Intertemporal Budgeting and Efficiency

Rolf Färe and Shawna Grosskopf
Department of Economics
Southern Illinois University
Carbondale, IL 62901-4515

and

Suthathip Yaisawarng
Department of Economics
Union College
Schenectady, NY 12308-2363

Abstract

This paper introduces an intertemporal variable cost indirect technology which permits technological change over time and allows for financial flexibility. It characterizes agencies which maximize the outputs or services subject to the budget they face. We define Farrell-type output oriented technical efficiency under different financial regimes and efficiency gains from financial flexibilities. An empirical illustration based on a sample of Illinois municipalities is included.

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I. Introduction

Not-for-profit organizations and local government agencies are among several forms of enterprises which are obviously not appropriately modeled as profit maximizers. A better characterization of a reasonable benchmark for these agencies is maximization of outputs or services subject to the budget they face. Typically, these organizations seek to balance their budgets for a given period. This myopic view can lead to inefficiencies. The lack of financial flexibility can also prevent them from adopting more advanced technology or from employing the optimal level of inputs, thereby restricting the maximum level of outputs that could have been achieved.

In a static framework, the budget constraint has been incorporated in the decision process, including (among others) Shephard (1974) and Färe and Grosskopf (1994). The resulting cost indirect technology allows decisionmakers to choose the appropriate level of inputs to produce the maximum feasible level of outputs, given the budget endowment and input prices. The cost indirect model has been used to evaluate producer performance by Färe, Grosskopf and Lovell (1988) and to analyze fiscal policy in schooling by Grosskopf et al. (forthcoming, 1995).

This paper extends the ***static*** one-period cost indirect technology to multiple period case and develops an intertemporal variable cost indirect technology along the line suggested by Shephard (1977). The intertemporal variable cost indirect technology consists of a sequence of static variable cost indirect technologies. It permits technological change over time and allows for financial flexibility. In particular, we consider four financial regimes for the intertemporal variable cost indirect technology: (1) when neither saving nor borrowing is permitted, (2) when only saving is permitted, (3) when only borrowing is permitted, and (4) when both saving and borrowing are permitted. We define and compute Farrell-type output-oriented technical efficiency relative to the intertemporal variable cost indirect technology under each financial regime. Efficiency gains from financial flexibilities are also calculated.

The paper is organized as follows. Section II presents intertemporal variable cost indirect technologies and the linear programming problems used to compute the Farrell-type measure for the different financial regimes. Section III illustrates the technique using a sample of Illinois municipalities for 1980 to 1982. Section IV discusses the merit of the technique and suggests other potential applications.

II. An Intertemporal Variable Cost Indirect Technology and Efficiency

Suppose that there are k = 1, ..., K production units for each period t, t = 0, ..., T. Let P^t(x, x) be the production technology in period t, where x , x are, respectively, ($1xN_v$) and ($1xN_f$) vectors of variable and fixed inputs used in period t. Let y^t be a (1xM) vector of outputs produced in period t. Let Y^t, X, and X be (KxM), (KxN_v) and (KxN_f) matrices of observed outputs, variable inputs and fixed inputs in period t. Let w be an (N_vx1) vector of prices of variable inputs at period t. Let C^t be a scalar value representing total endowed costs in period t.

Under the most flexible financial regime, i.e., regime 4, when both saving and borrowing are permitted, we assume that total saving in period t will be spent in period t+1 and that total borrowing from period t+1 is used in period t, and that there is no cost associated with saving and borrowing[1]. Let $S_{t,t+1}$ be the amount of saving in period t that will be spent in period t+1. Let $B_{t,t+1}$ be the amount of money borrowed from period t+1 for use in period t. The available money to be spent on variable inputs in period t is the sum of total endowed costs and borrowing minus saving in period t.

Under regime 4, the piecewise linear intertemporal variable cost indirect technology (IP) is specified as:

$$IP(w/C^t, x, t = 0, ..., T) \quad = \{(y^0,..., y^t, ..., y^T) :$$

a. $z^tY^t \geq y^t$,

b. $z^tX \leq x$,

c. $z^tX \leq x$,

d. $xw \leq C^t - S_{t,t+1} + S_{t-1,t} + B_{t,t+1} - B_{t-1,t}$,

$S_{t-1,t} = B_{t-1,t} = 0$ when $t = 0$,

$S_{t,t+1} = B_{t,t+1} = 0$ when $t = T$,

e. $z \geq 0, k = 1, ..., K \}$, (1)

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[1] This assumption can be relaxed by introducing an interest income generated from saving in period t that is spent in period t+1 and using the net present value (i.e., the face value of the borrowed amount adjusted by a discount rate) for money borrowed from period t+1 which is spent in period t. However, the intertemporal cost indirect technology will be formulated in a similar fashion.

where z^t is a (1xK) vector of intensity variables. The specification of the intertemporal variable cost indirect technology in (1) permits an enterprise to participate in saving and borrowing activities. It represents the most flexible financial regime considered here.

In the most restrictive financial regime considered here, an enterprise is not permitted to engage in any saving or borrowing activities, i.e., regime 1, the budget constraint (1d) reduces to

$$xw \leq C^t, \tag{2}$$

since $S_{t,t+1} = S_{t-1,t} = B_{t,t+1} = B_{t-1,t} = 0$ for all t = 0, ..., T. Regimes 2 and 3 are intermediate cases, where the specification of the intertemporal variable cost indirect technology differs from (1) in terms of the budget constraints (1d). Specifically, under regime 2 when only savings is permitted, (1d) becomes

$$xw \leq C^t - S_{t,t+1} + S_{t-1,t},\ S_{t-1,t} = 0 \text{ when } t = 0, \text{ and } S_{t,t+1} = 0 \text{ when } t = T, \tag{3}$$

and under regime 3 when only borrowing is permitted, (1d) is replaced by

$$xw \leq C^t + B_{t,t+1} - B_{t-1,t},\ B_{t-1,t} = 0 \text{ when } t = 0,\ B_{t,t+1} = 0 \text{ when } t = T. \tag{4}$$

The relationship of the intertemporal variable cost indirect technology under different regimes can be summarized as follows:

$$IP(\cdot)_{\text{Regime 1}} \subseteq IP(\cdot)_{\text{Regime 2}} \subseteq IP(\cdot)_{\text{Regime 4}} \text{ and}$$

$$IP(\cdot)_{\text{Regime 1}} \subseteq IP(\cdot)_{\text{Regime 3}} \subseteq IP(\cdot)_{\text{Regime 4}}. \tag{5}$$

Note that the relationship between IP(·) under regimes 2 and 3 cannot be determined.

The intertemporal variable cost indirect technology envelops the variable cost indirect technologies for all T periods, when the technology in each period is computed as linear combinations of outputs and inputs such that the variable input costs do not exceed the total available money for that period. An output vector on the frontier of the intertemporal variable cost indirect technology must be at least as big as an output vector on the frontier of a variable cost indirect technology in any period t, given the same output mix, since the intertemporal variable cost indirect technology gives firms more flexibility to choose the best variable input vectors over the T period horizon instead of a more rigid one period time frame. The nonnegativity restriction on each intensity variable for each period implies that the technology for each period t exhibits constant returns to scale. As a consequence, the intertemporal variable cost indirect technology exhibits constant returns to scale.

An intertemporal Farrell-type technical efficiency measure for unit k' is defined as the maximum proportional expansion of outputs in all T periods, holding constant: the output ratios, the input prices, and the total endowments of unit k' for each period t, t = 0, 1, ..., T. The linear programming (LP) problem for computing the Farrell-type measure of technical efficiency for regime 4 is written for each observation k' = 1, ..., K as:

$TE_{k'} = \max \theta$

s.t.

a. $z^t Y^t \geq \theta y^{t,k'}, t = 0, ..., T,$

b. $z^t X \leq x, t = 0, ..., T,$

c. $z^t X \leq x^{,k'}, t = 0, ..., T,$

d. $xw^{,k'} \leq C^{t,k'} - S_{t,t+1} + S_{t-1,t} + B_{t,t+1} - B_{t-1,t}, t = 0, ..., T,$

$S_{t-1,t} = B_{t-1,t} = 0$ when $t = 0,$

$S_{t,t+1} = B_{t,t+1} = 0$ when $t = T,$

e. $z \geq 0, k = 1, ..., K,$ (6)

where θ is a radial expansion of each period's output vector to the frontier of the intertemporal variable cost indirect technology. This LP problem is solved K times, one for each unit k.

The LP problem consists of ((M+N+N+K+1) x (T+1)) constraints. For each period, there are five sets of constraints: (a) outputs, (b) variable inputs, (c) fixed inputs, (d) budget, and (e) intensity variables. For example, consider the output constraints for period t = 0. The m^{th} output constraint is created as linear combinations of quantities of output m produced by all K units at t = 0, as indicated on the left-hand-side of the inequality. On the right-hand-side, the amount of output m produced by unit k' is multiplied by a radial expansion factor, θ. This output constraint indicates that the linear combinations of output m must be at least as large as θ times the quantity of output m produced by unit k' in period 0.

The next set of inequalities includes constraints on variable inputs. It states that the linear combinations of each variable input used by all K units is no greater than the variable input to be used by unit k' such that the outputs produced are at the maximum feasible point. The optimal usage of each variable input for each period is a decision variable in the LP problem to be determined simultaneously with the amount of savings and borrowings as specified in the budget constraint (the fourth inequality) such that the total variable costs in each period given the input prices faced by unit k' will not exceed the total available money.

The third set of inequalities specifies constraints on fixed inputs or exogenous variables affecting the production process. Like the constraints on variable inputs, it is formulated such that, for each fixed input, the linear combinations of the input used by all K units is no more than the fixed input used by unit k'. Unlike the variable inputs, the amounts of fixed inputs are given for unit k'; they are not choice variables in the LP problem.

The fourth set of constraints gives the budget constraints which reflect the different financial regimes under consideration. As specified in (6d), unit k' is allowed to both save and borrow between adjacent periods. Therefore, the budget set is expanded if there is net borrowing in period t, resulting in a larger amount of available resources than the initial endowment for that period. Similarly, the budget set for period t is reduced if there is net saving in period t. For the remaining three financial regimes, the appropriate budget constraints must be used. For example, (6d) is replaced by (2) for regime (1). The last set of constraints restricts the value of intensity variables to be nonnegative.

Note that the LP problem above uses the piecewise linear intertemporal variable cost indirect technology under an appropriate financial regime as constraints. Each static technology is constructed from all K units for that period. The intertemporal technology, however, consists of all static technologies and therefore it has T sets of intensity variables for each LP problem. This suggests that changes in technology over time are incorporated in the construction of the intertemporal variable cost indirect technology.

Solutions to the LP problem include the intertemporal Farrell-type measure of technical efficiency, the optimal level of variable inputs, as well as the optimal values of the intensity variables. Depending on the financial regime, the optimal saving and/or borrowing for each period are also included. The intertemporal Farrell-type technical efficiency measure is the largest radial expansion that satisfies all ((M+N +N+K+1)x(T+1)) constraints. Its value is greater than or equal to one, with one indicating that the observed output level produced by unit k' in each period is the maximum possible given the intertemporal variable cost indirect technology. The optimal values of saving and/or borrowing together with the solution values for variable inputs suggest how and when total endowments should be allocated toward the optimal mix and level of those inputs. They can be compared with the observed variable input levels to capture inefficiency due to misallocation of resources. The values of the intensity variables tell which unit is used to create the frontier output vector. This information is useful if an inefficient unit wishes to develop a strategic plan for performance improvement since the frontier unit serves as a role model for the inefficient unit to imitate.

Given the relationship between the intertemporal variable cost indirect technologies under different financial regimes, it can be shown that the Farrell-type efficiency measure under the most restricted financial regime (regime 1) is less than or equal to the efficiency score under the most flexible financial regime (regime 4). The efficiency gain from financial flexibility is defined as:

$$\text{Eff\_gain} = TE_{k,\text{Regime } 4} / TE_{k,\text{ Regime } 1}.$$

It represents the proportion by which outputs can be further increased if unit k is allowed to participate in saving and borrowing between adjacent periods such that the optimal use of endowments over all periods is achieved. It can also be used as a maximum potential gain in efficiency if some forms of financial flexibility such as regime 2 or regime 3 are permitted.

III. An Empirical Illustration

To compute meaningful Farrell-type output measure of technical efficiency relative to an intertemporal variable cost indirect technology, we require data for at least three periods. In this example, we have a balanced panel of twenty-two Illinois municipalities for 1980 to 1982. We assume that the aim of each municipality is to provide safety to its citizens. One of the indications of safety is the crime rate. The lower the crime rate, the safer citizens feel. In our model formulation, more output is better than less. Accordingly, we use the reciprocal of the actual number of crimes (CRIME) as a proxy for the municipality's output. Since the total number of crimes also depends on the size of the municipality, we use population (POP) as another proxy for output. Law enforcement officers are the key input in the provision of safety. Police cars and communication equipment such as radio or laptop computers are also used to enhance the efficiency of the operation. We therefore use total personnel police (TOTP) and capital (CAP) as two variable inputs in the provision of safety.

Socio-economic status also affects the level of safety in the community. The more educated are a municipality's citizens, the fewer crimes we would expect in the municipality. Similarly, the wealthier a person is, the less likely it is that the person will commit a crime. We use the percent of the population with a high school education (HSC) and the percent of the population who own their homes (HOME) as proxies for a municipality's socio-economic status. These characteristics are incorporated in our model as fixed inputs or controlled variables.

In short, our specification includes two outputs (CRIME and POP), two variable inputs (TOTP and CAP), and two fixed inputs (HSC and HOME). CAP is computed as the ratio of capital expenditures to the interest rate on bonds for each municipality, due to the unavailability of total capital value in our data set. For the prices of variable inputs, we use the average wage for police officer (WAGE), which is the ratio of total payroll to total police personnel, and the bond rate (BRATE). Total endowed budget (COST) is the sum of total payroll and total capital expenditures. Descriptive statistics of the data set are presented in Table 1.

Table 2 presents a comparison of efficiency scores across financial regimes. On average, technical efficiency for Illinois municipalities ranges from 1.24, when each municipality is not allowed to engage in savings or borrowings during the three periods timespan, to 1.27 when each municipality may save or borrow between adjacent periods. The average efficiency score suggests that the municipalities in our sample could proportionally expand their current output bundles between 24 and 27 percent on average had they made appropriate budgetary decisions and allocated variable inputs efficiently over the three-year period in their provision of safety. In addition, there is a two percent average efficiency gain if municipalities have flexibility in the use of its endowment.

Analyses of individual municipalities exhibit similar trends across financial regimes. Specifically, misallocation rather than excessive use of variable inputs is a major contributor to inefficiency. In addition the technology is becoming more capital intensive. The rank orderings of efficiency scores are relatively stable across financial regimes. Efficiency gains from financial flexibility range from 12 percent for La Grange to no gain for Arlington Heights, Aurora, Hinsdale, Mount Prospect and Peru. Individual results discussed below are based on the fourth financial regime. Detailed results for the other regimes are available upon request.

Table 3 summarizes the results in which saving and borrowing activities are permitted. Among the five municipalities that do not engage in saving or borrowing in any given year during our sample period, four are technically efficient. These municipalities are Arlington, Aurora, Hinsdale and Mount Prospect. Their current total endowed costs are optimal and the municipalities use the correct allocation of variable inputs, given their fixed inputs and the current state of technology. Peru is the only inefficient municipality in this group. Its efficiency score of 1.15 could be attributable to misallocation of variable inputs and operation inside the intertemporal variable cost indirect technology. Comparing Peru's current usage of variable inputs in each period with the optimal input level, given the intertemporal variable cost technology, the current usage exceeds the optimal level in all years except for total police personnel in 1982 which is approximately the same as the optimal level.

If a municipality is permitted to save or borrow money when needed over three-year period, our model suggests that eight municipalities would save during the first two periods (without borrowing). Furthermore, six of these municipalities should save more in 1980 than in 1981. By doing so, their efficiency scores (ranging from 1.22 for Wheaton to 1.65 for Wheeling) should decrease, i.e., they would move closer to the frontier and thus improve their technical efficiency. Our model further suggests that these municipalities should spend their savings on capital use rather than by increasing employment of police officers. The optimal number of police in each year is slightly less than the current level of employment.

Streamwood, Villa Park, Wheeling and Wilmette show excessive use of capital in 1980 relative to the optimal level predicted by the model; thereafter capital should be increased, except for Wheeling in 1981. The optimal level of capital for the remaining municipalities in this group shows an upward trend, suggesting that technology is becoming more capital intensive over the sample period.

On the other hand, there are seven municipalities which the model suggests should increase their endowments by borrowing. Efficiency scores in this group are relatively close to each other, with an average of 1.22. With exceptions for Bloomington and Hoffman Estates which should decrease their capital usage in 1980 and increase it thereafter, these municipalities should in general borrow to increase the number of police officers and capital usage in 1980. However, the magnitude of the increase in the number of police officers is far less than that of capital. The use of more capital tends to enhance efficiency of safety production. The optimal number of police officers is smaller than the observed level in 1982.

Elk Grove with an efficiency score of 1.81 has the worst performance relative to the other municipalities in our sample. Investigating the optimal levels of police employment and capital use reveals that Elk Grove over employs both types of variable inputs in 1980 and 1982. This is consistent with the solutions from the LP problem which indicate that the municipality should save in 1980 and borrow from 1982 endowments. Both saving and borrowing should be spent employing more policemen but less capital in 1981. A similar pattern is also suggested for Elmhurst which received an efficiency score of 1.22.

Our results suggest that it is possible for each municipality to increase its outputs proportionally over the three-year period by reallocating its usage of variable inputs. Note that the gain in productive efficiency could be achieved without increasing the overall total endowments. By permitting each municipality to engage in saving and borrowing activities, instead of an annually balanced budget strategy, the welfare of the society could be improved with no extra costs to taxpayers.

IV. Conclusions

In this paper, we illustrate how to evaluate firms or productive units when these units are able to choose different input levels for each period over the time horizon considered, given their available resources, but allowing for some interperiod financial flexibility. We also show that the financial flexibility enables firms to employ the optimal level of variable inputs given fixed inputs and the available technology in each period and hence increase their efficiency without additional costs. There is an efficiency gain associated with the level of financial flexibility the firms face. Since our intertemporal variable cost indirect technology incorporates any realized technological advancement for each period, the solutions to the LP problem not only give the optimal level of variable inputs at each time period but also a qualitative indication about the direction of technological development. Our results also show that it is possible to increase output produced through appropriate investment decisions and reallocation of resources without increasing the total sum of endowments.

In our empirical illustration, we use a three-year period and assume that saving and borrowing occur only for the adjacent period with no interest cost. Our model, however, can be extended to any number of periods. Alternatively, one may think of the three-year period as a window within a T-period time frame. One could then use moving three-year period windows to compute Farrell-type technical efficiency for a given intertemporal budget constraint to evaluate the enterprise over sucessive periods. As indicated in Section II, the cost of money can easily be incorporated in the specification of the intertemporal variable cost indirect technology and the measurement of technical efficiency.

The assumption that saving and borrowing are permitted only between two adjacent periods can be relaxed as well. In this case, the fraction of savings to be spent in each subsequent periods will be a choice variable in the model. Similarly, the fraction of borrowing from future periods to be spent in the current period will be an unknown in the model. This affects the specification of the intertemporal variable cost indirect technology in that it becomes a piecewise ***nonlinear*** instead of linear technology and therefore the intertemporal Farrell-type technical efficiency cannot be computed using the LP problem. Three possible alternative remedies are (1) imposing ***a priori*** fractions of savings or spendings, (2) specifying the intertemporal variable cost indirect technology as flexible functional forms and estimate the system of equations using a frontier technique, or (3) specifying the problem as a nonlinear programming problem.

The technique illustrated in this paper has broad applications. It can be applied to analyze non-profit organizations or local governments which face budget constraints. Instead of looking at their performance in a single period, the intertemporal model evaluates these enterprises over more than one period, allowing for financial flexibility within the time horizon. Being able to invest rather than always exactly getting a single period balanced budget (to avoid budget reductions in the future) would enhance efficiency. Through potential investment possibilities it could also provide an opportunity to adopt more advanced technology without additional costs, provided that the available resources are allocated and used efficiently. This technique could also be adopted by cooperatives in their decisions to lend money to individual farmers and to develop savings or loan repayment schedules for agricultural projects.

Table 1
Descriptive Statistics of Twenty-Two Illinois Municipalities
1980-1982

Variable	Mean	S.E.	Min.	Max.
Year = 1980				
Outputs:				
CRIME	0.0009888	0.00142	0.00017	0.00709
POP	35587.68	16639.00	10862.00	77115.00
Variable inputs:				
TOTP	68.00	35.72	24.00	189.00
CAP ($1000)	627.23	522.50	11.85	2543.42
Fixed inputs:				
HSC (%)	77.92	11.14	58.20	92.80
HOME (%)	71.95	8.79	57.05	91.98
Input prices:				
Wage ($1000)	19.32	2.80	15.38	25.24
BRATE (%)	8.22	0.19	8.06	8.44
Total endowed budget:				
COST ($1000)	1366.18	778.88	417.00	4185.00

Table 1 (cont.)
Descriptive Statistics of Twenty-Two Illinois Municipalities
1980-1982

Variable	Mean	S.E.	Min.	Max.
Year = 1981				
Outputs:				
CRIME	0.000972	0.00109	0.00015	0.00540
POP	35895.45	16791.93	10958.00	77794.00
Variable inputs:				
TOTP	67.86	37.42	26.00	199.00
CAP ($1000)	497.92	326.42	8.84	1029.41
Fixed inputs:				
HSC (%)	77.92	11.14	58.20	92.80
HOME (%)	71.95	8.79	57.05	91.98
Input prices:				
Wage ($1000)	22.07	3.39	15.88	28.58
BRATE (%)	11.06	0.22	10.88	11.31
Total endowed budget:				
COST ($1000)	1549.27	879.20	441.00	4699.00

Table 1 (Cont.)
Descriptive Statistics of Twenty-Two Illinois Municipalities
1980-1982

Variable	Mean	S.E.	Min.	Max.
Year = 1982				
Outputs:				
CRIME	0.00101	0.00099	0.00016	0.00456
POP	35874.05	16781.05	10951.00	77746.00
Variable inputs:				
TOTP	67.86	35.51	25.00	192.00
CAP ($1000)	521.84	385.96	8.45	1211.32
Fixed inputs:				
HSC (%)	77.92	11.14	58.20	92.80
HOME (%)	71.95	8.79	57.05	91.98
Input prices:				
Wage ($1000)	23.28	3.19	18.44	31.73
BRATE (%)	11.56	0.33	11.31	12.48
Total endowed budget:				
COST ($1000)	1664.73	970.64	493.00	5088.00

Note: For each municipality, we assume that the growth rates of population, high school graduates, and home owners are the same in each year. Thus, HSC and HOME for 1981 and 1982 are the same as those for 1980. This assumption is necessary since the HSC and HOME figures are obtained from the Census data, complied for each decade.

Table 2
A Comparison of Efficiency Scores

		Financial Regime							
	Efficiency	No saving or borrowing	Saving only		Borrowing only		Saving and borrowing		
City	Gain	TE	TE	Saving	TE	Borrowing	TE	Saving	Borrowing
Alton	1.02	1.34	1.34	yes, p2	1.37	yes	1.37	no	yes
Arlington Height	1.00	1.00	1.00	no	1.00	no	1.00	no	no
Aurora	1.00	1.00	1.00	no	1.00	no	1.00	no	no
Bloomington	1.01	1.15	1.15	no	1.16	yes	1.16	no	yes
Centralia	1.07	1.35	1.45	yes	1.35	no	1.45	yes	no
Elk Grove	1.10	1.64	1.78	yes, p1	1.75	yes, p3	1.81	yes, p1	yes, p3
Elmhurst	1.03	1.19	1.20	yes, p1	1.21	yes, p3	1.22	yes, p1	yes, p3
Highland Park	1.02	1.56	1.59	yes	1.56	no	1.59	yes	no
Hinsdale	1.00	1.00	1.00	no	1.00	no	1.00	no	no
Hoffman ES	1.03	1.33	1.33	yes, p2	1.37	yes	1.37	no	yes
La Grange	1.12	1.17	1.31	yes	1.17	yes, p2	1.31	yes	no
Moline	1.02	1.20	1.20	no	1.22	yes	1.22	no	yes
Mount Prospect	1.00	1.00	1.00	no	1.00	no	1.00	no	no
Normal	1.01	1.00	1.00	no	1.01	yes	1.01	no	yes
Peru	1.00	1.15	1.15	no	1.15	yes, p2	1.15	no	no
Quincy	1.01	1.18	1.18	no	1.19	yes	1.19	no	yes
Rock Island	1.02	1.25	1.25	yes, p2	1.27	yes	1.27	no	yes
Streamwood	1.05	1.31	1.38	yes	1.31	no	1.38	yes	no
Villa Park	1.03	1.51	1.56	yes	1.51	no	1.56	yes	no
Wheaton	1.03	1.19	1.22	yes	1.19	no	1.22	yes	no
Wheeling	1.06	1.55	1.65	yes	1.55	no	1.65	yes	no
Wilmette	1.03	1.46	1.51	yes	1.48	yes, p3	1.51	yes	no
Geometric									

Average		1.24	1.26		1.25		1.27		

Table 3
Intertemporal Farrell Technical Efficiency

Municipality	TE
Zero saving and borrowing:	
Arlington Heights	1.00
Aurora	1.00
Hinsdale	1.00
Mount Prospect	1.00
Peru	1.15
Geometric average efficiency scores	1.03
Positive saving and zero borrowing:	
Centralia	1.45
Highland Park	1.59
La Grange	1.31
Streamwood	1.38
Villa Park	1.56
Wheaton	1.22
Wheeling	1.65
Wilmette	1.51
Geometric average efficiency scores	1.45
Zero saving and positive borrowing:	
Alton	1.37
Bloomington	1.16
Hoffman Estates	1.37
Moline	1.22
Normal	1.01
Quincy	1.19
Rock Island	1.27
Geometric average efficiency scores	1.22
Positive saving and borrowing:	
Elk Grove	1.81
Elmhurst	1.22
Geometric average efficiency scores	1.48
Geometric overall average efficiency scores	1.27

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