ESSAYS ON ESTIMATING THIRD-DEGREE PRICE DISCRIMINATION

by

Tomohiko Yano

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Abstract

These three essays study third-degree price discrimination in the U.S. movie theater industry.

The first chapter describes datasets used in this study and presents the reduced-form evidence that movie theater chains price-discriminate households without children and households with children. The results are consistent with a model of a simple third-degree price discrimination where movie theater chains choose a regular ticket price and a family ticket price (that is, the sum of the regular ticket price and a child ticket price) separately by each movie theater so that they maximize profits from households with children and households with children.

In the second chapter, I estimate demand and supply of a movie theater in a structural model under the price discrimination and the one under no price discrimination, using the unique dataset of ticket prices and theater characteristics including location of movie theaters operating in the U.S. The results show that the model with price discrimination is sharply and statistically well-determined while the model without price discrimination is not, which supports that movie theaters conduct the price discrimination and incorporating it to the structural model significantly improves the estimates.

In the third chapter, I conduct counterfactual experiments to study two central topics in the literature of price discrimination. First, I evaluate the price effect of price discrimination by decomposing observed child discounts into cost difference and price discrimination. Then, I evaluate the welfare effect of banning a child discount to see the welfare effect of limiting firm's ability of price discrimination. The result shows that the ban deteriorates the social welfare because of the decrease in demand by households with children while consumers might be better off.

Contents

Introduction

In these three essays, I study third-degree price discrimination in the U.S. movie theater industry between the two main consumer segments: households without children under twelve years old and households with children. Movie theater chains conduct price discrimination between households without children and households with children by offering two types of tickets by each movie theater they own: a regular ticket, a ticket of any adult under 59 years old, and a child ticket, a ticket of any child under 12 years old. Since households with children purchase both regular tickets and child tickets as long as they go to a movie theater together while households without children purchase only regular tickets, movie theater can price-discriminate between households with those two types of family compositions by offering a regular ticket and a child ticket.

The first chapter describes datasets used in this study and presents the reduced-form evidence that movie theater chains price-discriminate households without children and households with children. The results are consistent with a model of a simple third-degree price discrimination where movie theater chains choose a regular ticket price and a family ticket price (that is, the sum of the regular ticket price and a child ticket price) separately by each movie theater so that they maximize profits from households with children and households with children.

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In the third chapter, I conduct counterfactual experiments to study two central topics in the literature of price discrimination. First, I evaluate the price effect of price discrimination by decomposing observed child discounts into cost difference and price discrimination. Then, I evaluate the welfare effect of banning a child discount to see the welfare effect of limiting firms ability of price discrimination. The result shows that the ban deteriorates the social welfare because of the decrease in demand by households with children while consumers might be better off.

This study contributes to three literature. First, it contributes to the literature of empirical studies on third-degree price discrimination. There are few empirical studies on price discrimination (e.g. Leslie (2004)) mainly because of availability of data, and their focus is on second-degree price discrimination rather than third-degree price discrimination. I constructed the unique dataset, including ticket prices, locations, and theater characteristics of movie theaters, from various sources, and those rich datasets enable me to study empirically third-degree price discrimination. The welfare effect of banning the third-degree price discrimination is the central issue in the literature of price discrimination because theoretical studies on it (Pigou (1920), Robinson (1933), Borenstein (1985), Holmes (1989), and Armstrong and Vickers (2001)) do not make a sharp prediction on it. The counterfactual experiment in this study gives a useful insight on it.

Second, it contributes to the literature of structural estimation of geographically differentiated markets (fast-food stores by Thomadsen (2005), gas stations by Houde (2012), and movie theaters by Davis (2006)). Thomadsen (2005) and Davis (2006) are the seminal works of structural estimation incorporating geographical differentiation of stores. Also, Houde (2012) estimates a structural model of price competition between gas stations and proposes using commuting route as consumer location instead of single points such as their residence.

Both of my study and Thomadsen (2005) identify a model of demand and pricing in geographically differentiated markets with only data on prices and no quantity (i.e. sales) using the estimation method suggested by Feenstra and Levinsohn (1995). However, this study shows that the idea of the identification of pricing game in Thomadsen (2005) extends to a model with price discrimination. My study is similar to Davis (2006) since it also estimates demand for movie theaters, but differs from his study because I model and estimate the pricing game by movie theater chains in my study.

Third, this study contributes to the literature of economic analysis of the movie theater industry. While there are some empirical and theoretical studies on the industry (Orbach (2004), Orbach and Einav (2007), Einav (2007), Gil (2009), Gil and Lafontaine (forthcoming)), only Orbach and Einav (2007) focus on ticket pricing in the movie theater industry and investigate why movie theaters use uniform pricing for differentiated goods (i.e. films). Although this study does not answer the puzzle directly, it proposes a method of structural estimation in the movie theater industry that enables me to answer it.

Chapter 1

A Reduced Form Analysis of Price Discrimination in the U.S. Movie Industry

1.1 Introduction

Movie theater chains conduct third-degree price discrimination between the two main consumer segments: households without children under twelve years old and households with children. MPAA (2012) reports that 87 percent of moviegoers are younger than sixty years old and 14 percent of moviegoers are children under twelve years old [1]. Since children often go to a movie theater with their parents, households with children make up a significant percentage of moviegoers. The MPAA report also shows that households with children are more frequent moviegoers than households

[1] In the MPAA report, frequent moviegoers are defined as those who go to a movie theater once a month or more.

without children.

Movie theater chains conduct price discrimination between households without children and households with children by offering two types of tickets: a regular ticket for any adult under 59 years old, and a child ticket for any child under 12 years old. Since households with children purchase both regular tickets and child tickets as long as they go to a movie theater together while households without children purchase only regular tickets, movie theaters can price-discriminate between those two types of households by offering a regular ticket and a child ticket.

In this chapter, I study price discrimination in this industry with reduced-form regressions, using the unique dataset of ticket prices I collected from movie theater ticketing websites and official websites. The results of the reduced-form regressions indicate that movie theater conduct simple third-degree price discrimination between households without children and households with children; they choose regular ticket prices to maximize profits from households with children, and choose family ticket prices (that is, the sum of a regular ticket price and a child ticket price) to maximize profits from households with children. This result motivates structural models to be estimated in Chapter 2.

The rest of this chapter proceeds as follows. In Section 1.2 and Section 1.3, I describe the industry and the data, respectively. Section 1.4 presents and discusses the results of reduced-form regressions, and Section 3.4 concludes.

1.2 U.S. Movie Theater Industry

The movie theater industry is one of the largest entertainment industries in the U.S. MPAA (2013) reports that the U.S. and Canada box office accounts total 10.8 billion dollars and that the total admission (i.e. the cumulative total number of people who went to a movie theater) is 1.36 billion in 2012. This is much greater than the attendance of theme parks (360 millions) and that of sports (131 millions) in 2012. Most of the movie theaters are *first-run movie theaters*, movie theaters that mainly play commercial films within a month after the date of its national release. Most of the first-run movie theaters are owned by movie theater chains such as Regal, AMC, Carmike, and Cinemark. They have indoor venues with screens while drive-in theaters have screens outside so that moviegoers can watch movies in their own car. First-run movie theaters make up for around 70 percent of movie theaters operating in the U.S. In Dallas, TX, for example, 53 movie theaters are first-run movie theaters while there are 73 movie theaters in 2010.

Movie theaters that do not play first-run films and play relatively old commercial films, especially past hit films, at a ticket price that is lower than the one in first-run movie theaters are referred to as second-run theaters. Second-run movie theaters do not compete intensively against first-run movie theaters, because most of the moviegoers prefer the latest films [2].

The other types of movie theaters, including art-film theaters, non-commercial movie theaters owned by NPOs and educational institutions (e.g. college), and IMAX theaters are not likely to compete against first-run movie theaters. Art-film theaters play non-commercial, art films. Some educational institutions including art museums have their own theaters for educational purposes. IMAX theaters play films taken with their own technology and their films are totally different from commercial films.

[2] According to *Box Office Mojo*, an information website for moviegoers, all of the top 100 films in 2012 domestic grosses in the U.S. and Canada are the ones that were released after the late November in 2011. This indicates that movie-goers prefer the latest movies to others and then second-run movies and first-run movies are not substitutive.

In the whole study in this dissertation, I focus on competition among first-run movie theaters. Later in this study, I refer to first-run movie theaters as “movie theaters”.

Pricing Policy of First-Run Movie Theaters Movie theater chains choose ticket prices for each of those theaters. They typically offer three types of tickets depending on age group of attendance by each movie theater they own: a regular ticket, a ticket for children (those under twelve years old), and a ticket for seniors (those over sixty years old). Posting admission fees by age groups is often observed in industries with low marginal cost (Rosen and Rosenfeld (1997), Leslie (2004)) such as entertainment parks. On the other hand, movie theaters do not offer a ticket for small size of groups including families while some movie theaters offer a ticket for large groups (for example, a group of more than twenty people).

Some movie theaters post different ticket prices across hours in a day, days of a week, occupations of attendees, 3D or non-3D films, and age group of attendees. Many movie theaters offer discounts for shows in weekdays or a specific day of a week and during the morning through early afternoon (e.g. matinée) discount and “Early Bird” discount), and they also discount ticket prices for attendance with specific occupation such as military and student. Furthermore, movie theaters with 3D screen often offer a 3D-show ticket that is more expensive than a non-3D show. Very few movie theaters offer different ticket prices across films, and most of the movie theaters use uniform pricing over films[3].

Sources of Revenue and Cost The main sources of theater revenue are ticket sales and concession sales, and the main sources of costs for operating movie theaters

[3] The uniform pricing over films is a puzzle in the movie theater industry. See Orbach and Einav (2004) for the detail of the practice

are film rental, rent for venues, and payroll. Products sold inside a movie theater including snacks and sodas are referred to as “concessions”.

According to the interview with Shari E. Redstone, president of National Amusement, Inc. (Squire (2004)), a “hypothetical” movie theater with sixteen-screen multiplex earns 72% of total theater gross from ticket sales and 26.5% from the sales of concessions. Also, the interview reports that film rental, rent, and payroll account for 35%, 15%, and 12% respectively of the total revenue from both ticket sales and concession sales. Theater-level net cash flow is around 15% of the total sales, and theater profit margins vary between 15% and 45%. Although the interview does not mention how much ticket sales and concession sales account for total profits, most of theater profits will come from concession sales since the main cost source is film rental, which is not for concession, and concessions are much more expensive than the same goods sold outside movie theaters, as discussed below.

The cost of film rental is determined mainly by revenue-sharing contract between movie theater chains and distributors of films[4]. Movie theater chains rent a film from a film distributor and share revenue from ticket sales of the film with the distributor based on the revenue-sharing contract. A typical revenue-sharing contract stipulates that a distributor takes the larger of amounts calculated in the following two formulas: weekly total ticket revenue minus allowance multiplied by split rate, and weekly total ticket revenue multiplied by “floor rate” (rate to split revenue). Those split rates are not observed, but Squire (2004) mentions that 90% of split rate and 70% of floor rate are the most commonly used percentages for the first week of the show, and the percentages are decreasing over time.

[4]See Orbach and Einav (2007) for the detail of revenue-sharing contracts between distributors and exhibitors.

The allowance and rates are determined by negotiation between the distributor and the exhibitor, depending on the quality of films (e.g. probability of the film's success) and the quality of theaters (e.g. the number of screens and seats).

Concession revenue is the main source of profits for movie theaters for two reasons. First, many movie theater chains do not allow attendees to bring drinks and foods purchased outside to into the theater, and they set a high margins on concessions. For example, a typical price of 24 oz. of soda is around four dollars, which is much more expensive than average price of the same type of products available outside movie theaters. Second, under typical revenue-sharing contracts, distributors do not take anything from concession sales while they take more than a half of revenue from ticket sales. For these reasons, movie theaters earn more than a half of profits from concession sales, instead of ticket sales.

1.3 Data

I use several datasets for this study (see the Appendix for the description and the construction of the datasets), and the key dataset is the cross-sectional data on movie theater characteristics including theater locations in terms of longitude and latitude, and prices of regular tickets and child tickets. The dates in which I collected the data on each of those variables varies between July 2010 and March 2011, depending on variables. I collected the data on 253 movie theaters operating in 66 Metropolitan Statistical Areas in the U.S. ("MSA" hereafter), and they cover all first-run movie theaters with an indoor venue that are operating in those MSAs as of July 2010.

I define the relevant market as a set of first-run movie theaters with indoor venue located in a MSA [5]. I do not include any non-first-run movie theaters and drive-ins in the product market under the assumption that they are not significant substitutes for first-run movie theaters. Defining a MSA as the geographic market is reasonable since, in most of the MSAs, resident and business are much denser in areas near the center of the MSA than its border. Since MSAs are sufficiently spacious, it is reasonable to assume that a movie theater in a MSA is not a substitute for a movie theater in another MSA for residents in those MSAs.

Ticket Prices Table 1.1 reports the summary statistics of prices of regular tickets and child tickets for shows on *Saturday evening*, child discount levels, and child discount rates. Table 1.2 reports the summary statistics of market-level mean and standard deviation of regular ticket prices and child ticket prices. Both the observed regular ticket prices and child ticket prices exhibit significant variation at theater and market levels. Also, they show that children tickets are discounted to some extent. Furthermore, both regular ticket prices and child ticket prices vary within each market.

The sample mean of a regular ticket price is 8.73 dollars, which is greater than its national average in 2010, 7.93 dollars, mainly because I exclude second-run theaters from my sample[6]. On the other hand, the mean of child ticket prices is 6.33 dollar,

[5] For some markets, I include movie theaters that are located slightly outside the MSA as long as they are so close to movie theaters inside the MSA that it is reasonable to assume that they compete against movie theaters inside the MSA.

[6] In general, second-run movie theaters offer tickets at much lower prices than do first-run movie theaters, and they make up more than ten percent of commercial movie theaters in markets, and ticket prices offered at them are much lower than those of first-run movie theaters. According to my data of Dallas, TX, for example, there are 61 commercial movie theaters and 8 out of them are second-run movie theaters, and the mean regular ticket price of the first-run movie theaters is approximately 7.8 dollars while that of the second-run movie theaters is 2.9 dollars. There is much level of price difference between first-run movie theaters and second-run movie theaters.

which is around 2.40 dollar cheaper than regular tickets. A regular ticket price, a child ticket price, and a child discount measured as the difference between regular ticket prices vary significantly across markets and within market. Regular ticket prices are more dispersed than child ticket prices. The standard deviation of regular ticket prices and child ticket prices are 1.47 and 1.08, respectively, and this shows that regular ticket prices are more dispersed than child ticket prices.

Table 1.2 reports the summary statistics of market-level ticket prices, that is, market-level mean and market-level standard deviation of ticket prices and child discounts. It shows that there are variation of ticket prices both within each market and across markets. For example, mean regular prices vary between 5.88 dollars and 10.5 dollars, and the mean of within-market standard deviation is 0.74. Which within-market price dispersion or between-market price dispersion is greater than the other? The dispersion of ticket prices come mainly from within-market dispersion. Table 1.3 reports the decomposition of the standard deviations into the one across markets and the one within each market. It shows that the between standard deviation of regular ticket prices is 0.515 and the within standard deviation is 1.270, which indicates that regular ticket prices vary mainly within each market. The table also shows that the standard deviation of child ticket prices also come mainly from the dispersion of child ticket prices within each market. This trend is also the case for child ticket prices.

Regular ticket prices and child ticket prices are strongly correlated. Figure 1.1 plots a regular ticket price and a child discount by theater, and Figure 1.2 plots them by each large chain (Regal, AMC, Carmike, and Cinemark). All of the figures show that child discounts are positively correlated with regular ticket prices while 1.2 shows that there is significant difference in discount given a regular ticket price, across theaters in the same chain (for example, Cinemark theaters offering regular tickets that are cheaper than around 7.75 dollars). Those figures also show that there is variation in the level of a child discount conditional on a regular ticket price. These indicate that either the level of child discounts or the rate of child discount is not constant.

Market Structure and Market-Level Demographic Attributes Market structure and demographic attributes vary across markets. Table 1.4 is the summary statistics of market-level demographic attributes and market structure in terms of the number of movie theaters and chains, and Table 1.5 shows the distribution of the number of movie theaters.

The mean of the number of chains in a market is 2.86, which is around two third of the mean of the number of movie theaters in a market, 3.83. Table 1.5 shows that more than 25 percent of the sampled markets are monopolistic. The table also shows that three or fewer chains compete in more than a half of the markets. The bottom row of Table 1.5 shows that, in more than a half of the markets with two or more movie theaters, at least one chain owns two or more movie theaters in a market. Also, those tables show significant variation in demographic attributes. Market size differs significantly in terms of population. The mean population is 360 thousand, but it varies much between only 64 thousand and 3.7 million. The table also shows that income level, educational level, and the fraction of households with children vary significantly across markets.

Variation Within Market As discussed above in this section, in Table 1.3, my data show that the variation of the observed ticket prices come mainly from their within-market dispersion. This within-market price dispersion may be caused by competition of movie theaters as well as theater attributes (e.g. quality of films and movie theaters). Since households incur transportation cost of going to a movie theater, households are likely to go to a movie theater located near them. Each movie theater competes with their competitors located near it. Therefore, ticket prices might be affected by demographic attributes in areas near theater, theater characteristics, and the degree of competition.

My data show that demographic attributes vary within each market. Table 1.6 is the summary statistics of block-group-level demographic attributes in Madison, WI. The table shows that there are 256 census block groups in Madison, WI, and they vary in population, size, and the other demographic attributes to significant extent. Mean of the area (in square mile) of block groups is 4.5 square miles, and the mean population is 1651. Those demographic attributes vary across areas near movie theaters too. Table 1.7 reports the summary statistics of demographic attributes in block groups within 5 miles away from the sampled movie theaters, and it shows that significant variation in demographic attributes across areas near each movie theater.

Movie theaters are differentiated in equipment such as the number of screens and the quality of them (e.g. sound systems) and films. They will attract moviegoers with the latest sound systems and hit films. Table 1.9 reports the summary statistics of theater characteristics including film characteristics. From this table, one can see that movie theaters are differentiated to the significant extent. The sample mean of the number of shows is 17, and its standard deviation is 8.75. The number of shows during a certain time is based on the number of screens, so this indicates that the number of screens vary across movie theaters. The table also shows that the fractions of films vary across movie theaters.

As mentioned above, movie theaters are also differentiated in location as well as the other theater and film characteristics. In a market where two movie theaters compete, those movie theaters are more spatially differentiated as they are located further away each other. My data shows the significant level of variation in the degree of competition between movie theaters. Table 1.8 is the summary statistics of three competition measures: the number of rival theaters within five and ten miles away from the theater, and distance to the nearest competitor [7]. From the table, one can see that movie theaters are located significantly far away each other. The table shows that more than a half of the movie theaters have any competitor within 5 mile away from them, and that the mean of distances to the nearest rival movie theater is 11.73 miles.

1.4 Reduced-Form Evidence

To see how theater-level and market-level attributes described in the last section are correlated with ticket prices and child discounts, I conduct reduced-form regressions of outcome variables (that is, ticket prices) on the set of variables described in the last section. Table 1.10 and Table 1.11 report the regression results of regular ticket prices, child discounts, and child ticket prices after controlling regular ticket prices.

In Table 1.10, Column 1-4 report the regression results of regular ticket prices with different sets of competition measures with 5 miles of distance bands, and Column 5 reports the regression result of regular ticket prices on the same type of the regressions with 4 miles of distance band.

In Table 1.11, Column 1-2 report the regression results of child discounts defined as difference between a regular ticket price and a child ticket price with the same

[7] The appropriate choice of measure of competition in this study will be discussed in Section 1.4.

regressors as the ones used in the first and fourth model for regressions of regular ticket prices, and Column 3-4 report the regression results of child ticket prices after controlling for regular ticket prices with the same sets of regressors as Column 1-2.

Later in this section, I discuss econometric specifications of the reduced form regressions focusing on the choice of distance bands to compute demographic attributes and measures of competition. Then, I discuss the regression results.

Competition Measure As shown in Table 1.8, around 70 percent of movie theaters have no competitor within 5 miles away from each theater, and around 40 percent of movie theaters have no competition even within 10 miles away from each theater. The table also shows that there is little variation in the number of competitors around each movie theater even if there is at least one competitor around it. For example, the table shows that there are at most only 4 competitors within 5 miles away from each movie theater. Which does the variation in the number of competitors or whether there is at least one competitor affect regular ticket prices more strongly than the others if it affects regular ticket prices? Column 1-4 in Table 1.10 reports the regression results of regular ticket prices on different sets of competition measures. The remaining regressors are all the same across those specifications. Those four specifications use only a competitor indicator that takes 1 if there is at least one competitor within a certain miles away from each movie theater, the number of competitors, both the competitor indicator and the competitor count, and both the competitor indicator and a distance to the nearest competitor.

There are some important findings. The results in Column 1 and 2 show that the competitor indicator is more strongly correlated with regular ticket prices than the competitor count in terms of both t-values of the coefficient of those competition measures and F-statistics. The estimate of the competitor indicator is statistically significant, but that of the competitor count is not. Can only the competitor indicator affect regular ticket prices? To see this point, I conduct two more regressions with both the competitor indicator and another competition measure. Column 3 and 4 report the results of those regressions. Both of them use the competitor indicator and another competition measure. The results show that either of competitor count and distance to the nearest competitor is not statistically significant while competitor indicator is statistically significant, but the model including the distance to the nearest competitor is more strongly correlated with regular ticket prices than the model including competitor count, in terms of adjusted R^2 and F-statistics while either of them does not differ significantly from the model with only competitor count. This indicates that whether there is at least one competitor within a certain mile away from each movie theater will be the key variable that can affect regular ticket prices.

Distance Bands for Demographic Variables and Competition Measures Distance bands for demographic variables and competition measures need to be appropriately chosen in order to capture the set of potential attendance to each movie theater and the set of competitors that can compete with each movie theater. As discussed above in this section, households are likely to go to movie theaters located near them, and then movie theaters compete competitors located near them. Therefore, a small distance band might result in the failure to capture the set of households located outside the distance band who will go to each movie theater with significant probability, and a large distance band might result in capturing households located inside the distance band who will go to each movie theater with quite small probability.

To see this point, I regress regular ticket prices on sets of demographic attributes and competition measures with various distance bands. Column 1 and 5 in Table 1.10 reports the part of the regression results. As expected, the regression results (unreported) show that demographic attributes of households and competition measures computed with distance bands of between 4 miles to 6 miles are more significantly correlated with regular ticket prices than the others in terms of adjusted R^2 and F-statistics. 1.10 reports only the result with 4 miles of the distance band and the one with 5 miles.

Regression of Child Discounts and Child Ticket Prices Controlled For Regular Ticket Prices I also regress of child ticket prices controlling for adult ticket prices (that is, a residual obtained by regressing child ticket prices on regular ticket prices) on the same sets of regressors as the ones used for the regressions of regular ticket prices. Table 1.11 reports the regression results. Overall, the results of F tests show that those variables are jointly significant, while any coefficient is not statistically significant.

Discussion: Reduced-Form Evidence and Model of Third Degree Price Discrimination From the results of the reduced-form regressions shown in Table 1.10, I found that the variables related to demographic attributes near each movie theater, theater attributes, and the degree of competition of each movie theater described in Section 1.3, are significantly correlated with ticket prices. These results indicate that movie theater chains offer ticket prices given those variables, and they also indicate that movie theater chains are involved in price discrimination between households without children and households with children.

For the regressions of regular ticket prices, most of the estimates have reasonable signs when they are statistically significant. Adjusted R^2 of the regressions of regular ticket price is near 0.5, and I conclude that those models describe the variation of regular ticket prices to significant extent. The results of regressions of child discounts show weaker correlation with these variables, but they are jointly significant. The signs of the statistically significant estimates are the same as the ones of regular ticket prices.

There are several important findings. First, the estimates of competition measures are all negative, which indicates that prices are lower when theaters have competitors within 5 miles of their locations. Interesting is that whether there is at least one competitor within a certain distance from each movie theater is more strongly correlated with regular ticket prices than the number of competitors within the distance from each movie theater. This indicates that movie theaters care about only whether they have any competitor within a certain distance but not the number of competitors within it.

I obtain different results from the regressions of child discounts, as reported in Column 1-2 in Table 1.11. The result shows that the fraction of households with children has a positive sign in both those two models.

From a theoretical point of view, those regression results are consistent with the model of pricing game among movie theater chains with third-degree price discrimination between households without children and households with children.

If movie theater chains price-discriminate between households without children and households with children, taking into account the variation of the number of children per household with at least one children or that households with children make a choice of *who* in the household goes to a movie theater, then any demographic variable relevant to family composition can affect regular ticket prices or child ticket prices. If they post ticket prices taking into account the variation of the number of children per household with at least one children, they will extract surplus from households with children by choosing both a regular ticket price and a child ticket price jointly and then the distribution of the number of children per household with children will affect regular ticket prices and child ticket prices. Also, if they post ticket prices taking into account that households with children make a choice of who in the household goes to a movie theater, the marginal effect of increasing a regular ticket price differs from that of increasing a child ticket price and then the fraction of households with children will affect regular ticket prices and child ticket prices. The regression results of child discounts show that the fraction of households with children is positively correlated with child discounts, which indicates that those factors can affect ticket prices.

1.5 Conclusion

In this chapter, I studied third-degree price discrimination in the U.S. movie theater industry using the dataset I collected by hand.

The main findings are as follows. First, there is significant variation within each market in both regular ticket prices and child discounts. Second, the reduced-form evidences indicate that the variation could be explained by the variation of demographic attributes and the degree of competition of movie theaters to some extent, as well as theater attributes. Third, the reduced-form evidence is consistent with a model where movie theater chains conduct price-discriminate between households without children and households with children. The fraction of households with children located near each movie theater is positively correlated with ticket prices, which indicates that those factors can affect ticket prices.

In the following chapter, I construct and estimate a structural model that is consistent with the findings above.

Chapter 2

A Structural Analysis of Price Discrimination in the U.S. Movie Industry

2.1 Introduction

In this chapter, based on the reduced-form evidence shown in Chapter 1, I estimate the structural model where movie theater chains price-discriminate between households without children and households with children. In the last chapter, I found that the variation of ticket prices came mainly from its within-market variation and the within-market variation of ticket prices could be explained by the variation of demographic attributes and the degree of competition of movie theaters to some extent, as well as theater attributes. Also, I found that my data is consistent with a model where movie theater chains price-discriminate between households without children and households with children. Any variable relevant to family composition of households located near each movie theater is not strongly correlated with ticket prices, which indicates possibility that movie theaters simply price-discriminate between households without children and households with children. This motivates a structural model to be estimated in this chapter.

The main question in this chapter is whether the variation of ticket prices supports the price discrimination in this industry. If this is true, structural parameters will be estimated more precisely from the variation of regular ticket prices and that of child ticket prices than only the variation of regular ticket prices. To study it, I estimate and compare the estimation results of the following three types of structural model that can explain the variation of ticket prices: a model without price discrimination where family composition does not shift demand (i.e. the same model as the one estimated in Thomadsen (2005), a model without price discrimination where family composition shifts demand, and a model with price discrimination.

The result shows that estimating a model with price discrimination using both regular ticket prices and child ticket prices significantly improve the estimates.

This chapter proceeds as follows. In Section 2.2, I present structural models to be estimated. Section 2.3 discusses estimation strategy, and Section 2.4 reports the estimation results. Finally, Section 2.5 concludes.

2.2 Structural Model

I model household's decision by a discrete choice model where choice sets are the set of movie theaters in a market. Movie theaters (firms) are differentiated in location as well as other theater characteristics, and chains (movie theater owners) are involved in a pricing game given the locations of movie theaters they own, and they price discriminate between households without children and households with children by offering a regular ticket and a child ticket by theater.

2.2.1 Households

There are M geographically-defined markets, and let the set of movie theaters operating in market $m = 1, \ldots, M$ be denoted by $\{1, \ldots, J_m\}$. Households in market m choose to go to theater $j \in \{1, \ldots, J_m\}$, or the outside option, that is, not going to any movie theater in $\{1, \ldots, J_m\}$. Household i derives utility from choosing theater j given by

$$U_{ij} = \delta_j(h_i, l_i, d_i) + \epsilon_{ij} \tag{2.1}$$

where $\delta_j(h_i, l_i, d_i)$ is a mean utility of households with type (h_i, l_i, d_i) and ϵ_{ij} is a iid preference shock distributed Type I Extreme Value with scale normalized to 1.

h_i indexes household i's family composition, where $h_i = R$ if the household has no children and $h_i = F$ if the household has at least one child. Let an age group of a moviegoer denoted by $v = A, K$, where A is an adult and K is a child. Then, households with family composition $h_i = R$, households without children, consist of a moviegoer with $v = A$, and households with family composition $h_i = F$, households with children consist of a moviegoer with age group $v = A$ and a moviegoer with age group $v = K$.

l_i indexes household i's location. I assume that all households are located in their residence, instead of their workplaces (Thomadsen (2005)) or their commuting paths (Houde (2012)) since any household typically make a decision on movie-going at home. Household location is measured by census block group, and I locate households at the centroids of census block groups where they belong. Let $d_i = (ed_i, income_i)$ denote a vector of demographic attributes excluding family composition. ed_i indexes household i's educational level, where $ed_i = 1$ if the household has college or higher degree and $ed_i = 0$ otherwise. $income_i$ indexes household i's income. I assume that all households in a location l have mean income level within the location. This assumption is fairly reasonable because each census block group is so small that income level does not vary across households within each block group. Note that the set of household types defined above is discrete. Both family composition, h_i, and educational level, ed_i, are binary variables. I discretize household location, l_i, to the centroid of each census block group, and income level, $income_i$, is also discrete under the assumption that income level for any household in a census block group is block-group-level mean.

The mean indirect utility of households with type (h_i, l_i, d_i) choosing theater j is given by

$$\delta_j(h_i, l_i, d_i) = k^{h_i} + d_i\nu + x_j\beta - \alpha^{h_i} p_j^{h_i} - \lambda Dist(l_i, l_j) \tag{2.2}$$

where

$$(p_j^{h_i}, k_j^{h_i}) = \begin{cases} (p_j^A, k^A) & \text{if } h_i = R \\ (p_j^A + p_j^K, k^A + k^K) & \text{if } h_i = F \end{cases} \tag{2.3}$$

and $Dist(l_i, l_j)$ is a driving distance of the shortest path between household location l_i and theater location l_j that is measured by their longitude and latitude. p_j^A and p_j^K are ticket prices for an adult and a child, and k^A and k^K are base utilities an adult and a child derive from going to any movie theater in $\{1, \ldots, J_m\}$. A price for households without children and a price for households with children are given by Eq (2.3) because movie theaters offer a ticket by age group of moviegoers instead of household type of households.

Finally, the mean utility a household derives from the outside option (that is, $j = 0$) is given by

$$\delta_0(h_i, l_i, d_i) = \beta_0 \tag{2.4}$$

for any (h_i, l_i, d_i). β_0 is normalized to zero.

The household will go to a movie theater that gives the highest utility and will choose the outside option if it gives the highest utility. Under these assumptions, the fraction of household i with type (h_i, l_i, d_i) has the following logit form:

$$S_j(h_i, l_i, d_i) = \frac{\exp(\delta_j(h_i, l_i, d_i))}{1 + \sum_{k=1}^{J_m} \exp(\delta_k(h_i, l_i, d_i))} \quad . \tag{2.5}$$

Let a vector of regular ticket prices, child ticket prices, and theater characteristics denoted by $P_m^A = (p_1^A, \ldots, p_{J_m}^A)'$, $P_m^K = (p_1^K, \ldots, p_{J_m}^K)'$, and $X_m = (x_1, \ldots, x_{J_m})$, respectively. Then the demand for theater j by households without children, Q_j^R is given by

$$Q_j^R(P_m^A, X_m) \quad = \quad \sum_d \sum_l N_m(R, l, d) S_j(R, l, d) \tag{2.6}$$

where $N_m(R, l, d)$ is the number of households without children with demographic type d in location l. Similarly, the demand for theater j by households with children,

Q_j^F is given by

$$Q_j^F(P_m^A, P_m^K, X_m) = \sum_d \sum_l N_m(F,l,d) S_j(F,l,d) \ . \tag{2.7}$$

Therefore, total demands for a regular ticket and a child ticket at theater j, denoted by Q_{jA} and Q_{jK}, are given by

$$\begin{aligned} Q_{jA}(P_m^A, P_m^K, X_m) &= Q_j^R(P_m^A, X_m) + Q_j^F(P_m^A, P_m^K, X_m) \\ Q_{jK}(P_m^A, P_m^K, X_m) &= Q_j^F(P_m^A, P_m^K, X_m) \ . \end{aligned}$$

2.2.2 Movie Theater Chains

There are M geographically-defined markets and J_m theaters are operating in market $m = 1, \ldots, M$. Movie theater chain f owns a subset F_{fm} of the theaters in market m and maximizes the sum of profits in each of the theaters. The total profit, denoted by Π_{fm}, is the sum of the profits from movie theaters owned by chain f, and it is given by

$$\Pi_{fm} = \sum_{j \in F_{fm}} \left\{ (p_j^A - mc_j^R) Q_j^R + (p_j^A + p_j^K - mc_j^F) Q_j^F \right\} \tag{2.8}$$

where mc_j^h is theater j's marginal cost of offering a seat (or seats) to households with family composition $h = R, F$.

Marginal Cost The marginal cost of offering a seat to a household without children, mc_j^R, is defined as follows:

$$\begin{aligned} mc_j^R &= c_j^A + e_j^R && (2.9) \\ &= c_A + g(w_j)\gamma + e_j^R && (2.10) \end{aligned}$$

where c_A is a constant term for adults, $g(w_j)$ is a vector of functions of theater attributes, w_j, and e_j^R is an unobserved marginal cost term. I denote the sum of the observed marginal cost terms by $c_j^R = c_A + g(w_j)\gamma$. Note that some variables in w_j and x_j are common and the others are not. Similarly, the marginal cost of offering seats a household with children is defined as follows:

$$mc_j^F = c_j^A + c_j^K + e_j^F \qquad (2.11)$$

where $c_j^K = c_K + g(w_j)\gamma$ denotes the observed marginal cost for children.

The components of w_j are chain dummies, the number of Saturday evening shows, and the fraction of some types of films in shows.

The variables are included as theater attributes while those variables are film attributes rather than theater attributes. The number of Saturday evening shows is used to proxy for the number of screens under the assumption that the number of shows is determined by the number of screens. The number of screens can affect marginal cost directly since it is used to compute the ratio of revenue-sharing between distributors and exhibitors in the revenue-sharing contract (see Section 1.3 for the detail). It is also a proxy for quality of a movie theater. A movie theater with more screens is likely to be newer than ones with fewer screens, and it is reasonable to assume that new movie theaters are likely to be equipped with new sound systems, and comfortable seats, which increase marginal costs.

Second, the fraction of specific types of films also reflect the quality of movie theaters.

As mentioned in Section 1.2, the main source of gross marginal cost is payment for film rental based on the revenue-sharing contract between exhibitors (chains) and distributors. Since the percentage is determined by negotiation and quality of a movie theater, which chain a movie theater belongs to and the number of shows can affect gross marginal cost. Also, marginal profit from concession sales described in Section 1.2 is included in the marginal cost term. The observed marginal cost, c_j^v $(v = A, K)$, contains expected marginal concession profits that are accounted by the observed attributes, and the error term, e_j^h $(h = R, F)$, means their deviation from it. Child-fixed effect, c_K, captures the mean difference in expected marginal concession profits between households without children and households with children as well as the difference in gross marginal cost caused by the difference in the size of party (a child accompanies a household with children). Note that ticket prices do not enter marginal concession profits. For this specification, I assume that moviegoers make a decision on whether to purchase concessions inside movie theater independently of a decision on which movie theater to consume.

Pricing Chains are involved in a pricing game among movie theaters in each market. Given ticket prices offered by competitors in the same market, they set two ticket prices, (p_j^A, p_j^K), by each movie theater they own in order to maximize profits defined by Eq (2.8). Then, the following two first-order conditions for profit maximization are obtained by each movie theater in market m:

$$\begin{aligned} \frac{\partial \Pi_{fm}}{\partial p_j^A} = & \quad Q_j^R + Q_j^F + \sum_{r \in F_{fm}} (p_r^A - c_j^A - e_r^R) \frac{\partial Q_r^R}{\partial p_j^A} \\ & + \sum_{r \in F_{fm}} (p_r^A + p_r^K - c_r^A - c_r^K - e_r^F) \frac{\partial Q_r^F}{\partial p_j^A} \\ & = 0 \end{aligned} \tag{2.12}$$

$$\frac{\partial \Pi_{fm}}{\partial p_j^K} = \quad Q_j^F + \sum_{r \in F_{fm}} (p_r^A + p_r^K - c_r^A - c_r^K - e_r^F) \frac{\partial Q_r^F}{\partial p_j^K} = 0 \quad . \tag{2.13}$$

Since each of the $1, \ldots, J_m$ movie theaters posts a regular ticket price and a child ticket price, the system of $2J_m$ equations is obtained by each market. Using the matrix notation, I can rewrite the system of the equations as a simple linear equation. I define a $2J_m \times 2J_m$ matrix Ω as

$$\Omega_m = \begin{bmatrix} \Omega_m^{RR} & \Omega_m^{RF} \\ \Omega_m^{FR} & \Omega_m^{FF} \end{bmatrix}$$

where $\Omega_m^{hh'}$ $(h, h' \in \{R, F\})$ is a $J_m \times J_m$ matrix. The (j, r) element of those matrices, denoted by $\Omega_{j,r}^{hh'}$ $(h, h' \in \{R, F\}$, and $j, r = 1, \ldots, J_m)$, has the following form:

$$\begin{aligned} \Omega_{j,r}^{RR} &= \begin{cases} \frac{\partial Q_j^R}{\partial p_r^A} & \text{if theater } j \text{ and } r \text{ are owned by the same owner} \\ 0 & \text{otherwise} \end{cases} \\ \Omega_{j,r}^{FR} &= \Omega_{j,r}^{FF} = \begin{cases} \frac{\partial Q_j^F}{\partial p_r^A} & \text{if theater } j \text{ and } r \text{ are owned by the same owner} \\ 0 & \text{otherwise} \end{cases} \\ \Omega_{j,r}^{RF} &= 0 \text{ for all } j, r \ . \end{aligned}$$

Also I define $Q_m^R = (Q_1^R, \ldots, Q_{J_m}^R)'$ and $Q_m^F = (Q_1^F, \ldots, Q_{J_m}^F)'$, and similarly, $C_m^v = (c_1^v, \ldots, c_{J_m}^v)'$ $(v = A, K)$ and $E_m^h = (e_1^h, \ldots, e_{J_m}^h)'$ $(h = R, F)$ are defined. Then the system of the first-order conditions can be rewritten as

$$\begin{bmatrix} Q_m^R \\ Q_m^R + Q_m^F \end{bmatrix} + \Omega_m \begin{bmatrix} P_m^A - C_m^A - E_m^R \\ P_m^A + P_m^K - C_m^A - C_m^K - E_m^F \end{bmatrix} = 0 \ . \tag{2.14}$$

The first J_m equations are the first-order conditions with respect to regular ticket prices, and the remaining J_m equations are the ones with respect to child ticket prices. Since the equation system is linear in E_m, solving it for E_m^R and E_m^F yields

$$\begin{bmatrix} E_m^R \\ E_m^F \end{bmatrix} = \begin{bmatrix} P_m^A - C_m^R \\ P_m^A + P_m^K - C_m^A - C_m^K \end{bmatrix} + \Omega_m^{-1} \begin{bmatrix} Q_m^R \\ Q_m^R + Q_m^F \end{bmatrix} \tag{2.15}$$

and E_m^R and E_m^F obtained from them are used as the predicted moment in the estimation.

2.2.3 Single-Pricing Models: Standard Model and Intermediate Model

I also estimate two models without price discrimination that has structure similar to the one estimated in Thomadsen (2005) and Davis (2006), as well as the model with price discrimination (hereafter "full model") described above.

Standard Model One is a model where family composition does not enter at all ("standard model" hereafter), which is the same model as Thomadsen (2005). This model can be presented as special cases of the full model. It assumes that households face the same price. In the model, a price for both households with children and households without children is given by

$$p_j^{h_i} = p_j^A$$

for $h_i = R, F$. A base utility is also assumed to be the same between households without children and households with children and it is given by k^A for any type of households. The model also assumes that both marginal cost and price sensitivity are the same between households without children and households with children. The marginal cost and price sensitivity are given by

$$\begin{aligned} mc_j^{h_i} &= c_j^A + e_j^R \\ \alpha^{h_i} &= \alpha \end{aligned}$$

for $h_i = R, F$, respectively. Then total demand for theater j is given by

$$Q_j(P_m^A, X_m) = \sum_h \sum_d \sum_l N_m(h, l, d) S_j(h, l, d) \tag{2.16}$$

and each chain chooses only p_j^A by theater they own to maximize profits given by

$$\Pi_{fm} = \sum_{j \in F_f} (p_j^A - c_j^A - e_j^R) Q_j \ . \tag{2.17}$$

From the first-order condition for profit maximization with respect to p_j^A, the following system of J_m equations are obtained by market:

$$E_m^R = (P_m^A - C_m^A) + \tilde{\Omega}^{-1} Q_m \tag{2.18}$$

where $Q_m = (Q_1, \ldots, Q_{J_m})'$ and $\tilde{\Omega}$ is a $J_m \times J_m$ matrix with (j, r) element, denoted by $\tilde{\Omega}_{j,r}$, given by

$$\tilde{\Omega}_{j,r} = \begin{cases} \frac{\partial Q_r}{\partial p_j^A} & \text{if } j \text{ and } r \text{ are owned by the same chain} \\ 0 & \text{otherwise.} \end{cases}$$

E_m^R obtained from the system of equations above are used as the predicted moments in the estimation of the standard model.

Intermediate Model The other single-pricing model ("intermediate model" hereafter) differs from the standard model only in a base utility. In the intermediate model, family composition enters only base utility. The base utility is given by

$$k^{h_i} = \begin{cases} k^A & \text{if } h_i = R \\ k^A + k^K & \text{if } h_i = F. \end{cases}$$

The other parts of the intermediate model are exactly the same as the standard model. The total demand is given as the same form as the one in standard model, (i.e. Eq (2.16)). Since this model also assumes single-pricing, each chain chooses only p_j^A by theater they own to maximize profits given by Eq (2.17) and the moment is obtained from Eq (2.18)

2.3 Identification and Estimation

Identification This econometric model is identified from the variation of the observed ticket prices. The idea of identification is based on Feenstra and Levinsohn

(1995) and Thomadsen (2001, 2005). Feenstra and Levinsohn (1995) propose the identification of a model from the variation of prices without quantity data in oligopolistic markets with multidimensional product characteristics. Thomadsen (2001, 2005) employs the method of Feenstra and Levinsohn (1995) to geographically differentiated markets. Thomadsen (2001) shows by numerical examples that in a Hotelling-type model where two stores located at the edges of a line market are involved in a pricing game, two different sets of primitive parameters lead to different sets of equilibrium prices. This indicates that those parameters will be recovered from the variation of the observed prices by solving the equation systems of the first-order conditions in a pricing game. Although the structural model in this study involves a richer structure than Thomadsen (2005) in a sense that each movie theater chain posts two ticket prices by theater and those prices are dependent, Thomadsen's (2005) idea of identification is still valid.

Estimation Method Next, I describe the estimation method. To reduce the burden of computing predicted market shares given by Eq (2.5), I follow Pakes and Pollard (1989) and McFadden (1989) and use simulation estimators. This makes easy to compute market shares while it leads to less efficiency of the estimates.

The steps of the estimation are as follows. First, I draw $\tilde{N}_m$ simulated households by each market from a population density function of household location, $P^*(l)$, over census block groups within each market. Note that household location is discretized, and every household is located in the centroid of census block groups. Also, note that income level, *income*, is also drawn from the population density function of household location because of the assumption that any household in the same location l has mean income in the location. Then, I draw the remaining household characteristics, family composition, h, and educational level, ed, from $P^*(h|l,m)$ and $P^*(ed|l,m)$. I observe a population density function of family composition and educational level, so I use them to draw those household attributes randomly.

Next, given the sets of the simulated households, I look for the vector of true parameters with efficient GMM. The procedure of calculating the predicted moments is as follows. Fixing parameter values, I calculate market share given by Eq (2.5) by household type (l,d,h), and calculate the aggregate demands given by Eq (2.6) by aggregating them over location and demographic type.

Let a vector of parameters to be estimated denoted as follows:

$$\theta = (k^A, k^K, \nu', \beta', \alpha^R, \alpha^F, \lambda, c_A, c_K, \gamma') \quad .$$

Also, I define $\bar{e}^h_m = \frac{1}{J_m}\sum_{j=1}^{J_m} e^h_j$ and $\Delta e^h_j = e^h_j - \bar{e}^h_m$ for $h = R, F$. Then, given the set of true parameters, θ^*, the moment conditions are given by

$$E(\Delta e^h_j(\theta^*)|Z_j, \omega^h_j) \quad = \quad 0 \quad \text{for } h = R, F E(\bar{e}^h_m(\theta^*)) = 0 \quad \text{for } h = R, F \qquad (2.19)$$

where Z_j is a vector of appropriate instruments that are common between households without children and households with children, and ω^h_j $(h = R, F)$ is a vector of appropriate instruments that are specific to households without children and households with children.

The sample analog to the population moment condition is

$$G_J(\theta) = \frac{1}{J}\sum_{m=1}^{M}\sum_{j_m=1}^{J_m}\begin{pmatrix} Z_j^R \Delta e_j^R(\theta) \\ Z_j^F \Delta e_j^F(\theta) \\ \frac{1}{J_m}\bar{e}_m^R(\theta) \\ \frac{1}{J_m}\bar{e}_m^F(\theta) \end{pmatrix} \quad . \tag{2.20}$$

where $Z_j^h = (Z_j, \omega_j^h)$ for $h = R, F$, $e_j^h(\theta)$ is obtained by solving Eq (2.15), and J is the number of movie theaters used in the estimation, that is, $J = \sum_{m=1}^{M} J_m$. Then, the GMM estimator is

$$\hat{\theta} = \underset{\theta}{\operatorname{argmin}}\, G_J(\theta)' W_J G_J(\theta)$$

where W_J is a weighting matrix (Hansen (1982)). I use the optimal weighting matrix of $\hat{W}_J = (\hat{G}_J(\hat{\theta})'\hat{G}_J(\hat{\theta}))^{-1}$, the inverse of consistent estimate of asymptotic variance matrix, obtained from the first step of the estimation.

Instrument Variables Three types of instrument variables are used in estimation: theater characteristics and theater location of competitors, and competition measures. Necessity of the first two arises because of endogeneity problems, and the last one is supplemented to estimate price sensitivity.

The first two types of instrument variables are used to instrument for theater attributes including theater location. Theater location is also one of theater characteristics, but I discuss it separately since it is an important issue in the literature of structural estimation of geographically differentiated markets (Davis (2006), Thomadsen (2005), Houde (2012)).

I use three types of theater characteristics in estimation: the number of shows, chain dummies, and fractions of films in some genres. The number of shows enters both utility and marginal cost, and then I use the sum of the numbers of shows in competitors near movie theater and its square to instrument for the number of shows. Since chain dummies also enter both utility and marginal cost, I use chain dummies and interact them with the number of shows of competitors. For the fraction of films in some genres, films are frequently updated as mentioned in Davis (2006), but I assume that *the fraction* of them is predetermined prior to ticket prices because it is determined by the theater's quality such as its sound system and the size of screens. For example, it is reasonable to believe that movie theaters with sound systems of good quality are likely to show better films. Therefore, I deal with those variables as theater attributes and instrument for them following the literature. As discussed in Section 1.4, a distance band needs to be appropriately chosen when one computes competitors' characteristics, and I use average characteristics of competitors located 6 miles away from the movie theater since reduced-form regressions (unreported) show that it the most strongly correlated with ticket prices.

Theater location is a theater characteristic as well as the other theater attributes discussed above, and the endogeneity problem arises with it. It arises when location and geographic characteristics around a theater that is unobservable to econometrician affects distributor's location choice in entry. If an area around theater j with high or low e_j^h $(h = R, F)$ tends to attract more households near the theater and then average distance to it tends to be low, the estimate of transportation cost parameter will be biased when population or the number of household near theaters are supplemented to instrument for theater location. Following Davis' (2006) idea, I use counts of households without children and with children within a particular distance away from its competitors located within a particular distance away from a movie theater. I define this variable formally below.

Let $f(j)$ denote the owner of theater j. Then, the household counts within b miles away from its competitors located within a miles away from theater j, $N_j^h(a,b)$, is defined as follows:

$$N_j^h(a,b) = \sum_{\{r\in\{1,\ldots,J_m\} | r\notin F_{f(j)m} \ \wedge \ Dist(l_j,l_r)\leq a\}} C_j^h(b) \quad h = R, F \tag{2.21}$$

where $C_j^h(b)$ is the count of households with family composition h in areas within b miles away from theater j.

The idea of using this variable to instrument for theater location is the same as the one for instrument variables of the other theater attributes. I instrument for theater location using its competitor's location. Let $\bar{D}_j^h$ denote average distance to movie theater j for households with family composition h. Then, it can be interpreted as one of attributes of theater j since $\bar{D}_j^h$ is clearly a function of theater location, and it can affect the demand for theater j by households' with family composition h. Then two equations, $E(\bar{D}_j^h e_j^h) = 0$ $(h = R, F)$, need to hold if there is no endogeneity, but these equations may not hold due to the endogeneity of theater location. High-e_j^h location might attract more households with family composition h and $\bar{D}_j^h$ might be low or high, which results in $E(\bar{D}_j^h e_j^h) \neq 0$. Thus, I instrument for $\bar{D}_j^h$ using $N_j^h(a,b)$ for $h = R, F$. The choice of distance bands, (a,b), matters here. From reduced-form regressions of regular ticket prices with $N_j^h(a,b)$ with various choice of them, I found that it is the most strongly correlated with regular ticket prices at $(a,b) = (7,5)$, and I use them for the appropriate choice of the distance bands. Only these instrument variables are family-composition particular parts of instrument variables (that is,

$\omega_j^h = N_j^h(7,5)$ for $h = R, F$).

Competitor indicator in particular distance bands and driving distance to the nearest competitor are supplemented as measures of competition. As discussed in Section 1.4 in Chapter 1, distance bands to compute competitor indicator will need to be appropriately chosen so that it captures whether or not each movie theater has any competitor that competes with it to significant extent. Following the results of the reduced-form regressions, I use a distance band of 5 miles.

Moment Condition for Estimation of Standard Model and Intermediate Model Let the set of parameters to be estimated in the standard model denoted by $\theta = (k, \nu', \beta', \alpha, \lambda, c_A, \gamma')$. Then, give the set of true parameters, θ^*, the moment condition is given by

$$E(\Delta e_j^R(\theta^*)|Z_j, \omega_j^R, \omega_j^F) \quad = \quad 0 \quad E(e_m^R(\theta)) = 0 \tag{2.22}$$

and the model is estimated in the same procedure as the one for the estimation of the full model described above.

In the estimation of the intermediate model, the set of parameters to be estimated is given by $\theta = (k^A, k^K, \nu', \beta', \alpha, \lambda, c_A, \gamma')$. The moment condition and the estimation procedure for the intermediate model are the same as the one for the standard model described above.

2.4 Estimation Results

Following the steps described in the last section, I estimate those three models (the standard model, the intermediate model, and the full model), using the data on66 markets where 253 movie theaters operate in total in estimation here.

Full Model Table 2.3 reports the estimation results of the full model. The estimated utility parameters have intuitive signs when statistically well determined.

The price sensitivity has the anticipated negative sign. The results show that households with children are more sensitive to ticket price than are households without children. In the estimation result of the first model, for example, the estimated price sensitivity for households without children and that for households with children are 0.42 and 0.46, respectively. The difference in price sensitivity is not so significant in terms of magnitude, but the result of the second model also shows that households with children are more sensitive to ticket prices than are households with children (the estimates are 0.67 and 0.73, respectively).

The transportation cost parameter also has the anticipated negative sign and is significant across the specifications. The estimates are 0.27 and 0.15, which are close to the ones in Davis (2006), 0.20 and 0.22. Also, the estimated coefficient of the number of shows in utility has anticipated negative sign while the one in the marginal cost is not well statistically determined. As mentioned in Section 2.2, the number of shows is a proxy for the number of screens, so these results indicate that moviegoers prefer movie theaters with more screens.

The estimated marginal cost for adults is smaller than the one for children. The difference between the estimated constant terms, that is, $c_A - c_K$, is around $4.96 -$

$6.73 = -1.77$ dollars in the first model. If explicit marginal cost is the same between adults and children, the only possible source of this difference is the difference in average concession sales. This negative difference indicates that households with children can purchase more concession than households without children, but at least the volume of concession purchased per attendee is smaller than in households with children than households without children [1].

The estimated markups (defined as the difference between a price and an estimated marginal cost) differ significantly between regular ticket prices and child ticket prices. The markup for children is even negative. In Column 1, the estimated markup for regular tickets and the one for child tickets are 3.97 and -0.24. This implies that the markup for households with children is 3.97+(-0.24)=3.73 dollars, which is smaller than the one for households with children. The second specification shown in Column 2 also shows a negative markup for children. Since positive marginal cost of children implies that marginal cost for households with children is greater than households with children, this result indicates that movie theaters offer child tickets with at a price below its marginal cost as price discrimination for households with children, the segment of price-sensitive households.

The negative margin for children indicates that movie theaters want to attract households with children even by subsidizing children. One interpretation of the result is that households with children are as "good" attendees for movie theaters as households without children in a sense that revenue from each households with children is positive since they purchase at least as much concession as households

[1] This result is opposite to the finding by Gil and Hartmann (2007), which found that concession revenues tend to be higher in movie theaters that play films that attract younger people such as adolescent-oriented films. However, they regress concession revenue on variables controlling for the number of attendees, but they do not regress concession revenue per attendee.

without children do. In Chapter 3, I will study this point more clearly by quantifying the magnitude of price discrimination for households with children.

The J-stats are at most 1, which is smaller than 5.99, χ^2 critical value at 5% with degree of freedom of 2, so I conclude that over-identification is not a problem.

Single-Pricing Models Table 2.1 and Table 2.2 report the estimation results of the standard model and the intermediate model described in Section 2.2.3. The specifications and instrument variables used in each columns of the estimation results are almost the same as ones used in the estimation results of the full model shown in Table 2.3. The estimation of the standard model uses only the count of adults near competitors computed by Eq (2.21) as an instrument variable for theater location, and the estimation of the intermediate model uses both counts of households without children and households with children near competitors.

Overall, the coefficients are not statistically significant in both of the standard model and the intermediate model and the coefficients are not sharply estimated, even though the estimates of the key parameters in those models (that is, price sensitivity and transportation cost) are similar to the ones obtained from the estimation of the base model.

Both in the standard model and the intermediate model, the estimates of transportation cost are between 0.20 and 0.27, which are slightly close to the estimates of the full model but not statistically significant. The results differ in price sensitivity between the standard model and the intermediate model. The estimates of price sensitivity are similar in both of the models. For example, in the first specification, the estimates of price sensitivity are 0.3575 in the standard model and 0.3602 in the second model, which are quite close each other. This is the case for the second specification (the estimates are 0.4966 and 0.4798, respectively).

Both of the standard model and the intermediate model are not well statistically determined seemingly because the number of observations is less than the one for the estimation of the base model. It uses 253 observations of regular ticket prices while the base model is estimated with 506 observations of regular ticket prices and child ticket prices.

Also, those results show that both the variation of regular ticket prices and that of child ticket prices reflect the variation in family composition of households located near each movie theater. The large standard deviation of adult and child base utility in the intermediate model indicates that the variation of child ticket prices is also the essential variation to identify those parameters.

Finally, those results indicate that one can estimate the model precisely by estimating demands in a structural model that incorporates the price discrimination, using the variation in prices offered by each consumer segment.

2.5 Conclusion

In this chapter, I estimate three structural models of demand and supply of movie theaters to investigate third-degree price discrimination in the U.S. movie theater industry.

The main findings are as follows. First, only the base model is statistically well determined while the other two models are not. Second, especially, the estimates of base utility parameters, that is, base utility for adults and base utility for children show significantly large standard deviation. Those two results indicate that incorporating the structure of price discrimination is essential to identify a model describing the variation of ticket prices and both regular ticket prices and child ticket prices are the key variation for that. Third, markup for households with children is smaller than the one for households without children. This result comes from greater price sensitivity of households with children than that of households without children.

The study in this chapter gives only some hints on why markups differ between households without children and households with children. In the following chapter, I quantify the sources of those estimated markups, that is, how much markup comes from cost difference and how much markup comes from difference in price sensitivity by conducting counterfactual experiments to investigate the difference in markups between households without children and households with children.

Chapter 3

Counterfactual Experiments

3.1 Introduction

Using the estimates of the full model, I conduct three counterfactual experiments to answer central questions in the literature of price discrimination.

In the first counterfactual experiment, I quantify how much child discounts come from cost difference and price discrimination. The price difference can be decomposed into two components: difference in marginal costs and price discrimination. By computing equilibrium price in a counterfactual setting where marginal costs are the same between adults and children and those in another counterfactual setting where child discounts are banned and then movie theater chains have to use uniform pricing between adults and children, I will answer this question.

In the second and the third counterfactual experiments, I evaluate the welfare effect of price discrimination and investigate how it differs across markets with different market structures. The second counterfactual experiment evaluates how collusion (i.e. a less intense competition in terms of the number of competitors) affects the welfare effect of imposing uniform pricing, and the third one evaluates how the importance of transportation cost affects it. These counterfactual experiments will give an insight on the welfare effect of banning third-degree price discrimination, one of the central questions in Industrial Organization. Theory does not give sharp predictions on the effect of banning third-degree price discrimination, and there are few empirical studies on it. Banning a child discount in the movie theater industry is similar to banning third-degree price discrimination since it limits the ability of price discrimination. The ban, however, does not mean uniform pricing between households without children and households with children. Although the welfare effect of banning a third-degree price discrimination is discussed with the premise that the ban is equivalent to uniform pricing in the literature, banning a child discount in the movie theater industry is not the same as uniform pricing across households without children and households without children. Banning a child discount might result in a greater difference between a price households without children face and a price households with children face.

3.2 Counterfacatual Experiment 1: Quantify The Sources of Child Discount

Child discounts are composed of cost difference between adults and children and price discrimination between households without children and households with children. In the first counterfactual experiment, I quantify how much child discounts come from cost difference and price discrimination. As shown in Chapter 2, the estimated marginal cost is greater for children than adults. This counterfactual experiment investigates the result more clearly.

For this counterfactual experiment, I compute sets of equilibrium ticket prices in two counterfactual models. One model assumes that marginal costs are the same between between adults and children and movie theaters are not allowed to offer tickets for adults and children at different prices. The other model assumes that marginal costs are the same between between adults and children but movie theaters are allowed to discount for children.

By comparing those two sets of equilibrium price with observed ticket prices, one can quantify how much child discounts come from cost difference and how much child discounts come from price discrimination. The difference in equilibrium price between those two counterfactual models indicates the price difference caused by only the price discrimination between households without children and households with children, since only the price discrimination is the source of the price difference between regular tickets and child tickets. Also, the difference between observed ticket prices and equilibrium prices under only the identical marginal cost assumption indicates the price difference caused by cost difference.

Results Figure 3.1 reports the results of the counterfactual experiment. In the figure, the left panel reports the amount of child discount caused by price discrimination and the right one reports the amount of child discount caused by cost difference. These panels show that observed child discounts come mainly from price discrimination between households without children and households with children and that cost difference even lowers the price difference, which is consistent with the result of the estimation in Chapter 2.

The mean child discount caused by price discrimination is around 3.47 dollars, and the one caused by cost difference is around -1.11 dollars, that is, cost difference should results in a higher ticket price for children than adults. The figures also show that the magnitude of child discounts caused by each of cost difference and price discrimination varies across markets. The amount of discount caused by price discrimination is between 1.39 dollars and 5.31 dollars, and the amount of discount caused by cost difference are between -2.77 dollars and 1.02 dollars. The standard deviation of the discount caused by cost difference and the one caused by price discrimination are 0.67 and 0.70, respectively.

3.3 Counterfactual Experiment 2: The Welfare Effect of Price Discrimination

In the second counterfactual experiment, I evaluate the welfare effect of price discrimination and study how market structure affects its welfare effect. For this study, I compare the welfare change when child discount is banned across different market structures. As market structure, I focus on two types of market structure. One is the number of movie theaters in each market, which is a traditional market structure, and the other is the importance of transportation cost.

3.3.1 Benchmark: Non-Collusive Market

First, I study how the welfare will change if child discount is banned and movie theater chains are forced to use uniform pricing in the actual market structure (that is, non-collusive markets). To do so, I compute equilibrium prices in a model where each movie theater chain offer one ticket by each movie theater they own and compare the welfare before and after the ban. Overall, the results show that allowing for child discount improves the welfare and firms are better off, while the effect on consumer significantly differs between consumer segments.

Figure 3.2-3.5 report the change in price, total surplus, consumer surplus, and producer surplus that are caused by the ban. The main findings are as follows. First, uniform pricing tends to deteriorate the welfare as the result that the decrease in total surplus for households with children outweighs the increase in total surplus for households without children. The median percent change in total surplus in the segment of households without children, the one in the segment of households with children, and the sum of them are 10.5%, -9.4%, and -1.6%, respectively. Figure 3.3 reports the percent change in total surplus aggregated across households without children and households with children, and total surplus in each segment, respectively. Those figures show that the aggregated total surplus decreases in more than a half of the sampled markets, and that total surplus in the segment of households without children increases in all of the markets while total surplus in the segment of households with children decreases in almost all of the markets.

The welfare effect is opposite between the segment of households without children and the segment of households with children, because uniform pricing lowers equilibrium prices for households without children while it raises equilibrium prices for households with children. Figure 3.2 explains this point. Those figures show that each uniform price in equilibrium is determined at the level between a regular ticket price and a child ticket price in the same theater. This indicates that a price for households without children decreases in all of the markets, and a price for households with children (i.e. a price of two tickets) increases in more than a half of the markets.

As the result of the decrease in a price for households without children, consumer surplus increases and producer surplus tends to decrease in the segment of households without children. In the segment of households with children, on the other hand, the effect on consumer surplus and the effect on producer surplus are ambiguous. Figure 3.4 show that uniform pricing increases consumer surplus for households without children significantly while it decreases consumer surplus for households with children. The median percent change in consumer surplus in the segment of households without children, the one in the segment of households with children, and the sum of them are 34.1%, -11.4%, and 1.8%, respectively.

Figure 3.5 reports the effect of uniform pricing on producer surplus. It shows that, in the segment of households without children, producer surplus tends to decrease. This is because the decrease in profit by the decrease in the markup outweighs the increase in profit by the increase in demand. Also, it shows that, in the segment of households with children, the effect on producer surplus is ambiguous. The median of the change in producer surplus in the segment of households without children, the one in the segment of households with children, and the sum of them are -7.9%, 0.2%, and -4.1%, respectively.

3.3.2 Market Structure 1: Collusive Market

Next, I study how market structure affects the welfare effect of price discrimination, which is not clear from the result of the counterfactual experiment in the last section. The counterfactual experiment above indicates that collusion between movie theater chains magnifies the welfare effect. In Figure 3.3, it looks like the welfare effect on both of the segments tends to be weak (the change in total surplus tends to be zero in markets in markets with more movie theaters) and the effect on the aggregated welfare is likely to be positive, but those results are not enough to figure out how market structure affects the welfare effect of price discrimination. To see this point more clearly, I compute the welfare change when movie theaters change their pricing policy from non-uniform pricing to uniform pricing in a market where movie theater chains collude (that is, movie theater chains choose ticket prices as a monopolist in each market) and compare the welfare change between collusive markets and the actual markets.

Result Figure 3.6 - Figure 3.13 report the change in total surplus, consumer surplus, and producer surplus that are caused by movie theater's changing pricing policy to uniform pricing. A left panel, a central panel, and a right panel in each figure report the difference in surplus change between collusion and non-collusion, surplus change in collusive markets, and surplus change in non-collusive markets, respectively.

Overall, those results indicate that collusion magnifies the welfare effect in each segment. Uniform pricing increases total surplus in the segment of households without children more significantly in collusive markets than in non-collusive markets, while it decreases total surplus in the segment of households with children more significantly in collusive markets than in non-collusive markets. As the result that the effect on the segment of households without children outweighs the effect in the segment of households without children, the aggregated total surplus tends to decrease more significantly in collusive markets than in non-collusive markets.

Figure 3.11 plots total surplus change in non-collusive markets on the horizontal axis and total surplus change in collusive markets on the vertical axis. Those panels in the figure show that the magnitude of total welfare change tends to be greater in collusive markets than in non-collusive markets.

When it comes to the effect on consumer surplus and producer surplus, the results indicate that collusion magnifies the positive effect and weakens the negative effect on the segment of households without children, and it magnifies the negative effect and weakens the positive effect on the segment of households with children. Figure 3.12 and Figure 3.13 make this point. The collusion's effect on the welfare effect on consumer surplus looks similar with the one on total surplus; collusion magnifies the effect on consumer surplus. Households without children are better off more significantly in collusive markets than in non-collusive markets while households with children are worse off more significantly. On the other hand, the welfare effect on producer surplus from households without children is *better* in collusive markets than in non-collusive markets. Figure 3.13 show that, in collusive markets, the effect on producer surplus from households without children tends to be greater than in non-collusive markets where the welfare effect is positive and tends to be smaller in magnitude than in non-collusive markets where the welfare effect is negative. The figure also shows that the effect of collusion on the welfare effect is reverse in the segment of households with children. As the results of those effects of collusion on consumer surplus and producer surplus for each segment, the effect on each segment is greater in magnitude in collusive markets than in non-collusive markets.

The collusion magnifies the welfare effect because it magnifies the price difference between households without children and households with children caused by price discrimination. Again, the estimated price sensitivity is greater for households with children than households without children. This magnifies the difference in markup between consumer segment with high price sensitivity (that is, households with children) and consumer segment with low price sensitivity (that is, households without children). The markup increases more significantly for households without children than for households with children in collusive markets, which yields the result here.

The effect of collusion on the welfare effect is stronger in markets with more movie theaters. Figure 3.7 and Figure 3.8 make this point. Those figures show that the difference in the magnitude of the welfare effect between collusion and non-collusion is greater in markets with more movie theaters.

3.3.3 Market Structure 2: Importance of Transportation Cost

Next, I study how geographic market structure, that is, the transportation cost, affects the welfare effect of price discrimination. The last counterfactual (Market Structure 1) shows that the welfare effect of price discrimination on each segment is magnified since the price difference among consumer segments that differ in price sensitivity is greater in a collusive model than a non-collusive model and consumer surplus for the segment of price-sensitive consumers decreases more significantly. In a model with more magnitude of transportation cost, on the other hand, each movie theater is more monopolistic for consumers located near them, which indicates that similar results will be obtained in this counterfactual experiment.

For this study, I compute equilibrium ticket prices and compare welfare change among different values of the transportation cost. To do so, I compensate average willingness for each consumer segment so that their market share for the outside option will not change from the one under the estimated transportation cost.

Result The result indicates that as it is more costly for consumers to go to a movie theater, the welfare effect of price discrimination on each consumer segment is greater. This is consistent with the result of the last counterfactual experiment

(Market Structure 1) where the welfare effect of price discrimination on each of the segments is magnified in a collusive model.

Figure 3.14 - 3.17 report the mean welfare changes in percent caused by movie theater's changing pricing policy to uniform pricing in a model with different value of transportation cost in range between -25% and 25% different from the value of the estimated transportation cost. Overall, those figures show that the importance of transportation cost does not significantly change the welfare effect of price discrimination. The difference in the welfare effect between the minimum transportation cost (-25 percent) and the maximum one (+25 percent) is less than 1 percent for households, movie theaters, and the sum of them in each segment. Also, those figures show that its effect on the welfare effect of price discrimination is similar to the one in the last counterfactual experiment (Market Structure 1); less competitive each market is, more negative the welfare effect of price discrimination on the consumer segment with high price sensitivity is.

Figure 3.14 shows that the effect on aggregated total surplus is almost constant, while the welfare change in the segment of households with children is more negative as the magnitude of transportation cost increases. This result indicates that it is not clear how the importance of transportation cost affects the welfare effect of price discrimination while it is clearer how it affects the effect of price discrimination on surplus in each segment.

In the last subsection (Market Structure 1), I show that the negative welfare effect of price discrimination on the segment of less price-sensitive consumers (i.e. households without children) is greater in collusive markets than non-collusive markets. The counterfactual experiment in this subsection is consistent with the finding. Figure 3.14 and Figure 3.15 show that both total surplus and consumer surplus in the segment households without children decrease more significantly by price discrimination in markets where competition across movie theaters is less intense (i.e. transportation cost is more important to moviegoers).

Figure 3.16 and Figure 3.17 are consistent with the result of the counterfactual experiment in the last subsection, too. Those figures show that less competitive markets (i.e. more importance of transportation cost) magnify the effect of price discrimination on consumer surplus and producer surplus in each segment.

Figure 3.18 confirms that those results are consistent with the result obtained in the last counterfactual. Those figures report the mean welfare change in percent for markets with two or less movie theaters and for those with three or more movie theaters. Figure 3.18 shows that the percent change in total surplus in the segment of households without children is greater in markets with two or less movie theaters than markets with three or movie theaters for any value of transportation cost, and the different between them is greater as the magnitude of transportation cost increases. It also shows that the percent change in total surplus in the segment of households with children is smaller in markets with two or less movie theaters than markets with three or movie theaters for any value of transportation cost, and the different between them is greater as the magnitude of transportation cost increases. These results indicate that the magnitude of transportation cost affects the welfare effect of price discrimination more significantly in less competitive markets in terms of the number of movie theaters in a market than competitive markets.

3.4 Conclusion

This chapter studies the source of child discounts in the U.S. movie theater industry and the welfare effect of price discrimination by conducting a few counterfactual experiment with utility function and marginal costs estimated in Chapter 2.

The main findings are as follows. First, observed child discounts for movie tickets, around 2.36 dollars on average in my sample, come solely from price discrimination. My result shows that price discrimination between households without children and households with children causes around 3.47-dollar discounts for children, which is greater than the average child discount, and the higher marginal cost for children than adults offsets the child discount caused by price discrimination by 1.11 dollars.

Second, price discrimination improves the welfare in this industry. Price discrimination causes price reduction for and increase demand by households with children, which improves the welfare in the segment so significantly that it outweighs the negative welfare effect caused by the decreases in demand by households without children.

Third, collusion magnifies the welfare effect on each consumer segment because price discrimination is likely to improve the welfare in this industry since it tends to decrease a price for consumer segment with high price sensitivity and collusion increases a price for a consumer segment with high price sensitivity more significantly than a consumer segment with low price sensitivity.

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Appendix: Construction of Datasets

I document how I constructed the datasets used in this study. Table A.1 summarizes how datasets used in this study are constructed.

The main dataset in this study is the one on characteristics of first-run movie theaters with indoor venue. The key variables in the dataset are ticket prices (regular and children), theater locations, and show schedules which are used to construct the statistics of shows playing at each of the theaters. To construct the dataset, first I identified the mailing addresses (locations) of all movie theaters operating in selected MSAs in the summer in 2010, regardless of whether they are first-run theaters or not. Finally I identified that there are 1435 theaters operating in 66 MSAs in total.

Then I obtained the schedules of shows playing at those movie theaters in mid-March in 2011 to construct variables of theater characteristics based on films playing at the theaters. The schedules contain the starting time and the title of the films, and whether or not they are projected in 3D in the theater (3D movies are projected in either non-3D or 3D). Also, I obtained the characteristics of those films such as its genre (e.g. Action, Adventure), release date, country where the film is produced, rating (e.g. R, R-18), length, scores by critics, via *IMDb* (The Internet Movie Database).

Then I converted those film characteristics into theater-level characteristics, such as the ratio of drama films playing at theater and the number of genres of films, by calculating the statistics of them based on the schedule.

Based on the film-related theater characteristics calculated in the way explained above, I excluded movie theaters as non-first-run theaters that satisfy either of the following conditions: the release date of the latest film in the theater is at least one month prior to the date of the data collection, more than half of shows are non-US films or classic films what are defined as films released before 2000, theaters located in educational institutions or centers or museums, IMAX theaters, theaters of which films are not projected in English (e.g. Spanish, French, Japanese). In this way I basically exclude second-run theaters (i.e. theaters that play only non-latest films at cheaper prices), arttheaters (i.e. theatersthat play only art theater films), movie theaters for educational purpose, and some other types of movie theaters with indoor venue that do not compete against first-run movie theaters. Also, I excluded as drive-ins theaters with the name of "Drive-In" or theaters I identified as drive-ins by hand. Finally I excluded 332 movie theaters for these criteria above and identified all 285 movie theaters operating in the selected markets.

At the same time, I obtained ticket prices from movie-ticket websites (e.g. *fandango.com* and *movieticket.com*) in August 2010, and then theater or chain's official websites in December 2010. Some of them are automatically collected while the most of the price data are obtained from movie theater's official websites and pricing policy information in movie ticketing websites

The next dataset is household locations and demographic attributes from *NHGIS* (*National Historical Geographic Information System*). The *NHGIS* dataset contains census-block-group level demographic attributes including population by age, average household income, and fraction of households or population with specific ethnicity, educational level, gender, whether or not to have children, and so on. *A census block group* is a geographical unit which is between the census tract and the census block and is the smallest geographical unit which the United States Census Bureau publishes sample data. A Metropolitan Statistical Area (MSA) consists of around 300 census block groups on average. I use the demographic attributes as in 2000, the latest version of the data. The dataset contains the geographic features of block groups (that is, its shape, latitude, and longitude) as well.

Finally, I constructed the dataset on driving distance between movie theaters and block groups using the locations of movie theaters and block groups and the data on the road network in the U.S. The distances are calculated as driving distance of the shortest path on the road network between the location (i.e. latitude and longitude) of movie theaters, and the location of centroids of block groups. The centroid is defined using areas as weight.

Tables and Figures

Table 1.1: **Summary Statistics of Ticket Prices, By Theater**

variable	N	mean	sd	min	p25	p50	p75	max
Regular	253	8.73	1.47	3.50	8.00	9.00	9.75	12.00
Child	253	6.33	1.08	2.00	6.00	6.50	7.00	9.25
Child Discount	253	2.40	0.68	0.00	2.00	2.50	3.00	4.50
Child Discount Rate	253	0.27	0.07	0.00	0.25	0.28	0.31	0.56

Note: Each observation is theater-level.

Table 1.2: **Summary Statistics of Market-Level Price Statistics, By Market**

variable	N	mean	sd	min	p25	p50	p75	max
Mean Reg	66	8.61	0.98	5.88	8.13	8.80	9.19	10.50
Std Reg	52	0.96	0.74	0.00	0.35	0.86	1.44	2.52
Mean Chi	66	6.26	0.69	4.50	5.75	6.41	6.69	7.77
Std Chi	52	0.72	0.57	0.00	0.29	0.56	1.06	2.24
Mean Disc	66	2.34	0.49	0.38	2.08	2.41	2.60	4.00
Std Disc	52	0.46	0.33	0.00	0.23	0.40	0.64	1.34

Note: Each observation is market-level. There are only one movie theater in 14 MSAs and those markets are omitted in Std Reg, Std Chi, and Std Disc.

Table 1.3: **Variance Decomposition by Market**

	Regular Ticket Price	Child Ticket Price
Total Standard Deviation (σ)	1.468	1.085
Between Standard Deviation (σ_u)	.515	.295
Within Standard Deviation (σ_e)	1.270	.956
ρ $(=\sigma_u^2/(\sigma_u^2+\sigma_e^2))$	.141	.087

Table 1.4: **Summary Statistics of Market-Level Attributes, By Market**

variable	**N**	**mean**	**sd**	**min**	**p25**	**p50**	**p75**	**max**
Population (1,000)	66	359.77	307.78	64.83	166.81	278.17	498.96	2112.20
Area (mi2)	66	15942.24	10726.53	2821.14	9665.87	13528.43	20209.29	78787.85
Population Density (1,000/mi2)	66	30.59	37.93	2.84	13.13	19.92	33.38	237.31
Ave Kids per HH	66	0.57	0.07	0.40	0.53	0.56	0.61	0.81
Ave HH Inc	66	66.09	11.10	53.54	58.37	63.08	71.19	101.30
Frac. Degree	66	0.53	0.09	0.36	0.47	0.52	0.60	0.76
Nb Theater	66	3.83	3.08	1.00	2.00	3.00	5.00	20.00
Nb Chain	66	2.86	1.86	1.00	1.00	2.50	4.00	11.00

Note: Each observation is market-level.

Table 1.5: **Number of theaters and Chains in MSAs**

Number	1	2	3	4	5	6-7	8-9	10-15	16-28
Frequency (Theater N=66)	14	8	14	12	9	2	4	2	1
Frequency (Chain N=66)	17	16	4	9	5	4	0	1	0

Table 1.6: **Summary Statistics of Block-Group-Level Demographics in Madison, WI**

variable	**N**	**mean**	**sd**	**min**	**p50**	**max**
Population	256	1651	898.9	0	1405	6200
Area (mi2)	256	1.78	3.55	.02	.21	26.10
% of Kids	254	.1452	.0593	0	.1458	.2953
Avg. Income	256	81.41	22.37	0	80.37	165.3
Nb. Kids per HH with Kids	247	1.11	.3369	0	1.132	2.348

Note: Each observation is a census block group.

Table 1.7: **Summary Statistics of Demographic Attributes within 5 Miles away from Theater, By Theater**

variable	N	mean	sd	min	p25	p50	p75	max
Population (1,000)	253	124.31	102.22	0.00	58.50	98.32	154.83	694.64
Frac. Degree	253	0.58	0.11	0.33	0.50	0.58	0.65	0.86
Ave HH Income (1,000)	253	73.44	15.17	42.75	62.27	69.25	81.47	125.13
Ave Kids per HH	253	0.55	0.10	0.14	0.49	0.56	0.61	0.93

Note: Each observation is theater-level.

Table 1.8: **Summary Statistics of Spatial Differentiation Measures, By Theater**

variable	N	mean	sd	min	p25	p50	p75	max
Nb. Competitor within 5mi	253	0.39	0.69	0.00	0.00	0.00	1.00	3.00
Nb. Competitor within 10mi	253	1.23	1.48	0.00	0.00	1.00	2.00	9.00
Dist to nearest rival	239	12.10	46.01	0.00	3.66	6.21	11.56	705.81

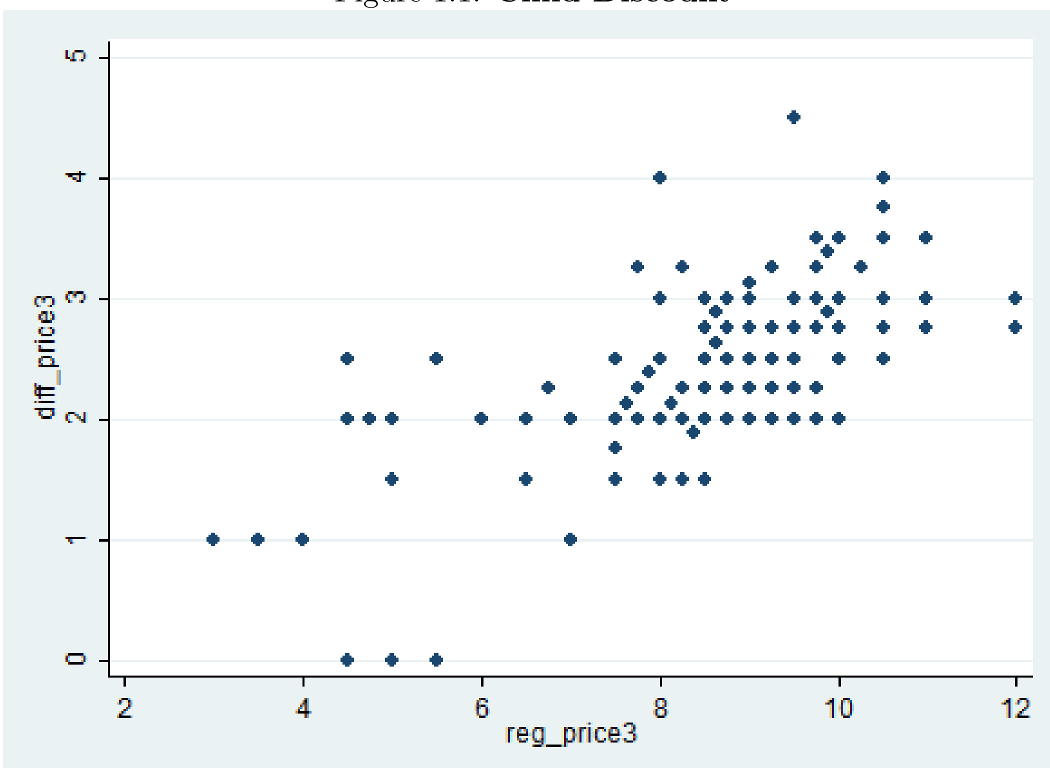
Note: The minimum value of the distance to the nearest competitor is zero because of mismeasurement of geocoding. This can happen for movie theaters located quite closely.

Table 1.9: **Summary Statistics of Theater Characteristics, By Theater**

variable	N	mean	sd	min	p25	p50	p75	max
Frac. Drama	253	0.29	0.15	0.00	0.22	0.31	0.38	0.67
Frac. Romance	253	0.14	0.08	0.00	0.11	0.14	0.17	0.67
Frac. Documentary	253	0.05	0.06	0.00	0.00	0.06	0.08	0.50
Film Variety	253	9.87	2.76	2.00	8.00	11.00	12.00	14.00
Nb. Shows	253	16.96	8.75	1.00	12.00	17.00	21.00	54.00

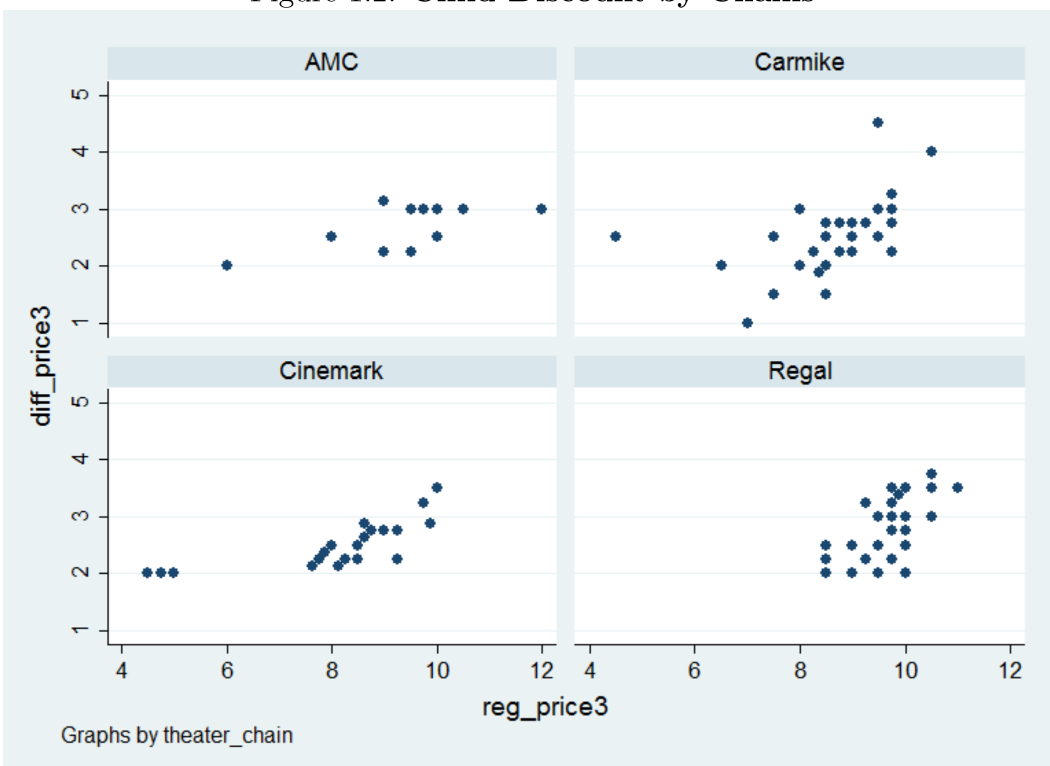
Note: Each observation is theater-level.

Figure 1.1: **Child Discount**



Note: Each observation is theater-level.

Figure 1.2: **Child Discount by Chains**



Note: Each observation is theater-level.

Table 1.10: **Regression of Regular Ticket Prices**

	(1)	(2)	(3)	(4)	(5)
Demographic Variables					
Population (million)	0.719	0.978	0.803	0.762	2.909**
	(0.808)	(0.820)	(0.822)	(0.809)	(1.305)
Ave Kids per HH	0.591	0.396	0.583	0.530	0.329
	(1.167)	(1.170)	(1.169)	(1.168)	(1.004)
Fraction College Degree	5.245***	4.690**	5.056***	5.907***	4.514***
	(1.879)	(1.907)	(1.910)	(1.985)	(1.627)
Ave HH Income	-0.0182	-0.0136	-0.0164	-0.0238	-0.0187
	(0.0147)	(0.0150)	(0.0151)	(0.0156)	(0.0128)
Competition Measure					
Competitor Dummy	-0.600*		-0.570*	-0.517	-0.320
	(0.339)		(0.344)	(0.349)	(0.412)
Competitor Count		-0.337	-0.237		
		(0.402)	(0.405)		
Dist. to Nearest Competitor				0.0129	
				(0.0125)	
Film Attributes					
Frac. Drama	1.370**	1.384**	1.351**	1.395**	1.564***
	(0.573)	(0.577)	(0.575)	(0.573)	(0.571)
Nb. Shows	0.138***	0.137***	0.143***	0.144***	0.132***
	(0.0320)	(0.0328)	(0.0328)	(0.0324)	(0.0328)
Nb. Competitor Shows	0.0410*	0.0425	0.0621	0.0417*	0.00251
	(0.0217)	(0.0406)	(0.0421)	(0.0217)	(0.979)
Constant	5.176***	5.220***	5.120***	5.005***	5.656***
	(1.141)	(1.152)	(1.147)	(1.153)	(0.979)
Observations	253	253	253	253	253
Distance Band	5mi	5mi	5mi	5mi	4mi
Adjusted R^2	0.552	0.546	0.550	0.552	0.549
F	8.806	8.535	8.277	8.355	8.655

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 1.11: **Regression of Child Discounts and Child Ticket Prices after Controlling for Regular Ticket Prices**

	(1)	(2)	(3)	(4)
Dependent Variable	Child Discount	Child Discount	Controlled Child Price	Controlled Child Price
Demographic Variables				
Population (million)	0.645	0.646	-0.331	-0.401
	(0.436)	(0.435)	(0.340)	(0.336)
Ave Kids per HH	1.154*	1.151*	-1.027**	-0.980**
	(0.623)	(0.628)	(0.484)	(0.485)
Fraction College Degree	0.947	0.897	0.558	0.999
	(1.015)	(1.067)	(0.790)	(0.824)
Ave HH Income	0.00138	0.00178	-0.00575	-0.00940
	(0.00800)	(0.00840)	(0.00623)	(0.00648)
Competition Measure				
Competitor Dummy		0.0163		-0.182
		(0.187)		(0.145)
Competitor Count	-0.00431		-0.104	
	(0.214)		(0.167)	
Dist. to Nearest Competitor		-0.000822		0.00497
		(0.00671)		(0.00518)
Film Attributes				
Frac. Drama	0.559*	0.559*	-0.115	-0.112
	(0.307)	(0.308)	(0.239)	(0.238)
Nb. Shows	0.0455***	0.0448**	-0.00168	0.00129
	(0.0175)	(0.0174)	(0.0136)	(0.0135)
Nb. Competitor Shows	0.00615	0.00459	0.00749	0.00881
	(0.0216)	(0.0117)	(0.0168)	(0.00902)
Constant	0.373	0.390	1.304***	1.218**
	(0.613)	(0.620)	(0.477)	(0.478)
Observations	253	253	253	253
Adjusted R^2	0.399	0.395	0.231	0.239
F	4.072	3.813	1.817	1.896

Standard errors in parentheses

* $p < 0.1$, ** $p < 0.05$, *** $p < 0.01$

Table 2.1: **Estimation Results of the Standard Model**

	(1)	(2)
Preference Parameter		
Price Sensitivity (α)	0.3575***	0.4966
	(0.1036)	(0.5415)
Transportation Cost (λ)	0.2044	0.2591
	(0.2441)	(0.3473)
Base Utility (k)	-0.9657	-4.6460
	(7.9400)	(14.9862)
Dummy for Collge Education (ν_{edu})	3.0591	3.1665
	(4.3180)	(4.9996)
Nb. of Sat Evening Shows (β_{show})	0.1666	0.2746
	(0.1597)	(0.1602)
Frac. of Drama Films (β_{drama})		4.5048***
		(1.5830)
Marginal Cost		
Constant (c)	3.8859	7.0109***
	(10.4608)	(1.5775)
Nb. of Saturday Evening Shows (γ_{show})	-0.0940	-0.0792
	(0.3340)	(0.1671)
Observations	253	253
Nb. of Movie Theaters	253	253
J-stat	0.004	0.007
Degrees of Freedom	2	2

Standard deviations in parentheses. *, **, and *** denote 90%, 95%, and 99% significance, respectively.
Note: All of the specifications includes unreported chain (only for AMC, Cinemark, Carmike, and Regal) fixed effects in marginal cost, and they also include Regal fixed effect and market fixed effects in utility.

Table 2.2: **Estimation Results of the Intermediate Model**

	(1)	(2)
Preference Parameter		
Price Sensitivity (α)	0.3602	0.4798
	(1.3104)	(0.4839)
Transportation Cost (λ)	0.2619	0.2604
	(0.9623)	(1.1860)
Adult Base Utility (k^A)	1.2725	2.0199
	(25.1843)	(11.3165)
Child Base Utility (k^K)	0.0926	-0.6968
	(53.2856)	(15.7533)
Dummy for Collge Education (ν_{edu})	-4.4365	-0.8293
	(22.4660)	(41.0601)
Nb. of Sat Evening Shows (β_{show})	0.1472	0.1705
	(1.1280)	(0.9215)
Frac. of Drama Films (β_{drama})		2.5217
		(14.0860)
Marginal Cost		
Constant (c)	4.7550	5.7362
	(13.1665)	(12.9925)
Nb. of Saturday Evening Shows (γ_{show})	-0.0213	-0.0348
	(0.4710)	(0.5857)
Observations	253	253
Nb. of Movie Theaters	253	253
J-stat	0.002	0.002
Degrees of Freedom	2	2

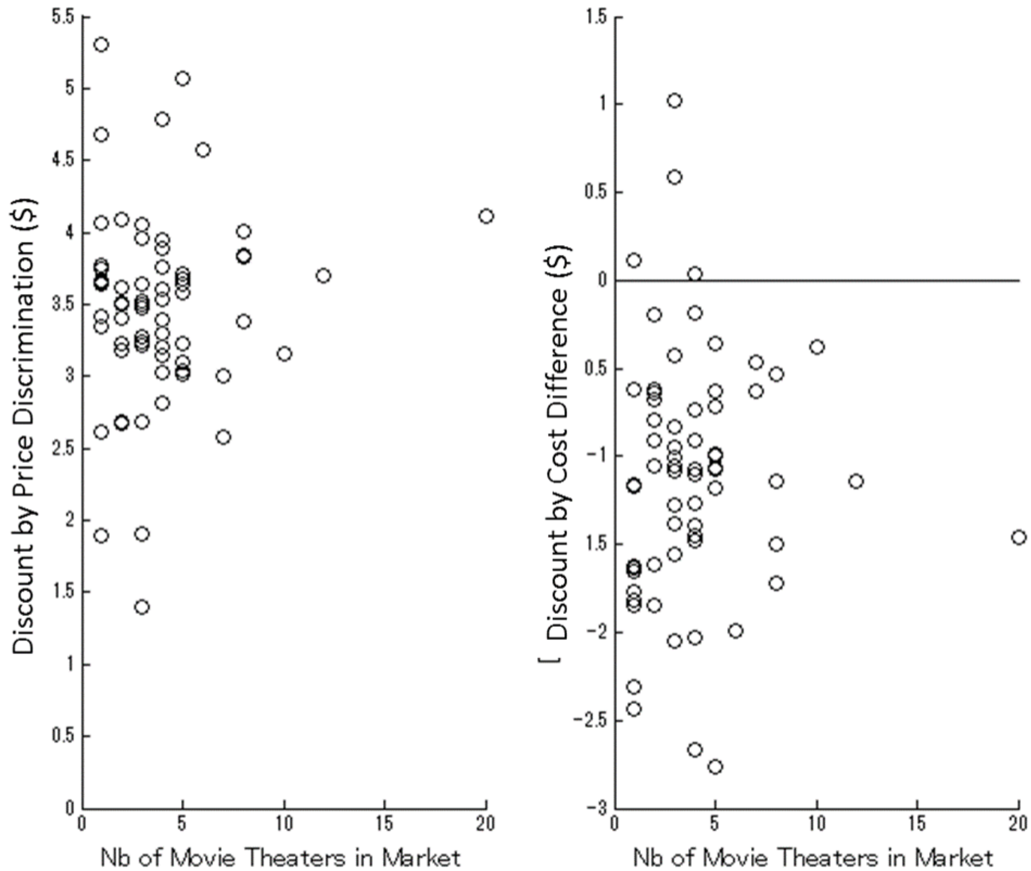
Standard deviations in parentheses. *, **, and *** denote 90%, 95%, and 99% significance, respectively.
Note: All of the specifications includes unreported chain (only for AMC, Cinemark, Carmike, and Regal) fixed effects in marginal cost, and they also include Regal fixed effect and market fixed effects in utility.

Table 2.3: **Estimation Results of the Full Model**

	(1)	(2)
Preference Parameter		
Price Sensitivity (α^R)	0.4179***	0.6334***
(Household Without Children)	(0.0665)	(0.0527)
Price Sensitivity (α^F)	0.4565 ***	0.7293***
(Household With Child)	(0.0805)	(0.1360)
Transportation Cost (λ)	0.2753***	0.1546***
	(0.0414)	(0.0670)
Adult Base Utility (k^A)	-2.9485	5.6480*
	(2.1831)	(2.7510)
Child Base Utility (k^K)	4.9639***	5.4082**
	(0.7119)	(2.3585)
Dummy for Collge Education (ν_{edu})	2.5837	-1.6062
	(1.0002)	(3.3675)
Nb. of Sat Evening Shows (β_{show})	0.2178***	0.1378***
	(0.0689)	(0.0340)
Frac. of Drama Films (β_{drama})		4.2305***
		(1.5984)
Marginal Cost		
Constant (c_A)	4.9639***	4.9534***
(Adult)	(0.7119)	(1.2021)
Constant (c_K)	6.7350***	6.6030***
(Child)	(1.0413)	(0.8590)
Nb. of Saturday Evening Shows (γ_{show})	0.0069	-0.0164
	(0.0592)	(0.0414)
Implied Markup for Regular Ticket ($p_j^A - mc_j^A$)	3.97	3.63
Implied Markup for Child Ticket ($p_j^K - mc_j^K$)	-0.24	-0.46
Observations	506	506
Nb. of Movie Theaters	253	253
J-stat	0.022	0.021
Degrees of Freedom	2	2

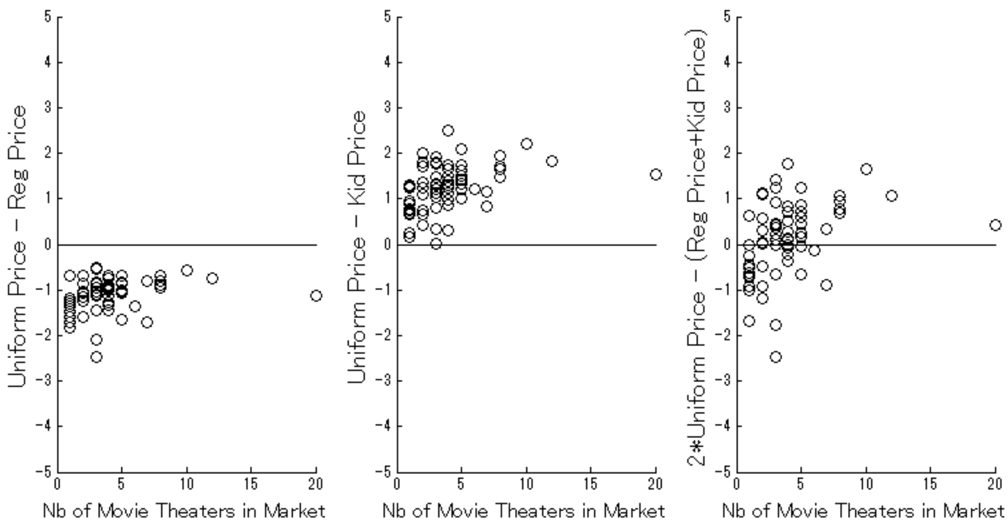
Standard deviations in parentheses. *, **, and *** denote 90%, 95%, and 99% significance, respectively.
Note: All of the specifications includes unreported chain (only for AMC, Cinemark, Carmike, and Regal) fixed effects in marginal cost, and they also include Regal fixed effect and market fixed effects in utility.

Figure 3.1: **Decomposition of Discount**



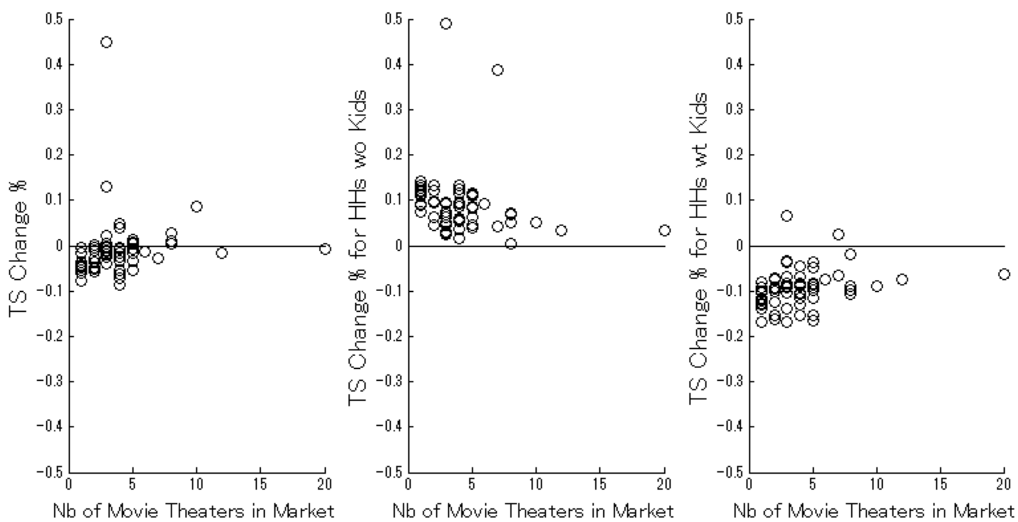
Note: Each observation is market-level mean of computed ticket prices.

Figure 3.2: **Price Change for Adults, Children, and Family (Non-Collusive Market)**



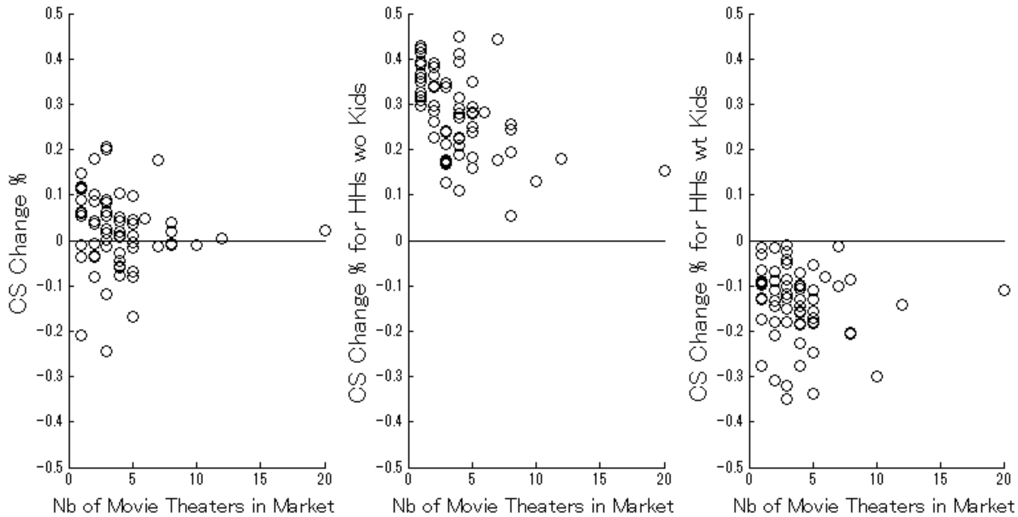
Note: Each observation is market-level mean of a computed ticket prices minus an actual ticket price. "Family price" is the sum of a regular ticket price and a child ticket price.

Figure 3.3: **Change in Total Surplus (Non-Collusive Market)**



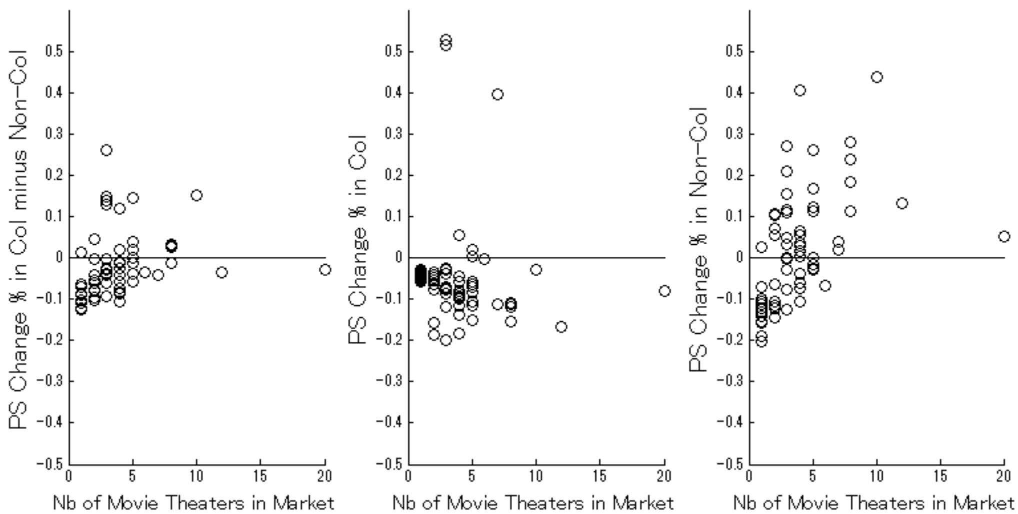
Note: Each observation is market-level mean.

Figure 3.4: **Change in Consumer Surplus (Non-Collusive Market)**



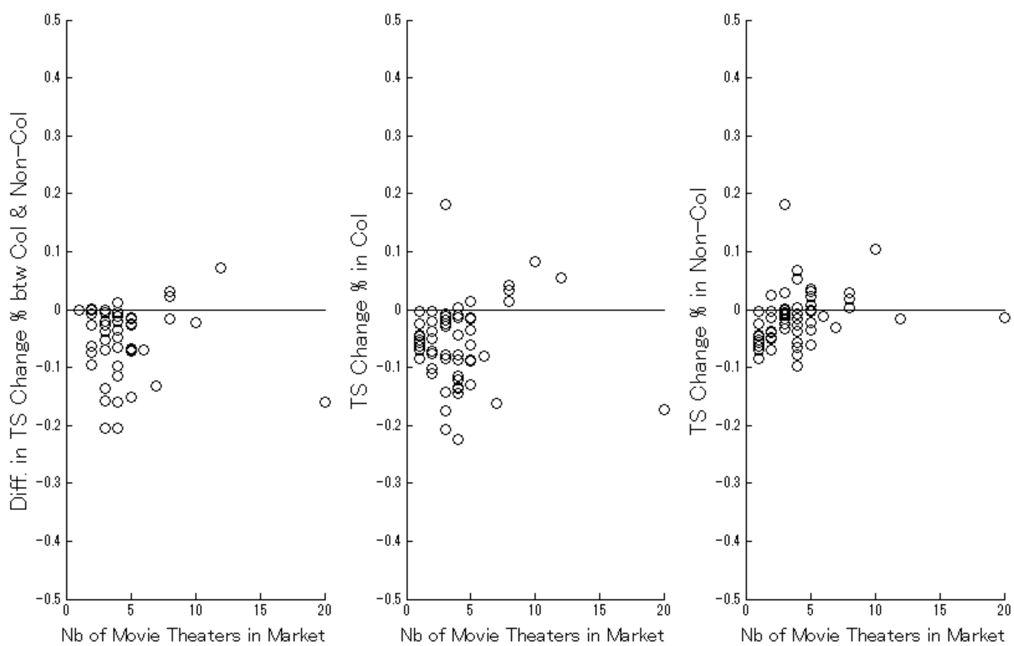
Note: Each observation is market-level mean of a computed ticket prices minus an actual ticket price.

Figure 3.5: **Change in Producer Surplus (Non-Collusive Market)**



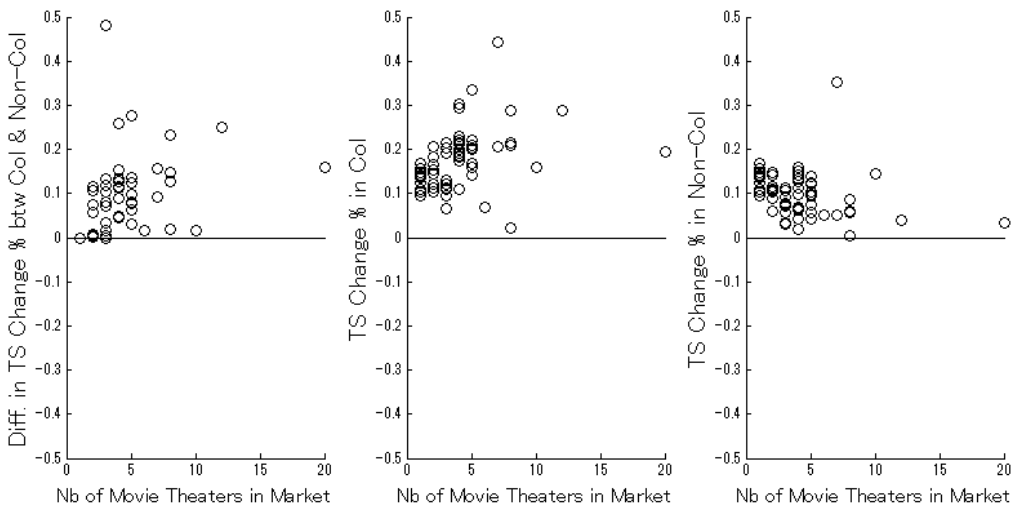
Note: Each observation is market-level mean of a computed ticket prices minus an actual ticket price.

Figure 3.6: **Difference in Total Surplus Change Between Collusion and Non-Collusion**



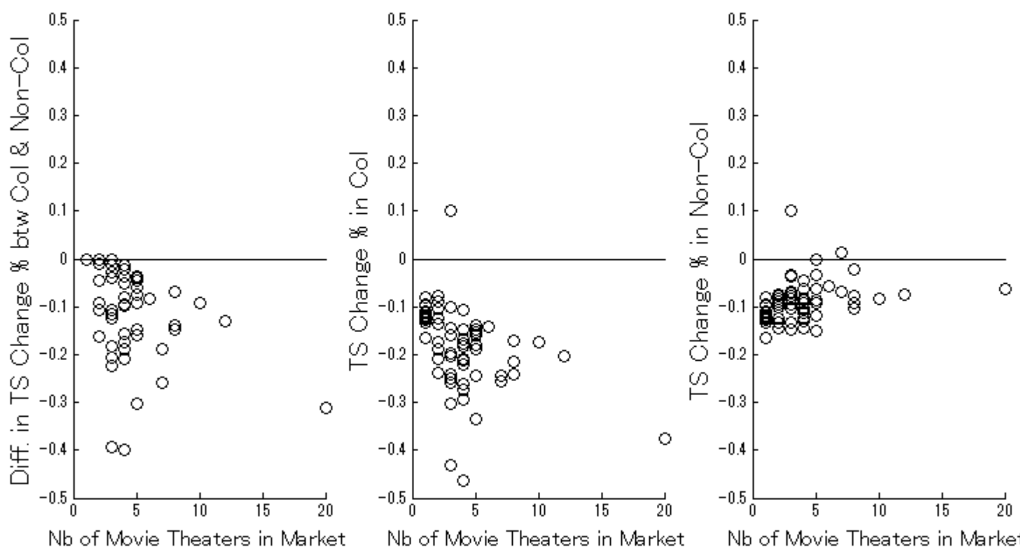
Note: Each observation is market-level mean of percent change in surplus.

Figure 3.7: **Difference in Total Surplus Change Between Collusion and Non-Collusion (Households without Children)**



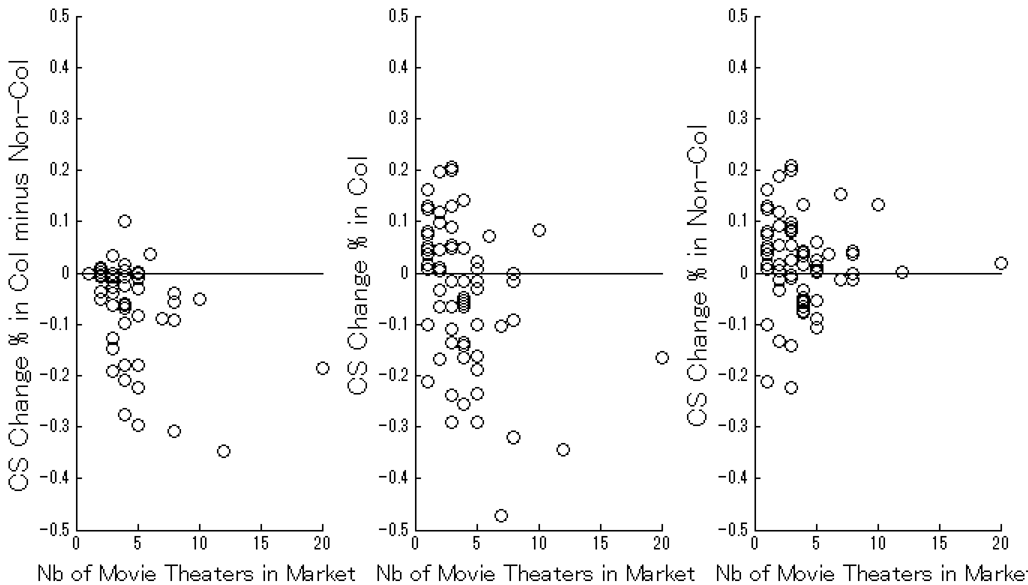
Note: Each observation is market-level mean of percent change in surplus.

Figure 3.8: **Difference in Total Surplus Change Between Collusion and Non-Collusion (Households with Children**



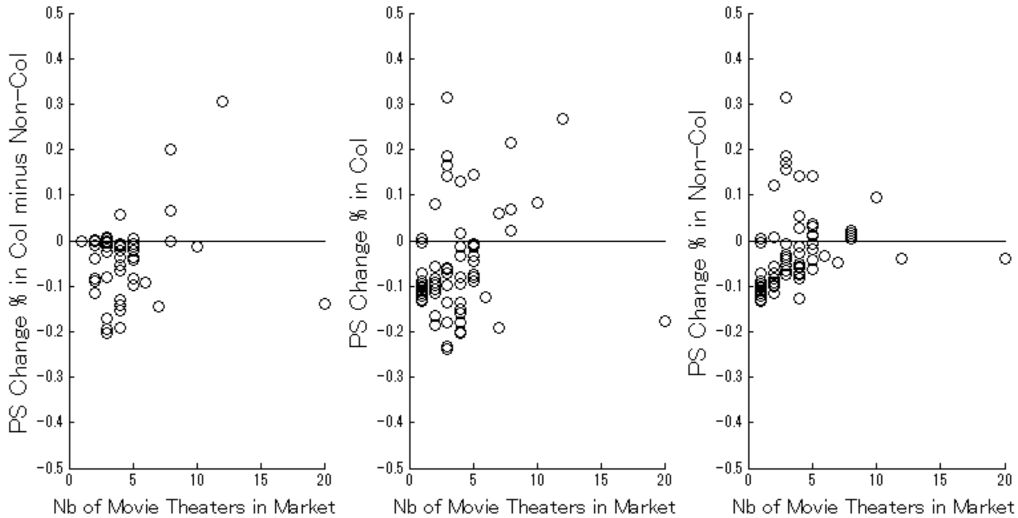
Note: Each observation is market-level mean of percent change in surplus.

Figure 3.9: **Difference in Consumer Surplus Change Between Collusion and Non-Collusion**



Note: Each observation is market-level mean of percent change in surplus.

Figure 3.10: **Difference in Producer Surplus Change Between Collusion and Non-Collusion**



Note: Each observation is market-level mean of percent change in surplus.

Figure 3.11: **Total Surplus Change in collusive markets and Non-Collusion**

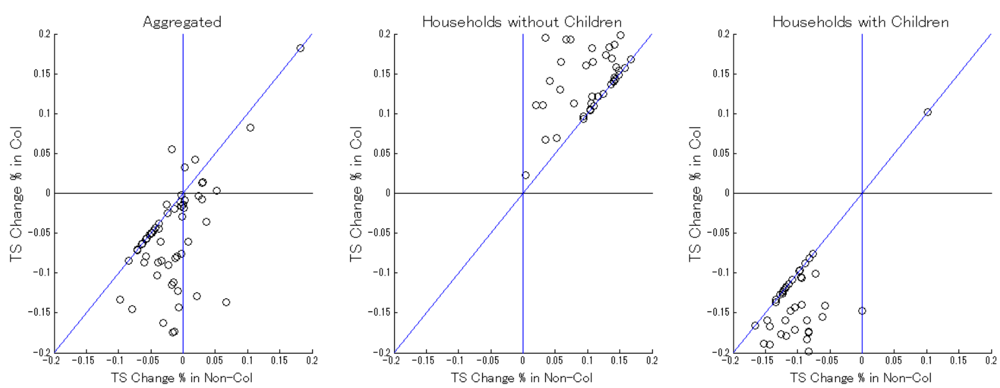
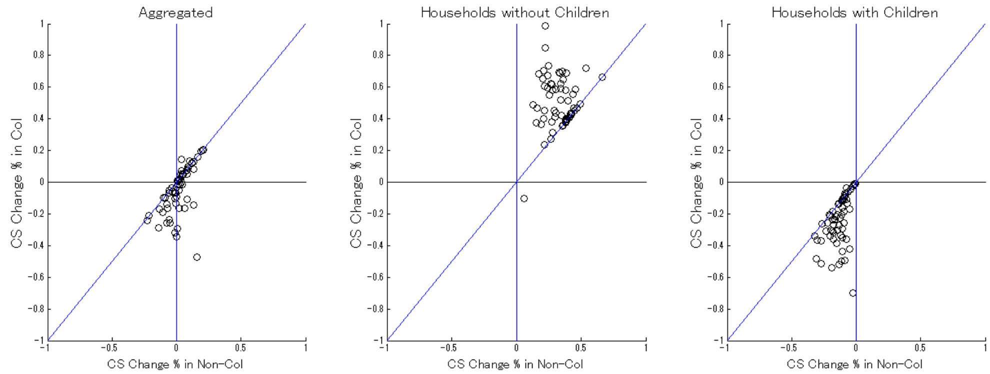
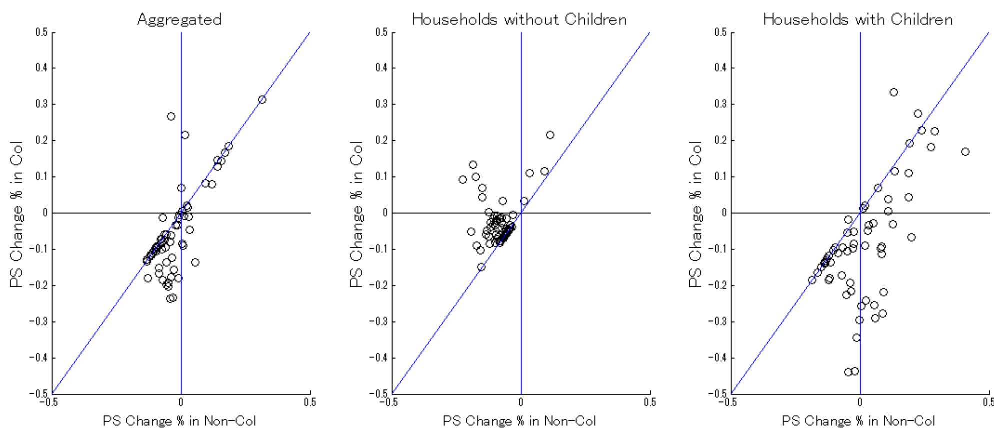


Figure 3.12: **Consumer Surplus Change in collusive markets and Non-Collusion**



Note: Each observation is market-level mean of percent change in surplus.

Figure 3.13: **Producer Surplus Change in collusive markets and Non-Collusion**



Note: Each observation is market-level mean of percent change in surplus.

Figure 3.14: **Total Surplus Change in Models with Different Value of Transportation Cost**

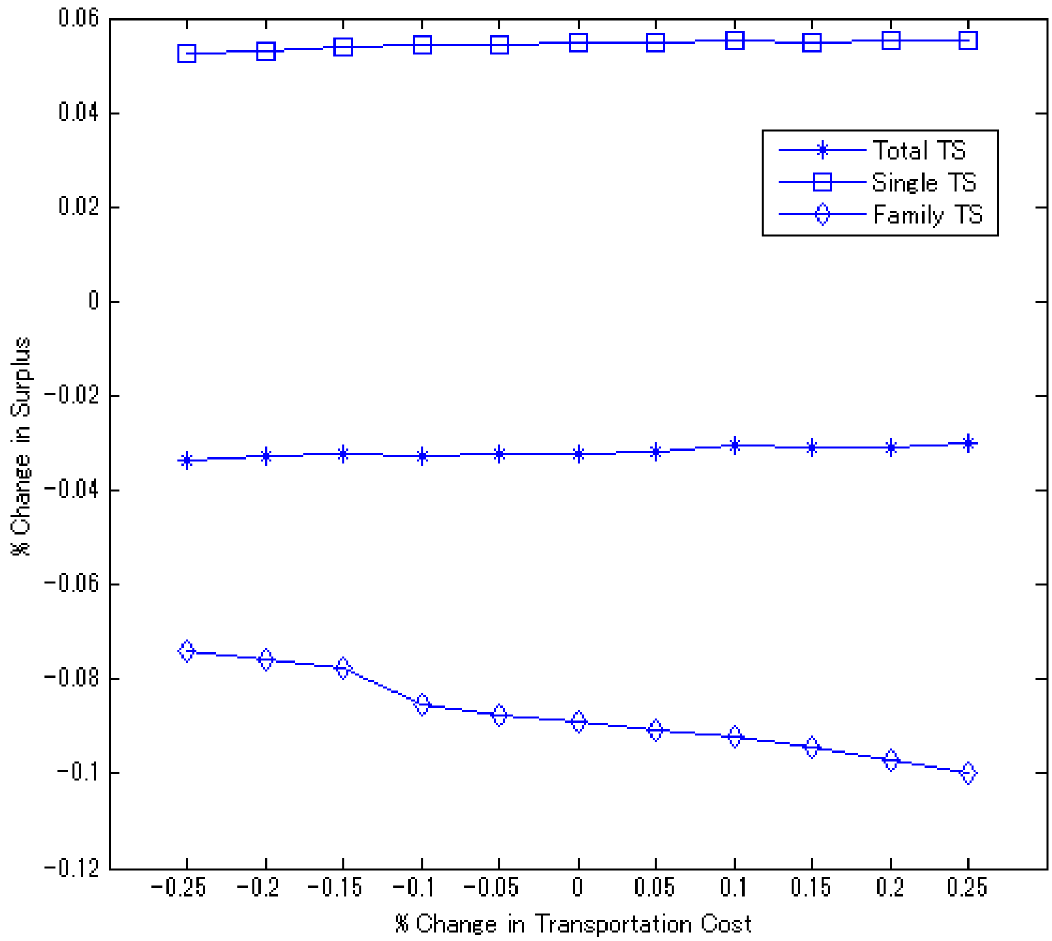


Figure 3.15: **Consumer Surplus Change in Models with Different Value of Transportation Cost**

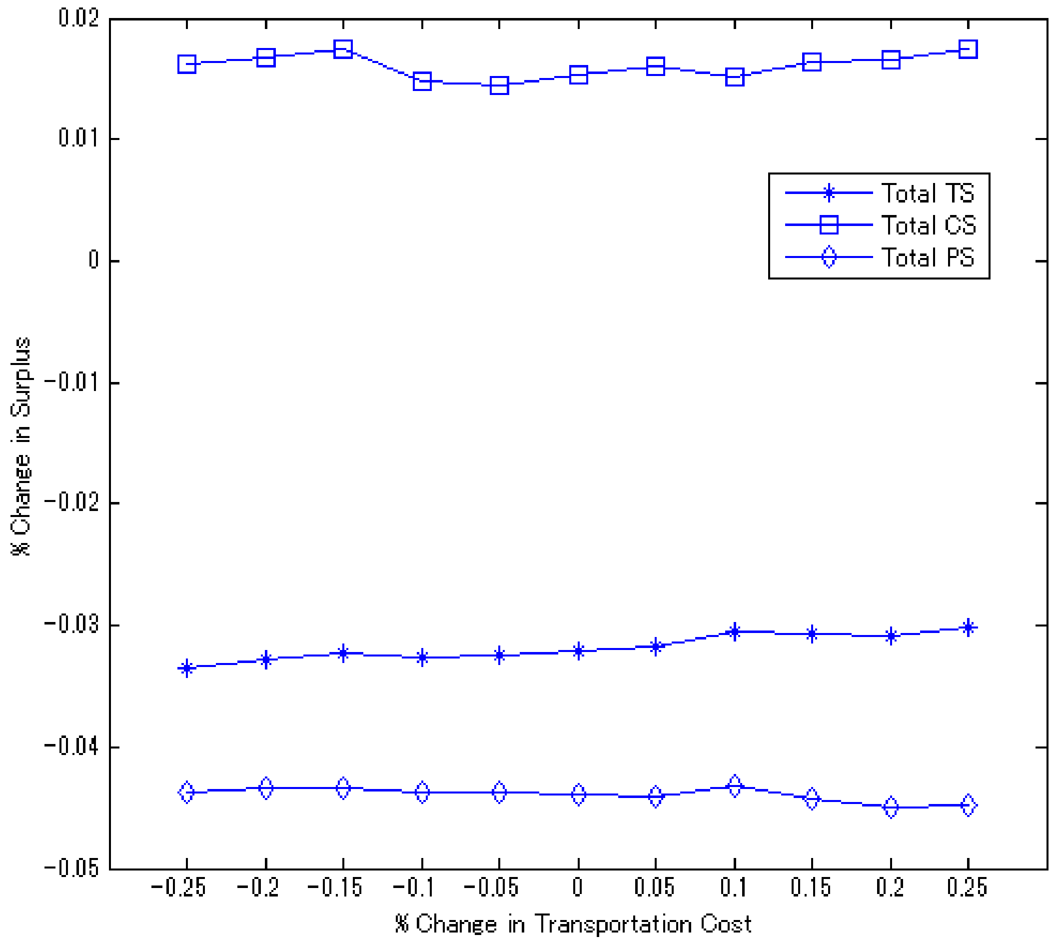


Figure 3.16: **Surplus Change in Models with Different Value of Transportation Cost (Households without Children)**

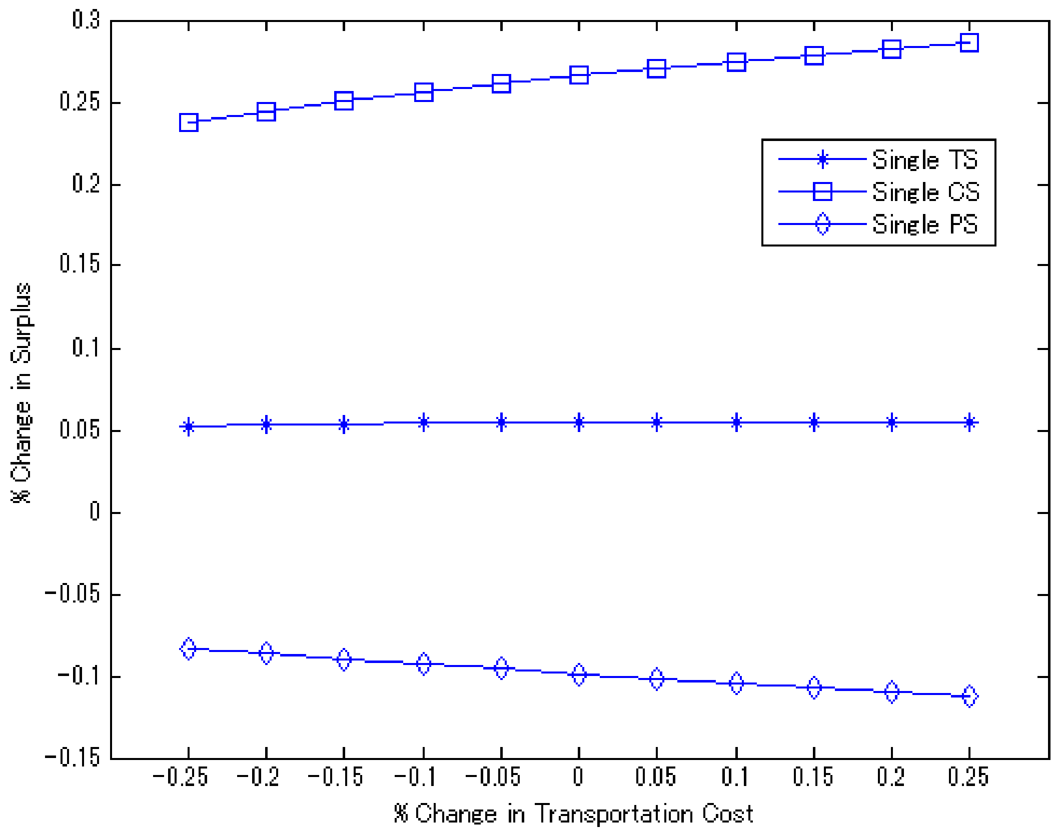


Figure 3.17: **Surplus Change in Models with Different Value of Transportation Cost (Households with Children)**

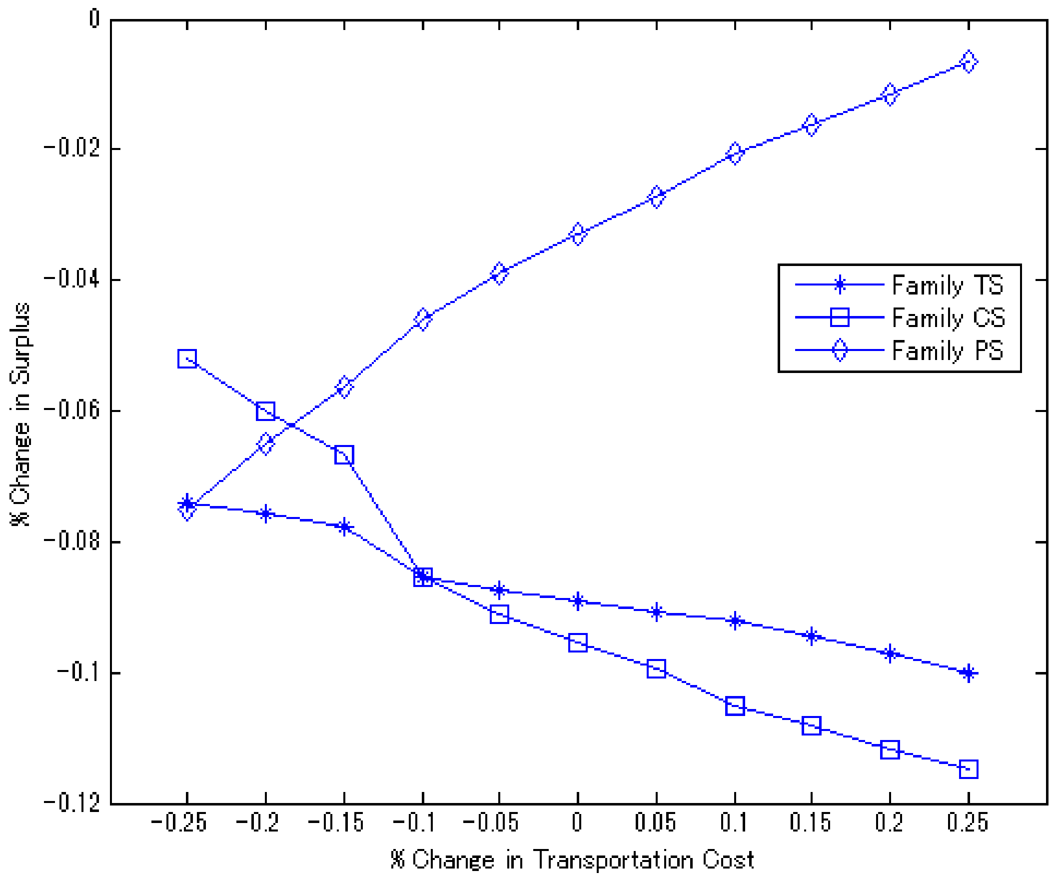


Figure 3.18: **Total Surplus Change in Models with Different Value of Transportation Cost**

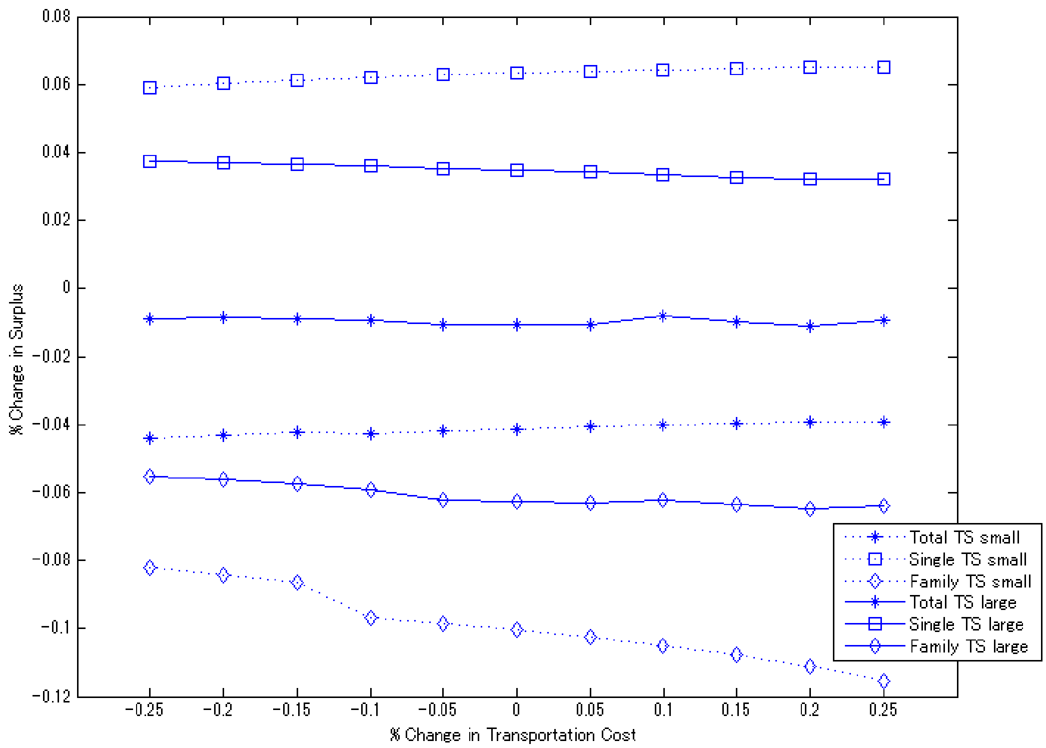


Table A.1: **Construction of Datasets (To Be Updated)**

Datasets	Variables	Data source	Year(/Month)	Size
Theater Characteristics	Ticket Price	*movietickets.com*	Jul 2010	48
		Fandango.com	Jul 2010	121
		official websites	Dec 2010	84
	Theater Location	*movieclock.com*	Jul 2010	$\|J\|$
	Show Schedule	*movieclock.com*	Mar 2011	$\|J\|$
	Film Characteristics	IMDb	Mar 2011	$\|J\|$
Demographic Attributes	All	*NHGIS*	2000	$\|B\|$
Driving Distance	All	Calculated with ArcGIS	N/A	$\sum_m \|J_m\| \cdot \|B_m\|$

Note: $|J| = 253$ is the size of the observations that are used in the estimation, and $|B|$ is the size of census block groups in the sampled 66 markets.