# COMPETITIVE OUTCOMES IN PRODUCT-DIFFERENTIATED OLIGOPOLY

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*Abstract*—This paper analyzes the effect of market concentration and product differentiation on the observed outcomes of competition among oligopolists. The empirical framework is designed to examine whether competition is less intense in markets with equal levels of concentration but more differentiation among the products offered. A two-stage estimation procedure is proposed to address the endogeneity problem inherent in comparing outcomes across different market structures. I estimate the competitive effects using data from a cross section of oligopoly motel markets located along U.S. interstate highways. The results indicate that firms benefit substantially by offering differentiated products. The presence of any market competitor drives down prices, but the effect is much smaller when the competitor is a different product type. Differentiation is optimal product choice behavior because the resulting competition among firms is less tough when their products are differentiated.

## I. Introduction

IN a differentiated-product oligopoly, a firm's profits will depend on the type of product it chooses to offer, as well as the entry and product-type decisions of its competitors. Price competition may be tougher if the market contains more operating firms. Firms can soften the price competition found in less concentrated markets, however, by offering differentiated products. Given market demand, quantity will also depend on firms' relative locations in product space. Using data from a large cross section of motel oligopolies, in which firms are differentiated according to the quality of services they offer, this empirical analysis measures the impact of both market concentration and product differentiation on competitive outcomes.

The empirical work extends a long line of research on the relationship between market structure and the profitability of firms. Such studies have primarily examined homogeneous product markets; by analyzing data from a product-differentiated industry, I can explicitly measure how the effects of competitors differ according to their relative product-space locations. The results demonstrate that competitors have a less harmful effect when products are differentiated. In the case of motels, duopoly prices are about 5% lower than the monopoly price when the two competitors offer similar-quality lodging services. If the quality of the two firms is different, however, there is no price effect associated with the second firm.

The paper also proposes an econometric methodology to address the endogeneity problem that confronts empirical work on the relationship between outcomes and market structure. Firms anticipate the competitive effects of market structure when making their entry and product-type decisions. The market structure variables used to explain the observed outcomes, therefore, derive from the related entry and product choice stage of the game. As a result, it is crucial to allow for correlation between unobserved factors that affect the entry and product-type decisions of firms and unobservables in the outcome regressions. To correct for the potential bias caused by this correlation, an econometric model of equilibrium market structure is employed as a selection equation in a two-step estimation procedure. The second-step outcome regressions are modified to reflect the market structure selection. This alternative approach emphasizes the logical relationship among firms' entry and product choice behavior, market structure, and price competition.

Following this introduction, I provide some background for the analysis of competitive outcomes in motel oligopolies. Section III presents the two-step estimation procedure developed to measure the effects of concentration and differentiation on outcomes. This procedure is used to analyze the observed outcomes of motels located along interstate highways; the data are outlined in section IV. In section V, I present the estimation results. Evidence from the analysis of these outcomes help demonstrate why motel firms find differentiation a profitable product choice strategy. Section VI provides some concluding remarks.

## II. Background

This paper analyzes the outcomes of competition among differentiated oligopolists. Since Hotelling (1929), a substantial literature has developed which uses game-theoretic models to predict equilibrium product-type configurations and market outcomes in differentiated product oligopolies.[1] These models propose that firms compete in prices and quantities once all the firms operating in the market have made entry and product space location decisions. To the extent that consumers gain different utility levels from various product types, competing firms can differentiate their products and maintain prices higher than marginal cost in equilibrium without losing their entire market share. Some consumers may be inclined to sacrifice the utility associated with paying a higher price, if they have a strong product-type preference. The distribution of consumer preferences over product types is crucial: if preferences are skewed in favor of a particular product type, the resulting price elasticity for a firm offering the popular type may be smaller. Firms offering an unpopular product type may need to charge a substantially lower price in order to attract

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[1] Shapiro (1989) provides a thorough review of this literature.


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customers.[2] This basic tradeoff between price and market share underlies the profit-maximizing choices of product space locations by firms.[3]

The relative product-space location of competitors also affects the relevant elasticities. In cases where the other firms are located nearby in product space, theory predicts that equilibrium prices will be closer to marginal cost. In other words, there is a first-order effect that drives down the price of similar competitors—price competition is tougher when products are not differentiated.[4] The impact of competitors' product-space locations provides the link between the two stages of the game. Firms choose product type optimally, anticipating how the competition will proceed given their product choice and what their profits will be under each product-type configuration. Product differentiation influences the toughness of competition, equilibrium outcomes, and profits—these in turn determine firms' entry and product choice behavior.

### A. *Empirical Profits-Concentration Literature*

Analyses relating profits and market concentration were a fundamental part of the structure-conduct-performance paradigm in industrial organization. Regressions that reported a positive correlation were treated as support for the hypothesis that firms would earn higher profits if they faced fewer competitors. Demsetz (1974) critiqued this literature by pointing out that even if a positive correlation between economic profits and concentration could be established, the direction of causation would remain in doubt. For example, if firms have different capabilities, some are apt to be more profitable (they may have lower costs) than others—these firms ought to outperform less capable counterparts. If the number of firms possessing superior capabilities is small, only a few will survive. In this scenario, a positive correlation between profits and market concentration occurs because the small number of highly profitable firms translates into a concentrated market, not because concentration somehow enables firms to earn higher profits. This argument casts fundamental doubt on nonstructural methods for examining the relationship between profits and market structure.[5]

Nonetheless, some authors proceeded to make improvements on these early regressions. Weiss (1989) responded with a compendium of studies that explored the relationship between market structure and prices, rather than profits. He contended that since prices are determined in the market, they would not reflect the technical superiority of operating firms, as profits might. Weiss's book summarized a collection of more that 100 empirical analyses—the typical study regressed price (controlling for variables related to market-level costs) on some measure of concentration for a collection of markets in a homogeneous product industry—and concluded: "our evidence that concentration is correlated with price is overwhelming."

The price and market structure regressions leave a further econometric difficulty unaddressed. Because of the relationship between price competition and market structure determination, it is likely that underlying shocks (to demand, for example) will affect both. Market concentration measures used to explain price may be correlated with unobservables in the price regression, causing bias in its estimated parameters. To date, remedies for this endogeneity problem have had limited success.[6] An effective two-stage least-squares procedure relies on instruments that affect market structure but not prices, which are typically difficult to isolate.[7] Reiss and Spiller (1989) employ a promising approach that embeds price and quantity determination, along with some assumptions about the nature of price competition, directly within a model of entry. This empirical strategy captures the effect of market structure on both outcomes and entry at once. While applying their model is limited by the difficulty of solving for all the equilibrium price and quantity strategies when several firms are operating, it does demonstrate the gains to be made from an integrated analysis of market structure determination and price competition.

The estimation procedure proposed in the following section extends the empirical literature on the effects of market concentration in two important ways. First, I estimate a much richer set of competitive effects. Since theory suggests that the impact of additional competitors ought to vary with product type, I regress the market outcomes on dummy variables representing the number of competing firms in

[2] In the empirical analysis below, I attempt to control for the consumer preference distribution across markets. Unfortunately, effectively capturing this distribution is difficult in the context of the motel industry. This provides motivation for the careful treatment of the unobservables and, specifically, the selection model developed in this paper. I will return to this topic at length below.

[3] Tirole (1988) derives the basic results and discusses extensions to the model. It is critical to assume that firms cannot price-discriminate according to consumers' willingness to pay for the various product types. This assumption is reasonable in the context of the highway motels studied here.

[4] When multiple firms are operating, there may be a second-order effect throughout the market as well. The now lower prices of the close-together firms puts competitive pressure (through the demand function) on the firms located elsewhere in product space. Even though their products are differentiated, such firms may be forced to lower their prices in order to maintain an adequate market share.

[5] In fact, similar versions of this argument in related areas ultimately placed running structure-conduct-performance regressions in disfavor. The literature turned to more structural approaches in response, first theoretical, now empirical (see Bresnahan, 1992).

[6] Evans, Froeb, and Werden (1993) also recognize this problem. They propose a solution appropriate for regressions using panel data sets. Another recent study of market structure on outcomes, by Emmons and Prager (1997), acknowledges the sources and potential consequences of the endogeneity problem, but does not attempt to endogenize market structure in response.

[7] For example, Borenstein (1989) uses the characteristics of competitors as instruments for prices. This does not take account of the equilibrium aspects of market structure determination.

their markets and the product type of each.[8] In addition, I utilize a two-step estimation procedure to address the endogeneity of market structure. An equilibrium model that predicts the number and product types of competing firms in a market is estimated in the first step; the parameters obtained are inserted into subsequent outcome regressions to correct for the endogeneity of the market structure variables. In this way, the framework incorporates the connection between the two stages of the game directly into the estimation.

### *B. Motel Industry*

Data for the empirical analysis comes from the motel segment of the lodging industry, which caters to highway travelers and represents nearly half of the estimated 48,000 hotel properties in the United States.[9] Motels began to prosper during the first half of the twentieth century: as Americans purchased automobiles in larger numbers, it became popular to criss-cross the country on vacations and to travel from town to town for business. The industry was buoyed further by the National System of Interstate and Defense Highways, a 42,500-mile network of freeways established in 1956 and constructed in the years since. Business establishments providing services for travelers have flourished along interstate highways, even in remote areas where little demand for such services would otherwise exist.[10]

While all motels provide the same basic services, they differ in the level of quality associated with these services. Industry observers have traditionally applied a single-index representation of differentiation based on quality to categorize roadside motel establishments.[11] Travel organizations like the American Automobile Association (AAA) have established rating systems to provide consumers with accurate information about the quality of motel services. Using AAA's rating for each motel, I have divided the motels in my sample into two product types: low and high quality. Further details on the data set are presented in section IV.

Though franchising and chain affiliation are widespread in the motel industry, independent entrepreneurs still make decisions for each individual property. This is crucially important for the empirical work, which assumes that the quality type of each establishment represents the choice that maximizes profits for that establishment. The individual franchisees and independent motel proprietors represented in my data set almost certainly behave in this manner. This assumption is particularly appropriate for smaller rural markets, where franchisees choose their quality by selecting which chain to represent and independent motels remain quite common.[12]

## III. Estimating Competitive Outcomes with Endogenous Market Structure

The framework outlined in the previous section suggests that, along with some measure of marginal cost, the number of competitors and their product types affect the prices firms charge. Therefore, I propose the following estimating equation for motel prices:

$$p_i = Z_p\gamma_p + h(\phi_p; \vec{N}) + \varepsilon_p,$$

where $p_i$ denotes the observed price of firm $i$. The $Z$-variables include market-level demographic characteristics representing the costs of operating at each particular location and firm-level variables, including brand dummies, to control for chain-specific regularities such as particular price reporting policies.[13] Some $Z$-variables may affect the costs and prices of low- and high-quality motels differently; terms can be included to allow the effects of regressors to vary by product type. The term $\varepsilon_p$ captures unobservables that affect the firm's price.

While clearly necessary, the $Z$-variables in the price regression serve primarily as controls. The more economically interesting parameters are contained in the function $h(\phi; \vec{N})$, where the vector $\vec{N}$ indicates the product types of the competitors a firm faces in its market.[14] Theory suggests that more competition results in lower prices, but that the reduction may be smaller if products are differentiated. The empirical exercise evaluates such hypotheses by isolating the incremental impact each additional competitor has on

[8] Bresnahan and Reiss (1991) measured the incremental price effects of additional competitors, but in undifferentiated markets (retail tire dealers). Their results indicated the highest prices in markets of one or two firms, with lower prices in markets of three or more firms. Prices were even lower in unconcentrated (more than five firms) markets. The authors did not allow for the endogeneity of the market structure regressors in their analysis.

[9] Standard and Poor's (1998) estimates 1997 industry revenue at about $80 billion. The 48,000 properties represent over 3.7 million rooms.

[10] Belasco (1979) is an excellent history of the early motel industry in the United States. Recent trends and the current state of the industry are chronicled by Jakle, Scule, and Rogers (1996).

[11] See, for example, Rompf (1994). It might be argued that certain classes of hotels differentiate themselves by the types of services they offer. Hartman (1989) has applied hedonic techniques to study the demand for luxury and specialty hotels using amenities such as free parking, business/meeting services, and airport shuttles.

[12] The establishment-level optimization assumption would not be ideal if franchisors made decisions for multiple outlets and the maximized franchise profit were not equal to the sum of the maximized profits for each establishment. Although several chains do own and manage some of their franchise outlets themselves, it is well documented that the company-owned establishments are more often located in urban areas (Brickley and Dark, 1987; LaFontaine, 1992). Nearly 45% of the rural highway motels in my data set are not affiliated with a chain or franchise.

[13] For example, a dummy indicating that a motel belongs to a chain such as Motel 6, which rarely offers discounts to its published prices, ought to have a negative coefficient if most other chains have transaction prices that are lower than the prices they report.

[14] Think of the market structure as an ordered pair $(L, H)$, where $L$ is the number of low-quality firms and $H$ is the number of high-quality firms operating. For each firm, $\vec{N}$ represents the product types of competing firms (not including itself). For a low-quality firm in a market $(L, H)$, $\vec{N} = (L - 1, H)$; for a high-quality firm, $\vec{N} = (L, H - 1)$.

motel prices and by observing how the competitive effects vary by product type. Thus, $h(\phi; \vec{N})$ takes a linear form, with the vector $\vec{N}$ indicating which of the $\phi$-parameters need to be inserted for each firm, based on the other firms operating in the market and their product types:[15]

$$
\begin{aligned}
h(\phi; \vec{N}) = {} & \phi_1 \times (\text{presence of first same-type competitor}) \\
& + \phi_2 \times (\text{presence of additional same-type competitors}) \\
& + \phi_3 \times (\text{presence of first different-type competitor}) \\
& + \phi_4 \times (\text{presence of additional different-type competitors}).
\end{aligned}
$$

Before estimating this price equation, it is necessary to confront the potential endogeneity of the market structure variables in these firm-level regressions. Firms choose whether to operate and select their product types on the basis of profits—they decide by anticipating how price competition will proceed, given the number and product types of firms that join them in the market. Suppose that profits for the low- and high-quality product-type alternatives are parameterized as

$$\pi_L = X\beta_L + g(\theta_L; \vec{N}) + \varepsilon_L,$$

$$\pi_H = X\beta_H + g(\theta_H; \vec{N}) + \varepsilon_H.$$

The $X$-variables in these equations are characteristics that affect the profitability of operating in the market. The function $g(\sigma; \vec{N})$ represents the effects of competing firms of each product type on profits. The error term is product-type-specific, representing unobserved factors associated with the profitability of operating each type of motel at the market. The market structure is determined by a set of potential entrants, who compare the profits of operating as each product type and of not operating under the various market structure possibilities.

Because the market structure outcome defines the variables contained in the $h(\phi; \vec{N})$ portion of the price regressions, the profit-function errors need to be uncorrelated with unobserved characteristics that affect motel prices. For example, consider the motels operating in a market with a (1, 1) product-type configuration. Given the market's characteristics, the values of the profit-function error terms that result in this market structure outcome can be denoted as $\{(\varepsilon_L, \varepsilon_H) : \vec{N} = (1, 1)\}$. Further, assume the price and profit errors are distributed as

$$(\varepsilon_p, \varepsilon_L, \varepsilon_H) \sim \text{TVN} \quad \text{with} \quad \vec{\mu} = [0 \quad 0 \quad 0] \text{ and}$$

$$\vec{\Sigma} = \begin{bmatrix} 1 & \rho_{L,p} & \rho_{H,p} \\ \rho_{L,p} & 1 & 0 \\ \rho_{H,p} & 0 & 1 \end{bmatrix}.$$

Critically, if we allow the potential of a nonzero correlation between $\varepsilon_p$ and $\varepsilon_L$ or between $\varepsilon_p$ and $\varepsilon_H$, it is not valid to assume that $E[\varepsilon_p|(\varepsilon_L, \varepsilon_H) : \vec{N} = (1, 1)] = 0$.[16] The logical connection between prices and profits in the multistage market structure game suggests that shocks to marginal cost and demand affect both. Thus, a zero correlation between these error terms is unlikely. In fact, the expectation of the errors in the price and quantity equations ought to differ for each possible realization of a market's product-type configuration.

As discussed in section II, this endogeneity problem is typically addressed by proposing instruments that affect firm profits but do not factor into price determination. I propose an alternative method that mirrors the two-step estimation process used to address the sample selection problem often encountered in labor econometrics.[17] The first step is a selection model; here it is a model that predicts the market structure of product-differentiated oligopolies. Specifying the selection model appropriately is critical—the economic assumptions embedded in the market structure determination model generate the nonlinearity that underlies the conditional mean correction. Parameters from the market structure model are used to calculate terms that, once inserted into the price regression, offset the correlation between the price and profit errors; the adjusted error terms have mean zero. The second step simply runs the modified regression.[18]

The market structure model generates estimable profit functions by assuming that the observed market structure is the Nash equilibrium of a game involving an infinite number of identical potential entrants. As such, the observation reveals two pieces of information that can be used to

[15] For example, for the low-quality motels operating in a (2,1) market, the dummy variables associated with the parameters $\phi_1$ and $\phi_3$ are *turned on* (set to 1)—for each there is one same-type competitor (low) and one different-type competitor (high). For the high-quality motel in this market, the relevant dummy variables multiply $\phi_3$ and $\phi_4$ (for the first and second different-type competitors). If the firm is the only one operating in the market, no dummies are turned on, while for motels in markets with three firms of each type (the largest considered) all the dummy variables take on a value of 1.

[16] Note that the price error is specified at the firm level, whereas the profit errors are type-specific. However, each firm (at a given market) draws the same $\varepsilon_L$ for operating as a low-quality motel and the same $\varepsilon_H$ for operating as a high-quality motel. If the price errors are also drawn from separate distributions for low ($\varepsilon_{LP}$) and high ($\varepsilon_{HP}$) firms, separate price profit correlation terms can be specified: $\rho_{L,LP}$ and $\rho_{H,LP}$ for low-type prices, and $\rho_{L,HP}$ and $\rho_{H,HP}$ for high-type prices.

[17] Heckman and MaCurdy (1986) discuss the problem and several empirical applications. Maddala (1983) also suggests a number of methods for estimating the parameters of this type of model.

[18] This market structure model may also contain an instrument that is not included in the subsequent outcome regression. I employ this approach in the empirical work—see section VA.

estimate the profit-function parameters: that no operating firm would prefer to switch product types, and that no firm would want to enter the market as either product type, given the entry and product-type decisions of the other market participants. A Nash equilibrium can be represented by an ordered pair $(L, H)$ for which the following inequalities are satisfied:

$$\pi_L(L-1, H) > 0, \quad \pi_L(L, H) < 0,$$
$$\pi_L(L-1, H) > \pi_H(L-1, H),$$
$$\pi_H(L, H-1) > 0, \quad \pi_H(L, H) < 0,$$
$$\pi_H(L, H-1) > \pi_L(L, H+1).$$

Assuming that an additional market participant always decreases profits and that the decrease is larger if the market participant is of the same product type, a unique equilibrium exists.

The dependent variable of this model is the observed product-type configuration at each market. Here, we allow for two product types and as many as three firms of each product type in the market—therefore, the dependent variable can take on one of fifteen possible values.[19] Under the assumptions defined above, a specific product-type configuration follows from the data for the market in question and values of the profit-function parameters, for every realization of $(\varepsilon_L, \varepsilon_H)$. Assuming a distribution for the error term, a predicted probability for each of the fifteen possible outcomes is calculated by integrating $f(\varepsilon_L, \varepsilon_H)$ over the region of the $\{\varepsilon_L, \varepsilon_H\}$ space corresponding to that outcome.[20] Maximum likelihood selects the profit-function parameters that maximize the probability of the observed market configurations across the data set. The likelihood function is

$$L = \prod_{m=1}^{492} \text{Prob}\,[(L, H)_m^O],$$

where $(L, H)_m^O$ is the observed configuration of firms in market $m$—its probability is a function of the parameters and the data for market $m$.

Having estimated the profit-function parameters, we can return to the price equation, in which the error is not mean-zero and depends on the competing firms in the market. If $\vec{N} = (1, 1)$, for example,

$$E[\varepsilon_p|(\varepsilon_L, \varepsilon_H): \vec{N} = (1, 1)]$$
$$= \rho_{L,p} \frac{\iint_{\vec{N}=(1,1)} \varepsilon_L f(\varepsilon_L, \varepsilon_H)\, d\varepsilon_L\, d\varepsilon_H}{\iint_{\vec{N}=(1,1)} f(\varepsilon_L, \varepsilon_H)\, d\varepsilon_L\, d\varepsilon_H} + \rho_{H,p} \frac{\iint_{\vec{N}=(1,1)} \varepsilon_H f(\varepsilon_L, \varepsilon_H)\, d\varepsilon_L\, d\varepsilon_H}{\iint_{\vec{N}=(1,1)} f(\varepsilon_L, \varepsilon_H)\, d\varepsilon_L\, d\varepsilon_H},$$

where $\iint_{\vec{N}=(1,1)} f(\varepsilon_L, \varepsilon_H)\, d\varepsilon_L\, d\varepsilon_H$ represents the probability that $\{(\varepsilon_L, \varepsilon_H): \vec{N} = (1, 1)\}$ holds. Using the estimated parameters, we can calculate predicted values for the integrals in the expectation above.[21] These are then added into the expression for prices:

$$p_i = Z_p\gamma_p + h(\phi_p; \vec{N}) + \rho_{L,p} \frac{\iint_{\vec{N}=(1,1)} \varepsilon_L f(\varepsilon_L, \varepsilon_H)\, d\varepsilon_L\, d\varepsilon_H}{\iint_{\vec{N}=(1,1)} f(\varepsilon_L, \varepsilon_H)\, d\varepsilon_L\, d\varepsilon_H} + \rho_{H,p} \frac{\iint_{\vec{N}=(1,1)} \varepsilon_H f(\varepsilon_L, \varepsilon_H)\, d\varepsilon_L\, d\varepsilon_H}{\iint_{\vec{N}=(1,1)} f(\varepsilon_L, \varepsilon_H)\, d\varepsilon_L\, d\varepsilon_H} + \mu_p,$$

where the covariances ($\rho_{L,p}$ and $\rho_{H,p}$) have become additional parameters to be estimated. The key to the correction procedure is that $\mu_p$ now has mean zero. As a result, effects of the market structure selection will not bias estimates of the effects of competitors and market characteristics. The resulting regression isolates the competitive effects from factors that influence the underlying profitability of these firms.

[19] The market structure model becomes more complex to estimate as the number of distinct product types assigned increases, because the number of inequalities that must be satisfied for each possible outcome increases. The number of data required is also larger, as there are more possible outcomes—with three product types, the dependent variable can take any of 64 values. Mazzeo (2002) estimates a three-type version of the model using simulation techniques. Seim (2002) allows for a continuum of product types by assuming that firms have asymmetric information about their own profits and the profitability of potential competitors.

[20] In the estimation, markets are constrained to have no fewer than zero and no more than three firms of either product type. The region corresponding to a product-type configuration with zero or three low- or high-quality firms operating, therefore, is unbounded on at least one side. The appropriate integration limit is (plus or minus) infinity.

[21] Note that the parameters are in the limits of integration—they define the region over which the error term is integrated.

## IV. Outcomes Data

The information used to estimate the effects of market structure on competitive outcomes is part of an extensive data set collected from a cross section of differentiated-product oligopoly motel markets. A market is defined as the cluster of motels located adjacent to an individual interstate highway exit. These clusters are typically isolated from one another geographically, limiting the extent to which motels at one exit compete with motels at other exits.[22] To obtain a comparable set of oligopoly markets, I collected data from only small, rural exits located along one of the 30 longest U.S. interstate highways.[23] Information must be obtained from every market participant in order to describe the equilibrium conditions at a given market accurately. I was able to assemble an exhaustive list of motel establishments at each exit using tour books published by the American Automobile Association (AAA, 1994), chain-affiliated motel directories, the American Hotel and Motel Association property guide, and telephone listings for each market.

A total of 1,817 firms were identified at 492 individual markets; the data set includes detailed information about each motel, including its chain affiliation and capacity (number of rooms available). I also assigned a product type to each motel—either low or high quality. For properties listed by AAA, I used their quality rating of between one and four diamonds to make this assignment. Motels with a one-diamond rating were put into the low category; two diamonds and above, the high. Chain-affiliated motels not listed by AAA were put into the category most populated by the members of the same chain that are in the tour books. Because AAA has minimum quality standards for inclusion in its tour books, independents AAA does not list were placed in the low-quality category. This quality level represents the product choice made by the firm; I examine competition among firms within and across these categories.

I also collected price information from the motel establishments. The sources used to identify market participants often reported a range of prices, rather than a unique transaction price. As the multistage game framework assumes, price decisions are less fixed than entry and product choice decisions for motels.[24] The lowest price in the range represents the base rate for a single customer, with higher prices listed for additional guests, larger rooms, and certain dates or periods (usually during the summer months or for special events). Where detailed information was available, it appears that the highest prices in the range remain in place for a much shorter period than the base price.[25] The high end of the range also exhibits much more volatility among the motels. Since the bottom end of the range most closely resembles the actual prices paid by consumers across the properties in the dataset, I use the lowest published price for each motel in the analyses below. For the properties surveyed by telephone, I requested the lowest one-person room rate for the motel.

Table 1.—Average Motel Price in Different Product-Type Configurations

| Product-Type Configuration | Number of Markets | Average Price: Low-Quality Motels | Average Price: High-Quality Motels |
|---|---|---|---|
| (1, 0) | 61 | $28.51 | — |
| (0, 1) | 67 | — | $35.48 |
| (2, 0) | 26 | $28.56 | — |
| (1, 1) | 40 | $30.10 | $38.15 |
| (0, 2) | 30 | — | $35.65 |
| (3, 0) | 10 | $30.93 | — |
| (2, 1) | 22 | $26.29 | $37.05 |
| (1, 2) | 30 | $26.17 | $35.50 |
| (0, 3) | 33 | — | $39.10 |
| (3, 1) | 13 | $28.82 | $45.69 |
| (2, 2) | 17 | $29.62 | $39.18 |
| (1, 3) | 35 | $29.66 | $38.24 |
| (3, 2) | 20 | $26.95 | $39.08 |
| (2, 3) | 30 | $27.23 | $38.46 |
| (3, 3) | 58 | $26.13 | $38.32 |
| Overall | 492 | $28.02 | $37.72 |

The product-type configuration indicates the number of motels of each quality type operating at the market—for the ordered pair $(L, H)$, $L$ is the number of low-quality and $H$ is the number of high-quality motels operating. The average motel price is calculated over the motels of the given quality type operating in a market with the corresponding product-type configuration. Each motel's price is the low end of the range of motel prices reported in the various sources.

Table 1 summarizes the raw price data for the motels in the data set. First, note the overall averages reported in the bottom row of the table. The average base price for low-quality motels is $28.02; for the high-quality motels, $37.72.[26] The rest of the table groups the motels based on the product-type configurations of the markets in which they operate. Each row in the table reports the base price averaged over all motels in the dataset in markets with the product-type configuration indicated in the first column, the low-quality average in the third column, and the high-quality average in the fourth. The number of observed markets with each product-type configuration is also listed in Table 1.

The raw evidence regarding the hypothesized relation between concentration, product differentiation, and price is mixed. In markets with two firms, for example, both low-

[22] I do control for the physical distance between motel exits. Solomon (1994) and Bleakley (1995) provide interesting anecdotes regarding intermarket competition.

[23] Three-digit interstates and several one- and two-digit interstates that do not cross a state boundary (for example, 4 in Florida, 27 in Texas, and 97 in Maryland) or predominantly covered metropolitan areas (for example, 84E, 91, and 93) were not included.

[24] In fact, some establishments adjust their prices quite often, charging different room rates for peak and off-peak seasons, on weekends and during the week, and even at various times of the day in extreme cases. McDowell (1995) reports how one motel uses intraday price variation as a yield management technique. This practice, however, is not common and has been denounced by industry trade organizations.

[25] For example, the Lake Country Inn in Clear Lake, Iowa, charges a price during the Buddy Holly Weekend that is twice its normal room rate.

[26] There is a cost associated with providing additional quality—the higher price for high-quality motels does not necessarily indicate greater profitability.

TABLE 2.—AVERAGE MOTEL CAPACITY IN DIFFERENT PRODUCT-TYPE CONFIGURATIONS

| Product-Type Configuration | Number of Markets | Average Motel Capacity: Low-Quality Motels | Average Motel Capacity: High-Quality Motels |
|---|---|---|---|
| (1, 0) | 61 | 30.15 | — |
| (0, 1) | 67 | — | 48.88 |
| (2, 0) | 26 | 32.60 | — |
| (1, 1) | 40 | 31.56 | 57.15 |
| (0, 2) | 30 | — | 65.43 |
| (3, 0) | 10 | 32.62 | — |
| (2, 1) | 22 | 25.86 | 61.00 |
| (1, 2) | 30 | 33.76 | 62.23 |
| (0, 3) | 33 | — | 74.03 |
| (3, 1) | 13 | 33.17 | 93.00 |
| (2, 2) | 17 | 43.76 | 64.32 |
| (1, 3) | 35 | 53.00 | 73.58 |
| (3, 2) | 20 | 35.54 | 72.60 |
| (2, 3) | 30 | 48.47 | 75.36 |
| (3, 3) | 58 | 46.01 | 73.64 |
| Overall | 492 | 37.92 | 65.91 |

The product-type configuration indicates the number of motels of each quality type operating at the market—for the ordered pair ($L$, $H$), $L$ is the number of low-quality and $H$ is the number of high-quality motels operating. The average motel price is calculated over the motels of the given quality type operating in a market with the corresponding product-type configuration. Capacity is the number of rooms available for rent in each motel.

and high-quality motels charge a higher average price when their competitor has a different quality level. The average price for a low-quality motel in a (1, 1) market is greater than in a (2, 0) market ($30.10 versus $28.56); likewise, the average price for a high-quality motel in a (1, 1) market is greater than in a (0, 2) market ($38.15 versus $35.65). This expected relationship also holds in markets with four and five motels, but breaks down in the three-motel markets. The regressions below analyze these hypotheses more carefully by adding market- and firm-level controls for cost and quality differences and by using the procedure to correct for the endogeneity of market structure regressors described in the previous section.

Table 2 displays similar data for motel capacity. Note that low-quality motels are much smaller on average: the average low-quality motel has about 38 rooms, and the average high-quality motel has nearly 66. This table also indicates that per-motel capacity is larger in markets with more motels. The relationship between capacity and product differentiation, moreover, is unclear. The average capacity is sometimes higher for motels whose competitors are the same product type: for example, the average high-quality motel has 65.43 rooms when the market structure is (0, 2), but only 57.15 rooms when it is (1, 1). Perhaps even more for capacity than for price, using additional firm- and market-level controls and incorporating the corrections for market structure endogeneity are necessary to decode the relation between capacity and market structure.

It is crucial to note that capacity is an imperfect proxy for quantity—the competitive outcome that actually determines firm profits. On any particular night, quantity may vary considerably depending on, among other things, the demand for accommodations on that night and the price charged. Obtaining per-night quantity data for all the motels in the dataset, however, was not possible. The difference between capacity and quantity will affect the interpretation of the outcome regressions only to the extent that capacity utilization differs across motels based on their markets' product-type configurations. Of course, one could consider an alternative game in which capacity is chosen at the same time as the entry and product-type decisions are made. The dynamics of such a game are potentially rich; it might be possible for firms to use capacity strategically, by overinvesting to deter potential entrants, for example.[27] However, fixed costs of entry have traditionally been quite low in the motel industry, and investments in motel capacity are not particularly sunk. This limits the ability of firms to use capacity as an entry deterrent, and increases the likelihood that capacity and quantity are highly correlated in this case.[28]

To complete the data set, I appended several demographic and geographic variables describing conditions at each market to the motel information. From the Census, I know the population, per capita income, and other demographics for each market. The annual average daily traffic that passes each market's exit along the interstate, which is monitored by the Federal Highway Administration (FHWA), is also included. I consulted AAA maps to determine the distance from each market to its nearest motel competition along the highway, noting whether the adjacent markets are also in the data set. These variables are used to help explain differences in competitive outcomes across markets.

## V. Empirical Analysis of Competitive Outcomes

This section presents and discusses the parameters, estimated using the procedure outlined in section III, that measure the effect of market structure on competitive outcomes. I begin with the market structure selection model, then proceed to the price and capacity regressions. The parameter estimates indeed confirm the theoretical prediction that the effects of additional competitors on outcomes are particularly strong when product offerings are similar. I also run the regressions separately for the high- and low-quality subsamples, to determine how competitive effects vary in different regions of the product space.

[27] Developments in computation may permit implementation of an empirical model that reflects such dynamics before too long. For a recent discussion of the progress toward this goal, see Pakes (2000).

[28] Capital requirements have not typically constrained entry into the motel business. Jakle et al. (1996) describes promotions by motel associations and developers offering low-cost setups to potential motel operators in the first half of twentieth century. Franchise companies, who often help arrange initial financing for their franchisees, serve this role today. In addition, several properties surveyed by telephone had once operated as motels, but were subsequently converted to apartment buildings. Selected rooms were also shut down on a temporary or seasonal basis in some properties. This also limits the ability of firms to use capacity as an entry deterrent.

### A. *First-Stage Profit-Function Estimates*

Recall the following profit functions from section III:

$$\pi_L = X\beta_L + g(\theta_L; \vec{N}) + \varepsilon_L,$$

$$\pi_H = X\beta_H + g(\theta_H; \vec{N}) + \varepsilon_H.$$

The *X*-variables should be ones that affect demand for motel rooms at that exit or the costs of establishing a motel. The following regressors are included in the profit function:[29]

- *PLACEPOP:* the population of the town nearest the highway exit—should be positively correlated with motel demand, because a larger town has more people and businesses that highway travelers would want to visit.
- *TRAFFIC:* the FHWA's measure of the annual average daily traffic that passes by the market's exit—should also be positively correlated with motel demand, because more-traveled stretches of highway have more consumers looking to stay at a motel.
- *SPACING:* the distance in miles from the market exit to the closest exits along the highway with motels (the sum of the distance to the closest competitors on either side). I expect a positive correlation between *SPACING* and demand—a location is more popular if the closest alternatives are further away.
- *AGVAL:* the average per-acre value of agricultural land in the market's county—relates to acquisition cost (agriculture is the primary alternative use in these rural markets) of a motel's property. Note that *AGVAL* acts an instrumental variable, because it is correlated with the costs of entering the market, but it is likely sunk when firms compete in prices. Such instruments may be included in the market structure model, but excluded from the subsequent outcome regressions.

The $g(\theta_T; \vec{N})$ portion of the profit function includes parameters that represent the incremental effects of additional competitors. The estimates reported reflect the following specification of the competitive-effect dummy variables:[30]

$$\begin{aligned} g_{\text{LOW}} = {} & \theta_{LL1} \times (\text{presence of first low competitor}) \\ & + \theta_{LL2} \times (\text{presence of second low competitor}) \\ & + \theta_{\text{L0H1}} \times [\text{presence of first high competitor} \\ & \quad (\text{no low competitors})] \\ & + \theta_{\text{L0HA}} \times [\text{no. of additional high competitors} \\ & \quad (\text{no low competitors})] \\ & + \theta_{\text{L1H}} \times [\text{no. of high competitors} \\ & \quad (\text{one low competitor})] \\ & + \theta_{\text{L2H}} \times [\text{no. of high competitors} \\ & \quad (\text{two low competitors})], \end{aligned}$$

$$\begin{aligned} g_{\text{HIGH}} = {} & \theta_{HH1} \times (\text{presence of first high competitor}) \\ & + \theta_{HH2} \times (\text{presence of second high competitor}) \\ & + \theta_{\text{H0L1}} \times [\text{presence of first low competitor} \\ & \quad (\text{no high competitors})] \\ & + \theta_{\text{H0LA}} \times [\text{no. of additional low competitors} \\ & \quad (\text{no high competitors})] \\ & + \theta_{\text{H1L}} \times [\text{no. of low competitors} \\ & \quad (\text{one high competitor})] \\ & + \theta_{\text{H2L}} \times [\text{no. of low competitors} \\ & \quad (\text{two high competitors})]. \end{aligned}$$

Table 3 displays the first-stage parameter estimates—the estimates for the low-quality profit function are in the top panel, and for the high-quality profit function in the bottom panel. The estimated parameters indicate the relative effects, on profits to operating as either a low- or a high-quality motel, of different market conditions and different product-type configurations. The relative values of the constants indicate that, all else equal, operating a high-quality motel is more profitable than operating a low-quality motel ($C_H = 2.5590$ versus $C_L = 1.6898$). For competitors, the large difference between the parameters representing the effects of the first same-type competitor and the first different-type competitor is striking. For low-quality firms, the first low-type competitor ($\theta_{LL1} = -1.8029$) has nearly twice the effect on payoffs as the first high-type competitor ($\theta_{L0H1} = -0.9878$). For high-quality firms, the effect of the first

[29] Note that the data for the *X*-variables are transformed as follows for use in the estimations:

$$PLACEPOP^*_m = \ln\left(PLACEPOP_m \Big/ \frac{1}{492}\sum_{m=1}^{492} PLACEPOP_m\right).$$

Consequently, a value of *PLACEPOP* equal to the mean in the data set is transformed to 0; a value above the mean becomes positive, and a value below the mean becomes negative. Analogous transformations are done on the variables *TRAFFIC, SPACING*, and *AGVAL*. These transformations facilitate estimation of the model—the optimization routine performs better when the variables are scaled so that the range of the data is narrower and more similar across the variables in the model.

[30] The goal is to make the specification of the competitive effects through $g(\theta_T; \vec{N})$ as flexible as possible, while maintaining estimation feasibility. For example, in the cases where the data indicate the number of competitors, I implicitly assume that the incremental effect of each additional competitor is the same.

TABLE 3.—ESTIMATED PARAMETERS—FIRST-STAGE MODEL

| Parameter | | Parameter Estimates | |
|---|---|---|---|
| | | Estimate | Standard Error |
| Effect on Low-Type Payoffs | | | |
| Constant | $C_L$ | 1.6898 | 0.9450 |
| Low competitor 1 | $\theta_{LL1}$ | −1.8029 | 0.9229 |
| Low competitor 2 | $\theta_{LL2}$ | −0.6511 | 0.0927 |
| High competitor 1 (0 lows) | $\theta_{L0H1}$ | −0.9878 | 0.9449 |
| Addnl. high competitors (0 lows) | $\theta_{L0HA}$ | −0.1214 | 0.0982 |
| No. of high competitors (1 low) | $\theta_{L1H}$ | −0.0163 | 0.1407 |
| No. of high competitors (2 lows) | $\theta_{L2H}$ | −0.0000 | 0.0000 |
| *PLACEPOP* | $\beta_{L\text{-}P}$ | 0.2654 | 0.0550 |
| *TRAFFIC* | $\beta_{L\text{-}T}$ | 0.0931 | 0.1070 |
| *SPACING* | $\beta_{L\text{-}S}$ | 0.3754 | 0.1271 |
| *AGVAL* | $\beta_{L\text{-}A}$ | −0.3762 | 0.1515 |
| Effect on High-Type Payoffs | | | |
| Constant | $C_H$ | 2.5590 | 0.9395 |
| High competitor 1 | $\theta_{HH1}$ | −2.0524 | 0.9280 |
| High competitor 2 | $\theta_{HH2}$ | −0.6920 | 0.0627 |
| Low competitor 1 (0 highs) | $\theta_{H0L1}$ | −1.2431 | 0.9314 |
| Addnl. low competitors (0 highs) | $\theta_{H0LA}$ | −5.25E−6 | 0.0006 |
| No. of low competitors (1 high) | $\theta_{H1L}$ | −2.82E−7 | 0.0001 |
| No. of low competitors (2 high) | $\theta_{H2L}$ | −0.0000 | 0.0000 |
| *PLACEPOP* | $\beta_{H\text{-}P}$ | 0.6823 | 0.0551 |
| *TRAFFIC* | $\beta_{H\text{-}T}$ | 0.4104 | 0.1137 |
| *SPACING* | $\beta_{H\text{-}S}$ | 0.4863 | 0.1332 |
| *AGVAL* | $\beta_{H\text{-}A}$ | −0.3141 | 0.1585 |
| Log likelihood | | −1143.01 | |

The β-coefficients reflect data that have been scaled to facilitate estimation. See section VA for details.

competitor is 65% greater if it is also a high type ($\theta_{HH1} = -2.0524$ versus $\theta_{H0L1} = -1.2461$).[31] The remaining θ-parameters indicate that the incremental effects of additional competing firms are smaller than for the first competitor. For example, the effect of the second high-type competitor on high-type payoffs is about one-third the effect of the first high-type competitor ($\theta_{HH1} = -2.0524$ versus $\theta_{HH2} = -0.6920$).

The parameter estimates on the control variables indicate that demographic characteristics help explain the conditions under which motels will be more profitable. The estimates also reveal profitability differences across the two quality types. For example, population has a positive and significant effect on payoffs of both product types, but the relative size of the *PLACEPOP* coefficients indicates that firms in markets with population above the sample mean tend to choose high quality, while low quality is more attractive in below-average population markets.[32] In contrast, the negative parameter estimates for *AGVAL* indicate that entry is less likely where land is more expensive.

## B. *Price Regressions*

Table 4 displays the results of the price regression run on all the motels in the dataset.[33] The right-side variables include firm and market-level controls, the effects-of-competitors dummies, and the endogeneity correction terms. Several of the market-level *Z*-variables (described in table 8) associated with market-level motel costs are significantly correlated with the prices motel firms charge. For example, labor and materials costs are likely higher in markets with larger populations, higher incomes, or nearby metropolitan areas. Labor may be relatively scarce and more expensive in markets in the *WEST* region, which tend to be more remote, but more available in the *SOUTH.* In each case, regressors associated with higher costs have a positive

TABLE 4.—MOTEL PRICE REGRESSION—ALL MOTELS

| Independent Variable | Parameter Estimate | Standard Error | *t*-Statistic | Sample Mean |
|---|---|---|---|---|
| Intercept | 25.6925 | 1.421 | 18.07 | 1.000 |
| Effects of Competitors | | | | |
| *1ST-SAME* | −1.8928 | 0.488 | −3.88 | 0.594 |
| *ADNL-SAME* | −1.1499 | 0.558 | −2.06 | 0.340 |
| *1ST-DIFF* | −0.2056 | 0.515 | −0.40 | 0.698 |
| *ADNL-DIFF* | −1.3836 | 0.535 | −2.58 | 0.463 |
| Market-Level *Z*-Variables | | | | |
| *PLACEPOP* | 1.56E−4 | 3.23E−5 | 4.56 | 6,387.71 |
| *PERCAPI* | 4.27E−4 | 1.11E−4 | 3.86 | 10,309.43 |
| *WEST* | 2.1252 | 0.451 | 4.71 | 0.196 |
| *SOUTH* | −0.7163 | 0.350 | −2.05 | 0.444 |
| *MSANEIGH* | 1.0829 | 0.299 | 3.61 | 0.476 |
| *SPACING* | 0.0112 | 0.006 | 1.80 | 54.971 |
| Endogeneity Correction Terms | | | | |
| *CORRECT-L × HI* | 0.7614 | 0.387 | 1.97 | −0.033 |
| *CORRECT-H × HI* | 0.6942 | 0.448 | 1.55 | 0.134 |
| *CORRECT-L × LO* | 1.0086 | 0.554 | 1.82 | 0.204 |
| *CORRECT-H × LO* | −0.1850 | 0.379 | −0.49 | −0.022 |

Dependent variable: motel price ($); mean = $33.10.
Observations: 1,815.
$R^2 = 0.5297$.
Dummy variables for motels with high quality, five individual chain affiliations, an attached restaurant, and AAA listing are not included in this table. Remaining variable definitions can be found in table 8. Observations have been weighted to avoid overemphasizing motels from the least concentrated markets. Each motel receives a weight of one divided by the total number of motels in its market. Each motel's price is the low end of the range of motel prices reported in the various sources.

[31] For both low and high quality, the negative effect of the first same-type firm is significantly different from zero, whereas the first different-type effect is negative, but not significant. The effect of the first same-type competitor is significantly greater than that of the first different-type competitor in both cases. The correlation between the parameter estimates is fairly high; therefore, the difference between the parameter estimates is statistically significant at the 5% level for both low and high types.

[32] Recall the transformation of the *X*-variables described in footnote 29. If a market's population is twice the sample mean, the parameter for *PLACEPOP* is multiplied by ln 2 = 0.693 and high quality becomes more attractive as population increases. However, in markets with population below the mean, lower quality is more attractive, since the *PLACEPOP* coefficient is multiplied by a negative number—for example, by ln 0.5 = −0.693 if the market's population is half the sample mean.

[33] The unit of observation in these regressions is a single motel; however, observations are weighted to avoid overemphasizing motels from the least concentrated markets. Each motel receives a weight of one divided by the total number of motels in its market. The results are similar when prices are expressed in logarithmic terms.

and significant effect on motel prices. The *SPACING* regressor captures the price elasticity associated with nonmarket competitors—prices are higher if the nearest market is further away. Finally, several motel-specific dummy variables (not listed in the table) effectively capture some of the within-quality-level price differences among firms.[34]

The effects-of-competitors estimates provide considerable support for the hypothesis that firms offering similar products are tougher competitors. The effect of the first same-type competitor is negative and statistically significant—prices in markets where a single same-type competitor is present are \$1.89 lower than in monopoly markets. On the other hand, if the first competitor is not of the same product type, there is virtually no effect on price. This result epitomizes the benefits of differentiation: when competing firms offer the same product, the price premium afforded a monopolist disappears much more quickly than if the competitors offer different product types.[35] It appears that price competition among differentiated firms is much weaker than if the firms had chosen to offer similar types of services.

The parameters representing the effects of additional competitors provide another interesting result. The incremental effect on price of the second firm of the same product type is also negative, but is smaller than that of the first same-type competitor. The presence of a second firm of the other product type also affects prices negatively—the parameter estimate for *ADNL-DIFF* is −\$1.38, and the coefficient is statistically significant at the 1% level. This result suggests that the benefits of offering a differentiated product erode when there is within-type competition elsewhere in product space. As mentioned in section II, there appears to be a second-order effect, whereby tough price competition within one product type puts competitive pressure on prices throughout the market.

Finally, the bottom panel of table 4 displays the estimated coefficients for the terms included to correct for the endogeneity of the market structure dummy variables. These parameters represent the correlation between the unobservables that affect prices and the error terms in the low- and high-type profit functions underlying firms' entry and product-type decisions. For the regressions run using all the motels in the data set, I have specified the correction terms separately to allow the correlations to differ for high- and low-quality motels.[36] The estimates suggest a positive correlation—there are unobserved factors that affect both observed prices and the probability of entry (through profits) in the same way. It is important to note that ignoring these correction terms changes the regression result substantially and biases the competitive effects coefficients downward.[37]

TABLE 5.—MOTEL CAPACITY REGRESSION—ALL MOTELS

| Independent Variable | Parameter Estimate | Standard Error | *t*-Statistic | Sample Mean |
|---|---|---|---|---|
| Intercept | 37.1610 | 3.292 | 11.29 | 1.000 |
| Effects of Competitors | | | | |
| *1ST-SAME* | −0.5681 | 2.137 | −0.27 | 0.594 |
| *ADNL-SAME* | −4.2384 | 2.435 | −1.74 | 0.340 |
| *1ST-DIFF* | −5.2334 | 2.171 | −2.41 | 0.698 |
| *ADNL-DIFF* | −0.6406 | 2.262 | −0.28 | 0.463 |
| Market-Level *Z*-Variables | | | | |
| *PLACEPOP* | 0.0021 | 3.59E−4 | 5.87 | 6,837.71 |
| *POPSQR* | −3.73E−8 | 1.06E−8 | −3.52 | 8.56E+7 |
| *TRAFFIC* | 6.61E−4 | 9.08E−5 | 7.28 | 16,414.21 |
| *METMILE* | 5.08E−4 | 1.41E−4 | 3.60 | 9,171.57 |
| *MSANEIGH* | −2.0796 | 1.279 | −1.63 | 0.476 |
| *SPACING* | 0.0973 | 0.028 | 3.50 | 54.97 |
| *NORTHEAST* | 15.2308 | 3.551 | 4.29 | 0.030 |
| *MIDWEST* | −3.4468 | 1.362 | −2.53 | 0.329 |
| Endogeneity Correction Terms | | | | |
| *CORRECT-L* × *HI* | 4.8848 | 1.648 | 2.96 | −0.033 |
| *CORRECT-H* × *HI* | 3.4974 | 1.999 | 1.75 | 0.134 |
| *CORRECT-L* × *LO* | 1.3381 | 2.484 | 0.54 | 0.204 |
| *CORRECT-H* × *LO* | 2.0383 | 1.587 | 1.28 | −0.022 |

Dependent variable: motel capacity (number of rooms); mean = 52.55.
Observations: 1,815.
$R^2$ = 0.5318.
Dummy variables for motels with high quality, five individual chain affiliations, and AAA listing are not included in this table. Remaining variable definitions can be found in Table 8. Observations have been weighted to avoid overemphasizing motels from the least concentrated markets. Each motel receives a weight of one divided by the total number of motels in its market. Capacity is the number of rooms available for rent in each motel.

## C. *Capacity Regressions*

Table 5 presents the estimates from the motel capacity regression run on all the motels in the data set.[38] The table indicates that market-level variables associated with demand for lodging have a statistically significant effect on the capacity of motel establishments. For example, in markets where population and freeway traffic are greater, per-motel capacity is higher, all else equal.[39] I also include variables

[34] In general, chain affiliation is associated with higher prices. Some individual chain dummy variables (Motel 6, Best Western, Budget Host), however, are negative and significant. The chain dummies represent idiosyncratic policies or business practices of franchises that are reflected in (published) prices. Elsewhere, motels with an attached restaurant charge significantly higher prices. The difference in prices for motels listed in AAA and those found in the phone survey was not, all else equal, statistically significant.

[35] The difference between the price effects of the first same- and the first different-type competitor is statistically significant at the 1% level.

[36] Reading from top to bottom in table 4, *CORRECT-L* × *HI* is the correlation between the low-type profit error and the price error for the high-quality motels in the data set ($\rho_{L,Hp}$), and *CORRECT-H* × *HI* is the correlation for the high-type profit error ($\rho_{H,HP}$). For the low-quality motels, *CORRECT-L* × *LO* is the correlation between their price error and the low-type profit error ($\rho_{L,LP}$), and *CORRECT-H* × *LO* is the estimated $\rho_{H,LP}$.

[37] In a regression run without the endogeneity correction terms, the estimated parameters for *1ST-SAME, ADNL-SAME,* and *ADNL-DIFF* were −\$1.23, −\$0.41, and −\$1.00, respectively. Each was estimated with less precision, and the *ADNL-SAME* parameter estimate was not significantly different from 0.

[38] An analogous procedure is used to correct for the endogeneity of the market structure variables in the capacity regression, as unobserved factors affecting the entry and capacity decisions are likely correlated.

[39] Along with the *TRAFFIC* variable obtained from the FHWA, I include *METMILE* as a measure of the urban traffic along highways. For each

TABLE 6.—MOTEL PRICE REGRESSION—SUBSAMPLE ANALYSIS

| Independent Variable | High-Quality Motels Dependent Variable: Price ($); Mean = $37.72 Observations: 1,043 $R^2$ = 0.4385 | | | | Low-Quality Motels Dependent Variable: Price ($); Mean = $28.03 Observations: 772 $R^2$ = 0.2453 | | | |
|---|---|---|---|---|---|---|---|---|
| | Parameter Estimate | Standard Error | t-Statistic | Sample Mean | Parameter Estimate | Standard Error | t-Statistic | Sample Mean |
| Intercept | 24.9624 | 2.016 | 12.38 | 1.000 | 24.6661 | 1.953 | 12.63 | 1.000 |
| Effects of Competitors | | | | | | | | |
| *1ST-SAME* | −1.4038 | 0.622 | −2.26 | 0.641 | −3.6222 | 0.917 | −3.95 | 0.525 |
| *ADNL-SAME* | −0.6170 | 0.769 | −0.80 | 0.395 | −3.0156 | 1.071 | −2.82 | 0.280 |
| *1ST-DIFF* | −0.6772 | 0.816 | −0.83 | 0.668 | 0.7761 | 0.741 | 1.05 | 0.731 |
| *ADNL-DIFF* | −0.9575 | 0.839 | −1.14 | 0.405 | −1.890 | 0.797 | −2.37 | 0.526 |
| Market-Level *Z*-Variables | | | | | | | | |
| *PLACEPOP* | 1.86E−4 | 4.79E−5 | 3.89 | 6,687.72 | 1.32E−4 | 4.67E−5 | 2.85 | 6,059.45 |
| *PERCAPI* | 5.58E−4 | 1.46E−4 | 3.83 | 10,321.19 | 1.79E−4 | 1.66E−4 | 1.07 | 10,296.56 |
| *WEST* | 3.5918 | 0.628 | 5.72 | 0.177 | 1.0208 | 0.638 | 1.60 | 0.216 |
| *SOUTH* | −0.9067 | 0.473 | −1.92 | 0.471 | −0.5286 | 0.511 | −1.04 | 0.416 |
| *MSANEIGH* | 0.7332 | 0.398 | 1.84 | 0.476 | 1.2654 | 0.437 | 2.90 | 0.477 |
| *SPACING* | 0.0069 | 0.0078 | 0.89 | 54.894 | 0.0219 | 0.011 | 2.08 | 55.055 |
| Endogeneity Correction Terms | | | | | | | | |
| *CORRECT-L* | 0.7130 | 0.613 | 1.16 | −0.062 | 3.1493 | 1.031 | 3.05 | 0.428 |
| *CORRECT-H* | 0.2083 | 0.575 | 0.36 | 0.257 | −0.4039 | 0.487 | −0.83 | −0.046 |

Dummy variables for motels with five individual chain affiliations, an attached restaurant, and AAA listing are not included in this table. Remaining variable definitions can be found in table 8. Observations have been weighted to avoid overemphasizing motels from the least concentrated markets. Here, each motel receives a weight of one divided by the total number of motels of its product type in its market. Each motel's price is the low end of the range of prices reported in the various sources.

representing demand elasticities—capacity is higher when alternative markets are further away and lower when a neighboring market is within a metropolitan area. Finally, motel capacity varies by geographic region. Firm-specific dummy variables are also included in the regression to help explain per-motel capacity, but are not listed in table 5.

The estimates in the top panel again represent the incremental effects of competing firms. Two aspects of these results are of particular note. First, across the board, the effect on motel capacity of additional competing firms at the market is negative. The demand controls help refine the implications of the raw data in table 2, in which capacities were higher for motels in markets with more firms. When demand is held constant, the equilibrium capacity of motels is smaller in markets with more competitors; this is the more expected result. Second, the particular competitor whose estimated impact is largest and most significant in the capacity regression—the first different-type firm—was the same one whose presence had little effect on price. Conversely, the effects of the first same-type and additional different-type motels on capacity are negligible, but were negative and significant for price. This result simply reflects a downward-sloping demand curve for motels in part, since capacity is higher when prices are lower and vice versa. It also may suggest that every additional firm has some competitive impact. In cases where prices are not competed down, capacities are lower when there is another firm in the market.

The results in the bottom panel of table 5 demonstrate the endogeneity correction terms that are statistically significant in the motel capacity regression. Capacity is higher for motels operating in markets where the unobserved portion of profits is positive; these estimated correlations appear somewhat stronger for the high-quality motels in the dataset.

### *D. Type-Specific Price and Capacity Regressions*

The type-specific regressions reveal some contrasts in the competitive effects for low- and high-quality motels that were obscured in the full-sample regressions. Table 6 demonstrates that the differences between the *1ST-SAME* and *1ST-DIFF* coefficient estimates remains in each subsample, but that the *ADNL-DIFF* dummy variable estimate differs between the subsamples. The coefficient estimate is negative and significant only in the low-quality price regression. The tough competition caused by the presence of two high-quality firms reduces prices enough to make these motels a reasonable option for consumers whose preference for motel quality is weaker. The low-quality firm lowers its price to avoid losing some of its clientele to its lower-priced high-quality competitors. Theoretical models of vertical product differentiation portend this finding; for example, in Shaked and Sutton's (1983) model, price competition

highway, *METMILE* represents the sum of the populations of all the MSAs through which the road passes divided by the total milage the highway covers.

TABLE 7.—MOTEL CAPACITY REGRESSION—SUBSAMPLE ANALYSIS

| Independent Variable | High-Quality Motels<br>Dependent Variable: Capacity (No. of Rooms); Mean = 65.92<br>Observations: 1,043<br>$R^2 = 0.5177$ | | | | Low-Quality Motels<br>Dependent Variable: Capacity (No. of Rooms); Mean = 37.92<br>Observations: 772<br>$R^2 = 0.3968$ | | | |
|---|---|---|---|---|---|---|---|---|
| | Parameter Estimate | Standard Error | *t*-Statistic | Sample Mean | Parameter Estimate | Standard Error | *t*-Statistic | Sample Mean |
| Intercept | 30.6639 | 5.270 | 5.82 | 1.000 | 40.8347 | 5.614 | 7.27 | 1.000 |
| | | | | Effects of Competitors | | | | |
| *1ST-SAME* | −3.7743 | 3.108 | −1.21 | 0.641 | 3.4062 | 4.116 | 0.83 | 0.543 |
| *ADNL-SAME* | −9.6733 | 3.772 | −2.56 | 0.392 | 3.2067 | 4.806 | 0.67 | 0.280 |
| *1ST-DIFF* | −0.6939 | 3.414 | −0.20 | 0.668 | −10.7135 | 3.302 | −3.24 | 0.731 |
| *ADNL-DIFF* | 2.8141 | 3.494 | 0.81 | 0.261 | −4.3263 | 3.751 | −1.15 | 0.526 |
| | | | | Market-Level *Z*-Variables | | | | |
| *PLACEPOP* | 0.0026 | 5.70E−4 | 4.54 | 6,687.72 | 0.0024 | 5.19E−4 | 4.62 | 6,059.45 |
| *POPSQR* | −4.04E−8 | 1.56E−8 | −2.59 | 8.98E+7 | −5.62E−8 | 1.59E−8 | −3.54 | 8.09E+7 |
| *TRAFFIC* | 6.12E−4 | 1.22E−4 | 5.02 | 16,919.85 | 8.95E−4 | 1.58E−4 | 5.69 | 15,860.94 |
| *METMILE* | 8.20E−4 | 1.83E−4 | 4.48 | 9,245.96 | 2.13E−4 | 2.18E−4 | 0.98 | 9,090.17 |
| *MSANEIGH* | −3.2418 | 1.674 | −1.94 | 0.476 | −1.1239 | 1.946 | −0.58 | 0.476 |
| *SPACING* | 0.0865 | 0.035 | 2.46 | 54.89 | 0.0970 | 0.047 | 2.09 | 55.06 |
| *NORTHEAST* | 27.6301 | 4.519 | 6.11 | 0.033 | −0.1112 | 5.645 | −0.02 | 0.028 |
| *MIDWEST* | −5.1131 | 1.835 | −2.79 | 0.319 | −1.6692 | 2.050 | −0.81 | 0.341 |
| | | | | Endogeneity Correction Terms | | | | |
| *CORRECT-L* | 1.7566 | 2.579 | 0.68 | −0.062 | −5.6615 | 4.797 | −1.18 | 0.428 |
| *CORRECT-H* | 7.2933 | 3.020 | 2.41 | 0.257 | 5.8655 | 2.243 | 2.62 | −0.045 |

Dummy variables for motels with five individual chain affiliations and for AAA listing are not included in this table. Remaining variable definitions can be found in table 8. Observations have been weighted to avoid overemphasizing motels from the least concentrated markets. Here, each motel receives a weight of one divided by the total number of motels of its product type in its market. Capacity is the number of rooms available for rent in each motel.

among multiple high-quality firms drives their prices down enough that the low-quality firms cannot operate profitably. This effect is certainly present in the price regression for low-quality motels, though it is not strong enough to prevent their entry. The subsample capacity regressions in Table 7 also demonstrate different effects for low- and high-quality firms. Although both *1ST-DIFF* and *ADNL-SAME* are negative and significant in the full-sample regression, it appears that *ADNL-SAME* affects only high-quality motels and *1ST-DIFF* only low-quality motels.

The remaining parameters indicate how the control variables differ between the low- and high-quality subsamples. For prices, the estimated effects are all of the same sign, but tend to be larger and more statistically significant in the high-quality regression. There are some differences in the capacity regressions that can be attributed to variation in the distribution of consumers' preference for quality across markets. For example, we might expect urban travelers to prefer high quality. *METMILE*, the measure of how urban a freeway's traffic is, comes in positive and significant for high-quality capacity only. In contrast, if the neighboring market is urban, high-quality capacity is lower. Unfortunately, further distinctions are hard to isolate, as demand and competition are very difficult to model. Low-quality motels may have more substitutes—some travelers may sleep at a campground or rest area if low-quality motels are priced too high for their taste—that are hard to identify and control for. While I have the *TRAFFIC* that passes by each exit, it would be useful to know whether these motorists are local or long-distance travelers, if they are driving passenger

TABLE 8.—EXPLANATORY VARIABLES USED IN THE OUTCOME REGRESSIONS

| Name | Description |
|---|---|
| *PLACEPOP* | Population of motel market's nearest town |
| *POPSQR* | Square of *PLACEPOP* |
| *PERCAPI* | Per capita income of market county's residents |
| *TRAFFIC* | Annual average daily traffic on interstate at the market exit |
| *METMILE* | Population of metropolitan areas along highway divided by total highway mileage |
| *MSANEIGH* | Dummy variable; equals 1 for markets with an adjacent MSA |
| *SPACING* | Miles from market exit to closest motel markets along highway |
| *WEST* | Dummy variable; equals 1 for markets in the West region |
| *SOUTH* | Dummy variable; equals 1 for markets in the South region |
| *MIDWEST* | Dummy variable; equals 1 for markets in the Midwest region |
| *NORTHEAST* | Dummy variable; equals 1 for markets in the Northeast region |
| *CORRECT-L* | Value of the expectation of the low-quality profit error, given the observed market structure. |
| *CORRECT-H* | Value of the expectation of the high-quality profit error, given the observed market structure. |

In tables 4 and 5 the effect of the correction terms is specified separately for low- and high-quality motels.

cars or commercial vehicles, and if the distribution of motorists along the highway is any different in the evening, when people begin to look for a place to spend the night.[40] Although substantial demand error may remain, it is difficult to speculate how this additional error is distributed or what specific biases the misspecification might cause.

To summarize, regressions run on the price and capacity outcomes provide evidence that helps explain why motels choose to differentiate their products. The results strongly suggest that competition among firms is tougher when the firms offer products similar to those offered by their competitors. The two-stage estimation procedure provides a method to connect the interrelated product choice decisions and the competition among firms by allowing for unobserved factors that affect both. Employing this method helped to correct for the bias that results when using market structure to explain competitive outcomes.

## VI. Conclusion

This paper proposes a two-stage procedure for analyzing price competition, product differentiation, and the entry and product-type decisions of firms. The empirical work stresses the logical connection between these elements—how they operate simultaneously to determine market structure and outcomes in product-differentiated oligopolies. The estimation method utilizes a structural model of entry and product choice to correct for endogeneity between outcomes and concentration measures. Such a procedure is particularly useful in cases where appropriate instruments are difficult to construct.

Using a sample of motel oligopolies, I examine how market outcomes are affected by market concentration and, unlike previous studies, specifically allow for differences in the competitive effects of firms based on their relative locations in product space. The estimation results reveal that firms substantially limit competition by offering differentiated products: the presence of any market competitor drives down prices, but the effect is smaller when the competitor is a different product type. Controlling for market characteristics, motel capacity is also smaller when there are more firms operating in the market. Taken together, the results suggest that firms choose to be different from their competitors because when products are differentiated, the resulting competition is less tough and profits are higher.

[40] Park Inn of York, Nebraska hails itself as being an "excellent stop for the interstate traveler located 9 hours east of Denver and 9 hours west of Chicago." Indeed, a York, NE dummy is positive and significant in the capacity regression. Although probably important, extremely detailed information on travel behavior would be required to properly incorporate this sort of effect into the outcome regressions framework.

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