An Empirical Investigation of the Ownership of Large Grain Hauling Vehicles by Farmers: A Case Study of Iowa

T. Edward Yu
Assistant Professor
Department of Agricultural & Resource Economics
University of Tennessee
Knoxville, TN 37996-4518
tyu1@utk.edu

Chad E. Hart
Associate Professor
Department of Economics
Iowa State University
Ames, IA 50011-1070
chart@iastate.edu

Xiaodong Du
Assistant Professor
Department of Agricultural & Applied Economics
University of Wisconsin
Madison, WI 53706-1503
xdu23@wisc.edu

Selected Paper prepared for presentation at the Southern Agricultural Economics Association (SAEA) Annual Meeting, Orlando, Florida, 3-5 February 2013

An Empirical Investigation of the Ownership of Large Grain Hauling Vehicles by Farmers: A Case Study of Iowa

Abstract This paper applied a negative Binomial model to investigate the factors influencing the number of semi trucks owned by grain producers in Iowa. Results suggest that crop sales, distance to market, utilized road types, ethanol plants, and farmers' perceptions on various marketing hindrances affected their ownership of semi trucks.

Keywords: semi truck, grain hauling, Iowa, negative Binomial

JEL code: Q12, R41

1. Introduction

The decision on vehicle ownership of farmers for hauling grain is an important investment decision for farm operations and reaching destination markets. For instance, the choice of larger vehicles, e.g. semi trucks, can provide more capacity to deliver grain at faster road speeds than tractor-wagons. Also, semi truck can provide producers the mobility and freedom to reach more distant markets with higher bid prices or specific markets for specialty products. Moreover, semi trucks have safety advantages such as brakes on all wheels, as opposed to tractor-wagon combinations with only brakes on the rear axle (Gervais and Baumel 1998).

From the economic standard point, the major advantage for grain producers to utilize semi trucks is the lower operating costs. The comparison of variable costs of different vehicles in earlier study demonstrated the advantage of using semi trucks for grain hauling (Hansen, et al., 1985; Gervais and Baumel, 1998). The variable costs per vehicle mile of farm tractor-wagons are more than double compared to that of other trucks. Among trucks, the variable costs per vehicle mile of semis are slightly higher

than for single and tandem-axle trucks. However, if the capacity of each vehicle is taken into account in the variable costs, semis has the least variable costs per bushel mile among tractor-wagons and trucks. In addition, the relative capital cost offers producers more incentive to own a semi truck as its price is as cheap as that of a tandem-axle truck.

There is a large body of literature examining vehicle ownership. However, nearly all of the studies focused on the ownership of passenger cars as they are more relevant to urban planning (Cullinane, 2002). Farm vehicle ownership has rarely been examined since the data on farm business vehicles is limited. The only two exceptions of studying the ownership of farm vehicles can be found in Kulshreshtha (1975) and Gervais and Baumel (1998). Kulshreshtha's study focused on the relationship between the size and age of the truck owned by farmers and the distance to an elevator. Applying a multivariate logit model to a survey data in Saskatchewan, they found that the distance to market has positive impact on the likelihood of maintaining a larger and a newer truck. Gervais and Baumel (1998) conducted a survey in the 1994/95 marketing year and analyzed the determinants of semi truck ownership based on farm characteristics in Iowa using a logit model. Their findings suggest that only the volume of grain sold off-farm and the average distance grain was hauled to country elevators were statistically significant factors contributing to the semi ownership decision in Iowa. They also expected that the trend of increasing semi ownership by farmers would continue.

A recent survey of Iowa grain and biofuels distribution in the 2006/07 marketing year confirms the projection (Yu and Hart, 2008). In 1994/95, only about 5 percent of Iowa grain producers owned semi trucks. The percentage has increased to more than one-third of Iowa farmers owning one or more semis in 2006/07. Also, about percent of grain

hauled to market by semi trucks increased from 38 percent to almost 70 percent during the same period. Figure 1 presents the percentage of Iowa grain producers owing semi as the largest grain hauling vehicles by the acreages of planted crops in 1994/95, 1999/2000 and 2006/07 marketing years. It is clear that the percent of owning semi truck as grain hauling vehicle by larger farms was considerably higher than that of smaller farms. Also the ownership of semi trucks in all categories of farm planted area increased between 1994/95 and 2006/07. Other Midwestern states, such as Nebraska, Indiana, Minnesota, etc., have also been experienced a similar transition in the vehicle utilization for grain hauling (Western, 2003).

The objective of this study is to extend our understanding in the factors influencing the ownership of semi trucks by Iowa farmers. In contrast to the two aforementioned studies, we used the number of semis owned by farmers, instead of a binary variable (yes or no) for ownership, to capture how evaluated factors affect farmer decisions on the number of semis owned. The The growth in the ownership of semi trucks implies an increasing demand on the road system. Thus, results from this study can potentially help the local and state transportation planners to make plans to accommodate the increasing semi truck traffic on the interstate highways and local roads.

2. Analytical Method

In this study, we first determined whether the overdispersion issue occurred in the dependent variable (number of semis owned by farmer) using the tests proposed by Cameron and Trivedi (1990) and Wooldridge (1997). If the null hypothesis is rejected, we employed negative binomial (NB) model, i.e., the number of semi truck owned by an

individual farm in Iowa follows the NB distribution, $Y \sim NB(r, p)$. The mean and variance of the distribution are $r(1-p)/p$ and $r(1-p)/p^2$, respectively. Given the fact that the Poisson model has one implicit restriction on the underlying distribution that the mean and variance are constrained to be equal, the NB model has more general specification and therefore is one of the most common alternative specifications for count data (Greene 2008).

In our setting, the NB model is re-parameterized by introducing latent heterogeneity in the conditional mean of the Poisson model, which is equivalent to the following Poisson-gamma mixture model.[1]

(1) $y_i \mid u_i \sim Poisson(u_i\lambda_i)$ and $u_i \sim gamma(\theta, 1/\theta)$

We have $E(y_i \mid X_i, \varepsilon_i) = u_i\lambda_i = \exp(X_i'\beta + \varepsilon_i)$ where X is a set of explanatory variables, which are assumed to determine the semi truck ownership, and $u_i = \exp(\varepsilon_i)$ is assumed to have a one parameter gamma distribution with mean 1 and variance $1/\theta$. After integrating out u_i, the resulting NB marginal distribution of Y is

(2) $$f(Y = y_i \mid X_i) = \int_0^\infty f(y_i \mid u_i) f(u_i) = \frac{\Gamma(\theta + y_i) r_i^\theta (1-r_i)^{y_i}}{y_i!\Gamma(\theta)},$$
$$y_i = 0,1,..., \theta > 0,\ r_i = \theta/(\theta + \lambda_i),\ \lambda_i = \exp(X_i'\beta).$$

With the parameterization in eqn. (1), By Bayes' theorem, the joint posterior distribution is proportional to the prior times the likelihood as

[1] In the following exposition, we follow closely with Greene (2008) and Ntzoufras (2009), Ch. 8.

$$
\begin{aligned}
p(\beta,\theta \mid y, X) &\propto p(y \mid u)p(u)p(\beta)p(\theta) \\
&= \prod_{i=1}^{n} \frac{\Gamma(\theta + y_i) r_i^{\theta} (1-r_i)^{y_i}}{y_i!\Gamma(\theta)} \times p(\beta)p(\theta)
\end{aligned} \tag{3}
$$

3. Variables and Data

Following Gervais and Baumel (1998), this study included crop planted acreage, crop used at farm, distance on alternative types of roads to the most commonly used market, and the share of crops entering alternative destination markets as the potential factors influencing the number of semi trucks owned by farmers. In addition, the impact of the perception of various issues that could be potential hindrances to efficient marketing on the ownership of semi truck by farmers was also evaluated in the analysis. Those potential issues to marketing hindrances include road weight restriction, bridge weight restriction, owned grain hauling equipment, access to rail service, and trucking cost.

Data used in this study were obtained from a survey on grain flows in Iowa during the 2006/2007 marketing (Yu and Hart 2008). The questionnaires were build on previous surveys that examined Iowa grain flows (Baumel et al., 1996, 2001) and extended to include grain producers' evaluations on the quality of state transportation system and their perceptions on some factors that potentially hinder the marketing of their commodities. Based on the responses of famers to those variables of our interest, total 639 farms from the 2006/07 survey were used to evaluate the relationship between the semi ownership decision and business operation. The definition of dependent and explanatory variables is presented in Table 1. The descriptive statistics of those variables is also summarized in the Table.

4. Preliminary Results

Both overdispersion tests rejected the null hypothesis at the 1% significance level. The preliminary estimate of the NB model is summarized in Table 2. As expected, the crop planted acreages had positive impact on the number of semi trucks owned by farmers at the 1% significance level. Similarly, the distance on the paved and state highway roads to the mostly common used markets was also influential to farmer's ownership of semis. Interestingly, the share of corn shipped to ethanol plants also positively affected the number of semis maintained by farmers at the 5% significance level, which suggests the emergence of ethanol market does affect the flows of corn and resulting the increase of having the larger grain hauling vehicles.

The perception of road weight restriction to efficiently marketing grain is positively related to grain producers' decision on holding a semi truck, suggesting the farmers usually have more semis when they consider road weight restrictions imposed on the routes to their markets. The size of the grain hauling equipment is also found to be significantly related to the ownership of semis. The farmers concerned less about the size of their hauling equipment when they maintain more semis in farm.

5. Summary

This study evaluated the relationship of semi ownership by farmers in Iowa and some factors. We found that the size of farm, the distance on different types of roads to the market, and share of produced corn delivered to ethanol plants all positively affect the number of semis maintained by farmers. In addition, farmers' evaluation on road weight restriction and the grain hauling equipment are also related to the ownership of semis.

References

Cameron, A.C. and P.K. Trivedi, 1990. "Regression-based Tests for Overdispersion in the Poission Model," *Journal of Econometrics,* 46:347-64.

Gervais, J-P. and C.P. Baumel, 1998. "The Iowa Grain Flow Survey: Where and How Grain Producers Ship Corn and Soybeans*," Journal of the Transportation Research Forum*, 37:15-28.

Greene, W. 2008. Functional Forms for the Negative Binomial Model for Count Data. *Economic Letters* 99:585-590.

Kulshreshtha, S.N. 1975. "Ownership of Farm Trucks for Hauling Grain: An Application of Multivariate Logit Analysis," American Journal of Agricultural Economics, 57:302-08.

Ntzoufras, I. 2009. *Bayesian Modeling Usign WinBUGS*. Hoboken, NJ: Wiley & Sons.

Wooldridge, J.M. 1997. "Quasi-Likelihood Methods for Count Data," Chapter 8 in M.H. Pesaran and P. Schmidt (eds.) *Handbook of Applied Econometrics, Vol. 2,* Malden, MA: Blackweall, 352-406.

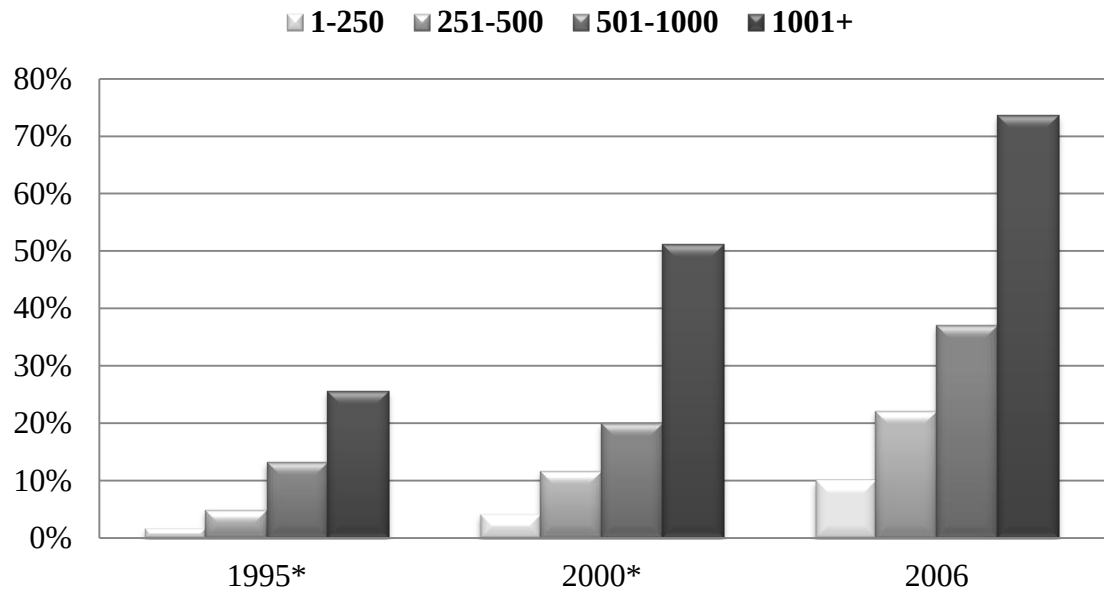
Yu, T. and C. Hart. 2008. *The 2006/07 Iowa Grain and Biofuel Flow Study: A Survey Report*. 08-SR 102. Iowa State University, Ames, IA

Table 1 Statistical Summary of Variables

Variable	Definition	Mean	Std dev.	CV
SEMIS	Number of semi truck owned by grain producer	0.70	1.11	1.58
CROPAREA	Number of acres planted for corn & soybeans	982.31	992.88	1.01
FARMUSE	Bushels of corn and soybeans used on farm	8.76	31.80	3.63
GRAVEL	Miles on gravel road to reach the mostly used market	3.08	2.99	0.97
PAVED	Miles on paved county road to reach the mostly used market	5.95	9.17	1.54
STATEHW	Miles on state highway to reach the mostly used market	11.93	20.46	1.71
SCE	Percent of corn and soybeans hauled to country elevators	0.15	0.30	2.04
SRT	Percent of corn and soybeans hauled to river terminals	0.08	0.25	2.98
SET	Percent of corn hauled to dedicated ethanol plants	0.06	0.20	3.32
SCP	Percent of corn hauled to processors	0.65	0.40	0.61
SSP	Percent of soybeans hauled to processors	0.17	0.34	1.99
ROADWT	Rating road weight restriction en routes to market as hindrances to efficient marketing, scale of 1-5 (1: not at all, 5:definitely)	2.52	1.38	0.55
BRIDGEWT	Rating bridge weight restriction en routes to market as hindrances to efficient marketing, scale of 1-5 (1: not at all, 5:definitely)	2.69	1.45	0.54
HAULSIZE	Rating size of owned grain hauling equipment as hindrances to efficient marketing, scale of 1-5 (1: not at all, 5:definitely)	2.17	1.26	0.58
RAILACCESS	Rating access to rail service as hindrances to efficient marketing, scale of 1-5 (1: not at all, 5:definitely)	2.56	1.38	0.54
TRUCKCOST	Rating trucking cost as hindrances to efficient marketing, scale of 1-5 (1: not at all, 5:definitely)	3.16	1.32	0.42

Table 2 Estimated Negative Binomial Model of Semi Trucks Owned by Iowa Farmers

Variable	Coefficient	Std. Error	P-value
CROPAREA	0.437	0.039	0.000
FARMUSE	0.002	0.001	0.134
GRAVEL	0.012	0.016	0.444
PAVED	0.021	0.004	0.000
STATEHW	0.009	0.002	0.000
SCE	0.245	0.309	0.428
SRT	0.438	0.358	0.221
SET	0.636	0.273	0.020
SCP	0.406	0.299	0.174
SSP	-0.009	0.157	0.953
ROADWT	0.211	0.049	0.000
BRIDGEWT	0.057	0.046	0.212
HAULSIZE	-0.280	0.045	0.000
RAILACCESS	-0.075	0.040	0.062
TRUCKCOST	0.081	0.046	0.076
C	-1.915	0.338	0.000



*source: Baumel et al. (1996, 2001)

Figure 1. Percentage of Iowa grain producers owing semi as the largest grain hauling vehicle by total planted acreages of corn and soybeans in 1994/5, 1999/2000, and 2006/2007