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Working Paper #08-21

September 2008

Who thinks about the competition?
Managerial ability and strategic entry in US local telephone markets

Avi Goldfarb
University of Toronto

Mo Xiao
University of Arizona

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Who thinks about the competition?

Managerial ability and strategic entry in US local telephone markets*

Avi Goldfarb
Rotman School of Management
University of Toronto
105 St George St
Toronto, ON M5S 3E6
416-946-9604
agoldfarb@rotman.utoronto.ca

Mo Xiao
Eller College of Management
University of Arizona
1130 E. Helen Street
P.O. Box 210108
Tucson, AZ 85721-0108
520-621-2192
mxiao@eller.arizona.edu

October 2008

ABSTRACT

This paper examines how manager and firm characteristics relate to entry decisions in US local telephone markets. To do so, it develops a structural econometric model that allows managers to be heterogeneous in their ability to correctly conjecture competitor behavior. The model adapts Camerer, Ho, and Chong's (2004) Cognitive Hierarchy model to a real-world setting. We observe the industry in 1998, shortly after the Telecommunications Act of 1996 opened up the market. We find that older firms with older, more experienced managers have higher estimated levels of strategic ability. Managers with degrees in economics or business, and managers with graduate degrees, also have higher estimated levels of strategic ability. We find no evidence that university quality is related to ability. We repeat this exercise using data from 2000, 2002, and 2004. While the core results do not change, the overall level of measured strategic ability increases substantially by 2004. The estimates of strategic ability are also correlated with survival: those firms with lower estimated levels of ability are more likely to exit the industry early.

Keywords: entry games, behavioral industrial organization, cognitive hierarchy, CLECs, local telephone competition

* We gratefully acknowledge financial support from the NET Institute (www.netinst.org) and the Kauffman Foundation. We thank Mike Mazzeo and Craig Clausen for sharing data and seminar participants at Boston University and the University of Toronto for helpful comments. Sheng Li and Beichuan Zhang provided excellent research assistance.

1) Introduction

Managers make decisions. Sometimes these decisions are made without full information, sometimes they are short-sighted, and sometimes they are brilliant. But all in all, the success of a company lies in the quality of decisions made by its management. This is why CEO succession is a common *Wall Street Journal* headline. Thus far, however, most empirical economists have treated firms as black boxes that make purely rational decisions. While empirical models allow heterogeneity in consumer preferences, market characteristics, and other dimensions, empirical work has generally failed to recognize the heterogeneity of manager ability.

The aim of this project is to understand the incidence of management heterogeneity in an industry which has experienced a rapid boom and equally rapid bust in less than a decade. The passage of the *Telecommunications Act of 1996* opened the competitive local telecommunications industry in the United States. Prior to this act, the market had been dominated by the incumbent local exchange carriers or "Baby Bells". While widespread competition is still not the norm, the 1996 Act led to substantial entry. The entrants (known as competitive local exchange carriers or CLECs) varied substantially in size, telecommunications experience, and management. New firms run by 35 year-old university dropouts competed alongside decades-old firms with educated, experienced, professional managers. These managers chose which cities and towns the firms should enter following the opening of the market.

NETtel Corporation provides a useful example. NETtel offered medium-sized business customers local and long distance telephony as well as data services. Founded in 1996 and run by a young CEO, NETtel expanded quickly into many large cities, paying out $70 million on capital expenditures in 1999 alone. In these large markets, NETtel often competed with six or more other CLECs for the same customer base. The company went bankrupt in late 2000 and ceased operations in 2001. One cannot help but wondering: Did they fully consider the competition they might encounter? Might a more experienced manager have helped?

We explore these possibilities by applying a model of iterated decision-making to the real-world entry decisions of these local telephone carriers. Numerous laboratory experiments show that people are heterogeneous in the strategies they use to play games.[1] Simply, some people are better at playing games than others. While "better" has several dimensions, the laboratory research has shown substantial heterogeneity in the ability of players to correctly conjecture competitor behavior. This heterogeneity does not appear to be random; rather, the observed behavior is consistent with an iterative decision process in which some participants do not consider the other players, others consider the other players but do not consider that the other players will consider them, etc. (Camerer 2003). An implicit assumption in most laboratory research is that the results will be applicable to situations outside the laboratory. Since a key application of game theory in economics is to understand the behavior of firms in competitive situations, the experimental evidence suggests that some managers may be better at making conjectures about competitor behavior than others.

There are several related models that allow for heterogeneity in the ability of players to correctly conjecture competitor behavior in entry games including quantal response equilibrium (e.g. McKelvey and Palfrey 1995), level-k thinking (e.g. Costa-Gomes and Crawford 2006), and cognitive hierarchy (e.g. Camerer, Ho, and Chong 2004). For our purposes, cognitive hierarchy (henceforth CH) models the heterogeneity in an especially useful way because it includes a parameter that unambiguously identifies players as being better at playing the game. In particular, players have types 0 to K. A type 0 player does not consider the competition. A type 1 player acts as if all other players are type 0. A type 2 player acts as if all other players are

[1] Camerer (2003) provides a comprehensive review.

distributed between type 0 and type 1. And a type k player acts as if all other players are distributed between type 0 and type k-1. Unlike games featuring Nash equilibria with fully rational players, this hierarchy yields a unique solution. We can therefore determine the identities of entrants and include manager and firm characteristics in our estimation. Relying on prior research, we interpret the hierarchy as a measure of strategic ability.[2] This interpretation allows us to examine which firm and CEO characteristics are associated with strategic ability. Further, it allows us to estimate how the overall level of ability changes over time and how the level of ability correlates with firm success.

Specifically, we look at the entry decisions of facilities-based CLECs in 234 midsize US markets with populations between 100,000 and 1,000,000 as of the 2000 census. We observe each market that each CLEC entered in 1998, 2000, 2002, and 2004. We focus on 1998, where the decision can most reasonably be treated as simultaneous because the industry was new and firms had less time to react to others' decisions. We also examine how strategic ability changes through the industry's boom, bust, and partial recovery.

From the 1998 data we have four major findings. First, although journalists like to play up unobservables such as charisma and leadership as driving CEO success, we find that the traditional wisdom of checking out a manager's curriculum vita works. Older, more experienced, and highly educated managers tend to correctly conjecture competitor behavior. Hiring a 35 year old as CEO can be quite risky. Managers that studied economics or business in university are especially likely to consider the competition. While level and field of education matter, we find no evidence of a correlation between school quality and strategic ability. Second, the experience

[2] Camerer and Johnson (2004) tracked how long subjects looked at competitor payoffs and found that measured strategic ability is positively correlated with time spent looking at competitor payoffs. Bosch-Domenech et al. (2002) asked subjects in a beauty contest game to explain their choices and found that people explain their actions with logic based on thinking steps.

and incentive structure of a firm play an important role in manager behavior. Firms that are older or financed by venture capital tend to be strategic in their choice of markets, while those that are subsidiaries tend not to. Third, we find that the estimation of this strategic ability parameter has validity in predicting outcomes outside our estimation window: firms with managers of higher caliber are more likely to stay in business. In short, smarter firms make smarter moves and survive. Fourth and last, simulation results show that although more strategic players have much less ex-post regret, strategic ability is not monotonically related to the level of competition. At very low levels of ability, we see considerable over-entry while at moderate levels we see under-entry. At high levels of ability, entry rates stabilize.

Comparing results across years, we find that the estimated level of ability is steady or perhaps falling before the shakeout and then rises sharply. By 2004, the measured level of ability is substantially higher than in 1998. The measure of ability requires a slightly different interpretation in the later years because firms could observe what competitors did in the prior periods. Therefore, the applicability of a simultaneous entry game into this setting is less appropriate. Rather than focus on interpreting the coefficients, we focus on the change in ability over time. We interpret the increase in measured ability after the shakeout as supporting evidence for an evolution towards the long-run equilibrium outcome assumed in much of the existing simultaneous entry literature (e.g. Greenstein and Mazzeo 2006, p. 337).

While a growing literature explores how manager and firm characteristics relate to outcomes (e.g. Chevalier and Ellison 1999, Bertrand and Schoar 2003), this is the first paper to structurally examine how these characteristics correlate with firm strategies in a real-world setting. Our structure allows us to examine how the ability to correctly conjecture competitor behavior correlates with manager education and income, and how it changes over time. We apply this structure to a unique combination of data that integrates manager and firm characteristics with entry decisions in the first years of a new industry. Next, we discuss several papers that put our study in context and provide details of the CLEC environment that motivate our choice to apply the CH model. The model, data, and results follow. We conclude with a discussion of limitations and of the general implications of our results.

2) Background and Literature

This paper addresses four distinct topics. First we discuss the nature of local telephone competition in the United States and explain why a model that allows for heterogeneity in strategic ability is particularly important here. Second, we discuss behavioral game theory, emphasizing the details of the CH model. Third, we discuss how our research relates to the literature on empirical discrete choice models of firm interactions. Finally, we build a list of potential correlates with strategic ability by discussing a literature that relates firm and CEO characteristics to actions and performance.

Local Telephone Competition

Between the Kingsbury Commitment of 1913 and the Telecommunications Act of 1996, there was little competition in local telecommunications in the United States. The 1996 Act opened up local competition, primarily by barring state regulators from denying entrants the right to compete and by forcing incumbent carriers to allow competitors to interconnect (Crandall 2005). It took until 1998 for entry to be observed on any scale, and by 2000 there were 98 CLECs operating in a total of 190 different mid-sized US cities.[3] A shakeout followed, and by

[3] We focus on mid-sized cities (with population between 100,000 and 1 million) for two reasons. First, smaller places are typically non-urban areas that contained few high-value business customers to attract CLECs. Second, larger cities often contain several sub-markets so it is difficult to determine the existence and scope of strategic interactions among entrants.

2004 there were just 53 CLECs operating in 187 locations. Of the CLECs that were licensed to enter these mid-sized markets in 1998, just 40% survived independently through 2004.

Both Goldstein (2005) and Crandall (2005) provide detailed histories of telecommunications competition following the 1996 Act; and both emphasize that many CLECs entered into the same markets and ended up competing fiercely with each other. For example, Goldstein (2005, p. 116) wrote that it seems "likely that the CAPs [CLECs] did not count on each other's dividing the take," and that this led to lower than expected revenues and large losses. Crandall (2005, p. 39) emphasized that "a major problem for the new competitors is their proliferation in a given market." Their assessments suggest that the ability to correctly conjecture the number of competitors that will enter a market is an important determinant of success.

Network Plus Corporation and Sage Telecom provide a useful contrast to underscore this point. Network Plus expanded quickly from the start. Run by a 30-something CEO with a background as a NYNEX sales agent, Network Plus entered many major markets by the end of 1999 including New York City, Chicago, Los Angeles, Atlanta, and Miami. The 1999 annual report states "Our plan is to establish a single contiguous network footprint from New England to Florida." They went bankrupt in 2002. Sage Telecom, on the other hand, was carefully focused on rural and suburban markets with no other entrants, first in Texas and then in a handful of other states. Run by a former long distance company executive, the company focused on controlling spending and expanding the number of customers in the few markets it operated. Sage survived the shakeout and continued to grow slowly until they were purchased by a private investment firm in 2007.

In addition to this anecdotal support for our modeling framework, our data suggest intriguing link between considering the competition, management characteristics, and eventual survival. Figure 1 presents data from 1998 and shows that being the only player in the market appears to be systematically correlated with manager and firm characteristics.[4] Firms run by managers with economics or business degrees are much more likely to be the only firm operating in a market. Further, older firms, and firms run by older managers, are more likely to be the only competitors in the markets they enter. The figure also shows that survival through 2004 is strongly correlated with being the only player in the market. Moreover, a comparison of entry patterns immediately surrounding the industry "meltdown" in 2001 suggests that firms started to differentiate better. In 2000, 18.8% of markets had no competitors, 12.8% had just one competitor, and 38.5% had six or more competitors. By 2002, 16.7% of markets had no competitors, 17.5% had just one, and 29.5% had six or more. Thus while firms were exiting from the markets with the fiercest competition, firms were entering markets without any competition. Rather than a meltdown that affected all firms and places equally, this suggests that the meltdown had its biggest impact in the areas with the most competition. Areas that were attractive due to low levels of competition experienced net entry even during the worse years of the telecom crash.

The above stylized facts suggest that managers with different personal backgrounds tend to act differently, and that competition plays a role in the success of individual firms and the evolution of market structure. Putting these facts together, we hypothesize that the abilities and experiences of managers have an impact on firm strategies and on outcomes. Therefore, we apply a model of heterogeneity in ability that matches manager characteristics to strategic entry decisions.

Before describing models of strategic ability in more detail, we conclude the section on local telephone competition by noting that our paper is not the first to examine competition in

[4] The results in the 2000 data are similar.

local telephone markets. Closest to our work is Greenstein and Mazzeo (2006). They examine CLEC entry decisions using a similar underlying structural model to ours, though they do not allow for heterogeneity in managerial ability. Instead, they emphasize another aspect of heterogeneity: heterogeneity in product characteristics defined by differences between national and local CLECs. Our paper therefore complements theirs in that both emphasize the importance of firm-level heterogeneity in understanding the CLEC market. We emphasize ability while Greenstein and Mazzeo emphasize product variation. Other papers on local telephone competition include Economides, Seim, and Viard (2008) on the consumer welfare effects of the increase in local phone competition between 1999 and 2003 in New York state and Mini (2001) and Alexander and Feinberg (2004) on the behavior of incumbent carriers in using non-price levers to restrict entry. Our paper takes a unique perspective on local telephone competition by using behavioral game theory as a framework for understanding several interesting patterns in the data.

Behavioral Game theory and the CH Model

The first step in building an entry model which links managerial ability with strategic actions is to select an estimable behavioral game theory model which fits our real world oligopolistic setting. Camerer's (2003) textbook provides a detailed review of behavioral game theory and how it differs from standard game theory. A key difference is that behavioral game theory has used laboratory-based evidence to adjust standard models to account for bounded rationality and personal biases. Of particular relevance to this research are the models of play in simultaneous games, including quantal response equilibrium, level-k thinking, and cognitive hierarchy (CH). We focus on CH for its clarity and parsimony in our context. Specifically, CH includes a single parameter that unambiguously identifies players as being better at playing the game.[5]

Specifically, in CH theory there is a hierarchy of rationality. Type 0 players do not consider their competitors; they either pick randomly (as in Camerer, Ho, and Chong 2004) or they act as if the competition is not relevant to their decision (as in Goldfarb and Yang 2008). Type 1 players assume all other players are type 0; type 2 players assume all other players are a combination of types 0 and 1; type k players assume all other players are distributed between types 0 and k-1. A Poisson distribution effectively describes the distribution of types in lab experiments and the model assumes that a type k player assumes all other players are distributed with a truncated (between type 0 and type k-1) version of the same Poisson distribution. In this model, higher types have what Chong, Camerer, and Ho (2005) call "increasingly rational expectations" in that the absolute total deviation between type k's beliefs and the true frequencies fall as k rises. Therefore, for high enough k, type k and type k+1 players will have approximately the same beliefs. Camerer, Ho, and Chong (2004) show that CH works well in both entry games and "beauty contest" games (Nagel 1995; Ho, Camerer, and Weigelt 1998).[6]

The most distinctive feature of the CH model lies in the limited rationality of all players, who fail to recognize the existence of other equally, if not more, strategic players. Beliefs are therefore not mutually consistent. Instead, each player acts if they can perfectly predict their rivals' actions, leading to a unique outcome. This outcome can be short lived because players may revise their beliefs and have an incentive to deviate once they observe other's actions. This

[5] Haile, Hortacsu, and Kosenok (2008) show that quantal response equilibrium is not separately identified from a perfect Bayesian equilibrium with noise and therefore strategic ability is not identified. K-step models other than CH allow for players to be too sophisticated in that they overestimate the ability of their competitors and end up performing worse. The CH model is useful here because it defines sophisticated players as those who *better* conjecture competitor behavior.

[6] In the standard beauty contest game, players are asked to pick a number between 1 and 100. The winner is the player who chooses the number closest to two-thirds of the average of all the players. Using diverse subject pools, the Nash outcome of all players choosing 1 explains actual choices poorly.

outcome can also be long lasting if changing actions is time-consuming and costly, or noises in the environment delay, or even prevent, players from updating their beliefs. While fully acknowledging the caveats of the CH model, we argue that our focus on a new industry, where naivety and noise are prevalent, gives us an ideal platform for the application of the CH model.

A small literature has taken this model and examined its consequences for market outcomes. Hossain and Morgan (2007) develop a theoretical model that shows that in a two-sided market, when players behave according to a cognitive hierarchy model rather than a standard equilibrium model, the market often has a unique tipped equilibrium. Goldfarb and Yang (2008) show that strategic ability slows the diffusion of a new product when retailers are strategic. We are not aware of any paper that has explored how manager and firm characteristics correlate with strategic ability as identified by a behavioral game theory model.

Empirical Models of Firm Interactions

We apply the CH model to an entry game. There is a rich literature on estimation of entry games in economics starting with Bresnahan and Reiss (1990, 1991), who link population thresholds for entry with changes in firms' competitive conduct by estimating a static entry game using cross sectional variation in the number of firms and population. The numerous papers that extended the Bresnahan and Reiss framework to other settings try to better accommodate firm-level heterogeneity into the model. The main challenge in modeling heterogeneous firms' strategic entry in a simultaneous setting is that multiple equilibria almost always arise. Previous researchers have had to forgo firm-level information and only study the numbers of different types of entrants in an equilibrium (Mazzeo 2002; Greenstein and Mazzeo 2006; Augereau, Greenstein, and Rysman 2006), to revise certain features of the game such as information structure (Seim 2006), to estimate the game under different equilibria to check robustness (Jia

2006), or to focus on bounds instead of point identification (Ciliberto and Tamer 2007). Our paper provides a solution to this problem from an alternative angle. By revising the behavioral assumption from complete to limited rationality, we are able to pin down a unique outcome, and are therefore able to utilize rich firm-level information in an entry game instead of abstracting the differences away or just focusing on a few categorical variables. Further, by adding a structural parameter of strategic ability to the standard entry models, it is possible to conduct counterfactuals to assess how manager and firm characteristics influence entry decisions and industry evolution.

A small number of other papers have explored estimating behavioral biases in games played by real-world firms. Aradillas-Lopez and Tamer (2008) develop a semi-parametric model to estimate rationalizability but do not take it to data. Consistent with the rationalizability literature (e.g. Bernheim 1984), they model level 0 as the set of all possible actions, level 1 as the set of all possible best responses to level 0, level 2 as the set of all best responses to level 1 (that are also best responses to level 0), etc. In contrast, our approach is parametric and we impose more structure on the meaning of level 0. This structure allows us to estimate heterogeneity in strategic ability rather than a lower bound on the level of ability in the market. Brown, Camerer, and Lovallo (2007) also impose structure and compare quantal response equilibrium, cursed equilibrium, and CH in the context of movie distributors' decisions to show movies to critics. Hortacsu and Puller (2007) show that older, more experienced firms behave closer to the Nash equilibrium prediction than other firms in electricity auctions. Che, Sudhir, and Seetharaman (2007) and Lim and Ho (2007) also explore the consequences of behavioral assumptions to firms. Finally, Goldfarb and Yang (2008) apply a similar CH-based model to data on 56k modem adoption by Internet Service Providers. Lacking data on manager and firm characteristics, Goldfarb and Yang emphasize the simulation results showing that firms with higher estimated ability were more likely to exist 10 years later and an increase in strategic ability would have slowed the diffusion of 56k modems.

Relating Firm and Manager Characteristics to Actions and Performance

By exploring which firm and CEO characteristics correlate with more steps of thinking, we address a growing literature that examines the link between firm (and CEO) characteristics and firm performance. Bloom and Van Reenan (2007) examine the correlation between management practices, management characteristics, and firm performance. They provide evidence of heterogeneity in the ability of managers. They also suggest some potential correlates with decision quality, including whether the firm is privately owned and the level of product market competition. Foster, Haltiwanger, and Syverson (2008) emphasize the role of firm age in decision-making and survival. Bertrand and Schoar (2003) track top managers as they move across firms and show robust evidence of heterogeneity in manager ability. Further, they find that older executives tend to be more conservative while managers with an MBA tend to be more aggressive. Chevalier and Ellison (1999) study the relationship between market excess returns and manager characteristics using a cross section of mutual funds managers. They find that managers who attended undergraduate institutions with higher average student SAT scores obtain higher returns even after adjusting for behavior differences and selection biases. Other papers that address similar themes are discussed in Baker, Ruback, and Wurgler's (2007) review article on behavioral corporate finance. Laboratory research also suggests correlations between characteristics and ability. Chong, Camerer, and Ho (2005) show that strategic ability is correlated with education level and quality and with training in game theory. Slonim (2005) shows that ability is correlated with experience.

This literature therefore suggests many possible covariates to include in our assessment of which firm and manager characteristics might be correlated with ability: firm age, firm ownership structure (private or public), whether the firm is venture capital backed, whether the firm is a subsidiary of a larger telecommunications firm, manager age, manager experience, manager education level, quality, and field, including whether the manager is trained in game theory (measured by business or economics education). We explore each of these covariates in our empirical analysis.

3) Model

In this section we describe how we model heterogeneity in managerial ability in a real-world oligopolistic entry game.[7] There are two significant deviations of our empirical model from the one used in laboratory experiments. First, we incorporate market- and firm-level covariates in order to allow for entry incentives to vary across markets and managerial ability to vary across firms. In the laboratory, the controlled environment meant this was not necessary. Second, type 0 players in our model choose whether to enter based on the expected profitability of the market without any competitors rather than choosing randomly as in Camerer, Ho, and Chong (2004). This is a more reasonable assumption in a real world setting because it is unlikely firms are unaware of public information or deliberately ignore the fact that larger markets have more potential customers. Higher-level players consider their competitors' behavior while evaluating the potential payoffs of each strategy.

More formally, at a given time period there are J_m potential entrants simultaneously deciding whether to enter market m. Market demand is public information except for a firm- and market-specific stochastic term. All firms make decisions based on expected market profitability

[7] This section builds on the estimation strategy in Goldfarb and Yang (2008).

and expected competition with other firms. However, these firms have different levels of strategic ability, type k $(k = 0,1,2...)$, which is drawn from a Poisson distribution with parameter τ_j $(j = 1,2,...,J_m)$. τ_j is a deterministic function of firm attributes such as ownership structure and firm age and manager characteristics such as manager experience and education. Parametrically, $\tau_j = \exp(\gamma_0 + Z_j\gamma)$ where Z_j is a vector of all the covariates which affect the strategic ability of firm j.[8] Firm j does not observe its competitors' specific types, but all τ_j is public information.

As τ_j increases, firm j is more likely to be a higher type player who has a better perception about the type distributions of its potential competitors. A type k player believes all its competitors have lower types up to $k-1$. Specifically, it believes that a potential competitor i $(i \neq j)$ is distributed with a Poisson distribution truncated at $k-1$ with parameter τ_i. If the potential competitor i has a high τ_i, firm j will perceive i as more likely to be a higher type and act more strategically.

A potential entrant decides whether the expected discounted value of the future profit stream is sufficiently high to support its entry. Firm j considering entering market m has an expected discounted value of future profits conditioning on its type k, which is specified below:

$$E\left(\Pi_{jm} \mid k\right) = \beta_0 + X_m\beta + \psi E\left(\#entrants \mid X_m, \tau_i, k\right) + \varepsilon_{jm} \tag{1}$$

We adopt the above reduced-form profit function for its tractability. Equation (1) states that the type-variant expected discounted value of future profits, $E\left(\Pi_{jm} \mid k\right)$, depends on a vector of time-invariant market attributes X_m, a perceived competition variable that will be discussed below,

[8] We use exponential functional form to ensure τ_j is non-negative, as required by the Poisson distribution.

and an idiosyncratic error term with standard normal distribution reflecting unobserved firm- and market- specific heterogeneity in expected profits. The entry decision of firm j is a dichotomous variable $D_{jm} \in \{0,1\}$ where $D_{jm} = 1$ if of firm j enters market m and $D_{jm} = 0$ otherwise. Firm j will enter the local market if the expected discounted value of future profits is positive, that is, $D_{jm} = 1$ if $E(\Pi_{jm} \mid k) \geq 0$, and $D_{jm} = 0$ otherwise.

In the above formulation, X_m contains market-level variables that might affect the profitability of market m. Market size as measured by population is a key element, as in Bresnahan and Reiss (1990, 1991) and the literature that followed. In the local telephone market, other plausible elements of X_m include local demographic variables such as race, age, household size, population mobility, household income, and unemployment rate.

The focus of this study is each firm's perception about the competition it will encounter upon entry, i.e., $E(\#entrants \mid X_m, \tau_i, k)$ in equation (1). The expectation is conditioned on each firm's own type, all the potential entrants' strategic ability, and market attributes. A type 0 firm, which does not take competitor entry into consideration, has expected discounted value of future profits of:

$$E(\Pi_{jm} \mid 0) = \beta_0 + X_m\beta + \varepsilon_{jm} \qquad (2)$$

A type 1 firm, which perceives all its potential competitors as type 0 players, has expected discounted value of future profits of:

$$E(\Pi_{jm} \mid 1) = \beta_0 + X_m\beta + \psi E\left(\sum_{i \neq j} D_{im} \mid X_m, Truncated\,Poisson(\tau_i, 0), 1\right) + \varepsilon_{jm} \qquad (3)$$

where $Truncated\,Poisson(\tau_i, 0)$ means that firm j, as a type 1 player, perceives any of its potential competitor i's type to be drawn from a Poisson distribution with parameter τ_i and truncated at 0. For a type 1, the distribution assumed is therefore not relevant: the truncation means that the type 1 player assigns 100% probability to its competitor's likelihood of being a type 0. The type 1 then uses the profit function specified in (2) to figure out expected number of entrants. We can iterate the same logic and write down any type's expected discounted value of future profits in the same fashion. For a firm of type $k > 1$, its perceived distribution of its competitor types is drawn from $\mathit{Truncated\,Poisson}\left(\tau_i, k-1\right)$. As k increases, the discrepancy between $\mathit{Truncated\,Poisson}\left(\tau_i, k-1\right)$ and $\mathit{Truncated\,Poisson}\left(\tau_i, k\right)$ gradually disappears and the truncated Poisson gradually approaches the real Poisson distribution. That is, a high type player is able make decisions based on nearly correct beliefs on its rivals expected behavior. [9]

The estimated parameters are $\theta = [\beta_0, \beta, \psi, \gamma_0, \gamma]$, where β measures how a firm' expectation about a market's profitability is affected by X_m, ψ measures how the same expectation is affected by the perceived competition, and γ measures how firm- and manager-specific characteristics shift a firm's strategic ability. As econometricians we do not observe any given firm's type. Therefore, to estimate θ, we need to evaluate each firm's entry probabilities conditioning on all possible types, and then integrate these probabilities over the distribution of types to predict the entry probability of this firm. We match the entry probabilities of all firms to the data using a standard maximum likelihood procedure. Specifically:

$$\hat{\theta} = \arg\max \sum_{j,m} \ln\left(prob\left(D_{jm} = 1\right)^{D_{jm}} \; prob\left(D_{jm} = 0\right)^{1-D_{jm}} \right) \tag{4}$$

To conclude this section we discuss the identification of this model. We identify the degree to which manager and firm characteristics correlate with the latent ability distribution

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[9] In estimation, we need to pick a maximum number of types because it is impossible to derive entry likelihood for an infinite number of types. We do this by increasing the number of types and repeating the estimation until the results no longer change. In our analysis, the results are stable at 8 or more types.

parameter, τ_j, rather than the exact number of steps of consideration the firms undergo. The number of steps of consideration, or the type of a firm, is the firm's private information, and therefore both the firm's rivals and we the econometricians can only assess of the probability of each possible type given our observation or estimate of τ_j, which is a function of firm- and manager-specific characteristics. Given that we observe firms with different firm- and manager-specific characteristics make systematically different entry decisions in markets with the same number of entrants, holding all other markets attributes constant, the relationship between the firm and manager characteristics and τ_j is identified from an exclusion restriction and the scale of τ_j is identified off of the Poisson and $\tau_j = \exp(\gamma_0 + Z_j \gamma)$ functional forms. To be more concrete, suppose we observe in data that firms with more experienced managers are systematically less likely to enter markets with a large number of competitors, we know that the experiences of managers lead to high τ_j and therefore the possibility of high types. In order to determine the impact of firm- and manager-specific characteristics on a firm's ability to consider its competition, we need these characteristics to be excluded from the covariates that determine market profitability outside of perceived competition. Therefore, we assume that manager characteristics such as age, education, and experience only affect profitability through their impact on manager decisions. In other words, γ is identified to the extent that a manager's education is not correlated with a firm's propensity to enter markets with few competitors, except through strategic decision-making. We feel this is reasonable because it seems unlikely that customers will be drawn to a company simply because its CEO has a graduate degree.

It is less clear, however, that all firm attributes should belong to the τ_j function exclusively. For example, an older firm may be able to make better strategic decisions, but it may also have accumulated some brand value over time so any market will be more profitable irrespective of competition. To deal with this issue, we carefully select firm attributes that are less likely to affect city-level profitability directly, such as ownership and financial structure. Further, in assessing whether the predicted value of ability is related to early exit from the industry, we include controls for firm attributes. As a final point on identification, we note that the constant term in τ_j is identified from the functional form of the strategic ability function. While we have explored robustness to alternative functional forms and found largely similar results, we need to be cautious in our interpretation of the overall level of strategic ability in the market. We can, however, compare across markets and across years given that we use the same functional form assumptions throughout.

4) Data

We combine information from several different sources to create a unique dataset which contains details on firms' entry decisions, firm- and manager-level characteristics, and market attributes.

First, we acquired the 1998, 2000, 2002, and 2004 CLEC annual reports from the New Paradigm Resources Group, Inc. (NPRG). These reports contain information on the universe of facilities-based CLECs in the United States since the passage of 1996 Telecommunication Act. NPRG provides a detailed profile for every CLEC on its history, management, ownership and organization, technology, state certification and ILEC (incumbent telephone companies or "Baby Bells") connection agreements, and the location of its local voice and data networks. From the profiles, we know all local voice markets a CLEC served and the exact year of the entry. We have firm attributes such as the year the company was founded, whether the company is public or private, whether the company is venture capital backed, and whether the company is a wholly owned subsidiary of a larger communications company, which affect the incentives and influence of managers over company decisions.

Second, using the information on CEO names from the NPRG reports, we conducted a thorough search of several public archived sources to identify CEO characteristics including education (highest degree, field of study, and school attended), age, and industry experience. For public companies, this information is typically available in the Form 10-K annual business and financial report. For private companies (and to fill out the remaining gaps for managers of the public companies), we used a variety of public sources including Who's Who directories, news archives, company websites, and other internet sources.[10] In the end, we have education information for 75% of the CEOs in our data, and age and experience information for 74%. When the data are missing, rather than drop those firms from our sample, we code the values as zero and create "missing data" covariates for experience, age, and education as controls. The coefficients on the missing data covariates have no economic interpretation.

Lastly, we obtain information on location characteristics from the 2000 US Census. The locations in the NPRG reports are best interpreted at the census "place" level, rather than the county or metropolitan statistical area. The Census provides place-level demographic information from the Census of Population but not place-level business information from the Economic Census. We selected the following variables for our analysis: population, household

[10] Both coauthors and an undergraduate research assistant conducted the search. All information found by the research assistant was confirmed by one of the coauthors. The search algorithm was as follows: (1) if public, search 10-K reports for biographical information (otherwise skip to step 2), (2) search company websites for biographical information, (3) search *Who's Who* archives, (4) search news archives for mentions of the company and the individual in the same article (allow for alternative names such as Bob for Robert), (5) search Google for mentions of the company and the individual, (6) search news archives and Google for mentions of the individual. Then confirm that it is the correct individual by triangulating with other sources on the individual's career path, (7) have a second person visit each source and confirm. If we were unsure about the match between the CLEC manager and the individual found in our search, we did not include the data (for example, we found information about a "Karl Douglas" with links to the telecommunications industry but we could not confirm that it was the Karl Douglas from REACH Communications").

income, racial composition, median age, number foreign born, household size, and unemployment.

This combination of NPRG data, manager characteristics data, and census data has several appealing features. We have information on all entry by all firms from the effective start of the industry. We can match this to rich data on firm and manager characteristics, including information on manager education and experience, and to measures of the demographic appeal of each market. Finally, a feature of the local telephone industry enables us identify a set of potential entrants in each market without assuming all firms can operate everywhere. Specifically, CLECs must first be approved by state regulators before they can operate in a given state. Once approved, the CLEC can operate anywhere it chooses within the state. Therefore, we identify potential entrants as the set of CLECs approved to operate in the state.[11]

Tables 1a, 1b, and 1c provide descriptive statistics. Table 1a shows that these firms are generally privately owned (64.5% in 1998) and have a high variance in age (the standard deviation is over twice the mean of 7.9 years in 1998). The managers average 18 years experience in the industry and are highly educated. Of the firms operating in 1998, 58% of managers have a graduate degree and 78% have at least one degree in economics or business. The table also shows the high turnover rate in the industry. Nearly 60% of the firms that operated in 1998 were no longer operating in 2004. The timing of the shakeout is clear: 50% of the firms operating in 2000 were gone by the end of 2002. Table 1b describes the 234 mid-size cities that we use in our analysis. Table 1c summarizes the data at the firm-market level.

[11] It is important to note that while regulatory approval is necessary for entry, it is not sufficient. Among the 98 CLECs approved to operate in 1998, just 56 actually entered at least one market in that year and only 79 had entered by 2004. Based on the NPRG reports, we believe that our definition of potential entrants is both simple and realistic. We check the robustness of our definition by excluding CLECs that had not entered anywhere by 2004.

5) Results

We estimate each year separately as a static simultaneous game.[12] We first discuss the coefficient estimates for 1998. As discussed above, this was effectively the first year of the industry. Therefore the entry decisions in this period are more likely to be truly simultaneous. After discussing coefficient estimates, we discuss the correlation of the estimates of strategic ability with survival and we simulate the consequences of changing the level of ability. At the end of this section, we examine how the results change over time.

5.1) What drives strategic ability?

In this sub-section we examine whether the standard information on a manager's biography relates to strategic ability. We also relate firm characteristics to ability. Table 2 column 1 shows the main results. The top part of the table shows the coefficients for the strategic ability function and the bottom part of the table shows the coefficients for market attributes used in estimating the latent profitability of entry. Before turning to analysis of firm- and manager-level characteristics, we note the strong negative relationship between the number of competitors and the level of entry (row 17). This is the most statistically significant result in almost all specifications and shows that firms appear to know, on average, that they should avoid direct competition. Therefore, it will be empirically relevant to examine how variation in strategic ability leads to variation in the avoidance of competition.

Rows 1 to 4 show the coefficients for firm-level characteristics in driving measured ability (τ) and rows 5 to 11 show coefficients for manager-level characteristics. In discussing the results, we focus on three areas: experience, education, and ownership structure.

[12] The analysis of the data from subsequent years (2000, 2002, and 2004) allows us to explore whether and how decisions improve over time. A fully dynamic CH model has not yet been developed and therefore it is not clear how to apply it to a real-world empirical setting.

Experience: Experience is widely viewed as an asset for managers. It is emphasized in manager bios and on company annual reports. Laboratory research has shown experience is positively correlated with ability in beauty contest games (Slonim 2005), and other research has documented a relationship between experience (measured at the firm or manager level) and behavior. Our results support the idea that ability is positively correlated with experience. Specifically, we find that older firms have higher values of τ (row 1). Older managers also have higher levels of τ and managers under 40 have especially low levels of τ (rows 9 and 10).We define age by three dummy variables rather than as a continuous measure in order to starkly test the hypothesis that ability improves with age up to a point, but then decreases for managers more than one standard deviation above the mean. Our results reject the idea that older managers become less sophisticated as they age. Instead, we find that 30-something CEOs tend to act naively about competition, supporting the traditional industry practice of hiring middle-aged CEOs. Further, while not significant in all specifications, the manager's experience in the industry is positively correlated with τ (row 11).

Education: We examine three different aspects of education: education level (row 5), education field (rows 6 and 7), and education quality (row 8). Whether education provides value or merely functions as a signal of ability, it should be correlated with the ability of managers. Encouragingly (for those of us in academia), managers with a graduate degree have higher levels of τ. Further, managers with a degree in either economics or business (where they likely learned about game theory) have higher levels of τ. The quality of the degree, however, is not systematically correlated with τ. Managers with degrees from schools in the US News list of top 25 colleges do not have higher levels of measured strategic ability. This result is robust to using the top 50 colleges.

Ownership structure: Ownership structure may be systematically related to manager ability because of incentives and experience. We find that CLECs that are subsidiaries of larger telecommunications companies tend to have lower measured ability (row 2). We see two possible explanations for this: these managers have fewer incentives to be cautious in entry decisions because they will be rewarded based on how fast their units grow and their loss can be covered by the mother company; or these managers were chosen to run a subsidiary business because they are either less skilled or less experienced than the others. We believe the former is more likely because the managers of subsidiaries are older and have more years experience than the other CLEC managers in our sample. Also consistent with a role for incentives, we find that private firms are more strategic than publicly-owned firms (row 3), although this result is not robust to all specifications. Venture capital backing is positively related to ability in many specifications (row 4). One possible explanation for this is that venture capitalists communicate their experience in entering new industries to the companies they support. Therefore, venture-backed CLECs drew on more experience than other new firms and consequently were more likely to consider their competition in their decisions.

Table 2 columns 2 through 4 show robustness to a number of alternative specifications. Column 2 defines potential entrants only as those 79 firms that did eventually enter the CLEC market rather than all firms licensed to do so. The core results described above are unchanged, some with significance even increased. Column 3 adds population as a predictor of strategic ability. The signs of the results of column 1 are unchanged though *venture capital*, *manager over 55*, and *manager has graduate degree* lose significance. The sign on population is significant and large (row 12). This result is consistent with Goldfarb and Yang (2008) who found that firms operating in urban areas tend to have higher values of τ . Column 4 uses an alternative functional form for τ: $\tau_j = K\Phi\left(\gamma_0 + Z_j\gamma\right)$, where $\Phi(.)$ is the density function of the standard normal distribution and K is the maximum number of types we allow for estimation. As expected, the only major change is in the value of the constant in τ, which is identified off functional form. Still, the average value of τ does not change much (3.5 rather than 3.4).

5.2) Are CLECs sufficiently strategic?

The average value of τ is 3.4 (derived from the estimates in table 2 column 1), meaning 3% of firms are type 0, 11% are type 1, 19% are type 2, 22% are type 3, 19% are type 4, and 26% are type 5 or higher. The average value is at the high end of the range found in Camerer, Ho, and Chong (2004), although it is well below their maximum of 4.9. We view this as providing support for the CH model: given that this is a more important decision than those faced by typical laboratory subjects, we expect the value of τ to be higher. Still, we want to be cautious in our interpretation of the value of τ because the constant (row 1) is only identified on the functional form. We are much more comfortable comparing the relative importance of manager and firm characteristics to strategic ability and comparing the value across years using the same functional form than interpreting the level of τ in any absolute sense.

5.3) Are more strategic firms more likely to survive?

Next, we examine whether the CLECs that we estimated to be more sophisticated are, in fact, more successful. Given that such a large percentage of firms failed, especially after telecommunications stocks crashed in 2001, we use survival as our measure of success. We use three different measures of survival: whether the CLEC exited within 2 years, within 4 years, and within 6 years. Firms that merged or were acquired are not considered to have exited the industry. Therefore exit means that the firm is no longer operating in the industry. We expect that the level of ability in 1998 will have a weaker relationship with survival as time passes. We predict each firm's τ based on the coefficients in Table 2 column 1 and the firm's characteristics. We then regress exit on the predicted τ using a probit.

Table 3 shows that τ is negatively correlated with early exit from the industry. We take exit within 4 years as the benchmark result because 2002 is right after the valuation crash. Column 3 shows that there is a significantly negative marginal effect of τ on exit of about 14%. Since the value of τ is predicted from a simple log linear function of firm and manager characteristics, it is important to be cautious in this interpretation. The results will be a consequence of spurious correlation to the extent that firm and manager characteristics drive survival for reasons other than strategic ability. Consistent with the prior literature (e.g. Dunne, Roberts, and Samuelson 1988), we especially suspect that firm age has effects on firm survival, independent of τ. As a robustness check, we run the same probit regressions of exit on τ conditioning on log of firm age. The results are robust.

5.4) What happens as strategic ability changes?

The purpose of this sub-section is to better understand how ability drives entry decisions. We simulate what would happen if strategic ability was higher or lower than estimated. In particular, we add or subtract a constant from the estimated value of τ in order to set the average value of τ to be 2, 3, 4, and 5. We then simulate how the CLECs would behave based on these different assumptions and our parameter estimates in table 2 column 1. We also simulate the consequences of all firms being type 0. Figures 2 and 3 show the results.

Figure 2 shows the number of entrants per market as strategic ability changes. If all firms are type 0, then there is substantial over-entry with 61% of markets having 5 or more competitors. As τ rises, the proportion of truly naïve (type 0) players decreases. Rather, when τ

averages two, too many firms anticipate naïve competitors' over-entry. As a consequence of this (incorrect) anticipation, CLECs are hesitant to enter and 56% of markets experience no entry at all. Then with further increases in τ, firms become better at conjecturing the behavior of competitors and consequently fewer markets have no competitors and more markets have one to four competitors. Gradually as τ increases, the entry rate stabilizes.

By construction, this means that fewer firms will have ex post regret about their decisions as strategic ability increases. By "regret", we mean that firms would have made a different decision had they correctly conjectured competitor behavior. Figure 3 shows the levels of regret as strategic ability changes. When all firms are type 0, too many firms enter and firms regret half of all decisions and nearly all entry decisions. As strategic ability increases, the nature of regret changes: firms regret *not* entering markets that have few competitors.[13] When τ averages 2, firms regret 32% of decisions. The vast majority of these regrets are decisions not to enter. As τ increases past 2, regret continues to fall for both entry and non-entry decisions. At the average value predicted in the estimation (3.4), firms regret 7% of decisions. When τ is 5, firms regret just 2% of decisions. Therefore, strategic ability lowers regret. More interestingly, the types of decisions regretted change as the average level of strategic ability changes.

Overall, strategic ability does not have a monotonic relationship with the level of competition. At very low levels of ability, firms over-enter. As ability rises, they start to under-enter. Once ability is high enough, the level of competition balances out across markets: more markets have just a few competitors. This result contrasts sharply with Goldfarb and Yang (2008) who found that strategic ability monotonically slows the diffusion of a new technology (i.e. it reduces entry). This contrast highlights the importance of the parameter estimates and

[13] In reading figure 3, note that the number of entrants and non-entrants varies as strategic ability changes.

actually conducting the simulations. The effects of changing strategic ability depend on the average observed entry level and the variance in the estimated level of ability.

5.5) How does strategic ability evolve over time?

Table 4 repeats the analysis in table 2 column 1 using data from 2000, 2002, and 2004. The measure of ability requires a different interpretation in these later years because firms could observe what competitors did in the prior periods. Therefore, a simultaneous entry game is less appropriate in this setting. Rather than focus on interpreting the coefficients, we focus on the change in measured ability over time and examine whether the industry as a whole moves to a more sophisticated level.[14] The mean and variance of τ change substantially over time. In 1998, the average firm has a τ of 3.4. This value decreases to 3.2 in 2000 and 2002 during the height of the boom and the volatile years that immediately followed. Then in 2004, with the recovery underway, τ increases substantially to 6.1. We interpret the increase in measured ability after the shakeout as supporting evidence for an evolution towards the steady equilibrium outcome assumed in much of the existing simultaneous entry literature (e.g. Greenstein and Mazzeo 2006).

At the same time, the variance across firms increases over time from 0.6 in 1998 to 7.8 in 2004. Comparing the minima and maxima of τ across years, it seems that the increased variation is driven by the emergence of highly sophisticated firms in later years. It also indicates that although the industry as a whole increases in sophistication over time, the naivety is a persistent phenomenon. Given that this is an industry with a high turnover rate and that we already found that new firms are less likely to act strategically, this pattern is not surprising. Some questions,

[14] Most of the relationships found in the 1998 data remain in later years: the number of competitors is negatively correlated with entry, older firms and managers with graduate degrees are more sophisticated, and subsidiaries of large firms and young managers are less sophisticated. The only significant reversal of signs is that venture capital financed firms appear less sophisticated than others in 2002 and 2004 but more sophisticated in 1998 and 2000.

however, still follow: do the smart get smarter, while the less strategic firms exit? Or does the entire industry learn over time? And do firms learn from past successes and failures? The dynamic implications of these questions, although beyond the scope of this project, warrant future research.

6) Conclusions

Overall, our approach provides insights into the incidence of strategic ability in a new market: local telephone competition following the 1996 Act. By combining structural econometric techniques and behavioral game theory, we show that firm behavior is related to manager and firm characteristics in a systematic way. Generally, older firms with educated, experienced managers make decisions that suggest they are better able to correctly conjecture competitive behavior.

Three aspects of our results suggest considerable validity for the CH model in this setting, especially in 1998. First, the coefficient estimates are suggestive that the strategic ability parameter, τ, is correlated with intelligence and experience. Managers that are trained in economics or business (and therefore are particularly likely to have been exposed to game theory) are estimated to be more sophisticated. Further, managers with graduate degrees and managers with more experience (measured by years in the industry and age) are estimated to be more sophisticated. Second, our estimate of τ increases following the shakeout suggesting that the industry became more sophisticated in its aftermath. The estimate of τ is also within the range found in many laboratory experiments. Third, our strategic ability parameter correlates with out-of-sample success: those firms estimated to be less strategic in 1998 are more likely to exit the industry early.

As with any empirical work, this paper has a number of limitations. First, we measure a very specific type of ability: the ability to correctly conjecture competitor behavior. There are many other dimensions of managerial ability and we cannot say anything about these. Second, the analysis is not a test of CH against Nash because the Nash concept is not nested in our model and therefore not testable. Still, we argue that our results have both internal and external validity. For internal validity, the signs of the covariates on firm and manager characteristics are consistent with the idea that model measures strategic ability. For external validity, we show that firms that are estimated to have higher levels of ability were less likely to exit. We also rely on the experimental literature that has generally supports many of our modeling assumptions. Finally, the empirical setting may differ from the model in ways that may affect the results. For example, there may be unobserved reasons why some markets are particularly attractive to inexperienced firms that are not a consequence of strategic considerations. Further, while we observe the industry very close to its inception, the game is not truly simultaneous and the extent to which actions are observable may bias our results toward a higher level of ability.

In summary, we have provided a structural framework for estimating strategic ability using revealed preference in a real-world setting. The unique solution to this structural model means that we can include manager and firm characteristics in our analysis. In contrast, entry models that use the Nash equilibrium concept often have multiple equilibria that force analysis to be at the market level rather than the firm level. Our results help explain several aspects of early competition in local telephone markets: firms run by educated older managers operated in markets with fewer competitors and firms that operated in markets with fewer competitors were more likely to survive. This framework may prove useful in other settings where firms make simultaneous decisions including other entry decisions, retailer choices to stock new products, and auctions.

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Table 1a: Descriptive Statistics by CLEC

	1998		2000		2002		2004	
Variable	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**Std Dev**
# markets available to enter	61.520	66.852	75.692	70.676	90.312	70.634	92.375	73.670
# markets entered	4.916	9.3624	11.350	16.521	15.671	16.787	16.946	17.397
Firm age	7.927	17.899	11.025	20.769	10.281	14.893	12.660	15.795
Subsidiary	0.312	0.465	0.282	0.451	0.218	0.416	0.321	0.471
Privately owned	0.645	0.480	0.581	0.495	0.625	0.487	0.678	0.471
Financed by venture capital	0.177	0.383	0.222	0.417	0.296	0.460	0.142	0.353
Exit by 2000	0.218	0.415	N/A		N/A		N/A	
Exit by 2002	0.510	0.502	0.495	0.502	N/A		N/A	
Exit by 2004	0.593	0.493	0.606	0.490	0.218	0.416	N/A	
Manager characteristics (conditional on being observed)								
Any economics or business degree	0.783	0.415	0.691	0.465	0.755	0.434	0.731	0.448
Any graduate degree	0.583	0.496	0.535	0.501	0.551	0.501	0.549	0.502
Any engineering or science Degree	0.396	0.493	0.368	0.485	0.372	0.488	0.382	0.491
Any degree from US News top 25 school	0.400	0.493	0.304	0.463	0.275	0.450	0.294	0.460
Age	46.619	9.040	48.912	8.590	48.297	7.138	49.512	7.599
Experience	18.436	8.162	19.882	11.013	19.685	9.683	21.187	9.120
# observations (CLECs)	**96**		**117**		**64**		**56**	

Table 1b: Descriptive statistics by market (N=234)

Variable	Mean	Std Dev	Min	Max
Population (in thousands)	224.07	160.84	100.27	951.27
% African American	0.178	0.180	0.003	0.840
Median Age	32.80	3.079	22.9	41.8
Household Size	2.636	0.418	2.03	4.55
% Foreign Born	0.156	0.125	0.011	0 .721
Household Income (in $1000)	41.67	11.67	23.48	88.77
% unemployed	0.079	0.040	0.023	0.290

Table 1c: Descriptive statistics by CLEC-market

	1998		**2000**		**2002**		**2004**	
	Mean	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**Std Dev**	**Mean**	**Std Dev**
Entry	0.0799	0.271	0.1501	0.357	0.173	0.378	0.183	0.387
Population (in thousands)	222.40	160.76	226.30	163.45	229.02	165.73	228.34	166.95
% African American	0.169	0.170	0.176	0.173	0.188	0.179	0.184	0.178
Median Age	32.75	3.13	32.79	3.14	32.86	3.10	32.83	3.10
Household Size	2.67	0.440	2.65	0.426	2.62	0.404	2.63	0.413
% Foreign Born	0.171	0.131	0.165	0.129	0.156	0.127	0.159	0.127
Household Income (in $1000)	42.33	12.16	41.74	12.00	41.05	11.70	41.28	11.83
% unemployed	0.079	0.040	0.079	0.039	0.081	0.042	0.080	0.041
Privately owned	0.432	0.495	0.409	0.491	0.439	0.496	0.524	0.499
Financed by venture capital	0.160	0.367	0.193	0.394	0.269	0.443	0.179	0.383
Firm age	13.71	27.26	10.85	19.11	12.94	21.84	15.48	23.04
Subsidiary	0.211	0.408	0.174	0.379	0.182	0.386	0.278	0.448
Experience	15.54	9.87	16.50	12.23	17.02	11.33	18.08	10.80
Age below 40	0.159	0.365	0.119	0.324	0.067	0.251	0.046	0.211
Age above 55	0.243	0.429	0.254	0.435	0.248	0.432	0.240	0.427
Any graduate degree	0.573	0.494	0.456	0.498	0.501	0.500	0.489	0.499
Any economics or business degree	0.553	0.497	0.432	0.495	0.636	0.481	0.560	0.496
Any engineering or science Degree	0.225	0.418	0.262	0.440	0.330	0.470	0.332	0.471
Any degree from US News top 25	0.409	0.491	0.264	0.441	0.271	0.445	0.300	0.458
Experience missing	0.164	0.370	0.143	0.350	0.122	0.328	0.110	0.313
Age missing	0.076	0.265	0.148	0.355	0.148	0.355	0.152	0.359
Education missing	0.135	0.342	0.181	0.385	0.033	0.180	0.038	0.192
# observations (CLECs-markets)	**5906**		**8869**		**5780**		**5173**	

Table 2: Strategic ability and entry coefficients for 1998

		Variables	(1) Main	(2) Potential entry means entered by end of 2004	(3) Allow firms τ to vary by market size	(4) Alternative functional form $\tau_j = K\Phi(\gamma_0 + Z_j\gamma)$
Coefficients on strategic ability parameter τ	(1)	Log (firm age)	0.096 (0.018)***	0.151 (0.026)***	0.124 (0.022)***	0.122 (0.019)***
	(2)	Subsidiary	-0.069 (0.035)**	-0.273 (0.050)***	-0.144 (0.042)***	-0.183 (0.035)***
	(3)	Privately owned	0.138 (0.038)***	-0.017 (0.037)	-0.036 (0.043)	0.020 (0.033)
	(4)	Venture capital	0.104 (0.050)**	0.009 (0.047)	0.087 (0.054)	0.014 (0.041)
	(5)	Manager has graduate degree	0.096 (0.034)***	0.098 (0.036)***	0.060 (0.039)	0.116 (0.034)***
	(6)	Manager has degree in economics or business	0.088 (0.032)***	0.123 (0.037)***	0.079 (0.039)**	0.069 (0.031)**
	(7)	Manager has degree in engineering or science	0.040 (0.036)	0.157 (0.046)***	0.053 (0.046)	0.076 (0.038)*
	(8)	Manager has degree from US News top 25	-0.046 (0.033)	-0.077 (0.035)**	-0.012 (0.034)	-0.056 (0.032)*
	(9)	Manager age below 40	-0.196 (0.057)***	-0.082 (0.040)**	-0.257 (0.059)***	-0.077 (0.035)**
	(10)	Manager age above 55	0.090 (0.034)***	0.060 (0.034)*	0.033 (0.038)	0.049 (0.030)
	(11)	Log (manager years of experience in industry)	0.0618 (0.033)*	0.018 (0.035)	0.032 (0.039)	0.044 (0.031)
	(12)	Place population in millions			1.282 (0.227)***	
	(13)	Years of experience missing	0.0529 (0.100)	0.006 (0.106)	0.072 (0.019)	0.078 (0.091)
	(14)	Manager age missing	-0.163 (0.047)***	0.095 (0.050)*	-0.064 (0.058)	-0.012 (0.043)
	(15)	Manager education missing	0.002 (0.033)	0.020 (0.036)	-0.008 (0.038)	0.016 (0.032)
	(16)	Constant in τ	0.837 (0.108)***	0.779 (0.122)***	0.464 (0.160)***	-0.565 (0.098)***
Coefficients on entry	(17)	# of competitors	-0.961 (0.070)***	-0.809 (0.078)***	-0.687 (0.063)***	-0.947 (0.069)***
	(18)	Place population in millions	16.159 (1.072)***	10.073 (1.026)***	7.136 (0.884)***	11.337 (0.961)***
	(19)	% black	2.489 (0.777)***	5.117 (0.823)***	2.172 (0.679)***	4.346 (0.821)***
	(20)	Median age	-0.037 (0.036)	0.072 (0.037)*	0.115 (0.036)***	0.082 (0.038)**
	(21)	Household size	-2.470 (0.358)***	-1.908 (0.373)***	-2.790 (0.340)***	-2.014 (0.372)***
	(22)	% foreign born	3.217 (1.193)***	7.041 (1.237)***	6.794 (1.155)***	5.192 (1.215)***
	(23)	HH income in $1000	-0.066 (0.591)	-0.231 (0.544)	-0.437 (0.532)	-0.317 (0.542)
	(24)	% unemployed	26.883 (4.867)***	-5.401 (3.147)*	10.184 (2.993)***	1.593 (2.742)
	(25)	Constant	2.029 (2.258)	0.237 (2.246)	1.617 (2.245)	0.253 (2.268)
		# of CLECs	96	79	96	96
		# of CLEC-markets	5906	5699	5906	5906
		Log Likelihood	-1378.0	-1324.9	-1306.7	-1308.5

*significant at 90% confidence level. **significant at 95% confidence level. ***significant at 99% confidence level.

Table 3: Firms with a higher τ are more likely to exit the industry early

	(1)	(2)	(3)	(4)	(5)	(6)
	Exit by 2000		**Exit by 2002**		**Exit by 2004**	
τ	-0.138	-0.157	-0.137	-0.160	-0.105	-0.066
	(0.078)*	(0.091)*	(.079)*	(0.091)*	(0.072)	(0.083)
Log(firm age)		0.024		0.029		-0.046
		(0.058)		(0.056)		(0.050)
Constant	0.909	1.001	1.654	1.768	1.776	1.563
	(0.721)	(0.754)	(0.759)**	(0.792)**	(0.800)**	(0.833)***
Log Likelihood	-61.387	-61.300	-60.875	-60.740	-53.978	-53.537

Notes: Probit regression of exit on τ and firm age using the τ calculated in Table 2 col. 1 (1998). Marginal effects reported. N=96.
*significant at 90% confidence level. **significant at 95% confidence level. ***significant at 99% confidence level.

Table 4: Strategic ability and entry coefficients for 1998, 2000, 2002, and 2004

			(1)	(2)	(3)	(4)
		Variables	**1998 (as Table 2)**	**2000**	**2002**	**2004**
Coefficients on strategic ability parameter τ	(1)	**Log (firm age)**	0.096 (0.018)***	0.034 (0.007)***	0.157 (0.063)**	0.226 (0.098)**
	(2)	**Subsidiary**	-0.069 (0.035)**	-0.024 (0.016)	-0.078 (0.087)	-0.377 (0.116)***
	(3)	**Privately owned**	0.138 (0.038)***	-0.030 (0.019)	0.236 (0.130)*	0.234 (0.110)**
	(4)	**Venture capital**	0.104 (0.050)**	0.064 (0.020)***	-0.107 (0.122)	-0.177 (0.103)*
	(5)	**Manager has graduate degree**	0.096 (0.034)***	0.037 (0.014)***	0.177 (0.097)*	0.170 (0.105)
	(6)	**Manager has degree in economics or business**	0.088 (0.032)***	0.046 (0.015)***	-0.060 (0.079)	0.094 (0.103)
	(7)	**Manager has degree in engineering or science**	0.040 (0.036)	0.050 (0.015)***	0.185 (0.094)**	0.107 (0.118)
	(8)	**Manager has degree from US News top 25**	-0.046 (0.033)	0.001 (0.015)	-0.095 (0.091)	0.052 (0.133)
	(9)	**Manager age below 40**	-0.196 (0.057)***	-0.067 (0.017)***	-0.281 (0.125)**	-0.387 (0.195)**
	(10)	**Manager age above 55**	0.090 (0.034)***	0.006 (0.014)	-0.092 (0.099)	0.127 (0.120)
	(11)	**Log (manager years of experience in industry)**	0.0618 (0.033)*	-0.039 (0.009)***	-0.014 (0.058)	-0.054 (0.101)
	(12)	**Years of experience missing**	0.0529 (0.100)	-0.175 (0.032)***	0.628 (0.278)**	1.643 (5.816)
	(13)	**Manager age missing**	-0.163 (0.047)***	0.047 (0.020)**	-0.550 (0.198)***	0.322 (0.219)
	(14)	**Manager education missing**	0.002 (0.033)	0.044 (0.017)**	-0.069 (0.097)	-0.119 (0.129)
	(15)	**Constant in τ**	0.837 (0.108)***	1.157 (0.042)***	0.755 (0.257)***	0.509 (0.422)
Coefficients on entry	(16)	**# of competitors**	-0.961 (0.070)***	-0.546 (0.028)***	-0.343 (0.055)***	-0.357 (0.039)***
	(17)	**Place population in millions**	16.159 (1.072)***	10.634 (0.821)***	6.824 (0.877)***	7.066 (0.744)***
	(18)	**% black**	2.489 (0.777)***	9.859 (0.698)***	2.752 (0.575)***	2.007 (0.504)***
	(19)	**Median age**	-0.037 (0.036)	0.002 (0.025)	0.009 (0.026)	-0.003 (0.026)
	(20)	**Household size**	-2.470 (0.358)***	-0.571 (0.294)*	-0.620 (0.221)***	-0.284 (0.241)
	(21)	**% foreign born**	3.217 (1.193)***	6.726 (0.754)***	-0.123 (0.659)	-2.947 (0.656)***
	(22)	**HH income in $1000**	-0.066 (0.591)	-0.330 (0.402)	-0.126 (0.303)	-0.061 (0.306)
	(23)	**% unemployed**	26.883 (4.867)***	-0.913 (2.989)	3.378 (2.207)	2.713 (2.077)
	(24)	**Constant**	2.029 (2.258)	-0.100 (1.793)	-0.015 (1.513)	-0.075 (1.536)
		Mean τ	3.427	3.177	3.205	6.141
		Standard deviation τ	0.644	0.231	1.132	7.767
		Minimum τ	1.935	2.597	1.696	1.221
		Maximum τ	4.764	3.909	9.261	31.021
		# of CLECs	96	117	64	56
		# of CLEC-markets	5906	8869	5780	5173
		Log Likelihood	-1378.0	-3201.8	-2321.7	-2127.3

*significant at 90% confidence level. **significant at 95% confidence level. ***significant at 99% confidence level.

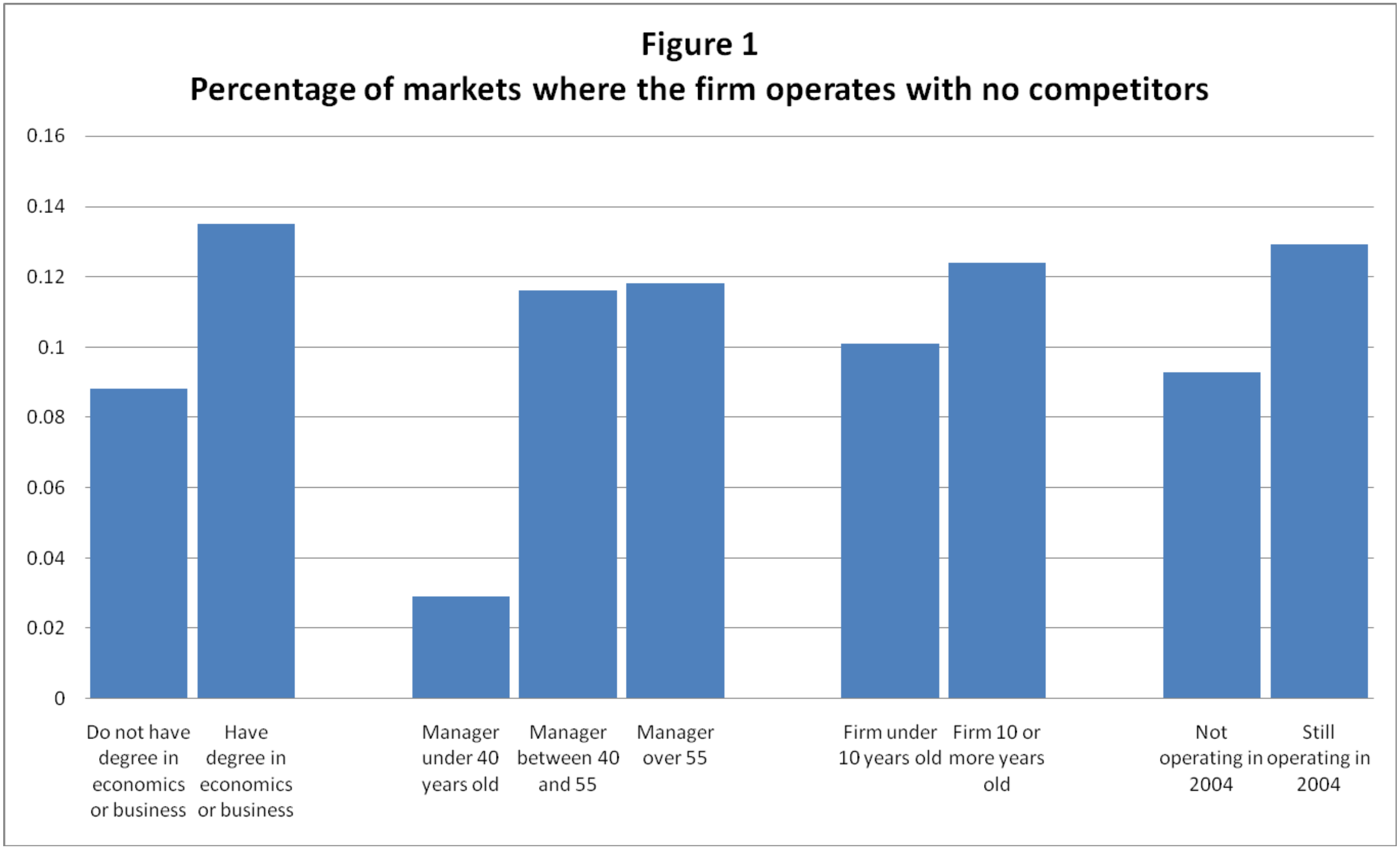
Figure 1
Percentage of markets where the firm operates with no competitors
0.16
0.14
0.12
0.1
0.08
0.06
0.04
0.02
0
Do not have degree in economics or business
Have degree in economics or business
Manager under 40 years old
Manager between 40 and 55
Manager over 55
Firm under 10 years old
Firm 10 or more years old
Not operating in 2004
Still operating in 2004

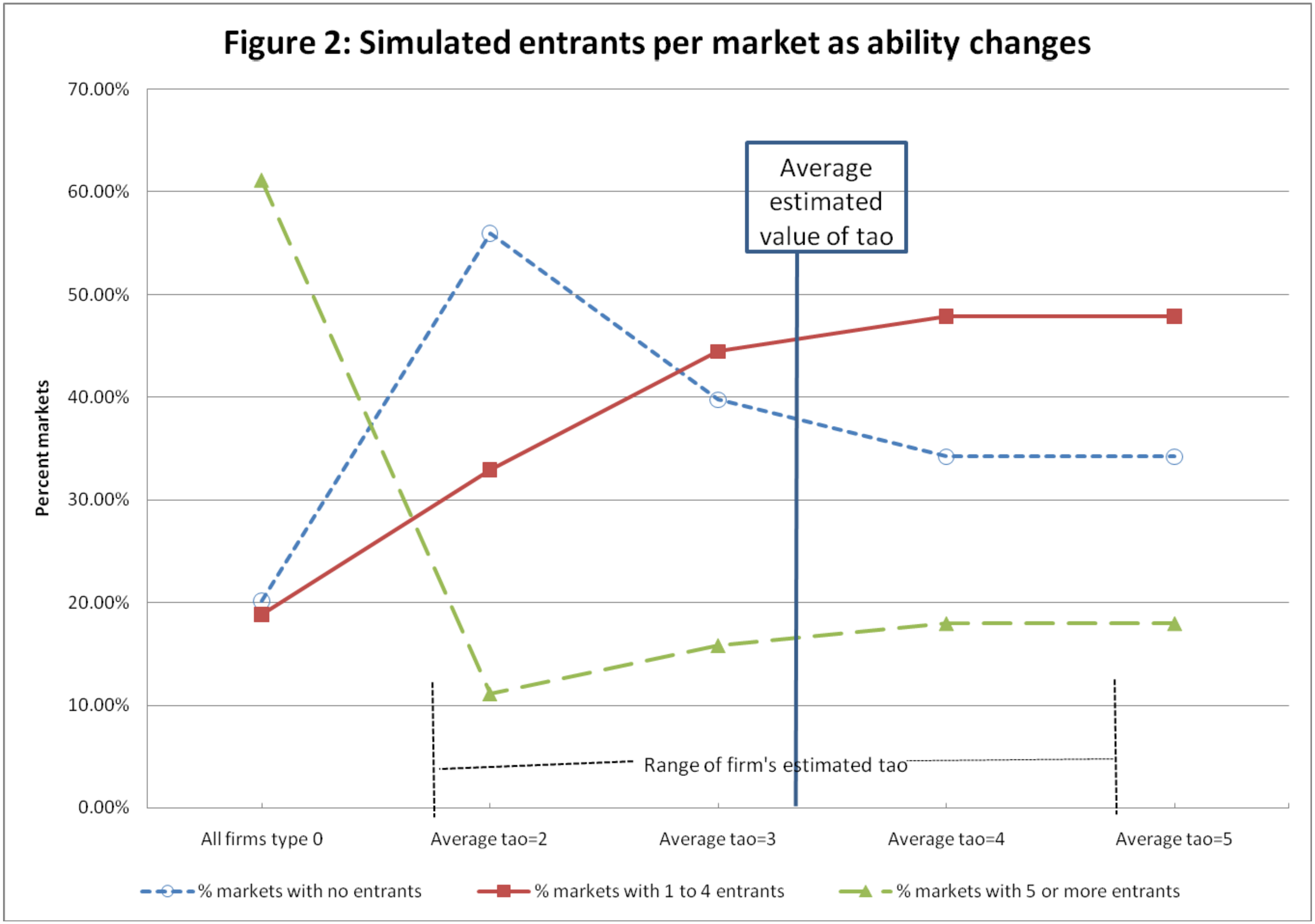
Figure 2: Simulated entrants per market as ability changes
70.00%
60.00%
50.00%
40.00%
30.00%
20.00%
10.00%
0.00%
Percent markets
Average estimated value of tao
Range of firm's estimated tao
All firms type 0
Average tao=2
Average tao=3
Average tao=4
Average tao=5
% markets with no entrants
% markets with 1 to 4 entrants
% markets with 5 or more entrants

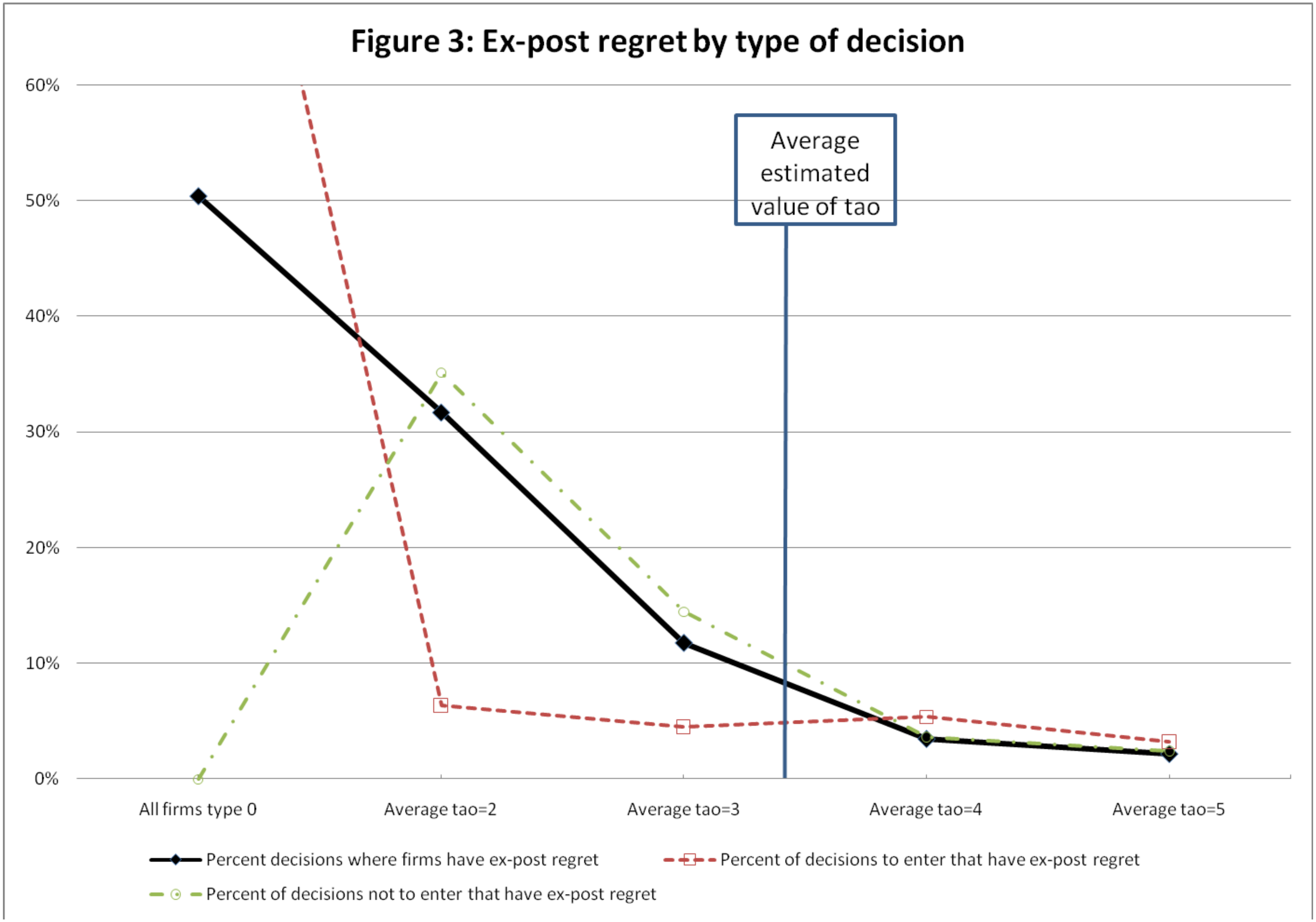
Figure 3: Ex-post regret by type of decision
60%
50%
40%
30%
20%
10%
0%
Average estimated value of tao
All firms type 0
Average tao=2
Average tao=3
Average tao=4
Average tao=5
Percent decisions where firms have ex-post regret
Percent of decisions to enter that have ex-post regret
Percent of decisions not to enter that have ex-post regret