TRANSPORTATION INVESTMENT DECISIONS FOR COUNTRY ELEVATORS

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UGPTI Staff Paper No. 95

June 1989

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JUNE 1989

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EXECUTIVE SUMMARY

Trainload shipments of grain by elevators substantially reduce their transportation costs. However, many elevators must make investments upgrading their plant before they can ship in trainload movements. In this report, a logit model is developed which considers the investment decision for particular elevators in terms of the physical characteristics of the facility and firm attributes. The results suggest there are considerable differences across elevators in the likelihood of being targeted for investment and shipping grain in trainload movements.

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I. INTRODUCTION

A major restructuring of the country grain elevator industry has occurred over the past 20 years, in large part as a result of the increased usage of multiple-car rail rates. However, the pace of this restructuring has not been consistent across all regions of the country. As a result, problems or opportunities associated with the upgrading of country elevators to trainloading elevators vary by region.

Multiple-car rail rates were first introduced in Illinois in 1967 and were widely available in the Midwestern states by the mid-1970s (Cobia et al.). For example, the first trainloading elevators in Iowa were built in 1973. Over the next decade, the number of trainloading elevators in Iowa grew steadily to 137 by 1979 and 192 by 1984 (Table 1). Since 1984, the number of trainloading elevators in Iowa has fallen to 166 because of a redefinition of terms, as well as affiliations, mergers, and failures.[1]

In other regions, such as the Pacific Northwest and the Northern Plains, multiple-car rail rates were not introduced until after passage of the Stagger's Rail Act of 1980. The number of trainloading elevators grew from none in 1979 to 34 and 93 in 1984 in Washington and North Dakota, respectively (Table 1). Elevators are still being upgraded in North Dakota, with the total number of trainloading elevators rising to 117 in 1988.

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[1] According to Wendell Maysett, Iowa DOT rail planner, previous data may have overstated the number of trainloading elevators in Iowa because any elevator loading more than single car shipments was defined to be a trainloading shipper. The 1988 data only includes shippers capable of loading in consignments of 25 or more cars.

TABLE 1. Number of Trainloading Elevators for Selected States and Years

State	Year		
	1979	1984	1988
Iowa[a]	137	192	166
North Dakota[b]	0	93	117
Washington[c]	0	34	34

[a] 1979 and 1984 data - Cobia et al. *Pricing Systems of Trainloading Country Elevator Cooperatives*. Agr. Econ. Report No. 214. Dept. of Agr. Econ., North Dakota State Univ., Fargo, 1986. 1988 data - Wendell Maysett, Iowa Department of Transportation.
[b] 1979 and 1984 data - Cobia et al. 1988 data - Upper Great Plains Transportation Institute, North Dakota State Univ., Fargo.
[c] 1979 and 1984 data - Dooley, F.J. "The Theory and Economics of Multiplant Firms Applied to Washington Grain Elevators." Ph.D. dissertation, Dept. of Agr. Econ., Washington State Univ., Pullman, 1986. 1988 data - Robert Sargent, Washington State Univ.

The growth in the number of trainloading elevators has led to a concern there is excess capacity in Iowa and other Midwestern states. According to Cobia et al., Iowa has 5.83 bushels of storage capacity at elevators with unit-train loading capability for every bushel of major grain shipped out of the state annually by rail or truck. There is a concern that many of the trainloading elevators will likely fail when the grain industry returns to an environment which focuses upon a merchandising rather than a storage function. Unlike Iowa and other Midwestern states, excess capacity is not yet a widespread problem in the Northern Plains or the Pacific Northwest. Thus, the issue in these regions is one of determining whether opportunities exist to upgrade additional country elevators to trainloading elevators.

Numerous studies have been conducted as researchers attempt to determine the effects multiple-car rates have upon the cost and structure of firms assembling and shipping grain. A common research design has addressed this problem from an area efficiency perspective, obtaining minimum cost solutions for assembling, handling, and shipping grain to terminal markets.[2] A general weakness with area efficiency studies noted by French is that the results are those from a social planner's perspective. "Although such information may be of general value in formulating both public and private goals, the results are apt to be rather sterile in the absence of some central planning authority" (French). Thus, the area efficiency studies have limited ability to address firm level decision-making.

One study which did consider firm level decision-making has been provided by Fuller et al. (1986). Using a simulation framework, a two-phase model was developed which analyzed the elevator's investment decision to upgrade specific facilities to access multiple-car rail rates. In the first phase, ten of the newer and higher capacity elevators in the Texas panhandle were assumed to have upgraded their facilities. A spatial network model was then used to calculate the increased grain flows at the specified elevators resulting from the introduction of multiple-car rates. In the second phase, a computerized budgeting program was used to evaluate the investment decision by calculating the return on investment. The authors concluded that the feasibility of the investment depends upon the level of the rate reduction, the level of the investment, and the elevator's ability to increase its volume of grain handled.

The objective of this analysis is to complement Fuller's work by using an econometric procedure which examines the elevator's investment decision of upgrading its plant to become a trainloading elevator. The approach used in this paper differs substantially from that of Fuller et al. (1986) in that it is an econometric model as opposed to a network flow/budgeting program. In a network flow/ budgeting research design, the location of trainloading facilities is pre-specified. In the econometric approach, various characteristics of elevators are observed which represent the outcome of an investment decision to upgrade an elevator. While the results and/or implications

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[2] For example, see Ladd and Lifferth; Hilger, McCarl, and Uhrig; Martin, Devine, and Kulshreshta; Harris; Fuller et al. (1981); and Dooley.

emanating from the models are quite distinct, they are complementary. The network flow/budgeting program is useful in identifying profitability requirements for an elevator to make an investment decision. The econometric approach is useful in identifying the determinants of the investment decision and empirically examining the magnitude and significance of those determinants.

The results of the econometric procedure can be used to evaluate the critical determinants of the investment decision and to provide a tool for predicting locations of trainloading elevators. Since an econometric approach is used, the model cannot predict with certainty which specific elevators will expand. However, transportation planners, policy makers, and firms can use this model to forecast which elevators are likely candidates for either investment or disinvestment in trainloading facilities. Based on this information, more sophisticated investment analyses may be performed for those elevators most likely to invest.

The remainder of this analysis is organized as follows. In section II, the conceptual aspects of the investment decision are addressed. The data used in the analysis are described and the empirical model is developed in the context of the available data in section III. In section IV, the results and usages of the model are provided. A summary of the analysis and conclusions are provided in section V.

II. CONCEPTUAL FRAMEWORK

Multiple-car rail shipments offer benefits to railroads, grain elevators, and farmers. Railroad productivity is enhanced with trainload shipments because of better car utilization and switching economies. Grain elevators benefit as a result of substantial reductions in outbound transportation shipping costs. Lower transportation rates could also allow trainloading elevators to pass on part of the cost savings to farmers in the form of higher bid prices. A higher bid price will most likely attract grain from a wider market area, thereby increasing the elevator's throughput and allowing the elevator to also achieve economies of utilization.[3]

To operate as a trainloading elevator, the elevator must be designed for the rapid handling of a large volume of grain in a limited period. Tariff restrictions and contracts generally require that the shipment be loaded within 24 hours. Schnake and Stevens suggest that trainloading elevators be designed "such that a 12-hour loading time restraint can be met under normal operating conditions."

The ability of an elevator to meet a loading time constraint depends in part upon its plant configuration. Three plant characteristics are critical in meeting loading time constraints. First, elevators having sufficient storage capacity to load trainload shipments out of existing inventory have an obvious advantage over elevators that must attract additional grain from farmers during the loading period. Second, high speed rail loadout equipment is perhaps the most critical plant characteristic in meeting loading time constraints. Technically, it is possible to load 26 cars in 24 hours with a loadout capacity of 3500 bushels per hour. However, most trainloading elevators have larger loadout capacities to reduce operating time and costs. Finally, trainloading elevators also must have adequate rail car siding capacity (the number of rail cars that an elevator's siding can hold without switching). Elevators which must switch rail cars while loading have longer loading times and incur additional switching costs.

A trainloading elevator designed to load a 25 car shipment of wheat or barley in 12 hours requires 350,000 bushels of storage capacity, 10,000 bushels per hour rail loadout capacity, and rail car siding capacity for 25 cars (Schnake and Stevens). "However, many country elevator facilities are not currently capable of making multiple carload shipments for which significant rate reductions may be offered" (Fuller et al. (1986)). Thus, the introduction of multiple-car rates has caused many firms to reconsider the plant configuration of their elevators. If an elevator cannot meet the

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[3] See Dooley and Wilson for a discussion of the use of pricing as a mechanism to attract greater throughput.

loading time constraint, the firm is faced with the discrete decision of whether or not to upgrade its facility to become a trainloading elevator and the continuous decisions of how to change its plant configuration.

When making an investment decision to upgrade an elevator, a firm observes the present configuration of its elevator in terms of storage, loadout, and rail car siding capacities and determines what is required to make it technically possible to load a trainload shipment. An investment in a particular elevator may require additional storage, loadout, rail car siding capacity, or some combination of the three, or

$$(1) \qquad C = f(S,L,R)$$

$$= s(S_t - S_g) + l(L_t - L_g) + r(R_t - R_g)$$

where: C is the minimum investment cost required to become a trainloading elevator;

S is the level the storage capacity;

L is the level of rail loadout capacity;

R is the level of rail car siding capacity;

s, l, and r are factor prices for the respective variables;

t denotes minimum capacity requirements to become a trainloading elevator; and

g denotes initial capacities of a country grain elevator.

The value of C represents the minimum investment cost required to upgrade an elevator to become a trainloading elevator. Although equation (1) includes the relevant variables required to technically upgrade an elevator, other important aspects of the investment decision are excluded. The investment decision at a particular elevator cannot be made by simply observing storage, loadout, and rail car siding capacities. Specifically, the investment decision is complicated as a result of the possible interactions between storage, loadout, and rail car siding capacities. In addition, certain firm characteristics, including the type of firm organization, the location of elevators within a firm, and the change in throughput, have a bearing on the decision to upgrade an elevator. Including these variables, an elevator's investment decision is taken to be a function of its plant configuration (before investment) and firm characteristics, or

$$(2) \quad Z = f(S,L,R,ORG,LOC,CHQ)$$
$$= \alpha_0 + \alpha_S S + \alpha_L L + \alpha_R R + \alpha_{SL} SL + \alpha_{SR} SR + \alpha_{LR} LR$$
$$+ \beta_{CHQ} CHQ + \beta_{ORG} ORG + \beta_{LOC} LOC$$

where: Z is an investment cost index;

S, L, R are as previously defined;

CHQ is the change in throughput associated with making the investment decision;

ORG is a dummy variable denoting the type of firm organization (multiplant or single plant firms);

LOC is a dummy variable denoting the location of elevators within a firm (central or non-central);

α are parameters to be estimated for individual plant characteristics; and

β are parameters to be estimated for firm attributes.

Unlike C in equation (1), the dependent variable Z in equation (2) does not have the simple interpretation of minimum investment costs. Rather, the predicted value of Z may be interpreted to be an index for minimal investment costs. In general, as Z becomes larger, a country grain elevator can become a trainloading elevator with lower investment costs. As a result, it is more probable that an elevator with a large Z will make an investment upgrading its plant configuration than one with a small Z, given all else is the same.

In equation (2), the marginal impact of investing in additional storage, loadout, and rail car siding capacity can be analyzed for three types of variables. First, the marginal impact of investing for each plant attribute is expected to be positive ($\alpha_S > 0$,

$\alpha_L > 0$, and $\alpha_R > 0$). Second, the interaction terms (SL, SR, and LR) allow the impact of each plant attribute to depend on the other plant attributes. Finally, the remaining variables (CHQ, ORG, and LOC) pertain to firm characteristics rather than plant specific items.

The expected signs for the interaction terms vary. The marginal impact of both additional loadout and rail car siding capacity is expected to be negatively related to the level of storage capacity ($\alpha_{SL} < 0$ and $\alpha_{SR} < 0$). Storage capacity alone has little bearing on an elevator's ability to load trainload shipments. Virtually every country grain elevator has the storage capacity required to load the 83,000 bushels for a 25-car shipment of wheat. However, elevators with lower storage capacity require more time to load trainload shipments because of the time lost while attracting additional grain from farmers and/or shifting among bins. Thus, elevators with low storage capacity value the time savings offered by high speed loadout equipment or from the reduction in switching with additional rail car siding capacity more than elevators with large storage capacity. By adding loadout and/or rail car siding capacity, elevators with limited storage capacity can attain the capability to load trainload shipments. In contrast, the marginal effect of rail car siding capacity on the decision to invest in loadout capacity, and vice versa, is expected to be positive ($\alpha_{LR} > 0$). In other words, if the loadout (rail car siding) capacity is adequate for trainload movements, the marginal impact of investing in the other is higher because there are complementarities between loadout and rail car siding capacities.

In addition to plant specific characteristics, throughput levels will also affect investment decisions. The impact of greater throughput on the investment decision rests with the elevator's ability and/or need to attract greater volumes of grain. This is largely a reflection not only of the type of firm organizational structure (see below), but also the competitive environment within which a firm operates. As Fuller et al. (1986) suggest, an investment upgrading an elevator to a trainloading elevator is more likely to be successful if it can attract a larger volume of grain. Thus, the change in throughput proxy (CHQ) is expected to have a positive effect on the probability of investing ($\beta_{CHQ} > 0$).

Until this point, the discrete decision to invest has focused on the specific plant characteristics and throughput of an elevator. The results allow the determinants of the decision to be identified and empirically evaluated at the elevator level. However, the type of firm organizational structure (ORG) and the location of plants within a firm (LOC) also affect the investment decision to upgrade an elevator to a trainloading elevator. Two types of firm organizational structures are represented in the industry, multiplant and single plant firms. Elevators within a multiplant firm can be either centrally or non-centrally located.

Lower costs and minimum investment economies are associated with multiplant organization. By operating several elevators as an integrated system rather than as individual elevators, a multiplant firm may be able to reduce total operating and shipping costs. The multiplant firm can lower costs through better utilization of plants and multiple-car rates. To achieve these cost savings, a multiplant firm would ideally consist of two types of elevators, a centrally located trainloading elevator with several station or branch elevators located around it. The trainloading elevator receives grain from the station elevators, thereby expanding the market area of the trainloading elevator and increasing plant utilization. Even with the transshipment cost from the station elevators to the trainloading elevator, the firm's total cost declines because of the favorable rate structure at the trainloading elevator (Dooley). In addition, some multiplant firms are able to reduce their investment costs by practicing "investment staging," an investment strategy which coordinates investment among all of a firm's plants.[4] Therefore, by integrating the operation of trainloading and station elevators, multiplant firms have larger market areas, more intensive plant utilization, and lower investment costs than single plant firms.

In multiplant firms, the location of the elevators within the firm is an additional consideration in making the investment decision. Multiplant firms will obviously first consider investing in firm elevators which are centrally located within the system because of transshipment considerations. However, multiplant firms may invest in a non-centrally located firm elevator if the plant attributes (storage, loadout, and rail car siding capacities) of that elevator dominate, by some critical margin, the plant attributes of centrally located firm elevators.

An elevator is assumed to be part of a multiplant firm if ORG is equal to 1, otherwise the elevator is assumed to be a single plant firm. If LOC is equal to 1, an elevator from a multiplant firm is assumed to be centrally located within the firm. The dummy variables, ORG and LOC, reflect the aggressiveness of the firm's management in a relative manner. With single plant firms as the base, the signs of ORG and LOC depend upon whether or not multiplant firms are more aggressive in their management practices with respect to elevator investment decisions. The only clear empirical implication rests upon comparisons between ORG and LOC. A priori, it is expected that a centrally located elevator in a multiplant firm will more likely be upgraded to a trainloading facility than a non-centrally located elevator in a multiplant firm.

III. DATA AND EMPIRICAL MODEL

Grain elevator firms in Washington state were surveyed to gather information about the operating practices of the firm as well as information about each specific elevator within the firm. The questionnaire was pretested with two elevator managers

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[4] A discussion of multiplant investment theory is beyond the scope of this article. More information is found in F.M. Scherer et. al., *The Economics of Multi-plant Operation,* Harvard U. Press, Cambridge, MA, 1975.

to determine any difficulties in responding to and improve the clarity of questions. Firms operating more than 15 elevators were personally interviewed to minimize data collection problems while the other firms received a mail questionnaire. A follow-up mailing and telephone contact were made in an attempt to increase the response rate.

The population of 61 firms operating 233 licensed country grain elevators was obtained from the Washington State Department of Agriculture. The final response rates of the survey were: 67.2 percent (41) of the firms which operate 73.4 percent (171) of the elevators. Of the 171 elevators, 29 were trainloading shippers and 142 were single car rail or truck shippers. Elevators with incomplete data and truck only elevators were eliminated from the analysis. Thus, responses for 23 of the 29 trainloading elevators and 86 of the 142 other shippers operating in Washington were used in this analysis.

The data set consists of two sets of observations of plant and firm characteristics for each elevator. The first set of observations is the observed physical characteristics for each elevator (storage, loadout, and rail car siding) and firm characteristics, including throughput, firm organizational structure, and location within the firm. In the second set of observations, it is assumed that each elevator added the storage, loadout, and/or rail car siding capacity necessary to reach the minimum level required to be a trainloading elevator capable of shipping 25 car consignments of wheat or barley.

Let $Z_i = 1$ if the ith elevator chooses to ship in trainload shipments and zero otherwise. Let X_i denote a vector of explanatory variables underlying the investment decision. Given Z_i and X_i, a logit specification is chosen to estimate the parameters of the decision.

$$(3) \quad P(Z | X_i, \Theta) = 1/(1 + e^{-xi\Theta})$$

where: X_i is the vector of previously defined variables, [1, S, L, R, SL, SR, LR, CHQ, ORG, LOC]; and Θ is a vector of coefficients to be estimated.

The mean values for the observed plant capacity variables are 675,000 bushels of storage, 6,045 bushels per hour of rail loadout, and rail car siding for 13.6 cars. Any elevator which does not initially meet the minimum trainloading elevator plant capacity requirements (S = 350,000 bushels, L = 10,000 bushels per hour, and R = 25 cars) is assumed to add the capacity needed to become a trainloading elevator. For example, if an elevator had 300,000 bushels of storage capacity, 8,000 bushels per hour rail loadout, and rail car siding for 25 cars, it would be assumed to add 50,000 bushels of storage capacity and 2,000 bushels of loadout capacity, but no rail car siding capacity.

Pre-investment decision throughput ratios were calculated for all elevators in the sample. Since similar data are not available for the post-investment decision, a proxy throughput variable was defined as follows. The expected throughput ratios for the upgraded single car elevators were assumed to equal that for a similar trainloading elevator. Throughput ratios were calculated for the 23 trainloading elevators in the sample and were stratified by firm organization (multiplant versus single-plant) and elevator storage size. The constructed throughput ratios for the upgraded single car elevators were then set equal to the mean throughput for similar trainloading elevators.

Multiplant firm elevators were subjectively classified as centrally or non-centrally located on the basis of various locational attributes, including proximity to the other elevators within the firm, type of rail line (mainline versus branch line), and type of highway (primary versus secondary). Proximity to other firm elevators was the dominant attribute in determining whether an elevator was centrally located. In general, elevators found on main lines, near primary highways, and with several other firm elevators within twenty miles were classified as centrally located. Alternatively, elevators located on secondary highways, branchlines, and at the fringe of the firm were classified as non-centrally located.

For estimation purposes, a logit specification was used. However, since the proportion of trainloading elevators sampled was greater than the proportion of single car elevators, it was necessary to deal with a choice-based sampling problem.[5] The presence of choice-based sampling problems makes the usual estimators inconsistent. There are a variety of estimators available depending upon the availability of additional information with respect to the distribution of the X_i's and/or the sample and population proportions of observations making the choice, H_i and Q_i, respectively. Here the proportion of elevators both making and not making the investment in the population is known while the distribution (the X_i's) is unknown.

When, as in this case, aggregate shares (H_i, Q_i) are known the binary logit estimator with intercept (dummy terms for the choice) is consistent apart from a correction term subtracted from the intercept ($\ln H_i/Q_i$) (Coslett). While the corrected logit specification is consistent, to obtain asymptotic efficiency, the covariance structure was calculated using Coslett's modification of the estimator as introduced by Manski and McFadden.

IV. RESULTS AND USAGES OF THE MODEL

This section begins with a brief review of the overall performance of the model. The effects of a change in plant characteristics (S, L, and R) and throughput upon the probability of investing are then examined. Next, the overall average probability of investing for different types of elevators is reported. Finally, three usages of the model are presented.

A. Overall Model Performance

In general, the model performed extremely well in terms of correctly classifying elevators as trainloading or single car elevators. Ninety-six percent of all observations are correctly classified (Table 2). The model is more accurate in correctly classifying

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[5] See Manski and Lerman, Manski and McFadden, Coslett, and Amemiya for a discussion of the problems introduced by choice-based sampling and several consistent estimators under a variety of assumptions and/or available information.

TABLE 2. Parameter Estimates and Classification Percentages for Elevator Investment Decision Function[1]

Variable	Coefficient Estimates	Asymptotic Standard Error
Intercept	-10.915396**	5.987973
S	1.968114*	0.888103
L	0.050539	0.781624
R	-0.601406	0.529024
SL	-0.201720**	0.113318
SR	-0.030141**	0.017988
LR	0.209140**	0.113197
LOC	-4.402391**	2.374292
ORG	-2.067680	1.588759
CHQ	0.989474**	0.557914
Percent All Elevators Correctly Classified		96.3 %
Percent Trainloading Elevators Correct		87.0 %
Percent Single-Car Rail Elevators Correct		98.8 %

[1] A * indicates significance at the 5 percent level, while a ** indicates significance at the 10 percent level.

those elevators that did not invest (99 percent) than those that did invest (87 percent). Thus, the model is extremely accurate in predicting which elevators will remain single car elevators, but somewhat less accurate in predicting which elevators will upgrade to become trainloading elevators.

All the variables except loadout (L), rail car siding (R), and type of firm organizational structure (ORG) were significant at least at the 10 percent level (Table 2). All significant variables were consistent with a priori sign expectations for coefficient estimates.

B. Change In Plant Characteristics or Throughput

The effects of changing the three elevator plant characteristics (S, L, and R) and throughput (CHQ) are considered for three types of elevators, single plant firm elevators (SP), multiplant firm, centrally located elevators (MPC), and multiplant firm, noncentrally located elevators (MPN). Empirical results for the three types of elevators reflect the difference in the type of firm organizational structure (ORG) and the location of plants within a firm (LOC). The effect of changing loadout or rail car siding capacity will likely differ from changing storage capacity or throughput as the former two variables directly affect the speed of loading while the latter two variables are indirectly related to actual loading speed. The results for the four variables are presented both graphically (Figures 1-4) and numerically (Table 3). The average change in probability refers to the effect of a change in one of the plant characteristics or throughput upon the investment decision.

First, the change in throughput variable, CHQ, has a positive and significant influence on the investment decision (Table 2). However, this effect varies among the different types of elevators, being greatest for single plant elevators. The average change in the probability of investing caused by a change in throughput is 2.6 percent for MPN elevators, 7.4 percent for MPC elevators, and 9.0 percent for SP elevators (Table 3).

In Figure 1, the probability of investing for the three types of elevators is plotted against change in throughput. The probability estimate of investing for SP elevators rises from less than 5 percent for a SP elevator which has a throughput less than 100,000 bushels to about 30 percent for a SP elevator with a throughput of 2.5 million bushels. In contrast, MPC elevators begin with a high probability of investing (67 percent) which rapidly increases to a value of one as throughput increases. Finally, the probability plot for MPN elevators suggests that changes in throughput have little effect upon the investment decision for these types of elevators.

TABLE 3. Overall Average Probability of Investing by Type of Elevator and Average Change in Probability of Investing by a Change in Loadout Capacity (L), Rail Car Siding Capacity (R), Storage Capacity (S), and in Added Throughput (CHQ)

Type of Elevator	Overall Average Probability of Investing by Type of Elevator	Impacting Variable	Average Change in Probability by Variable
	--Percent--		--Percent--
SP	22.2	L	13.6
		R	1.3
		S	7.0
		CHQ	9.0
MPN	11.8	L	7.2
		R	1.3
		S	0.4
		CHQ	2.6
MPC	44.5	L	14.4
		R	2.6
		S	3.4
		CHQ	7.4
ALL	20.1	L	9.3
		R	1.6
		S	1.7
		CHQ	4.2

The results are consistent with a priori considerations. Comparing the average change in probability arising from a change in throughput for MPC and MPN elevators reaffirms the importance of location within a multiplant firm. Multiplant firms have a ready volume of grain for the firm's trainloading elevator because they can funnel grain from station elevators through a centrally located trainloading elevator. Lacking this ready supply of grain, the ability to increase throughput is much more important for SP elevators.

Second, storage capacity has a positive and significant impact on the probability of investing which is similar to CHQ (Table 2). The average change in probability of investing caused by a change in storage capacity is 0.4, 3.4, and 7.0 percent for MPN,

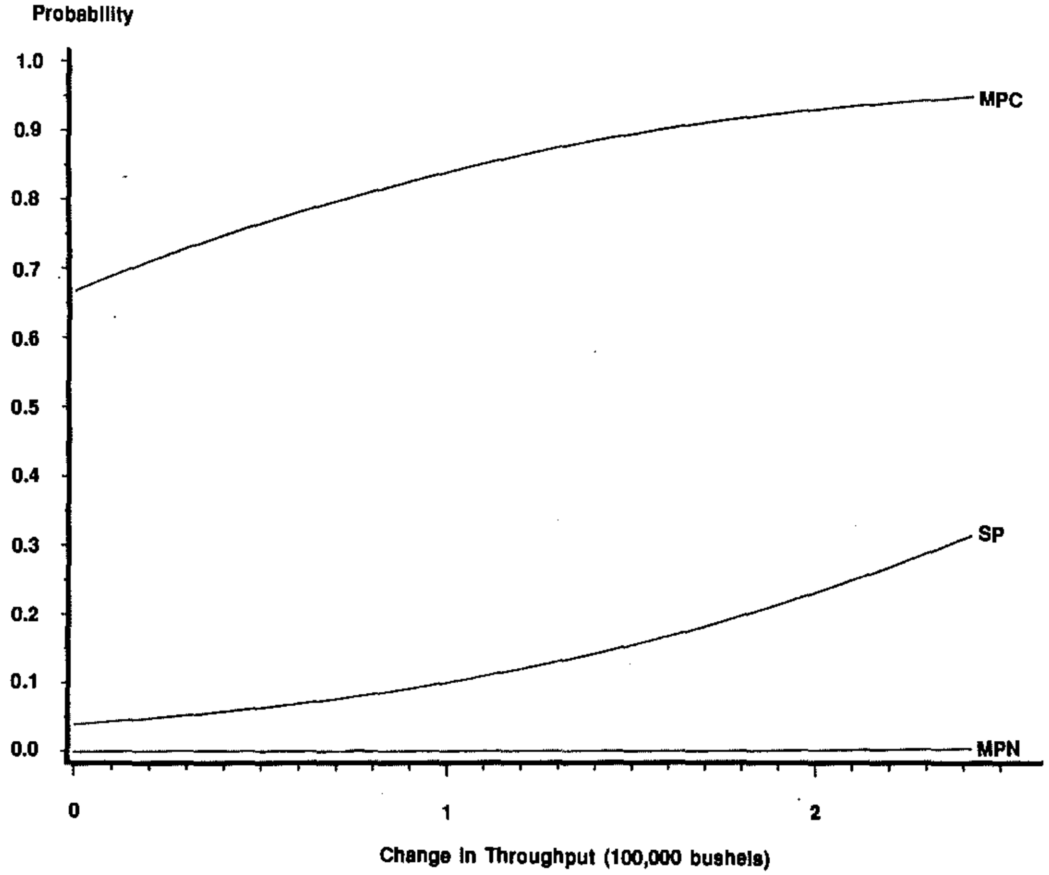

Figure 1. Probability of Investing as Throughput Changes.

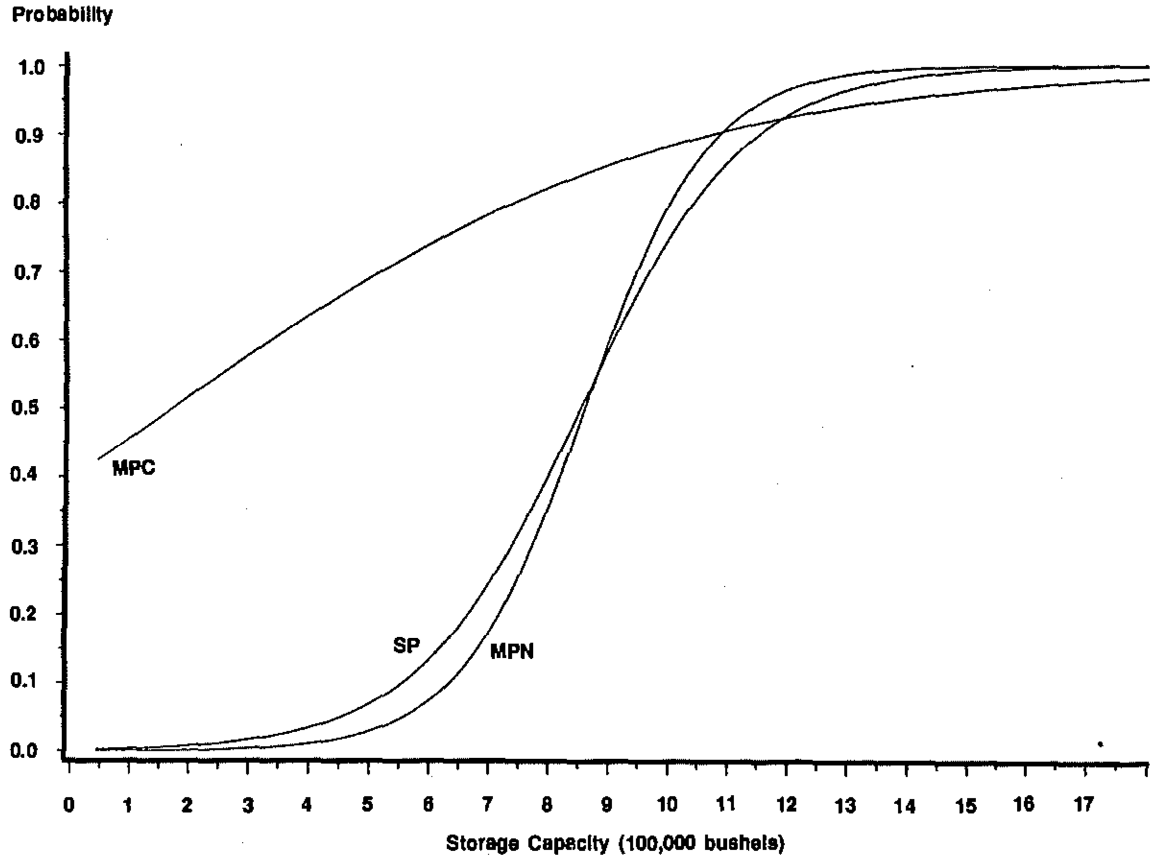

Figure 2. Probability of Investing as Storage Capacity Changes.

MPC, and SP elevators, respectively (Table 3). MPC elevators again begin more likely to invest than SP or MPN elevators, with the probability of investing rising to a value of one as storage capacity increases to 1 million bushels (Figure 2). The level of storage for MPN and SP elevators impacts the likelihood of investing more dramatically over the range of values observed. The probability estimate for SP and MPN elevators rises from near zero to near one for elevators with storage volumes of 1.2 million bushels (Figure 2). As with the change in throughput, storage is less important for MPC elevators at the margin than for SP elevators since the storage function is typically undertaken by the station elevators in a multiplant firm.

Finally, the probability of investing in loadout and rail car siding varies among the types of elevator. The average change in the probability of investing caused by a change in loadout and rail car siding capacity is 7.2 and 1.3 percent for MPN elevators, 13.6 and 1.3 percent for SP elevators, and 14.4 and 2.6 percent for MPC elevators (Table 3).

At low capacity levels, the probability estimates for investing in loadout and rail car siding are low for all types of elevators (Figures 3 and 4). Recall that loadout and rail car siding directly affect the ability of the elevator to load a train rather than indirectly as was the case with storage capacity. Consequently, elevators with low values for loadout and rail car siding capacities require substantial investments. The impact of increasing either loadout or rail car siding is much larger for MPC elevators than either SP or MPN elevators (Figures 3 and 4). Thus, MPC elevators with larger capacity levels for loadout and rail car siding are the most likely candidates to make investments upgrading a country elevator to become a trainloading elevator.

In conclusion, as hypothesized, the average effect of a change in loadout is more important than changes in storage or rail car siding for all types of elevators. The average impact of changes in rail car siding and loadout capacities, the variables directly related to loading, are highest for MPC elevators. In contrast, the average

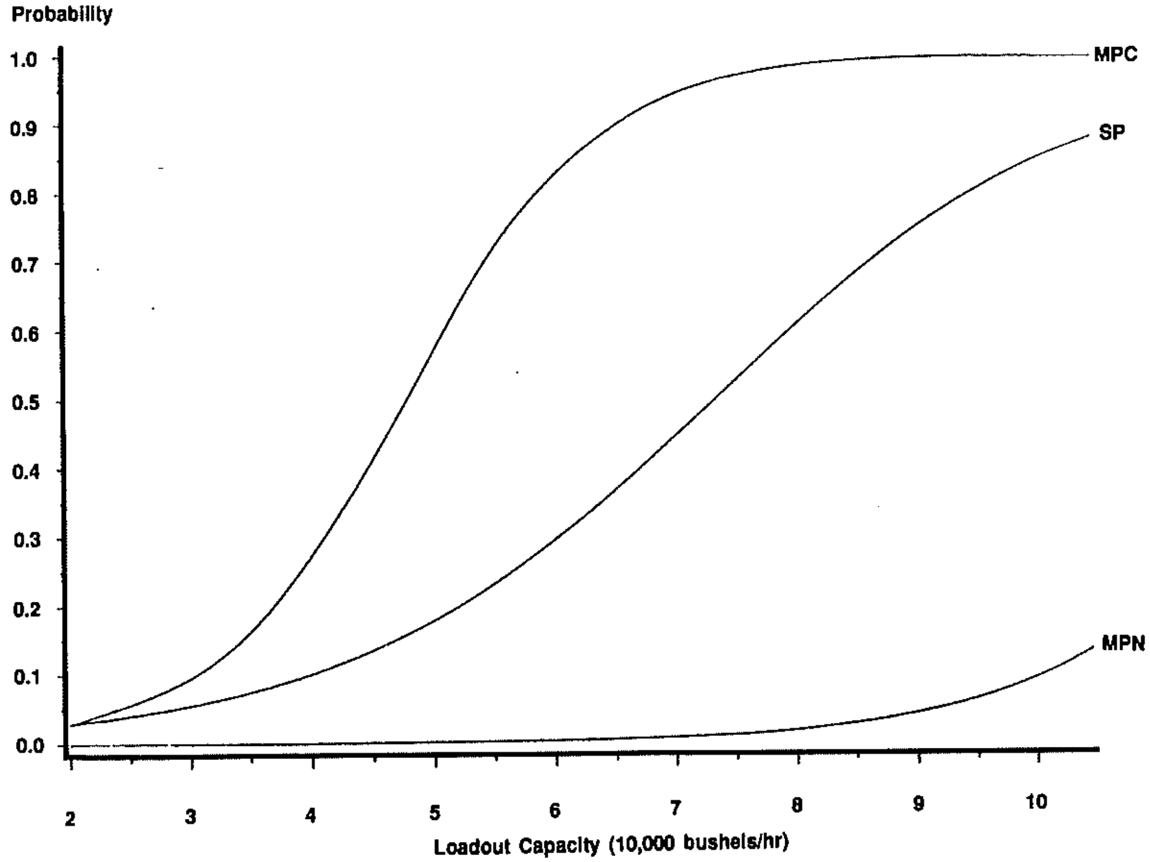

Figure 3. Probability of Investing as Loadout Capacity Changes.

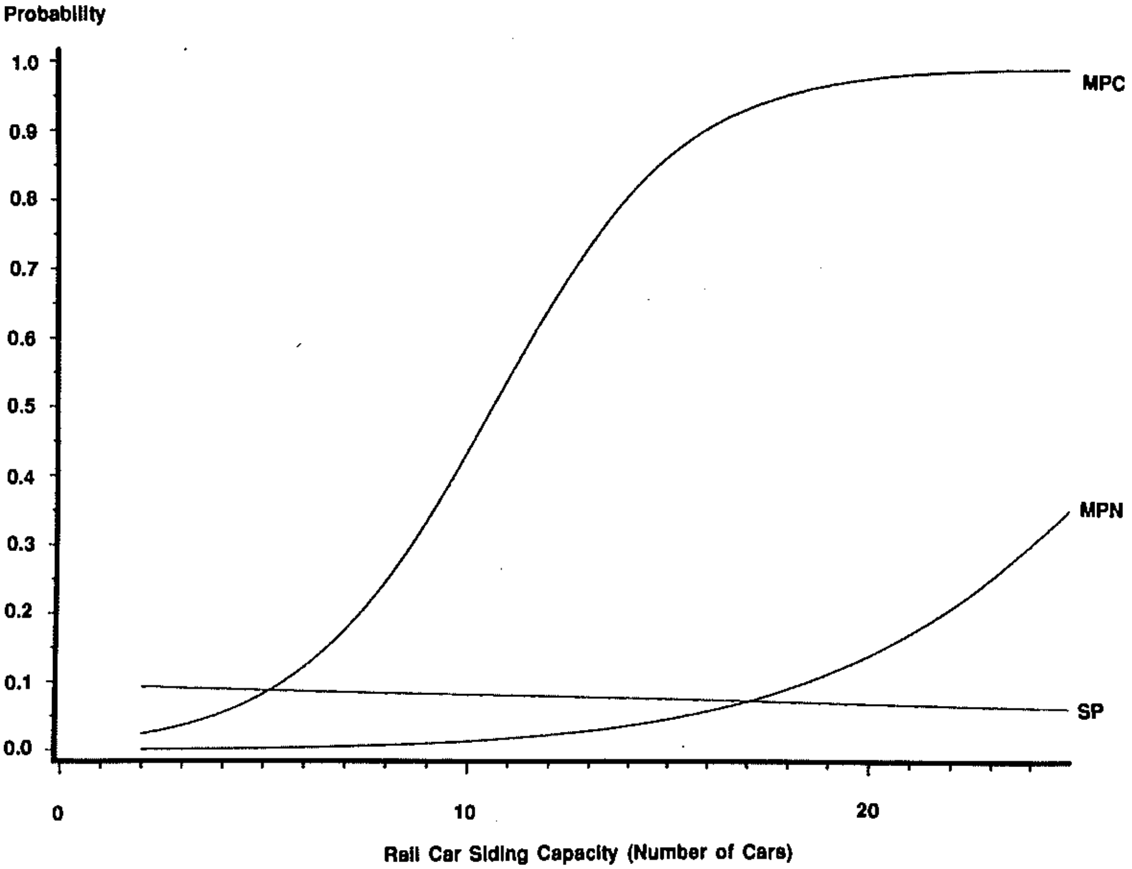

Figure 4. Probability of Investing as Rail Car Siding Capacity Changes.

impact of changes in throughput and storage capacity, the variables indirectly related to loading, are highest for the SP elevators. In a relative sense, storage and throughput are more important to the single plant firm than for the multiplant firms. The rationale for this finding rests quite simply that in a multiplant firm, station elevators can provide more of the gathering and storage functions.

C. Overall Probability of Investing

The overall average probability of investing is the mean of the estimated Z values by type of elevator. The overall probability of investing ranges from 44.5 percent for MPC elevators, to 22.2 percent for SP elevators, to 11.8 percent for MPN elevators (Table 3). The general inference is that MPC elevators are the elevators most likely to upgrade their plant to become trainloading elevators. Single plant elevators are the second most likely investors, while MPN elevators are the least likely investors.

D. Usage of Models

The predicted Z value of the logit model can be interpreted as the probability that a given elevator will be the target of investment. It is assumed that elevators with probability estimates greater than 75 percent should upgrade their elevator to become a trainloading elevator, elevators with probability estimates less than 25 percent should not invest, and elevators with probability estimates between 25 and 75 percent merit further study. The logit model has at least three applications by either private or public sector planners.

First, private sector planners may use the model to forecast locations for likely future trainloading elevators. For example, 81 of the 86 elevators in the sample which did not make any investment had a predicted probability of making the investment of less than 25 percent, four had a predicted probability between 25 and 75 percent, and one had a predicted probability greater than 75 percent. The 81 elevators with predicted probabilities less than 25 percent are not likely investors and probably can be eliminated from further analysis. However, the other five elevators which have not yet invested warrant more sophisticated investment analysis. By using the logit model as a screening tool, management can then focus its attention and gather additional information about the particular circumstances at the identified elevators.

Second, government planners may use the model as a tool to allocate state resources and encourage private investment. Using the model to screen and identify elevators with a strong potential for upgrading, the state then has a more informed basis on which to spend limited funds for highway construction and maintenance or rail line rehabilitation. The state may also encourage private investment and make it more feasible, by informing likely investors that the state is willing to use its scarce funds to upgrade highways or rail lines if a particular elevator is upgraded.

Finally, if private or public sector planners feel that disinvestment is likely, they may use the model to forecast the locations of trainloading elevators which have a strong potential for disinvestment. For example, of the 23 trainloading elevators, 14 had a predicted probability of making the investment of greater than 75 percent, eight had a predicted probability between 25 and 75 percent, and one had a predicted probability less than 25 percent. It is arguable that the trainloading elevator with a probability of less than 25 percent should not have invested in the first place. Conversely, it may be a likely candidate for disinvestment. Once again, the eight elevators with probabilities between 25 and 75 percent warrant further study. State planners may wish to monitor carefully the performance of these elevators, while private firms may wish to reconsider their original investment decision.

V. CONCLUDING COMMENTS

The rapid growth in the number of trainloading elevators has led to a concern there is excess capacity in Midwestern states, while in the Northern Plains elevators are still being upgraded. In this article, an econometric model is developed which can be used by public and private sector planners to forecast the probability that a given elevator will be a likely candidate for investment or disinvestment. Early identification of these elevators, would allow firms and/or states to develop policies to make more informed decisions.

The model also provides information about the magnitude and significance of the determinants of the investment decision of converting a single-car rail elevator to a trainloading elevator. Plant and firm characteristics are important in predicting which elevators will make investments upgrading their facilities. In general, there are considerable differences between centrally located elevators in multiplant firms and single plant elevators. Centrally located elevators in multiplant firms are the elevators most likely to be upgraded to become trainloading elevators. When compared with single plant elevators, the decision to invest in these elevators is driven primarily by loadout and rail car siding capacities, variables directly related to the speed of loading. In contrast, the decision to invest in single plant elevators is driven relatively more by throughput and storage capacity, attributes indirectly related to loading speed.

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