# Exit Decisions in the Canadian Grain Elevator Industry

**Sichao Jiang** · **James Nolan** · **Wesley W. Wilson**

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**Abstract** Grain elevators play a central role in the movement of grain to market and to rural economies in terms of employment and investment. Over the last three decades, the grain elevator industry in Canada has experienced a major decline in the number of elevators as older and technologically obsolete elevators have been replaced by larger and more technologically advanced elevators. We develop a model of exit in the Canadian grain elevation industry using data from 1999 to 2016 collected at the individual elevator level. Our specification explains elevator exit based on traditional variables used in the industrial organization literature such as capacity, multi-plant ownership, and vintage. But, we also include a measure of vertical linkage in the industry (i.e., elevator linkage to the freight transport sector) as well as spatial measures to account for local demand, supply and competition. The results provide strong evidence that exit in this key agricultural and trade industry is affected by whether an elevator is a recent entrant (vintage), its size, vertical linkages, local demand and supply conditions, and spatial competition.

**Keywords** Exit Decisions · Grain Elevator · Transportation Infrastructure · Vertical Investment · Spatial Competition

**JEL Codes:** L66 · L92 · R12 · Q13 · O13

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Sichao Jiang
University of Oregon, Department of Economics
E-mail: sichaoj@uoregon.edu

James Nolan
University of Saskatchewan, Department of Agricultural and Resource Economics
E-mail: james.nolan@usask.ca

Wesley W. Wilson
University of Oregon, Department of Economics
E-mail: wwilson@uoregon.edu

# 1 Introduction

Grain elevators have long been a visible and important component in rural communities. They not only provide employment opportunities and invest in the local areas, they are also the central local gathering point for agricultural products and link the local markets to destinations. Elevators not only receive grain, they also store, blend and/or treat grains, ultimately loading the stored grain for shipment to terminals and processing plants. In Canada, since the first Prairie elevator was built in 1881 in Gretna, Manitoba there has been enormous investment in rural elevators to accommodate the long-term growth of the Prairie grain industry.[1]

Over the last few decades, the industry has transitioned as older (mostly built of wood) and smaller elevators have given way to more modern (mostly built of concrete) larger elevators. In this paper, we examine this transition by developing and estimating a model of exit that captures traditionally used determinants such as scale, multi-plant firms, plant vintage, but also develop and include a measure of vertical linkages as well as local measures of demand, supply, and spatial competition. We develop a panel dataset of Western Canadian elevators in operation during 1999-2016 time period. These data provide a comprehensive unbalanced panel that allow patterns of exit to be described and allow the estimation of a unique model of exit to be estimated. We first estimate a model motivated by the industrial organization literature on exit. The model includes variables such as capacity, multi-plant ownership, and whether or not an elevator was a recent entrant to the market to capture elevator vintage. We then develop and include in the model, measures of the vertical relationship between the elevators and the transportation markets as well as a set of variables to reflect the spatial setting of the elevator. These latter include local measures such as demand, supply and spatial competition. The results provide strong evidence consistent with the literature that capacity and time of entry (i.e. more recent, newer technology) have negative effects on exit. We also find that vertical relationships as well as spatial measures of demand, supply and spatial competition have expected and strong effects on the probability that an elevator in the sample exited the market.

The current industry in Canada consists of four types of elevators. These are: primary, forwarding, process, and terminal elevators. Primary elevators receive grain directly from producers for storage and forwarding. Process elevators receive and store grain for direct manufacture or processing into other grain products. Terminal elevators receive grain after official inspection and weighing, cleaning and storing grain before moving it along the supply chain; and transfer elevators transfer grain that has been officially inspected and weighed at another elevator. Transfer elevators can also receive, clean, and store domestic or foreign grain.[2] Primary elevators still dominate the grain elevator industry in Canada. In 1999, there were 976 primary elevators, and a total of 57 other types of elevators. The number of primary elevators generally decreases throughout the range of the data (1999-2016). Yet since 2004, total capacity of primary grain elevators has increased in most Canadian provinces. For example, Alberta has seen total primary elevator capacity increases from 1,685,250 to 1,834,160 tonnes within the time frame of 1999 to 2016. British Columbia is the only province where inland elevator capacity fell, from 46,030 in 1999 to 41,130 tonnes in 2016.[3] Overall, the industry now has fewer but larger elevators, while these remain mostly primary elevators. Concurrently, the number of process and terminal elevators have increased while their average capacity has dropped. And since 2013, no transfer elevators have been operational in this market. We focus the analysis on primary elevators, given their dominance in the industry.

[1] https://www.thecanadianencyclopedia.ca/en/article/grain-elevators.

[2] https://en.wikipedia.org/wiki/Grain_elevator

[3] The data comes from the Canadian Grain Commission, https://www.grainscanada.gc.ca/wa-aw/geic-sgc/summary-sommaire-eng.asp

There is considerable research on industrial entry and exit.[4] Generally, this literature finds that inefficient firms/plants tend to exit the market either due to the lack of scale economies or due to inherent inefficiencies.[5] Other research points to strategic motivations for exit e.g., Ghemawat and Nalebuff (1985), Ghemawat and Nalebuff (1990), and others. In addition, recent research provides evidence that firm characteristics at time of entry have an important effect on exit (Dunne et al. (2005), while other research theoretically points to the role of multiplant ownership e.g., Reynolds (1988) and Ghemawat and Nalebuff (1990) and and empirically (e.g., Audretsch and Mahmood (1995), Mata et al. (1995), and Miller and Wilson (2018)).[6] Previous research has shown that the effects of scale can have a positive effect on the likelihood of exit. That is, in declining demand markets. Ghemawat and Nalebuff (1985) show theoretically that a small single plant firm can profitably "hang on" longer than a large firm, with the result that the larger firm exits first. In a subsequent paper, Ghemawat and Nalebuff (1990) allow partial capacity adjustments, but similarly find that large firms reduce capacity before small firms and then both small and large firms reduce capacity until their plants are equally sized, subsequently reducing capacity at the same rate. When firms operate multiple plants, Whinston (1988) find that the large plant can improve a multi-plant firm's strategic position in the survival game, with the result that this firm will not necessarily be the first to exit or cut capacity. Fudenberg and Tirole (1986) analyze a model in which two firms possess asymmetric information about each other's fixed costs, but hold symmetric expectations. They identify a unique subgame perfect equilibrium where high-cost firms exit earlier than low-cost firms. We conclude that overall, the implications of plant capacity on exit decisions are mixed. That is small and/or inefficient firms can be "shaken" out earlier, but in declining markets it may be that small firms "stakeout" the market with the result that larger firms exit first. (Lieberman (1990), and Blonigen et al. (2007))

In this paper, we control for what have become standard exit related variables such as capacity, multi-plant ownership, and whether the plant (individual elevator) is a recent entrant (to capture vintage effects). But given the nature of the industry, we also introduce industry specific variables that may also have an effect on elevator exit. Since elevators are part of an extensive grain supply chain in Canada, their individual relationships with the grain transportation market can also influence their long term viability. In this sense, rail transportation in particular represents a vertical linkage connecting individual grain elevators to final markets. Plants/elevators supported by well developed transportation infrastructure would seem less likely to exit the market. Some elevators now also have considerable capacity to load hopper cars, which means they can ship large quantities, leading to lower negotiated freight rates than elevators with smaller capacities. We capture this effect with a rail carload capacity variable and find that it has a significant negative effect on the probability of a given elevator exiting the market. In addition, we also introduce a set of variables to account for differences in local demand and supply conditions, as well as spatial competition from other proximate elevators. The latter measure is a measure of capacity of other proximate elevators (calculated using weights inversely related to distance to the neighboring elevators).

There is a limited amount of research that applies to vertical relations in firms' exit decisions. As an example, Chen (2002) use a duration model to find that vertical integration reduces the likelihood of survival for US petroleum plants. de Figueiredo and Silverman (2012) examine exit rates in the US laser printer and manufacturing industry, finding that the density of a vertically related population has an adverse effect on exit rate. In our market, a clear vertical linkage exists between grain elevators and rail transportation. While some elevators can

[4] There is a related literature that examines the effects of financial information on firm failure e.g., Altman (1968; 1973), Zingales (1998). Zingales (1998) finds, for example, that highly leverages trucking firms are less likely to survive following deregulation. In the case of the Canadian grain elevator industry, elevator success in Western Canada is tied to several factors, including financial/operational elements (e.g. turnover, capacity, pricing, etc.) as well as transportation (i.e. rail and road) connectivity (Lawrence et al. 2016).

[5] See, for example, Franklin (1974), Jovanovic (1982),Dunne et al. (1988; 1989), Lieberman (1990),Audretsch (1991; 1995), Dunne and Hughes (1994), Mata et al. (1995), Gibson and Harris (1996), Audretsch et al. (2000), Segarra and Callejón (2002), Elston and Agarwal (2004), Miller and Wilson (2018)and etc.

[6] There are other studies that reinforce these findings, covering a broad range of countries. These include Italy(Colombo and Delmastro 2000), the United States (Bernard and Jensen 2007), Belgium (Van Beveren 2007), Sweden (Bandick 2007), Japan (Kimura and Kiyota 2006), New Zealand (Gibson and Harris 1996), Chile (Alvarez and Görg 2009), etc.

load only a few cars at a time, others can load dozens of rail cars in short order. Railroads will typically offer rate discounts for multiple rail car shipments over smaller rail car movements, a situation that places elevators having high car loading capacity with a substantial competitive advantage.[7] Due to this, car loading capacity is our measure of vertical linkage. In the case of grain elevators, Sarmiento and Wilson (2005) show that large elevators have a greater tendency to adopt a shuttle train technology than smaller ones, while the size of a rival has a negative impact on adoption decisions. They also find shuttle train technologies tend to be adopted in regions with high production and less competition.

The remainder of this paper is organized as follows: Section 2 contains some general background of the grain elevation industry in Canada and provides a review of related academic literature; Section 3 describes the data on Western Canadian grain elevators, providing more details about firm entry and exit during the study period; Section 4 presents the results of various econometric specifications and then discusses our findings; Section 5 concludes. At the very end of the paper, we have added an Appendix of the basic model estimates as Section 6.

## 2 Background

Grain elevators have long been crucial to Canadian rural agricultural communities, not only in terms of the services provided but also in terms of employment, investment, local purchases, etc. Their primary role is to provide a convenient collection point for local grain, including storage and processing, as well as providing a connection with rail transportation that allows access to both domestic and international markets. In Canada, most grain operations on the Prairies are linked to the Class 1 railroad network. An interesting feature of Canadian elevators is their geographic dispersion. As discussed by Selyem (2000), Canadian Prairie towns were historically located approximately 6-10 miles apart, a distance based mostly on the limitation of transportation modes at the time, as well as the availability of farm inputs such as water and fuel. While much fewer in number today, grain elevators were and remain a significant business activity in many rural communities, especially in Western Canada. While rooted in history, change now characterizes the modern grain elevator industry in Canada. As an example, up until 2012, Canadian farmers sold their grain through the Canadian Wheat Board (CWB), the quasi-governmental agency acting as the sole marketer of Prairie grains destined for export from Canada.[8] While the CWB no longer exists, farmers still need to deliver and sell their grain through a licensed grain elevator company. In turn, grain companies gain comparative advantages through procuring grain in local markets, coupled with other factors such as elevator capacity, ownership, and rail carload capacity.

In this market, historical smaller capacity elevators have gradually given way to fewer but larger and more modern successors. Average elevator capacity has nearly tripled in recent years; in 1999 capacity was 6,558.34 tonnes but grew to 20,568.66 tonnes by 2016. Modern elevators offer higher-speed loading and unloading facilities, fast grain cleaning capabilities, unit train loading ability, and substantial storage space.

The history of the ownership of Canadian grain elevators is of interest and is important to understand the transition to the modern era. In early pioneer days individuals living in Western Canada's prairie towns often built their own grain elevators (as co-operatives), and this process gradually brought in private grain companies as competition.[9] While much of the 20th century was dominated by the provincial (Alberta, Saskatchewan and Manitoba) pool elevator companies, by the mid-1990s falling costs of grain processing led to increased

[7]While there remains limited regulation on grain rates in Canada, the importance of rate discounts for larger shippers was buttressed with the so-called Great Northern Grain (GNG) case of 2007 (filed with the Canadian Transportation Agency (2007)) whereby a relatively small grain shipper (GNG) filed a rate complaint against a major railway. The case concerned the level of rate discounts being offered by railways at that time to elevators that had high loading capacities. GNG argued this was effectively undue discrimination against smaller grain shippers like itself who could not easily improve their loading situation. GNG won the case with the regulator, with the consequence that the major railways were forced to revise their grain rate schedules to render them less discriminatory against smaller grain shippers.

[8]https://www.thecanadianencyclopedia.ca/en/article/canadian-wheat-board

[9]https://en.wikipedia.org/wiki/Grain_elevator

consolidation through mergers.[10] Within our data set, in fact, several major mergers occurred. These include Agricore United taking over United Grain Growers in 2001, and subsequently Agricore United was taken over by the Saskatchewan Wheat Pool in 2007. The latter merger created the largest grain handler in Canada, re-named as Viterra Inc.[11] Mergers in this industry have been mostly approved by Canadian competition authorities, but the latter merger was subject to some regulatory intervention due to competitive concerns (i.e. creation of more market power) in several areas, including at the Port of Vancouver. In summary, over the last 25 years, the grain elevator industry in Canada has been characterized by relatively small number of multi-plant (elevator) firms.

Bulk transportation has been a driving force in agriculture and in particular the grain industry in Canada. When the Canadian Pacific Railway (CPR) linked the Pacific province of British Columbia to the rest of Canada in 1871, one goal of the Federal government at that time was that this would help Canada expand its nascent grain export markets (Larson and James 2007). Railroads were an important part of Western Canadian expansion, with farming and rail access going hand in hand for new immigrants looking to settle the West. To this end, grain transportation rates were regulated by the Canadian government ever since the subsidy given to help CPR build the final rail linkage to British Columbia. But as a mature industry, by the 1970s the Canadian government had also started to subsidize various mainline rail upgrades to support on-going grain shipments. However, around this time the government also began to allow the two Canadian Class 1 railways to sell or abandon rail lines that were deemed to be uneconomic (Vachal and Bitzan 1997).

Many of the abandoned lines were in fact so-called "grain dependent" branch lines, track that in some cases served long lines of individual town grain elevators through distant parts of the Prairies. The peak period of this abandonment process was between 1984 to 1996, where the total length of so-called grain-dependent branch lines in Western Canada dropped by about 14 percent (Thraves 2007). These abandonments hastened the demise of the old and small wooden elevators. The trend was reinforced with the repeal of Crow rate regulations in 1996 (Nolan and Kerr 2012) and then slowed when new and stricter rate regulations were introduced in 2000 as the railways and grain companies had streamlined into more efficient grain handling networks (Brewin et al. 2017).

Concurrently, the ownership of one major Class 1 railroad underwent dramatic change with the privatization of the formerly publicly owned Canadian National Railway in 1995. Prior to this, the operations of the multi-modal Canadian Pacific Limited had been devolved into five independent companies. This ultimately left two private railroads carrying Canadian grain at regulated rates. Change was visible in other ways. The average number of rail cars that could be loaded by remaining grain elevators increased with the consolidation and modernization of the grain handling system. For example, over the duration of the data set we found average car load capacity for all elevators nearly tripled from 22.97 to 62.84.

In comparing the industry in Canada and the U.S., it is worth noting that Canada is a considerably smaller grain producer, with a much greater focus on export markets, whereas the U.S. grain industry splits between domestic and export markets, with domestic grain markets dominating elevator operations in most states. To this end, previous research on the grain elevator industry and industry evolution focuses on the U.S. market. Relevant works include Frittelli (2005) who find that between 1980 to 1998, the number of farms decreased by 15%, but farm size increased by 11%; concurrently, the number of terminal elevators increased, but the total number of grain elevators dramatically fell, mostly due to country elevators exiting the market. Other research has looked into vertical relations within the grain industry in the U.S. Schmiesing et al. (1985) find that increases in the use of (large) unit grain trains in turn gives elevators access to larger and in some cases more distant markets, improving their price efficiency. Huang (2003) determined factors affecting shuttle[12] adoption, and as of the late 1980s with changes to how railroads marketed to grain shippers, shuttle trains have been increasingly adopted by the elevator industry. Prater et al. (2013) highlighted the importance of grain train shuttles to railroad efficiencies.

[10] https://en.wikipedia.org/wiki/Grain_elevator

[11] https://en.wikipedia.org/wiki/Viterra

[12] A type of bulk train movement. A shuttle is a dedicated set of 75 to 110 covered grain hopper cars that carry just grain from one destination to another. https://www.up.com/customers/ag-prod/shuttle/index.htm

Local grain elevators that have been unable to accommodate shuttle-train shipments (for example, because they had small siding or loading capacity) have mostly gone out of business. In essence, many believe that with the demise of the CWB, the Canadian grain elevator industry is becoming similar to that in the US, but "is approximately 20 years behind the grain movement system now operating in the United States.(Wallace 1997)." Finally, Vachal and Bitzan (1997) examine survey data of Canadian grain elevators. At that time, they concluded that industry parties were in fact expecting a declining number of elevators in Canada in the short run. However, respondents also expected an increase in production as well as in overall elevator capacity.

# 3 Data

The data we use contains information on all grain handling facilities in Western Canada that were licensed from 1999 to 2016 (through the Canadian Grain Commission). The data was downloaded directly from the Canadian Grain Commission website.[13] In total, 1346 elevators operated over this time period. Many elevators are observed over time which allows us to ascertain whether an individual facility exited the market (or not) and when it exited. For each elevator, the data contains details such as storage capacity, ownership, the town closest to the facility, the geographical coordinates of the town, the type of elevator, the railroad(s) that serve the elevator, as well as the type of elevator. As we shall see, due to the importance of proximate grain production to an elevator, we also added data on regional agricultural production.

Initial examination of the data highlights the major changes in the industry, especially at the beginning of the sample. As alluded to earlier, the number of primary grain elevators decreased markedly through the 1990s as a result of rail line abandonment and the repeal of Crow rates (discussed previously). Some of the decline of the 1990s is reflected in our data from 1999 to 2002 (Figure 1) and indicates the magnitude of the declines. But since 2002, the total number of elevators in the region has been relatively stable.[14]

The dramatic decline in elevators was the result of more cost efficient transportation options for grain movement as well as industry technological change. Ceteris paribus railroads prefer higher loading and shipment volume, creating the so called "unit trains".[15] These lead to lower unit costs. As a result of increased freedoms to conduct line abandonments at that time, Canadian railroads chose to abandon numerous low-density branch lines on the Prairies. Concurrently, small-town grain elevators were gradually replaced by more dispersed but larger and more efficient terminals, which effectively caused farmers to truck their grain over considerably longer distances (Nolan 2007). Since older grain elevators remain a nostalgic symbol for many western Canadians, some towns have succeeded in preserving elevators by switching them into museums or art galleries. But preservation is not the norm and most have been deteriorated or dismantled. Over the last 20 years, newer grain elevators have tended to have much larger capacities and are more efficient and durable than their predecessors.[16] These high-efficiency grain elevators not only facilitate loading/unloading grain more quickly than previously, but they also help maintain higher grain quality on a large scale (Simmins 2004).

The dependent variable in our analysis is a discrete variable that reflects whether or not an elevator exits in the subsequent time period. This variable reflects a determination by the owning grain company that the long-run profit of a given individual elevator does not support keeping it open. In effect, these profits are assumed to be a function of the elevator capacity, whether the elevator is owned by a company that owns other elevators, whether

[13] https://www.grainscanada.gc.ca/en/grain-research/statistics/grain-deliveries/

[14] In our later analysis, we model the data using both the whole sample period as well as data after 2002, and the results are qualitatively equivalent as well as numerically similar.

[15] A unit train, also called a block train or a trainload service, is a train in which all cars (wagons) carry the same commodity and are shipped from the same origin to the same destination, without being split up or stored en route. https://en.wikipedia.org/wiki/Unit_train

[16] https://www.farmprogress.com/grain-handling/new-innovations-grain-storage-systems-higher-capacities-and-better-grain-quality

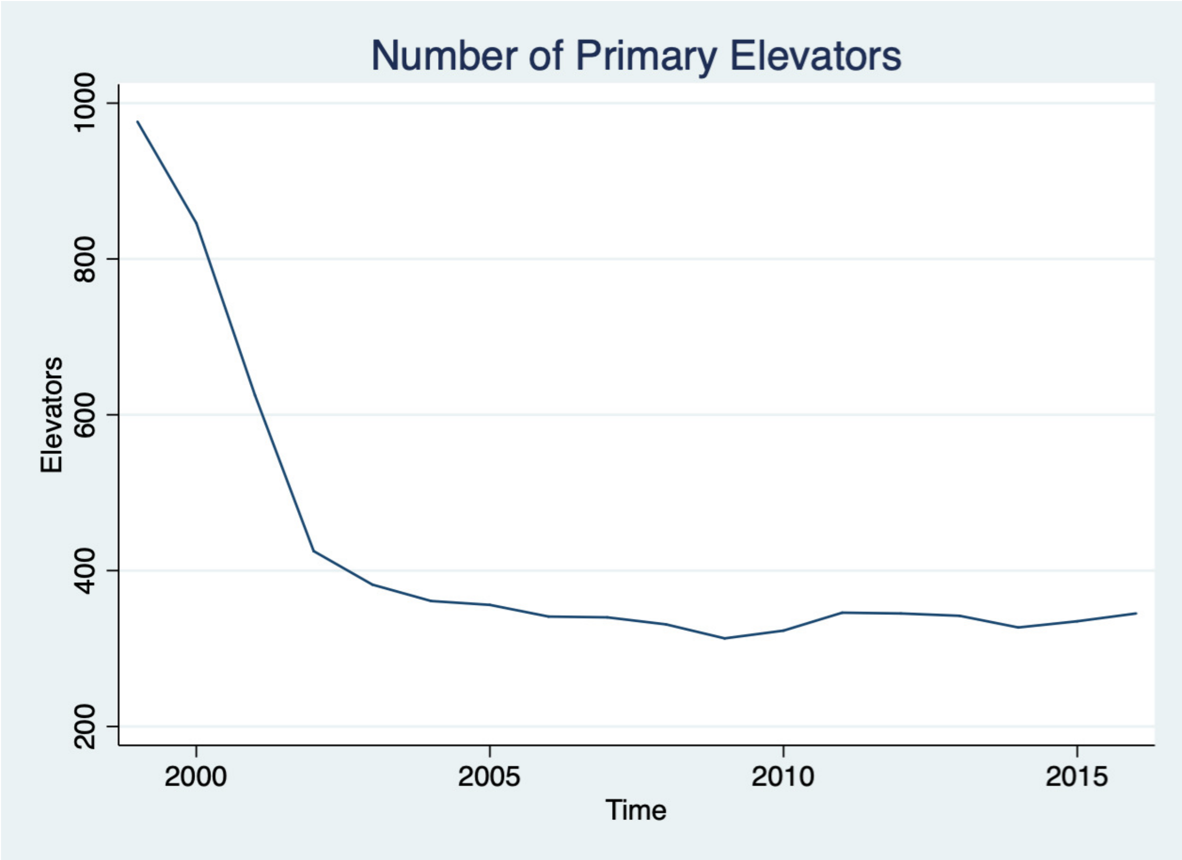



Fig. 1: Number of Primary Elevators Over Time

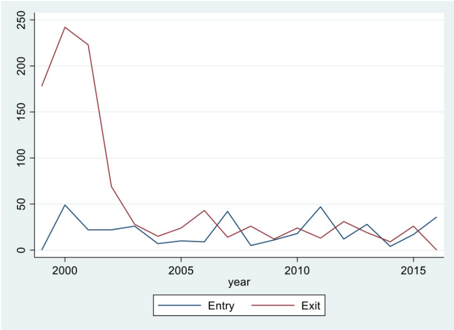
the elevator entered the data after the first year of the data (i.e., new entrant[17]), rail car loading/siding capacities, and local demand and supply conditions, including the degree of spatial competition.

The size of a grain elevator plays an essential role on exit behavior. Over time the average capacity has increased. In 1999, the average capacity was 6,558 tonnes, increasing to 16,723 tonnes in 2009, and to 20,568 tonnes in 2016 (Table 1).

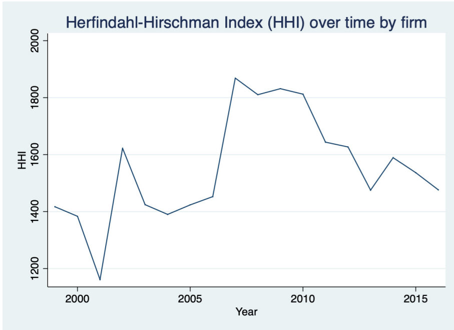
Elevator ownership is a discrete variable that takes a value of one if it is the single elevator owned by a firm or zero if it is owned by a firm operating multiple elevators. The number of single ownership elevators is relatively small, but has increased modestly through the time period (Table 1). We also observe from the data that the status of grain elevator ownership (i.e self-owned-plant or a multi-plant firm) usually does not change given that the elevator remains in the market. Statistically, we only have a single observation that switched its (plant) ownership. In fact, this elevator was owned by a multi-plant firm at the beginning of the sample period, but later became a self-owned elevator, and went out of business in 2006.

Since we have the capacity of each licensed primary elevator throughout the sample, if an elevator is not part of the 1999 data then we record it as an entrant and, as such, these are more likely to be more technologically advanced than elevators that have been in the market longer. In principle, such elevators tend not to exit (at least immediately after entry), which is consistent with Dunne et al. (2005), who found that entry barriers are also exit barriers. The total number of new entrants since 1999 increased to 247 by 2016, as shown in Table 1. Figure 2 ((a)) illustrates the number of entrants and exits throughout the data. As noted earlier, there was dramatic exit from 1999-2003. Since then the number of exits has been relatively stable and remain about the same over time.

[17]In our case the first year of data is 1999. We do not observe when the plants that existed in 1999 first appeared. But, we are able to identify plants that first appeared after 1999 which is the basis for the entrant dummy and follows an approach used by Dunne et al. (2005).




(a) Entrants and Exits




(b) HHI

Fig. 2

The number of firms in the industry has also changed over time. But, the change varies over time. In 1999, there were a total of 32 firms in our data increasing to 68 by 2011 and remaining somewhat constant since then. In 1999, the top three elevators owners in our data are Saskatchewan Wheat Pool (303 elevators with 1,523,880 tonnes capacity), Agricore Cooperative Ltd. (258 elevators and 1,371,140 tonnes capacity), and United Grain Growers (126 elevators and 820820 tonnes capacity). The number of elevators owned by top firms within the industry dropped largely while the total capacity increased. In 2016, the largest three elevator owners were Viterra Inc. (72 elevators and 1,884,570 tonnes capacity), Richardson Pioneer (58 elevators and 153,640 tonnes capacity), and Patterson Grain (28 elevators and 710,750 tonnes capacity) leading the market.

The number of firms is changing over time and has generally increased over the time span of the data, but the average capacity held by firms has also changed. The average capacity per firm, was initially large in 1999, fell dramatically over the next five years and then increased, leaving the concentration in the market somewhat mixed. As illustrated in Figure 2(b), the Hirshmann-Herfindahl Index (HHI) for the industry generally increased from 1999 to 2007, but has fallen somewhat since then.

Vertical linkage of a grain elevator to the transportation sector is measured through car loading capacities (in rail cars) associated with each elevator. Elevators that can load greater numbers of rail cars tend not to leave the industry. The average car loading number for each of the elevator has increased from 22.96 in 1999 to 62.83 in 2016 as shown in Table 1. From this table, it is also clear that surviving elevators enlarge their grain and car capacities.

Total agricultural production data[18] in the area was collected at the elevator station level.[19] We also have data on the third level of census division, or subdivision of Canada, and we aggregate total production in the subdivision to provide a measure of local demand for elevator services.[20] Additionally, we aggregate the total amount of elevator capacity in each of the subdivisions as a measure of the supply of elevator services. From Table 1, we find that agricultural production per subdivision, per elevator, and per unit capacity are all increasing throughout the sample period.

The data contain the geographical coordinates of each elevator. We use the geographic coordinates to first calculate distances between each of the facilities. Then using the distances between facilities, we construct an inverse distance weighted mean value of elevator capacity (Liu et al. 2021). The idea is that nearby elevators have a larger influence than elevators located further away. The general formula for inverse weighted means is given below. Different exponent values relate to the decay associated with distance. To this end, we considered $\frac{1}{2}$, 1 and 2. Further, we restricted the range of a fixed distance. In our case, the calculations were based on a

[18] https://www150.statcan.gc.ca/n1/en/type/data?MM=1

[19] The original data has the station geographic coordinates in the smallest administrative division in Canada, such as cities, towns, villages, townships, and parishes and etc. https://en.m.wikipedia.org/wiki/Administrative_divisions_of_Canada

[20] https://en.wikipedia.org/wiki/Census_geographic_units_of_Canada

distance of 20 miles, but we also considered distances that ranged from 10 to 150 miles. The formula is given by:

$$\hat{z}(\mathbf{x}_0) = \sum_{i=1}^{n} z(\mathbf{x}_i) \cdot d_{ij}^{-r} / \sum_{i=1}^{n} d_{ij}^{-r}$$

Our empirical findings are consistent across varying exponents and distances. The reported results are based on an exponent of $\frac{1}{2}$ and we have included all elevators in the sample within 20 miles of the reference point.[21]

Table 1: Descriptive Data of Primary Elevators

| Variables | 1999 | 2009 | 2016 |
|---|---|---|---|
| Number of Elevators | 976 | 314 | 345 |
| Exit | 178 | 12 | 0 |
| Capacity (tonnes) | 6558 | 16723 | 20569 |
| Single Elevators | 18 | 23 | 39 |
| Entrant | 0 | 151 | 247 |
| Car Loading Capacities | 22.96 | 54.87 | 62.83 |
| Agriculture Production (thousands of tonnes) | 63.5 | 210 | 280 |
| Weighted Capacity of 20 mile range | 7093.88 | 16705.81 | 20221.44 |
| Agriculture Production Per Elevator (in subdivision) | 3170 | 25852 | 34549 |
| Agriculture Production Per Unit of Capacity (in subdivision) | 0.486 | 1.79 | 1.78 |

# 4 Econometric Specification and Results

In this section, we examine exit behavior under a logit choice specification. In particular, we know that conceptually firms will exit if the long-run profits of the firm with exit are greater than the long-run profits of the firm if they do not exit. Our approach is common in the literature e.g., Lieberman (1990), Blonigen et al. (2007), Dunne et al. (2005), and Miller and Wilson (2018). As discussed in Miller and Wilson (2018), the approach can emerge naturally from common dynamic models of entry and exit e.g., Ericson and Pakes (1995) where firms make exit decisions based on expected future profits which are a function of their individual state, the state of their competitors as well as market conditions. In our model, we capture individual states with measures of capacity, whether the elevator is recent entrant, whether it is part of a multi-plant firm, the state of competitors is captured in inverse weighted capacity measures (spatial competition), and market conditions are captured in the local demand and supply measures. The specification allows us to identify characteristics that contribute to elevator longevity in this market. Effectively, for the $i$th elevator, we define the latent variable as $Y^*$

$$Y_i^* = \beta \times X_i + \varepsilon_. \tag{1}$$

As discussed earlier, we do not observe profits, but we do observe whether the elevator or firm exits, which is represented by $Y_i$.[22] The dependent variable equals one if the elevator exits the market at the end of the year, and has a value of zero if it did not.

The explanatory variables are represented by $X_i$, while $\beta$ is a vector of parameters to be estimated. The variables considered include grain capacity, if the elevator is part of a multi-plant firm, if the elevator is an entrant, car loading amounts, agricultural production at the subdivision level, weighted capacity, subdivision capacity, as well as agricultural production per unit of capacity within the subdivision.[23] The detailed explanations are:

We present two sets of results. Table 2 contains a base model with elevator, capacity, ownership, and whether the elevator is a new entrant (after 1999) with different fixed treatments (by time and subdivision). Column 1

[21] We also explored different exponents (r=1 and 2) and examined different distances (d=10,20,$\cdots$,150 miles). These results are generally consistent with those presented through the rest of the paper.

[22] Another approach that could be considered is based on hurdle rates which reflect the minimum rate of return to gauge where or not to pursue (or maintain) a project e.g., Brigham (1975), Liesch and Knight (1999), These are, of course, very comparable in concept in that

| | | |
|---|---|---|
| LOG_CAP | = | Logged capacity of the elevator |
| ELEV_OWNERSHIP | = | One if the grain elevator is owned by a single plant firm; zero if the elevator is owned by multiplant firms. |
| ENTRANT | = | One if the grain elevator is not operating at the start of the observation year but enter the market later on; zero if the firm is operating at the beginning |
| LOG_CAR | = | Logged elevator car loading capacities |
| AG_Production | = | Total agriculture production within each subdivision level. |
| Weighted_CAP_20_Mile | = | Weighted average capacity with inverse distance of all elevators from the sample excluding the reference point, center elevator, within 20 miles |
| Subdiv_CAP | = | Total grain elevator capacity within a subdivision area |
| Ag_Production/Subdiv_Capacity | = | Average Agriculture Production per total elevator capacity in a subdivision area |

does not contain any fixed effects and is the base specification; Column 2 includes time fixed effects; Column 3 includes subdivision fixed effects; and Column 4 contains both time and subdivision fixed effects. Table 3 adds measures of rail car-loading capacity (vertical linkages) and measures of regional demand, supply and local competition. All of the specifications in this model include time fixed effects.

The results reported in Table 2 are largely consistent with the previous literature.[24] That is, the effects of capacity and whether the elevator entered since the beginning of the data are both negative and statistically significant. This means that larger and more modern elevators are less likely to exit. The effect on elevator ownership (a binary variable) has a negative coefficient, but is statistically significant only in Column 1 (which does not contain any fixed effects). A negative value here means that single ownership elevators are less likely to exit the market. While the overall results are mixed in terms of significance, as discussed earlier, the industry is still dominated by grain companies owning multiple elevators.

Table 3 incrementally adds rail car loading capacity, regional demand, regional capacity, and spatial competition. In all cases, the results related to capacity and whether or not the elevator is an entrant are quite similar to those found in Table 2. Both capacity and being an entrant have a negative effect on the likelihood of exit. In column 1, we add car loading capacity as a measure of vertical linkages. In this specification as well as the ensuing specifications this coefficient is negative and statistically significant. In column 2, we add total agricultural production of the subdivision in which the elevator is located, while in column 3, we add the total elevator capacity in the region. The former reflects demand conditions and the latter supply conditions. The coefficients on the demand measure are negative, while the coefficients on the supply measure are positive, which provide strong evidence that elevator in areas with strong demand and weak supply are less likely to exit the market. In Column 5, we add the ratio of the demand measure to the supply measure, and we find that the coefficient is negative, reinforcing our findings. Finally in Columns 4 and 5 we include our measure of spatial competition, that is the inverse distance weighted measure of rival elevator capacities. These, as discussed, capture the presence of rivals in the nearby area. This estimated coefficient in both specifications is positive and statistically significant, providing more evidence that the likelihood of exit is positively affected by the presence of spatial competition.

Overall, multiple specifications are presented in Tables 2 and 3, yet there is a remarkable similarity among the various models. In all models (both Table 2 and Table 3), capacity has a negative effect on the likelihood

decisions can be interpreted as the result of long-run profits. In our case, we simply do not have access to the cost and returns necessary to implement a hurdle approach, and instead follow the bulk of the literature to use the decision to reflect the long-run profits.

[23] The pairwise correlations amongst the right-hand side variable are generally quite small and the empirical results are generally robust across a wide range of specifications suggesting the any issues related to multicollinearity are non-existent or quite small. Further, a referee suggested that we consider the possible endogeneity of capacity. However, given that the market shares defined over sub-divisions are quite small (These average about 12 percent overall, and only 6 percent for existing plants, with only about a 2.6 percent median value). Given the relatively small market shares and the stability of coefficients, endogeneity does not appear to be a major issue.

[24] Given the large degree of exit in the first few time periods, we estimated the models excluding the initial three time periods where a lot of the exits were observed. The results are quite comparable with similar results and is attached in the appendix, Table 4

Table 2: **Basic Model Results**

| | (1) exit | (2) exit | (3) exit | (4) exit |
|---|---|---|---|---|
| LOG_CAP | $-0.941^{***}$ | $-0.889^{***}$ | $-1.017^{***}$ | $-0.986^{***}$ |
| | (0.0474) | (0.0506) | (0.0516) | (0.0553) |
| Elev_Ownership | $-0.364^{*}$ | $-0.223$ | $-0.308$ | $-0.208$ |
| | (0.203) | (0.209) | (0.216) | (0.221) |
| Entrant | $-1.307^{***}$ | $-0.799^{***}$ | $-1.390^{***}$ | $-0.931^{***}$ |
| | (0.110) | (0.125) | (0.114) | (0.131) |
| Time Fixed Effect | ✗ | ✓ | ✗ | ✓ |
| Subdivision Fixed Effect | ✗ | ✗ | ✓ | ✓ |
| Constant | $6.623^{***}$ | $5.928^{***}$ | $6.980^{***}$ | $6.419^{***}$ |
| | (0.406) | (0.427) | (0.563) | (0.587) |
| $N$ | 7662 | 7317 | 7660 | 7315 |
| Log Likelihood | $-2552.8261$ | $-2375.8799$ | $-2489.3525$ | $-2324.9201$ |

standard errors in parentheses

$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table 3: **Vertical Linkages and Spatial Competition Model Results**

| | (1) exit | (2) exit | (3) exit | (4) exit | (5) exit |
|---|---|---|---|---|---|
| LOG_CAP | $-0.660^{***}$ | $-0.461^{***}$ | $-0.483^{***}$ | $-0.468^{***}$ | $-0.328^{***}$ |
| | (0.061) | (0.061) | (0.062) | (0.062) | (0.068) |
| Elev_Ownership | $-0.138$ | $-0.413^{*}$ | $-0.447^{**}$ | $-0.371^{*}$ | $-0.474^{**}$ |
| | (0.220) | (0.222) | (0.224) | (0.224) | (0.235) |
| Entrant | $-0.821^{***}$ | $-0.849^{***}$ | $-0.887^{***}$ | $-0.899^{***}$ | $-0.847^{***}$ |
| | (0.127) | (0.129) | (0.131) | (0.131) | (0.134) |
| LOG_CAR | $-0.371^{***}$ | $-0.386^{***}$ | $-0.391^{***}$ | $-0.380^{***}$ | $-0.267^{***}$ |
| | (0.062) | (0.062) | (0.063) | (0.063) | (0.067) |
| LOG(AG_Production) | | $-0.108^{***}$ | $-0.113^{***}$ | $-0.115^{***}$ | $-0.274^{***}$ |
| | | (0.008) | (0.008) | (0.008) | (0.019) |
| LOG(Subdiv_CAP) | | | $0.271^{***}$ | $0.231^{***}$ | $0.219^{***}$ |
| | | | (0.052) | (0.053) | (0.054) |
| LOG(Weighted_CAP_20_Mile) | | | | $1.876^{***}$ | $1.650^{***}$ |
| | | | | (0.457) | (0.475) |
| LOG(Ag_Production/Subdiv_Capacity) | | | | | $-0.255^{***}$ |
| | | | | | (0.027) |
| Constant | $5.034^{***}$ | $4.818^{***}$ | $1.855^{***}$ | $-14.450^{***}$ | $-13.741^{***}$ |
| | (0.435) | (0.430) | (0.715) | (4.037) | (4.186) |
| Time Fixed Effect | ✓ | ✓ | ✓ | ✓ | ✓ |
| $N$ | 7297 | 7297 | 7297 | 7297 | 7231 |
| Log Likelihood | -2340.7356 | -2244.6586 | -2230.1823 | -2221.7229 | -2138.394 |

standard errors in parentheses

$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

of exit which is consistent with the notion that small country elevators are disappearing. Second, elevators that entered since the beginning of the data are less likely to exit. Our interpretation is that these elevators have been built with increasingly modern technology, so our results highlight the importance of elevator modernization as necessary in order to compete in this market. The results with respect to ownership are somewhat mixed. The estimated effects are negative in all specifications, but are mixed in terms of statistical significance. This may be the result, as mentioned, that the industry in Canada is dominated by multi-elevator firms.

Rail car loading capacity has a negative effect on the likelihood of exit in all specifications. This means that elevators set up for large scale rail shipment are less likely to exit and suggests that another avenue for elevator survival would be to invest in rail car capacity. The regional demand and supply measures are as expected. Elevators in regions with strong demand (large agricultural production) are less likely to exit, while elevators in regions with considerable capacity are more likely to exit. Finally, we introduced a measure of spatial competition and found it has a positive effect on the likelihood of exit. Hence, elevators in areas with large nearby competitors are more likely to exit the market.

The results in Table 3, Column 5 appear to be have the best overall results based on the log-likelihood. In addition, generally, the coefficient estimates are remarkably stable across specifications and consistent with prior expectations. The overriding conclusion for the collective results is that the industry has transitioned from one of small capacities and dated technologies to one of large elevator sizes and more modern technologies. Elevators with a strong tie to transportation (rail car capacity), in areas with strong demands (agricultural production) and little capacity are more likely to remain in the market than those with limited car loading capacity, those located in low demand, and high capacity regions. In all models, elevators that existed at the beginning of the data (1999) were more likely to exit than elevators that entered later. This is consistent with the findings of Dunne et al. (2005). Finally, the role of spatial competitors in elevator exit decisions makes intuitive sense and is underscored by the empirical results. In all pertinent specifications, the effect of the inverse distance measure of competitor capacity is statistically important and has a strong positive effect on the probability of exit.

It is clear from the results in tables 2 and 3 whether an entrant has a strong negative effect on exit. As discussed in section 3, entrants are more likely to be more technologically advanced than non-entrants. In tables 2 and 3, we simply have entrant or not. In tables 4 and 5, we replicate the results in table 2 and 3, but introduce a measure of entrant age. All qualitative results remain the same and are numerically similar. The effects of age are positive (as expected) and significant in all specifications, suggesting that plants that enter later are less likely to exit the market.

Table 4: **Basic Model with Age Included**

| | (1) exit | (2) exit | (3) exit | (4) exit |
|---|---|---|---|---|
| LOG_CAP | $-0.942^{***}$ | $-0.895^{***}$ | $-1.023^{***}$ | $-0.997^{***}$ |
| | (0.048) | (0.051) | (0.052) | (0.056) |
| Elev_Ownership | $-0.358^{*}$ | $-0.185$ | $-0.293$ | $-0.163$ |
| | (0.204) | (0.210) | (0.216) | (0.222) |
| Entrant | $-1.352^{***}$ | $-1.017^{***}$ | $-1.512^{***}$ | $-1.931^{***}$ |
| | (0.178) | (0.182) | (0.182) | (0.187) |
| Age | 0.00836 | $0.0478^{*}$ | 0.0235 | $0.0584^{**}$ |
| | (0.026) | (0.028) | (0.027) | (0.028) |
| Time Fixed Effect | ✗ | ✓ | ✗ | ✓ |
| Subdivision Fixed Effect | ✗ | ✗ | ✓ | ✓ |
| Constant | $6.635^{***}$ | $5.978^{***}$ | $7.028^{***}$ | $6.523^{***}$ |
| | (0.408) | (0.428) | (0.566) | (0.590) |
| $N$ | 7662 | 7317 | 7660 | 7315 |
| Log Likelihood | $-2552.77$ | $-2374.41$ | $-2488.97$ | $-2322.83$ |

standard errors in parentheses

$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

Table 5: **Vertical Linkages and Spatial Competition Model Results with Age included**

| | (1) exit | (2) exit | (3) exit | (4) exit | (5) exit |
|---|---|---|---|---|---|
| LOG_CAP | $-0.668^{***}$ | $-0.469^{***}$ | $-0.491^{***}$ | $-0.476^{***}$ | $-0.333^{***}$ |
| | (0.061) | (0.061) | (0.062) | (0.062) | (0.067) |
| Elev_Ownership | $-0.0982$ | $-0.363$ | $-0.393^{*}$ | $-0.317$ | $-0.430^{*}$ |
| | (0.221) | (0.224) | (0.226) | (0.225) | (0.236) |
| Entrant | $-1.061^{***}$ | $-1.227^{***}$ | $-1.280^{***}$ | $-1.293^{***}$ | $-1.129^{***}$ |
| | (0.184) | (0.188) | (0.190) | (0.191) | (0.193) |
| LOG_CAR | $-0.370^{***}$ | $-0.387^{***}$ | $-0.391^{***}$ | $-0.380^{***}$ | $-0.266^{***}$ |
| | (0.062) | (0.063) | (0.063) | (0.063) | (0.067) |
| LOG(AG_Production) | | $-0.110^{***}$ | $-0.116^{***}$ | $-0.117^{***}$ | $-0.275^{***}$ |
| | | (0.008) | (0.008) | (0.008) | (0.019) |
| LOG(Subdiv_CAP) | | | $0.274^{***}$ | $0.234^{***}$ | $0.220^{***}$ |
| | | | (0.052) | (0.053) | (0.054) |
| LOG(Weighted_CAP_20_Mile) | | | | $1.883^{***}$ | $1.654^{***}$ |
| | | | | (0.458) | (0.476) |
| LOG(Ag_Production/Subdiv_Capacity) | | | | | $-0.254^{***}$ |
| | | | | | (0.027) |
| Age | $0.0523^{*}$ | $0.0836^{***}$ | $0.0866^{***}$ | $0.0868^{***}$ | $0.0625^{**}$ |
| | (0.028) | (0.028) | (0.028) | (0.028) | (0.029) |
| Constant | $5.092^{***}$ | $4.910^{***}$ | $1.910^{***}$ | $-14.46^{***}$ | $-13.72^{***}$ |
| | (0.437) | (0.431) | (0.717) | (4.045) | (4.194) |
| Time Fixed Effect | ✓ | ✓ | ✓ | ✓ | ✓ |
| $N$ | 7297 | 7297 | 7297 | 7297 | 7231 |
| Log Likelihood | -2339.00 | -2240.39 | -2225.65 | -2217.17 | -2136.15 |

standard errors in parentheses

$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$

## 5 Conclusion

In Western Canada, elevators remain a key part of the modern grain supply chain. But over the last few decades, the number of grain elevators on the Prairies has fallen dramatically. In this paper, we develop and estimate a model of elevator exit that encompasses relationships from the extant industrial organization literature, but also measures of vertical linkages to transport markets and the spatial setting of the elevator.

Our findings are largely consistent with prior literature in that we find the likelihood of exit is negatively affected by elevator size and also whether a given elevator was an entrant over the duration of the sample. But unlike prior literature, we find mixed evidence that multi-plant (elevator) ownership have a significant effect on exit decisions. To this basic specification, we also added variables intended to capture vertical linkages to the freight transportation market and to accommodate local demand and supply conditions (including spatial competition). We find that our measure of vertical linkages has a strong negative effect on the likelihood of exit, indicating this is still a factor critical for elevator investment decisions. We also find that local measures of demand, supply and spatial competition matter in the exit decision. Simply put, as local agricultural production levels increase, spatial competition falls, and production relative to capacity increases, we find elevators were less likely to exit.

As an important industry to the economy of Western Canada, grain elevators have a long history, characterized by a series of ongoing changes to its organization. Based upon relatively recent industry data, the focus of this analysis was on obtaining a better understanding of grain company decisions about opening or closing individual grain elevators. In spite of various factors unique to this industry that have affected its evolution, our basic findings still strongly accord with prior work on industrial exit. To this end and due to the inherently spatial nature of grain elevator markets, we found that conditioning on market factors the degree of localized spatial elevator competition was a significant determinant of an exit decision. The latter raises concerns as per the continued evolution of the industry with respect to potential mergers/consolidation and the degree of local market power in various key production regions.

One factor that could not be accounted for in this analysis is the overall effect that elevator closures have had on primary agriculture in Canada. For example, in moving grain to their "local" elevator, Prairie farmers have seen this average distance grow considerably over the past 30 years (Nolan 2007). Aside from the social costs of rural road damage (Larson and Nolan 2007) and considering the benefits of economies of scale, elevator exit and consolidation have shifted some logistics costs over to individual farmers and has thus affected the long-term sustainability and structure of Prairie agriculture.

Unlike its close counterpart in the U.S., grain elevators in Canada have always been characterized by just a few co-operatives or private firms. With the demise of the Canadian Wheat Board in 2012, along with climate change, the lengthening of the crop season, more arable land and increased crop diversity in the region, the Canadian Prairie elevator industry is poised to see major changes in the near future. Our findings on exit decisions support the need for vigilance on the part of competition authorities in shaping how the industry moves forward. This must be done in order to avoid the monopolizing effects of economies of scale in elevation coupled with the identified objective of minimizing spatial competition.

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# 6 Appendix

Table 4: **Basic Model Results After 2002**

| | (1) exit | (2) exit | (3) exit | (4) exit |
|---|---|---|---|---|
| LOG_Cap | $-0.522^{***}$ | $-0.525^{***}$ | $-0.592^{***}$ | $-0.598^{***}$ |
| | (0.0545) | (0.0569) | (0.0609) | (0.0640) |
| Elev_Ownership | 0.155 | 0.208 | 0.229 | 0.263 |
| | (0.210) | (0.214) | (0.228) | (0.232) |
| Entrant | $-0.795^{***}$ | $-0.632^{***}$ | $-0.947^{***}$ | $-0.799^{***}$ |
| | (0.124) | (0.133) | (0.135) | (0.146) |
| Time Fixed Effect | ✗ | ✓ | ✗ | ✓ |
| Subdivision Fixed Effect | ✗ | ✗ | ✓ | ✓ |
| Constant | $2.397^{***}$ | $3.118^{***}$ | $2.740^{***}$ | $3.469^{***}$ |
| | (0.489) | (0.517) | (0.752) | (0.780) |
| $N$ | 5214 | 4869 | 5153 | 4816 |
| Log Likelihood | −1221.539 | −1163.7757 | −1180.4597 | −1125.3187 |

standard errors in parentheses

$^{*}$ $p < 0.1$, $^{**}$ $p < 0.05$, $^{***}$ $p < 0.01$