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Effect of High-speed Train Introduction on Consumer Welfare

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Abstract

This paper examines the impact of introducing high-speed trains on consumer welfare using South Korean transportation industry data. The model treats the rail company's choice of train schedules as endogenous in order to take the firm's choices of product line into account. I estimate a model of the demand for travel that incorporates consumers' heterogeneous preferences over travel schedules into an otherwise standard discrete choice model. My results show that consumers are affected differentially by both the introduction of high-speed trains and the ensuing changes in train schedules. The welfare implications for consumers depend on the availability of high-speed trains in their choice set. Consumers who travel between two cities that are connected by high-speed trains are the main beneficiaries of the new service. However, reductions in schedule frequencies of non-high-speed trains operating along high-speed rail lines, generate losses that offset 50% of gains even for these consumers. Travelers on these lines who are not served by high-speed trains only experience substantial losses due to reduced schedule frequencies. Consumers who travel between two cities that are not located along high-speed rail lines gain from increased train frequencies, and the gains make up for the losses in other markets without high-speed trains. These results highlight the importance of accounting for changes in existing products when analyzing the impact of new product entry on consumers.

JEL classification: L13, L25, L92

Keywords: endogenous product characteristics; product line; new product entry; consumer surplus; high-speed train; Korea

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1 Introduction

Generally speaking, introducing an additional differentiated product to a market benefits consumers due to the increased number of alternatives if everything else such as price remains same. However, the effect on consumer welfare is not so simple if producers also change other products characteristics and the set of other products offered. This paper considers firms' reactions to the introduction of new products, particularly changing product characteristics or changing the set of products offered, and analyze the effects of new products on consumer surplus, taking those reactions into account. The goal of my analysis is to investigate changes in consumer welfare due to the introduction of a new product, based on available Korean transportation industry data. Specifically, this paper decomposes the effects of high-speed train introduction into the gains or losses attributable to having high-speed trains and those attributable to firms' choices of products to offer across different types of consumers.

Did consumers benefit from high-speed trains in Korea? High-speed rail systems were introduced in South Korea in April 2004. These rail systems continue to significantly impact the nation's entire transportation industry, thereby affecting its mass-transportation consumers, which has motivated this paper. I observed and analyzed differences in train schedules and train availability after high-speed rail introduction, both of which affect the alternatives available to consumers. Heterogeneity across consumers is also an important factor in the analysis of consumer welfare because consumers might be differentially affected by the newly-introduced high-speed trains. Two dimensions of heterogeneity were relevant to my analysis: preferences regarding travel schedule and the choice sets available to consumers.

Other researchers have theoretically considered firms' choices of product characteristics and product-lines in response to the introduction of a new product. Spence (1976) demonstrates that introducing new products may result in social inefficiency due to product choices. In his work, he illustrates two forces in the product selection under monopolistic competition. On one hand, he demonstrates that products important to social welfare could be inadvertently eliminated because revenue may not cover their costs. On the other hand, he demonstrates that the number of products will exceed the socially optimal number when a firm introduces a substitute product, which negatively affects other firms' profits in the market. He also considers the specific case of a multi-product firm. He considers the possible negative effects of launching a new product on the profits generated by the firm's other products. As a result, the firm tends to limit the number of products it offers by not introducing close substitutes for its existing products, leading to ambiguous implications regarding the introduction of new products on consumer welfare. In the context of my own work, the aforementioned findings imply that firms might choose a set of products.[1]

Gabszewicz, Shaked, Sutton, and Thisse (1986) illustrate how a monopolist would choose product quality if it can only produce a bounded number of products. Such a firm can provide optimal product lines, given a range of possible product quality, and the quality of each product may change as the range of possible product quality changes. The lesson to be learned from both of these analyses is that firms can react to new product introduction by manipulating product characteristics other than prices; therefore, it is important to take changes in product selection into account when analyzing the effects of new products on consumer surplus.

The possible effects of new product introduction can be explored by reviewing the considerable amount of literature available. Trajtenberg (1989) proposes how to measure product innovations, and he provides an example examination based on the social benefits from innovation of CT scanners. Petrin (2002) quantifies the effects of the introduction of the minivan. However, many of the empirical studies of the markets with differentiated products primarily address firms' pricing strategies given the characteristics of each product and treat the market structure as being exogenous. Moreover, the effects of ensuing changes in product characteristics and product-line after new product introduction have not been discussed substantially in the empirical literature, although the corresponding theory is well-documented.[2] Berry, Carnall, and Spiller (2006); Berry and Jia (2010) also emphasize that producers might have an incentive to manipulate product characteristics other than price.[3] In particular, a rail

[1] In Korea, high-speed train introduction was determined by government in 1989.
[2] Eizenberg (2011) accounts for the product-line choices after innovation.
[3] Bresnanhan also comments on Hausman (1996).

company in Korea might have a strong incentive to control product characteristics such as train schedules particularly since by regulation it has only limited power over pricing. Accordingly, I will treat rail company's choice of train schedule as endogenous in all subsequent discussion, and I will instrument for it in the estimation.

To study the effects of both new product introduction and the ensuing changes in product characteristics on consumer welfare, I performed counterfactual analyses to separately quantify the gains resulting from introducing high-speed trains and the welfare changes resulting from the rail company's schedule adjustments. My work adds to the existing literature by considering the changes in product characteristics or the set of products offered to consumers after new product introduction, and by investigating how those changes affect consumer welfare. In order to take into account consumer welfare changes resulting from such adjustments, I observe the set of products offered in the Korean transportation markets before high-speed trains were introduced and I utilize the changes in my subsequent welfare analysis although I do not estimate a model of supply.

Estimation of consumers' demand for travel is necessary for my examination of the impact of introducing high-speed trains on consumer welfare based on the counterfactual analyses. In order to consider travelers' heterogeneous preferences regarding travel schedules along side the rail company's schedule changes, I estimate consumers' demand for travel by explicitly incorporating preference heterogeneity into an otherwise standard discrete choice model.(Koppelman, 2006) Heterogeneity is captured in my model through a modification of the concept of "Schedule Delay" suggested in Miller (1972) and Douglas and Miller (1974). Although preference over travel schedule is an essential factor in travel demand, there has been limited modeling of it in the past due to data constraints. Some research that analyzes travel demand such as Koppelman, Coldren, and Parker (2008) models departure time preferences, but in general they consider neither potential endogeneity from the schedules, nor heterogeneity of preferences over travel schedule across consumers.

As a result of the research I will present in the remainder this paper, I found that the introduction of high-speed trains caused sizable increases in consumer surplus in the Korean transportation markets where high-speed trains have been made available. However, due to the losses caused by the changes in the sets of products offered to consumers, the overall change in consumer surplus in the Korean transportation market as a whole after the introduction of high-speed train is smaller than the increases resulted from adding high-speed trains. I also found that there are significant differences in the magnitude of consumer welfare changes across heterogeneous consumers. The benefits from the new product introduction are somewhat confined to a small number of the markets, while the changes in choice set affects a broader range of consumers.

In order to examine how differentially heterogeneous consumers are affected by new product introduction, I divided the consumers into three groups based on high-speed train availability. The first group of consumers has high-speed trains in their choice set of transportation options. The second group of consumers travel between two cities, that are not connected by high-speed trains, but are located along a high-speed rail line. The third group of consumers travel between two cities at least one of which is not located along a high-speed rail line. Thus consumers in the second and the third group do not have high-speed trains in their choice set. The first two groups of consumers are expected to experience a stronger effect from introducing high-speed trains and schedule adjustment than the rest of consumers because of the mere existence of a high-speed rail line.

Each of the three groups of consumers experience different changes in the products in their choice set after the introduction of high-speed trains, which leads to variations in consumer surplus changes across those consumer groups. On the surface, consumers who had high-speed trains added to their choice set benefited as a result. However, this group endured about 50% fewer non-high-speed trains after the introduction, which offset the gains from high-speed trains. Thus, the net gains for that consumer group are not as large as intuitively expected since the schedule changes caused substantial welfare losses and that offset 50% of the gains from having high-speed trains. Consumers who travel between two cities, that are not connected by high-speed trains but are located along a high-speed rail line, are also subjected to about 50% fewer trains. As a result, that consumer group only experienced the losses in consumer surplus. On the other hand, consumers who travel between two cities which are not located along a high-speed rail line, experienced an increased number of trains, thus a substantially increased consumer surplus. These changes in the train schedules are more noticeable than mere price changes after the high-speed train introduction, yielding more significant effects on consumer surplus than those of price changes.

Overall, the losses for consumers in the second consumer group(available high-speed rail line but no high-speed train available) outweigh the gains for the first consumer group(available high-speed train). However, the increased consumer surplus for the third consumer group(no high-speed rail line available) made up for the losses, which incidentally increased the overall consumer surplus after high-speed train introduction.

The remainder of this paper is organized as follows: Section 2 explains transportation industry in South Korea, and Section 3 describes the data used. Section 4 and Section 5 presents the model, the estimation procedure and the assumptions imposed. Section 6 addresses the procedure to calculate consumer welfare, followed by the discussion on the results in Section 7. Summary and concluding remarks are offered in Section 8.

2 Industry Background

In this section, I will briefly describe the transportation industry in South Korea to provide a better understanding of consumers' travel demand and the rail company's service approach. Although this paper focuses on the rail industry, it is also important to understand other mass transit infrastructures such as inter-city buses and domestic flights in order to analyze the demand for rail service, because of potential competition. Thus, this section provides information on common modes of mass transportation available in Korea, and on the regulations imposed on the respective service providers.

Rail service in South Korea is provided by only one company, Korail, which leases railroads from Korea Rail Network Authority. It currently operates four different types of trains, categorized in terms of speed: KTX, Sae-ma-eul, Mu-gung-hwa and Tong-il. It had been operating the latter three types prior to the introduction of high-speed trains in April of 2004. KTX, the high-speed train introduced in 2004, is the fastest train type available in Korea, which makes only a few stops during its trips. Sae-ma-eul is the second fastest train type. It skips small stations, but it stops at a large city in each region. Mu-gung-hwa can be regarded as a "local" train, which stops even at stations in small cities. In the analysis, only three types of trains are considered because Tong-il covers relatively short distances and it is usually used by commuters who live in suburbs that are not reached by subways.

Korail was a governmental organization until 2004, at which time it became a public enterprise financed by the government. Although it became a corporation, its general behavior such as pricing strategy did not change because the government is the only shareholder. It has extremely limited power regarding its pricing. In particular, the fare must only depend on the train type and the traveled distance, and the firm cannot set price differently for a given destination within the same day. Specifically, Korail determines a "Minimum Fare" and a "Rate per km" for each type of train, subject to government's approval, and calculates fares based on a combination of train-type and distance using the "Distance Scale Rates".[4]

This paper takes advantage of these strict regulations on pricing. In the empirical literature, one major econometric issue is potential endogeneity bias caused by prices. That problem does not arise in this paper, since rail pricing is under strict regulations; therefore, prices are assumed to be uncorrelated with unobserved product characteristics. In addition, since the rail fare is the same for a given destination within a day regardless of the departure time, consumers' observed choices of travel schedule such as "morning" or "evening" reflected a preference based on travel schedule without being influenced by price.

Although this paper focuses on the rail industry, it is still important to understand other modes of transit in order to analyze the demand for rail service. In particular, substitution between rail services and other modes of transportation affects the overall effect of high-speed train introduction on consumer surplus. Therefore, it is important to take market size and outside alternatives into consideration. I define outside alternatives here as traveling by bus, airline or car as well as foregoing travel.

[4]It means *Fare = Greater value among Minimum Fare and (Rate per Km)·(Trip Distance)* . However, other types of price discrimination can be still offered to travelers. For example, the fares for weekdays are about 5% lower than the ones for weekends or holidays. There are also discount offers for members, students, and seniors. Unfortunately, my data neither identifies weekend travelers from weekday travelers nor contains information on individual travelers, and thus any price discount or weekend surcharges would not be addressed throughout this paper.

Travel by bus accounts for 70% of passenger transit in Korea.[5] There are multiple bus companies operating on each route, and their pricing regulations resemble those of the rail company. Bus fares are calculated using "Distance Scale Rates", and fare changes are similarly subject to the government's approval.

Domestic air travel is not as common as the other alternative modes since the Korean territory is rather compact.[6] Only 14 out of 6456 routes included in my analysis are covered by airlines.[7] Pricing of air fare is much less restrictive than that of rail fare. Fares can be set at the discretion of airline companies as long as they provide public notice in advance. Changes in air fares are rarely observed, however.

3 Data

The main analysis employs three different sets of data. This dataset is self constructed by using raw data provided by Korail, Korea Airports Corporation(KAC), Korean Statistical Information Service(KOSIS) and Statistical Yearbook of Land, Transport & Maritime Affairs. The first data set pertains to the South Korean railroad industry and consists of market shares and product characteristics for years 2006 and 2007. The second data set includes the market size and the market share of outside alternatives. These two data sets, used in the demand estimation, only contain observations during the period after the introduction of high-speed trains. The third data set contains characteristics of products offered to travelers in 2002, when high-speed trains were not available. This data set is used for the calculation of traveler's surplus as well as for performing counterfactual analysis.

The first dataset pertaining to the railroad industry combines three different types of information from Korea Railroad(Korail) - i) the number of train passengers for each route(defined as a directional pair of stations) by train type and departure time of day aggregated monthly, ii) the major characteristics of each route, including fares, travel distances, and distance from

[5] Bus connection refers to inter-city buses and express inter-city buses. Express inter-city buses connect two cities farther than 100Km apart and run on highways for more than 60% of the trip.

[6] Air travel occupies the smallest share of passenger travel among bus, air and rail, comprising only 4 percent of the market

[7] There are two major airline and three low-cost carriers. Routes between the mainland and Jeju island are excluded because rail service does not compete with airlines in these routes.

a station to a city-center, iii) the train schedules with train types, routes, departure times and arrival times. In all, the data set covers 6,456 routes throughout the country in existence during the time period of the data, and it contains the monthly aggregate numbers of train passengers for each route by train type and departure hour of day, observed for 12 months between July 2006 and June 2007. This data set also contains major characteristics of the route-train type combinations, such as fares, travel distance, distance from a station to a city-center, that are key variables for demand estimation.

Lastly, the schedule data provides for each train identified by a train identification number, the stations at which stops are made, train type, and departure and arrival times. The ideal data set for my research would include the numbers of train passengers aggregated for each train and for each route to facilitate more robust cross-referencing with the schedule of train services.[8] Unfortunately, the available data only summarizes counts by train type and the hour of the departure time; therefore, to infer a train-level data set I imposed an assumption on the distribution of train passengers over trains departing within an hour. Each train for each route within a given hour, is assumed to have the same number of passengers. Using this assumption, the unit of observation for the combined data is a single train, identified by its train ID number, running on a specific route over a month. Therefore, my analysis treats a train running on a route A and a train running on a route B as different observations even if train ID number is the same.

The second dataset contains the market size and market share of the outside alternatives. "The market" as used herein, is defined as a one-way travel choice from an origin to a destination city hence, I treat a directional city pair and month combination as a separate market. "Travel choice" refers to traveling by rail, bus, car or domestic flight or choosing to forego travel. Potential travelers were estimated rather than observed, however, by assuming that the number of potential travelers is proportional to the geometric average of the populations of the two respective cities involved in a route.(Berry et al., 2006)

Table 8 summarizes the data used in the demand estimation of this paper, which combines the first and the second data. It contains 392.459 products(station pair and trainID

[8]It is possible that there are multiple trains departing and arriving within a given hour.

combinations) over 1,114 directional city pairs and 12 months, thus the number of combinations of city-pair and month, which is recognized as a market, is 13,347. I excluded one of four train types, Tong-il, from the first dataset, because it is usually used for commuters who live in suburbs not reached by subways as discussed in Section 2, thus it services a different demand than this paper is concerned with. On average, 182 passengers travel on a train-route combination over a month period. N(Own Type Train/Day), N(Other Type Train/Day) and Station-City Centers are the variables used to capture the convenience of each route. N(Own Type Train/Day) counts a single type of train scheduled for a particular route within a day. N(Other Type Train/Day) similarly counts the other types of trains. Distance from city-center for a given route is defined as the sum of the distances between the departure and arrival stations from their respective city centers. This variable is meant to capture how conveniently located departure and arrival stations are in terms of in terms of intra-city transportation.

The price variations within a market primarily come from price differences across train types and from routings, since fares for each route-train type combination does not vary within a day or between markets due to the distance scale rates system. Another source of price variation is nominal rail fare changes, which were observed twice in my data period.

A third dataset is employed to compare traveler's surplus before and after the introduction of high-speed trains. It contains information on the products offered to consumers before high-speed rail was inaugurated. Table 2 compares the number of products offered in 2006 with that in 2002 by train type. Each panel summarizes a specific type of train. The first row of each panel shows the number of city pairs for which the given train type is available, and the next three rows show the mean, median and standard deviation. Each column of the panels summarizes a separate group of markets. In order to compare the train frequencies in 2006 to those of 2002, I partitioned markets into three groups based on high-speed train availability and location. Group 1, containing the city pairs with high-speed connections, is summarized in Columns (1) and (4). Group 2, containing the city pairs which are located along a high-speed rail line but are not connected by a high-speed train is summarized in Columns (2) and (5). The city pairs that belong to Group 3, which are not on a high-speed rail line(thus, not connected by high-speed trains), are summarized in Columns (3) and (6).

Each group has been differentially affected by the introduction of high-speed trains. The numbers of Mu-gung-hwa trains offered to Group 1 and Group 2 markets in 2006, were significantly lower than in 2002, while the numbers of Mu-gung-hwa trains offered to markets of Group 3 did not substantially decrease. The panel for Sae-ma-eul, reveals two distinctive patterns. First, the numbers of Sae-ma-eul trains offered to markets of Group 1 and Group 2 in 2006, also decreased compared to those in 2002.[9] This change was caused by major reductions in the number of train scheduled for the routes along high-speed rail lines. Second, the panel also reveals that the number of city pairs where Sae-ma-eul trains are available increased from 127 city pairs to 260. This increase occurred because Sae-ma-eul trains stop more frequently and therefore became available in the cities where these additional stops are made. Group 3 experienced only relatively minor changes. In that group, Mu-gung-hwa trains became available bewteen more city pairs despite the average number of Mu-gung-hwa trains slightly decreasing in the group of markets. The average number of Sae-ma-eul trains increased slightly for Group 3.

4 Model on Empirical Demand

In order to evaluate consumer surpluses resulting from the introduction of high-speed trains, one must analyze the demand that describes how travelers choose a means of transportation, taking into account their preferred travel schedules. I estimated the demand for travel using a discrete choice model, that has been used effectively in the past.(see Berry (1994); Berry et al. (2006); Koppelman et al. (2008); Berry and Jia (2010).) I also extended the standard multinomial logit model by allowing for heterogeneous travel schedules among consumers.

4.1 Notions of Markets, Products and Schedule Delay

This section describes in detail markets and products as I've conceptualized them for this research.

[9]The number of Sae-ma-eul trains offered to the city pairs of column (2) in 2006 is understated because the number of city pairs where Sae-ma-eul is larger than the one in 2002. However, it still significantly decreased, compared to the one in 2002. The average number of Sae-ma-eul trains offered in 2006 to the 127 city pairs where Sae-ma-eul trains have been available since 2002, is 11.

A "market", as used in this paper, is defined as a unidirectional travel from an origin city to destination city. Each unique market is identified by a unidirectional city pair and a month. Each market has own set of products offered. A "product" is defined as a specific train operating for a specific route(a unidirectional pair of two stations) within a specific market. Each train, which is identified by a unique ID number, runs from a start-node station to an end-node station, with additional stops made during the trip. This definition of a product therefore implies that a single train connecting cities A, B and C is treated as a different product for the two connections it makes(A to B and B to C) because it operates for two distinct routes.

In reality, travelers can transfer from one train to another or change modes of transportation over the course of a single trip. I avoid this problem by defining a product as a combination of a route and a train ID rather than as the complete trip an individual traveler conceptualizes. A single rail trip is therefore a series of products, as defined above, in that a traveler may take different trains for each section of his trip.[10]

The characteristics of each product are inherited from the respective product's train and that train's routing. The characteristics of a train are its type, fare, traveled distance, and schedule. The characteristics of a train's routing include distance from station to the city-center, and the number of trains scheduled for the route within a day. Those characteristics of a train's routing attempts to explain the convenience of each route in terms of intra-city transportation.

This paper attempts to explicitly incorporate traveler's heterogeneous preference on travel schedule. Because the fares for a given product, do not vary within a single day, I have assumed that travelers' schedule choices are based entirely on the schedule themselves. This ignores, however, that travelers might need to travel at times other than those they prefer due to train availability. Douglas and Miller (1974) suggest two reasons why people cannot travel at their preferred times: the difference between a traveler's desired departure time and the

[10]For example, a traveler may take train 1 from A0 to A5 and transfer to train 2 at A5 to arrive at B7. Then, the product that the traveler purchases is $\{$(A0$\rightarrow$ A5,train 1),(A5$\rightarrow$ B7,train 2) $\}$. The dataset provided by Korail(dataset 1) does not contain information regarding individual passengers' itineraries; therefore, that data could not support a trip-based analysis. This is the primary reason I chose to define products as I did.

closest scheduled departure; and delays due to excess demand during a traveler's preferred travel time. This paper focuses more on the first source of compromise, which was referred to as *frequency delay* by Douglas and Miller (1974). Personal preference is compromised even more if a traveler wants to take a specific type of train because it decreases the likelihood of traveling at a preferred time even further. Thus, the difference between travelers' most preferred travel times and the actual times chosen could cause inconvenience, and it would significantly affect the demand for trains. In order to measure the potential traveler inconvenience, I adopted the notion of *schedule delay* from Douglas and Miller (1974); Miller (1972), which defines it as the absolute difference between the passenger's most preferred time to travel on 24-hour clock and that of his actual time to travel. Each traveler's schedule delay causes disutility. Unlike Douglas and Miller (1974), this paper does not consider capacity constraint as a source of schedule delay, but the train schedules. Therefore, *Schedule Delay* is defined in this paper as the absolute difference between a traveler's most preferred travel time and his actual time to travel.

This paper assumes that each traveler has a target time in mind for one endpoint of each potential trip that does not vary with mode or schedule choices. In existing literature that discusses preferences over travel schedule, departure time is usually considered instead of arrival time.(Douglas & Miller, 1974; Koppelman et al., 2008) Although it is not common to use preferences over arrival time, this paper adopts arrival time for travel schedule because a traveler normally chooses a departure time and a mode of transportation with a target arrival time in mind. His preferred departure time there depends on how he travels, while his target arrival time remains constant during the selection process. In this context, using preference over arrival time instead of departure time is more consistent.[11]

4.2 Traveler's Problem

As I mentioned earlier, the logit model with traveler's heterogeneous preferences with respect to travel time will be adopted in this paper. A traveler i, whose preferred travel time

[11] I use departure time for a_{jmt}, and adopt preference over departure time instead of arrival time in an alternative specification for the purpose of robustness check. The results are robust.

is h^i, faces a choice problem over products given a city-pair m in a time period t: He has to choose how to travel.[12] Traveler i will consider all of the products in the market mt to choose a product that yields the highest utility. This paper assumes a linear utility(or disutility); hence, the utility function of a traveler i for a product j(a train-route combination), is given by

$$U^i_{jmt} = x_{jmt}\beta + \eta_m + \xi_{jmt} + \gamma \cdot d(a_{jmt}, h^i) + \epsilon^i_{jmt} \tag{1}$$

where a vector $x_{j.}$ contains the observed characteristics of each product including fare. Because the heterogeneity of city pairs is huge, the model includes a dummy variable for each city pair m- the coefficient on the dummy variable for city pair m is η_m -in the demand to allow the valuation of inside goods to be different across markets.$\gamma \cdot d(a_{jmt}, h^i)$ measures the inconvenience caused by schedule delay, where $\gamma < 0$. $d(a_{jmt}, h^i)$ is the absolute difference between a_{jmt} and h^i, where h^i is traveler i's preferred travel time of day, and a_{jmt} is his actual time of day to travel specific to product j in market mt.[13]

The product-level unobservable, ξ_{jmt} accounts for a number of product characteristics, which are not observed by econometricians, such as unobserved characteristics of the routes or trains, the facilities inside each train or in the train stations, and the quality of the train attendants. ϵ^i_{jmt} is an additive error term, specific to product j in market mt, which is assumed to follow an extreme value distribution and to be distributed independently across both consumers and products.[14][15] This error term captures each traveler's idiosyncratic tastes in trains or routes, or possibly his physical location or the purpose of his trip.[16]

I explicitly introduced "outside" alternatives in Section 3, which include traveling by modes of transportation other than trains as well as not traveling. The outside alternatives have utility The mean of this utility is normalized to be zero. The coefficients on city-pair specific dummy variables(η_m) in the utility of "inside goods" are interpreted as being relative to

[12] As discussed in Section 2, he is allowed to choose not to travel at all.

[13] $d(x, y) = \min\{|x - y|, 24 - |x - y|\}$

[14] Berry et al. (2006) consider this as a factor from preference on time to travel. I explicitly include the preference on arrival or departure time in the model

[15] This model was first proposed in McFadden (1973)

[16] As discussed in Section 4.1, the purpose of trip can be transferring to another mode or another train.

the outside goods.

Given the utility function (1), each traveler i purchases one unit of a product j that yields the highest utility. That is, conditional on $(x_{mt}, \eta_m, \xi_{mt}, a_{mt})$ and his preferred time to travel h^i, he will purchase one unit of j if and only if

$$U^i_{jmt} > U^i_{kmt} \qquad \forall k \in J_{mt} \cup \{0\},\ \ k \neq j$$

where J_{mt} is a set of products available in market mt and $\{0\}$ is a set of outside alternatives.

The "market share" of a product is defined as the percentage of travelers using that product out of all potential passengers. The market size is discussed in Section 3. Based on the assumption on the distribution of ϵ, the probability that traveler i purchases a product j conditional on $(x_{mt}, \eta_m, \xi_{mt}, a_{mt})$ and i's preferred time to travel, is given by the well-known formula

$$s^i_{jmt}(\delta_{mt}, a_{mt}, \gamma, h^i) = \frac{\exp(\delta_{jmt} + \gamma d(a_{jmt}, h^i))}{1 + \sum_{q \in J_{mt}} \exp(\delta_{qmt} + \gamma d(a_{qmt}, h^i))} \tag{2}$$

where $\delta_{jmt} = x_{jmt}\beta + \eta_m + \xi_{jmt}$,, and is shared among all travelers in the market.

If the distribution of h^i is known, the market share for each product can be easily obtained from the expectation of (2) over h^i. This paper assumes the traveler's preferred time of day to travel to be discrete so that each traveler has his preferred "hour" to travel on a 24-hour clock. This allows the model to be a discrete mixture of logit models. In other words, h^i takes an integer between 1 and 24.[17], and its probability mass function is

$$\text{Prob}(h^i = \tau) = \phi_{\tau mt} \qquad \forall \tau \in B$$

where B is the set of support of h^i, the 24 integers between 1 and 24. The overall market share of product j is

[17] Although I assume h^i to take an integer, it can be generalized to take one of any 24 real numbers between 0 and 24.

$$s_{jmt}(\delta_{mt}, a_{mt}, \gamma, \phi_{mt}) = \sum_{\tau \in B} \phi_{\tau mt} \cdot s^i_{jmt}(\delta_{mt}, a_{mt}, \gamma, \tau)$$

where $\phi_{\tau mt}$ denotes the percentage of travelers in the potential travelers of market mt whose preferred time to travel is τ.

4.3 Distribution of Traveler's Preferred Time

Although this paper does not contain any random coefficient, the model is similar to the mixture model with random coefficients due to the existence of h^i. Ideally, a variable ϕ_τ, defined as the proportion of travelers whose preferred time is τ, can be estimated from the model; however, it is not practical to estimate a different vector of ϕ for each market. Such a task would be impractical even if I assumed that the distribution travelers is common across markets, because estimation is difficult and it is sensitive to small changes in the specification or instruments as Berry and Jia (2010) points out.[18]

To sidestep this issue, this paper uses a proxy for the proportion of the potential travelers with preferred travel time τ, obtained using the following assumptions. First, I assumed that the distribution of traveler's preferred time to travel varies across city-pairs but does not vary across time periods. That is, $\{\phi_{\tau mt}\}_{\tau=1}^{24} = \{\phi_{\tau m}\}_{\tau=1}^{24}, \quad \forall t$. I also assume that the distribution of h^i is same across all the alternatives. Let $w_{\tau m}$ denote the proxy for the proportion of travelers in city-pair m whose preferred time to travel is τ. Replacing $\phi_{\tau mt}$ with the proxy $w_{\tau m}$ allows the overall market share for product j to be rewritten as

$$s_{jmt}(\delta_{mt}, a_{mt}, \gamma) = \sum_{\tau \in B} w_{\tau m} \cdot s^i_{jmt}(\delta_{mt}, a_{mt}, \gamma, \tau) \tag{3}$$

Next, it is essential to find a proxy for $\{\phi_{\tau m}\}_{\tau=1}^{24}$ for each m, which reflects the distribution of travelers preferred times of day to travel. The process of constructing the proxy is based on the underlying belief that all travelers will travel at times that is close to their most preferred times. This is a plausible assumption because fares do not vary within a single

[18] According to Berry and Jia (2010), the mixture model with more than three types of consumers is difficult to estimate and sensitive to small changes in the specification or instruments.

day. Therefore, preference for a given travel time can be inferred by the number of travelers during that time. Thus, one reasonable candidate for the distribution of h^i is the hourly train ridership in each market taken from the historical data.[19] This assumes that the company schedules trains to support travelers using knowledge of the true distribution of consumers' preferences over the travel schedules; thus the hourly ridership should reflect travelers' true preferences. I obtained the proportion of travelers in each city pair m who actually travel during time period τ using

$$Q_m^\tau = \frac{\sum_t \sum_{j \in J_{mt}^\tau} q_{jmt}}{\sum_t \sum_{j \in J_{mt}} q_{jmt}} \tag{4}$$

where J_{mt}^τ is the set of available trains in a market mt with schedule is τ, and q_{jmt} is the number of passengers purchasing product j.[20]

I construct a proxy for $\{\phi_{\tau m}\}_{\tau=1}^{24}$ for each m, smoothing the proportion of travelers in city pair m who actual travel at τ above using Kernel density estimation.[21]

5 Estimation

To estimate the demand parameters (β, γ), I followed the standard BLP procedure due to the presence of the unobserved product characteristics ξ, and of heterogeneous travel time preference h^i.[22] Although the model in this paper does not include random coefficients, the existence of heterogeneous taste on preferred time to travel makes the model similar to the ones with random coefficients. Therefore, I first inverted the following market share equation for each market to solve for the vector of δ_{mt} as a function of data and the parameters to be

[19] Figure 1(a) displays the mean of the percentage of rail travelers who travel within an hour across city pair with bars.

[20] This paper uses "hour of arrival time" for train schedule, and discuss the reason in Section 4.1, and thus $J_{mt}^\tau = \{j \in J_{mt} | a_{jmt} = \tau\}$

[21] In other words,

$$w_{\tau m} = \int_{\tau-1}^{\tau} \frac{1}{Q_m h} \sum_{y=1}^{24} Q_m^y \cdot K\left(\frac{x-y}{h}\right) dx, \quad \tau = 1, 2, \cdots 24 \tag{5}$$

where $Q_m = \sum_{y=1}^{24} Q_m^y$ and $K(x) = \frac{1}{\sqrt{2\pi}h} \exp(-\frac{x^2}{2h^2})$. Figure 1(a) shows the mean percentage of rail travelers who travel within an hour across city pairs(with bars) and the mean of proxies(with lines) for distribution of travelers' preferred travel time to illustrate the distribution of travelers' preferred time.

[22] proposed in Berry, Levinsohn, and Pakes (1995)

estimated

$$s_{mt}(\delta_{mt}, a_{mt}, \gamma) = s^o_{mt} \qquad \forall m, t$$

where $s_{mt}(\delta_{mt}, a_{mt}, \gamma)$ is a vector of market shares in market mt as described in (3), and S^o_{mt} is a vector of observed market shares in market mt. As in Berry et al. (1995), this system of equations is nonlinear in the parameters to be estimated ; however, they can be solved numerically using the contraction mapping. [23]. As described in Nevo (2000), I use two-stage least squares which solve the linear parameters β as a function of the nonlinear parameter γ and limits the nonlinear search in GMM methodology to the nonlinear parameter only.

By assumption, the rail company considers travelers' schedule preference when determining train schedules; therefore, $E(\xi)$ could have non-zero. Accordingly, we must include a set of exogenous instrumental variables to identify the parameters. The moment conditions used in the estimation are derived from

$$E\left[\xi_{mt} | z_{mt}\right] = 0$$

where z_{mt} is a vector of instruments. For any vector of function $h(\cdot)$[24], the moment conditions imply

$$E\left[\xi_{mt} \cdot h(z_{mt})\right] = 0$$

Although strict regulations on pricing mitigate the endogeneity problem from prices, the endogeneity from train schedules is of concern to this research. Since a rail company in Korea has only limited power over pricing, it might have a strong incentive to control product characteristics such as train schedules instead of fares. As a result, the arrival time of product j, a_{jmt} and Schedule Delay, $d(a_{jmt}, h^i)$ might be endogenously determined by the rail company. [25] Therefore, it is necessary to include valid instruments in order to identify the demand

[23] I iterated until the maximum difference between each iteration is smaller than $2 \cdot e^{-25}$

[24] For this paper, I transformed z_{mt} using a principal component analysis of a given function $h(\cdot)$ to make the columns of $h(z_{mt})$ orthogonal.

[25] For example, the rail company could schedule more trains at a popular time, thus the schedule delay might be small for high demand products.

model.

The identification strategy used in this paper searches for the variables that affect the rail company's schedule decision, but not those that affect consumer demand, exploiting a special circumstance of the railroad industry. Consider, for example, trains running along a rail line A with stops at stations between A_0 through A_{N+1}(N intermediate stations). When a rail company determines the schedule for those trains, it would ideally consider the demands for each of the individual routes along the railroad. However, a traveler would care only about the routes in the market he travels in. For example, consider two cities, City 1 and City 2. Assume the cities have stations, A_{n_1} and A_{n_2}, respectively, both located on rail line A. Since people who travel from City 1 to City 2 would not care about the routes $A_n \rightarrow A_{n'}, \quad \forall n, n' \neq n_1$ & $n, n' \neq n_2$, the demand for product j, given a train t_1, of $A_n \rightarrow A_{n'}, \quad \forall n, n' \neq n_1$ & $n, n' \neq n_2$ constitutes valid instrumental variables for j, and let R_{jmt} denote such routes.[26]

6 Expected Utility Calculation

The demand estimates provide information about how consumers value each of the product characteristics. These results indicate that consumers have significant disutility from traveling at a time other than their preferred time to travel. The next step is to quantify the changes in consumer surplus after high-speed train introduction. Since the train schedules changed as a result of the introduction of high-speed trains, I separately considered the changes in consumer surplus caused by train rescheduling and those caused by high-speed train introduction.

The change in consumer welfare can be measured by the difference between the expected utilities in two different situations. I primarily compared the consumers' expected utilities from the set of products offered after the introduction of high-speed trains to those from the products offered before high-speed trains were introduced. To examine the effects of

[26]For example, two of the instrumental variables are $z_{l,jmt} = \sum_{k \in C^l_{jmt}} q_{kmt}$
where $C^1_{jmt} = \{k \in \cup_m J_{mt} | k$'s train ID $= j$'s train ID & station pair of $k \in R_{jmt}\}$
and $C^2_{jmt} = \{k \in \cup_m J_{mt} | k$'s train ID $\neq j$'s train ID & $a_{kmt} = a_{jmt}$ & station pair of $k \in R_{jmt}\}$

high-speed train introduction separately from other changes such as train reallocation, I considered equilibria under the six different sets of products to evaluate the travelers' surplus, followed by a stepwise comparison to illustrate the effects of situation changes. The six product sets are defined as following :

(S1) Train schedules offered to travelers in 2002, before high-speed trains were available, using the prices from 2002.

(S2) Train schedules offered in 2002, before high-speed trains were available, using the prices from 2006.[27]

(S3) High-speed train schedules offered in 2006, including the other types of trains considered in (S2), using the prices from 2006.

(S4) Same as product set in (S3), but excluding the trains that were no longer part of the 2006 schedule, using the prices from 2006.

(S5) Same as product set in (S4), but including the trains that were newly offered in 2006 versus 2002, using the prices from 2006.

(S6) Train schedules offered in 2006, using the prices from 2006.

(S1) and (S6) present actual situations, whereas the others present hypothetical situations. The changes from (S1) to (S2) correspond to the effects of price changes between 2002 and 2006. A comparison between (S2) and (S3) provides the effects of high-speed train introduction on traveler's surplus. The changes from (S3) to (S6) corresponds the effects of schedule changes after the introduction of high-speed trains, and the stepwise comparisons from (S3) to (S6) break down those effects into three components: the effects from the elimination of trains((S3)→(S4)); the effects from the addition of trains((S4)→(S5)); and the effects from the pure reallocation of the existing trains((S5)→(S6)).

To break down the effect of schedule changes into the three components discussed above, it is necessary to group the trains offered in 2002 into those subsequently removed in 2006 and those still remaining in 2006. Since the systems used to assign identification numbers to trains were different in 2002 and 2006, it was not possible to use the train identification number for

[27] This paper uses the fare and the trains schedules from November 2006 for all 2006 pricing.

the sorting. Thus, this paper exploits the partition of hours, which is defined in Section 4.3 by matching Morning trains offered in 2002 to Morning trains offered in 2006 based on arrival time and train type. For example, if there were five Mu-gung-hwa trains in the Morning group in 2002 and there were six Mu-gung-hwa trains in the Morning group in 2006, I paired the first offered in 2006 with the five trains offered in 2002 and considered them as trains with "adjusted schedules". The one remaining train was then considered as "an added train". Under this sorting rule, a change in the schedule of a train within a time group(B_g) was considered a reallocation, whereas scheduling a train such that it fell into a different time group($B_{g'}, g' \neq g$) was considered a removal of that train from the first time group(B_g) and adding a new train to the second time group($B_{g'}$). Using a different sorting rule could result in a different distribution of consumer welfare changes across "removing trains", "adding trains" and "reallocating trains"; however, the total effects of "schedule changes", which consists of all the three changes, is invariant across different sorting rules.

To approximate the expected utility given the estimated demand, this paper replaces $\phi_{\tau mt}$, the proportion of travelers whose preferred time to travel is τ, with a proxy $w_{\tau m}$, as defined in (5). Since ϵ^i_{jmt} in (1) is assumed to have the extreme value distribution, the expected utility can be rewritten as[28]

$$EU_{mt} = \sum_{\tau \in B} \phi_{\tau m} \left[\log \sum_{j \in J_{mt}} \exp \left(V^i_{jmt}(\hat{\beta}, \hat{\gamma}, \hat{\eta_m}, \tau) \right) \right]$$

From Nevo (2003), a monetary measure of the change in traveler's welfare, EV_{mt} can be constructed by

$$EV_{mt} = -\frac{M_{mt}}{\beta_p}(EU^1_{mt} - EU^0_m) \tag{6}$$

where β_p is the price coefficient and M_{mt} is the market size of mt. EU^1_{mt} and EU^0_m represent the expected utilities of situations with high-speed trains and without high-speed trains respectively, thus, (6) allows us to compare two different situations with the same demand

[28]shown in Ben-Akiva (1973)

system.[29]

7 Results

This section covers the results of the estimations using the demand model and the expected utility calculations. Section 7.1 presents the results of the estimation using the demand model, and contains its own discussion. In Section 7.2 I discuss the main findings of this research; The results of analyzing changes in consumer surplus resulting from both high-speed train introduction and train schedule adjustment.

7.1 Travel Demand

Table 3 shows the results of demand estimations based on the main specification that takes both travelers and non-travelers into consideration. Table 3 shows the estimated parameters, which include the mean utility parameters(β) and the parameter representing schedule delay(γ). Column (1) shows the parameters using the main specification, and Column (2) shows the same parameters estimated using the same model without employing the excluded instrumental variables. Column (3) shows the parameters resulting from an OLS estimation of $\ln(s_{jmt}/s_{0mt})$ on δ_{jmt}.

As expected, the mean estimated utility of high-speed trains(KTX) was higher than other types of train, and that of Sae-ma-eul trains was lower than KTX but higher than the other two types of train. Schedule Delay has significantly negative impact on demand. In Column (1) of Table 3, the estimated coefficient for Schedule Delay is -0.311. The most straightforward method of interpreting this coefficient is to compare it to the price coefficient. The price coefficient(-0.115) and the coefficient for Schedule Delay imply that travelers are willing to pay up to about 2700 KRW to reduce their Schedule Delay by one hour, holding everything else fixed. The coefficient for price shows that consumers are not as sensitive to price. To be more specific, the probability to purchase a product decreases by 9.9% when price increases

[29] While a city pair m is observed for multiple periods in the estimation, the products offered in a counterfactual situation are observed for one period, thus EU_m^0 is subscripted only with m. I take mean of EU_{mt}^1 over months, t within a city pair m to compare it to EU_m^0.

by 10%.

Examination of the estimated coefficients of the variables that indicate the convenience of each route such as N(Own Type Train/Day), N(Other Type Train/Day) and Station-City Center, reveals that the routes with more trains scheduled provide a higher utility for travelers. The number of a given type of train scheduled within a day affects a traveler's utility more than the schedules of the other types of train. If the number of a given type of train scheduled within a day increases by 10%, travelers choose the corresponding products with 7% higher probability. On the other hand, a 10% increase in the number of other types of trains scheduled within a day results in only a 0.8% higher purchase probability. Distance between station and city center is also an important factor on demand, based on the estimated parameters. If a given station was relocated 10% farther from its city center, consumers would choose the corresponding products with 9.5% lower probability.

7.2 Consumer Surplus

I partitioned the markets into three groups based on high-speed train availability in order to consider the heterogeneity of choice sets as well as heterogeneous preferences over travel schedules. This partitioning facilitates an examination of the different effects across heterogeneous consumers. The results for Group 1, which considers consumers in the markets with high-speed train stations, are shown in Column (1) of Tables 4, 5 and 6. Group 1 contains 107 million travelers per month across 107 city pairs. Column (2) of Tables 4, 5 and 6 summarizes the results for Group 2, which consists of the markets that are located along high-speed rail lines without available high-speed trains. Group 2 contains 190.7 million travelers per month across 330 city pairs. The consumers not accounted for in the first two groups belong to Group 3, whose results are shown in Column (3) of Tables 4, 5 and 6. Group 3 covers 615 city pairs with 348.9 million travelers per month. Consumers in Group 1 and Group 2 were expected to experience stronger effects from both introduction of high-speed trains and the resulting schedule adjustments than consumers in Group 3. I summarized the changes in consumer surplus based on these groups, and Table 4, 5 and 6 reflect the main findings of this paper.

Table 4 summarizes the expected consumer surplus changes per person for each market. Each subpanel of Panel A in Table 4 displays the change in consumer welfare resulting from each of the five different sources described in Section 6. The "Price Change" panel shows the estimated change in consumer welfare due to price differences between 2002 and 2006. Since rail fares decreased for 50% of the products available in my dataset, the changes in consumer surplus due to price change is positive. The "Add KTX" panel shows the gains from attributable to the introduction of high-speed trains into the markets. Since high-speed trains became available in the markets of Group 1, only the consumers in Group 1 directly benefited from the new service. The next three subpanels summarize respectively the changes in consumer welfare due to reducing scheduled trains, scheduling additional trains and rescheduling existing trains to another time within same day. The "Total Effect" panel reflects the overall changes in consumer surplus resulting from all the sources of impact.

Each column of Table 4 shows the heterogeneous impacts all normalized to be per person on consumers in each of the three groups, described above.[30] The median of the expected per-person change in Group 1 resulting from introducing high-speed trains, is 5,600 KRW(see Panel A), but the expected change resulting from train schedule adjustments is -1,900 KRW, offsetting some of those gains.[31] The median of the expected per-person loss in Group 2 resulting from schedule adjustments after high-speed train introduction, is about 11,140 KRW. This loss occurred because some trains that were available before the high-speed train introduction became unavailable after the introduction. Group 3 consumers experienced only minor changes overall compared to consumers in other groups. The median of the expected per-person change in consumer welfare in Group resulting from schedule adjustments after high-speed train introduction, is about 1,900 KRW. Total effect summarizes the changes of consumer welfare compared to that in 2002. The median of the expected consumer surplus change per person in Group 1 is 4,000 KRW, while that in Group 2 is -8,500 KRW.

Table 5 summarizes the expected consumer surplus changes in each market, taking into

[30] How to define a group does not affect the demand estimates and the change of consumer surplus. Welfare analysis by groups facilitates the understanding on how heterogeneous consumers are differentially affected by high-speed train introduction and ensuing schedule changes.

[31] The expected change from schedule adjustment after high-speed train introduction is the sum of the changes from removing trains, adding trains and rescheduling trains.

consideration market sizes and the magnitudes of impact per person.[32] The results obtained using the main specification(shown in Panel A) demonstrate that both the introduction of high-speed train and the ensuing changes in train schedule had substantial effects on consumer welfare, and that the size of the impact varied across consumers. The fact that the median and mean impacts are substantially different suggests that the changes in consumer surplus are heterogeneous across markets. Although the mean of the expected *per-person* consumer surplus change in Group 1 resulting from reallocating trains is positive, the mean calculated *per market* is negative. This implies that the losses resulting from reallocating trains occurred in larger markets, which tended to also be more strongly affected by high-speed train introduction directly, while some other markets in Group 1 benefited.

Table 6 summarizes the gross changes of consumer surplus in each of the three groups. As I pointed out earlier, rail fares decreased for 50% of the products available in my dataset, thus the overall changes in consumer surplus due to price change was positive. The second row in each panel shows the gains from introducing high-speed trains to the markets. Since high-speed trains became available in the markets of Group 1, only the consumers in Group 1 benefited from the new high-speed rail service. More concretely, the introduction of high-speed trains caused an estimated 10 trillion KRW increase in consumer surplus per month(see Panel A). The net gains for travelers in Group 1 are not as large as superficially anticipated, however, since schedule changes such as reallocation and reduction of non-high-speed trains caused sizable losses that offset 50% of the direct gains resulting from the introduction of high-speed trains.

The next three rows(rows 3-5) summarize the changes in consumer welfare due to rescheduling such as reducing the number of scheduled trains, scheduling additional trains and reallocating existing trains to another time slot within same day. The consumer welfare change due to schedule adjustments in Group 1 markets was about -560 billion KRW. Consumers in Group 2 suffered a considerable amount of loss, -2.4 trillion KRW, due to changes in the set of products offered because train schedules in the corresponding markets were reduced by

[32]Table 5 shows the summary statistics of (The per-person expected surplus changes in each market) $\times$ (Market Size)

more than 50%. Without any added benefits from new high-speed services, consumers in the markets of Group 2, experienced losses three times higher than the gains of Group 1 resulting from the introduction of high-speed trains. On the other hand, consumer welfare in the markets of Group 3, increased by about 2 trillion KRW. Although some trains were removed from the original schedules, the gains resulting from additional non-high-speed trains and from reallocated trains outweighed the losses resulting from removed trains. Unlike consumers in Groups 2 and 3, consumers in Group 1 suffered a loss of 73 billion KRW resulting from trains rescheduled to other time slots. This is because KTX trains are primarily scheduled at peak times and non-high-speed trains are primarily scheduled away from those times.

Overall, the gains from having high-speed train are substantial. However, the losses from schedule adjustments that consumers were subjected to in the markets that are located along high-speed rail lines without high-speed trains scheduled, outweighed those gains. Overall changes in consumer surplus were about 317 billion KRW, however, the positive changes are led by the gains from schedule adjustment in Group 3 markets, but the gains from high-speed trains do not exceed the losses that occurred due to schedule reductions in Group 2 markets.

To summarize, introducing high-speed trains substantially raised consumer surplus in markets where they were actually made available. The changes in the set of products offered to consumers offset 50% of the gains, however. Moreover, it resulted in greater losses of consumer surplus in markets located along high-speed rail lines but not connected by high-speed trains, and those losses outweighed the gains directly from introduction of high-speed trains. The overall change in consumer surplus after the introduction of high-speed train was positive because the gains resulting from schedule adjustments in markets that are not located along high-speed rail lines made up for the losses in markets that are located along high-speed rail lines without available high-speed trains. I also found that there are substantial differences in the magnitudes of the consumer welfare changes across heterogeneous consumers. The benefit gained directly from high-speed trains is concentrated in some of the markets, although changes in the choice sets affected a broader range of consumers.

7.3 Limitation

A critical limitation of these results is an implicit assumption on the stability of demand system. This approach presumes that consumers had the same demand over product characteristics regardless of the existence of the new product. The results are derived based on the estimates of indirect utility function for the period after the innovation although ex ante and ex post welfare calculations provide quantitatively different measures.(Trajtenberg, 1989) Since the estimated demand is only based on the revealed preferences observed for the periods after the introduction, the counterfactual consumer surplus is valid only if the functional form of the demand is stable as we move away from the center of the data.

More serious problem arises due to the distribution of travelers' preferred time. First, we cannot guarantee that the distribution over travelers' preferred time is time invariant. The assumption imposed when the proxy for ϕ is constructed could lead to the bias in the results. I used the hourly train ridership in each market from the historical data for the proxy, assuming that the train schedule and the hourly ridership reflect travelers true preference. However, this could lead to a biased result if the preference over travel schedule changed after the introduction because scheduling trains in a different way from the one observed in 2006 will result in welfare losses. I believe that this bias is not serious because i) the welfare implication is robust under other distributions, ii) the proportion of welfare changes due to schedule preference is relatively smaller than those coming from schedule frequencies.

Lastly, I want to suggest a potential extension of this research. In the model, I focus heterogenous preference over travel schedule rather than heterogeneous sensitivity to fare and schedule delay. The model suggested in this chapter can be generalized so as to allow for the random coefficient on price and schedule delay. The heterogeneity of sensitivity to schedule delay is another dimension of heterogeneity though it is potentially correlated with travelers preferred time of traveling. In reality, the sensitivity would affect consumers modal choice together with the sensitivity to prices.[33] Therefore, in the generalized model, one needs to consider potential correlation between preference on travel schedule and sensitivity

[33] For example, travelers whose disutility from schedule delay is severe are more likely to take high-speed trains, which are scheduled more frequently than conventional trains.

to fare and schedule delay.[34]

8 Conclusion

In this paper I addressed the effect on consumer surplus resulting from the introduction of high-speed trains and the ensuing changes in train schedules. I examined the impacts of introducing high-speed trains on consumer welfare using Korean transportation industry data, taking changes in rail company's product selection into account. With his data, I estimate a model of travel demand, that incorporates consumers' heterogeneous preferences over travel schedules into a standard discrete choice model. My analysis treated the rail company's choice of train schedules as endogenous. After comparing the consumer surplus resulting from a set of products offered to consumers before and after high-speed train introduction, this paper yields the implications in consumer surplus. I discussed in detail a rich analysis of consumer welfare changes after the introduction of high-speed trains and of the indirect welfare changes resulting from changes in the firm's product selection.

My results show that consumers newly introduced high-speed trains had differential effects on consumers, and that the ensuing changes in train schedules also indirectly affects consumer surplus. The changes in consumer surplus within a market depended on availability of high-speed train. In order to investigate the effect, which varies across heterogeneous consumers, I partitioned markets into three groups based on the availability of high-speed trains in consumers' choice sets. Group 1 consumers who travel between two cities connected by high-speed trains benefited from the new product, but 50% of the gains were offset by the changes in the set of products offered to those consumers. On the other hand, Group 2 consumers, who travel along high-speed rail lines but do not have high-speed trains in their choice sets, suffered significant welfare losses from a reduction in frequency of non-high-speed trains. Group 3 consumers who travel between two cities that are not located along high-speed rail lines, experienced an increased number of trains scheduled, thus substantially increasing consumer surplus. Overall, the losses for Group 2 consumers outweighed

[34] For example, business travelers who are likely to be more sensitive to schedule delay than fare would have different preference over travel schedule from leisure travelers'.

the gains resulting from high-speed trains being made available to Group 1 consumers. However, the consumer surplus for Group 3 consumers increased due to the increased schedule frequencies; the increase incidentally made up for the losses for Group 2. The overall consumer surplus after high-speed train introduction increased; however, that increase was not nearly as substantial as the gains directly resulting from the introduction of high-speed trains because of the losses incurred by groups to which high-speed trains were not made available.

My research calls attention to the impact on consumer welfare from new product introduction and the subsequent changes. Such subsequent changes may be due to the reactions of economic agents in the related industries or the industrial circumstance. The impact from those changes is neither limited to one industry nor restricted to a specific group of consumers. Although the subsequent changes may result in substantial influence on consumer surplus, the scope of investigation can be easily restricted to one specific industry or a particular group of consumers. Such restricted scope or the understated impact from the subsequent changes can lead to the biased results of welfare implication. My results emphasize the importance of accounting the impact of ensuing changes after new product introduction and urge more careful investigation regarding the benefit of new product introduction when one evaluates a new product entry.

This study also provokes a discussion regarding government spending. As expected, the construction of high-speed rail lines was costly and Korean government allocated enormous budget, which was levied from the entire tax payers. However, the benefits tend to be concentrated in a few markets despite diffused costs. The findings of this research can be applied to government's investment decision on other industries too. Whether an investment decision is appropriate depends not only on the direct impact from the investment but also on its indirect impact. Therefore, a thorough investigation regarding the benefit of government spending and its wider impact and an in-depth discussion is essential for better decisions on government's investment. The influence on the people who are seemingly unaffected should also be taken into account.

Table 1: Summary Statistics

Variable	Mean	STDEV	Median	Min	Max
N=13,347					
Average Population	616,195	724,814	358,772	53,353	7,796,378
Rail,Air,Bus Passengers + Car Ownership	100,172	126,147	56,331	6,874	1,366,424
N=392,459					
Market Share(j)	0.0002	0.0004	0.0001	0.0000	0.0242
Q_j	182	447	49	0	15041
Price(10^3KRW)	8.6	6.7	6.5	1.9	47.0
Distance(Km)	126.0	97.3	96.6	2.9	506.4
N(Own Type Train/Day)	12.5	11.3	9.0	1.0	68.0
N(Other Type Train/Day)	5.7	10.3	1.0	0.0	92.0
Station-City Center(Km)	13.8	9.4	11.4	1.0	82.3

Table 2: Number of Products Available in Each Group of Markets

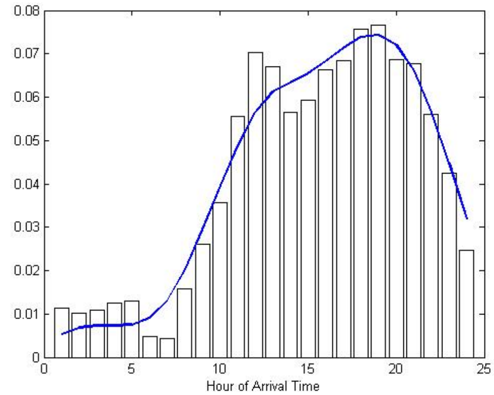
		Data in 2002			Data in 2006		
		(1)	(2)	(3)	(4)	(5)	(6)
		Group 1	Group 2	Group 3	Group 1	Group 2	Group 3
N(City Pairs)		107	330	644	108	330	676
KTX	N	-	-	-	108	-	-
	Mean	-	-	-	14.6	-	-
	Median	-	-	-	8	-	-
	STDEV	-	-	-	19.0	-	-
Sae-ma-eul	N	105	127	257	108	260	246
	Mean	15.9	26.4	4.6	8.4	6.7	7.6
	Median	8	25	4	5	4	5
	STDEV	22.2	18.2	3.4	9.0	8.7	7.3
Mu-gung-hwa	N	107	330	637	107	330	669
	Mean	80.1	62.0	23.3	41.7	31.8	20.5
	Median	50	42	13	32	25	15
	STDEV	76.1	50.9	23.8	33.0	23.1	21.3

N: the number of city pairs in each group where each type of trains is available.

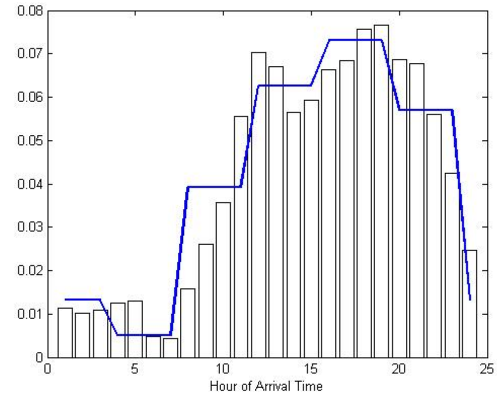
Group 1 : City pairs with high-speed connection

Group 2 : City pairs on high-speed rail lines without available high-speed trains

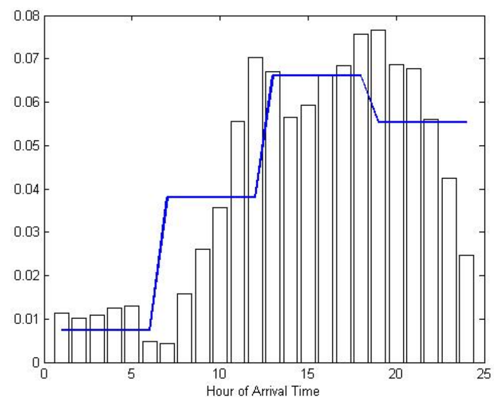
Group 3 : City pairs that are not located along high-speed rail lines



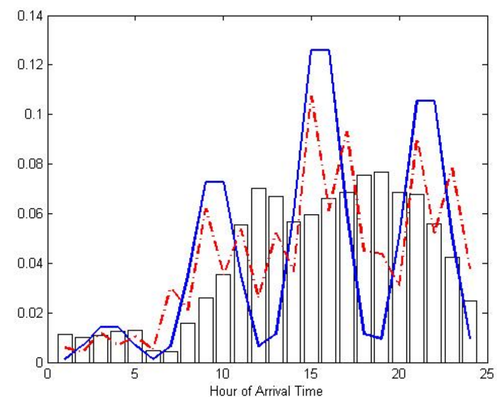
(a) Hourly Ridership and Distribution used in the Estimation



(b) Hourly Ridership and Distribution with 6 Time-Groups and Uniform Distribution



(c) Hourly Ridership and Distribution with 4 Time-Groups and Uniform Distribution



(d) Hourly Ridership and Distribution with 4 Time-Groups and Gaussian, Arbitrary Distribution

Figure 1: Hourly Ridership and Distribution of Travelers' Preferred Time

Table 3: Estimated Coefficients of Demand Model

	(1) Main Model	(2) Without Instruments	(3) OLS
Schedule Delay(Hour)	-0.311***	-4.613***	-
	(0.004)	(0.474)	-
Price(10^3KRW)	-0.115***	-0.113***	-0.118***
	(0.002)	(0.002)	(0.002)
N(Own Type Train)	0.056***	0.058***	0.056***
	(3.0E-4)	(3.2E-4)	(2.7E-4)
N(Other Type Train)	0.015***	0.017***	0.014***
	(2.4E-4)	(2.8E-4)	(2.8E-4)
Station-City Center	-0.069***	-0.071***	-0.067***
	(2.9E-4)	(3.0E-4)	(2.6E-4)
I(KTX)	-1.240***	-1.262***	-1.204***
	(0.029)	(0.032)	(0.033)
I(Sae-ma-eul)	-0.434***	-0.502***	-0.348***
	(0.017)	(0.018)	(0.018)
I(KTX)*Distance	0.017***	0.015***	0.017***
	(3.4E-4)	(3.8E-4)	(3.8E-4)
I(Sae-ma-eul)*Distance	0.008***	0.007***	0.008***
	(1.7E-4)	(1.8E-4)	(1.9E-4)
I(KTX)*Distance^2	-8.8E-6***	-6.5E-6***	-8.8E-6***
	(8.4E-7)	(9.2E-7)	(9.1E-7)
I(Sae-ma-eul)*Distance^2	-6.2E-6***	-4.5E-6***	-7.1E-6***
	(4.3E-7)	(4.6E-7)	(4.7E-7)
Distance	0.011***	0.010***	0.011***
	(2.4E-4)	(2.4E-4)	(2.2E-4)
Distance^2	-2.1E-5***	-2.1E-5***	-2.1E-5***
	(6.3E-7)	(6.2E-7)	(5.6E-7)
Constant	-8.872***	-7.030***	-9.187***
	(0.036)	(0.029)	(0.020)
R^2	0.578	0.584	0.536
City Pair FE	YES	YES	YES

N=392,459; N(Markets)=13,347; N(City Pairs)=1,114

***Significant at p=0.01;**Significant at p=0.05;*Significant at p=0.1

Table 4: Changes of Consumer Surplus Per Person Across Markets(10^3KRW)

			(1)	(2)	(3)
			Group 1	Group 2	Group 3
	N(City Pairs)		107	330	615
Panel A	Price change	Mean	0.54	0.33	0.96
		Median	-0.18	-0.39	0.23
		STDEV	1.44	1.42	1.82
	Add KTX	Mean	5.64	0.00	0.00
		Median	3.65	0.00	0.00
		STDEV	5.46	0.00	0.00
	Remove Trains	Mean	-6.20	-13.81	-1.62
		Median	-5.74	-13.09	-1.66
		STDEV	4.04	8.42	12.42
	Add Trains	Mean	1.71	2.47	3.93
		Median	0.87	0.68	2.26
		STDEV	2.16	7.06	11.38
	Reallocate Trains	Mean	2.29	2.52	2.16
		Median	1.91	1.40	1.56
		STDEV	3.79	3.87	4.67
	Total Effect	Mean	3.98	-8.50	5.43
		Median	3.74	-10.68	3.01
		STDEV	7.81	11.41	8.07

Panel A is based on the estimates shown in Column (1) of Table 3
Group 1 : City pairs with high-speed connection
Group 2 : City pairs on high-speed rail lines without available high-speed trains
Group 3 : City pairs that are not located along high-speed rail lines

Table 5: Change of Consumer Surplus Across Markets(10^6 KRW)

			(1)	(2)	(3)
			Group 1	Group 2	Group 3
	N(City Pairs)		107	330	615
Panel A	Price change	Mean	-400.29	120.38	359.80
		Median	-79.15	-65.07	67.78
		STDEV	2136.95	1336.25	1525.64
	Add KTX	Mean	9930.24	0.00	0.00
		Median	1359.58	0.00	0.00
		STDEV	22579.08	0.00	0.00
	Remove Trains	Mean	-6317.17	-9868.11	-1106.28
		Median	-1879.11	-4427.52	-578.20
		STDEV	11722.20	19636.37	11437.76
	Add Trains	Mean	1790.29	1274.05	3079.74
		Median	333.52	217.88	672.13
		STDEV	3870.33	3994.22	12537.64
	Reallocate Trains	Mean	-683.35	1333.59	1262.32
		Median	562.99	438.95	455.32
		STDEV	4782.99	2850.51	5191.70
	Total Effect	Mean	4319.72	-7140.08	3595.59
		Median	1340.29	-2668.40	833.82
		STDEV	16219.36	19151.81	7673.53

Panel A is based on the estimates shown in Column (1) of Table 3
Group 1 : City pairs with high-speed connection
Group 2 : City pairs on high-speed rail lines without available high-speed trains
Group 3 : City pairs that are not located along high-speed rail lines

Table 6: Gross Change of Consumer Surplus in Each Group of Markets(10^9 KRW)

		(1)	(2)	(3)	
		Group 1	Group 2	Group 3	National Gross
	N(City Pairs)	107	330	615	1052
Panel A	Price change	-42.83	39.73	221.28	218.17
	Add KTX	1062.54	0.00	0.00	1062.54
	Remove Trains	-675.94	-3256.47	-680.36	-4612.77
	Add Trains	191.56	420.44	1894.04	2506.04
	Reallocate Trains	-73.12	440.08	776.33	1143.30
	Total Effect	462.21	-2356.23	2211.29	317.27

Panel A is based on the estimates shown in Column (1) of Table 3

Group 1 : City pairs with high-speed connection

Group 2 : City pairs on high-speed rail lines without available high-speed trains

Group 3 : City pairs that are not located along high-speed rail lines

References

Ben-Akiva, M. E. (1973). *Structure of passenger travel demand models* (Unpublished doctoral dissertation). Department of Civil Engineering, MIT, Cambridge, MA.

Berry, S. (1994). Estimating discrete-choice models of product differentiation. *Rand journal of economics*, *25*(2), 242-262.

Berry, S., Carnall, M., & Spiller, P. (2006). Airline hubbing, costs and demand. In D. Lee (Ed.), (Vol. vol1. Competition Policy and Anti-Trust, p. 183-214). Elsevier Press.

Berry, S., & Jia, P. (2010, August). Tracing the woes: An empirical analysis of the airline industry. *American Economic Journal: Microeconomics*, *2*(3), 1-43.

Berry, S., Levinsohn, J., & Pakes, A. (1995). Automobile prices in market equilibrium. *Econometrica*, *60*(4), 889-917.

Douglas, G. W., & Miller, J. C. (1974). Quality competition, industry equilibrium, and efficiency in the price-constrained airline market. *The American Economic Review*, *64*(4), 657-669.

Eizenberg, A. (2011). Upstream innovation and product variety in the u.s. home pc market. *SSRN Working Paper Series*.

Gabszewicz, J. J., Shaked, A., Sutton, J., & Thisse, J.-F. (1986). Segmenting the market: The monopolist's optimal product mix. *Journal of economic theory*, *39*, 273-289.

Hausman, J. (1996). The economics of new goods. In T. F. Bresnahan & R. J. Gordon (Eds.), . University of Chicago Press.

Ho, K. (2006). The welfare effects of restricted hospital choice in the u.s. medical care market. *Journal of Applied Econometrics*, *21*, 1039– 1079.

Koppelman, F. S. (2006). Handbook of transport modeling. In D. A. Hensher & K. J. Button (Eds.), (chap. Closed Form Discrete Choice Models). Elsevier Science Ltd.

Koppelman, F. S., Coldren, G. M., & Parker, R. A. (2008). Schedule delay impacts on air-travel itinerary demand. *Transporation Research Part B*, *42*, 263-273.

McFadden, D. (1973). Frontiers of econometrics. In P. Zarembka (Ed.), (p. 105-142). Academic Press.

Miller, J. C. (1972). A time of day model for aircraft scheduling. *Transportation Science*, *6*(3), 221-246.

Nevo, A. (2000). A practitioner's guide to estimation of random coefficients logit models of demand. *Journal of economics & management strategy*, *9*(4), 513-548.

Nevo, A. (2003). New products, quality changes, and welfare measures computed from estimated demand systems. *Review of Economics and Statistics*, *85*(2), 266-275.

Petrin, A. (2002). Quantifying the benefits of new products: The case of the minivan. *Journal of political economy*, *110*(4).

Spence, M. (1976). Product selection, fixed costs, and monopolistic competition. *The Review of economic studies*, *43*(2), 217-235.

Train, K. (2009). *Discrete choice methods with simulation* (Second ed.). Cambridge University Press.

Trajtenberg, M. (1989). The welfare analysis of product innovations, with an application to computed tomography scanners. *The journal of political economy*, *97*(2), 444-479.

A Appendix

A.1 Alternative Assumption on Market Size

The numbers of airline passengers for each route within a month and the numbers of rail passengers for each route within a month are accurately observed and provided by Korea Airports Corporation(KAC) and Korail respectively.

I did not observe the number of inter-city bus passengers and auto travelers for each route, which I did for domestic flights. Instead, I took the monthly-aggregated numbers of inter-city bus passengers throughout the country from the Statistical Yearbook of Land, Transport & Maritime Affairs, and combined them with the numbers of households per city from from Korean Statistical Information Service, KOSIS to infer the number of travelers using inter-city buses or cars. First, to allow disaggregation of the numbers of bus passengers at the city-pair level, I imposed two assumptions: i) inter-city buses are available between all pairs of cities ii) the number of passengers is proportional to the geometric average of two respective cities' populations. [35][36] Assumption (ii) implies that the percentage of travelers using buses among the geometric average of two cities population is constant for all the city pairs.[37] Second, I inferred the number of auto travelers using the geometric averages of the number of cars owned in the two respective cities.

The assumptions discussed above are very limiting, and they may be unrealistic since the geometric averages of populations might not have a strong linear relationship with the respective numbers of bus travelers. It is also true that the proportion of bus travelers in a given market mt, among all bus travelers in period t, only depends on the populations of two cities', although other factors such as distance between two cities or convenience of bus connection could also be important. Similarly, the number of cars owned might not have a strong linear relationship with the number of car travelers when considering all routes. I imposed these assumptions and use the sum of the monthly aggregated number of rail

[35] Data used in the estimation covers 86 cities and there are more than 150 bus terminals throughout the country.

[36] obtained from Korean Statistical Information Service, KOSIS

[37] number of travelers using bus in $mt =$
(number of travelers using bus throughout the country in t) $\times \frac{\text{geometric average of two cities population in } mt}{\sum_m \text{geometric average of two cities population in } mt}$

and airline passengers for each route, bus travelers disaggregated at city pair level and auto travelers constructed above as the market size for the secondary specification.

A.2 Robustness

In addition to the main analysis that allows travelers to choose to forego travel, I imposed an alternative assumption that do not allow travelers to choose to forego travel. This experiment analyzes how the results vary with the assumption on the market size, and differs from the main analysis in that now the benefits from the introduction of high-speed train are limited to only travelers and not non-travelers. Unlike the definition used in the main specification, the set of outside alternatives is composed of bus, car and domestic flight. Thus, the market size of outside alternatives is calculated by adding the numbers of rail passengers, airline passengers, bus passengers and auto travelers.[38] Using the inferred market size, I compared the changes in consumer surpluses in this specification to those calculated in the main specification, in which the model allows non travelers to switch to traveling by trains.

To examine how robust the results are, this paper considers several different distributions of h^i, based on several assumptions about the distribution of travelers' preferences over travel schedule. I am concerned with the possibility that hourly ridership might distort the distribution of h^i due to train schedules. For example, consider a hypothetical situation where a consumer wants to travel at 10 AM using a Sae-ma-eul train, but there is no such train available. Suppose he has the options of waiting until 12 PM, or taking a KTX train at a higher price. If he chose to wait until 12 PM instead paying the higher price, he would be counted as a consumer whose preferred time is 12 PM instead of 10 AM. To examine how robust the results are, this paper considers several different distributions of h^i.

To consider this issue, I first exploit the conjecture that travelers would travel at times around their preferred time of day, then I combine that with another distributional assumption. Specifically, I partition a set of the 24 numbers(denoted by B) into four groups(denoted

[38] I describe how I calculate the numbers in Section A.1.

by B_g, $g = 1, \cdots, 4$) that can be interpreted as Morning, Daytime, Evening, and Night.[39] [40][41] I construct a proxy for the proportion of travelers whose preferred time of day belongs to each time group using actual data. Note that this does not violate the assumption that each traveler would travel at a time that is close to their most preferred time, as I used in the main specification.

In order to take the effects of train availability on the distribution into account, and in attempt to reduce those effects, I assumed a uniform distribution within each time-group(B_g). By extension, this assumption implies that h^i is uniformly distributed within time-group(B_g) but also the train availability induces the observed hourly ridership.[42] Therefore, $\text{Prob}(h^i \in B_g) = \sum_{\tau \in B_g} \phi_{\tau m}$ in each city pair m is replaced with the proportion of rail passengers in a city-pair m traveling at time $\tau \in B_g$, and the same number of travelers are located at each point within B_g by assumption. Hence, $\phi_{\tau m}$, the proportion of travelers who prefer to travel at during time period τ, is replaced with $w_{\tau m}$ such that

$$\begin{aligned} \sum_{\tau \in B_g} w_{\tau m} &= \frac{\sum_t \sum_{j \in J_{mt}^{B_g}} q_{jmt}}{\sum_t \sum_{j \in J_{mt}} q_{jmt}}, \quad \text{and} \\ w_{\tau m} &= \text{Prob}(h^i = \tau | h^i \in B_g) \cdot \sum_{\tau \in B_g} w_{\tau m} \end{aligned} \tag{7}$$

where $J_{mt}^{B_g}$ is a set of available trains in a market mt whose schedule belongs to B_g, and q_{jmt} is the number of passengers purchasing j.[43] $\text{Prob}(h^i = \tau | h^i \in B_g)$ is the distributions within time-group.[44]

Figure 1 shows the mean of the percentage of rail travelers who travel within an hour across city pairs(with bars) and the mean of proxies(with lines) for the distribution of travelers' preferred travel times under the different assumptions of the time group distribu-

[39]Thus, it satisfies $B_g \cap B_{g'} = \emptyset$ for any $g \neq g'$, and $B = \cup_{g=1}^{4} B_g$.

[40]The partition is defined based on the observation of actual train schedule. The four groups are defined as 6:00-12:00, 12:00-18:00, 18:00-24:00, and 24:00-6:00 respectively.

[41]This paper experiments different partitions with the length of interval as 4 hours instead of 6 hours, thus the 24 numbers are partitioned into 6 groups- 3:00 7:00, 7:00 11:00, 11:00 15:00 15:00 19:00 19:00 23:00, and 23:00 3:00.

[42]In addition to uniform distribution, I apply Gaussian distribution centered at the median of each time-group and a randomly chosen arbitrary distribution.

[43]In other words, $J_{mt}^{B_g} = \{j \in J_{mt} | a_{jmt} \in B_g\}$

[44]When uniform distribution is assumed for the distribution within time-group, $\text{Prob}(h^i = \tau | h^i \in B_g) = 1/(\text{length of } B_g)$.

tion. Figure 1(b) and Figure 1(c) show the distribution of h^i based on six time-groups and four time-groups, respectively, combined with the uniform-distribution regarding the within time-group distributions. 1(d) display the mean of two different proxies based on the four time-groups, one using a Gaussian(with solid line) and an arbitrary distribution(with dashed line) for the within time-group distribution. The results under these assumptions is discussed in Section A.3.

A.3 Alternative Specifications

Tables 7, 8 and 9 provide the results under alternative assumptions. Table 7 provides the coefficients estimated under alternative assumptions and Table 9 compares the respective changes in consumer welfare.

Column (1) of Table 7, Table 8 and Panel A of Table 9 show the results under the assumption that does not allow non-travelers to travel. Panel A of Table 8 shows the heterogeneous impacts all normalized to be per person on consumers in each of the three groups. Panel B of Table 8 summarizes the expected consumer surplus changes in each market, taking into consideration market sizes and the magnitudes of impact per person. Panel A of Table 9 displays the nationwide total changes in consumer welfare resulting from each of the five different sources. The per-person impacts from each source(shown in Panel A of 8) are similar shown in Panel A of Table 4, whether consumers are allowed to forego travel or not. However, the changes of consumer surplus *per market* reflected in Panel B of 8 are different from those in Table 5 despite the similar magnitudes of per-person impact. Moreover, the nationwide total effect became negative because these results are based on the assumption that the changes in consumer surplus from the introduction of high-speed trains are limited to travelers and the estimated changes are understated. One general conclusions to be made regardless of the assumed market size, is that the gains from high-speed trains introduction are not as substantial as superficially anticipated due to the losses resulting from the reduced schedule frequency in Group 2. These results highlight the importance of accounting for changes in existing products when analyzing the impact of new product entry on consumers.

Table 7 provides the coefficients estimated under alternative assumptions and Table 9 compares the respective changes in consumer welfare. Column (2) presents the results from the specification that use departure time instead of arrival time. Therefore, travel time of day a_{jmt} is hour of product j's departure time, and preference of travel schedule h^i is also defined over departure time. Column (3)-(6) of Table 7 and Panels B-E of 9 present the results from the specification that adopts $w_{\tau m}$ shown in (7) as a proxy for the distribution of h^i. Column (3) and Panel B assume that B is partitioned into 6 time groups with 4-hour intervals as defined in A.2 and h^i is uniformly distributed within each time-group. Columns (4),(5) and (6) and Panels C, D and E assume that B is partitioned into 4 time groups with 6-hour intervals as defined in A.2 with different within-group distributional assumptions for h^i. Column (4) and Panel C utilizes a uniform distribution, and Column (5) and Panel D use a normal distribution centered at the median of each time-group. Column (6) and Panel E employ a randomly-chosen arbitrary distribution, which is shown in Figure 1(d). Since most of the losses resulting from schedule changes are due to the reduced number of scheduled trains and not due to reallocations, the implications regarding consumer welfare are still consistent with the findings from the main specification. They are robust across the assumptions on the distribution of h^i.

Table 7: Estimated Coefficients of Demand Model under Alternative Distribution of h^i

	(1)	(2)	(3)	(4)	(5)	(6)
Distribution of h^i	Kernel	Kernel				
N(Time-groups)	N\A	N\A	6 Time-Groups	4 Time-Groups	4 Time-Groups	4 Time-Groups
Within Group Distribution	N\A	N\A	Uniform	Uniform	Gaussian	Arbitrary
Schedule Delay(Hour)	-0.322***	-0.329***	-0.361***	-0.480***	-0.497***	-0.481***
	(0.004)	(0.004)	(0.005)	(0.008)	(0.009)	(0.008)
Price(10^3KRW)	-0.106***	-0.114***	-0.115***	-0.115***	-0.114***	-0.115***
	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)	(0.002)
N(Own Type Train)	0.057***	0.056***	0.057***	0.057***	0.058***	0.057***
	(3.0E-4)	(3.0E-4)	(3.0E-4)	(3.0E-4)	(3.1E-4)	(3.0E-4)
N(Other Type Train)	0.016***	0.015***	0.015***	0.015***	0.015***	0.015***
	(2.4E-4)	(2.4E-4)	(2.4E-4)	(2.4E-4)	(2.5E-4)	(2.4E-4)
Station-City Center	-0.068***	-0.069***	-0.069***	-0.069***	-0.069***	-0.069***
	(2.9E-4)	(2.9E-4)	(2.9E-4)	(2.9E-4)	(3.0E-4)	(2.9E-4)
I(KTX)	-1.259***	-1.241***	-1.236***	-1.240***	-1.231***	-1.242***
	(0.029)	(0.029)	(0.030)	(0.030)	(0.030)	(0.030)
I(Sae-ma-eul)	-0.466***	-0.435***	-0.417***	-0.408***	-0.369***	-0.406***
	(0.017)	(0.017)	(0.017)	(0.017)	(0.018)	(0.017)
I(KTX)*Distance	0.016***	0.016***	0.016***	0.016***	0.016***	0.016***
	(3.4E-4)	(3.4E-4)	(3.4E-4)	(3.5E-4)	(3.5E-4)	(3.5E-4)
I(Sae-ma-eul)*Distance	0.008***	0.008***	0.008***	0.008***	0.008***	0.008***
	(1.7E-4)	(1.7E-4)	(1.7E-4)	(1.7E-4)	(1.8E-4)	(1.7E-4)
I(KTX)*Distance2	-9.1E-6***	-8.3E-6***	-8.6E-6***	-8.3E-6***	-7.9E-6***	-8.2E-6***
	(8.2E-7)	(8.3E-7)	(8.4E-7)	(8.4E-7)	(8.6E-7)	(8.4E-7)
I(Sae-ma-eul)*Distance^2	-6.7E-6***	-6.1E-6***	-6.1E-6***	-6.1E-6***	-6.3E-6***	-6.1E-6***
	(4.4E-7)	(4.3E-7)	(4.4E-7)	(4.4E-7)	(4.5E-7)	(4.4E-7)
Distance	0.010***	0.011***	0.011***	0.011***	0.011***	0.011***
	(2.4E-4)	(2.4E-4)	(2.4E-4)	(2.4E-4)	(2.5E-4)	(2.4E-4)
Distance^2	-2.1E-5***	-2.1E-5***	-2.1E-5***	-2.1E-5***	-2.0E-5***	-2.0E-5***
	(6.3E-7)	(6.4E-7)	(6.3E-7)	(6.3E-7)	(6.4E-7)	(6.3E-7)
Constant	-7.306***	-8.834***	-8.750***	-8.476***	-8.440***	-8.472***
	(0.036)	(0.036)	(0.036)	(0.038)	(0.039)	(0.038)
R^2	0.573	0.578	0.580	0.577	0.568	0.575
City Pair FE	YES	YES	YES	YES	YES	YES

In all the specifications above except (1), a market is consist of travelers and non-travelers.
In all the specifications above except (2), travel time preference is defined over arrival time.
In Column (2), it is defined over departure time
N=392,459; N(Markets)=13,347; N(City Pairs)=1,114
***Significant at p=0.01;**Significant at p=0.05;*Significant at p=0.1

Table 8: IF non-travelers are excluded from the consideration

			(1)	(2)	(3)
			Group 1	Group 2	Group 3
	N(City Pairs)		107	330	615
Changes of Consumer Surplus Per-Person Across Markets(10^3 KRW)					
Panel A	Price change	Mean	0.54	0.33	0.96
		Median	-0.18	-0.39	0.23
		STDEV	1.44	1.42	1.82
	Add KTX	Mean	6.22	0.00	0.00
		Median	4.03	0.00	0.00
		STDEV	6.03	0.00	0.00
	Remove Trains	Mean	-6.79	-15.20	-2.14
		Median	-6.23	-14.36	-1.82
		STDEV	4.43	8.82	11.21
	Add Trains	Mean	1.87	2.75	4.66
		Median	0.95	0.75	2.49
		STDEV	2.36	7.21	10.71
	Reallocate Trains	Mean	2.41	2.75	2.40
		Median	2.04	1.50	1.73
		STDEV	4.23	4.23	4.72
	Total Effect	Mean	4.24	-9.36	5.89
		Median	4.08	-11.83	3.27
		STDEV	8.59	12.49	8.81
Change of Consumer Surplus Across Markets(10^6 KRW)					
Panel B	Price change	Mean	-57.74	35.09	59.61
		Median	-13.21	-10.39	11.89
		STDEV	310.35	239.03	249.15
	Add KTX	Mean	1887.60	0.00	0.00
		Median	236.08	0.00	0.00
		STDEV	4286.02	0.00	0.00
	Remove Trains	Mean	-1119.94	-1842.63	-230.97
		Median	-344.91	-804.49	-97.34
		STDEV	2173.30	4066.60	1850.27
	Add Trains	Mean	373.02	215.18	494.61
		Median	59.87	35.96	120.20
		STDEV	858.81	687.04	1912.64
	Reallocate Trains	Mean	-207.59	219.79	228.43
		Median	85.57	75.17	75.89
		STDEV	1082.54	524.21	840.52
	Total Effect	Mean	875.35	-1372.56	551.68
		Median	224.52	-496.24	141.45
		STDEV	3313.28	3978.88	1109.29

Panels A and B are based on the estimates shown in Column (2) of Table 7
Group 1 : City pairs with high-speed connection
Group 2 : City pairs on high-speed rail lines without available high-speed trains
Group 3 : City pairs that are not located along high-speed lines

Table 9: Change of Consumer Surplus in Each Group of Markets(10^9 KRW)

		(1) Group 1	(2) Group 2	(3) Group 3	National Gross
Panel A	Price change	-6.18	11.58	36.66	42.06
	Add KTX	201.97	0.00	0.00	201.97
	Remove Trains	-119.83	-608.07	-142.05	-869.95
	Add Trains	39.91	71.01	304.19	415.11
	Reallocate Trains	-22.21	72.53	140.48	190.80
	Total Effect	93.66	-452.95	339.28	-20.00
Panel B	Price change	-42.74	39.74	220.67	217.68
	Add KTX	1072.59	0.00	0.00	1072.59
	Remove Trains	-681.41	-3299.42	-688.46	-4669.29
	Add Trains	193.48	434.63	1949.32	2577.43
	Reallocate Trains	-72.51	464.37	836.58	1228.44
	Total Effect	469.41	-2360.68	2318.11	426.84
Panel C	Price change	-42.88	39.68	219.18	215.99
	Add KTX	1086.82	0.00	0.00	1086.82
	Remove Trains	-686.53	-3350.46	-718.88	-4755.87
	Add Trains	196.25	467.69	2116.00	2779.94
	Reallocate Trains	-66.38	517.71	915.54	1366.88
	Total Effect	487.29	-2325.38	2531.84	693.75
Panel D	Price change	-42.74	39.65	219.34	216.24
	Add KTX	1079.29	0.00	0.00	1079.29
	Remove Trains	-686.33	-3362.60	-728.49	-4777.42
	Add Trains	198.34	456.26	2126.00	2780.60
	Reallocate Trains	-74.86	489.85	901.31	1316.30
	Total Effect	473.69	-2376.84	2518.16	615.00
Panel E	Price change	-42.93	39.69	218.99	215.75
	Add KTX	1083.39	0.00	0.00	1083.39
	Remove Trains	-684.86	-3344.87	-715.69	-4745.41
	Add Trains	196.15	462.47	2110.71	2769.32
	Reallocate Trains	-66.99	513.11	911.36	1357.48
	Total Effect	484.77	-2329.59	2525.35	680.53

Panel A is based on the estimates shown in Column (1) of Table 7
Panel B is based on the estimates shown in Column (3) of Table 7
Panel C is based on the estimates shown in Column (4) of Table 7
Panel D is based on the estimates shown in Column (5) of Table 7
Panel E is based on the estimates shown in Column (6) of Table 7
Group 1 : City pairs with high-speed connection
Group 2 : City pairs on high-speed rail lines without available high-speed trains
Group 3 : City pairs that are not located along high-speed rail lines

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