Exit Decisions in the Canadian Grain Elevator Industry*

Sichao Jiang
sichaoj@uoregon.edu†

James Nolan
james.nolan@usask.ca‡

Wesley W. Wilson
wwilson@uoregon.edu§

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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 industry has experienced a major decline in the number of elevators as older and technologically obsolete elevators have been replaced by larger and more technologically advanced elevators. In this paper, we develop and estimate a model of elevator exit in the Canadian grain elevator industry, using data from 1999 to 2016 at the individual elevator level. We estimate a model that explains exit based on traditionally used variables in the industrial organization literature such as capacity, multi-plant ownership, and vintage of the elevator. We also include a measure of vertical linkages (i.e., elevator linkages to the transport market) and spatial measures to account for local demand, supply and competition. The results provide strong evidence that exit in this industry is affected by whether an elevator is a recent entrant, size (measured by capacity), vertical linkages, local demand, supply and spatial competition, each of which are each statistically and economically significant.

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†University of Oregon, Department of Economics
‡University of Saskatchewan, Department of Agriculture and Resource Economics
§University of Oregon, Department of Economics

1 Introduction

Grain elevators have long been a focal point in Canadian rural communities. They are indeed a necessary component for many agricultural markets where they are a gathering point for local production. Elevators store and sometimes treat grain, as well loading and then shipping grain to terminals and processing plants. Over the last 100 years or more, since the first Prairie elevator in Canada was built in Gretna, Manitoba in 1881, there has been enormous investment in rural elevation to accommodate the growth of the grain industry.[1] Over the last several decades, the industry has transitioned as older (mostly built of wood) and smaller elevators have given way to more modern (mostly concrete) larger elevators. In this paper, we examine the disappearance of Prairie grain elevators by specifying a model of exit based on the realities of the market. We develop a panel dataset of Western Canadian elevators that operated from 1999-2016. This allows patterns of exit to be described and a model of exit to be estimated. Following the industrial organization literature on exit, our model includes variables such as capacity, multiplant ownership, and whether the elevator was a recent entrant to the market. We also develop measures of the vertical relationship between elevators and the transportation market, along with local measures of demand, supply, and spatial competition. We find strong statistical support for traditionally used variables as well as additional variables that better reflect the spatial nature of grain elevation.

The current industry consists of four types of elevators. These are: primary, forwarding, process, and terminal elevators. Primary elevators receive grain directly from producers for storage and/or 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, storing, and treating grain before moving it forward along the supply chain; transfer elevators transfer grain that has been officially inspected and

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

weighed at another elevator. Transfer elevators also receive, clean, and store domestic or foreign grain.[2] Primary elevators dominate the Canadian grain industry with 976 elevators in total operating at the beginning of the sample period, with the remaining type of elevators comprising only 57. The number of primary elevators decreases throughout the sample period but in fact the total capacity of primary grain elevators has increased in most Canadian provinces. For example, Alberta has seen total primary elevator capacity increase from 1,685,250 to 1,834,160 tonnes, from 1999 to 2016.[3] British Columbia is the only province where inland capacity fell, from 46,030 in 1999 to 41,130 tonnes in 2016.[3] Overall, the industry now has fewer but larger elevators, and these remain mostly primary elevators. The number of process and terminal elevators are both increasing while their average capacity is decreasing. Since 2013, transfer elevators have been out of the Canadian market completely. Given the dominance of primary elevators in this market, we limit the empirical analysis to primary elevators only.

There is considerable research on industrial entry and exit. Generally, the literature finds that inefficient firms/plants tend to exit the market either due to the lack of scale economies or due to inherent inefficiencies.[4] Dunne et al. (2005) provide evidence that firm characteristics at time of entry have an important effect on exit, while other research points to the theoretical role of multiplant ownership e.g., Ghemawat and Nalebuff (1990) and Reynolds (1988) and empirically e.g., Audretsch and Mahmood (1995), Mata et al. (1995), and Miller and Wilson (2018) [5]

The effects of scale are somewhat ambiguous in declining markets. Ghemawat and Nalebuff (1985) analyze exit behavior of firms in a declining industry. They find a small

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

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

[4] 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) and etc.

[5] There are other studies that reinforce and cover a broad range of countries. These include Italy(Colombo and Delmastro 2000), the United States (Bernard and Jensen 2007), Belgium (Van Beveren 2006), Sweden (Bandick 2007), Japan (Kimura and Kiyota 2006), New Zealand (Gibson and Harris 1996), Chile (Alvarez and Görg 2005), etc.

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) they allow partial adjustments, but similarly find that large firms reduce capacity before small firms.[6]

In this paper, we control for traditional variables such as capacity, multi-plant ownership, and whether the elevator is a recent entrant. We also introduce vertical linkages to the freight transportation sector as well as local measures of demand, supply, and spatial competition. Regarding the first, elevators are part of a grain handling logistics system and their ability to facilitate grain transportation can influence their viability. In this sense, transportation is a vertical linkage connecting individual grain elevators to final markets. Plants/elevators supported by a well developed transportation infrastructure would seem less likely to exit the market. Some elevators have considerable capacity to load rail cars.This affords them the ability to ship larger quantities and obtain lower rates than elevators with smaller capacities. We represent this effect, the co-called the vertical linkage effect, by car loading capacity. We find that the greater the car loading capacity for a given elevator, the less likely it is to exit.

Regarding the second, grain elevators operate and compete spatially. To capture these differences, we incorporate local demand and supply conditions as well as a measure of spatial competition. This latter measure is a weighted inverse distance, weighted by the capacity of other proximate elevators, as well as the market share of each of the owning companies making an exit decision.

There is only a limited amount of research that applies to vertical relations in firm exit decisions. Chen (2002) develops a duration model of US petroleum refining plants from 1982 to 1986 and finds that vertical integration may in fact reduce the likelihood of survival.

[6] Whinston (1988) investigates multi-plant firms' survival in declining industries and finds that while a larger plant can improve a multi-plant firm's strategic position in the survival game it may 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 find a unique subgame perfect equilibrium where high-cost firms leave earlier than low-cost firms. Overall, the implications of plant capacity on exit are mixed. That is, small and/or inefficient firms can be "shaken" out, but in declining markets it may be that small firms "stakeout" the market with larger firms exiting first. (Ghemawat and Nalebuff (1990), Lieberman (1990), and Blonigen et al. (2007))

de Figueiredo and Silverman (2012) examine the density of a vertically related population using data from US laser printer and laser manufacturing industries from 1984 through 1996, finding that the density of a vertically related population has an adverse effect on the exit rate. In our model, a vertical linkage exists between elevators and rail transportation. For instance, some elevators can load only a few cars at a time, while others can load dozens of rail cars. Railroads typically offer much lower rates for multiple car shipments over single car movements, a situation that places elevators having high car loading capacity with a substantial competitive advantage. Due this this, car loading capacity is our measure of vertical linkage.

Related to our work is Sarmiento and Wilson (2005) who examine the vertical relationships between grain elevators and shuttle train services. Large elevators have a greater tendency to adopt technology than small, while the size of a rival has a negative impact on adoption decisions. They find a greater tendency for adoption in regions with high production density and less dense competition. This paper is an explanation on why increasing car loading numbers will reduce elevators exit rates, as well as explaining the increasing trend of car loading capacity throughout the sample period. Vachal and Bitzan (1997) provide evidence that grain elevators that have survived have higher storage capacity, higher annual throughput volumes, etc.

The remainder of this paper is organized as follows: Section 2 begins with a general background of grain elevation; Section 3 provides a review of the academic literature on the grain industry, including theoretical models and empirical results of exit work from economics; Section 4 describes the data on Western Canadian grain elevators and provides more details about both entrants and exiters during the study period; Section 5 presents the econometric specifications and our results; Section 6 concludes.

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 coincide with the extensive Canadian Class 1 railroad networks. 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 elevation industry in Canada. For example, up until 2012, Canadian farmers sold their grain through the Canadian Wheat Board (CWB), the governmental agency acting as the sole marketer of Prairie grains destined for export from Canada.[7] 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 loading or rail car capacity.

In this market, historical smaller capacity elevators have gradually given way to fewer but larger and more modern successors. Average elevator[8] capacity has nearly tripled in recent years; in 1999 capacity was 6558.34 tonnes but grew to 20568.66 tonnes by 2016. Modern elevators offer higher-speed loading and unloading facilities, fast grain cleaning capabilities, unit train loading ability, and substantial storage space.

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

[8] The term elevator here includes all four types of the elevators from the very original data.

The history of the ownership of Canadian grain elevators is of interest. For example, 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 lower costs of grain processing meant that elevator companies had begun to embrace corporate 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 itself was taken over by the Saskatchewan Wheat Pool in 2007. The latter merger created the largest grain handler in Canada, re-named named 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 a local monopoly in elevation) in several areas, including at the Port of Vancouver. Over the last 50 years, the industry has been characterized by small number of key players.

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 (Lawrence et al. 2016). 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 CP 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

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

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 these lines were in fact so-called "grain dependent" branch lines, track that in some cases served long lines of individual town grain elevators through parts of the Prairies. The peak period of this abandonment process was between 1984 to 1996, wherein the total length of so-called grain-dependent branch lines in Western Canada dropped by about 14 percent (Thraves 2007). Without question, gradual grain dependent track abandonment hastened the demise of the old and small wooden elevators.

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 grain elevation 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, much of the previous research on grain elevation and industry evolution focuses on the U.S. market. For example, works including Frittelli (2005) 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 unit grain trains in turn give elevators access to larger and in some cases more distant markets, which improve their price efficiency. Huang (2003) determined factors affecting shuttle[12] As of the late 1980's 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. 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 elevation market 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) examined survey data on the Canadian grain elevator industry. 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 contain information on all of the grain handling facilities in Western Canada that were licensed through the Canadian Grain Commission, from 1999 to 2016. In total, there were 1346 elevators that operated over the time period. The elevators are observed over time and this allows a determination about whether the facility exited the market or not. For each facility, the data also contain details such as storage capacity, ownership, the town nearest to where the facility is located, the geographical coordinates of the town, the type of elevator, the railroad(s) that serve the elevator, as well as the type of elevator. Due to the importance of proximate grain production to the elevator, we also found data on

[12] A grain train movements. 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

regional agricultural production. This data was downloaded directly from the Canadian Grain Commission website.[13] The latter data reveals additional insights from the supply side of the grain industry.

The data were reported for 19 years. The initial analysis suggests major changes in the industry, especially at the beginning of the sample. As alluded to earlier, the number of primary grain elevators decreased markedly over three years from 1999 to 2002 (Figure 1). But since 2002, the total number of elevators has been relatively stable.[14]

The dramatic decline in elevators were the result of less expensive transportation options in grain movement as well as technological change. Simply put, ceteris paribus railroads prefer high volume shipments, and have abandoned numerous low-density branch lines in Canada. Concurrently, high density small-town grain elevators were gradually replaced by more dispersed but larger and more efficient terminals. The latter effectively also demanded that farmers truck their grain over condsiderably longer distances than previously.[15] 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 deteriorated or been 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 an elevator exits in the subsequent time period. This exit variable reflects a determination by the owning grain company that the long-run profit of the elevator does not support keeping

[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] https://nationalpost.com/news/canada/preserving-prairie-cathedrals-progress-is-leaving-albertas-historic-grain-elevators-in-its-wake

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

it open. In effect, these profits are assumed to be a function of elevator capacity, whether the elevator is owned by a company that owns other elevators, whether the elevator entered the data after the first year of the data (i.e. new entrant), rail car loading/siding capacities, and local demand and supply conditions, including the degree of spatial competition.

The size of grain elevators plays an essential role on exit behavior. Simply put, the larger the elevator, the less likely it is to exit this market. The average capacity of Prairie grain elevators has increased from 6,558 tonnes in 1999 to 16,723 tonnes as of 2009. By 2016, it grew to 20,568 tonnes, as shown in 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 0 if it is owned by a firm operating multiple elevators. As portrayed in Table 1, the number of single ownership elevators have been increasing through time. There were 18 of these elevators in 1999, increasing to 39 in 2016. We also note that these elevators reflect only a small but growing fraction of the total number of elevators operating in the region. We also observe from the data that the status of grain elevators ownership (by self-owned-plant or multi-plant firm) usually does not change, given that the elevator remains in the market. Statistically, we only have a single elevator 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 it later became a self-owned elevator. However, this elevator 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. We observe that entrants tend not to leave the market shortly after they enter, 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 has increased to 247 as of 2016, as shown in Table 1. In figure 2, we also constructed a graph of the cumulative number of entrants and exits throughout the data. New entrants enter the market each year, but the entry rate is much slower than the exit rate. Given the number of elevators is dropping yet the size of elevators is growing, the Hirshmann-Herfindahl Index (HHI) for the industry has in fact grown from 2000 to 2010. It points to larger elevator sizes and fewer elevator numbers in general.

Vertical linkages of elevation to the transportation sector is measured by car loading capacities (in cars) for each elevator. Elevators serving 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[17] in the area was collected at the elevator station level.[18] 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. [19] 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 also contain the geographical coordinates of each facility. This allows the construction of a distance matrix between each of the facilities. Based on this matrix, we define a weighted measure of the elevator capacity that competes with a given elevator. The weighted capacity is computed as follows: First, we locate each elevator in space, then we measure the distance to each competing elevator (that is, proximate elevators owned by a different firm). Then we weight each sample point according to the inverse of its linear distance from each competing elevator, taken to the r exponent. Finally, we average the weighted attribute values of the sample points and assign the resulting value to the target

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

[18] 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

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

location. Mathematically, we construct the weighted capacity as follows:

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

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

We also construct market shares to capture the ownership capacity within the subdivision area to better reflect firm level competition on elevators' exit decisions. The market share variable is computed by summing all the elevator capacities within a subdivision area with common ownership, as well as the capacities of all elevators in the area. We then divide the firm capacity by the area capacity, yielding a market share for each of the firms within each subdivision in each year.

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

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

4 Econometric Specification and Results

In this section, we examine exit behavior with a logit specification. In particular, we know that conceptually firms 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 shutdown the elevator. The model allows us to identify characteristics that contribute to elevator sustainability. Effectively, for the ith elevator, we define the latent variable as Y_*

$$Y_i* = \beta \times X_i + \varepsilon_i; \tag{1}$$

As discussed earlier, we do not observe profit, but we do observe whether the elevator or firm exits, which is represented by Y_i. The explanatory variables are represented by X_i, while β 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 station level, weighted capacity of other competitors computed inversely by distance, owner market share and the interaction between weighted capacity with market share, as well as agricultural production per unit of capacity within the subdivision.

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:

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 station level.
LOG_Weighted_CAP_20_Mile	=	Weighted average capacity with inverse distance of all elevators from the sample excluding the reference point, center elevator, with 20 miles
Owner_Market_Share	=	Market share of the elevator's owner within the subdivision area
Market_Share*Weighted_Cap	=	The interaction between the owner market share and the Weighted_Capacity
Ag_Production/Subdiv_Capacity	=	Average Agriculture Production per total elevator capacity in a subdivision area

We present three sets of results. Table 2 includes a model based on traditional literature, containing elevator capacity ownership and whether the elevator is a new entrant (after 1999) with different fixed treatments (by time and subdivision). Table 3 adds both vertical linkages and spatial variables to the model. Table 4 reproduces Table 3 but uses a different measure of market size. In all these specifications, we find that there are no differences between single plant and multi-plant ownership, and that entrants have negative effects on the probability of exit. We do note that by 2016, 247 of the 345 elevators are entrants (i.e., defined as new elevators since since 1999). The industry, as discussed previously, has experienced technological innovation and extensive system renewal over the sample period. Overall the results in Table 2 (as well as other results) provide strong evidence that newer and larger elevators in this industry tend to survive, while smaller and older elevators tend to exit. Grain capacity as well as grain car loading numbers have a strongly negative effect on the exit behavior of Prairie grain elevators.

4.1 Basic Model

The base model includes variables that are grounded in the previous literature. These are grain capacity of each elevator, elevator ownership, whether the elevator has been established since the beginning of the data. Table 2 contains the results with various specifications. Column 1, does not contain any fixed effects and is the base specification; Column 2 includes time fixed effects; Column 3 include subdivision fixed effects; and Column 4 contains both time and subdivision fixed effects.

$$\begin{aligned} Prob(exit) &= \alpha_0 + \alpha_1 * log(elev\_capacity) \\ &+ \alpha_2 * elev\text{-}ownership + \alpha_3 * entrant \\ &+ (Fixed\_Effect) + \epsilon \end{aligned}$$

Table 2: **Basic Model Results**

	(1) exit	(2) exit	(3) exit	(4) exit
LOG_Cap	-0.941^{***}	-0.889^{***}	-1.017^{***}	-0.986^{***}
	(-19.83)	(-17.57)	(-19.73)	(-17.84)
Elev_Ownership	-0.364^{*}	-0.223	-0.308	-0.208
	(-1.79)	(-1.07)	(-1.43)	(-0.94)
Entrant	-1.307^{***}	-0.799^{***}	-1.390^{***}	-0.931^{***}
	(-11.90)	(-6.39)	(-12.17)	(-7.12)
Time Fixed Effect	✗	✓	✗	✓
Subdivision Fixed Effect	✗	✗	✓	✓
Constant	6.623^{***}	5.928^{***}	6.980^{***}	6.419^{***}
	(16.32)	(13.88)	(12.39)	(10.94)
N	7662	7317	7660	7315
Log Likelihood	-2552.8261	-2375.8799	-2489.3525	-2324.9201

t statistics in parentheses

* $p < 0.1$, ** $p < 0.06$, *** $p < 0.01$

The results are consistent across treatments of the various fixed effects and in-line with the bulk of the previous literature on exit. Essentially, capacity reduces the likelihood of exit and entrants are more likely to survive. Interestingly, there is little evidence to suggest single/multi-elevator ownership matters, owing, perhaps, to the fact the the data are dominated by multi-elevator firms. From the values of the log-likelihood, the specification with both time and subdivision controls seems to offer the best fit.[21]

4.2 Vertical Linkages and Spatial Competition

In tables 3 and 4, we added rail car loading capacity and other measures intended to reflect the spatial characteristics of the elevator. In addition, we find the results with time fixed effects usually generate the best model results. In column 1 of Table 3, we add the logarithm of car siding capacity as a right hand side variable. Rail car capacity captures the vertical linkage to transportation. Elevators with considerable car loading capacity are able to ship greater volumes per shipment which offers both the elevator and the railroad efficiency gains and leads to lower transportation rates for such elevators. The effect of car capacity on exit is negative and statistically different from zero, which is consistent with theory and prior expectation. Columns 2-5 include different variables intended to capture spatial considerations. In column 2, we add agriculture production at the station level (the smallest geographical measure in the original data) to capture the demand for elevator services. We find that the effect is negative and significant which shows that the higher of the agriculture production in the region, the less chance that the elevators exit the market. In column 3, we add the inverse distance weighted capacity excluding the targeted elevator itself of all elevators within 20 miles to capture the spatial competition. We find a significant positive result revealing that more competition in the area increases the probability of exit. In columns 4 and 5, market share interacted with the weighted competition measure and this measure interacted with owner market share and then the

[21] For robustness, 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, Tab 2.A.

owner market share and the weighted capacity. These are in columns 4 and 5, respectively. Market share has a negative effect on exit, and the interaction with weighted capacity is positive. This means that the effect of competition is stronger for elevators owned by firms with a large market share.

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

	(1) exit	(2) exit	(3) exit	(4) exit	(5) exit
LOG_CAP	-0.660^{***}	-0.330^{***}	-0.316^{***}	-0.344^{***}	-0.364^{***}
	(-10.88)	(-5.37)	(-5.13)	(-5.54)	(-5.82)
Elev_Ownership	-0.138	-0.526^{**}	-0.446^{**}	-0.257	-0.210
	(-0.63)	(-2.35)	(-1.99)	(-1.14)	(-0.93)
Entrant	-0.821^{***}	-0.826^{***}	-0.842^{***}	-0.805^{***}	-0.804^{***}
	(-6.47)	(-6.31)	(-6.40)	(-6.14)	(-6.13)
LOG_CAR	-0.371^{***}	-0.325^{***}	-0.316^{***}	-0.315^{***}	-0.304^{***}
	(-6.01)	(-5.16)	(-5.00)	(-4.98)	(-4.80)
LOG(AG_Production)		-0.179^{***}	-0.181^{***}	-0.177^{***}	-0.180^{***}
		(-17.57)	(-17.57)	(-16.99)	(-17.19)
LOG(Weighted_Cap_20_Mile)			2.039^{***}	1.804^{***}	1.611^{***}
			(4.45)	(3.94)	(3.49)
Market_Share*Weighted_Cap				0.103^{***}	1.843^{***}
				(5.54)	(3.99)
Owner_Market_Share					-16.31^{***}
					(-3.76)
Time Fixed Effect	✓	✓	✓	✓	✓
Constant	5.034^{***}	3.818^{***}	-14.40^{***}	-12.48^{***}	-10.28^{**}
	(11.56)	(8.89)	(-3.51)	(-3.04)	(-2.47)
N	7297	7297	7297	7297	7297
Log Likelihood	-2340.7356	-2187.5922	-2177.5937	-2162.7023	-2155.7933

t statistics in parentheses

* $p < 0.1$, ** $p < 0.06$, *** $p < 0.01$

Overall, there are multiple models presented, but there is a remarkable similarity among the various models. First, we find there is little, if any effect, from being owned by a multi-plant firm. Second, firms that entered over the time period analyzed are termed "entrants". We find these firms are less likely to exit in all specifications and the effect appears to relatively consistent. Vertical linkages are very important and consistent both in magnitudes and signs in all specifications. In Table 3, column 1, we find the marginal effect of the car loading numbers is -.027 which means that a one percent increase in loading

Table 4: **Vertical Linkages and Spatial Competition Model Results II**

	(1) exit	(2) exit	(3) exit	(4) exit	(5) exit
LOG_CAP	-0.619^{***}	-0.339^{***}	-0.332^{***}	-0.352^{***}	-0.371^{***}
	(-9.33)	(-5.09)	(-4.96)	(-5.22)	(-5.49)
Elev_Ownership	-0.234	-0.574^{**}	-0.477^{**}	-0.286	-0.214
	(-1.01)	(-2.44)	(-2.02)	(-1.21)	(-0.90)
Entrant	-0.804^{***}	-0.842^{***}	-0.863^{***}	-0.804^{***}	-0.779^{***}
	(-6.18)	(-6.29)	(-6.40)	(-5.97)	(-5.77)
LOG_CAR	-0.333^{***}	-0.319^{***}	-0.309^{***}	-0.303^{***}	-0.286^{***}
	(-5.12)	(-4.84)	(-4.68)	(-4.58)	(-4.31)
LOG(AG_Production)		-0.186^{***}	-0.188^{***}	-0.176^{***}	-0.175^{***}
		(-16.42)	(-16.54)	(-15.11)	(-14.95)
LOG(Weighted_Cap_20_Mile)			2.085^{***}	1.773^{***}	1.505^{***}
			(4.50)	(3.80)	(3.20)
Market_Share*Weighted_Cap				0.108^{***}	2.269^{***}
				(5.38)	(4.51)
Owner_Market_Share					-20.16^{***}
					(-4.29)
AgProduction/SubdivCapacity	-185.9^{***}	16.33	30.84	-28.16	-70.19^{**}
	(-4.63)	(0.52)	(1.00)	(-0.84)	(-1.98)
Time Fixed Effect	✓	✓	✓	✓	✓
Constant	4.665^{***}	3.933^{***}	-14.64^{***}	-12.18^{***}	-9.320^{**}
	(9.85)	(8.47)	(-3.53)	(-2.92)	(-2.21)
N	7231	7231	7231	7231	7231
Log Likelihood	-2285.3587	-2150.637	-2140.4655	-2126.1857	-2117.0158

t statistics in parentheses

* $p < 0.1$, ** $p < 0.06$, *** $p < 0.01$

capacity translates to about a -2.7 percent change in the probability of exit.

Finally, in table 4, we add a variable that combines both of the demand and supply of services. Specifically, the agriculture production in the region points to demand for services, while the amount of capacity in the region points to supply. In Table 5, we reflect demand relative to supply with total production in the region divided by total capacity in the region. The previous results are unaffected qualitatively and are numerically similar. The effect of the added variable is negative and significant. This means that as agriculture production relative to capacity increases, the likelihood of exit is reduced. Using the results in Table 4, column 5, the model with the largest log likelihood value, we find that the marginal effect of entrant is about -.053 which means that entrants are about 5.3 percent less likely to exit given all else equal. This result is consistent with the results of Dunne et al. (2005) and also points to the role of significant technological advancement in the technology such as the unit train advancement and system renewal.

Table 4 column 5 gives the best overall results based on the log likelihood value. In this model, the marginal effect of agriculture production is negative and significant, and it has a value of -.012. The marginal effect of local competition ($LOG\_Weighted\_CAP\_20\_Mile$) is significant with a value of .106, which means that the value of weighted capacity in the area are about 10.6 percent more likely to exit given all else equal.

To summarize the effects of the major variables, we plot the probability schedules for entrant and incumbent firms at median values for the continuous variables. The results are summarized in Figure 4.

The incumbent is more likely than entrants in all cases. Both of the elevator capacity and the car loading numbers have negative effects on elevator exit rates. That is, the larger is the elevator, the lower chance the elevator is exiting the industry. From the estimates, the smallest incumbent elevators have about a 50 percent chance of exit, but as capacity grows the probability of exit declines to nearly zero. The same generally patterns are observed for car loading capacity although smaller.

Agricultural production has a major effect. In regions with small production levels, elevators (both incumbents and entrants) are more likely to exit, but as agricultural production grows, the probability again falls to nearly zero.

Both of the variables with market share play significant role in deciding the elevator's exit decisions. In Table 4, Column 5, we find a negative effect of the owners' market share with exit decisions, meaning that firms' with higher control of the market in the region leading to less exit. The marginal effect is -1.04 which means that firms with large market shares are much less likely to exit than firms with lower market shares. We also included interaction variable of weighted capacity and the owner market share. The result is significant in both of the models (Table 4 Column 4 & 5) with a positive value. It shows that if the market share is large, chances of exit decrease, but if competition is big, the propensity to exit increases.

Local demand and supply conditions also appear to matter. That is, the measure is agriculture production relative to total supply of capacity in the region.

5 Conclusion

In many grain producing areas, elevators are a center piece. But, in the last few decades the number of elevators has fallen dramatically. In this paper, we develop and estimate a model of exit based on the exit literature applied to this agricultural market. The results are largely consistent with that literature in that the likelihood of exit is negatively affected by the size of the elevator and whether the elevator is an entrant over the time period. Unlike the previous literature, we do not find evidence that multiplant ownership has an effect. This is largely due to the fact that the industry is dominated by multiplant firms. To this specification, we add variables intended to capture the vertical linkage to the transportation market and to capture local demand and supply conditions (including spatial competition). We measure the vertical linkage to transportation with the car loading capacity of the elevator. We find that it has a strong negative effect on the likelihood of exit, which may be important for elevator investment decisions. We also find that local measures of demand, supply and spatial competition matter. As agricultural production levels increase, spatial competition falls, and production relative to capacity increases, elevators are less likely to exit.

While the focus of this analysis was on firm level exit behaviors, a number of different researches or policy implications can be suggested in the future. If we have access to the prices of grain, we can look into the marginal willingness to pay for another unit of capacity, the value of being an entrant, etc. Market concentration can be a problem for grain elevator markets especially after Canada privatize the Canadian Wheat Board. The research is focused on identifying these locations spatially and can be used to connect policy e.g., controlling the distribution of licenses in different areas.

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6 Appendix

Table 5: **Basic Model Results After 2002**

	(1) exit	(2) exit	(3) exit	(4) exit
LOG_Cap	−0.522***	−0.525***	−0.592***	−0.598***
	(−9.59)	(−9.24)	(−9.71)	(−9.35)
Elev_Ownership	0.155	0.208	0.229	0.263
	(0.74)	(0.97)	(1.00)	(1.13)
Entrant	−0.795***	−0.632***	−0.947***	−0.799***
	(−6.40)	(−4.76)	(−7.02)	(−5.47)
Time Fixed Effect	✗	✓	✗	✓
Subdivision Fixed Effect	✗	✗	✓	✓
Constant	2.397***	3.118***	2.740***	3.469***
	(4.90)	(6.03)	(3.64)	(4.45)
N	7662	7317	7660	7315
Log Likelihood	−1221.539	−1163.7757	−1180.4597	−1125.318

t statistics in parentheses

* $p < 0.1$, ** $p < 0.06$, *** $p < 0.01$

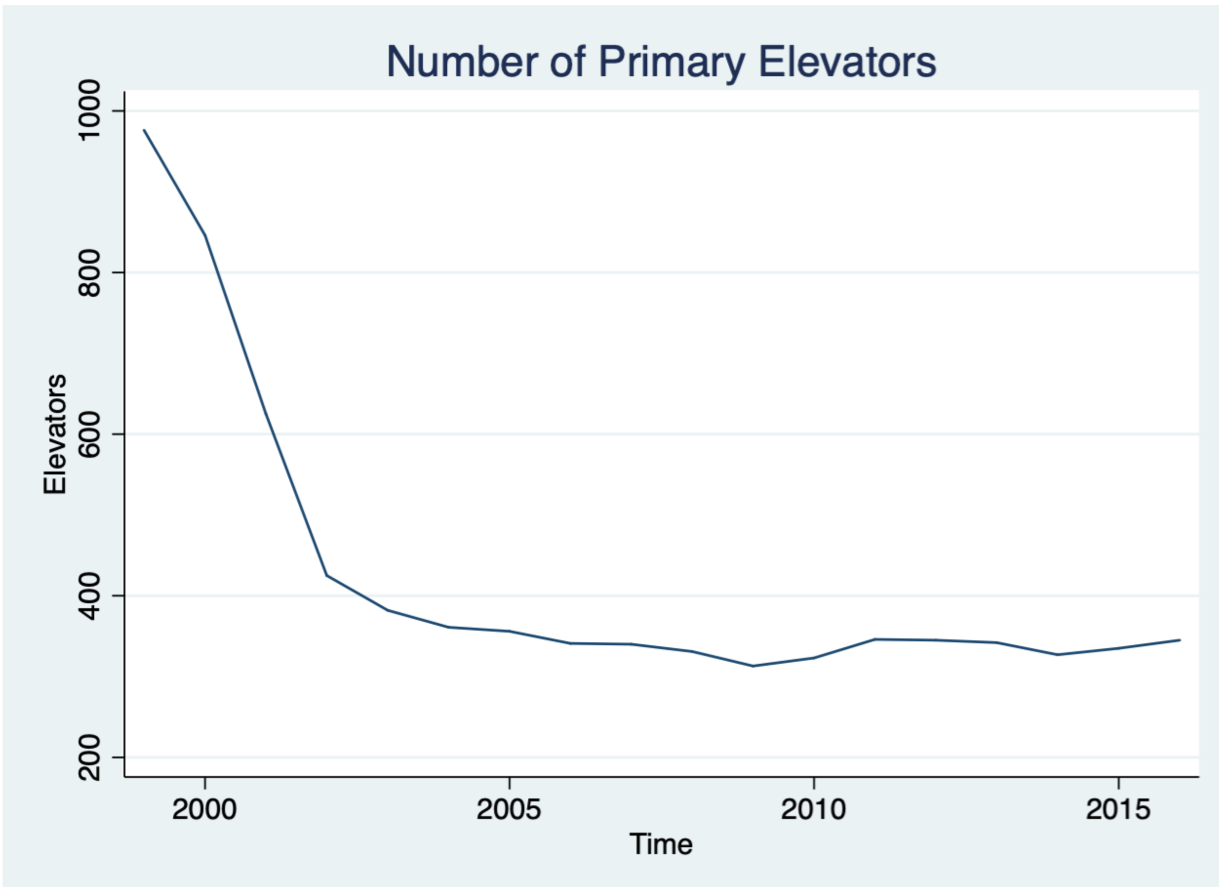

Figure 1: Number of Primary Elevators Over Time

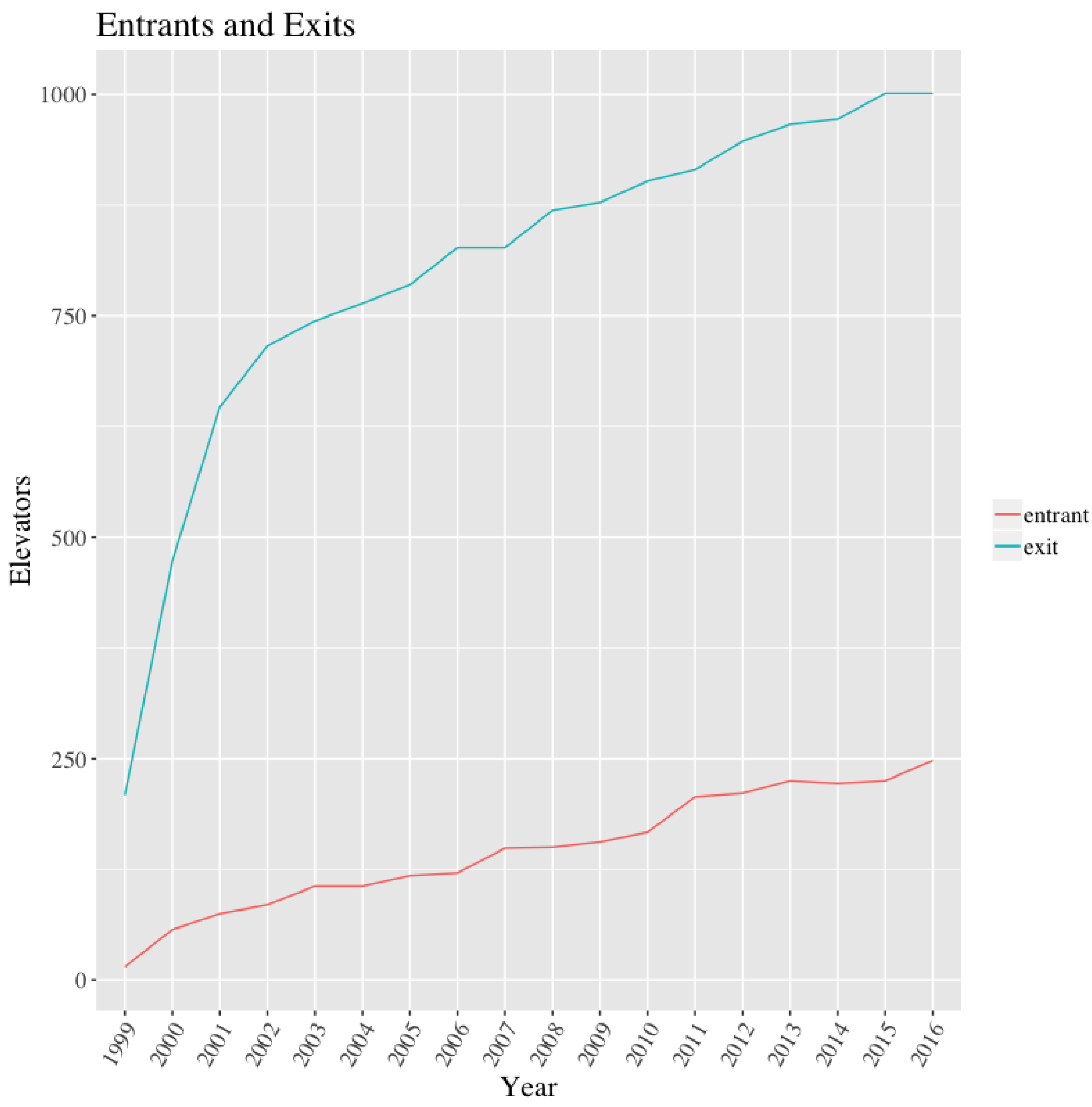

Figure 2: Entrants and Exits

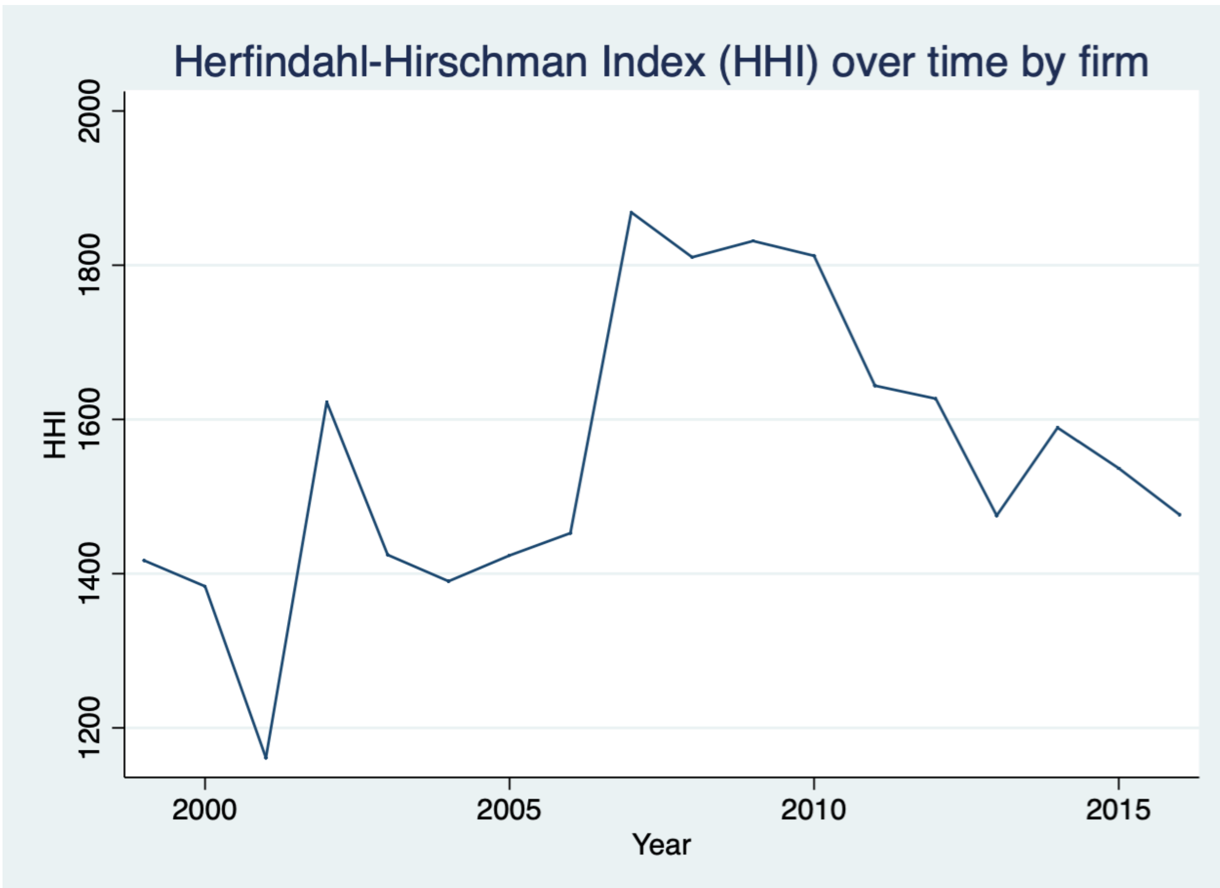
Herfindahl-Hirschman Index (HHI) over time by firm
HHI
2000
1800
1600
1400
1200
2000
2005
2010
2015
Year

Figure 3: HHI