The Impact of Entry and Exit on Industry Efficiency

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The contribution of individual firms to industry growth has 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 old firms to exit and for new firms to enter or old firms to re-enter the market given the decreasing entry rigidness in the industry. The dynamism of markets facilitates the entry and exit of the firms in an industry. The entry and exit of firms brings in and retires capital, and also accounts for the numerous mergers and acquisitions. The impact of a firm or farm's entry and exit has been examined in the economic and agriculture sector alike. However, there has been little research on the impact of a firm's entry and exit on the industry from the efficiency paradigm. This paper uses available panel information to examine the impact of entry and exit of firms on industry efficiency.

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, locate processing-food manufacturing facilities and distribution centers advantageous, and transact business (Stephenson 1987).

Lower transportation costs enable managers and owners of agribusiness firms to sell their products at reduced prices or expand marketing efforts to reach more-distant markets. The money saved by the managers due to the lower transportation rates charged by agribusiness trucking carriers can then be passed directly on to the customers of these agribusiness firms or spent on trucking carriers to haul the agribusiness agricultural and food products over greater distances (Stephenson 1987). Agribusiness trucking carriers play a vital role for agribusiness firms making wise decisions; they also play a vital role in consumers obtaining a wide variety of reasonably priced products and allow others to supply consumers with products that satisfy their wants and needs (Allen and Shaik 2005). Agribusiness-trucking companies also serve as competitors and cooperators with other modes of transportation such as rail, barge, and air.

This article develops an empirical application to U.S. agribusiness trucking data for the period 1994–2002 in an efficiency framework. The parametric efficiency method is used to examine the impact of entry and exit on industry efficiency. Efficiency measures are estimated using parametric stochastic frontier analysis due to its ability to differentiate the error into true random error and an efficiency component. The empirical application and results are presented in the next section, followed by the summary and conclusions.

Stochastic Frontier Analysis

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

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

where y denotes output produced from a vector of input, and x and β are the associated vectors of parameters. Equation (1) can be used to estimate the efficiency measures by non-parametric or parametric approach. We use the parametric stochastic frontier analysis approach.

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

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techniques in the parametric efficiency measures, (Allen and Shaik 2005).

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

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

where v represents firm- or time-specific random errors which are assumed to be identical and independently and normally distributed, with mean zero and variance σ^2_V; u represents the technical efficiency, which must be positive and hence absolutely normally distributed, with mean zero and variance σ^2_U; and y, x, and β are defined as in Equation (1).

From Jondrow et al. (1982), individual firm-specific efficiency measures (u) conditional on ε can be represented as

$$(3) \qquad E(u|\varepsilon) = \frac{\sqrt{(\sigma_v^2+\sigma_u^2)}\,(\sigma_v^2/\sigma_u^2)}{1+(\sigma_v^2/\sigma_u^2)^2}\left[\frac{\varphi(a_{it})}{1-\Phi\,(a_{it})} - a_{it}\right]$$

where $a = \varepsilon \dfrac{\sqrt{(\sigma_V^2+\sigma_U^2)}}{(\sigma_U^2/\sigma_V^2)}$, φ is the standard normal density function and Φ is the standard normal cumulative density function.

To examine the technical efficiency of the entry, exit, and remaining firms, Equation (1) can be re-written with current time t and the following year $t+1$ as

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

Data

The variables used to satisfy the objective of this paper are obtained from Transportation Technical Service (TTS) Blue Book of Trucking Companies for the period 1994 to 2002. The data for the input variables was divided into labor, capital, operating variable costs and operating fixed costs.

The labor variables include the number of drivers and helpers; the number of cargo handlers; the number of officers, supervisors, clerical and administrative staff; and the total number of other laborers. Capital variables include the number of tractors owned, the number of trucks owned, the number of tractors leased, the number of trucks leased, and other equipment.

Operating variable costs include fuel-gallons, oil, and lubricants; and total maintenance. The operating fixed-cost category is composed of total operating taxes and licenses, total insurance, and depreciation and amortization. The output variable consists of total ton-miles, which is the measurement most commonly used according to Caves, Christensen, and Swanson (1980), McGeehan (1993) and Cantos, Pastor, and Serrano (1999), given that this demand-related measure of output allows an assessment of the level of user consumption and the value they place on the service. The ton-mile output measurement assumes little or no government control on the provision of the service; otherwise, measures that isolate the government regulatory measures—such as 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, Pastor, and Serrano 2000) The agribusiness trucking firms analyzed in this study are firms that haul agricultural commodities for-hire.

Empirical Application and Results

Efficiency measures are estimated using yearly trucking companies data for the period 1994 to 2002. Equation (2) is used to estimate the efficiency measures for each trucking company. To make the discussions of the results of more manageable, we will compare the information on the exiting, remaining, and entering firms for 1994, 1994–1995, and 1995 with 2001, 2001–2002 and 2002.

Table 1 shows the number of firms entering, exiting, and remaining in the industry and the means of the output and input variables used in the efficiency analysis. Results from the study reveal that 297 firms exited the industry in 1994 while 520 firms exited the industry in 2001, a net increase of 223 firms. The results further indicate that output declined while labor, capital, operating variable costs, and operating fixed costs increased from 1994 to 2001. These results indicate that the output of exiting firms declined while costs increased, revealing that these firms were not able to stay in this market because of low output and increased cost.

The number of firms that remained increased from 643 in the 1994–1995 to 787 in 2001–2002, a net increase of 144 firms. Output increased from

Table 1. Summary Statistics of Yearly Output and Input Variables by Entering, Exiting, and Remaining Firms.

Year	Status of firm	Number of firms	Output	Labor	Capital	Operating variable cost	Operating fixed cost
1994	Exit	297	286,658	243	186	1,845	3,319
1994–1995	Remain	643	235,246	580	275	1,984	4,573
1995	Entry	198	279,429	354	227	2,092	4,161
1995	Exit	227	180,732	196	158	1,554	2,474
1995–1996	Remain	614	284,853	681	311	2,616	5,498
1996	Entry	358	184,388	160	132	1,613	2,185
1996	Exit	272	188,469	184	148	1,547	2,557
1996–1997	Remain	700	291,530	2,987	293	2,604	5,138
1997	Entry	247	303,536	190	180	2,095	3,567
1997	Exit	338	251,242	779	330	2,175	4,771
1997–1998	Remain	609	388,631	387	246	2,326	5,096
1998	Entry	316	349,865	284	227	2,231	3,447
1998	Exit	236	335,845	285	210	2,374	3,930
1998–1999	Remain	689	386,358	405	262	2,649	5,169
1999	Entry	265	252,122	1,007	350	2,297	5,566
1999	Exit	258	260,012	1,055	373	2,258	5,907
1999–2000	Remain	696	395,214	393	261	3,556	5,306
2000	Entry	689	196,305	165	111	1,885	2,214
2000	Exit	460	177,997	146	107	1,652	2,055
2000–2001	Remain	925	357,818	351	232	3,284	4,857
2001	Entry	382	176,877	912	310	2,267	4,422
2001	Exit	520	250,962	769	304	2,901	4,876
2001–2002	Remain	787	357,358	357	254	3,044	4,977
2002	Entry	228	201,201	180	153	1,635	2,452

235,246,000 ton-miles to 357,358,000 ton-miles, labor declined, and capital declined, while operating variable costs and operating fixed costs increased for these firms. These results imply that the firms that stayed in the industry from 1994–1995 to 2001–2002 increased output with less labor, but in order to do this with less capital usage, the firms had to increase the operating variable and fixed costs of their operations to stay in the market and serve their customers.

Entry of firms increased from 198 in 1995 to 228 in 2002; output, labor, capital, operating variable and operating fixed costs all declined from 1995 to 2002. These results indicate that firms entered the market from 1995 to 2002 experienced lower output and lower costs, possibly implying that firms that entered the trucking industry had to lower costs and output to compete with existing firms in the industry.

The means, standard deviations, and minimum and maximum values of efficiency measures by the number of firms exiting the industry, the number of the firms remaining in the industry, and number of the firms entering the industry are presented in Table 2. The results of this section of the analysis will be discussed in terms of the efficiency measures for those firms that remained, entered, or left the industry. Results from the analysis reveal that firms that stayed in the trucking industry in the periods analyzed for this study had higher mean efficiency ratios than did those firms that entered or exited the industry. The firms that entered the industry had the second highest mean efficiency values, while the firms that left the industry had the lowest mean efficiency values. These results show that firms that stayed in the industry were more efficient than firms that entered or exited the industry.

Summary and Conclusions

This analysis estimated the effects of exit and entry of firms on the efficiency of carriers in the U.S. trucking industry. Results reveal that the efficiency measures were relatively low for the firms analyzed. Thus firms serving this industry need to improve the efficiency of their operations in order to stay competitive and serve their customers with the transportation services they require.

Results further reveal that in most years, firms that stayed in the industry had the highest mean efficiency values, followed by firms that entered the trucking industry. These results may imply that firms that stayed in the industry are better able to meet the transportation service needs of their customers by operating with greater efficiency than do carriers that entered or exited the industry. The results should further indicate to managers of the firms that entered or exited that they need to improve the efficiency of their operations to be competitive in this industry.

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Table 2. Summary Statistics of the Yearly Technical Efficiency Measure by Entering, Exiting, and Remaining Firms.

Stats	Year	Number of firms	Technical efficiency	Year	Number of firms	Technical efficiency	Year	Number of firms	Technical efficiency	Year	Number of firms	Technical efficiency
N	94	297	297	95	227	227	96	272	272	97	338	338
Min	94	297	0.149	95	227	0.065	96	272	0.025	97	338	0.054
Max	94	297	0.993	95	227	0.985	96	272	0.985	97	338	1
Mean	94	297	0.548	95	227	0.417	96	272	0.473	97	338	0.669
STD	94	297	0.217	95	227	0.203	96	272	0.205	97	338	0.178
N	94–95	643	643	95–96	614	614	96–97	700	700	97–98	609	609
Min	94–95	643	0.065	95–96	614	0.039	96–97	700	0.054	97–98	609	0.072
Max	94–95	643	0.997	95–96	614	0.997	96–97	700	1	97–98	609	1
Mean	94–95	643	0.451	95–96	614	0.518	96–97	700	0.692	97–98	609	0.238
STD	94–95	643	0.205	95–96	614	0.205	96–97	700	0.175	97–98	609	0.159
N	95	198	198	96	358	358	97	247	247	98	316	316
Min	95	198	0.068	96	358	0.025	97	247	0.024	98	316	0.088
Max	95	198	0.996	96	358	0.99	97	247	1	98	316	0.992
Mean	95	198	0.432	96	358	0.465	97	247	0.678	98	316	0.239
STD	95	198	0.207	96	358	0.204	97	247	0.174	98	316	0.168
N	98	236	236	99	689	689	00	460	460	01	520	520
Min	98	236	0.072	99	689	0.067	00	460	0.063	01	520	0.099
Max	98	236	0.992	99	689	1	00	460	1	01	520	0.979
Mean	98	236	0.235	99	689	0.308	00	460	0.314	01	520	0.273
STD	98	236	0.16	99	689	0.179	00	460	0.186	01	520	0.174
N	98–99	689	689	99–00	258	258	00–01	925	925	01–02	787	787
Min	98–99	689	0.113	99–00	258	0.112	00–01	925	0.192	01–02	787	0.002
Max	98–99	689	1	99–00	258	0.966	00–01	925	1	01–02	787	1
Mean	98–99	689	0.361	99–00	258	0.331	00–01	925	0.323	01–02	787	0.416
STD	98–99	689	0.198	99–00	258	0.194	00–01	925	0.192	01–02	787	0.241
N	99	265	265	00	696	696	01	382	382	02	228	228
Min	99	265	0.112	00	696	0.051	01	382	0.099	02	228	0.004
Max	99	265	0.973	00	696	1	01	382	0.965	02	228	1
Mean	99	265	0.339	00	696	0.381	01	382	0.266	02	228	0.37
STD	99	265	0.183	00	696	0.208	01	382	0.155	02	228	0.229

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