Crowding and Consumer Welfare in the Swedish Light Lager Market

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March 19, 2012

Abstract

I estimate consumer welfare gains from the entry of new products in the Swedish market for light lager beers by estimating a structural demand model using bar-code level data provided by the Swedish alcohol retail monopoly. Following Ackerberg and Rysman (2005), I explicitly allow for crowding in the product space as new varieties enter. I find strong evidence for crowding effects. My results suggest that consumers do not value new goods *per se*; the love-for-variety effect is absent. Further inspection of the entering and exiting products suggests that entrants on average provide consumers with higher utility than exiting lagers. In a methodological contribution, I show that following the commonly accepted practice of determining the relevant market outside of the demand estimation can be misleading. A positive correlation between net entry and total consumer welfare can simply be spurious and does not necessarily imply that entry raises welfare. My findings regarding the benefits of new varieties are robust to this concern.

JEL classification: D6, L10, L66

Keywords: structural demand estimation, crowding, consumer welfare, beer, entry and exit

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1 Introduction

The introduction of new varieties is a central feature of differentiated goods markets. Whether such novel products contribute to an increase in consumer welfare has been of strong interest in the existing literature (Berry and Waldfogel (1991), Petrin (2000), Goolsbee and Petrin (2004)). In many cases, previous findings are based on logit-type structural models of demand that allow to estimate changes in consumer welfare as new product varieties enter the market.

This paper directly deals with an undesirable feature of the functional form of logit demand. Imposing logit-type preferences on consumers ensures that consumers value goods as such and are thereby willing to pay for having more choice (as in Dixit-Stiglitz preferences, love-for-variety effect). In the standard logit model, however, consumers' willingness to pay for having the choice among more products drives down consumers' willingness to pay for better quality products, as the number of varieties in the market increases. Imposing this counterintuitive pattern on the data solely by functional form threatens the credibility of welfare estimates.

Ackerberg and Rysman (2005) develop a modification of the logit model that allows for a decreasing willingness to pay for more choice as the number of varieties increases (product space congestion or crowding). Contrary to alternative approaches (Berry and Pakes (2007), Bajari and Benkard (2005)), the modification is easily implemented for markets with a large number of products.

Methodologically, I analyze how predictions of changes in consumer welfare in response to entry differ between a demand model adjusting for crowding effects and a demand model that does not. At one extreme, a pure congestion model eliminates the love-for-variety effect, while a logit model maximizes the impact of changes in the number of products on welfare. The difference between the two models is how the change in welfare is allocated between two components: consumers' monetary valuation of new varieties entering the market and consumers' willingness to pay for the average mean utilities of the available products (quality). I show that in-sample both types of models make exactly the same predictions about the rate of change of total consumer welfare. This is based on the commonly accepted practice of defining the market's potential outside of the demand model and the fact that consumer welfare is simply a transformation of the outside good's market share.

In a novel decomposition of consumer welfare in the framework of Ackerberg and Rysman (2005), I relate the share of the outside good and the number of products to the two components of consumer welfare. Then, in the logit model, all else equal, a fall of the outside good's market share and an increase in the number of products raises consumer welfare. In the pure congestion model, a reduction in the share of the outside good is sufficient to yield the same outcome. Thus, if the entry of new products is associated with a decrease in the share of the outside good, both models predict that consumers gain. This finding is robust across the logit and pure congestion models.

Even though economically intuitive, I caution that this reasoning can be misleading. As is common practice in the literature, I define the market's potential size outside of the demand estimation. Put differently, the share of the outside alternative is not jointly estimated with the structural demand parameters. A positive correlation between net entry and consumer welfare can therefore be spurious.

To address this concern, I use my analytical welfare decomposition to derive deterministic relationships between the estimated and directly observed components of each model. Changes in the number of varieties and the share of the outside good are observed directly, while consumers' willingness to pay for the size and quality of their choice set are estimated. In the pure congestion model, the share of the outside good and consumers' willingness to pay for quality are perfectly negatively correlated. While in the standard logit model, consumers' willingness to pay for having more choice is perfectly positively correlated with the number of varieties in the market. These deterministic relationships hold for the aggregate market and not necessarily for individual or groups of products. I therefore disaggregate the market into groups of incumbents, entrants and exiting varieties and compare how closely the estimated welfare components for each of these groups conforms to the aggregate relationship with the share of the outside good and observed net entry.

The methodological upshot of the paper is that it is desirable to jointly estimate the market share of the outside alternative with the structural demand parameters. This could alleviate concerns that entry and consumer welfare are spuriously correlated by the exogenous delineation of the relevant market.

Empirically, I add to the few papers (Mariuzzo et al. (2010)) that use the framework of Ackerberg and Rysman (2005) to assess the empirical importance of crowding effects in a market with many differentiated products. The Swedish market for light lagers provides a good testing ground, because a liberalization of market access in the wake of Sweden entering the European Union's common market in 1995 has resulted in a rapid increase of the number of lagers available to Swedish retail customers.

Indeed, I find strong evidence for substantial crowding effects in the Swedish light lager market. The estimation results suggest that the market is best described by a pure congestion model, where consumers do not value additional goods *per se*. In other words, the love-for-variety effect is absent.

Nevertheless, consumers are still willing to pay for higher quality beers. I find that exiting lagers provide the representative consumer with less utility than newly introduced lagers. This effect is strongly driven by entering lagers having lower prices than the beers that exit the market, while offering similar non-price characteristics. Net entry is therefore beneficial to consumer welfare. Moreover, I can dispel concerns that this finding is the artifact of a spurious correlation between changes in the number of varieties and changes in the share of the outside good.

For both the logit and pure congestion models, the welfare estimates for the group of

entering beers are least influenced by movements in the observable changes in the number of lagers and the share of the outside good. It is therefore unlikely that the positive effect of entry on consumer welfare is a product of the functional form of the estimator.

The remainder of the paper is structured as follows. Section 2 presents some stylized facts about the Swedish light lager market. Section 3 outlines the advantages of the approach by Ackerberg and Rysman (2005) over alternative demand models allowing for crowding for the data at hand. The demand model and the relationship between its observable and estimated components are analyzed in detail. Section 4 presents the outcomes of the demand estimation and its implications for consumer welfare. Section 5 analyzes the relation between the entry and exit of lagers and consumer welfare. Section 6 concludes.

2 The Swedish Market for Light Lagers

I use nationwide monthly retail sales data at the bar-code level provided by Systembolaget, the Swedish retail monopoly for alcohol. The sample covers the period from January 1996 to December 2004. I only observe sales of beers (liters and revenue in Swedish krona) with a minimum alcohol content of 3.5 % of volume. Beers with a lower alcohol content can be purchased in regular supermarkets and these sales are not covered by the data. I use the terms a lager and a product interchangeably. Heineken in a .33 liter bottle is an example of a lager.

On average almost 9.5 million liters of light lager beer are sold monthly during the sample period. This corresponds to average monthly sales of 274 million Swedish krona. In terms of sales of all types of beer[1], light lagers capture between 93 and 97 percent of total revenue and liters sold. Moreover, the number of light lagers tracks the total number of beers sold by Systembolaget very well. I therefore focus on the light lager segment and drop the other types of beer.

Before the beginning of 1995, the Swedish market for alcohol was characterized by two monopolies. Vin & Sprit[2] owned the monopoly on the production, import, export and wholesaling of alcohol, while Systembolaget owned the monopoly for sales of alcohol to restaurants and the retail monopoly.

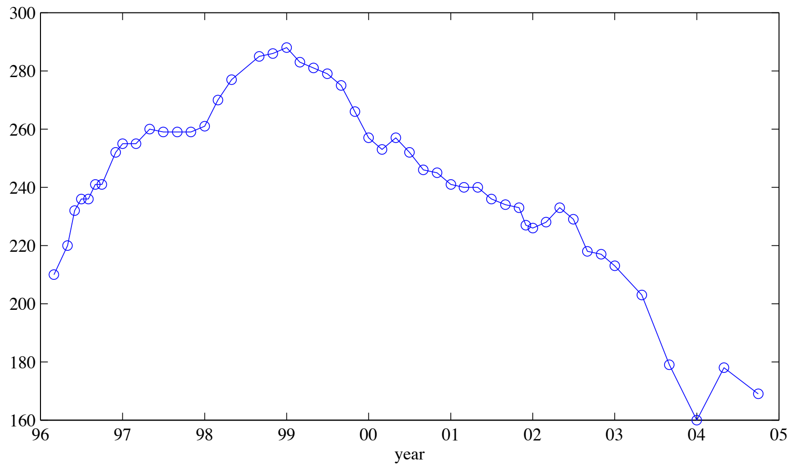
On the first of January 1995, however, Sweden joined the European Union (EU) and its common market. The European Commission ruled that the monopolies owned by Vin & Sprit and Systembolaget are not compatible with the common market and have to be abandoned upon Sweden's entry to the EU. As the Swedish government views the consumption of alcohol as a potential hazard to the public's health, however, it was allowed to let Systembolaget retain its retail monopoly for alcohol. All other monopolies

[1] There are also ales, dark lagers, spontaneously fermented beers, special beers such as Christmas beers, stouts and weissbeers on sale.

[2] Outside of Sweden, Vin & Sprit is probably best known for its Absolut Vodka brand. On the 31st of March, 2008, the Swedish government eventually sold the company to Pernod Ricard for 55 billion Swedish krona

had to be abandoned. One of the consequences was that Vin & Sprit no longer had control over which product is allowed to enter the market. For the Swedish light lager market this led to a rapid rise in the number of products available for sale in the retail outlets of Systembolaget until the beginning of 1999. Figure 1 plots the number of available varieties over the sample period.

Figure 1: The Number of Light Lagers for Sale During the Sample Period



Initially, the number of light lagers on offer increases by almost forty percent from January 1996 to January 1999. A period of consolidation follows until May 2002 in which the number of products is reduced by roughly twenty percent. During the remaining months of the sample, the pace of product reductions quickens substantially as the lagers on offer are reduced by almost another thirty percent. Given the substantial variation in the number of products and the rapid initial increase at the beginning of the sample, that is likely due to the liberalization of market entry, the Swedish light lager data should provide a good testing ground for the extent and relevance of crowding effects in a market with a very large number of differentiated products.

Before I move on to the description of the demand model, I have to mention that Systembolaget publishes the range of products that can be bought in its retail outlets in regular intervals in freely available catalogs. It enforces the rule that prices can only be changed and entry and exit of products can only take place when a new catalog is published. Thus, in the periods in-between catalog issues, prices and the number of products are held fixed. Ackerberg and Rysman (2005) caution that when including such periods, I would effectively be attempting to identify price elasticities and crowding intensities in these periods without ever observing a price change or entry and exit of products. This can yield biased estimates of the structural demand parameters. I therefore drop the periods in-between catalog issues, which reduces the months in the sample period from 108 to 50. When estimating a logit model with the full and reduced sample, the differences in the point estimates are small, which suggests that the periods in-between issues do not

contain much useful variation.

3 Demand

The inability of standard discrete choice models to capture crowding effects as the number of products increases, is based on the assumption of each individual consumer, i, having a logit-type taste shock for each product j, $_{ij}$. Crucially, these shocks have unbounded support. Bajari and Benkard (2003) investigate the implications of this assumption in a discrete choice model nesting the logit, nested logit, generalized extreme value, and random coefficients logit models. The authors derive two major implications of the logit taste shock assumption as the number of products tends to infinity. First, for any given share of the outside good, consumer welfare rises without bound. Second, individual i's taste shock for product j, $_{ij}$, fully accounts for i's utility derived from purchasing the product, u_{ij}.[3]

The first finding implies that using standard random utility models to analyze the welfare gains from new product introductions is faced with serious limitations. It is unappealing to impose welfare gains from enlarging consumers' choice set, if there already are many products in the market. Given a limited space in which products differentiate, any two closely neighboring products eventually become indistinguishable and consumer utility is unaffected when removing one of the products. This mechanism, however, is absent in standard logit type models of demand.

The second finding implies that estimates of the observable taste coefficients are biased downwards in a market with many products. As the number of products expands, the estimated mapping from product characteristics to consumer utility is becoming less and less relevant for explaining purchasing decisions, until the distributional assumption alone fits the observed pattern of market shares.

In response to these undesirable features of standard discrete choice models, several alternatives have been proposed. Ackerberg and Rysman (2005) allow the mean of the random taste shocks, $_{ij}$, to be a decreasing function of the number of products in the market.[4] This limits both the welfare gains from new product introductions and the role of random taste shocks in accounting for consumer utility. Thereby, the model addresses both of the undesirable features identified by Bajari and Benkard (2003). Moreover, implementing the approach for a market with many products is straightforward.

Berry and Pakes (2007) and Bajari and Benkard (2005) drop the random error terms $_{ij}$ altogether and estimate hedonic models of demand, where consumers have preferences

[3] Bajari and Benkard (2003) go on to identify more unpleasant properties of the logit taste shock assumptio as the number of products becomes very large. For my purposes, however, the above two ndings are the most relevant.

[4] In an appendix to the paper, Ackerberg and Rysman (2005) illustrate that one can also modify the logit-type estimating equations to allow the number of products to alter the variance of the random errors. The implications are very similar.

over a finite set of product characteristics. These approaches are attractive, as their theoretical predictions are "well behaved" as the number of products increases: closely neighboring products eventually become perfect substitutes and welfare gains from enlarging consumers' choice set only stem from the structurally estimated mean utilities of the products. Thereby, the love-of-variety effect is excluded *a priori*.

Given the high number of light lagers in the Swedish beer market, however, these two approaches are difficult to implement. Berry and Pakes (2007) caution that their algorithm used to minimize the distance between the simulated and observed market shares is not guaranteed to converge and equating the model's predicted shares with the actual ones becomes harder as the number of products increases.

The model of Bajari and Benkard (2005) is unattractive for the data at hand, because it is likely to generate counterintuitively large elasticities. Moreover, with few observable product attributes the model tends to yield few strictly positive cross-price elasticities for any product j.

3.1 Demand Model

Following Ackerberg and Rysman (2005), I modify the standard logit framework to allow the mean of consumers' taste shocks, ${}_{ij}$, to decrease with the number of products in the market. Let consumer i's indirect utility from purchasing product j be

$$u_{ijt} = {}_{jt} + {}_{irt}; \quad i = 1; : : : ; I; \quad j = 1; : : : ; J_t; \quad r = 1; : : : ; R_t: \qquad (1)$$

${}_{jt} = x_{jt} \quad - \quad p_{jt} + {}_{jt}$ is product j's mean utility, mapping the observable attributes, x_{jt}, the price, p_{jt}, and the unobservable characteristic, ${}_{jt}$, to consumer utility. Table 1 presents the observable product characteristics included in x_j and their descriptive statistics for the sample period.

Integrating over consumer taste shocks yields the market share of product j.

$$s_{jt} = \frac{R_{jt} \exp({}_{jt})}{R_{ot} \exp({}_{ot}) + \sum_k R_k \exp({}_{kt})} \qquad (2)$$

${}_{ot}$ and R_{ot} denote the mean utility and the crowding term for the outside good. Without detailed information about the outside good, it is common practice to hold its mean utility constant. I follow this practice here and make the normalizations ${}_{ot} = R_{ot} \equiv 0; \forall t$. Moreover, I follow Ackerberg and Rysman (2005) and parameterize R_{jt} as

$$R_{jt} = \quad = \widetilde{J}_t + 1 - \quad : \qquad (3)$$

$\widetilde{J}_t \equiv J_t + 1$ is the number of inside products plus the outside good. This choice ensures that R_{jt} is decreasing in the number of products for positive values of , the crowding parameter. Applying the results of Small and Rosen (1981) and McFadden (1981), the monetary value of consumer welfare is given by

Table 1: Observable Product Characteristics, X

Column	Variable	Mean	[Min,Max]	Std. Dev.
X_1	price per liter	32:09	[15:6; 64:24]	6:46
X_2	richness	5:28	[1; 9]	1:57
X_3	sweetness	2:10	[1; 7]	1:18
X_4	bitterness	6:00	[1; 12]	1:88
X_5	alcohol (% of vol.)	5:38	[4; 10:2]	:95
X_6	advertising (mln SEK)	:13	[0; 13:85]	:76
X_7	.5 liter bottle	:26	[0; 1]	:44
X_8	.33 liter bottle	:36	[0; 1]	:48
X_9	.5 liter can	:34	[0; 1]	:47
X_{10}	entrant	:07	[0; 1]	:26
X_{11}	exiter	:13	[0; 1]	:33
X_{12}	foreign	:38	[0; 1]	:49
X_{13}	constant	1	[1; 1]	0

$$CW_t = (1= \quad) \ln \left[R_{ot} \exp(\quad _{ot}) + \sum_k R_{kt} \exp(\quad _{kt}) \right] + K;$$

where K is an arbitrary constant. Using $R_{jt} = R_t \; \forall t$, $R_{ot} = 1 \; \forall t$, and $\quad _{ot} = 0 \; \forall t$ the expression can be rearranged as follows.

$$CW_t = (1= \quad) \ln(R_t \widetilde{J}_t \bar{\quad}_t) + K;$$

where $\bar{\quad}_t = \widetilde{J}_t^{-1} \left(1{=}R_t + \sum_{j=1}^{J_t} \exp(\quad _{jt}) \right)$ is the average of the exponential mean utilities of both the outside and inside goods. For simplicity, I simply refer to $\bar{\quad}_t$ as the quality of the choice set. Then, consumer welfare can be decomposed into two relevant terms, the monetary values of the size and the quality of consumers' choice set.

$$CW_t = \frac{\ln(R_t \widetilde{J}_t)}{\quad} + \frac{\ln(\bar{\quad}_t)}{\quad} + K \qquad (4)$$

It is now easy to see that (3) has a structural interpretation. For $\quad = 0$, the crowding term equals one and the expression for consumer welfare specializes to that of the standard logit model. For $\quad = 1$, the crowding term equals the reciprocal of the total number of products and the first term on the left-hand side vanishes. Thereby, changes in the number of products have no effect on consumer welfare, and (4) specializes to the pure congestion model.

Due to the arbitrary constant, interpreting the level of consumer welfare is meaningless. Welfare changes over time, however, are independent of K. I define $\Delta X_{t+1} \equiv X_{t+1}{=}X_t$ as the (gross) rate of growth of a variable X. The change in consumer welfare between periods t and $t+1$ is then given by

$$CW_{t+1} - CW_t = \frac{\ln(\Delta R_{t+1}\Delta \widetilde{J}_{t+1})}{} + \frac{\ln(\Delta \bar{\ }_{t+1})}{}:$$

Using (2), changes in consumer welfare can be related to changes in the share of the outside good.

$$\ln(s_{ot}) = -\ln(R_t \widetilde{J}_t \bar{\ }_t)$$

It follows immediately that

$$CW_{t+1} - CW_t = -\ln(\Delta s_{ot+1}) = \ :$$

Combining the two expressions for welfare changes between dates $t+1$ and t yields an identity for the rates of changes of terms that are directly observable and those terms that derive from the structural demand estimation.

$$(\Delta s_{ot+1})^{-1} = \Delta \bar{\ }_{t+1} \Delta \widetilde{J}_{t+1} \Delta R_{t+1} \tag{5}$$

ΔR_{t+1} and $\Delta \bar{\ }_{t+1}$ are determined by the structural demand parameters, while the remaining terms are observed directly. This identity illustrates that in-sample welfare changes predicted by the logit and pure congestion models are perfectly correlated. If both models yield the same estimate of consumers' price sensitivity, even the level of consumer welfare estimates are identical. Given that substantial congestion in product space implies that taste coefficients are biased downwards in the logit model, this outcome is unlikely, however.

In-sample, the difference between the models is how the change in welfare is allocated between the two components of consumer welfare, $\Delta \bar{\ }_{t+1}$ and $\Delta \widetilde{J}_{t+1} \Delta R_{t+1}$. Posing the question "Did the entry of good A raise total consumer welfare?" can therefore yield misleading conclusions, because the answer completely depends on the definition of the relevant market. Typically, the delineation of the relevant market lies outside of the demand model and is taken as given during the estimation of the structural demand parameters. Without certainty that the relevant market has been correctly determined, this creates the possibility that entry of products and fluctuations in the share of the outside good are spuriously related.

To further illustrate the dependence of the two welfare components on the outside good's market share, for small gross rates of growth, (5) can be approximated in terms of the net rates of growth, $g_X = X_{t+1}=X_t - 1$, by noting that $\ln(\Delta X_{t+1}) \approx g_X$.

$$-g_o = g_{\widetilde{J}} + g_R + g_\delta$$

With the structural crowding term (3), this approximation can be specialized to the cases of the logit model and the pure congestion model.

$$g_\delta = \begin{cases} -(g_o + g_{\tilde{J}}) & ; \quad = 0 \\ -g_o & ; \quad = 1 \end{cases}$$

Thus, in the pure congestion model, periods in which the share of the outside good increases (falls) are periods in which the quality of the choice set falls (increases). As ¯ contains the unobservable product characteristics, , the demand estimation's error term is included in the identity (5) and the above approximation. Thus, this relationship between the quality of the choice set and the share of the outside good is deterministic.

For the logit model, a similar relationship holds. The quality of the choice set is predicted to increase (fall), when the sum of the rates of growth of the outside good and the number of products is negative (positive). Holding the share of the outside good constant, it is clear that a rise in the number of products is associated with a fall in quality. The logit model allows a fall in the number of products to compensate for a rise in the share of the outside good. Even as consumers switch to the outside alternative, quality is unaffected, as long as a sufficient number of products exits. In contrast, in the pure congestion model, the number of products is irrelevant. Only the changes in the share of the outside good matter.

When determining the relevant market outside of the demand estimation, one should be aware of the deterministic relationships between the observable and unobservable variables in the demand model. Gauging the impact of a new product on consumer welfare at a time when the outside good's market share is falling will inevitably lead to the conclusion that total welfare is increasing. This result, however, is not necessarily driven by entry but by the definition of the relevant market's size.

I present the estimation framework and results next.

4 Estimation

To arrive at an estimating equation for the crowding model of the previous section, I use the market share equation for product j, (2), and apply the Berry (1994) inversion. This yields the regression specification for an arbitrary crowding term, R_{jt}.

$$\ln(s_{jt}) - \ln(s_{ot}) = X_t \quad - \quad p_t + \quad _t + \ln(R_{jt})$$

I adopt the structural crowding term from Ackerberg and Rysman (2005) and estimate R_{jt} parametrically, as shown in (3). Then, my final estimating equation is given by

$$\ln(s_{jt}) - \ln(s_{ot}) = x_{jt} \quad - \quad p_{jt} + \ln(\; = J_t + 1 - \quad) + \quad _{jt}: \qquad (6)$$

4.1 Instruments

The unobservable product characteristic $_{jt}$ has a vertical interpretation in the model. All else equal, a higher realization of $_{jt}$ gives product j a greater market share. In other words, consumers' willingness to pay is increasing in the unobservable product characteristic. As firms incorporate this into their pricing decisions, realizations of the unobservable and prices will tend to be positively correlated, which in turn renders prices endogenous. This is a well-known problem in the existing literature and I follow the instrumenting strategy of Berry, Levinsohn and Pakes (1995). Table 2 lists all the excluded instruments and their correlation with price. The remaining columns of the instrument matrix Z are the observable characteristics listed in Table 1.

Table 2: Excluded Instruments

Column	Variable	z_i, p	Column	Variable	z_i, p
$z_{t,1}$	$J_t^{-1} \sum_{j=1}^{J_t} x_{t,2}$	$-:2523$	$z_{t,9}$	$\sum_{j \in \mathcal{F}} x_{t,5}$	$-:2078$
$z_{t,2}$	$J_t^{-1} \sum_{j=1}^{J_t} x_{t,3}$	$:2131$	$z_{t,10}$	$\sum_{j \in \mathcal{F}} x_{t,6}$	$-:1094$
$z_{t,3}$	$J_t^{-1} \sum_{j=1}^{J_t} x_{t,4}$	$-:3362$	$z_{t,11}$	$\sum_{j \notin \mathcal{F}} x_{t,2}$	$:0314$
$z_{t,4}$	$J_t^{-1} \sum_{j=1}^{J_t} x_{t,5}$	$-:2917$	$z_{t,12}$	$\sum_{j \notin \mathcal{F}} x_{t,3}$	$:0895$
$z_{t,5}$	$J_t^{-1} \sum_{j=1}^{J_t} x_{t,6}$	$-:1201$	$z_{t,13}$	$\sum_{j \notin \mathcal{F}} x_{t,4}$	$:0097$
$z_{t,6}$	$\sum_{j \in \mathcal{F}} x_{t,2}$	$-:1907$	$z_{t,14}$	$\sum_{j \notin \mathcal{F}} x_{t,5}$	$:0405$
$z_{t,7}$	$\sum_{j \in \mathcal{F}} x_{t,3}$	$-:2110$	$z_{t,15}$	$\sum_{j \notin \mathcal{F}} x_{t,6}$	$-:0701$
$z_{t,8}$	$\sum_{j \in \mathcal{F}} x_{t,4}$	$-:2044$	$z_{t,16}$	$J_f \equiv \sum_{j \in \mathcal{F}}(1)$	$-:1940$

To ensure sufficient variation of the instruments across observations, I only include the first five columns of the observable characteristics matrix, because the remaining columns contain dummy variables and the constant. For the majority of the excluded instruments the magnitude of their correlation with price is at least $:2$, indicating that they can qualify as relevant. To examine whether the instruments fulfill this requirement, the two instrumental variable tables in the Appendix present the results of regressing the excluded instruments only and all instruments on price, respectively. The former regression explains roughly twenty percent of the variation in price and the excluded instruments are jointly significant as implied by the value of the F-statistic. When utilizing the included instruments as well, the regressors explain nearly sixty percent of the variation in price, the instruments are jointly significant and, importantly, the included instruments do not drive out the excluded ones.

To address the question of validity, I test the overidentifying restrictions imposed by the instruments. The bottom panel of Table 3 shows the values of the Sargan statistic for the linear instrumental variables regression, specification (II), and the value of the J-statistic for the efficient GMM-instrumental variables estimation, specification (IV). Both statistics are distributed Chi squared with degrees of freedom given by the difference between the

number of instruments and the number of regressors. For both instrumental variables specifications, the null of the instruments being orthogonal to the residuals cannot be rejected at the five percent significance level. For the computation of both statistics, I cluster the errors at the firm level.[5] I conclude that the instrumenting strategy of Berry, Levinsohn and Pakes (1995) yields relevant and valid instruments for the data.

4.2 Estimation Results and the Implications for Consumer Welfare

Table 3 presents the results of the demand estimation. The first two columns estimate the standard logit model without any adjustment for potential crowding effects. The estimation in column (II) instruments for the endogeneity of prices, as discussed in the previous section, while the specification in column (I), does not use instruments. The fact that the price coefficient in column (II) is almost three times as large as that in column (I) illustrates that the endogeneity of prices is an important feature of the data.

Across all the specifications the estimated coefficients on lagers' taste parameters, richness, sweetness, bitterness and alcohol content are quite similar. Lagers that are very rich in taste and have a high alcohol content tend to have higher market shares, while relatively high scores for sweetness and bitterness yield all else equal smaller market shares. Finally, marketing expenditures tend to raise sales.

The large and highly significant coefficients on the entrant and exiter dummies show that these types of products behave quite differently from incumbent lagers. In contrast to the descriptive statistics section, I assign the entrant dummy to all new products that have been in the market for at most three periods. Similarly, a lager is an exiter during the last three periods of its life.[6] Shortening these entrant end exiter periods yields coefficients of greater magnitude. This outcome is intuitive, as these effects should eventually vanish. As with the taste coefficients, the estimated effects of being an entering or exiting product are very similar across all specifications.

Columns (III) and (IV) of the Table show the results of estimating the crowding specification (6), where the latter instruments for price and the former does not. In both cases, the structural crowding parameter is insignificantly different from one. Thus, the demand estimates suggest that market shares in the light lager market are better explained by a pure congestion model than by a standard logit model. Recalling the high overall number

[5] As Hoxby and Paserman (1998) show, not doing so in the presence of intra-cluster correlation tends to yield too frequent rejections of the overidentifying restrictions. For the data at hand, this e ect is important.

[6] Naturally, I exclude the rst and the last three periods of the sample, when setting up the dummies. This de nition of exiter introduces a forward-looking variable. When dropping exiter from the regression, the coe cients are nearly unchanged. The R^2 of the estimation drops, however. This is because even though exiting products tend to lower price, the fall in market share cannot be fully explained by the price adjustment. The remaining product characteristics are xed. A substantial drop in sales can therefore only be explained by large negative unobservables, ξ.

of products in the market during the sample period and the rapid expansion of consumers' choice set in the beginning of the sample, this result seems plausible.

Table 3: Estimation Results

Regressor	(I)	(II)	(III)	(IV)
Price per liter	-.0432	-.1009	-.0445	-.1006
	(.0136)	(.0069)	(.0130)	(.0110)
Richness	.0931	.0988	.0908	.0898
	(.0368)	(.0168)	(.0363)	(.0221)
Sweetness	-.1023	-.0992	-.0964	-.0453
	(.1010)	(.0407)	(.0998)	(.0432)
Bitterness	-.1172	-.1118	-.1157	-.1127
	(.0361)	(.0209)	(.0357)	(.0231)
Alcohol Vol. %	.4251	.5259	.4202	.4657
	(.1219)	(.0581)	(.1220)	(.0575)
.5 Liter Bottle	-.9455	-1.5453	-.9570	-1.5053
	(.2727)	(.1375)	(.2618)	(.1394)
.33 Liter Bottle	-.3375	-.8323	-.3502	-.9357
	(.2476)	(.1139)	(.2474)	(.1161)
.5 Liter Can	.6892	-.1526	.6446	-.2221
	(.2713)	(.1591)	(.2676)	(.1899)
Entrant	-1.2880	-1.3212	-1.2711	-1.2580
	(.1728)	(.0627)	(.1721)	(.0658)
Exiter	-3.6303	-3.6612	-3.6571	-3.6466
	(.1354)	(.0520)	(.1367)	(.0590)
Foreign	-.1455	.1254	-.1538	.0632
	(.2222)	(.0981)	(.2191)	(.1171)
Advertising	.3512	.3342	.3487	.3316
	(.0571)	(.0063)	(.0595)	(.0071)
Constant	-7.0773	-5.3170	-1.4951	.4926
	(.8440)	(.2912)	(1.0107)	(.5766)
	-	-	1.0000	1.0000
	-	-	(.0016)	(.0009)
R^2	.43	.41	.43	.42
Sargan Stat.		9.21		
J-Stat.				21.72
^{2}(15)		.56		
^{2}(14)				.92

Given this result, the two major implications of the logit taste shock assumption derived by Bajari and Benkard (2003) should be quantitatively important for the sample data. First, I examine the implication that the taste coefficients tend to be biased towards zero in markets with a large number of products. Looking at Table 3, a pairwise comparison of the estimated coefficients between both the instrumented and uninstrumented specifications

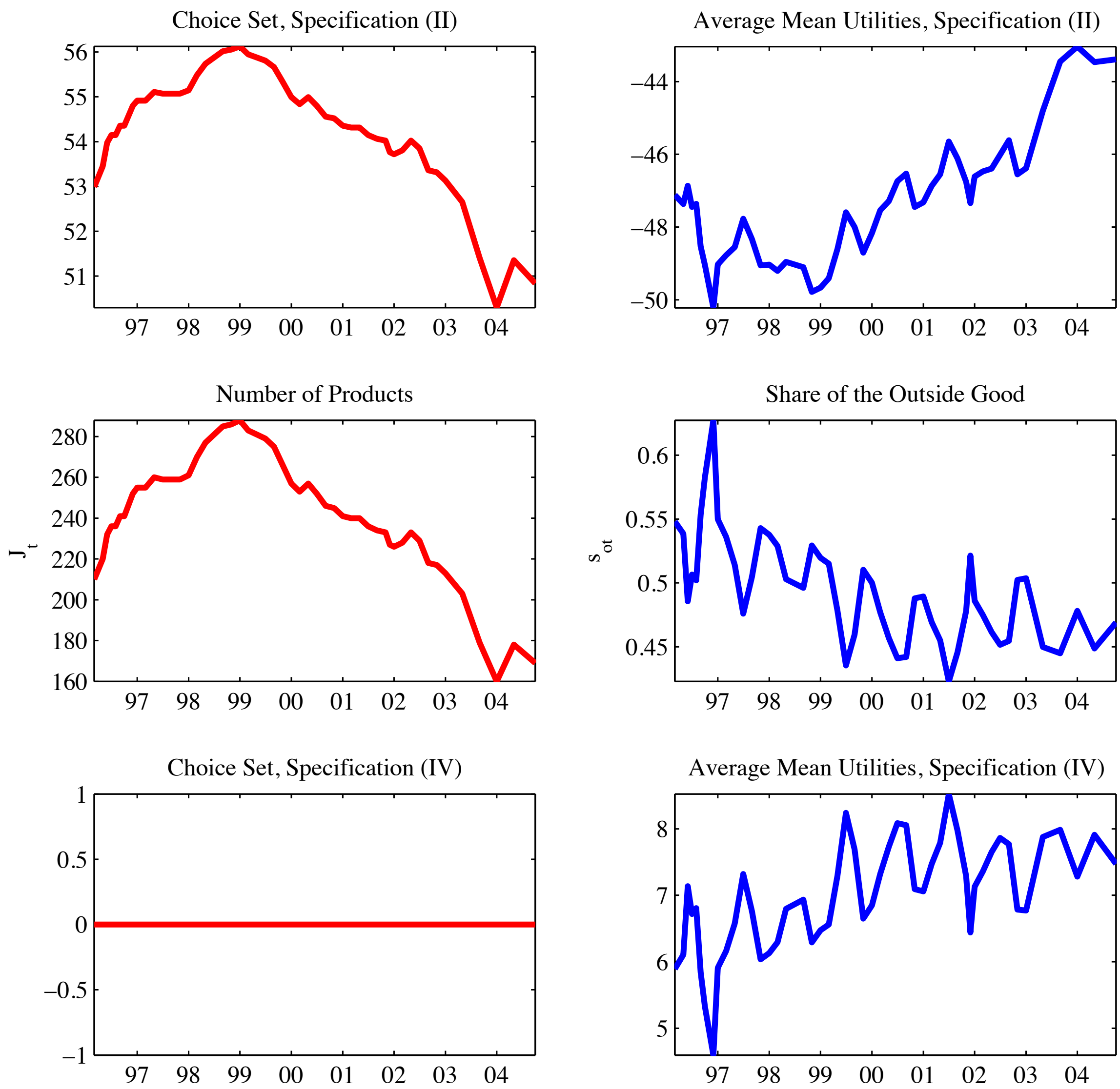
shows that more than half of the coefficients are of greater magnitude in the crowding specifications. The by far biggest difference, however, is in the value of the constant. When adding the structural crowding term to the uninstrumented specification, the constant increases from -7 to $-1{:}5$. In the instrumented regressions, the constant even switches sign and moves from about -5 to ${:}5$.

To see how this impacts the role of product characteristics in explaining market shares, recall (2) and the fact that the constant enters the observable characteristics matrix in the computation of mean utility, $_{jt} = x_{jt} \quad - \quad p_{jt} + \ _{jt}$. Each product's market share is positively related to its mean utility, $@s_{jt}{=}@ \ _{jt} = s_{jt}(1 - s_{jt}) > 0$. Thus, all else equal, an increase in the constant term is equivalent to a rise in all product market shares. Given that the observed shares of each lager and the outside good are fixed, a rise in the constant increases the proportion of market shares and consumer utility that is explained by product characteristics. Looking back at the closed-form decomposition of consumer welfare, (4), it follows immediately that the proportion of consumer welfare explained by mean utilities rises, too.

Thus, my estimates indeed suggest that not accounting for crowding effects reduces the role of the estimated taste coefficients in explaining market shares and thereby consumer welfare.

I reinforce this point by computing consumer welfare using the decomposition in (4) for each date in the sample period. The top row of Figure 2 plots consumers' valuations of their choice set's size (left plot) and quality (right plot) using the estimated structural parameters from specification (II), which corresponds to a logit model. The bottom row

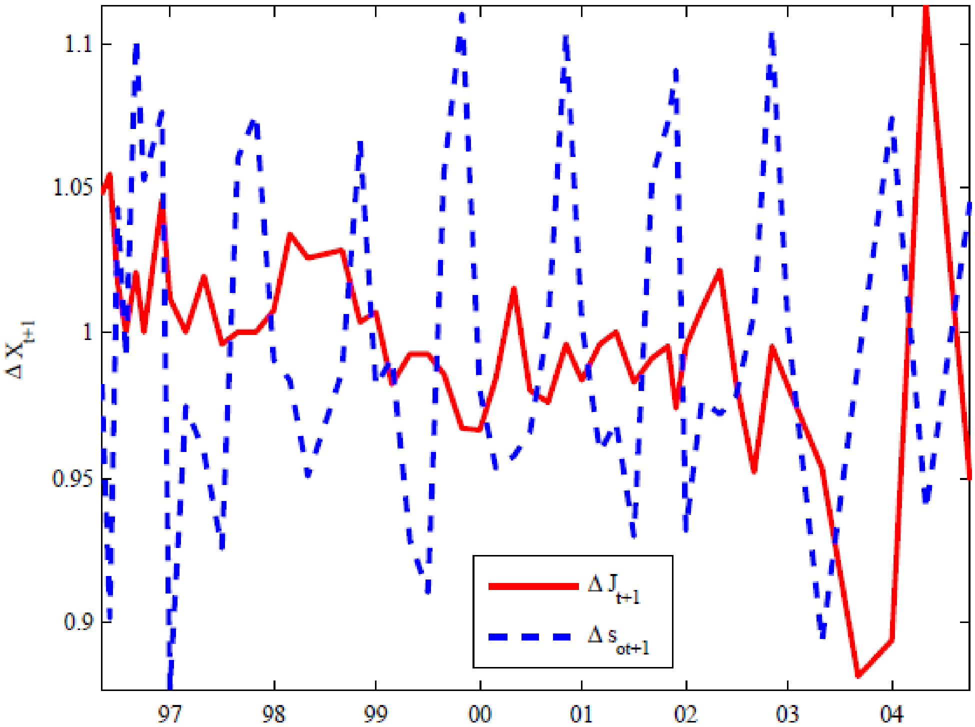
Figure 2: The Number of Products, the Outside Good and the Components of Welfare During the Sample Period



numbers are $-.25$ and -1.

These findings are fully in line with the derivation of (5) in section 3.1. Equipped with this identity, we can now easily determine the correlation between net entry and consumer welfare in the logit and pure congestion model. Figure 3 plots the gross rate of changes of the total number of inside products and the share of the outside good. As can be gauged from the plot, the two series tend to be negatively correlated, especially towards the end of the sample. The actual correlation between the series is $-.19$. We can thereby conclude immediately that for both specifications, net entry is positively correlated with total consumer welfare. For the instrumented crowding model, specification (IV), the actual correlation is $.17$, whereas for specification (II) the actual correlation is $.18$.

Figure 3: Net Entry and the Share of the Outside Good



It is tempting to take this story at face value, because intuitively, entry should raise competition and thereby increase the quality of all goods. As I have argued before, however, with the share of the outside good not having been determined in the demand estimation, it is potentially misleading to end the investigation at this point.

5 A Closer Look at Entry and Exit

To obtain a more reliable assessment of the welfare benefits of entry and exit, I compute the quality terms for the groups of entering, exiting and incumbent products separately. These terms are determined by the structural part of the demand model and not by the distributional assumption placed on consumers' taste shocks. Quality is therefore a more reliable assessment of each group of products' value to consumers. As in the previous section, I use the structural parameters from specification (II), the instrumented logit model and specification (IV), the instrumented crowding model.

Table 4: Average Mean Utility by Group

Including Unobservables,

	Specification (II)			Specification (IV)		
	Incumbents	Entrants	Exiters	Incumbents	Entrants	Exiters
sample mean	.0199	.0076	.0043	4.0521	1.7605	1.0280
sample median	.0095	.0054	.0042	2.3517	1.3390	1.0117
correlation with J_t	-.3186	-.0523	-.1978	-.2991	.1662	.1664
correlation with s_{ot}	-.1904	-.2693	-.3749	-.1925	-.2167	-.3087

Excluding Unobservables,

	Specification (II)			Specification (IV)		
	Incumbents	Entrants	Exiters	Incumbents	Entrants	Exiters
sample mean	.0021	.0001	.0001	.4796	.0150	.0119
sample median	.0020	.0000	.0000	.4686	.0099	.0096
correlation with J_t	-.4835	-.1363	-.3381	-.4730	-.1360	-.3343
correlation with s_{ot}	-.6053	-.2120	-.3810	-.6103	-.2033	-.3894

Looking back at the estimation results in Table 3, it is clear that including the exiter and entrant dummies favors new product introductions over those lagers that exit the market in the following period.

As I am interested in obtaining robust results regarding the benefits of entry and exit, I exclude both dummies. If entering lagers have a higher quality than exiting lagers without the dummies, this difference is only going to widen when including them. Moreover, to investigate the importance of the estimated unobservable product characteristics, I compute two sets of results, one including the error term and the other excluding it.

For the comparisons I define the group quality terms, $\widehat{\ }_{gt}$ as follows.

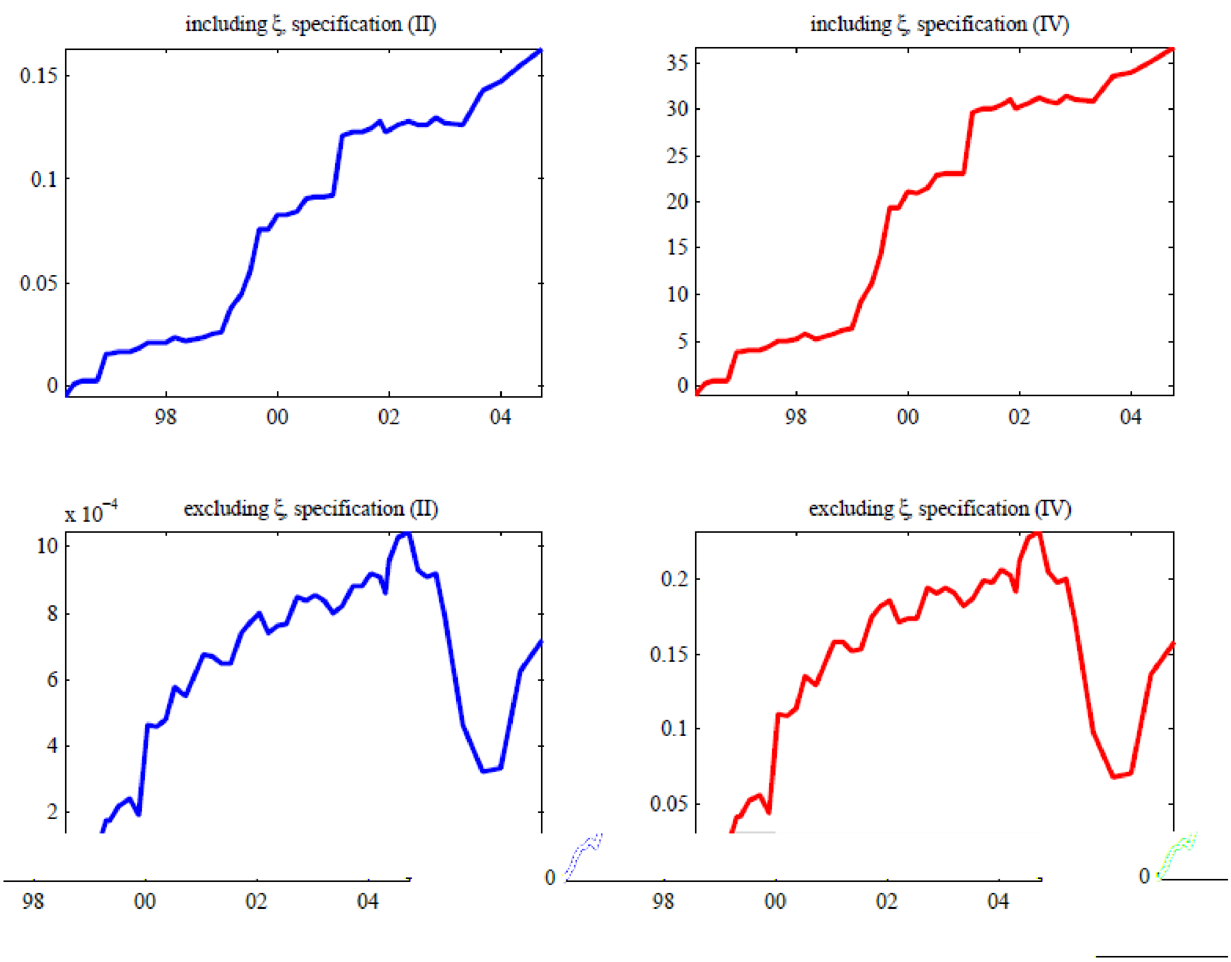
$$\widehat{\ }_{gt} = (J_{gt})^{-1} \sum_{j=1}^{J_{gt}} \exp(\widehat{\ }_{jt})$$

J_{gt} is the total number of products in the specific group and the hat above the mean utilities is a reminder that $\widehat{\ }_{jt} \neq \ _{jt}$, because the entrant and exiter dummies and depending on the set of results the unobservable product characteristics, have been stripped out. I also ignore the outside good here to ensure that differences between the groups are driven by different qualities and not by the entrant and exiter groups being much smaller than the incumbent lagers group. Summing the $\widehat{\ }_{gt}$ therefore does not yield $\bar{\ }_{t}$.

Table 4 and Figure 4 tell the same story about the impact of entry and exit on welfare. On average, lagers entering the market have a higher quality than those exiting the market. This holds for both specifications. Moreover, the fact that the two specifications draw such a similar picture of the quality differences between entering and exiting lagers

is particularly reassuring, because there are substantial differences between the logit and pure crowding estimates regarding the aggregate market's quality.

Figure 4: Cumulative Average Quality Differences Between Entering and Exiting Products During the Sample Period



This impression is strengthened when looking at the correlations between the quality measures and the number of products and the outside good's market share. For the logit specification, the correlation between the number of products and average quality is weakest for the group of entering products. This holds both for the case where product unobservables are included and excluded and suggests that the estimated quality of entrants is not mainly driven by the observed changes in the number of products.

For the pure congestion estimates, the correlation between average quality and the share of the outside good is lowest for the group of entrants. By the same logic, this finding builds confidence in the result that entry raises consumer welfare by providing better lagers and is not simply the result of a spurious correlation between changes in the number of varieties and changes in the share of the outside good.

6 Conclusion

Using a structural demand model within the framework of Ackerberg and Rysman (2005), I find strong evidence for substantial crowding effects in the Swedish market for light lagers. The estimation results suggest that market shares are generated by a pure congestion model. In other words, the available choice set to consumers has become so wide that additional products are not valued *per se*. There is no longer a love-for-variety effect. Instead, consumer welfare can only be raised by improving the quality of the lagers in the market.

During the sample period, I find entry to be positively correlated with consumer welfare. I consider the possibility that this finding stems from the exogenous definition of the relevant market. As decreases in the share of the outside good imply an increase in the average quality and thereby a rise in consumer welfare in the pure congestion model, entry can simply be correlated with but not the cause of consumers switching from the outside alternative to one of the lagers in the market.

To address this concern, I assess the difference between the average mean utilities of entering and exiting products. Here, I use the structural part of the demand model, because it is less likely to be driven by the distributional assumption imposed on the logit taste shocks. I find that entering products tend to be more attractive to the representative consumer than exiting products and that this finding is stable throughout the sample period. Moreover, changes in the average mean utilities of entering products appear much less correlated with the share of the outside good, than this is the case for incumbent products and exiting lagers. This strengthens the robustness of the finding that entry and exit raise consumer welfare.

From a methodological point of view, the upshot of the paper is that it is desirable to jointly estimate the market share of the outside alternative with the structural demand parameters. This could alleviate concerns that entry and consumer welfare are spuriously correlated by the exogenous delineation of the relevant market. Huang and Rojas (2010) emphasize the potentially biased estimates of consumer demand resulting from exogenously delineating the share of the outside. Their suggested estimation methods for jointly estimating the share of the outside good with the structural demand parameters could complement my approach for assessing to which extent welfare gains from product introductions are driven by the functional form of the estimator.

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8 Appendix

Table 5: Regressing the Excluded Instruments on Price

Variable	Coefficient	$P > \|t\|$	Variable	Coefficient	$P > \|t\|$
z_1	44.58	.071	z_{10}	-.02	.321
z_2	60.20	.000	z_{11}	-.20	.068
z_3	-54.79	.000	z_{12}	-.25	.045
z_4	-96.06	.001	z_{13}	.17	.005
z_5	3.66	.700	z_{14}	.43	.001
z_6	-.11	.317	z_{15}	-.04	.115
z_7	-.24	.000	z_{16}	-1.80	.000
z_8	.08	.193	constant	522.19	.000
z_9	.09	.481			
Observations	12,080				
F(16,12063)	204.53				
$P > F$	.000				
R^2	.213				
adjusted R^2	.212				

Table 6: Regressing the Excluded Instruments on Price

Variable	Coefficient	$P > \|t\|$	Variable	Coefficient	$P > \|t\|$
z_1	47.22	.009	z_{15}	-.04	.011
z_2	82.61	.000	z_{16}	-.84	.000
z_3	-53.20	.000	x_2	.14	.000
z_4	-67.20	.002	x_3	-.11	.006
z_5	5.37	.158	x_4	.03	.318
z_6	-.16	.047	x_5	2.03	.000
z_7	-.36	.000	x_6	-.06	.242
z_8	.13	.004	x_7	-10.06	.000
z_9	.13	.149	x_8	-7.96	.000
z_{10}	-.02	.217	x_9	-13.10	.000
z_{11}	-.20	.011	x_{10}	-.58	.000
z_{12}	-.35	.000	x_{11}	0	.990
z_{13}	-.17	.000	x_{12}	4.28	.000
z_{14}	.30	.001	constant	292.47	.000
Observations	12,080				
F(24,12553)	619.97				
$P > F$	.000				
R^2	.581				
adjusted R^2	.581				