
AVERAGE VERY LARGE (9)	48774.38	0.52	0.29	na
<b>TOTAL (174)</b>	<b>5336.98</b>	<b>0.54</b>	<b>0.29</b>	<b>0.51</b>
<b>SAP</b>				
AVERAGE SMALL (1)	1228.00		0.00	na
AVERAGE LARGE (1)	7093.00	0.56	0.28	na
AVERAGE VERY LARGE (4)	156900.00	0.53	0.02	0.14
<b>TOTAL (6)</b>	<b>105986.83</b>	<b>0.53</b>	<b>0.02</b>	<b>0.14</b>
<b>CREDIT UNIONS</b>				
MICRO AVERAGE (13)	485.77	0.28	0.00	0.71
MEDIUM AVERAGE (1)	3140.00	0.09	0.00	0.75
LARGE AVERAGE (1)	8690.00	0.20	0.00	0.65
VERY LARGE AVERAGE (1)	16459.00	0.54	0.00	na
<b>TOTAL (16)</b>	<b>2162.75</b>	<b>0.37</b>	<b>0.00</b>	<b>0.66</b>
<b>CAJAS SOLIDARIAS</b>				
MICRO AVERAGE (27)	299.04	0.30	0.02	0.91
SMALL AVERAGE (55)	942.33	0.30	0.03	0.92
MEDIUM AVERAGE (29)	2210.17	0.26	0.03	0.93
<b>TOTAL (111)</b>	<b>1154.08</b>	<b>0.29</b>	<b>0.03</b>	<b>0.92</b>
<b>CIVIL ASSOCIATIONS</b>				
MICRO AVERAGE (2)	170.00	0.24	0.07	1.00
SMALL AVERAGE (2)	552.50	0.62	0.17	na
MEDIUM AVERAGE (5)	2337.20	0.50	0.32	0.52
LARGE AVERAGE (4)	12981.50	0.49	0.02	0.15
VERY LARGE AVERAGE (1)	40296.00	0.58	0.17	0.05
<b>TOTAL (14)</b>	<b>6746.36</b>	<b>0.58</b>	<b>0.21</b>	<b>0.58</b>
<b>OTHER (23)</b>				
MICRO AVERAGE (15)	147.47	0.64	0.11	0.77
SMALL AVERAGE (4)	671.00	0.58	0.02	0.47
LARGE AVERAGE (2)	7664.00	0.40	0.01	0.30
VERY LARGE AVERAGE (2)	58322.50	0.81		0.43
<b>TOTAL (23)</b>	<b>5950.83</b>	<b>0.53</b>	<b>0.01</b>	<b>0.65</b>

Client profiles are also presented in Table 2. Female clients have been targeted by microfinance institutions not only because of their exclusion from formal finance, but also because women spend a greater percentage of their share of household income on food, children's clothes, education, and health than men do, as several studies have demonstrated (Hopkins, Levin, and Haddad 1994). Interestingly, women represent a majority of total clients in the CAPs, SAPs, Civil Associations, and Other institutions. In contrast, the credit unions and Cajas Solidarias serve a predominantly male population with only 37 percent and 29 percent female clients respectively.

A significant portion of the total members of CAP (29 percent) and civil associations (21 percent) are children. These accounts are almost exclusively small scale juvenile savings accounts, many of which are used to save for education expenses.

Due to the high transactions costs associated with serving a largely dispersed population and the high risk associated with agriculture, formal financial intermediaries have avoided rural areas. The PSCS has been a leader in the rural financial sector. As Table 2 illustrates, all institutional types with the exception of SAPs have a predominantly rural clientele. In fact 2/3 of credit union and "other" institutions' clients are rural while 92 percent of Cajas Solidarias' clients are rural.

Attaining banking scale efficiency has been a challenge in Mexico. On the one hand, large commercial bank branches are overwhelmed with clients. There were nearly 16,000 inhabitants per bank branch in Mexico in 1994 compared to 2100 in Western Europe and 4000 in the United States. On the other hand, most of the PSCI serve fewer than 5,000 clients and often have only one location thereby limiting the ability to mitigate risk and attain scale economies. Some, such as the Cajas Solidarias, have kept costs

down by operating self-sufficient branches in remote villages and shifted administrative costs to the groups themselves. Therefore, there is no *ex ante* assumption about efficient scale for this complex and diverse PSCS.

### ***B. Model Specification***

No consensus exists within the banking literature about the specification of outputs and inputs, however, two main approaches are commonly delineated. The "*intermediation approach*" looks at a bank as an intermediary between savers and depositors. Therefore, the bank's inputs are deposits, capital, and labor, and the outputs include loans and investments. According to the "*production approach*," a bank is a producer of savings and loan accounts. This method uses the number of accounts as the output while inputs are restricted to only physical inputs including capital and labor and do not include interest expense.

The intermediation approach may be the most relevant technique for analyzing overall institutional efficiency since it accounts for interest expense and may be superior at evaluating profitability (Berger and Humphrey, 1997). However, if breadth of outreach is desirable, the production approach may be a more relevant measure of outreach in developing countries.

Both the production and intermediation approaches will be estimated using DEA and SFA for the PSCS following the input / output mixes found in Aly, et. al. (1990). Using the production specification, the number of outstanding loans ( $Y_1$ ) and the number

of savings accounts ( $Y_2$ ) are the outputs derived from two inputs including capital<sup>7</sup> ( $X_1$ ) and the number of employees ( $X_2$ ).

Alternatively, the intermediation approach outputs consist of the outstanding loan portfolio ( $Y_1$ ), investments ( $Y_2$ ), and demand deposits ( $Y_3$ ) which are derived from a mix of inputs including capital ( $X_1$ ), the number of employees ( $X_2$ ), and loanable funds ( $X_3$ ). Using the Aly, et. al. (1990) specification, loanable funds take into account time and savings deposits, notes, and other loans, but do not include demand deposits which are considered to be an output.

A functional form is needed to estimate the stochastic frontier and a translog production function was selected (Battese and Coelli, 1995). The multiple outputs of the DEA model were summed to create a single output with the following specifications:

***Production Approach:***

$$\ln QP_i = \beta_0 + \beta_1 \ln K_i + \beta_2 \ln L_i + \beta_3 \ln K_i^2 + \beta_4 \ln L_i^2 + \beta_5 \ln K_i \ln L_i + v_i - u_i, \quad (11)$$

***Intermediation Approach:***

$$\begin{aligned} \ln QI_i = \beta_0 + \beta_1 \ln K_i + \beta_2 \ln L_i + \beta_3 F_i + \beta_4 \ln K_i^2 + \beta_5 \ln L_i^2 + \beta_6 \ln F_i^2 + \\ \beta_7 \ln K_i \ln L_i + \beta_8 \ln K_i \ln F_i + \beta_9 \ln L_i \ln F_i + v_i - u_i, \end{aligned} \quad (12)$$

where  $\ln QP$  is the log of the number of loans plus the number of savings accounts,  $\ln QI$  is the log of the volume of loans, investments, and demand deposits in pesos,  $\ln K$  is the log of the value of total capital equipment and assets,  $\ln L$  is the log of the total number of workers,  $\ln F$  is the log the volume of loanable funds, the  $\beta$ 's are the parameters to be

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<sup>7</sup> fixed and other assets

estimated,  $v$  is a normally distributed error term with a zero mean and variance  $\sigma_v^2$ , and  $u_i$  is a random variable that follows a half-normal distribution with mean  $\mu_u$  and variance  $\sigma_u^2$ .

## V. EFFICIENCY RESULTS

### A. DEA Technical Efficiency Results

DEA was performed for 350 institutions using both the production approach and the intermediation approach. Given incomplete data for certain variables, the dataset was reduced to 325 institutions for the intermediation approach and 294 institutions for the production approach. The results of the non-parametric DEA analysis are summarized in Table 3. Using either approach, it is clear the X-inefficiency levels for the average Mexican PSCIs are much lower than those found in other efficiency studies (Table 1). Given that the X-inefficiency levels are relative measures to the frontier measured in any dataset, it is impossible to compare across studies. However, the low values found in this study indicate a wider dispersion of efficiency values relative to the institutions found on the efficient frontier.

As in most efficiency studies, technical efficiency scores are lower than scale efficiency scores indicating that source of inefficiency is more a function of mismanagement of inputs than incorrect institutional scale. With the exception of the SAPs, technical efficiency scores are higher using the intermediation approach.

**TABLE 3**  
**TECHNICAL AND SCALE EFFICIENCY BY INSTITUTIONAL TYPE**  
**INTERMEDIATION APPROACH AND PRODUCTION APPROACH**

	<b>INTERMEDIATION APPROACH</b>		<b>PRODUCTION APPROACH</b>	
	Technical Efficiency	Scale Efficiency	Technical Efficiency	Scale Efficiency
<b>CAPs</b>	0.49	0.74	0.33	0.55
<b>SAPs</b>	0.58	0.44	0.64	0.33
<b>Credit Unions</b>	0.45	0.60	0.14	0.25
<b>Cajas Solidarias</b>	0.55	0.69	0.50	0.51
<b>Civil Associations</b>	0.54	0.54	0.28	0.60
<b>Other</b>	0.65	0.63	0.56	0.51

Using either approach, the SAPs have the highest average technical efficiency scores which is not surprising given their more professional, bank-like nature. Credit unions have the lowest technical efficiency scores which may be a function of their declining resources and arrears. The credit union X-inefficiency is particularly low (0.14) using the production approach since credit unions have few deposits and grant a few larger loans.

Table 4 shows the dispersion of efficiency values by institutional type. Using the production approach, at least one institution from each institutional type was found on the efficient frontier. Using the production approach, even the most efficient credit unions and civil associations were far from the efficient frontier.

**TABLE 4**  
**DEA TECHNICAL EFFICIENCY BY INSTITUTIONAL TYPE**

<i><b>TECHNICAL EFFICIENCY: INTERMEDIATION APPROACH</b></i>						
	Mean	Variance	Minimum	Maximum	Theil Index	Number of Observations
<b>CAPs</b>	0.49	0.09	0.07	1.00	0.18	174
<b>SAPs</b>	0.58	0.15	0.05	1.00	0.22	6
<b>Credit Unions</b>	0.45	0.16	0.04	1.00	0.39	16
<b>Cajas Solidarias</b>	0.55	0.07	0.09	1.00	0.11	110
<b>Civil Associations</b>	0.54	0.08	0.07	1.00	0.14	12
<b>Other</b>	0.65	0.14	0.10	1.00	0.18	13
<i><b>TECHNICAL EFFICIENCY: PRODUCTION APPROACH</b></i>						
	Mean	Variance	Minimum	Maximum	Theil Index	Number of Observations
<b>CAPs</b>	0.33	0.08	0.00	1.00	0.34	152
<b>SAPs</b>	0.64	0.15	0.10	1.00	0.19	6
<b>Credit Unions</b>	0.14	0.01	0.03	0.46	0.23	16
<b>Cajas Solidarias</b>	0.50	0.06	0.18	1.00	0.10	99
<b>Civil Associations</b>	0.28	0.01	0.05	0.43	0.10	10
<b>Other</b>	0.56	0.14	0.08	1.00	0.22	11

The dispersion of the efficiency scores by institutional type is given by the variance and Theil's index. Theil's index is typically a measure of income inequality, but can be modified to represent the dispersion of efficiency among financial institutions when written as:

$$T = \frac{1}{n} \sum_{p=1}^n \frac{e_p}{\mu_E} \log\left(\frac{e_p}{\mu_E}\right)$$

where

- n = # of individuals
- $e_p$  = efficiency of firm p
- $\mu_E$  = population average efficiency

Following the intermediation approach, Theil's index and the variance of x-inefficiency are the highest for credit unions which indicate a high degree of heterogeneity among institutions. In contrast, Cajas Solidarias are more homogeneous in their technical efficiency, a fact that is understandable given that all Cajas Solidarias are under a single government agency and are quite homogeneous in nature. By using the production approach, the most heterogeneous set of institutions is the CAPs.

There are several advantages of using DEA for this type of analysis. As previously noted, it is not restricted by a functional form and is therefore flexible. In addition, the multiple input / multiple output approach gives detailed information about the relative efficiency of individual institutions and can compare them to similar target institutions. Data on scale efficiency provide supplementary information for sectoral analysis. Another benefit is that the relative efficiency of individual inputs can be determined by institution.

As Table 5 illustrates, the average institutions in this sample use at least two to three times as many inputs than "necessary", as determined by the institutions on the efficient frontier. The strikingly high overuse of all inputs reinforces the overall heterogeneity, dispersion, and inefficiency of the PSCS. In the case of CAPs, credit unions, and Cajas Solidarias, investments in capital equipment and infrastructure were the largest source of inefficiency relative to the other inputs. In other words, the physical infrastructure was too large to support a relatively small operation. In the case of SAPs, civil associations, and other institutions, the number of employees was too large relative to the most efficient institutions. The overinvestment in labor, a relatively inexpensive

input with low marginal productivity, has been well documented in developing countries (Perkins et al., 2001).

**TABLE 5  
OVERUSE OF INPUTS**

	<b>capital</b>	<b>labor</b>	<b>loanable funds</b>
<b>CAPs</b>	230%	222%	219%
<b>SAPs</b>	374%	375%	374%
<b>Credit Unions</b>	1092%	601%	595%
<b>Cajas Solidarias</b>	163%	140%	135%
<b>Civil Associations</b>	212%	232%	214%
<b>Other</b>	212%	313%	198%

### ***B. DEA Scale Efficiency Results***

Tables 6 gives an indication of whether scale inefficiency is a result of increasing returns to scale or decreasing returns to scale. The average CAP, SAP, credit union, and civil association faces decreasing returns to scale. Thus, as inputs are doubled, outputs are less than doubled. This is somewhat unexpected since typically, one might expect increasing returns to scale in the financial sector. The fact that decreasing returns to scale are found in a preponderance of PSCIs indicates institutions which have grown in personnel and capital have not experienced a similar growth in output. One possible cause of this decreasing returns to scale is the inability for these small institutions to grow beyond a single branch as they face increased coordination, technology, and backoffice costs. SAPs have the highest Theil value, indicating their scale heterogeneity.

Increasing returns to scale are more predominant using the production approach where only SAPs and civil associations face decreasing returns to scale (Table 6). The

greatest degree of heterogeneity is found in the credit unions, given the Theil index of 0.58. Overall, some caution must be exercised when addressing returns to scale since a more accurate interpretation would be possible by tracing the same institutions over time, rather than using cross-sectional data.

**TABLE 6**  
**DEA SCALE EFFICIENCY BY INSTITUTIONAL TYPE**

	<i>SCALE EFFICIENCY: INTERMEDIATION APPROACH</i>						
	Mean	Variance	Min.	Max.	Theil Index	Mean Returns to Scale	No. Observations
<b>CAPs</b>	0.74	0.04	0.19	1.00	0.04	drs	168
<b>SAPs</b>	0.44	0.07	0.01	0.71	0.20	drs	6
<b>Credit Unions</b>	0.60	0.09	0.21	0.99	0.13	drs	16
<b>Cajas Solidarias</b>	0.69	0.06	0.09	1.00	0.07	irs	110
<b>Civil Associations</b>	0.54	0.06	0.22	1.00	0.10	drs	12
<b>Other</b>	0.63	0.11	0.18	1.00	0.14	irs	13
<i>SCALE EFFICIENCY: PRODUCTION APPROACH</i>							
	Mean	Variance	Min.	Max.	Theil Index	Mean Returns to Scale	Number of Observations
<b>CAPs</b>	0.55	0.09	0.00	1.00	0.19	irs	152
<b>SAPs</b>	0.33	0.09	0.14	0.92	0.28	drs	6
<b>Credit Unions</b>	0.25	0.09	0.00	0.96	0.58	irs	16
<b>Cajas Solidarias</b>	0.51	0.09	0.02	1.00	0.19	irs	99
<b>Civil Associations</b>	0.60	0.08	0.25	0.99	0.11	drs	10
<b>Other</b>	0.51	0.08	0.03	0.92	0.16	irs	11

### ***C. DEA Technically Efficient Frontier Institutions***

For those with a depth of knowledge about the individual financial institutions comprising the PSCS in Mexico, a detailed list of those institutions that form the technically efficient frontier is useful. Appendix 1 lists all of the firms that appear on the frontier using both approaches. Among the sampled 350 institutions, 38 firms are technically efficient using the production approach and 55 firms are on the technically efficient frontier using the intermediation approach.

The fact that numerous institutions comprise the frontier reveals that one institution is not dominating the frontier, a possible outcome using DEA. In particular, the inclusion of Caja Popular Mexicana (CPM) does not dictate efficiency for the other institutions. Caja Popular Mexicana is a true outlier in terms of institutional scale within the sector. However, due to the number of institutions found to be efficient, its inclusion or exclusion do not drive the results. Using both approaches, CPM is technically efficient, but not scale efficient (and faces decreasing returns to scale).

It is interesting to note that most institutions that are found to be technically efficient using the production approach are not technically efficient using the intermediation approach (Appendix 1). This result is understandable since the production approach focuses on the sheer number of financial transactions, regardless of size. The intermediation approach uses the volume of financial transactions as the output. Therefore, a firm targeting the poor with numerous small transactions may be technically efficient using the production approach but have significant X-inefficiency when the intermediation approach is implemented.

A small subset of institutions are technically efficient using both techniques and are thus of interest for the sector as a whole. Table 7 shows the 11 institutions in the sample found to be technically efficient using both approaches. It is interesting to note that they represent differing institutional types and scales. The CAPs and SAPs are vital institutional types since they not only have technical efficiency, but serve a significant number of clients. The Cajas Solidarias have a much lower scale of outreach. In addition, the technical efficiency scores may be somewhat misleading given that the backoffice costs of the government bureaucracy are not included in the inputs.

**TABLE 7**  
**DEA TECHNICALLY EFFICIENT FIRMS**  
**USING THE INTERMEDIATION AND THE PRODUCTION APPROACHES**

<b>Institution</b>	<b>Institutional Type</b>	<b>No. Clients</b>
Caja Libertad, S.C. de R.L.	CAP	235992
Caja Popular Santiago de Tecomán S.C.L.	CAP	5189
Caja Inmaculada S.A.P.	SAP	42084
Caja Popular Mexicana, S.A.P.	SAP	496270
Caja Solidaria Teuchitlán, S.C.	Caja Solidaria	356
Caja Solidaria Matachic, S.C.	Caja Solidaria	428
Caja Solidaria Tierra Blanca, S.C.	Caja Solidaria	976
Caja Solidaria La Ilusión, S.C.	Caja Solidaria	173
Caja Sol. 4 Ejidos de Puerto Vallarta	Caja Solidaria	270
Caja Solidaria La Amistad, S.C.	Caja Solidaria	197
Kaxa Taón S.C. Microbanco San José	Other	599

More information about institutional types is available by looking at the percentage of firms that are technically efficient (using either approach) by institutional category. Twenty-four percent of CAPs and also credit unions were found on the efficient frontier. Twenty-two percent of Cajas Solidarias were efficient compared to

only 7 percent of civil associations. "Other" institutions had a higher percentage of institutions on the efficient frontier, and therefore, may warrant further investigation. However, the group with the highest percentage of firms on the technically efficient frontier was the SAPs, with half of the institutions being technically efficient.

#### ***D. SFA Technical Efficiency Results***

The efficiency scores of the Stochastic Frontier Analysis vary from the Data Envelopment Analysis in that there are no institutions on the frontier, due to the way that technical efficiency is estimated. The technical efficiency scores are calculated by transforming the estimated inefficiency error term ( $\hat{u}_i$ ):

$$\text{Technical Efficiency} = \text{Exp}(-\hat{u}_i) \quad (13)$$

which gives a range of efficiency scores from 0 to 1 with higher scores indicating greater technical efficiency.

Table 8 shows the technical efficiency scores by approach and by institutional type. One vexing problem that exists in frontier analysis is the variation of results between DEA and SFA given the different approaches to measuring efficiency (Berger and Humphrey, 1997). The greatest divergence between the two approaches is apparent when using the intermediation approach. Whereas DEA ordered other institutions and SAPs to be the most technically efficient on average, SFA ranked CAPs and Cajas Solidarias as more technically efficient. Meanwhile, SFA indicated that civil associations

and other institutions were the least technically efficient using the intermediation approach.

Turning to the production approach, the ordering by institutional type follows more closely the results of the Data Envelopment Analysis. In this case, SFA revealed that SAPs were the most technically efficient, followed by civil associations. Like the DEA, credit unions ranked as the least technically efficient on average.

**TABLE 8**  
**SFA TECHNICAL EFFICIENCY BY APPROACH**

<i><b>SFA TECHNICAL EFFICIENCY INTERMEDIATION APPROACH</b></i>						
	Mean	Variance	Minimum	Maximum	Theil Index	Number of Observations
CAPs	0.498	0.044	0.009	0.922	0.099	160
SAPs	0.431	0.091	0.039	0.752	0.207	6
Credit Unions	0.433	0.082	0.070	0.807	0.222	17
Cajas Solidarias	0.481	0.044	0.065	0.891	0.103	110
Civil Associations	0.421	0.044	0.085	0.742	0.125	13
Other	0.369	0.084	0.047	0.798	0.302	10
<i><b>SFA TECHNICAL EFFICIENCY PRODUCTION APPROACH</b></i>						
	Mean	Variance	Minimum	Maximum	Theil Index	Number of Observations
CAPs	0.251	0.027	0.001	0.673	0.239	150
SAPs	0.491	0.056	0.085	0.731	0.106	6
Credit Unions	0.130	0.027	0.002	0.450	0.631	14
Cajas Solidarias	0.218	0.015	0.021	0.564	0.156	97
Civil Associations	0.255	0.054	0.055	0.690	0.368	9
Other	0.135	0.024	0.000	0.475	0.491	9

Measures of variance, range, and dispersion (Theil index) indicate once again the heterogeneity within the sector (Table 8). Using either approach, credit unions and other institutions have the highest Theil indices, signifying wide variations in X-inefficiency among the sector. Similar to the DEA results, Cajas Solidarias have the least dispersion of technical efficiency given their relative homogeneity as a sector. Clearly, the relative lack of regulation within the various semi-formal financial sectors in Mexico has resulted in a wider range of efficient institutions than may exist in a tighter regulatory environment.

#### ***E. SFA Technically Efficient "Frontier" Institutions***

Since SFA does not estimate institutions that are actually on the frontier (with a technical efficiency of 1), the most technically efficient firms in the sample are those with the highest efficiency scores. A list of all scores by institution can be found in Appendix 2. From that list, a grouping of the highest efficiency institutions by approach was compiled in Appendix 3. In order to be considered technically efficiency vis-à-vis the intermediation approach, a technical efficiency score of 0.75 or greater was required. The technical efficiency scores overall were lower using the production approach with the highest score being 0.73 for Caja Popular Mexicana. Therefore, all institutions with technical efficiency scores greater than 0.5 were considered to be the most technically efficient.

Using these definitions of technical efficiency, Table 9 shows the institutions that were found to be technically efficient using both the intermediation and production approaches. Interestingly, this list of institutions is mutually exclusive of the list of DEA

frontier institutions using both approaches (Table 7), highlighting the disparate results of the different methodologies.

**TABLE 9**  
**SFA TECHNICALLY EFFICIENT FIRMS**  
**USING THE INTERMEDIATION AND THE PRODUCTION APPROACHES**

<b>Institution</b>	<b>Institutional Type</b>	<b>No. of Clients</b>
Caja Hipódromo	CAP	13,564
Caja Popular las Huastecas S.C.L.	CAP	7920
Caja Popular Tres Arcángeles	CAP	1857
Caja Crescencio A. Cruz, S.A.P.	SAP	22,335
Servicios Financieros Comunitarios (FINCOMUN)	Credit Union	16,459
Caja Solidaria Nuevo Ideal, S.C.	Caja Solidaria	1872

The institutions that are technically efficient using either approach have a range of institutional types and sizes (Table 9). Three CAPs of varying sizes (1857 clients to 13,564 clients), one SAP, and one Caja Solidaria make the list. In addition, one credit union appears on this list, unlike the results from the DEA. FINCOMUN is an atypical credit union that does not follow the credit-only approach of most Mexican credit unions. It is a relatively large credit union (16,500 clients) that follows more of an international model of credit unions, emphasizing both savings and loans. FINCOMUN is one of the most sophisticated institutions in this sample in terms of technology. Given recent large investments in technological infrastructure, DEA analysis revealed an overuse of inputs, a situation that may adjust over time as the institution grows into its infrastructure.

Another individual firm worth mentioning is Caja Popular Mexicana. While it ranked as the most efficient institution using the SFA production approach, it was not considered technically efficient using the SFA intermediation approach. Nonetheless, it

was DEA technically efficient using both approaches. When combining the DEA and SFA results, Caja Popular Mexicana stands out as being one of the most technically efficient firms in the sample. This is an important finding given that CPM has attained a much larger scale than the other institutions, is financially viable, and may represent a model for other PSCIs.

## **VI. DETERMINANTS OF TECHNICAL EFFICIENCY**

As a second analytical stage, the DEA and SFA estimated technical efficiency values were regressed on a number of independent variables. *Ex ante*, two main potential sources of X-inefficiency were hypothesized to be significant: 1.) institutional factors, including the number of bank branches, technology (proxied by the number of computers per employee), the practice of group lending, arrears, average loan size, and institutional type, and 2.) client outreach, including percentages of rural, female, and juvenile clients.

Initial regressions and specification revealed the insignificance of client outreach as a determinant of technical efficiency and therefore were eliminated from subsequent regressions. This was a somewhat surprising result since a trade-off between institutional viability and the depth of client outreach has been documented (Paxton, 2002). In addition, the number of bank branches and average loan size were found to be insignificant. Nevertheless, the strong significance of institutional type reflects client outreach, number of branches, and average loan size implicitly.

Table 10 shows the final specification of variables that were incorporated for regressions using both approaches for DEA and SFA technical efficiency scores<sup>8</sup>. Consistent with the failure of client outreach to explain technical efficiency, the percentage of rural clients was not found to be significant in three of the four specifications. In the DEA production approach, the percentage of rural clients was a positive and significant determinant of institutional efficiency, reflecting the high percentage of rural clients in many of the efficient institutions.

Several institutional variables were found to be highly significant determinants of technical efficiency using both approaches. These variables include the arrears rate, the number of computers per employee, the use of lending groups, and institutional type.

In many of the institutions, particularly credit unions and Cajas Solidarias, arrears rates have been a critical problem for institutional viability. The arrears rate was a significant determinant of technical efficiency in all of the specifications. In three of the four specifications, it had a negative effect on technical efficiency, and in the SFA production approach, it was positive but close to zero.

As expected, the number of computers per employee was a positive and significant determinant of technical efficiency using the intermediation approach for DEA and SFA. The institutions with higher levels of technology were more likely to be technically efficient. This is an important finding in a sector where technology is rudimentary in many institutions. However, this technological proxy was not significant in the production approach specifications.

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<sup>8</sup> Using these variables, both specifications pass the Ramsey RESET specification test and the Breusch-Pagan / Cook-Weisberg test for heteroskedasticity. The analytical weight used in the intermediation approach was arrears.

**TABLE 10**  
**DETERMINANTS OF TECHNICAL EFFICIENCY BY APPROACH**

<i>indep. variable</i>	<i>(1) DEA inter</i>	<i>(2) DEA prod</i>	<i>(3) SFA inter</i>	<i>(4) SFA prod</i>
rural	-0.0441 (0.51)	1.054 (3.42)**	-0.126 (1.85)	-0.113 (2.24)*
arrears	-0.000 (6.30)**	-0.056 (3.97)**	-0.021 (6.31)**	0.009 (3.90)**
computers	0.147 (3.62)**	-0.220 (1.28)	0.171 (4.45)**	0.054 (1.90)
groups	-0.216 (3.14)**	0.378 (1.36)	-0.250 (4.05)**	-0.103 (2.27)*
cap	0.160 (2.13)*	-0.974 (3.62)**	0.079 (1.32)	0.143 (3.23)**
sap	0.682 (2.79)**	1.775 (1.85)	0.259 (1.14)	0.375 (2.38)*
caja	0.246 (4.98)**	1.461 (7.50)**	0.087 (1.98)*	0.128 (4.01)**
civil	0.361 (2.09)*	-0.158 (0.18)	0.045 (0.29)	-0.017 (0.12)
other	0.633 (5.38)**	1.725 (1.20)	-0.172 (1.63)	0.033 (0.14)
Constant	0.194 (1.93)	2.467 (7.26)**	0.314 (4.11)**	0.137 (2.45)*
Observations	177	157	176	157
R-squared	0.48	0.49	0.39	0.37

Absolute value of t statistics in parentheses

\* significant at 5%; \*\* significant at 1%

An interesting outcome was that those institutions that engage in group lending are less technically efficient using the intermediation approaches. Many of these institutions use a village banking approach (Cajas Solidarias) that process small transactions and therefore do not have a large volume of financial transactions that would be requisite for technical efficiency using the intermediation approach. When using the production approach, the DEA methodology led to a positive but not significant

coefficient for groups while the SFA methodology had a negative coefficient, significant at the 5 percent level.

As seen in Table 10, institutional type was a primary determinant of technical efficiency. Given the enormous heterogeneity of the PSCS, finding which types of institutions are more technically efficient sheds light onto the sector and may point to policy implications regarding support for different institutional types. Each of the institutional types was measured as binary variables with the baseline variable being credit unions. Compared to credit unions, most other institutional types were more technically efficient, with positive and significant coefficients. Only in the DEA production approach did CAPs show a negative and significant coefficient, thereby indicating their relative inefficiency compared to credit unions.

## VII. CONCLUSIONS

This study highlights the wide discrepancies that exist among institutions in the Popular Savings and Credit sector of Mexico and their ability to serve a largely rural clientele in a technically efficient manner. Given the relative vacuum of formal banking institutions in rural areas, the performance and future of this semi-formal sector is critical to the financial and economic development of Mexico.

Measures of X-inefficiency were calculated for 350 PSCIs using two methodologies found in the banking literature: Data Envelopment Analysis, a non-parametric technique, and Stochastic Frontier Analysis, a method that incorporates a parameterized functional form with a stochastic error term. Each technique has advantages over the other and gives different results and therefore, it is worthwhile to estimate both methods. In this particular case where limited data on inputs, prices, and costs were available, the DEA method was preferred. SFA relies on good information about institutional characteristics and detailed input and price information in order to adequately specify a production or cost function. DEA's flexible form, ability to disaggregate outputs, and depth of interpretation make it ideally suited for this dataset.

Following the banking literature, an intermediation approach (where banking output is defined as the volume of loans, investments, and demand deposits) and a production approach (where the number of loans and savings accounts are considered output) are estimated to determine technical efficiency. Both approaches lead to important insights into the PSCS since the intermediation efficient institutions tend to be the most bank-like at transforming savings into loans while the production efficient institutions are able to provide the greatest number of financial products with the least

inputs. Particularly interesting are those institutions that are both production and intermediation efficient. In general, these institutions come from the CAPs, SAPs, and Cajas Solidarias.

When looking at the overall technical efficiency scores by institutional type, several results are noteworthy. First the average technical efficiency scores, irrespective of methodology or approach, are very low in comparison with other studies of banking technical efficiency. To date, all known frontier studies have focused on the commercial banking sector, primarily in developed countries. This study is novel in that it tests for technical efficiency in a semi-formal sector in a developing country.

Since the frontiers are determined solely by individual datasets, it is impossible to compare aggregate efficiency scores across studies. However, the average scores do indicate the degree of homogeneity within the sector. For example, in the United States, the average commercial bank is 21 percent less efficient than those on the frontier. In a similar study of the Mexican commercial banking sector (Taylor, et. al, 1997), the average bank had an X-inefficiency of 28 percent. In contrast, the average Mexican PSCI is greater than 50 percent<sup>9</sup> less efficient than those on the frontier. This heterogeneity can be explained in part by the fragmented financial landscape which does not encourage competition and is not fully regulated. As the sector becomes more professional, those inefficient institutions will be forced to go out of business, be transformed to encourage efficiency, or merge with more solid institutions.

The results on returns to scale in the PSCS are important indicators of the challenges facing the sector. When using the intermediation approach, decreasing returns to scale were found for most institutions. As the volume of loans, investments, and

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<sup>9</sup> depending on the estimation by SFA, DEA, and approach (production or intermediation)

demand deposits doubled, institutions were found to be more than doubling inputs. In a sector characterized principally by small firms, this result pinpoints a challenge for the institutions to increase their portfolios in an efficient manner. As might be expected, those institutions that had better technology (computers per employee) were more likely to be technically efficient using the intermediation approach.

Turning to the production approach, increasing returns to scale were found for the sector as a whole. This is a concern for the semi-formal banking sector where a proliferation of very small firms exists. The results suggest that a doubling of inputs would result in more than double the number of loan and deposit accounts, thus supporting increased institutional size. The challenge of efficient growth and appropriate use of inputs will mark the sector in coming years. For most institutions, the source of inefficient input use stems from the overuse of capital infrastructure (small operations in a relatively large capital investment) or the overemployment of labor.

Finally, the determinants of technical efficiency shed light on institutional variables affecting efficiency. One of the most important outcomes of the analysis is that client profiles (including the percentage of female, juvenile, and rural clients) did not affect technical efficiency. This is important in the sense that institutions with varying client profiles can be equally technically efficient.

Institutional variables were important in determining technical efficiency. In general, the most technically efficient firms have lower arrears, do not use group lending, and have a higher ratio of computers per employee. Institutional type was a leading predictor of technical efficiency with most institutions outperforming credit unions. The SAPs were found to be the most technically efficient institutional type using DEA or the

SFA production approach while CAPs were found to be the most efficient using the SFA intermediation approach. In three of these four estimations, Caja Popular Mexicana, the largest of all institutions was found to be efficient. Given its outreach and ability to operate efficiently, this firm stands out as a model within the industry. In addition, other smaller firms on the efficient frontier warrant additional study. Following the technical efficiency over time would provide additional useful insights into the direction and viability of the PSCS.

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## APPENDIX 1: LIST OF DEA TECHNICALLY EFFICIENT FIRMS

<b>Institution</b>	<b>Production Approach</b>	<b>Intermediation Approach</b>
<b>CAPs (41/174 institutions)</b>		
Caja Popular Cotija		C6
Caja Hipódromo		C26
Caja Progreso de Vicente Guerrero		C27
Cooperativa de consumo Caja de Ahorro Tepeyac Renacimiento	C29	
Caja Popular San Rafael		C32
Caja San Juan Bosco		C35
Caja Sagrada Familia		C38
Caja Colonia Obrera de Morelia S.C.		C44
Caja de Ahorro Santiaguito, S.C.		C46
Caja AQUIC		C49
Organ. Regional Apoyo Campesino	C56	
Caja Libertad, S.C. de R.L.	C59	C59
SPARKASSE, Cooperativa Limitada		C61
Vida Digna de Jilotlán de los Dolores	C63	
Cuquio al futuro, S.C. DE R.L.	C67	
Coop. de Servicios La Alteña S.C.	C68	
Quitupan Esfuerzo y Trabajo, S.C.	C69	
Zapotitlán de Vadillo, SC DE RL	C71	
Trabaja y Progresá S.C. de R.L.	C72	
La Esperanza de Hostotipaquillo	C73	
Caja Popular 2000, S.C. de R.L.	C74	
San Justino Orona	C75	
San José del Carmen S.C. de R.L.	C77	
La Fortaleza de Ixtlahuacan S.C.	C78	
Tuxcacuesco Francisco Villa S.C.	C79	
Caja Fátima, S.C.L.		C82
Cooperativa Santa Elena de la Cruz		C90
Caja Popular Progreso García		C93
Caja Popular Oblatos		C98
Caja Popular Santa María de Guadalupe	C101	
Caja Popular Villanueva		C103
Caja Popular León Franco		C106
Sociedad coop. Caja Popular Libertad		C107
Caja Cristóbal Colón		C112
Caja Popular Santiago de Tecomán S.C.L.	C135	C135
Sociedad Coop. Consumo San Miguel		C141
Caja Popular Tetlán, S.C. de R.L.		C144
Inmaculado Corazón de María		C145
Coopdesarrollo, S.C.L. de C.V.		C158
Coop. De Ahorro y Prést. Unión Oaxaca		C164
Opción Cooperativa de Servicios, S.C.L.		C169
<b>SAPs (3/6 institutions)</b>		
Caja Crescencio A. Cruz, S.A.P.		C177
Caja Inmaculada S.A.P.	C178	C178

Caja Popular Mexicana, S.A.P.	C180	C180
<b>Credit Unions (4/17 institutions)</b>		
Unión de Crédito Chihuahuense,S.A.		C182
Unión Crédito Agricultores Cuauhtémoc		C187
Unión de Crédito Allende, S.A. de C.V.		C191
Unión de Crédito Unagra, S.A. de C.V.		C192
<b>Cajas Solidarias (24/111 institutions)</b>		
Caja Solidaria Jerécuaro, S.C.		C198
Caja Solidaria de la Costa Chica, S.C.		C207
Caja Solidaria San Dionisio Ocoatepec	C211	
Caja Solidaria Los Tres Reyes, S.C.		C212
Caja Solidaria San Miguel Arcángel	C216	
Caja Sol. 2000 Sierra Norte de Puebla	C217	
Caja Solidaria Santa Prisca, S.C.	C220	
Caja Solidaria Epitacio Huerta, S.C.		C221
Caja Solidaria Nuevo Ideal, S.C.	C226	
Caja Solidaria Santiago Papasquiario		C227
Caja Solidaria Canatlán, S.C.	C231	
Caja Solidaria Ki'Che-Tzi, S.C.		C235
Caja Solidaria La Unidad Cafetalera	C246	
Caja Solidaria Teuchitlán, S.C.	C261	C261
Caja Solidaria Tecolotlán, S.C.		C267
Caja Solidaria Sierra Madre de Chiapas	C276	
Caja Solidaria Matachic, S.C.	C277	C277
Caja Solidaria Jilotepec, S.C.		C278
Caja Solidaria Sur de Jalisco, S.C.	C279	
Caja Solidaria Tierra Blanca, S.C.	C292	C292
Caja Sol. Campesinos Unidos Culiacán		C303
Caja Solidaria La Ilusión, S.C.	C306	C306
Caja Sol. 4 Ejidos de Puerto Vallarta	C309	C309
Caja Solidaria La Amistad, S.C.	C311	C311
<b>Civil Associations (1/14 institutions)</b>		
Centro Mixteco de Ed. 2 de agosto		C324
<b>Others (8/23 institutions)</b>	0.35	
Activo Empresarial S.C.		C328
Kaxa Taón S.C. Microbanco San José	C329	C329
Microbanco Nuu La Vi, S.C.		C330
Jamutchin Mujeres, S.S.S.		C334
Centro de Ahorro Progreso		C343
Centro de Apoyo al Microempresario	C344	
Financiera Compartamos, S.A. de D.V.	C346	
Su Casita, Sociedad Mutualista		C347

**APPENDIX 2: TECHNICAL EFFICIENCY SCORES USING STOCHASTIC FRONTIER METHOD, ALL INSTITUTIONS**

<b>Institution</b>	<b>Intermediation</b>	<b>Production</b>
Caja Popular Apaseo el Alto	0.323	0.388
Caja Popular Arboledas	0.635	0.359
Caja Popular Cerano	0.396	0.310
Caja Popular Comonfort	0.609	0.308
Caja Popular Cortázar		0.469
Caja Popular Cotija	0.615	0.118
Caja Popular Dolores Hidalgo	0.744	0.583
Caja Popular Jesús Ma. Montaña	0.653	0.121
Caja Popular José Antonio Urquiza	0.699	0.231
Caja Popular Juventino Rosas	0.698	0.334
Caja Popular La Merced	0.685	0.375
Caja Popular Lagunillas	0.708	0.335
Caja Popular Los Reyes	0.737	0.368
Alianza Caja Popular Maravatío	0.674	0.350
Caja Popular Peñitas	0.634	0.286
Caja Popular Purépero	0.592	0.215
Caja Popular Sahuayo	0.317	0.465
Caja Popular Santiago Apóstol	0.653	0.182
Caja Popular SantiagoTingambato	0.687	0.346
Caja Popular Santuario Guadalupano	0.548	0.346
Caja Popular Tanhuato	0.736	0.072
Caja Popular Tata Vasco	0.662	0.275
Unión Familiar, UNIFAM	0.440	0.553
Caja Popular Yuriria	0.385	0.104
Caja Chalchihuites	0.747	0.208
Caja Hipódromo	0.810	0.482
Caja Progreso de Vicente Guerrero	0.484	0.419
Caja Sombrerete	0.792	0.070
Cooperativa de consumo Caja de Ahorro Tepeyac Renacimiento	0.640	0.414
Cooperativa Nuevo México	0.581	0.528
Caja Noreste, S.C.L.	0.500	0.060
Caja Popular San Rafael	0.543	0.613
Cooperativa Tlahuica, S.C.L.	0.744	0.188
Caja Popular La Providencia	0.794	0.376
Caja San Juan Bosco	0.325	0.380
Caja Maya del Sur S.C.C. de R.L. de CV.	0.660	0.243
Caja 29 de Octubre S.C.C. de R.L. de C.V.		
Caja Sagrada Familia S.C.C. de R.L. de C.V.	0.361	0.380
Caja Gerardo Green S.C.C. de R.L. de C.V.	0.347	0.247
Caja La Asunción S.C. de R.L.,	0.246	0.207
Caja La Natividad S.C.C. de R.L. de C.V.,	0.659	0.155
Cooperativa Tepoztlán S.C.L.	0.846	0.406
Caja Popular Metropolitana de Guadalajara, S.C. de R.L.	0.792	0.077
Caja Colonia Obrera de Morelia S.C. de R.L. de C.V.	0.619	0.264
Caja Gonzalo Vega, S.C.L.		

<b>Institution</b>	<b>Intermediation</b>	<b>Production</b>
Caja de Ahorro Santiaguito, S.C. de R.L.	0.395	0.202
Caja Popular Santa Cruz, S.C.L. de C.V.	0.172	
Grupo Popular San José de Iturbide		
Caja AQUIC	0.263	
Cooperativa Caja Popular Agua Blanca 87 S.C.L.	0.180	0.222
Caja de Ahorro y Servicios BAMPECO	0.105	0.089
Financiera Impulso Económico	0.336	0.059
Caja Cristo Rey S.C.C. de R.L. de C.V.	0.178	0.230
Cooperativa SOFIC	0.307	0.003
Caja de Antequera, S.C. de R.L.	0.696	0.256
Organización Regional de Apoyo Campesino	0.230	0.398
Caja Popular las Huastecas S.C.L.	0.796	0.466
Caja Polotitlán, S.C.L.	0.693	0.162
Caja Libertad, S.C. de R.L.	0.558	0.673
Caja San Nicolás, S.C.L.	0.555	0.526
SPARKASSE, Sociedad de Cooperativa Limitada	0.354	0.062
Cooperativa Yolomécatl S.C.L.	0.643	0.576
Vida Digna de Jilotlán de los Dolores, S.C. de R.L.	0.292	0.099
La Tecaliltense, S.C. de R.L.	0.206	0.100
Miguel Brizuela S.C. de C.L.	0.445	0.059
Tuxpan Milenio 2000, S.C. de R.L.	0.443	0.259
Cuquio al futuro, S.C. DE R.L.	0.433	0.087
Coop. de Servicios La Alteña S.C. de R.L.	0.516	0.103
Quitupan Esfuerzo y Trabajo, S.C. de R.L.	0.204	0.046
Nuevo Milenio de Jilotlan, S.C. de R.L.	0.639	0.149
Zapotitlán de Vadillo, SC DE RL	0.544	0.259
Trabaja y Progresá S.C. de R.L.	0.511	0.156
La Esperanza de Hostotipaquillo	0.422	0.131
Caja Popular 2000, S.C. de R.L.	0.460	0.127
San Justino Orona		
Servicio Renacer, S.C. de R.L.	0.401	0.171
San José del Carmen S.C. de R.L.	0.619	0.129
La Fortaleza de Ixtlahuacan S.C. de R.L.	0.558	0.118
Tuxcacuesco Francisco Villa S.C. de R.L.	0.650	0.037
Cooperativa de Ahorro y Prestamo FINAGAM, S.C. de R.L.	0.585	0.384
Cooperativa de Consumo Caja Popular Colonias Unidas S.C.L.		
Caja Fátima, S.C.L.		
Caja San Miguel Palmas, S.C.L.	0.204	0.160
Sociedad Cooperativa La Unión, S.C.L.	0.192	0.245
Préstamo y Ahorro Produce S.C. de R.L.	0.401	0.004
Cooperativa Cihualpilli de Tonalá	0.410	0.480
Caja Popular Río Presidio	0.151	0.256
Caja Popular Pío XII	0.342	0.002
Caja Popular Tzaulán		
Cooperativa de Consumo Ahorro y Préstamo Santa Elena de la Cruz	0.813	0.298
Caja Popular Mixtlán, S.C.L. de C.V.	0.753	0.229
Caja Popular Ntra. Señora de Tonaya	0.878	0.296
Caja Popular Progreso García	0.668	0.077
Caja Popular José María Mercado, S.C.L. de C.V.	0.383	0.445

<b>Institution</b>	<b>Intermediation</b>	<b>Production</b>
Caja Popular Concordia	0.575	0.267
Caja Popular El Limón,	0.545	0.118
Caja Popular Manzanillo	0.727	0.322
Caja Popular Oblatos	0.694	0.003
Caja Popular Minatitlán, S.C.L. de C.V.	0.372	0.265
caja Popular José María Velasco	0.536	
Caja Popular Santa María de Guadalupe	0.728	0.548
Caja Popular Villanueva	0.832	0.296
Caja Popular Fray Juan Calero	0.413	0.489
Regio Ahorro, S.C. de R.L.		
Caja Itzaez, S.C.C. de R.L. de C.V.		
Caja Popular León Franco	0.766	0.299
Sociedad Coop. Consumidores y Servicios, Caja Popular Libertad	0.666	0.561
Caja La Guadalupana, S.C.L.	0.138	0.236
Inversiones de Tlaxcala	0.582	0.024
Caja Regional Anáhuac	0.693	0.203
Cooperativa de Consumo Nueva Atemajac del Valle S.C.L.	0.820	0.124
Caja Cristóbal Colón	0.757	
Cooperativa Acapiotzin, S.C. de R.L.	0.254	0.136
Sociedad Cooperativa de Ahorro y Préstamo UNCEA de R.L. de C.V.	0.234	0.050
Caja Tampico, S.C.L	0.469	0.278
Caja Santa Rosa, S.C.L.	0.322	0.277
Nueva Rosita	0.194	
Caja San Ignacio, S.C.L.	0.531	
Caja San Isidro, S.C.L.		
Caja Mitras, S.C.L.	0.276	
Caja Cerro de la Silla, S.C.L.	0.266	0.405
Caja Amistad	0.416	0.002
Caja Buenos Aires	0.361	0.518
Caja Fama	0.336	0.361
Caja Linares	0.463	0.175
Caja DEPAC Poblana, S.C. de R.L.	0.731	0.277
Cooperativa Pirámides	0.244	0.213
Sistema Cooperativo La Colonia	0.114	0.045
Caja del Sur	0.114	0.137
Caja Azteca	0.690	0.069
Caja Popular Rosario	0.513	0.312
Caja Popular San José de Casimiro Castillo	0.651	0.418
Caja Popular Tecuala	0.600	0.002
Caja Popular Tres Arcángeles, S.C. de R.L. de CV	0.922	0.447
Caja Popular Santiago de Tecomán S.C.L. de C.V.	0.232	0.474
Capaz, S. Co.	0.148	0.048
Acrecenta , S.C.L.	0.355	0.225
Sociedad Cooperativa Ayoquezco S.C.L.	0.234	0.001
Operadora de Recursos Universal	0.565	0.419
Caja Progressa S.C de R.L.		0.195
Sociedad Cooperativa de Consumo San Miguel, S.C.L.	0.490	
Fondo Solidario del Frente Democrático Campesino de Chihuahua	0.193	0.114
Sstema Cooperativo 15 de Agosto, S.C. de R.L.	0.588	0.511

<b>Institution</b>	<b>Intermediation</b>	<b>Production</b>
Caja Popular Tetlán, S.C. de R.L.	0.857	0.313
Inmaculado Corazón de María	0.351	
Caja Popular Reforma	0.424	0.002
Caja Cooperativa del Parque, S.C.L.	0.551	0.500
Cooperativa de Consumo Sta. Rosa de Lima	0.707	
San Andrés Coyutla	0.581	0.302
Cooperativa 19 de Octubre	0.633	0.233
Cooperativa Coatetelco, S.C.L.	0.735	0.060
Cooperativa El Rosario, S.C.L.	0.548	0.464
Cooperativa Jardines de Santa Clara	0.555	0.102
Cooperativa Rerum Novarum	0.560	0.361
Cooperativa Roma Uno	0.797	0.116
Cooperativa Suljaa'	0.748	0.178
Cooperativa Tilza, S.C.L.	0.674	0.130
Coopdesarrollo, S.C.L. de C.V.	0.495	0.626
Únete Opción Financiera	0.423	0.063
URBIPLAN	0.343	0.103
Cooperativa Caja Popular San Juan Bosco, S.C.L.	0.271	0.333
SOFISAN	0.258	0.145
Coop. Consumidores, Serv. Caja Popular San Miguel de Tlaquepaque		
Cooperativa de Ahorro y Préstamo Unión Oaxaca, S.C. de R.L.	0.188	0.055
Nuestra Caja, S.C. de R.L.	0.276	0.477
Cooperativa Sinvacrem, s.C. De R.L.	0.094	0.279
Caja Popular Sureste	0.066	0.174
Cooperativa de Ahorro y Crédito Popular los Girasoles, S.C. de R.L.		0.023
Opción Cooperativa de Servicios, S.C.L.	0.489	0.218
Cooperativa de Ahorro y Préstamo Agua Blanca de San Marcos, S.C.L.	0.450	
Sociedad Cooperativa de Consumo Caja Popular Jiménez	0.587	
Cooperativa de Consumo Caja Popular Mascota, S.C.L.	0.214	
Del Mineral del Fresnillo, S.c. De R.L.	0.009	0.404
Sumando Esfuerzos	0.613	0.013
<b>CAP AVERAGE</b>	<b>0.498</b>	<b>0.251</b>
Santa María Guadalupe	0.210	0.355
Caja Real del Potosí, S.A.P.	0.614	0.607
Caja Crescencio A. Cruz, S.A.P.	0.752	0.522
Caja Inmaculada S.A.P.	0.039	0.642
Fomento Latinoamericano, S.A.P.	0.720	0.085
Caja Popular Mexicana, S.A.P.	0.251	0.731
<b>SAP AVERAGE</b>	<b>0.431</b>	<b>0.491</b>
Servicios Financieros Comunitarios (FINCOMUN), S.A. de C.V.	0.803	0.450
Unión de Crédito Chihuahuense, S.A. de C.V.	0.162	0.034
Unión de Crédito Costa Esmeralda S.A. de C.V.	0.136	
U.C. de Comercio, Servicios, Turismo y la Industria de Tabasco	0.371	0.111
Unión de Crédito Comercial y de Servicios del Edo. de México	0.324	0.022
Unión de Crédito Agrícola de Corerepe, S.A. de C.V.	0.684	0.020
Unión de Crédito Agricultores de Cuauhtémoc, S.A. de C.V.	0.199	0.090
Unión de Crédito Agropecuario Industrial Colonos de Irrigación	0.437	
Unión de Crédito Estatal de Productores de Café de Oaxaca	0.581	0.410

<b>Institution</b>	<b>Intermediation</b>	<b>Production</b>
Unión de Crédito Alpura	0.797	
Unión de Crédito Allende, S.A. de C.V.	0.756	0.079
Unión de Crédito Unagra, S.A. de C.V.	0.772	0.414
Unión de Crédito Impulsa, S.A. de C.V.	0.095	0.109
Unión de crédito Delicias S.A. de C.V.	0.202	0.020
Unión de Crédito Agropecuaria y Comercial de Villa de Cos	0.070	0.041
Unión de Crédito Agropecuaria, Industrial y Comercial de Sombrerete	0.161	0.002
Unión de Crédito, Organización Auxiliar del Crédito (CREDITUR)	0.807	0.018
<b>CREDIT UNION AVERAGE</b>	<b>0.433</b>	<b>0.130</b>
Caja Solidaria Jerécuaro, S.C.	0.622	
Caja Solidaria Valle de Guadalupe, S.C.	0.524	0.200
Caja Solidaria Aguascalientes, S.C.	0.309	0.102
Caja Solidaria Aramberri, S.C.	0.192	0.423
Caja Solidaria Región Zoque, S.C.	0.424	
Caja Solidaria Valle de San Luis, S.C.	0.249	
Caja Solidaria del Sur de Champotón, S.C.	0.698	0.291
Caja Solidaria La Esperanza, S.C.	0.237	0.080
Caja Solidaria Campesinos de Yucu Iti, S.C.		
Caja Solidaria de la Costa Chica, S.C.	0.662	
Caja Solidaria Santiago, S.C.	0.463	0.157
Caja Solidaria Santa Catarina Juquila, S.C.	0.468	0.225
Caja Solidaria La Trinidad Vistahermosa, S.C.	0.371	
Caja Solidaria San Dionisio Ocotepéc, S.C.		
Caja Solidaria Los Tres Reyes, S.C.	0.295	0.068
Caja Solidaria San Juan, S.C.	0.553	0.207
Caja Solidaria La Unión Campesina, S.C.	0.453	0.151
Caja Solidaria Concepción Papalo, S.C.	0.247	
Caja Solidaria San Miguel Arcángel, S.C.	0.110	
Caja Solidaria 2000 de la Sierra Norte de Puebla, S.C.	0.469	0.187
Caja Solidaria Cafen-Chichiltik, S.C.	0.148	0.298
Caja Solidaria Alianza de Campesinos 88 , S.C.	0.632	0.159
Caja Solidaria Santa Prisca, S.C.	0.891	0.147
Caja Solidaria Epitacio Huerta, S.C.	0.589	0.249
Caja Solidaria San Miguel Huimilpan, S.C.	0.435	0.194
Caja Solidaria D. Pedro Escobedo, S. C.	0.308	0.145
Caja Solidaria Tepehuanes, S.C.	0.330	0.478
Caja Solidaria Durango, S.C.	0.496	0.214
Caja Solidaria Nuevo Ideal, S.C.	0.777	0.564
Caja Solidaria Santiago Papasquiari, S.C.	0.807	0.179
Caja Solidaria San Miguel de Cruces, S.C.	0.388	0.207
Caja Solidaria Santa Clara, S.C.	0.427	0.254
Caja Solidaria El Oro, S.C.	0.432	0.362
Caja Solidaria Canatlán, S.C.	0.638	0.122
Caja Solidaria Esfuerzo Campechano, S.C.	0.783	0.197
Caja Solidaria Bahía de la Buena Pelea, S.C.	0.267	0.197
Caja Solidaria Unificación y Progreso, S.C.		
Caja Solidaria Ki'Che-Tzi, S.C.	0.786	0.129
Caja Solidaria Los 2 de Oro de la Mixteca, S.C.	0.516	0.267
Caja Solidaria Kondoy, S.C.	0.293	0.219

<b>Institution</b>	<b>Intermediation</b>	<b>Production</b>
Caja Solidaria Che Zane Yezr, S.C.	0.249	0.256
Caja Solidaria de los Artesanos Tradicionales de los Valles de Oaxaca	0.670	0.181
Caja Solidaria Unión Yucucui, S.C.	0.173	
Caja Solidaria Rosamorada, S.C.	0.758	0.061
Caja Solidaria Sierra de San Juan, S.C.	0.366	0.333
Caja Solidaria Tecuala, S.C.	0.503	0.235
Caja Solidaria Xu-Un Nuu, S.C.	0.208	
Caja Solidaria Kafen Tomin, S.C.	0.225	0.320
Caja Solidaria La Unidad Cafetalera, S.C.	0.730	0.031
Caja Solidaria La Fuerza Cafetalera, S.C.		
Caja Solidaria Terrenate, S.C.	0.399	
Caja Solidaria Ejidos Unidos de San Pedro Lagunillas, S.C.	0.224	0.162
Caja Solidaria Ixtlán del Río, S.C.	0.065	0.219
Caja Solidaria Adalberto Peña Maldonado S.C.	0.341	0.085
Caja Solidaria Nueva Galicia, S.C.	0.486	0.273
Caja Solidaria Ahuacatlán, S.C.	0.633	0.362
Caja Solidaria Tapalpa, S.C.	0.595	0.253
Caja Solidaria Talpa, S.C.	0.730	0.300
Caja Solidaria Hostotipaquillo 95-97, S.C.	0.533	0.292
Caja Solidaria San Marcos, S.C.	0.808	0.194
Caja Solidaria El Limón, S.C.	0.289	0.310
Caja Solidaria Puente de Camotlán, S.C.	0.083	0.070
Caja Solidaria Tintoc, S.C.	0.660	0.132
Caja Solidaria Teuchitlán, S.C.	0.575	0.090
Caja Solidaria Tuxca, S.C.	0.422	0.115
Caja Solidaria Zapotitlán, S.C.	0.090	0.189
Caja Solidaria del Norte de Nayarit, S.C.	0.293	0.097
Caja Solidaria José María Mercado, S.C.	0.786	0.223
Caja Solidaria Santa María del Oro, S.C.	0.557	0.427
Caja Solidaria Tecolotlán, S.C.	0.706	0.263
Caja Solidaria Amatlán de Cañas, S.C.	0.460	0.456
Caja Solidaria Dos Ríos, S.C.	0.475	0.225
Caja Solidaria Ejidos de Xalisco, S.C.	0.405	0.219
Caja Solidaria Campesinos Unidos de Manzanillo, S.C.	0.193	
Caja Solidaria Armeria, S.C.	0.607	0.083
Caja Solidaria Colimotl, S.C.	0.263	0.128
Caja Solidaria Regional Colimán, S.C.	0.405	0.318
Caja Solidaria Villa de Alvarez 97, S.C.	0.622	0.187
Caja Solidaria Sierra Madre de Chiapas, S.C.	0.548	0.517
Caja Solidaria Matachic, S.C.		
Caja Solidaria Jilotepec, S.C.	0.661	0.153
Caja Solidaria Sur de Jalisco, S.C.	0.550	0.432
Caja Solidaria Huejuquilla, S.C.	0.754	0.239
Caja Solidaria Magdalena, S.C.	0.698	0.115
Caja Solidaria Chiquiliztli, S.C.	0.698	0.474
Caja Solidaria del Municipio de la Huerta, S.C.	0.440	0.099
Caja Solidaria Guachinango, S.C.	0.477	0.382
Caja Solidaria Tonaya S.C.	0.717	0.086
Caja Solidaria Mulmeyah, S.C.	0.501	0.338

<b>Institution</b>	<b>Intermediation</b>	<b>Production</b>
Caja Solidaria La Catorceña, S.C.	0.075	0.147
Caja Solidaria Kena Unka, S.C.	0.276	0.114
Caja Solidaria Sierra Alta Cafetalera, S.C.	0.521	0.299
Caja Solidaria Playa Vicente, S.C.	0.300	0.190
Caja Solidaria Tzacualtitla Sanctorum, S.C.	0.768	0.043
Caja Solidaria Tierra Blanca, S.C.	0.338	0.354
Caja Solidaria Plan de Arroyos de Tlapacoyan, S.C.	0.143	0.271
Caja Solidaria Azotal, S.C.	0.216	0.232
Caja Solidaria Regional Queretana, S.C.	0.705	0.094
Caja Solidaria Teocaltiche, S.C.	0.462	0.244
Caja Solidaria Tala, S.C.	0.731	0.054
Caja Solidaria San Gabriel, S.C.	0.669	0.534
Caja Solidaria Xochitlán, S.C.	0.810	0.216
Caja Solidaria San Sebastián del Oeste, S.C.	0.520	0.221
Caja Solidaria Vicente Guerrero, S.C.	0.769	0.323
Caja Solidaria Canelas, S.C.	0.816	0.116
Caja Solidaria Campesinos Unidos de Culiacán, S.C.	0.307	0.216
Caja Solidaria Madera, S.C.	0.326	0.122
Caja Solidaria del Valle de Jiquipilas, S.C.	0.637	
Caja Solidaria La Ilusión, S.C.	0.376	0.094
Caja Solidaria Tomatlán, S.C.	0.720	0.088
Caja Solidaria Campesinos Unidos de Cuauhtémoc	0.659	0.469
Caja Solidaria 4 Ejidos de Puerto Vallarta, S.C.	0.250	0.021
Caja Solidaria Cuautla-Jalisco, S.C.	0.666	0.022
Caja Solidaria La Amistad, S.C.	0.273	0.104
Caja Solidaria Ejidos Unidos, S.C.	0.665	
<b>CAJA SOLIDARIA AVERAGE</b>	<b>0.481</b>	<b>0.218</b>
Caja Popular de Ahorros Yanga, A.C.	0.496	0.415
Patrimonio Creciente, A.C.	0.309	0.141
Caja Arturo Márquez Aguilar		
Caja Popular Tepeyac de Mazatlán		
Foro para el Desarrollo Sustentable, A.C. 2/	0.664	0.059
Caja Vencedores, A.C.	0.408	0.055
Administrador de Caja Bienestar	0.085	0.408
Asociación de Empresarias Mexicanas, A.C.	0.260	
Fundación Economía Solidaria, A.C.	0.447	
Acremex	0.389	0.690
Caja Popular Motolinía, A.C.	0.732	0.062
Centro Mixteco de Educación 2 de agosto, A.C.	0.742	
Caja Popular Cristo Rey, A.C.	0.169	0.411
Caja Guadalupe, A.C.	0.544	0.058
Caja Villanueva, A.C.	0.227	
<b>CIVIL ASSOCIATION AVERAGE</b>	<b>0.421</b>	<b>0.255</b>
Activo Empresarial S.C.		0.011
Kaxa Taón S.C. Microbanco San José		
Microbanco Ñuu La Vi, S.C.	0.479	0.146
Caja Popular Mujeres de Hoy, S.C.		
Mujeres Cobanaras, S.S.S.		
Amas (Adelante Mujeres Activas y Solidarias)		

<b>Institution</b>	<b>Intermediation</b>	<b>Production</b>
Jamutchin Mujeres, S.S.S.		
Mujeres Las Serranitas, S.S.S.		
Mujeres del Presente, S.S.S.		
Quirigueñas, S.S.S.	0.047	0.001
Teresa Urrea, S.S.S.	0.087	
Avance Chalco (Amextra), S.S.S.		
JAMUT YUMA, S.S.S.		
Mujeres Asociadas de Ures S.S S.		
UAIM MAYOJUSALIT	0.798	0.000
Centro de Ahorro Progreso	0.121	0.230
Centro de Apoyo al Microempresario (CAME)	0.080	0.475
Fundación Los Emprendedores	0.305	0.138
Financiera Compartamos, S.A. de D.V.	0.745	
Su Casita, Sociedad Mutualista		
La Esperanza del Mañana	0.360	0.018
Cooperativa Quetzal	0.669	0.191
Cooperativa San Mateo		
<b>OTHER AVERAGE</b>	<b>0.369</b>	<b>0.135</b>

### APPENDIX 3: LIST OF THE MOST SFA TECHNICALLY EFFICIENT FIRMS

Institution	Intermed.	Production	Intermed. efficient	Prod. efficient
Caja Popular Cortázar		0.47		x
Caja Popular Dolores Hidalgo	0.74	0.58		x
Caja Popular Sahuayo	0.32	0.47		x
Unión Familiar, UNIFAM	0.44	0.55		x
Caja Popular Yuriria	0.38	0.10		
Caja Chalchihuites	0.75	0.21	x	
Caja Hipódromo	0.81	0.48	x	x
Caja Sombrerete	0.79	0.07	x	
Cooperativa Nuevo México	0.58	0.53		x
Caja Popular San Rafael	0.54	0.61		x
Caja Popular La Providencia	0.79	0.38	x	
Cooperativa Tepoztlán S.C.L.	0.85	0.41	x	
Caja Popular Metropolitana de Guadalajara	0.79	0.08	x	
Caja Popular las Huastecas S.C.L.	0.80	0.47	x	x
Caja Libertad, S.C. de R.L.	0.56	0.67		x
Caja San Nicolás, S.C.L.	0.55	0.53		x
Cooperativa Yolomécatl S.C.L.	0.64	0.58		x
Cooperativa Cihualpilli de Tonalá	0.41	0.48		x
Coop. Consumo Ahorro y Prést. Santa Elena de la Cruz	0.81	0.30	x	
Caja Popular Mixtlán, S.C.L. de C.V.	0.75	0.23	x	
Caja Popular Ntra. Señora de Tonaya	0.88	0.30	x	
Caja Popular José María Mercado, S.C.L. de C.V.	0.38	0.45		x
Caja Popular Santa María de Guadalupe	0.73	0.55		x
Caja Popular Villanueva	0.83	0.30	x	
Caja Popular Fray Juan Galero	0.41	0.49		x
Caja Popular León Franco	0.77	0.30	x	
Soc. Coop. Consumidores y Servicios, Caja Pop. Libertad	0.67	0.56		x
Cooperativa de Consumo Nueva Atemajac del Valle S.C.L.	0.82	0.12	x	
Caja Cristóbal Colón	0.76		x	
Caja Buenos Aires	0.36	0.52		x
Caja Popular Tres Arcángeles, S.C. de R.L. de CV	0.92	0.45	x	x
Caja Popular Santiago de Tecomán S.C.L. de C.V.	0.23	0.47		x
Sstema Cooperativo 15 de Agosto, S.C. de R.L.	0.59	0.51		x
Caja Popular Tetlán, S.C. de R.L.	0.86	0.31	x	
Caja Cooperativa del Parque, S.C.L.	0.55	0.50		x
Cooperativa El Rosario, S.C.L.	0.55	0.46		x
Cooperativa Roma Uno	0.80	0.12	x	
Cooperativa Suljaa'	0.75	0.18	x	
Coopdesarrollo, S.C.L. de C.V.	0.50	0.63		x
Nuestra Caja, S.C. de R.L.	0.28	0.48		x
Caja Real del Potosí, S.A.P.	0.61	0.61		x
Caja Crescencio A. Cruz, S.A.P.	0.75	0.52	x	x
Caja Inmaculada S.A.P.	0.04	0.64		x
Caja Popular Mexicana, S.A.P.	0.25	0.73		x
Servicios Financieros Comunitarios (FINCOMUN)	0.80	0.45	x	x

<b>Institution</b>	<b>Intermed.</b>	<b>Production</b>	<b>Intermed. efficient</b>	<b>Prod. efficient</b>
Unión de Crédito Alpura	0.80		x	
Unión de Crédito Allende, S.A. de C.V.	0.76	0.08	x	
Unión de Crédito Unagra, S.A. de C.V.	0.77	0.41	x	
U.C., Organización Auxiliar del Crédito (CREDITUR)	0.81	0.02	x	
Caja Solidaria Santa Prisca, S.C.	0.89	0.15	x	
Caja Solidaria Tepehuanes, S.C.	0.33	0.48		x
Caja Solidaria Nuevo Ideal, S.C.	0.78	0.56	x	x
Caja Solidaria Santiago Papasquiario, S.C.	0.81	0.18	x	
Caja Solidaria Esfuerzo Campechano, S.C.	0.78	0.20	x	
Caja Solidaria Ki'Che-Tzi, S.C.	0.79	0.13	x	
Caja Solidaria Rosamorada, S.C.	0.76	0.06	x	
Caja Solidaria San Marcos, S.C.	0.81	0.19	x	
Caja Solidaria José María Mercado, S.C.	0.79	0.22	x	
Caja Solidaria Amatlán de Cañas, S.C.	0.46	0.46		x
Caja Solidaria Sierra Madre de Chiapas, S.C.	0.55	0.52		x
Caja Solidaria Huejuquilla, S.C.	0.75	0.24	x	
Caja Solidaria Chiquilztlí, S.C.	0.70	0.47		x
Caja Solidaria Tzacualtitla Sanctorum, S.C.	0.77	0.04	x	
Caja Solidaria San Gabriel, S.C.	0.67	0.53		x
Caja Solidaria Xochitlán, S.C.	0.81	0.22	x	
Caja Solidaria Vicente Guerrero, S.C.	0.77	0.32	x	
Caja Solidaria Canelas, S.C.	0.82	0.12	x	
Caja Solidaria Campesinos Unidos de Cuauhtémoc	0.66	0.47		x
Acremex	0.39	0.69		x
UAIM MAYOJUSALIT	0.80	0.00	x	
Centro de Apoyo al Microempresario (CAME)	0.08	0.48		x
Financiera Compartamos, S.A. de D.V.	0.75		x	