

Brokerage Firms

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Abstract. This article measures overall, allocative, technical, pure technical and scale efficiency levels for a sample of residential real estate brokerage firms using data envelopment analysis, a linear-programming technique. The results suggest that real estate brokerage firms operate inefficiently. Inefficiencies are primarily a function of sub-optimal input allocations and the failure to operate at constant returns to scale rather than from poor input utilization. Regression analysis is employed to determine which firm and/or market characteristics affect efficiency levels. The results show that increasing firm size increases efficiency while choosing to franchise, adding an additional multiple listing service and increasing operating leverage decreases firm performance.

Introduction

Over the last decade the market for real estate brokerage services has experienced many significant changes. One of the important changes is that today, the residential real estate brokerage industry consists of fewer, but larger firms. In fact, between 1979 and 1996 the percentage of large firms (with fifty or more employees) making up the industry's total workforce has risen from 29% to 68% (NAR, 1996). Most of this increase has come at the expense of smaller firms through mergers, consolidations and failures. The market efficiency implications of these changes are important. If larger firms are more efficient, the movement towards consolidation should continue, barring regulatory intervention. If firms become less efficient as firm size increases, further consolidation should be viewed with concern in a marketplace with few barriers to entry and exit.

The market has also undergone structural changes. New market arrangements are arising, such as buyer's agency, disclosed dual agency, facilitators and other non-agency brokerage contracts. The market is also relying more heavily on interactive multimedia marketing arrangements such as the Internet and e-mail to complement the traditional use of the multiple listing service (MLS). These changes are likely to

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alter product mix and competitiveness in the market, which will, in turn, affect firm performance and efficiency levels.

The lack of usable data has hindered empirical research on firm performance in the residential real estate brokerage industry. There are currently only two studies that directly address the efficiency issues described earlier (Zumpano, Elder and Crellin, 1993; and Zumpano and Elder, 1994). These studies indicate that most firms in the industry are too small to take full advantage of economies of scale. In addition, product mix is found to be important. Zumpano and Elder found the presence of significant economies of scope, which suggests that firms are most efficient when they produce a balanced output of both sales and listings.

While these two studies provide a good starting point for addressing firm efficiency questions, additional information is needed. Traditional cost studies assume that all firms are operating on their efficient frontier.¹ Tests of this assumption in other sectors have revealed that most firms operate, to differing degrees, off their efficient frontier. Termed X-inefficiencies, these deviations from the efficient frontier have been shown to harm firm performance even more severely than failure to operate in a manner that optimizes economies of scale or scope (Berger, Hunter and Timme, 1993). Hence, the validity of this assumption should be examined for the residential real estate market. It is also important to analyze the sources of these X-inefficiencies should they be found to exist in this market in order to better understand firm performance.

This article addresses these concerns by estimating X-inefficiency levels for a set of residential real estate brokerage firms using a technique called the data envelopment analysis (DEA). This approach allows us to quantify overall efficiency levels as well as decompose this measure into its allocative, technical, pure technical and scale efficiency components. Subsequently, a regression analysis is used to identify what firm and/or market conditions influence the estimated efficiency levels.

The second section is a literature review. The third section discusses efficiency determination. The fourth section presents the efficiency results. The fifth section discusses firm characteristics and efficiency measures. The sixth section presents regression results and the final section is the conclusion.

Literature Review

Examination of Early Efficiency Studies

Although the performance of the market for residential real estate brokerage services has been under examination for many years, data problems have limited most studies to theoretical models or indirect tests of market efficiency.

Many of the early studies argue that this market is inefficient. Yinger's (1981) theoretical study suggests that the market is operationally inefficient and suffers from excess capacity. Others characterize the market as a cartel² where various types of entry barriers allow existing participants to enjoy market power and monopoly profits.

Miller and Shedd (1979) and Crockett (1982) argue that the industry can be characterized as monopolistic where firms can differentiate their products and realize short-run excess profits. Wachter (1985) argues that the percentage commission structure used in this market is a form of price discrimination and market imperfection.

Conversely, other early studies imply that this market is relatively efficient. Schroeter (1987) and Knoll (1988) develop different arguments that suggest that the commission structure in the market is consistent with market efficiency when transaction time is considered. Carroll (1989) argue that the percentage commission structure reduces agency costs and helps promote market efficiency. With all of these differing opinions, Zumpano and Hooks (1988) note a need to resolve this issue by directly examining the underlying production function for firms in this industry.

There exists a vast literature on economies of scale, scope and X-inefficiencies for other industries such as public utilities, transportation, manufacturing, banking, health care and law enforcement.³ The comparable data needed for research of the residential real estate industry has only recently become available.

Production and Cost Studies

Zumpano, Elder and Crellin (1993) conducted the first study of production costs and economies of scale for the residential brokerage market. Using a single output translog cost function, the authors found that residential firms have average cost curves that are generally U-shaped. This study also found that many firms were too small to effectively take advantage of scale economies.

Seeking to determine why firm size was so small in the presence of positive scale economies, Zumpano and Elder (1994) estimate economies of scale and scope for the residential real estate market using a multi-product translog function. They essentially find the same U-shaped average cost curves for total output, but only decreasing returns to scale when product-specific economies of scale are measured separately for listing and sales. Once firms get large enough, agents can specialize in listing or sales activities and better utilize sharable inputs. By allowing the firm to efficiently produce more of both goods, economies of scale can be achieved by a balanced production mix. In effect, the presence of scope economies allows firms to achieve economies of scale in production.

The Importance and Meaning of X-Inefficiencies

Previous studies in real estate have not examined why, and the degree to which, firms deviate from their efficient frontier.⁴ Leibenstein (1966) was the first to recognize and formally define the term X-inefficiency. At the heart of his definition is the realization that firms can operate suboptimally for two reasons. The first is the failure to allocate resources in the most efficient manner or allocative inefficiency. The second is related to a firm's ability to utilize its resources given their allocation (technical inefficiency). In other words, two firms may have the exact same resource allocation, yet one firm produces less output than the other. The difference between how a firm could

potentially utilize its resources versus its actual utilization was termed X-inefficiency. Leibenstein argues that the majority of X-inefficiency losses arise from inadequate motivation by firm management. He also suggests that motivation levels are linked to the structure and competitiveness of the market.⁵

More recent studies generally discuss X-inefficiency in somewhat more technical terms. X-inefficiency is usually defined as deviations from an efficient frontier response surface that is attributable to a misallocation of resources or the lack of effective utilization of current resources; in other words, allocative and technical inefficiencies.

To measure firm efficiency, this article employs DEA approach. The DEA is a linear-programming procedure that measures the relative efficiency level of any economic unit that can be characterized as producing multiple outputs and utilizing multiple inputs.⁶

Efficiency Determination

The DEA Technique

Farrell (1957) first suggests the use of the DEA to examine efficiency. The work by Färe, Grosskopf and Lovell (1985) further promoted the usefulness of DEA. Since then, many efficiency studies in other sectors have employed this technique. Within the DEA framework, performance of an individual firm is evaluated with respect to an efficient frontier, which is constructed by linear combinations of existing firms.

There are several approaches to measure efficiency. This study employs the input-based approach where inputs are contracted proportionally with exogenous outputs. While the procedure is computationally rigorous, a simple graphical depiction can demonstrate how the methodology works and how the efficiency measures are obtained. Exhibit 1 displays the overall (OE), technical (TE) and allocative (AE) efficiency measures. There are two inputs (X_1 and X_2), one output (Y) and constant returns to scale. Technology is fixed and PP represents the cost if a firm had been technically and allocatively efficient. Suppose a firm operating at c (say firm C) produces an output equivalent to that produced along YY . C is said to be both technically and allocatively inefficient. Assuming that input allocations are fixed, the best that firm C would have done technically was to operate at b . As the firm moves from c to b , it can reduce its inputs proportionally while maintaining the current output level. The TE of firm C is expressed as ob/oc . ob indicates the input usage for the best practice firm while oc is the input combination used by firm C . The extra input usage that was incurred by firm C as a percentage of total input usage is expressed as bc/oc ($1 - ob/oc$). In other words, firm C could reduce inputs proportionally by bc/oc percent and still produce an output level indicated by YY . Notice that as a firm becomes technically efficient, the efficiency measure equals one (*i.e.*, ob/ob). When the technical efficiency measure is equal to one, the firm can no longer reduce its input combinations without reducing its output level.

Even if the firm operates at *b* at which no resources are wasted, the firm is allocatively inefficient. It is inefficient because the firm is not choosing the optimal input mix. The budget line *PP* represents the cost if the firm had been allocatively efficient. However, the actual cost of production when firm *C* became technically efficient is represented by *P'P'*. AE for firm *C* is thus expressed as $od/ob \cdot db/ob (1 - od/ob)$ represents the percentage of inputs that can be reduced if the firm chose the optimal input mix. OE is equal to the product of AE and TE. Therefore, for firm *C*, the overall efficiency measure is equal to $od/oc (ob/oc \cdot od/ob)$. This ratio is simply a measure of the cost of the best practice firm divided by a firm's actual production cost. In Exhibit 1, a firm operating at *a* attains overall efficiency; that is, it does not waste any resources and employs the optimal input mix.

TE can be decomposed further into a pure technical (PTE) and scale (SE) measures. PTE simply refers to deviations from the efficient frontier that result from failure to utilize the employed resources efficiently, allowing variable returns to scale. SEs, on the other hand, are losses due to failure to operate at the long-run optimal scale (constant returns to scale). Exhibit 2 illustrates these two efficiency measures.

Exhibit 1
Overall, Technical, and Allocative Efficiencies

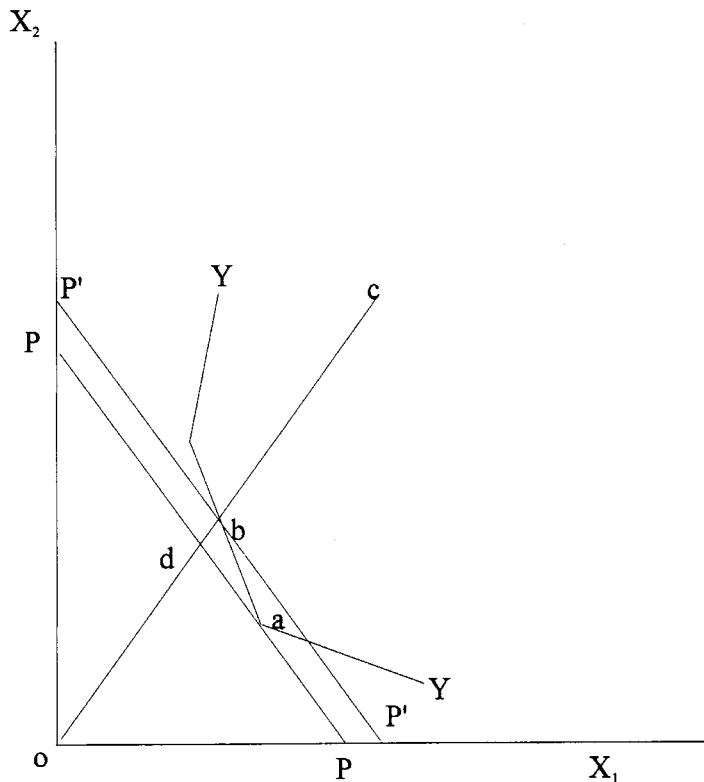
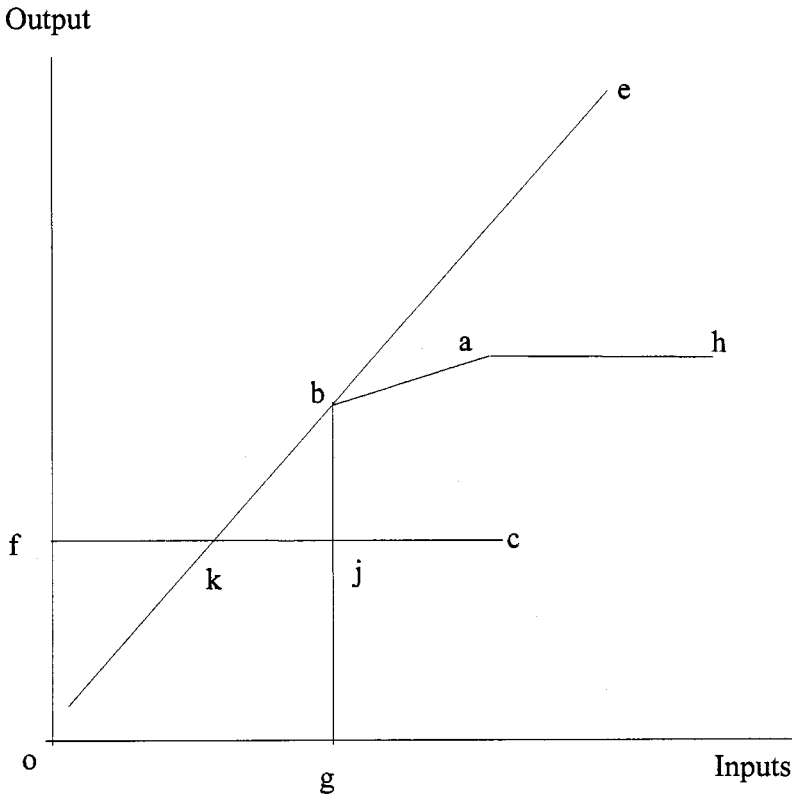


Exhibit 2
DEA Illustration
Pure Technical and Scale Efficiency



In Exhibit 2, the vertical axis represents output and the horizontal axis represents input combinations (*X*) that contain an equal amount of both input 1 and input 2. Movement to the right along the horizontal axis requires a proportional increase in both inputs. The graph shows three observations denoted *a*, *b* and *c*, respectively. Here two frontiers are illustrated, a constant returns frontier *obe*, and a variable returns frontier *gbah*. To measure PTE, an examination of the variable frontier must take place. For *c*, PTE is equal to the ratio of input usage assuming variable returns to scale to the actual input usage (i.e., fj/fc). SE is equal to the ratio of the TE measure assuming constant returns to scale (fk/fc) to the technical efficiency measure assuming variable return to scale (fj/fc), (i.e., fk/fj). In other words, $SE = TE/PTE$.

If the SE measure equals one, the firm is operating at constant returns to scale. If SE does not equal one, then the firm is either operating in a range of increasing or decreasing returns to scale. To determine the nature of the returns to scale when SE does not equal one, we need to calculate the TE measure assuming nonincreasing returns to scale.

In sum, $OE = AE \cdot TE$ or equivalently $OE = AE \cdot PTE \cdot SE$ since $SE = TE/PTE$. This shows that sources of operational inefficiency may be due to some combination of an incorrect input mix (allocational inefficiency), a nonoptimal production scale (scale inefficiency), or underutilization of inputs (pure technical inefficiency) The Appendix provides a formal mathematical treatment of these efficiency measures.

The Data

The data employed to estimate the efficiency scores were obtained from the Economics and Research Division of the National Association of Realtors. They conduct periodic nationwide surveys of the real estate brokerage industry. The current data come from the sixth survey, which encompasses 1990–91.⁷ The information was obtained from professionals who are Certified Real Estate Brokerage Manager designees and a random selection of members of the National Association of Realtors.⁸

A census of all the data for residential (a firm was termed residential if 75% of its revenue transaction were from residential dealings) real estate firms was obtained. With adjustment for incomplete and missing data, the final data set contains 276 firms.

To make sure that the results obtained are robust to model specifications, four models with different input-output combinations were constructed. In Exhibit 3, Models (1) and (2) contain five inputs: the number of salespersons, the number of nonsales employees, the number of offices, promotion and advertising expenses, and other inputs which is proxied by other expenses. Model (1) defines only one output, the number of revenue transactions. Model (2) decomposes revenue transactions into sales

Exhibit 3
Model Specification

Model	Outputs	Inputs
1	y	$X1 - X5$
2	$y1, y2$	$X1 - X5$
3	y	$X1 - X4$
4	$y1, y2$	$X1 - X4$

Note: Models 1 and 2 have associated input prices of $p1-p5$, and Models 3 and 4 have associated input prices of $p1-p4$.

Output and Inputs:

- y = Total revenue transactions
- $y1$ = Sales transactions
- $y2$ = Listing transactions
- $X1$ = Number of sales personnel
- $X2$ = Number of nonsales employees
- $X3$ = Number of offices
- $X4$ = Advertising and promotion expenses
- $X5$ = Other expenses

and listings. Models (3) and (4) are parallel to Models (1) and (2) except that other inputs are excluded.

The price of a salesperson was computed by dividing total sales-related expenses by the number of full-time equivalent salespersons. The price of nonsales labor was calculated by dividing clerical, secretarial and sales managers' salaries by the number of nonsales employees. The price of offices was calculated by dividing total occupancy expense by the number of real estate offices. The last two prices, advertising and promotion and other inputs are expressed as a percentage of revenue transactions. Summary statistics for the inputs, outputs, and input prices are given in Exhibit 4.

Exhibit 4 Summary Statistics

Variable	Mean	Std. Dev.	Min.	Max.
<i>Y</i>	764	1,638	26	21,275
<i>y</i> 1	376	817	9	10,642
<i>y</i> 2	392	834	10	10,633
<i>X</i> 1	60	130	1	1,472
<i>X</i> 2	16	33	1	350
<i>X</i> 3	4	14	1	225
<i>X</i> 4	176,124	416,442	2,490	4,818,769
<i>X</i> 5	231,580	410,860	8,018	3,445,090
<i>p</i> 1	25,690	13,785	2,156	127,100
<i>p</i> 2	14,099	8,333	1,143	55,000
<i>p</i> 3	42,414	35,296	1,725	254,000
<i>p</i> 4	269	285	40	3,896
<i>p</i> 5	414	467	30	4,506

y = Total revenue transactions
*y*1 = Sales transactions
*y*2 = Listing transactions
*X*1 = Number of sales personnel
*X*2 = Number of nonsales employees
*X*3 = Number of offices
*X*4 = Advertising and promotion expenses
*X*5 = Other expenses
*P*1 = Price of sales personnel
*P*2 = Price of nonsales employees
*P*3 = Price of an office
*P*4 = Price of advertising and promotion
*P*5 = Price of other inputs

Efficiency Estimation Results

The five efficiency measures, OE, AE, TE, PTE and SE are computed for the model specifications. Their mean values and standard deviations are summarized in Exhibit 5. Overall efficiency scores are very low, regardless of which model is estimated, as evidenced by mean efficiency scores of less than .3.

The low overall efficiency levels are driven by both technical and allocative inefficiencies. AE scores range from approximately 34% to 68% and TE scores range from 38% to 54%. Division of the TE measure into PTE and SE levels, however, reveals that most of the technical inefficiencies are scale in nature. SE measures only range from 50% to 66%, while the PTE scores, which measure utilization of employed inputs, all exceed 80%. This implies that employing an improper input mix hampers firm performance more than poor input utilization.

Further analysis of the SE measures shows that most of the sample firms are not operating under constant returns to scale. To summarize, the number of firms that operated under increasing, constant and decreasing returns to scale are reported in Exhibit 6. The majority of firms show increasing returns to scale. In particular, more than 70% were operating in the range of increasing returns to scale in each model.

These results are consistent with the findings of Zumpano, Elder and Crellin (1993) and Zumpano and Elder (1994) who found that the real estate brokerage industry is characterized by the existence of many small firms that failed to capture the benefits of expanding the scale and scope of their operations. These results also help explain the growth in average firm size that has occurred over the last decade. Faced with a mature market, growth in firm size and market share can only be accomplished in many cases through consolidation by way of mergers and acquisitions. The small firms that remain are being increasingly forced into niche markets, or providing what

Exhibit 5
Summary Statistics of the Efficiency Measures for the Four Models

Var	Model (1)		Model (2)		Model (3)		Model (4)	
	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.	Mean	Std. Dev.
OE	0.16	0.12	0.18	0.13	0.25	0.17	0.27	0.19
AE	0.40	0.14	0.34	0.14	0.68	0.22	0.52	0.19
TE	0.41	0.23	0.54	0.24	0.38	0.22	0.52	0.24
PTE	0.82	0.27	0.85	0.24	0.82	0.27	0.84	0.25
SE	0.54	0.27	0.66	0.26	0.50	0.26	0.65	0.26

OE = Overall Efficiency
 AE = Allocative Efficiency
 TE = Technical Efficiency
 PTE = Pure Technical Efficiency
 SE = Scale Efficiency

Exhibit 6
Economies of Scale

Model	CRS	IRS	DRS
1	14	219	43
2	20	213	42
3	12	224	40
4	16	216	44

CRS = Constant Returns to Scale

IRS = Increasing Returns to Scale

DRS = Decreasing Returns to Scale

may be higher cost services to limited segments of the market; the growth in buyer agencies is a good example.

The low efficiency scores for the residential brokerage industry could also reflect other factors that have nothing to do with the industry; in particular, the methodology used in the estimation of efficiency measures. The data envelopment analysis technique used here assumes that any deviation from the efficient frontier represents inefficiency. If there are several firms that are extremely efficient, the resulting average efficiency score for the sample would be very low. Thus, some of the findings could reflect measurement problems. To investigate this problem, the efficiency scores were computed multiple times by deleting the most efficient and/or the most inefficient firms. No matter which firms were deleted, the results were virtually identical. Although this does not mean there is not a problem, it does increase confidence in our estimations.

The results obtained from the data envelopment analysis are sensitive to model specification. The Spearman Rank Correlation test was conducted to determine if the different input-output specifications yielded significantly different efficiency scores. Results are reported in Exhibit 7 and indicate that the efficiency scores of the different models are all significantly related to each other.

Firm Characteristics and Efficiency Measures

It is of interest to know how firm and/or market characteristics are related to the various efficiency measures. To explain possible determinants of OE, the following regression model is estimated:

$$\begin{aligned}
 EFF_i = & B_0 + B_1SIZE + B_2FRAN + B_3DENSE + B_4AGE \\
 & + B_5FIXED + B_6BAL + B_7MLS + B_8FIRMTYPE + e_i, \quad (1)
 \end{aligned}$$

The dependent variable, EFF_i , represents firm i 's efficiency score (either OE, AE, TE, PTE or SE). $SIZE$ is a variable representing firm size. It is expressed as the log

Exhibit 7
Spearman's Correlation Coefficients for Efficiency Measures by Model

Panel A: Overall Efficiency

	OE1	OE2	OE3	OE4
OE1	1			
OE2	.977 (.0001)	1		
OE3	.7549 (.0001)	.7437 (.0001)	1	
OE4	.7235 (.0001)	.7423 (.0001)	.9845 (.0001)	1

Panel B: Allocative Efficiency

	AE1	AE2	AE3	AE4
AE1	1			
AE2	0.9157 (.0001)	1		
AE3	.4764 (.0001)	.3908 (.0001)	1	
AE4	.3785 (.0001)	.4088 (.0001)	.9069 (.0001)	1

Panel C: Overall Technical Efficiency

	TE1	TE2	TE3	TE4
TE1	1			
TE2	.9377 (.0001)	1		
TE3	.9588 (.0001)	.9253 (.0001)	1	
TE4	.9178 (.0001)	.9893 (.0001)	.9378 (.0001)	1

Panel D: Pure Technical Efficiency

	PTE1	PTE2	PTE3	PTE4
PTE1	1			
PTE2	.9798 (.0001)	1		
PTE3	.9861 (.0001)	.9651 (.0001)	1	
PTE4	.9804 (.0001)	.9987 (.0001)	.9673 (.0001)	1

Exhibit 7 (continued)
Spearman's Correlation Coefficients for Efficiency Measures by Model

Panel E: Scale Efficiency

	SE1	SE2	SE3	SE4
SE1	1			
SE2	.9247 (.0001)	1		
SE3	.9460 (.0001)	.9124 (.0001)	1	
SE4	.9142 (.0001)	.9825 .0001	.9326 (.0001)	1

Note: The numbers following the efficiency abbreviations denote the model under consideration.

of total revenue transactions. Previous studies by Zumpano, Elder and Crellin (1993) and Zumpano and Elder (1994) both suggest that firms in this market are too small to operate efficiently. In addition, our results indicate that, on average, firms in this market could increase their performance levels by expanding the scale of their production. Therefore, firm size is expected to have a positive effect on operational efficiency.

FRAN is a dummy variable taking on a value of one if the firm is franchised and zero otherwise. Franchising may reflect efficiency considerations for several reasons. Early franchising theory suggested that a franchised firm could raise capital at a lower cost than traditional firms.⁹ If this is true, the franchised firms would be more efficient. Furthermore, the rental of an established name could help a firm's reputation and selling power, which would increase efficiency. Moreover, the structure of franchises leads to a lower probability of quality debasing since the franchise could be terminated if certain standards are not met. Lastly, if advertising and promotion are more efficiently handled at the national level, but production and distribution at the local level, franchising may prove to be an efficient form of business.

However, it is possible that franchising could reduce efficiency. For instance, if several other franchisees provide poorer services or inferior products, a high quality-producing firm could still be associated with lower standards. Moreover, franchised firms may feel as if they can "ride" on their franchisor's reputation and shirk on quality and customer service. Finally, the payments to the parent company, by increasing variable costs, may also hurt profits to a greater extent than the potential increase in incremental revenues that may result from franchising.

DENSE, the market population per salesperson variable, is used as a proxy for market density. In markets with greater population density, there should be more properties to list and sell in close proximity to the firm. This should reduce transportation costs, increase the effectiveness of advertising and decrease the time costs in the listing and

selling process. In addition, in many large metropolitan areas, there exist many real estate firms. Hence, there should be greater competition, which would tend to increase efficiency levels.

AGE represents the number of years a firm has been operating. Older firms may be able to obtain more listings and/or make more sales than their new firm counterparts because of reputation and accumulated brandname capital effects. However, it is possible that older, more established firms may attempt to “ride” on their established reputation and not utilize the resources they have available.

FIXED is the proportion of fixed costs to total firm costs and is a measure of operating leverage. Operating leverage greatly impacts a firm’s business risk level. If a firm has an extremely high level of fixed costs, a small decline in sales can lead to a substantial decline in returns. Conversely, a small increase in sales would greatly enhance the profitability.¹⁰ The *ex ante* hypothesis is that market conditions may dictate the relationship of this variable with the efficiency measures.

BAL is a dummy variable with a value of one if the firm produces a balanced output of sales and listings and zero otherwise. A firm is assumed to produce a balanced output of sales and listing if no less than 40% and no more than 60% of their total output comes from sales. *BAL* is expected to be positively related with efficiency as Zumpano and Elder (1994) found significant economies of scope in this sector.

MLS is a dummy variable taking on a value of one if the firm belongs to more than one MLS and a value of zero otherwise. Zumpano and Hooks (1988) suggest that the *MLS* increases rather than decreases efficiency. This is evident by the fact that over 98% of the firms in the sample set belong to at least one MLS. However, here the number of MLS affiliations is tested in order to determine if the marginal benefits of joining an additional MLS are co-measurable with the costs.

FIRMTYPE is a dummy variable that takes a value of one if the firm is a corporation and zero otherwise. According to agency theory, firm type may impact efficiency levels. For sole proprietorships and partnerships, the owner/managers have unlimited personal liability. In a corporation, owner/managers are not exposed to personal liability for the debts of the company. Moreover, the manager may not be a direct residual claimant. Hence, agency theory would predict that a corporation would be more inefficient than either the sole proprietorship or the partnership (Jensen and Meckling, 1976).

Regression Results¹¹

As shown in Exhibit 8, firm size (*SIZE*) is positively and significantly related with all efficiency measures except PTE. The result is consistent with the findings of Zumpano, Elder and Crellin (1993) and Zumpano and Elder (1994) in that most residential real estate brokerage firms are too small to operate efficiently. The negative coefficient on PTE suggests that input utilization decreases as firm size increases. This result is consistent with agency theory. Jensen and Meckling (1976) suggest that as firms grow,

Exhibit 8
Regression Results for the One Output-Five Input Model

X-Variables	OE	AE	TE	PTE	SE
Intercept	0.141 (3.0)	0.318 (5.4)	0.459 (4.9)	1.613 (15.9)	-.041 (-.4)
<i>SIZE</i>	0.027 (4.1)*	0.018 (2.2)**	0.043 (3.4)*	-0.063 (-4.5)*	.104 (7.3)*
<i>FRAN</i>	-0.050 (-3.6)*	-0.052 (-2.9)*	-0.082 (-2.9)**	0.003 (0.1)	-.098 (-3.2)*
<i>DENSE</i>	4.09E-8 (0.6)	2.67E-8 (0.3)	2.63E-8 (0.2)	-0.000 (-0.9)	8.81E-8 (0.6)
<i>AGE</i>	<-0.001 (-0.5)	<-0.001 (0.4)	<-0.001 (-0.7)	-0.001 (-1.9)***	<-0.001 (0.2)
<i>FIXED</i>	-0.205 (-2.3)**	-0.203 (-1.8)***	-0.215 (-1.2)	-0.455 (-2.3)**	0.198 (1.0)
<i>BAL</i>	0.010 (0.5)	0.018 (0.8)	0.292 (0.8)	-0.082 (-2.0)**	0.113 (2.691)*
<i>MLS</i>	-0.026 (-3.1)*	0.018 (1.7)***	-0.086 (-5.1)*	-0.073 (4.0)***	-0.054 (2.9)*
<i>FIRMTYPE</i>	-0.015 (-0.7)	-0.017 (-0.6)	-0.033 (-0.7)	0.032 (-0.6)	(-0.019) (-0.4)
ADJ-R ²	.1307	.0723	.1253	.2300	.2431

*Significance at the 1% level.

**Significance at the 5% level.

***Significance at the 10% level.

The dependent variables are: *SIZE* = firm size measured as the log of total revenue transactions, *FRAN* = 1 if the firm is franchised and 0 otherwise, *DENSE* = market density, *AGE* = the age of the firm in years, *FIXED* = fixed costs as a percentage of total costs, *BAL* = 1 if sales transactions account for 40–60% of total revenue transactions and 0 otherwise, *MLS* = the number of multiple listings services that a firm subscribes and *FIRMTYPE* = 1 if the firm is a corporation and 0 otherwise.

monitoring employee productivity becomes increasingly difficult and expensive. Hence, input utilization is negatively related to size. However, the SE component dominates the PTE measure and, as such, the TE and OE measures suggest that performance can be improved by increasing firm size.

All of the *FRAN* coefficients are negative and significant except when PTE is the dependent variable. For PTE, the franchising coefficient is positive but insignificant. The results are consistent with that found by Bates (1995). Bates found that franchised firms were poorer performers and had lower survival rates than their non-franchised counterparts.

The number of *MLS* services that a firm subscribes is significantly related to all of the efficiency measures. In particular, increasing the number of *MLS* affiliations

increases AE, but decreases all other efficiency measures. It appears that employing a MLS promotes optimal input mix. However, firms seem to have excessive MLS memberships. Overall, the results suggest that the marginal benefits of joining an additional MLS are not co-measurable with the costs.¹²

The operating leverage variable, *FIXED*, is negatively related to OE, AE and PTE. There is no significant relationship between *FIXED* and overall TE and TE measures. The overall negative impact of this variable may be due to relatively sluggish real estate growth in 1990.

Producing a balanced output was found to be related to TE. However, the overall TE variable is insignificant due to the opposing signs of the PTE and SE measures. The production of a balanced output reduces PTE, but increases SE. These results are intuitively appealing. The production of a balanced output reduces utilization gains related to specialization and thus PTE suffers. However, the ability to both sell and list allows for more expansion opportunities which promotes SE.

The *AGE* variable is only significant with respect to PTE. The variable is significant and negatively related to PTE. This suggests that input utilization suffers as firms become older. Older firms are positively correlated with size. The correlation coefficient is .157. and the agency problems noted earlier may be driving the results. Finally, the density of the market and the firm type variables were shown to be insignificant in all regressions.

Conclusion

This article employed the DEA to a set of residential real estate brokerage firms in order to measure their relative efficiency levels. Five different efficiency measures were used. The results are significant and provide much needed information on the efficiency characteristics of this market. PTE for the sampled firms was very high and comparable to that obtained for financial institutions in previous empirical studies. However, the OE scores are very low. The low efficiency scores are mainly attributable to allocative and scale inefficiencies. Most of the sample firms are too small to capture the cost savings associated with larger scale operations. From the regression analysis, firm size, franchising, operating leverage and the number of MLSs were significantly related to the OE levels. In particular, firm size is positively related to overall efficiency levels while choosing to franchise, adding an additional MLS and increasing operating leverage are all associated with poorer firm performance. Lastly, market density and firm type are not significantly related to any of the efficiency measures.

Appendix

Overall, Technical and Allocative Efficiencies

The efficiency measures can also be stated more formally. OE is defined as the ratio of the best practice firm's production cost to the actual cost of a particular firm. As

previously mentioned, OE can be decomposed as the product of technical efficiency and allocative efficiency, *i.e.*, $OE = TE * AE$, or equivalently, $OE = AE * PTE * SE$. To estimate OE for a particular firm, say j , the following linear program is employed:

$$\text{Min } Px \tag{1}$$

$$\text{s.t.} \tag{2}$$

$$y_j \leq ZY \tag{2}$$

$$x_j \geq ZX \tag{3}$$

$$Z \in R \tag{4}$$

Here, y_j is a $m \times 1$ vector of outputs produced by firm j ; x_j is a $n \times 1$ vector of inputs utilized by the firm and P is a $1 \times n$ vector of input prices. Y is a $K \times m$ matrix of firm outputs where K is the number of firms in the sample. X is a $K \times n$ matrix of inputs and Z is a vector of weights attached to each firm when constructing hypothetical efficient firms.

For demonstration purposes, a detailed form of the above program for a one output (y) and two inputs (X_1 and X_2) model with k sample firms is given below:

$$\begin{aligned} &\text{Min } p_1x_1 + p_2x_2 \\ &\text{s.t. } y_j \leq Z_1y^1 + Z_2y^2 + Z_3y^3 + \dots + Z_ky^k \\ &x_{1j} \geq Z_1x_1^1 + Z_2x_1^2 + Z_3x_1^3 + \dots + Z_kx_1^k \\ &x_{2j} \geq Z_1x_2^1 + Z_2x_2^2 + Z_3x_2^3 + \dots + Z_kx_2^k \\ &Z_1, Z_2, Z_3, \dots, Z_k \in R \end{aligned}$$

Equations (2) and (3) are the output and input constraints, respectively. The purposes of the constraints are to construct an efficient frontier to which an individual firm is compared. To identify efficient firms, the program examines all linear combinations of sample firms that produce an output equal to or greater than that produced by firm j (Equation 2) and use no more than the input used by firm j (Equation 3). The linear combination that has the lowest production cost is the best practice firm. The solution represents the minimum cost level that an individual firm should achieve given its output. Dividing the minimum cost by the cost of firm j yields the overall efficiency measure for firm j .

The following linear program is used to calculate technical efficiency:

$$\text{Min TE} \tag{5}$$

$$\text{s.t. } y_j \leq ZY \tag{6}$$

$$TEx_j \geq ZX \tag{7}$$

$$Z \in R \quad (8)$$

TE is the ratio of inputs utilized by the best practice firm to the inputs actually utilized by firm j . Therefore, if firm j is efficient, $TE = 1$. When $TE < 1$, firm j can reduce its input usage without reducing its outputs. Efficient firms are constructed by a process similar to that stated in the program for calculating OE. Efficient firms are linear combinations of sample firms that produce output equal to or greater than that produced by firm j (Equation 6) and uses no more than TE percent of input used by firm j (Equation 7). Within a set of efficient firms, the program chooses the combination that minimizes TE. The solution to this minimization problem is the efficient index for firm j . Refer to Exhibit 1, TE for firm C equals ob/oc .

The measures of PTE and SE can be shown mathematically. First, PTE is derived by the following linear program:

$$\text{Min PTE} \quad (9)$$

$$\text{s.t. } y_j \leq ZY \quad (10)$$

$$\text{PTE}x_j \geq ZX \quad (11)$$

$$\sum z_i = 1 \quad (12)$$

$$Z \in R \quad (13)$$

The only difference between the program for calculating TE and that for PTE lies on the constraints on the vector Z . Equation (12) allows for variable returns to scale. As previously mentioned, SE is obtained by dividing TE by PTE. In order to determine the nature of the returns to scale when $SE \neq 1$, another linear program must be solved. This program constructs a frontier that allows for non-increasing returns to scale. This frontier can be calculated by the following linear program:

$$\text{Min } \sigma \quad (14)$$

$$\text{s.t. } y_j \leq ZY \quad (15)$$

$$\sigma x_j \geq ZX \quad (16)$$

$$\sum z_i \leq 1 \quad (17)$$

$$Z \in R \quad (18)$$

Equation (17) allows for non-increasing returns to scale. It can be shown that when $SE \neq 1$, decreasing return to scale exist if $\sigma = \text{PTE}$, and increasing returns to scale exist if $\sigma \neq \text{PTE}$ (see Färe, Grosskopf and Lovell, 1985).

Notes

¹ Or at least, the studies assume that all firms deviate from the efficient frontier by the same magnitude.

² The cartel hypothesis was supported by Maurizi's (1974) study, but was rejected by Shillings and Sirmans (1985) and Johnson and Loucks (1986).

³ Examples of such studies include Christensen and Greene (1976) on electric power generation, Caves, Christensen and Swanson (1981) on the railroad industry, McKay (1988) on the nursing home industry and Darrough and Heinke (1978) on law enforcement agencies. Additionally, many studies on economies of scale and scope exist in banking and will be noted later.

⁴ Leibenstein (1966) argued that X-inefficiency losses should be substantial in any industry. Hence, obtaining a measure of X-inefficiency is important for all sectors such that the true structure and performance of the market can be gleaned.

⁵ If managers and/or workers can be encouraged or persuaded to work more effectively, firms could improve performance without changing their resource allocation. If a firm is operating in a competitive market, managers and workers may feel more pressure to work more efficiently.

⁶ This method is derived from an engineering ratio concept for measuring efficiency. However, the engineering efficiency ratio was only capable of measuring efficiency for the case of a single input and a single output.

⁷ Most of the respondents reported income and expenses for the year ending December 31, 1990. However, some of the firms operate on a fiscal year that carried into 1991. Hence, the data comes from both 1990 and 1991.

⁸ A sample of the NAR survey questionnaire is available from the authors upon request.

⁹ For representative studies see Oxenfeldt and Kelly (1969), Oxenfeldt and Thompson (1969), Ozanne and Hunt (1971) and Caves and Murphey (1976).

¹⁰ In order to speculate on how operating leverage may alter profits, the degree of total risk, which includes financial risk, needs to be calculated. Firms could trade high levels of operating leverage for low levels of financial leverage. Thus, in economic upturns, the firms with high operating leverage may not be able to translate the increased revenues into profits. Unfortunately, the data set is insufficient to measure financial risk. However, financial risk is proxied by the ratio of interest and financing expenses to net income. Operating leverage and the proxy for financial leverage are slightly negatively correlated. However, when they are regressed against one another, no statistically significant relationship is found. Hence, it is reasonable to assume that firms with higher operating leverage have higher levels of total risk and vice versa.

¹¹ As the regression results using efficiency measures based on different input/output definitions are similar, only the results for Model 1 are reported here.

¹² This result does not necessarily contradict Zumpano and Hooks (1988) who suggested that the use of a MLS increases efficiency levels. Over 98% of the sampled firms belonged to at least one MLS. The results presented here show that adding another MLS may reduce efficiency levels. However, no claim is made as to whether the decision to belong versus the decision not to belong to an MLS alters efficiency levels.

References

Bates, T., Analysis of Survival Rates Among Franchise and Independent Small Business Startups, *Journal of Small Business Management*, 1995, 33, 26–35.

Berger, A. N., W. C. Hunter and S. G. Timme, The Efficiency of Financial Institutions: A Review and Preview of Research Past, Present, and Future, *Journal of Banking and Finance*, 1993, 17, 223–27.

Carroll, W., Fixed Percentage Commissions and Moral Hazard in Residential Real Estate Brokerage, *Journal of Real Estate Finance and Economics*, 1989, 2, 349–65.

Caves, D. W., L. R. Christensen and J. A. Swanson, Productivity Growth, Scale Economies and Capacity Utilization in U.S. Railroads, 1955–1974, *American Economic Review*, 1981, 71, 994–002.

- Caves, R. E. and W. F. Murphey, Franchising: Firms, Markets, and Intangible Assets, *Southern Economic Journal*, 1976, 42, 572–86.
- Christensen, L. R., and W. H. Greene, Economies of Scale in U.S. Electric Power Generation, *Journal of Political Economy*, 1976, 84, 655–68.
- Crockett, J. H., Competition and Efficiency in Transacting: The Case of the Residential Real Estate Brokerage, *The Journal of the American Real Estate and Urban Economics Association*, 1982, 10, 23–7.
- Darrough, M. N. and J. M. Heinke, The Multi-Output Translog Production Cost Function: The Case of Law Enforcement Agencies, in J. M. Heinke, editor, *Economic Models of Criminal Behavior*, Chapter 7, North Holland, 1978.
- Färe, R., S. Grosskopf and C. A. K. Lovell, *The Measurement of Efficiency of Production*, Boston, MA: Kluwer-Nijhoff, 1985.
- Farrell, M., The Measurement of Productive Efficiency, *Journal of the Royal Statistical Society, Series A, General*, 125, Part 2, 1957, 252–67.
- Jensen, M. and W. Meckling, Theory of the Firm: Managerial Behavior, Agency Costs and Ownership Structure, *Journal of Financial Economics*, 1976, 3, 305–60.
- Johnson, L. J. and C. Loucks, The Effects of State Licensing Regulations on the Real Estate Brokerage Industry, *The Journal of the American Real Estate and Urban Economics Association*, 1986, 14, 567–82.
- Knoll, M. S., Uncertainty, Efficiency, and the Brokerage Industry, *Journal of Law and Economics*, 1988, 31, 249–66.
- Leibenstein, H., Allocative Efficiency vs. X-Efficiency, *American Economic Review*, 1966, 56, 392–14.
- Maurizi, A., Occupational Licensing and the Public Interest, *Journal of Political Economy*, 1974, 87, 399–13.
- McKay, N. L., An Econometric Analysis of Cost and Scale Economies in the Nursing Home Industry, *Journal of Human Resources*, 1988, 23, 57–75.
- Miller, N. G. and P. J. Shedd, An Economic Explanation for the Uniformity of Real Estate Brokerage Fees, and Projections for Change, Unpublished paper presented at the American Real Estate and Urban Economics Association Meeting, Atlanta, 1979.
- National Association of Realtors, *Profile of Real Estate Firms, 1996*, Washington, DC, 1996.
- Oxenfeldt, A. and A. Kelly, Will Franchise Systems Ultimately Become Wholly Owned Chains? *Journal of Retailing*, 1969, 69–83.
- Oxenfeldt, A. and D. Thompson, Franchising in Perspective, *Journal of Retailing*, 1969, 3–13.
- Ozanne, V. B. and S. D. Hunt, The Economics of Franchising, U.S. Senate, Select Committee on Small Business, Committee Print, 92d Cong., 1st session, Washington, DC, U.S. Government Printing Office, 1971.
- Schroeter, J. R., Competition and Value-of-Service Pricing in the Residential Real Estate Brokerage Markets, *Quarterly Review of Economics and Business*, 1987, 27, 29–40.
- Shillings, J. D., and C. F. Sirmans, The Effect of Occupational Licensing on Complaints Against Real Estate Agents, Working Paper No. 506, Louisiana State University Real Estate Research Institute, 1985.
- Wachter, S. M., Residential Real Estate Brokerage: Cartel Without Entry Barriers, in A. J. Jaffe, editor, *Research in Real Estate*, Greenwich, CT: JAI Press, 1985.
- Yinger, J., A Search Model of Real Estate Broker Behavior, *American Economic Review*, 1981, 71, 591–05.
- Zumpano, L. V. and D. Hooks, The Market of Residential Real Estate Brokerage Services: A Critical Reevaluation, *The Journal of the American Real Estate and Urban Economics Association*, 1988, 16, 1–17.
-

Zumpano, L. V., and H. W. Elder, Economies of Scope and Density in the Market for Real Estate Brokerage Services, *The Journal of the American Real Estate and Urban Economics Association*, 1994, 22, 497–13.

Zumpano, L. V., H. W. Elder and G. E. Crellin, The Market for Residential Real Estate Brokerage Services: Costs of Production and Economies of Scale, *Journal of Real Estate Finance and Economics*, 1993, 6, 237–50.

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