Impact of Entry and Exit on Agribusiness-Trucking Industry Efficiency: Stochastic Frontier Analysis

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Abstract
In this paper, the impact of entry and exit of firms on the overall efficiency of the industry is examined in the efficiency framework, using agribusiness-trucking firms for the period 1994-2003. Specifically, industry efficiency is compared with and without firms that enter and exit using panel stochastic frontier analysis.

Role of individual firms contribution to the industry growth have been examined using the traditional market power and concentration hypothesis followed by the game theoretic approach. However, due to financial and other constraints there is tendency for the firms to exit and the re-entry of old or entry of new firms into the same market given the decreasing entry rigidness if the industry. Notion of markets being dynamic facilitates the entry and exit of the firms in an industry. Apart from the traditional notion that entry and exit of firms brings in and retires capital, it also accounts for the numerous mergers and acquisitions. Does this process of economic selection foster or hinders the overall efficiency of the firm? The impact of firm or farm's entry and exit has been examined in economic and agriculture sector alike. However, seldom has there been any research on the impact of firm's entry and exit on the industry from the efficiency framework (Allen and Shaik, 2005).

Agribusiness trucking carriers play a vital role in the survival and successful operations of firms in the agribusiness system. For example, trucking carriers in this system enable agribusiness firms to sell their agricultural and food products at competitive prices, generate production and marketing opportunities, to locate

processing-food manufacturing facilities and distribution centers advantageous, and transact business.

Two-fold objective of the paper is to 1) examine the patterns of entry and exit of the firms in the trucking industry and 2) examine the impact of entry and exit of firms on industry efficiency using panel stochastic frontier analysis.

Stochastic Frontier Analysis

To represent efficiency in the primal approach for a firm i, $i = 1, ..., I$, the basic form of the model can be represented as

(1) $y_i = f(x_i; \beta) \cdot \varepsilon_i$

where y denotes output produced from a vector of input, x and β the associated vector of parameters. Furthermore equation (1) can be utilized to estimate the efficiency measures by non-parametric or parametric approach. In this paper, we utilize the parametric stochastic frontier analysis approach.

Comprehensive literature reviews [Forsund, Lovell and Schmidt (1980), Schmidt (1986), Bauer (1990), Greene (1993), and Kumbhakar and Lovell (2000)] on the use of stochastic frontier analysis has been evolving since it was first proposed by Aigner, Lovell and Schmidt; Meeusen and van den Broeck; and Battese and Corra in the same year, 1977. The past decade has witnessed a surge in the extension of the parametric techniques to efficiency measurement. Furthermore within the primal framework, there has been progress made on the ability to handle multiple outputs and inputs via the distance functions, adjusting for time series properties, incorporating autocorrelation and

heteroskedasticity, and finally the use of Bayesian techniques in the parametric efficiency measures.

The particular form considered here is the efficiency estimation from a primal production function. To formally represent this measure, equation (1) can be re-written to represent the parametric stochastic frontier analysis model with the decomposed error as:

(2) $y = f(x;\beta)\cdot v - u$

where v representing firm or time specific random error which are assumed to be identical and independently distributed and normally distributed variable with mean zero and variance σ_V^2; u represent the technical efficiency which must be positive hence absolutely normally distributed variable with mean zero and variance σ_U^2; and y, x and β as defined in equation (1).

With the paper by Jondrow, Lovell, Materov, and Schmidt in 1982, individual firm specific efficiency measures (u) conditional on ε can be represented as

(3) $$E(u \mid \varepsilon) = \frac{\sqrt{\sigma_{\mathrm{V}}^2 + \sigma_{\mathrm{U}}^2}\,\dfrac{\sigma_{\mathrm{U}}^2}{\sigma_{\mathrm{V}}^2}}{1+\left(\dfrac{\sigma_{\mathrm{U}}^2}{\sigma_{\mathrm{V}}^2}\right)^2}\left[\frac{\phi(a_{it})}{1-\Phi(a_{it})} - a_{it}\right]$$

where $a = \varepsilon\dfrac{\sqrt{\sigma_{\mathrm{V}}^2 + \sigma_{\mathrm{U}}^2}}{\sigma_{\mathrm{U}}^2/\sigma_{\mathrm{V}}^2}$, and ϕ and Φ are the standard normal density and standard normal cumulative density function.

To examine the technical efficiency of the entry, exit and remaining firms, equation (1) can be rewritten with current time, t and the following year, t+1 as:

$$
\begin{aligned}
& y_{i,t} = f(x_{i,t};\beta).\varepsilon_{i,t} && \textit{firms exiting the industry} \\
(4) \qquad & y_{i,tt+1} = f(x_{i,tt+1};\beta).\varepsilon_{i,tt+1} && \textit{firms remaining} \\
& y_{i,t+1} = f(x_{i,t+1};\beta).\varepsilon_{i,t+1} && \textit{firms entering the industry}
\end{aligned}
$$

Data

The variables used to satisfy the objective of this paper are obtained from TTS Blue Book of Trucking Companies for the period, 1994 to 2003. The data for the input variables was divided into labor, capital, operating variable costs and operating fixed costs. The labor variables include (1) the number of drivers and helpers, (2) number of cargo handlers, (3) number of officers, supervisors, clerical and administrative staff, and (4) total number of other laborers. Capital variables include (1) number of tractors owned, (2) number of trucks owned, (3) number of tractors leased, (4) number of trucks leased, and (5) other equipment.

Operating variable costs include (1) fuel-gallons, oil, and lubricants and (2) total maintenance. The operating fixed cost category is composed of (1) total operating taxes and licenses; (2) total insurance; and (3) depreciation and amortization. The output variable consists of total ton-miles, which is the measurement most commonly used according to Caves et al (1980), McGeehan (1993) and Cantos et al. (1999), given that these demand related measure of output, allow an assessment of the level of user consumption and the value they place on the service. This ton-mile output measurement assumes little or no government control on the provision of the service, otherwise measures that isolate the government regulatory measures like truck-miles , which represents the degree of capacity or service level supplied by the trucking company, are

more suitable for this type of analysis (Cantos, P. et al., 2000) The agribusiness trucking firms that this study analyzes to determine whether they are technically efficient are firms that haul agricultural commodities for hired.

Results

Efficiency measures are estimated using yearly trucking companies data for the period, 1994 to 2003. Specifically equation (2) is used to estimate the efficiency measures for each trucking company. Table 1 shows the number of firms that are entering, exiting and remaining in the industry, the means of the output and input variables used on the efficiency analysis.

Results reveal that the largest number of firms exiting the industry occurred in the year 2000. In that year the number of firms exited the industry totaled 171. The firms that exited from the industry had output totaling almost 379.4 million ton-miles. The firms generated these ton-miles by using 320 workers and 227 units of capital. The operating variable and operating fixed costs were 3.5 and 4.3 million dollars respectively. The year that had the smallest number of firms exiting the industry was 1995. In that year 91 firms exited the industry. The firms that exited the industry during 1995 produced 358.6 million ton-miles and it cost them almost 3.1 million dollars in terms of operating variable expenses and almost 5.1 million dollars in fixed cost to operate. In addition these firms used 433 labor units and 325 vehicles.

Table 1 Summary Statistics of Firms Entering, Exiting and Remaining in the Industry, 1994-2003

Year	Entry/Exit/Remaining Firms	Number of Firms	Output (1,000)	Labor (no.)	Capital (no.)	Operating Variable Costs (1,000)	Operating Fixed Costs (1,000)
1994	Exit	129	568,649	515	368	3,658	6,621
1994/1995	Remaining	208	563,235	1,683	725	4,662	11,970
1995	Entry	85	596,957	780	482	4,348	9,004
1995	Exit	91	358,569	433	325	3,065	5,088
1995/1996	Remaining	202	713,488	1,959	830	6,371	14,746
1996	Entry	134	393,957	368	281	3,432	4,635
1996	Exit	118	386,191	376	295	2,953	5,198
1996/1997	Remaining	218	750,811	9,471	810	6,651	14,316
1997	Entry	121	554,302	365	327	3,725	6,630
1997	Exit	146	501,412	13,105	706	4,296	10,109
1997/1998	Remaining	193	1,023,778	1,065	647	5,853	13,750
1998	Entry	159	623,475	518	410	3,846	6,196
1998	Exit	111	634,062	547	395	4,394	7,514
1998/1999	Remaining	241	929,807	1,028	641	6,184	12,731
1999	Entry	129	446,202	2,013	675	4,220	10,760
1999	Exit	115	512,870	2,299	784	4,384	12,340
1999/2000	Remaining	255	907,243	952	611	7,998	12,524
2000	Entry	220	479,282	423	273	4,696	5,386
2000	Exit	171	379,366	320	227	3,461	4,318
2000/2001	Remaining	304	901,557	935	597	8,329	12,603
2001	Entry	131	403,883	2,581	845	5,455	11,561
2001	Exit	163	654,931	2,330	876	7,966	13,791
2001/2002	Remaining	294*	822,154	872	597	6,940	11,656
2002	Entry	120	345,564	319	276	2,629	4,325
2002	Exit	169	482,435	400	346	3,450	6,308
2002/2003	Remaining	245	845,415	947	558	8,630	12,348
2003	Entry	132	568,497	726	398	7,272	9,252

*The reason for the difference is due to the presence of firms or "mcn" numbers, i.e., a single firm transporting multiple commodities are counted multiple times. For example a firm or "mcn" number involved in transporting two commodities are counted twice.

The firms remaining in the industry ranged from a low of 193 in 1997/1998 to a high of 304 in 2000/2001. These results show that there was a net increase of 211 firms between the two time periods. In addition the remaining firms in 1997/1998 had an

output of over a billion ton-miles while the firms in 2000/2001 had an output of almost 901.6 million ton-miles. The remaining firms in 1997/1998 used 1,065 labor units and 647 vehicles with operating variable costs of almost 5.9 million dollars and operating fixed costs of 13.8 million dollars. The firms in 2000/2001 used 935 labor units and 597 vehicles to generate the 901.6 million ton-miles. The costs to the firms in terms operating variable and operating fixed expenses were 8.3 million dollars and 12.6 million dollars, respectively.

Firms entering the industry ranged from a low of 85 firms in 1995 to a high of 220 in 2000. The entering firms in 1995 produced almost 597 million ton-miles with 780 labor units and 482 units of capital. The operating variable expenses were 4.3 million dollars while the operating fixed costs were 9.0 million dollars. The entering firms in 2000 generated almost 479.3 million ton-miles. The firms were able to produce that volume of ton-miles with 423 units of labor and 273 units of capital. The operating variable costs totaled almost 4.7 million dollars while the operating fixed expenses totaled almost 5.4 million dollars.

The means, standard deviations, and minimum and maximum values of efficiency measures by the number of firms exiting the industry, number of the firms staying and number of the firms entering the industry are presented in Table 2. Results show that in the years 1996/1997, 1997/1998, 1999/2000, and 2001/2002 remaining firms had efficiency values of 1.000, while in 1997 and 2000 entering and exiting firms had efficiency values of 1.000. These results imply that these firms were operating at

maximum level of efficiency with the available resources at their disposal during these years.

Table 2 Efficiency Measures of Firms Entering, Exiting and Remaining in the Industry, 1994-2003

Year	Status of Firms	No. of Firms	Mean	Std	Min	Max
1994	Exit	129	0.658	0.173	0.035	0.985
1994/1995	Remaining	208	0.552	0.196	0.015	0.992
1995	Entry	85	0.502	0.212	0.023	0.991
1995	Exit	91	0.483	0.189	0.023	0.964
1995/1996	Remaining	202	0.662	0.173	0.202	0.992
1996	Entry	134	0.586	0.178	0.129	0.978
1996	Exit	118	0.572	0.182	0.129	0.962
1996/1997	Remaining	218	0.779	0.181	0.016	1.000
1997	Entry	121	0.724	0.173	0.021	1.000
1997	Exit	146	0.729	0.179	0.016	1.000
1997/1998	Remaining	193	0.331	0.182	0.091	1.000
1998	Entry	159	0.278	0.176	0.106	0.979
1998	Exit	111	0.282	0.168	0.091	0.979
1998/1999	Remaining	241	0.750	0.151	0.003	0.996
1999	Entry	129	0.689	0.166	0.108	0.987
1999	Exit	115	0.681	0.182	0.003	0.987
1999/2000	Remaining	255	0.755	0.183	0.034	1.000
2000	Entry	220	0.687	0.191	0.015	0.997
2000	Exit	171	0.675	0.194	0.015	1.000
2000/2001	Remaining	304	0.726	0.152	0.260	0.996
2001	Entry	131	0.621	0.169	0.241	0.986
2001	Exit	163	0.659	0.170	0.241	0.988
2001/2002	Remaining	294*	0.728	0.201	0.021	1.000
2002	Entry	120	0.583	0.262	0.004	1.000
2002	Exit	169	0.597	0.254	0.004	1.000
2002/2003	Remaining	245	0.424	0.197	0.009	0.997
2003	Entry	132	0.329	0.222	0.000	0.977

* Please refer to the footnote under Table 1.

Efficiency measures of firms group by entering, exiting and remaining in the industry categories from 1994-2003 reveal that the mean efficiency values of the firms remaining in the industry during the study period were higher in almost all cases, Table 3.

The exception to those cases was the firms exiting the industry in the year 1994. In that year the mean efficiency value of the firms was 0.658. The efficiency measures ranged from a low of 0.278 for firms entering the industry in 1998 to high of 0.779 for firms remaining in the industry in 1996/1997. These results imply that firms entering the industry in the year 1998 were not that efficient when compared with the firms remaining in the industry. Thus, the entering firms were coming in at a precarious position that would have been most likely detrimental to the operations of these carriers.

Table 3 Categories, years, status of firms, mean efficiencies and rank of firms in categories

Categories	**Year**	**Status of Firms**	**Mean efficiencies**	**Rank**
1	1994	Remaining Entry Exit	N/A N/A 0.658	N/A N/A 1
2	1994/1995 1995 1995	Remaining Entry Exit	0.552 0.502 0.483	1 2 3
3	1995/1996 1996 1996	Remaining Entry Exit	0.662 0.586 0.572	1 2 3
4	1996/1997 1997 1997	Remaining Entry Exit	0.779 0.724 0.729	1 3 2
5	1997/1998 1998 1998	Remaining Entry Exit	0.331 0.278 0.282	1 3 2
6	1998/1999 1999 1999	Remaining Entry Exit	0.750 0.689 0.681	1 2 3
7	1999/2000 2000 2000	Remaining Entry Exit	0.755 0.687 0.675	1 2 3
8	2000/2001 2001 2001	Remaining Entry Exit	0.726 0.621 0.659	1 3 2
9	2001/2002 2002 2002	Remaining Entry Exit	0.728 0.583 0.597	1 3 2
10	2002/2003 2003	Remaining Entry	0.424 0.329	1 2

	N/A	Exit	N/A	N/A

Source: Developed from Table 2.

The range of efficiency measures for the firms exiting the industry was from a low of 0.282 in 1998 to a high of 0.729 in 1997. These results show that firms in the year 1998 were primarily exiting the industry because they were not efficient to compete with firms remaining or entering the industry. However, the exiting firms in the 1997 had efficient values that could have allowed them to be competitive with firms that were remaining or entering the industry during that time period. This result may imply that these firms found better alternative markets to enable them to receive higher profits than those found in the current markets.

Efficiency values for the remaining firms ranged from a low of 0.331 in 1997/1998 to high of 0.779 in 1996/1997. These results imply that the remaining firms in 1997/1998 were in a precarious efficient position and were not likely providing services to their customers at reasonable prices while firms in the 1996/1997 were providing adequate transportation and handling services to their customers at reasonable prices. By providing transportation and handling services at reasonable prices these firms were more likely to remain in the market than those firms that had low efficient values in the year 1997/1998.

Results show that the range of efficiency values for firms entering the industry was from a low of 0.278 in 1998 to high of 0.724 in 1997. These results imply that the firms entering the industry with the mean value of 0.278 were more likely candidates for early exit from the industry than the firms that came in the industry with efficiency value of 0.724. The entering firms with that efficiency value were more likely able to be

competitive with other firms entering the industry or those that were remaining in the industry in the long-run.

Summary and Conclusions

The purpose of this paper was to measure the impact of exit and entry of firms in the trucking industry for the period 1994-2003 using the stochastic frontier analysis as an estimation method. To accomplish the objective of the analysis, data was obtained from Technical Transportation Services (TTS) Blue Book of Trucking Companies. Results from this analysis reveal that in most cases the firms remaining in the industry had higher efficiency measures than those entering or exiting the industry. The efficiency values imply that the remaining firms in the industry were much likely able to provide better service to their customers at reasonable rates than those firms entering or exiting the industry.

Results further show that in the years 1996/1997, 1997/1998, 1999/2000, and 2001/2002 remaining firms had efficiency values of 1.000, while in 1997 and 2000 entering and exiting firms had efficiency values of 1.000. These results imply that these firms were operating at maximum level of efficiency with the available resources at their disposal during these years.

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