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MARKET STRUCTURE AND PRODUCT ASSORTMENT:
EVIDENCE FROM A NATURAL EXPERIMENT IN LIQUOR LICENSURE

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ABSTRACT

We examine how market structure, measured as the number of firms, affects prices, quantities, product assortment, and consumer surplus. Our analysis exploits Washington's deregulation of spirit sales, which generated exogenous variation in market structure across the state. Consistent with the uniform pricing literature, we find no effect of increased competition on prices. Rather, we document an expansion of product assortment, which in turn increases purchasing. Using a discrete-choice demand model, we estimate that wider assortments increase consumer surplus by $3.20/month when moving from monopoly to duopoly. However, the likelihood that a household engages in heavy drinking, as defined by the CDC, increases by 5.6 percentage points, raising concerns about social welfare.

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An online appendix is available at http://www.nber.org/data-appendix/w27011

The relationships between market structure, prices, product variety, and consumer welfare are important inputs into many economic questions, such as how to design antitrust policy and the effects of licensure restrictions. Because theoretical models make starkly different predictions about the effect of market structure on prices (Bresnahan and Reiss (1991)) and on product variety (Stole (2007)), the onus falls on empirical work to determine how a change in the number of firms actually affects a market.

This paper studies the effect of market structure in the retail market for liquor in Washington.[1] This context is interesting for three reasons: first, recent work documents that retailers follow uniform pricing policies across broad regions of the United States (Adams and Williams (2019); DellaVigna and Gentzkow (2019); Hitsch et al. (2017)). Such pricing policies call into question the role of competition in determining market outcomes at the local level. Indeed, our examination of liquor markets reveals that firms do not adjust prices in response to local competition. Nonetheless, we find that local competition does increase consumer surplus because it induces retailers to broaden their product assortment.

A second motive for studying competition in Washington's liquor markets is to learn about the potential for licensure restrictions to reduce the negative externalities associated with liquor consumption. An explicit goal of licensure restrictions, such as those imposed in Washington, is to curb alcohol purchasing by reducing the number of liquor retailers. However, the success of these restrictions in reducing externalities, such as alcohol-fueled car accidents, depends who consumes less when fewer retailers sell spirits and how much less they consume. Do would-be liquor shoppers substitute to beer or wine? Would they engage in heavy-drinking behavior were liquor more readily available? By investigating these questions, we hope to provide guidance for improving liquor regulation.

The main hurdle for identification of these causal relationships is that entry responds to market conditions that are unobserved to the econometrician. This endogeneity challenge provides a third reason to study liquor retail in Washington: this case study features a natural experiment that provides exogenous variation in the number of liquor retailers across markets in the state. This variation allows

[1] Defined as beverages above 24% ABV.

us to identify how competition affects market outcomes. The natural experiment was induced by Washington's deregulation of liquor markets in 2012. From the end of Prohibition through May 2012, the Washington State Liquor Control Board (WSLCB) held a monopoly on spirit sales, similar to fourteen other "Alcohol Beverage Control" (ABC) states.[2] On June 1, 2012, private retailers were allowed to enter the deregulated market so long as their premises exceeded $10,000\text{ft}^2$ and they paid a fee of \$316.[3] Importantly, these regulations do not apply to the sale of beer and wine, which have long be deregulated in Washington. Thus, we refer to the set of retailers that sold beer and/or wine before liquor deregulation as *potential entrants* into Washington's fledgling liquor markets. Using this population of potential entrants, we adopt a regression discontinuity design to leverage the licensure threshold. Controlling for a rich set of market characteristics, we compare outcomes in markets with a potential entrant just above versus just below the $10,000\text{ft}^2$ threshold.[4] Our identification argument is that potential entrants sized just above $10,000\text{ft}^2$ are otherwise similar to those sized just below, except in their license-eligibility.

The natural concern with this identification strategy is that retailers might alter their square footage in response to the restriction. For example, a retailer sized $9,000\text{ft}^2$ might build an annex to qualify for a liquor license. We present evidence that this type of gaming did not occur by documenting that there are very few renovations following the announcement of the deregulation law. Further, a formal test does not reject the that the density of retailer outlet sizes is smooth at $10,000\text{ft}^2$. An additional concern is that the threshold may not bind; that is, stores with sizes near $10,000\text{ft}^2$ might not find it profitable to sell liquor. To the contrary, we show that there is a large discontinuity in licensure probability at the threshold: a 27 percentage point jump across all stores, and an 86 percentage point jump for chain stores.

At the market level, we show that the size requirement does indeed reduce the

[2] Alabama, Idaho, Maine, Maryland, Mississippi, Montana, New Hampshire, North Carolina, Ohio, Oregon, Pennsylvania, Utah, Vermont, and Virginia.

[3] For a combination Beer/Wine/Spirits Grocery license.

[4] In our preferred specification, we also exploit markets with multiple potential entrants near the threshold by conditioning on the total number of potential entrants with square footage in the neighborhood of $10,000\text{ft}^2$, and then comparing markets with different numbers of incumbents just above versus just below it.

number of spirits retailers. On average, markets with a potential entrant sized just above the threshold sustain 0.88 more liquor retailers than those with a potential entrant sized just below. As a placebo test, we verify that markets with a retailer sized just above/below $10,000\text{ft}^2$ are similar in demographics such as age, income, and race, as well as pre-privatization liquor purchasing, which we interpret as a proxy for spirits demand. Thus, we feel confident employing the natural experiment in a two-stage least squares estimator to compare outcomes across different market structures.

Our estimates reveal that retailers alter product assortment rather than prices when facing an additional competitor in the same ZIP code. Using point-of-sale data from 390 Nielsen RMS stores, we find that the average retailer offers roughly 20 more products (UPCs) when competing as a duopolist instead of operating as a monopolist. Further, we find that the marginal entrant offers unique inventory, so that an exogenous shift from monopoly to duopoly broadens the market-wide assortment available to consumers by approximately 160 UPCs. The wider product assortment and greater convenience afforded by an additional competitor in a duopoly increase liters sold by approximately 28% over monopoly markets. We note, however, that our results indicate strongly diminishing returns as the number of firms increases. The combination of additional variety and increased consumption delivers a consumer surplus increase of $3.2 dollars a month when moving from monopoly to duopoly.

Taken together, our findings highlight how competition benefits consumers, even when it does not alter prices. They underscore the need for antitrust analysis to look beyond prices to assess how competition affects consumer welfare in retail markets. More broadly, the results suggest that models of retail competition that impose optimal pricing but ignore assortment decisions may poorly approximate firm conduct in practice.

Finally, our findings suggest that licensure restrictions can successfully curb risky drinking behaviors. First, we show that Washington's restrictions reduce spirits purchasing for off-premise consumption, without increasing either beer or wine purchasing or expenditures on spirits at restaurants and bars. In other words, ZIP codes in Washington with an additional spirits retailer see an overall increase in alcohol purchasing. Second, we examine how the size restriction affects the distribution of purchasing across consumers using Nielsen data on a panel of Washington households. We document that an additional firm increases in the proportion of households that engage in heavy drinking, as defined by the Center for Disease Control. For example, an exogenous shift from monopoly to duopoly increases the likelihood of heavy drinking by 5.6 percentage points. However, as we noted before, the effect magnitude falls in the number of firms so that a shift from 5 to 6 liquor outlets yields no detectable change in heavy drinking.

Related Literature This paper contributes to a growing literature, including Adams and Williams (2019), DellaVigna and Gentzkow (2019), and Hitsch et al. (2017), that documents uniform pricing among US retail chains. This paper provides additional evidence on this phenomenon; we show that prices do not respond to exogenous shocks to competition. Instead, retailers appear to tailor their product assortment to the local retail environment.

By taking a reduced-form approach to studying market structure, this work also contributes to long literatures on entry (see Berry and Reiss (2007) for a survey) and product variety (Berry and Waldfogel (2001); McManus (2007); Fan (2013); Sweeting (2010, 2013); Eizenberg (2014); Wollmann (2018)), which chiefly employ structural methods. We leverage a natural experiment to quantify how an additional firm affects prices and product assortment, so that we need not take a stand on objects such as the distribution of unobservables, the choice set facing consumers, or firm conduct. Thus, the natural experiment enables us to study a setting with hundreds of differentiated products and dozens of retailers, where solving an optimal entry, product assortment, and pricing game might otherwise require heavy-handed assumptions.

Our results also add to the burgeoning literature investigating liquor regulation in the United States, including Milyo and Waldfogel (1999), Seim and Waldfogel (2013), Conlon and Rao (2015, 2019), Miravete et al. (2018, 2020), Seo (2016), and Huang et al. (2019). We complement these previous studies by documenting the effects of licensure restrictions on private liquor market outcomes and our focus on the product variety margin.

The rest of the paper proceeds as follows: section I introduces our data sources, section II describes our empirical strategy, section III presents our results, and section IV concludes.

I. Data

I.A. Data on Beer, Wine and Liquor Licensure

We obtain data on beer, wine and liquor licensure from WSLCB off-premise licensee lists. These lists contain information on every retailer licensed to sell beer, wine, and/or liquor for consumption outside of the store, including former licensees that have ceased operations. We observe all licensees from 2011 through 2017. From the WSLCB, we also obtain off-premise liquor revenues (excluding beer and wine sales) and on-premise licensee lists for this period.

Our analysis focuses on the set of beer and wine retailers that began operating before 2012. These licensees compose the set of firms for whom we have a natural experiment on entry into spirits markets, as they did not set square footage in response to the licensure threshold. Our identification strategy rests on the assumption that stores sized just above the $10,000\text{ft}^2$ threshold are comparable to those just below. Beginning in 2011, the licensure threshold induces a discontinuity in the payoff to square footage for new establishments. Thus, new retailers sized just above the threshold may value the spirits licensure option more than those sized just below, perhaps due to differences in local liquor demand. Therefore, there is no clear control group for retail outlets that commence beer and/or wine sales after the licensure threshold is introduced.

Table 1 presents summary statistics for licensees over time. There are 4,978 beer and wine licensed retailers in December 2011, of which 2,098 are chains. At liberalization, on June 1st of 2012, 4,977 of these stores were still operating, and 1,075 of them obtained liquor licenses. Most of these entrants belong to retail chains (924 of 1,075). These 1,075 pre-existing beer and wine retailers constitute the lion's share of liquor retailers in Washington's nascent spirits markets. While 570 new alcohol retailers enter during 2012, a mere 57 sell spirits. That is, only 5% of spirits retailers fall outside of our potential entry sample. The low level of liquor licensure for stores that were not selling beer or wine prior to 2012 makes us confident that

Table 1: Summary Statistics for WSLCB Stores

Summary Statistics for Beer, Wine and Liquor Licensure	
Prior to 2012: Beer and wine licensed retailers	4,978
Chain licensees	2,098
At Liberalization: Existing Beer/Wine Licensees	4,977
Liquor-licensed	1,075
Chain liquor licensees	924
At Liberalization: Entrants	570
Liquor-licensed	57
Beer and wine licensed	558
Chain stores	130

the set of retailers that we consider captures the vast majority of potential entrants.

Chain identity is an important characteristic of liquor retailers. We define a chain as a group of at least two outlets in different locations with the same store name on their license application. In what follows, we will use the term "independent" stores to refer to non-chain stores. Most chains are all-or-nothing with spirits licensure; either all outlets sell spirits or none of them do, as shown by Appendix Figure A1. Appendix Figure A2 reports chain name and number of branches for all chains with 5 or more stores. Overall, 44% of chains obtain a liquor license. Chains that never sell spirits, such as gas stations and convenience stores, typically feature formats that are quite small. In contrast, large format retailers, like Costco and Safeway, always sell liquor. Variation in licensure is highest for small-footprint grocery chains like Trader Joe's, where retail outlet sizes fall on both sides of the licensure threshold.

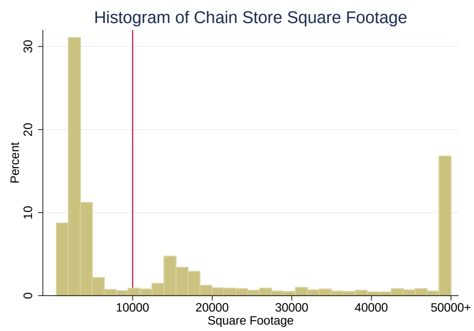
I.B. Data on Square Footage

We employ Google Map Developers' Area Calculator to measure square footage for the retail outlets in our sample.[5] This application overlays a tool for calculating square footage on top of Google Maps' satellite images. Figure B1 in Appendix B presents an example of how we use the application to calculate store areas. To obtain data for all 4,978 stores in our sample, we hired Amazon Mechanical Turk (MTurk) workers to measure each store's square footage. Appendix B details our procedure.

[5] https://www.mapdevelopers.com/area_finder.php

Figure 1: Histogram of Store Sizes

(a) Chain Stores



(b) Independent Stores

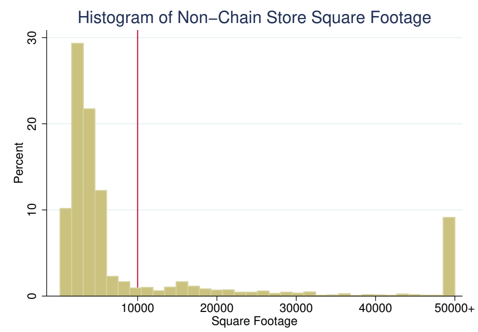


Figure 1 presents histograms of retailer sizes separately for chain and independent stores. Both distributions are skewed towards small formats, which are typical of gas stations and convenience stores. Overall, 73% of our sample consists of stores below $10,000\text{ft}^2$, which are not license-eligible. Chain stores are larger than independents, but the majority (54.6%) are still below the licensure threshold.

I.C. Data on Liquor Prices and Quantities

Our data on liquor sales comes from two sources: the Nielsen Consumer Panel and Retail Scanner Datasets hosted by the Kilts Center. The former comprises all transactions for a revolving panel of 2,700 households in Washington State between 2010 and 2015. The latter includes product-level weekly prices and quantities of liquor sold at a set of retail chains that partner with Nielsen (which account for approximately 45% of spirits sales in Washington).

Table 2 displays summary statistics for panelist households living in a ZIP code with at least one store sized between $5,000\text{ft}^2$ and $10,000\text{ft}^2$. This includes some 141 ZIP codes and 1,138 households. Note that only 10% of households live in a ZIP code that had a WSLCB store under the state monopoly, but these panelists average nearly 5.4 liquor retailers within their ZIP code after deregulation. To calculate liquor consumption, we restrict attention to products in the Nielsen alcohol module that also qualify under the WSLCB definition of liquor. See appendix C for details on

Table 2: Panelist Summary Statistics

Panelist Summary Statistics					
		Mean	SD	Min	Max
WSLCB Stores before 06/2012		0.10	0.30	0	1
Number of Beer & Wine Licensees	Operating in 2011	22.18	10.96	1	51
	Selling Liquor in 2012	5.43	2.52	0	11
	5k - 15k ft^2	1.52	0.79	1	4
	10k - 15k ft^2	1.02	0.80	0	4
Monthly Liquor	Purchase Probability	0.09	0.28	0	1
	Total Expenditures ($)	6.00	31.35	0	558.71

Notes: Sample is 1,138 households who reside in a Washington State zip code with at least one chain store sized 5,000-15,000 ft^2 in 2012-2015.

sample construction. The summary statistics in table 2 reveal that liquor purchasing is highly skewed across households. The average household spends only $6.00 on spirits per month, but the standard deviation of expenditures is $31.35.

The household data does not include information on products that are on store shelves but are not purchased by Nielsen panelists. The Nielsen Scanner Dataset, supplemented with data on retailer 5-digit ZIP codes, fills in this gap. Figure 2 plots the distribution of annual quantity sold for each ZIP code $\times$ UPC combination in the Consumer Panel Dataset and in the Retail Scanner Dataset. While many products appear only once in the former, singleton sales seldom occur in the latter. In fact, over 60% of products sell at least 30 units annually per store in the Retail Scanner Dataset. Tis suggests that there are few products on shelves that are not transacted at least once in a month.

Two salient facts emerge from the Retail Scanner Dataset: first, there is little variation in prices across stores, and second, variation in product assortment is substantial. Table 3 provides descriptive statistics about prices and product assortment at these chains. To measure price variation for a particular UPC, we first calculate its coefficient of variation (the average selling price at each outlet for a given year, scaled by the standard deviation of this average price across outlets for that same year). The average coefficient of variation across products and years is 9%, showing that there is little variation in price relative to its level. Most of this variation is across chains. The average within-chain coefficient of variation is 3%. These descriptive statistics dovetail with findings in Adams & Williams (2019), DellaVigna & Gentzkow (2019), and Hitch, Hortacsu & Lin (2019).

In contrast, chains sell widely different assortments across retail outlet locations. On average, chains sell 678 unique UPCs each year, but the average retail outlet sells only 327. This figure varies substantially across outlets. The coefficient of variation for the number of products sold annually is 47%. Even within chain, the coefficient of variation for the number of products is 18%. Part of this heterogeneity could results from differences in square footage across outlets within a chain. We therefore investigate product overlap between retail outlets in the same chain. For each pair of outlets in the same retail chain, we compute the fraction of the smaller outlet's products (UPCs) that are also sold at the larger store. This calculation mitigates concerns related to shelf space. If assortment simply expands with store size, then this ratio should be one. It is zero if the intersection of the two assortments is empty. The average overlap across chains is our sample is 81%, which means that one in five products carried by a small store is not available at larger outlets. These findings motivate our interest in understanding whether competition drives local product assortment decisions.

Figure 2: Annual Quantity Sold by UPC

(a) Consumer Panel - by Zip Code (b) Scanner - by Store

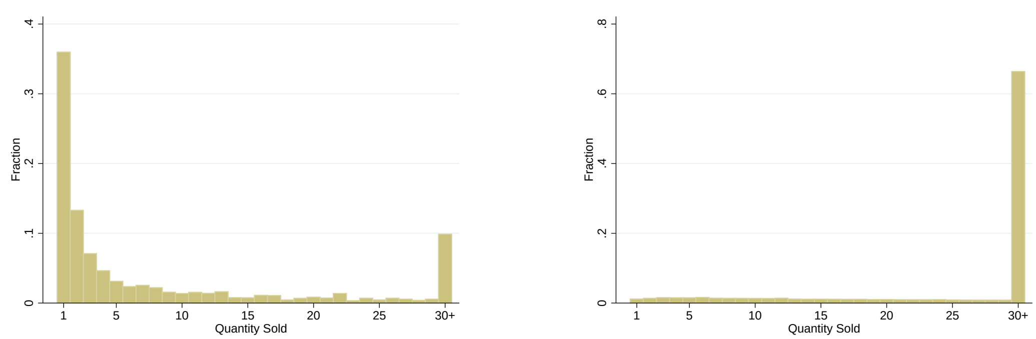


Table 3: Price and Product Variety for Scanner Stores

Price and Product Variation within and across Chains						
	Variable	# Observations	Mean	SD	Min	Max
# Outlets per Chain		30	85.37	51.14	1	169
Annual Quantity Sold (mil)		30	1.84	1.77	0.00	6.17
Annual # Products - Chain		30	678	403	49	1,676
Annual # Products - Store		2,561	327	158	19	1,274
Coefficient of Variation	Price	6,442	0.09	0.09	0	1.24
	Price - within Chain	29	0.03	0.03	0	0.11
	# Products	4	0.47	0.03	0.44	0.51
	# Products - within Chain	29	0.18	0.14	0.02	0.43
Overlap - within Chain		8	0.81	0.12	0.63	0.94

Notes: Based on the sales of 9 retail chains in the Nilesen Scanner data operating in Washington State May 2012 - December 2015. Coefficient of variation for price is the average across UPCs of the following quotient: standard deviation of price divided by its mean. To calculate the within chain coefficient of variation, we recalculate the CoV separately by chain and then report the average across chains. "Overlap - within Chain" is a measure of similarity between intenvtories of two stores within the same chain. For any two stores within the same chain, we calculate the share of the smaller store's inventory also carried in the larger store, and then average that measure across branches within the chain.

II. Empirical Strategy

Our estimation strategy leverages the discontinuity of license eligibility in store size at $10,000\text{ft}^2$ to identify the effect of market structure on outcomes. To establish the power and validity of this strategy, we begin by documenting the effects of the licensure threshold on individual firm's entry decisions. We then discuss our market-level identification strategy and present evidence on the effects of the licensure threshold on the number of entrants in a given location.

II.A. Firm-Level Entry Decisions

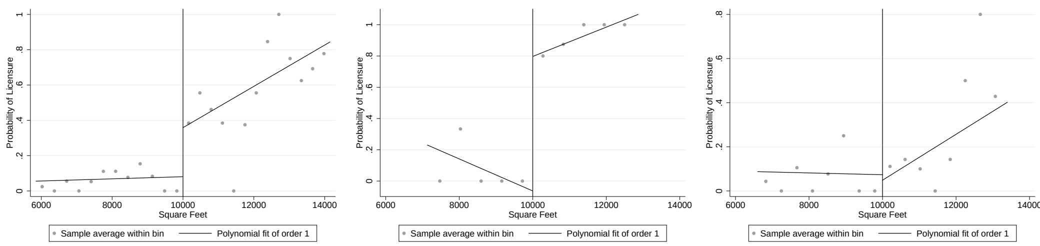
The basic model for estimating the effect of eligibility on entry is:

$$\begin{aligned} 1\left[\text{Liquor Licensed}\right]_s = \alpha_0 + \alpha_1 \cdot 1\left[SqFt_s \geq 10,000\right]_s + \alpha_2 \cdot SqFt_s \\ + \alpha_3 \cdot 1\left[SqFt_s \geq 10,000\right]_s \times SqFt_s + \epsilon_s \end{aligned} \tag{1}$$

where $1\left[\text{Liquor Licensed}\right]_s$ and $SqFt_s$ are a liquor licensure indicator variable and the square footage of store s, respectively, and the model is estimated using only stores in a neighborhood around the threshold. We are mainly interested in the coefficient on $1\left[SqFt_s \geq 10,000\right]_s$, an indicator variable for square footage above $10,000\text{ft}^2$, which captures any change in the probability of licensure at that threshold. Because these retail outlets were established years before the threshold rule was

Figure 3: Probability of Spirits Licensure by Store Size

(a) All Stores　　(b) Chain Stores　　(c) Independent Stores



introduced (and because there is no other regulation that induces a discontinuity in retailer profits at $10,000\text{ft}^2$), we argue that whether a particular outlet is above or below the threshold is as good as random.

One concern with this approach is that firms might game the licensure threshold, for example by building an annex. This behavior would create a selection problem, as only stores that can profitably sell liquor would expand. To test for manipulation of square footage, we examine whether there is bunching above $10,000\text{ft}^2$. Table A1 presents the results of a McCrary test (McCrary (2008)) for manipulation of the running variable around the threshold. For all specifications, we cannot reject the null hypothesis that there there is no discontinuity in the density of store square footage at $10,000\text{ft}^2$ at the 5% level.

In appendix D, we also analyze whether retail outlet characteristics are balanced around the licensure threshold, and whether retail outlets that are just below the licensure threshold are differentially likely to expand their premises after 2012. We find no differences along these margins. Overall, the results from these regressions leave us confident in the validity of the exclusion restriction.

A separate concern is whether stores just above $10,000\text{ft}^2$, which are marginally-eligible, actually choose to sell liquor. For instance, large firms may deter entry by marginal firms. Alternatively, marginally-eligible firms may face prohibitively high wholesale costs from powerful upstream distributors. If the licensure threshold does not bind, then we would not expect it to affect market structure or outcomes. Figure 3 presents estimates of equation (1), obtained by estimating a local linear regression discontinuity design model with robust, bias-corrected standard errors

Table 4: Regression Discontinuity Estimates of the Effect of License Eligibility on Liquor Revenues

RD Estimates of the Effect of Licensure and License-Eligibility on Liquor Sales			
	(1)	(2)	(3)
	All Stores	Chain Stores	Large Chains (10+ Stores)
License-Eligibility	26,164	71,538	72,747
	(17,707)	(32,898)	(33,284)
Observations	4,605	2,006	1,973
Effective Observations – Below	167	27	24
Effective Observations – Above	123	49	47
Bandwidth	4016.2	3264.9	3195.8

Notes: This table presents results of a local polynomial regression-discontinuity design model with robust bias-corrected confidence intervals and an MSE-optimal bandwidth, estimated in Stata via the “rdrobust” command using techniques in Calonico, Cattaneo and Titiunik (2014), Calonico, Cattaneo and Farrell (2016) and Calonico, Cattaneo, Farrell and Titiunik (2016). Total liquor sales in 2012 (7 months) is the outcome variable, square footage is the running variable, and 10,000 square feet is the cutoff. Column 1 reports the estimates revenue discontinuity for all stores in our sample. Column 2 considers only independent stores, while column 3 only considers chain stores and Column 4 considers only chain stores for chains with 10 stores or more. Robust, bias-corrected standard errors in parentheses.

and an optimal bandwidth as in Calonico et al. (2014).[6] There is a 26 percentage point jump in the probability of licensure at the threshold (column 1), which rules out the concern that the discontinuity does not bind.

We also learn that selling liquor is not profitable for all eligible firms; the probability of licensure among outlets sized $10,000\text{ft}^2+$ is approximately 40%, well below full compliance. Furthermore, the likelihood of licensure is approximately 10 percent among retail outlets sized just below $10,000\text{ft}^2$, indicating that some measurement error in square footage remains (as these retailers must, in fact, be larger than $10,000\text{ft}^2$).

Figure 3 also plots the likelihood of liquor licensure separately for chain and independent stores. Independents may behave differently than chains if spirits sales involve substantial fixed costs. For example, chains may be able to exploit established relationships with suppliers and distributors. Indeed, the discontinuity for chain stores is 86 percentage points, statistically indistinguishable from perfect compliance. This suggests that the licensure threshold forecloses chain retail outlets

[6] Appendix table A1 reports the coefficients.

that almost surely would sell spirits absent regulation. In contrast, independent store licensure exhibits no evidence of a discontinuity at the threshold. Measurement error does not appear to drive this result, as the licensure probability hovers around 10% on both sides of the cutoff. Therefore, we conclude that the licensure threshold does not exclude independent stores from spirits sales; rather, it is not profitable for these marginally-eligible independent retailers to sell liquor. Among the few exceptions that do, monthly revenues from spirits sales amount to a meager $\$1,780$ a month ($SD = \$5,759$).[7]

To quantify the effect of license eligibility on liquor sales, in table 4 we present results obtained from estimating equation (1) using total liquor revenues in 2012 as the outcome variable. We do not report results for independent stores because there is no first-stage for this subgroup. For chain stores, the sales discontinuity is on the order of $\$70,000$ for this period, or $\$10,000$ a month.

II.B. Market-Level Entry Decisions and Empirical Strategy

Our regression of interest analyzes how a purchasing outcome y for unit u (which could be a household, retail outlet, or ZIP code) in month t changes with the number of firms in u's ZIP code, denoted $z(u,t)$:

$$y_{ut} = \alpha_0 + \alpha_1 \cdot NL_{z(u,t)} + \alpha_2 \cdot NL^2_{z(u,t)} + X'_{z(u,t)}\delta + \epsilon_{ut} \tag{2}$$

where $NL_{z(u,t)}$ is the number of liquor-selling retailers and $X_{z(u,t)}$ includes market-level control variables. The quadratic term for the number of liquor outlets allows for diminishing returns to the number of competitors, as in Bresnahan and Reiss (1991).

Because the number of liquor retailers in a ZIP code is likely correlated with demand and cost unobservables, we construct instruments for $NL_{z(u,t)}$ and $NL^2_{z(u,t)}$ inspired by the licensure threshold. In particular, we condition on the number of retail outlets within a ZIP code sized $5,000-15,000$ft^2, and then employ the number sized $10,000 - 15,000$ft^2 as an instrument. The essence of our identification assumption is that unobserved demand and cost characteristics are similar between markets with

[7] Among independents retailers sized $10,000$ft^2-$15,000$ft^2.

different numbers of retail outlets above and below the threshold, conditional on the number of firms in the bandwidth. Any differences in outcomes across these markets we therefore attribute to differences in the number of spirits retailers.

The first stage regressions specify the number of liquor outlets in ZIP code z at time t and its square as:

$$\begin{aligned} NL_{z(u,t)} =& \pi_0 + \pi_1 \cdot N^{10-15}_{z(u,t)} + \sum_i \tilde{\pi}_i \cdot N^{10-15}_{z(u,t)} \times 1\left[N^{15+}_{z(u,t)} = i\right] \\ & + \sum_k \lambda_k \cdot 1\left[N^{5-15}_{z(u,t)} = k\right] + \sum_j \gamma_j \cdot 1\left[N^{15+}_{z(u,t)} = j\right] + \epsilon_{z(u,t)} \end{aligned} \tag{3}$$

where the regressor of interest is $N^{10-15}_{z(u,t)}$, the number of pre-existing chain stores sized $10,000 - 15,000\text{ft}^2$. Controls include indicator variables for $N^{5-15}_{z(u,t)}$, the number of chain stores sized $5,000 - 15,000\text{ft}^2$, so that λ_k is a fixed effect for ZIP codes that had k beer/wine licensees sized $5,000 - 15,000\text{ft}^2$ in 2011. We also include fixed effects for the number of large retail outlets (above $15,000\text{ft}^2$) in the ZIP code ($N^{15+}_{z(u,t)}$). Finally, we allow for interactions between indicator variables for the number of large retailers and the number of retailers just above the threshold ($N^{10-15}_{z(u,t)}$). These interaction terms exploit variation in how pre-determined market characteristics mediate the effect of a marginally-eligible retailer, and provide additional instruments.

Results of these first stage regressions are presented in appendix A. As an example, in ZIP codes without a large beer or wine outlet, shifting a firm from just-below to just-above $10,000\text{ft}^2$ leads to an additional 1.27 liquor retailers. We do not report the full set of interactions out of space considerations, but the effects are smaller in ZIP codes with retailers above $15,000\text{ft}^2$, consistent with crowd-out.

In Appendix D we repeat the previous covariate balance exercise, but now at the market level. Overall, we do not find significant differences across ZIP codes with different numbers of retail outlets sized just above and below $10,000\text{ft}^2$, conditional on having the same number of stores in the bandwidth. This also holds for characteristics of the Nielsen households living in these ZIP codes, including their pre-privatization liquor purchases. We interpret these results as strong evidence that the proposed instrument is not correlated with underlying liquor demand.

One potential concern is that the instruments described above might affect market outcomes through channels beyond the number of retailers. For example, shifting a firm above the licensure threshold could elicit an entry deterrence response by larger firms. In that case, the two-stage least squares exclusion restriction will not hold. However, the reduced form is still valid; it captures the net causal effect of license-eligibility on equilibrium outcomes. In what follows, we find that the economic magnitudes of the reduced form results are in line with the magnitudes of the two stage least squares results, so we do not revisit this point further. Results for these reduced form regressions are presented in Appendix A.

Finally, it is important to mention that while our regressions are specified at the ZIP code level, our estimation procedure does not assume that consumers only shop in their ZIP code or that the game being played by retailers is contained within a single ZIP code. Instead, we study whether consumers and retailers respond to exogenous variation at the ZIP code level. Our interest in ZIP code level effects is motivated in part by earlier work that demonstrates that most consumers shop within a few miles of home (Ver Ploeg et al. (2015)).

III. Effects of Market Structure

III.A. Price Effects

We first examine whether and to what extent increasing the number of retailers puts downward pressure on prices. We begin by estimating equation (3) at the retail outlet-level, so that the dependent variable of interest is the average price of liquor products offered by retailer u in month t. In column 1 of table 5, we present the results of this baseline regression. The point estimate implies that moving from 1 to 2 retailers increases average price by $0.635. This effect magnitude is small relative to the average pre-tax price in our sample, which is approximately $19.

This specification exploits variation in price across retailers and variation in price across UPCs, confounding how competition changes the price of a given product with how it changes product assortment. To sharpen the analysis, columns 2 and 3 progressively add retailer and UPC fixed effects. Across the board, point estimates are small and statistically insignificant, revealing that prices do not respond to an

Table 5: Effect of Market Configuration on Price ($)

Effect of Market Structure on Price ($)					
	Store			Household	
	(1)	(2)	(3)	(4)	(5)
# Liquor Outlets	0.902	0.394	0.168	1.424	0.981
	(0.511)	(0.38)	(0.290)	(1.591)	(1.182)
# Liquor Outlets^2	-0.089	-0.039	-0.022	-0.118	-0.059
	(0.036)	(0.027)	(0.021)	(0.124)	(0.090)
# Stores in the Bandwidth FE	X	X	X	X	X
# Stores above the Bandwidth FE	X	X	X	X	X
Month FE	X	X	X	X	X
Chain FE		X	X		
UPC FE			X		X
F-Stat	9.08	9.43	9.41	15.54	14.51
Observations	1,104,659	1,104,659	1,104,659	6046	6046

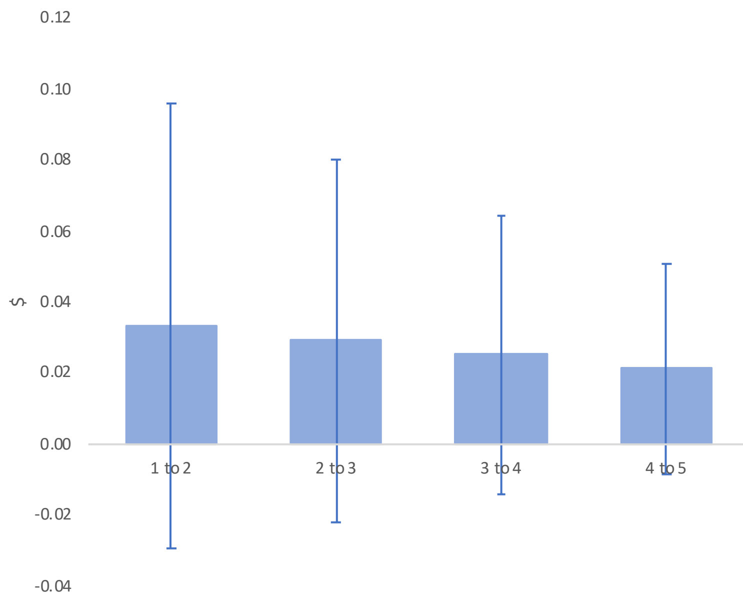
Notes: Standard errors clustered by ZIP code and reported in parentheses. Columns 1-3 use data on Nielsen scanner store sales in 2015. Columns 4&5 use data from the Consumer Panel from 2012-2015. The bandwidth is 5,000-15,000ft^2. The instruments include the interactions between the number of marginally license-eligible stores and a full set of indicators for the number of stores above 15,000ft^2. The mean pre-tax price of a liquor product (UPC) in 2015 was $18.82.

increase in local competition. Figure 4 plots the effect of increasing the number of retailers on price under our preferred specification, which controls for UPC and retail chain fixed effects. It highlights the precision of our estimates, which preclude a $0.04 price reduction at the 95% confidence level.

Columns 4 & 5 of table 5 examine prices for products purchased by Nielsen panelists. Because panelists record purchases at all stores, they allow us to test whether retailers that do not participate in the Retail Scanner dataset change their prices in response to enhanced competition. Again, we detect no effect of competition on prices. Taken together, these results are inconsistent with textbook models of retail price competition, but conform to the predictions of newer models where retail chains engage in uniform pricing across broad geographical zones.[8]

[8] To be clear, uniform pricing models predict low covariance between prices and competition at the local level, but they still allow for competition to affect prices if it changes the average demand elasticity faced by a retailer within a zone.

Figure 4: Effect of Market Configuration on Price ($)



III.B. Product Assortment Effects

The null price effects that we estimate beg the question of whether and how retailers compete on other margins, as in Berry and Waldfogel (2001) or Wollmann (2018). We begin to answer by exploring whether firms strategically alter their product assortments in response to competition. Specifically, we estimate equation (3) with dependent variables that capture features of the product assortments offered by retailers in 2015. Columns 1 and 2 of Table 6 present results using the number of unique products sold at retail outlet u in month t as the dependent variable. Column 3 presents results using the number of unique products in a ZIP code as the dependent variable. We label this column *union* as it corresponds to the cardinality of the union of UPCs offered across all retail outlets within a ZIP code. Column 4, in contrast, reports results where the intersection of the product assortments offered by retail outlets within a ZIP code is the dependent variable. Finally, column 5 reports results of the effect of market structure on the number of unique UPCs purchased by panelists.

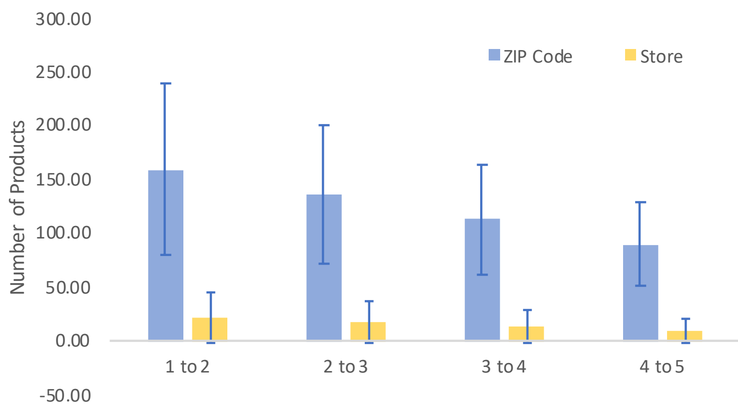
Both at the retail-outlet and ZIP code level, we find that competition increases

Table 6: Effect of Market Configuration on Number of Unique Products Offered/Purchased (UPCs)

Effect of Market Structure on Number of Unique Products (UPCs)					
	Store		ZIP Code		Household
			Union	Intersection	
	(1)	(2)	(3)	(4)	(5)
# Liquor Outlets	33.324	27.853	193.997	-53.664	0.157
	(27.865)	(15.931)	(45.688)	(28.492)	(0.041)
# Liquor Outlets^2	-3.055	-2.114	-11.572	3.200	-0.012
	(2.051)	(1.255)	(3.811)	(1.974)	(0.003)
# Stores in the Bandwidth FE	X	X	X	X	X
# Stores above the Bandwidth FE	X	X	X	X	X
Month FE	X	X	X	X	X
Chain FE		X			
Observations	4,630	4,630	1,377	1,377	31,875
F-Stat	9.81	11.1	7.15	7.15	13.01
Mean	304.78		453.8	60.451	0.15

Notes: Standard errors clustered by ZIP code and reported in parentheses. Columns 1-4 use data on Nielsen scanner store sales in 2015 at the monthly level. Column 5 uses data from the Consumer Panel from 2012-2015. The bandwidth is 5,000-15,000ft^2. Instruments include the interactions between the number of marginally license-eligible stores and a full set of indicators for the number of stores above 15,000ft^2. For reference, the mean number of products purchased by panel households per month is 0.27.

Figure 5: Effect of Market Configuration on Number of Products Carried



product assortment. Figure 5 plots the marginal effects implied by the coefficients in columns 2 (store level) and 3 (ZIP code level). Focusing on the retail outlet effects, we find that increasing the number of liquor retailers from 1 to 2 increases the average number of products offered per retailer by approximately 20 UPCs. This increase corresponds to 7.1% of the average number of products carried across all Nielsen retailers that sell spirits. As expected, the effect exhibits diminishing returns. For example, moving from 4 to 5 liquor retailers results in an increase of 8.8 UPCs (2.9%). At the ZIP code level, we find an increase of 159 UPCs (35.1%) when moving from 1 to 2 retailers. As before, the effect decreases when shifting from 4 to 5 retailers to 90 UPCs (19.8%).

These two results imply together that the difference between the total assortment in the market and the average assortment in a store increases with the number of firms (see Proposition 1 in Appendix E for a proof). This finding is consistent with competition inducing specialization among retailers. To provide additional evidence of differentiation, column 4 presents estimates of how the intersection of products offered across retailers in a ZIP code changes in the number of firms; the coefficients imply that the number of overlapping products (products that are carried by all stores) falls with entry.

Differentiation in product assortment may occur for two reasons: first, the marginally-eligible retailer may stock products that are new to the market and second, infra-marginal retailers (sized above $15,000\text{ft}^2$) may change their assortments in response to competition. Based on the revenue regressions presented in table 4, it seems unlikely that marginally-eligible retailers account for the totality of the new products available in the ZIP code because these retailers earn less than $10,000 per month in revenue from spirits. This revenue figure suggests that marginally-eligible firms offer a limited selection of liquors.

We also formally test whether infra-marginal retailers adjust their product offerings in response to exogenous shifts in competition. To fix ideas, consider a market with one infra-marginal retail outlet and one *potentially-eligible* retail outlet (i.e. sized between $5,000 - 15,000\text{ft}^2$). Assuming that both retailers enter when eligible, this market becomes a duopoly (monopoly) when the potentially-eligible retailer's square footage exceeds (lies below) $10,000\text{ft}^2$. Our test compares the product offerings of the infra-marginal firm across these two scenarios. To this end, corollary 1 in Appendix E demonstrates that a combination of the retail outlet- and ZIP code-level estimates presented in table 5 delivers a test for the null hypothesis that the infra-marginal firm does not change the number of UPCs it stocks in response to competition. The test is built on the observation that if the *infra-marginal* firm does not respond, then the sum of the marginal change in the union and intersection should be twice as large as the change in the average retail-level assortment. We can reject this hypothesis at the 1% confidence level.[9]

To summarize, we find that increasing the number of retailers increases the number of UPCs offered by individual retail outlet and in the market as a whole. Further, retail outlets within the same market differentiate in response to competition. These results are consistent with models such as Champsaur and Rochet (1989), where competition expands the product space.

As a robustness check, in column 5, we examine whether we can detect similar responses in panelist purchasing behavior. The results are consistent with our earlier findings; they indicate that a shift from monopoly to duopoly increases the number of unique UPCs purchased by panelists by 0.12 products per month (an 80.7% increase). In table A3, we also provide evidence on the types of products that retailers stock when facing increased competition; our results indicate an increase in large-format

[9]We construct standard errors by bootstrapping the test statistic 1,000 times with replacement.

(1.75L) and high-proof product.

III.C. Quantity and Revenue Effects

To recap, our results indicate that increasing the number of firm broadens product assortment without affecting prices. In this subsection, we explore effects on consumption. Table 7 presents estimates of specification (3) with several measures of quantity as the left-hand side variable.

At the retail outlet level (columns 1 and 2), the evidence on quantities is inconclusive. The point estimates indicate an increase of 9.23% (255 liter) and 8.37% (231 liter), respectively, when moving from monopoly to duopoly. However, these effects are imprecisely estimated and the 95% confidence intervals include a null effect. At the ZIP code (column 3) level, the estimates imply that duopolies sell 28% (712 liters) more liquor than monopolists, which is significant at the 5% level. The increase is 8.55% (214 liters) when moving from 4 to 5 firms in the market. Finally, at the household level (column 4) we find a 59% (0.16 liter) increase when shifting from monopoly to duopoly, and a 26.5% (0.07 liter) increase of moving from 4 to 5 firms. Taken together, our results indicate that liquor sales increases with an additional retailer, but the average retailer does not necessarily sell more liquor.

As a robustness check, in table 8, we repeat the previous exercise with monthly revenues as the outcome variable. As before, we find that increasing the number of retailers within a ZIP code increases market-level sales considerably: as shown in column 3, we find a 25.4% ($35,130) increase in revenue from a shift from monopoly to duopoly, and a 16.3% ($22,530) increase when moving from 4 to 5 firms. We also estimate the effect on revenues using administrative data from the Washington State Liquor Control Board, which comprises quarterly sales from all stores. This data includes, but is not limited to, stores in the Nielsen Scanner Dataset. As shown in column 4 reports, the estimates suggest a 51.1% ($260,860) increase in yearly revenues of a shift from monopoly to duopoly, and a 15.3% ($77,920) increase when moving from 4 to 5 firms. In contrast to the ZIP-code level estimates, the effect of retail outlet-level revenues is modest. Columns 1 and 2 present results at the store level, where the latter includes chain fixed effects. We find that revenues increase by 4.52% ($2,030) and 6.84% ($3,070), respectively, when moving from monopoly to

Table 7: Effect of Market Configuration on Liquor Volumes

Effect of Market Structure on Liquor Volumes (Liters)				
	Store		ZIP Code	Household
	(1)	(2)	(3)	(4)
# Liquor Outlets	124.663	50.419	1117.354	0.208
	(335.796)	(262.342)	(534.576)	(0.091)
# Liquor Outlets^2	-26.309	-9.561	-100.367	-0.015
	(25.469)	(20.483)	(44.265)	(0.007)
# Stores in the Bandwidth FE	X	X	X	X
# Stores above the Bandwidth FE	X	X	X	X
Month FE	X	X	X	X
Chain FE		X		
Observations	4,630	4,630	1,377	31,875
Mean	1,944	1,944	2,511	0.275

Notes: Standard errors clustered at the ZIP-level and reported in parentheses. Columns 1-3 use data on Nielsen scanner store sales in 2015 at the monthly level. Column 4 uses data from the Consumer Panel from 2012-2015.

duopoly, and the effects are even smaller for markets with more firms.

Why do consumers buy more liquor in markets with an additional retailer? First, consumers enjoy a broader product assortment. Second, for some consumers, the marginally-eligible retailer is more convenient than the infra-marginal retailer. In the markets that we study, marginally-eligible retailers are on average quite close to infra-marginal retailers; however, some consumers may place a large value on one-stop shopping for liquor and groceries, so that even small changes in distance could deliver large changes in utility (Seo (2016)).

At first blush, the result that average revenues per retailer increase (albeit modestly) is somewhat puzzling, as we would expect that marginally-eligible firms steal business from infra-marginal firms. Recall, however, that infra-marginal retailers expand their product assortment in response to competition. In appendix F we show through a simple model the incentive for a retailer to carry fewer products as a monopolist than it would when facing a competitor. Further, we demonstrate that under fixed prices, the monopolist can simultaneously earn less revenue and higher profits than when competing as a duopolist.

Taken together, our findings caution against a narrow focus on price in studies of

Table 8: Effect of Market Configuration on Liquor Revenues

Effect of Market Structure on Liquor Revenue & Expenditures					
	Store		ZIP Code		Household
			Nielsen	Alll	
	(1)	(2)	(3)	(4)	(5)
# Liquor Outlets	0.287	0.493	4.143	35.233	4.621
	(0.496)	(0.563)	(1.947)	(16.431)	(1.660)
# Liquor Outlets^2	-0.028	-0.062	-0.21	-3.049	-0.324
	(0.038)	(0.042)	(0.172)	(1.436)	(0.123)
# Stores in the Bandwidth FE	X	X	X	X	X
FE	X	X	X	X	X
Month/Quarter FE	X	X	X	X	X
Chain FE		X			
Observations	4,630	4,630	1,377	846	31,875
Mean	4.49	4.49	13.86	51.04	5.31

Notes: Standard errors clustered at ZIP-level. Columns 1-3 use data on Nielsen scanner store sales in 2015 at the monthly level. Column 4 uses quarterly revenue data from the WSLCB from Q3 2012 - Q4 2013. Columns 1-4 are measured in $10,000s. Column 5 uses data from the Consumer Panel from 2012-2015 and is measured in dollars.

market structure. This case study highlights two other channels, convenience and product assortment, through which retail competition benefits consumers.

III.D. Consumer Welfare Effects

In this section, we expand on our previous results by estimating the change in consumer welfare that arises from the increases in product assortment that we document above. To fix ideas, under the assumption that all consumers purchase weakly more spirits as the number of firms in the market increases, a shift from monopoly to duopoly will affect consumer welfare through four channels:

1. Increases in utility for consumers who do not purchase liquor under monopoly, but purchase under duopoly at the marginal retailer;

2. Increases in utility for consumers who do not purchase liquor under monopoly, but purchase under duopoly at the infra-marginal retailer;

3. Changes in utility for consumers who purchase spirits under both market configurations, but switch to shop at the marginal retailer under a duopoly;

and

4. Changes in utility for consumers who shop at the infra-marginal store under both market configurations.

Note that by revealed preference, (1) and (2) necessarily increase welfare because the outside option remains under both monopoly and duopoly - that is, consumers can always elect not to purchase spirits. In contrast, welfare for (3) and (4) depend on the composition of product assortments under monopoly and duopoly. Further, observe that both product assortment and convenience contribute to welfare changes for consumer types (1) and (3), while changes in product assortment alone affect welfare for consumer types (2) and (4).

Traditional demand estimation tools can be used to quantify welfare under these four scenarios, but its application poses two chief challenges. First, it requires defining choice sets for individuals; in contrast to our earlier analyses, we must now take a stand on which stores are considered by each individual. Second, it requires data on prices and product assortments at retailers that do not participate in the Nielsen RMS dataset. To circumvent these challenges, we focus on nineteen mass merchandizers in the Nielsen dataset that are located in ZIP codes with a potentially eligible retailer (a retailer sized $5,000 - 15,000$ft^2).[10] For simplicity, we assume that consumers who shop at these stores do not consider purchasing liquor elsewhere. We can then estimate demand at the outlet level, and calculate the change in consumer surplus when the mass merchandiser in question faces $N + 1$ rather than N competitors. Note that this welfare change stems solely from changes in product assortment, as the mass merchandiser is infra-marginal. That is, under these assumptions we are able to estimate a combination of the welfare changes for consumer types (2) and (4).

To be concrete, we estimate a store level nested logit demand system by two stage least squares (Berry (1994)) and calculate welfare for every store-week. The nests are (1) Bourbon, Whiskey, & Scotch, (2) Rum, (3) Tequila, (4) Vodka and (5) other liquor

[10] Although we do not know the exact identity of each RMS store (beyond 5-digit ZIP code), we are confident that mass merchandizers are not marginal to the $10,000$ft^2 threshold because of their format. Further, we found a null effect of our instrument on the number of mass merchandizers that sell spirits in a ZIP code (using specification (3)).

(such as Gin). Following Miravete et al. (2018)), we instrument for prices using input prices. However, we hesitate to use the number of products within a nest as an additional instrument despite its ubiquity in the literature. This instrument violates the exclusion restriction if retailers tailor their product assortments to unobserved demand shocks in the way they adjust assortments to local competition. Thus, we turn to the licensure square footage threshold as a source of identifying variation. We employ the number of stores sized $10,000 - 15,000\text{ft}^2$ as an instrument for nest shares, as we have previously documented that this shifts product assortment. Appendix G provides additional implementation details and estimation results. We calculate expected welfare using the demand estimates, and employ this measure as the dependent variable in equation 3 to identify the effect of market structure on consumer welfare. Standard errors are computed by block bootstrapping the whole procedure, with store-weeks as blocks. Reassuringly, our estimates imply an average own-price elasticity of -4.02, which is similar to Miravete et al. (2020), who peg the average elasticity at -3.75.

Results, presented in table 9, indicate that competition increases welfare, albeit with diminishing returns. Our estimates imply that an exogenous shift from monopoly to duopoly increases consumer surplus \$0.80-\$1.40/week, depending on the specification – roughly 3.1-5.5% of the average price of a bottle of liquor in Washington in 2015.[11] For comparison, moving from four to five firms increases welfare by \$0.16-\$0.37/week. While these results may appear unsurprising given our results on quantities, under the assumptions laid out above, this welfare increase stems solely from changes in product assortment. Thus, this simple model highlights the importance of product assortment responses to changes in competition.

III.E. Effects on Adverse Behaviors

To round out our study of market structure in retail liquor markets, we turn to understanding the implications of increased competition for social welfare. These implications are hard to nail down because total welfare depends on how society trades off consumption utility and the adverse effects of liquor consumption, such

[11] The average pre-tax price bottle of liquor is \$18.82. Excise taxes include a 20.5% proportional tax and a \$3.7708 per liter tax, so that the final price for a 750ml bottle is approximately \$25.50.

Table 9: Product Variety Effects of Market Configuration on Consumer Welfare

Product Variety Effects of Market Configuration on Consumer Welfare			
	(1)	(2)	(3)
# Liquor Outlets	1.175	1.226	1.977
	(0.189)	(0.180)	(0.629)
# Liquor Outlets^2	-0.113	-0.117	-0.179
	(0.0248)	(0.0232)	(0.0540)
Week FE		X	X
Chain FE			X
Marginal Effect			
1 to 2 Firms	0.835	0.875	1.441
	(0.123)	(0.119)	(0.472)
4 to 5 Firms	0.157	0.172	0.369
	(0.0867)	(0.0824)	(0.191)
N	54987	54987	54987

Notes: Bootstrap standard errors in parentheses, clustered at the week-store level. All columns use nested logit welfare estimates at the store level for mass merchandisers, and are measured in dollars per week.

as addiction or domestic abuse. Some of these adverse effects might occur in the future and may be hard to trace back to licensure restrictions and variation in market structure. Nonetheless, these social ills were the precise motivation for the $10,000\text{ft}^2$ licensure threshold.[12]

We adopt four approaches to shed light on these issues: first, we analyze the identities of complier households. In particular, we investigate whether the presence of an additional spirits retailer encourages teetotal households to purchase liquor or instead increases purchasing among households that were already at the high-end of the purchasing spectrum. Second, we study the relationship between market structure and heavy drinking, as defined by the Center for Disease Control (CDC). Third, we analyze whether changes in market structure increase liquor purchasing at the expense of alternative types of alcohol (such as beer and wine or purchasing spirits at restaurants and bars). And fourth, we study the relationship between market structure and alcohol-related car accidents.

[12] Harry Esteve. November 8, 2011. "Washington voters OK sales of liquor in big grocery stores." The Oregonian. http://www.oregonlive.com/politics/index.ssf/2011/11/washington_voters_ok_sales_of.html

Table 10: Effect of Market Configuration on Adverse Behaviors

Effect of Market Structure on Adverse Outcomes								
	Household Level (Monthly)					Zip Code Level		
	Buy Alcohol			Drink ≥ 2.66 L Alcohol	Beer & Wine Consumption (Gallons)	Accidents 06/2012-12/2015		Bars Operating January 2013
	All	Heavy Drinkers	Non-Drinkers			All	Severe	
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
# Liquor Outlets	0.073	0.204	0.011	0.071	-0.207	0.021	0.012	9.597
	(0.020)	(0.051)	(0.010)	(0.016)	(0.300)	(0.168)	(0.031)	(9.583)
# Liquor Outlets^2	-0.005	-0.017	-0.001	-0.005	0.029	-0.007	-0.000	-0.825
	(0.002)	(0.004)	(0.001)	(0.001)	(0.022)	(0.014)	(0.002)	(0.940)
# Stores in the Bandwidth FE	X	X	X	X	X	X	X	X
FE	X	X	X	X	X	X	X	X
Month FE	X	X	X	X	X			
Observations	31,875	8,024	17,810	31,875	31,875	141	141	141
Mean	0.095	0.199	0.031	0.047	0.711	1.820	0.074	34.589

Notes: Observations in column 1-5 are at the panelist-month level for May 2012 - January 2015, and standard errors are clustered at the zip code level. Observations in columns 5-7 are at the zip code level, and standard errors are heteroskedasticity-robust. Severe accidents include: "Dead at Scene," "Dead on Arrival," "Died in Hospital" or "Suspected Serious Injury." 2.66L of alcohol is the CDC definition of heavy drinking for men. "Heavy" in column 2 refers to households above the 75th percentile in average per-person consumption January 2010-May 2012. Instruments are interactions between the number of marginally eligible firms and indicator variables for the number of stores above 15,000 ft^2.

To understand which households respond to an increase in the number of firms, we classify Nielsen panelists according to their spirits purchasing behavior from January 2010 through May 2012–before privatization. Households are deemed "non-drinkers" if they never purchase liquor and "heavy drinkers" if they are in the top quartile of households in per-person ethanol purchases (among households who buy liquor at least once). For each group, we separately estimate the effect of market configuration on the likelihood of purchasing spirits using specification (3).

Column 1 in table 10 reports results for the full population. Compliers are 5.8 percentage points more likely to purchase liquor each month in duopoly compared to monopoly markets, and 2.8 percentage points more likely when moving from 4 to 5 firms. The effects for heavy drinking households are 14.8 percentage points and 5.1 percentage points, respectively. Finally, the effects for non-drinking households are negligible. Clearly, the response is concentrated among the households who purchased the most liquor before privatization.

Market configuration appears to operate on the intensive margin, which is concerning if it leads to excessive drinking and alcohol-related fatalities. To quantify whether this is the cause, in column 4 of table 10 we study whether entry affects the likelihood a household engages in heavy drinking, as defined by the CDC. [13]

[13] Heavy drinking is classified by the Center for Disease Control as more than 15 drinks per month

Results indicate that households in duopoly markets are 5.6 percentage points more likely to engage in heavy drinking than those in monopoly markets. The effect is 2.6 percentage points when moving from 4 to 5 firms. We consider these to be sizable effects.

A corresponding reduction in beer and wine purchasing or a reduction in consumption at bars could mitigate any adverse effects of higher spirits purchasing. In column 5, we use the same Nielsen data to study beer and wine purchases, and find no evidence of a change in response to the liquor licensure threshold. In column 8, we estimate equation (3) using the number of bars operating in the zip code as of January 2013 as the outcome variable, and also find noisy effects. While this last regression is admittedly under-powered, it does not support either of these stories.

Finally, we obtain a comprehensive dataset of alcohol-related accidents from the Washington State Department of Transportation to directly examine whether liquor market configuration affects car accidents. For every accident between 2010 and 2015, we observe location, date and time, as well as the sobriety level and any resultant injuries. One challenge is linking accident locations to purchase locations; we observe the ZIP code where an accident occurred, not the ZIP code where a driver purchased liquor. We therefore estimate a modified version of equation (3) at the ZIP code level, where the number of accidents in that ZIP code is the dependent variable. Coefficient estimates for the number of firms and its square are economically small and statistically insignificant. The estimates imply that a shift from monopoly to duopoly does not change the likelihood of an accident at all.

IV. Conclusion

This paper examines how market outcomes vary with the number of competitors, a central question in Industrial Organization. We establish causality using a quirk of Washington state's deregulation of liquor sales in 2012. Before 2012, only state stores could sell spirits, although private retailers sold beer and wine. At privatization, these retailers could apply for a spirits license, but only if their premises exceeded

for adult men. We calculate whether a household's purchasing per adult member of the household exceeds this limit. https://www.cdc.gov/alcohol/pdfs/excessive_alcohol_use.pdf

$10,000\text{ft}^2$. This threshold leads to differences in the numbers of spirits retailers across otherwise similar ZIP codes, which we exploit in an RD-inspired research design.

A first finding is a null effect of market structure on price, which contravenes textbook models of competition but squares with a burgeoning literature on uniform pricing in US grocery retail. Rather than compete in prices, our findings suggest that firms compete by adjusting their product assortments. We find that an exogenous shift from monopoly to duopoly broadens the product assortment of the average retail outlet by 7% and the market-wide assortment (pooled across all RMS retailers in the ZIP code) by 35%. Estimates from a stylized model of spirits purchasing suggest that this wider assortment increases consumer surplus on the order of $3.20 per month, roughly 12% of the average price of a bottle of hard liquor.

Our results have implications for antitrust analysis, cautioning against a narrow focus on price that may significantly understate the consumer benefit of enhanced competition. More broadly, models of retail competition that impose optimal pricing while ignoring the assortment margin may poorly approximate how these markets function. Finally, our findings speak to the success of Washington's licensure threshold as an instrument to mitigate the negative externalities associated with liquor consumption. Curbing entry does indeed reduce consumption, albeit only in relatively concentrated markets. Even in these markets, where consumers are less likely to engage in heavy-drinking, we observe no reduction in alcohol-related car accidents. An important caveat, however, is that our findings speak to the marginal effect of entry. Removing the licensure threshold altogether would constitute a much larger shock to market structure. As an example, the current threshold forecloses convenience stores, including 242 7-Eleven outlets. Perhaps it is unsurprising that Costco, whose stores average $140,000\text{ft}^2$, spent $22 million on advertising to support an incarnation of the referendum with this particular entry requirement.[14]

[14]Melissa Allison. July 18, 2011. "Costco revamps liquor-sales initiative." The Seattle Times. http://www. seattletimes.com/seattle-news/costco-revamps-liquor-sales-initiative/

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