The Effect of Price Advertising on Prices: Evidence in the Wake of *44 Liquormart*

By JEFFREY MILYO AND JOEL WALDFOGEL*

The 44 Liquormart decision, eliminating Rhode Island's ban on liquor price advertising, made Rhode Island the subject of a natural experiment for measuring the effect of advertising on prices. Using Massachusetts prices as controls, we find that advertising stores substantially cut only prices of the products that they advertise. Prices of other products, at both advertising and nonadvertising stores, do not change. Advertising stores cut their prices on products advertised by rivals, while nonadvertising stores do not. We find no reductions in price dispersion across stores. Newspaper-advertising stores appear to draw a higher share of customers after they advertise. (*JEL* L11, L51, L66)

Over the past four decades two views have emerged on the effects of price advertising on prices. The first one originates in the theoretical work of George J. Stigler (1961). In this view, advertising reduces the cost of consumer search and, in equilibrium, results in a lower mean and variance of prices. More recent models, such as Steven C. Salop and Joseph E. Stiglitz (1977), emphasize firms' decisions on how to set prices, given heterogeneity among consumers in their ability to acquire information.[1] While price advertising reduces the cost for consumers to become informed about prices, if consumers still face different costs of becoming informed, they can remain differentially informed in the post-advertising equilibrium. Consequently, price advertising may affect different firms' demand curves differently. Compared with traditional precursors, models emphasizing heterogeneous consumers predict different effects of price advertising on prices. The introduction of price advertising need not have the same effect across all firms. In particular, price advertising need not reduce the mean of prices or its variation across firms.[2]

Empirical studies of prohibitions on advertising (e.g., Lee Benham, 1972) have consistently found the permissibility of advertising to be associated with lower prices. The approach taken in the existing literature is to compare prices in jurisdictions that forbid advertising to prices in jurisdictions that permit advertising.[3] It has commonly been inferred from the association between advertising and prices that price advertising *causes* prices to be lower; indeed,

* Milyo: Department of Economics, Braker Hall, Tufts University, Medford, MA 02155; Waldfogel: Public Policy and Management Department, The Wharton School, University of Pennsylvania, Philadelphia, PA 19104. We are grateful to Mary Benner, Jerry Drummond, Tim Groseclose, and Hannah and Sarah Waldfogel for help gathering data. Chris Dulude of the Rhode Island Lottery provided information on lottery sales. We received helpful comments from two anonymous referees, Al Klevorick, Jonathan Baker, Kyle Bagwell, Judy Chevalier, Amihai Glazer, Tim Sass, and seminar participants at the Federal Trade Commission, the University of Chicago, Tufts University, Pennsylvania State University, the College of William and Mary, The Wharton School, Yale University, the Duke University/University of North Carolina joint applied economics seminar, and the NBER Summer Institute joint IO/Law and Economics session. We alone are responsible for any errors.

[1] See also Gerald R. Butters (1977), Gene M. Grossman and Carl Shapiro (1984), and Michael Peters (1984).

[2] Salop and Stiglitz (1977) model an economy with a homogenous product in which consumers differ in their cost of becoming informed about firm prices. They demonstrate that equilibrium does not require that all firms sell at the perfectly competitive price. In equilibrium firms that sell disproportionately to uninformed consumers can profit by raising their prices above marginal cost. Advertising may serve to reallocate consumers among firms in such a way that more firms find it to their advantage to charge noncompetitive prices in equilibrium.

[3] This is the approach of Benham (1972), Roger D. Feldman and James W. Begun (1978), and John E. Kwoka (1984), who compare prices of eyeglasses and optometry services across states, and John F. Cady (1976), who compares prescription drug prices across states.

this has become a standard lesson in textbooks [e.g., Jean Tirole (1995) and Lynne Pepall et al. (1998)]. However, the attribution of cross-jurisdictional differences in prices to differences in advertising prohibitions ignores both the possible endogeneity of these regulations and the inability to control for omitted firm-specific or market-specific factors in single cross sections.

In contrast, we make use of an exogenous change in price advertising to measure its effect on prices in longitudinal data. In the *44 Liquormart* case the U.S. Supreme Court overturned a Rhode Island ban on advertising the prices of alcoholic beverages. Prior to May 13, 1996, Rhode Island retailers could not advertise prices in any way.[4] Since 1956, Rhode Island had maintained explicit prohibitions on the publication or broadcast of the prices of alcoholic beverages. While Rhode Island argued before the Supreme Court that the law was designed to promote temperance, Evan Lawson, the attorney arguing the case against the ban, claimed that "everybody in the courtroom knew that in reality the ban was a way of helping liquor dealers fix prices." Newspaper accounts (John E. Mulligan, 1995) acknowledged "little dispute that a byproduct of the ban has been to assist 'mom and pop' package stores that tend to charge higher prices than bigger retailers." The Rhode Island Liquor Stores Association's support of the ad ban, because "smaller retailers would be devastated by the kind of advertising splash that big chains would sponsor," was consistent with Lawson's claim.[5] The Supreme Court rejected Rhode Island's defense of the law, in part because temperance could be advanced by more direct means, such as higher taxes.

This decision made Rhode Island the subject of a natural experiment for testing the effects of price advertising on both the level and variation of market prices. For our study we collected longitudinal data on Rhode Island retail prices of alcoholic beverages, as well as two controls for retail prices, Rhode Island wholesale price and retail prices in neighboring Massachusetts, where price advertising had been legal and remained so.

In addition to measuring the overall effect of advertising on prices, we also attempt to document the mechanism by which advertising affects prices. Does advertising only reduce prices of advertised products and only at the stores that advertise? Or does advertising reduce average prices of products at advertising stores, regardless of whether the products are advertised? Does the effect of advertising propagate across stores, so that all stores, including nonadvertising stores, reduce their prices? This is the mechanism suggested by Stigler (1961). Furthermore, how do prices vary with rivals' price advertising? We address these questions by estimating separate effects of the change in the law on prices at advertising and nonadvertising stores. We also measure how the effects vary according to whether products are advertised at a rival's store. By showing whether the effects of advertising differ across stores and products, our answers shed light on the importance of consumer heterogeneity in the post-advertising equilibrium.

We do find that the association between changes in prices at a particular store and the presence of advertising by rival stores varies across advertising and nonadvertising stores. Newspaper-advertising stores charge lower prices on products advertised elsewhere, while nonadvertising stores do not. This association between store prices and rival advertising suggests that different stores service different types of customers (in terms of their price elasticity of demand), so that these stores react differently to the ability to advertise. However, even though price advertising has little effect on overall prices charged, price advertising may nevertheless provide valuable information. Stores that ultimately advertise in the newspaper have lower prices than other stores both before and after price

[4] Not only could they not advertise in the media, they could not post prices in their windows or on signs outside their stores. Stores were forbidden even from sending or faxing price information to customers. John Haronian, owner of 44 Liquormart, initially challenged the advertising restriction when he was cited for using the word "wow" in an ad that included prices of peanuts and potato chips along with pictures of various liquor products. At the urging of Haronian's competitors, the State of Rhode Island interpreted the ad as an illegal suggestion about prices (interview with John Haronian). See also Andrews Publications (1996).

[5] Notwithstanding this reference to chain stores, Rhode Island law prohibits ownership of multiple liquor stores.

advertising becomes legal. Further, consumers apparently heed the signals provided by price advertising. Indirect information on quantities sold, based on Rhode Island lottery ticket sales, indicates that advertising stores draw a higher share of customers after they advertise than before.

The paper proceeds in four sections. Section I describes the existing empirical literature, its appeal, and the shortcomings inherent in the data researchers have examined. Section II describes the data employed in the current study. Section III presents our measurement strategy, results, and some speculation about interpretation. A brief conclusion follows.

I. Empirical Literature on Advertising Prohibitions

Most empirical work on the effect of advertising on prices relies on cross-sectional comparisons of prices in jurisdictions allowing and forbidding price advertising. This is the approach of Benham (1972), who compares eyeglass prices across states, Cady (1976), who compares prescription drug prices across states, and Feldman and Begun (1978, 1980) and Kwoka (1984), who compare prices of optometry services across states. These studies find that prices are higher and exhibit greater variation in jurisdictions that forbid advertising.

Identifying the effect of advertising in cross-sectional data requires a strong assumption: that advertising restrictions are exogenous to prices. It is difficult to know whether estimated relationships between advertising permissibility and prices reflect an effect of advertising on prices or the influence of some third factor on both.[6]

Amihai Glazer's (1981) study of the effect of advertising on grocery prices is a significant exception to the cross-sectional studies discussed above.[7,8] He identifies the effect of advertising using exogenous variation in advertising provided by a newspaper strike. He compares the evolution of prices at stores that generally advertise, but are unable to advertise during the strike, with the evolution of prices at "control" advertising stores that continue to advertise, unaffected by the strike. He finds that the stores that stop advertising raise their prices, relative to the controls, during the strike and reduce them again afterward.

By design Glazer's study includes only commonly advertised produce and meat products. Hence, Glazer's results address the question of how advertising affects the prices of advertised products at the stores advertising them. In an environment such as a grocery (or liquor) store, which carries many products and advertises prices of relatively few products, this distinction is important. He finds that advertising reduces the price of advertised products at stores that advertise but that advertising has no effect on the prices of the advertised products at smaller stores that do not normally advertise. Because Glazer includes only commonly advertised products in his sample, his results do not measure the effect of a store's advertising on its prices of products that it does not advertise. Our measurement approach is similar to Glazer's. However, our sampling approach is quite different. We sample prices of a broader group of products, including both some that do, and

[6] Benham (1972) cautions that advertising restrictions may be correlated with other market conditions or regulations that may themselves cause higher prices. He therefore recommends that future research examine the effects of changes in advertising regimes, an approach taken here.

[7] William Luksetich and Harold Lofgreen (1976) take a related approach. They examine retail prices of alcoholic beverages before and after lifting of a ban on price advertising in Minnesota in 1973. However, their pre- and postchange data are not collected by the same agencies and can not be linked, so their data are not truly longitudinal.

[8] D. Grant Devine and Bruce W. Marion (1979) analyze the effects of state-sponsored experiment in which the Canadian Food Price Review Board collected grocery price data from stores in a test and a control market. The Board then publicized prices—through newspaper ads and direct mail—in the test market. They find that this exogenous increase in consumers' information causes the mean and variance of food prices to decline in the test market relative to the control market. The contrast between what they measure and what we measure is important, however. Their interesting study documents the effect of forced exogenous advertising, while we are measuring the effects of the *permissibility* of price advertising.

predominantly those that do not, become commonly advertised.

II. Data

The basic information for this study are a longitudinal data set consisting of 6,480 observations on the retail prices of 33 alcoholic beverage products at 115 different liquor stores in Rhode Island and Massachusetts between June 1995 and June 1997. We also collected information on wholesale prices in both states, as well as information on advertising and state lottery sales in Rhode Island.

A. *Price Data Collection Procedure*

Liquor stores sell hundreds of different products and few stores in Massachusetts or Rhode Island employ checkout scanners, so it is not feasible to collect data on the prices of all products. Recognizing this, we solicited the advice of some liquor retailers in order to devise a list of widely available products. Our sample includes the national top-selling brands of beer (Budweiser), whiskey (Jack Daniels), gin (Tanqueray), rum (Bacardi), and sparkling wine (Korbel); the full product sample is listed in Table 1.[9] However, during our first efforts to collect price information, we discovered that many retailers strongly object to the gathering of price data in their stores.[10] For this reason, we collected price information surreptitiously; at times, we were forced to narrow our product list to a subset of roughly ten products whose prices we could collect by memorizing.[11]

TABLE 1—PRODUCTS IN THE SAMPLE

Product	Number of observations	Average price
Liquor	2,667	$16.55
Bacardi 80 proof rum (0.75 liter)	224	$ 9.43
Bacardi 80 proof rum (1 liter)	298	$12.13
Jack Daniels Tennessee Whiskey (0.75 liter)	281	$14.94
Jack Daniels Tennessee Whiskey (1 liter)	457	$19.00
Kahlúa (0.75 liter)	283	$15.07
Kahlúa (1 liter)	436	$20.49
Stolichnaya Vodka 80 proof (0.75 liter)	130	$15.42
Stolichnaya Vodka 80 proof (1 liter)	134	$19.03
Tanqueray Gin (0.75 liter)	180	$15.91
Tanqueray Gin (1 liter)	244	$20.08
Beer	1,706	$ 7.15
Amstel Light 6-pack	56	$ 6.64
Budweiser 12-pack (cans)	491	$ 8.44
Coors 12-pack (cans)	173	$ 8.79
Heineken 6-pack (bottles)	195	$ 6.61
Labatts Blue 6-pack (bottles)	56	$ 5.67
Miller High Life 12-pack (cans)	138	$ 6.76
Molson 6-pack (cans)	78	$ 5.78
Narragansett 6-pack (cans)	28	$ 3.16
Sam Adams 6-pack (bottles)	491	$ 6.27
Wine	915	$ 5.68
E & J Gallo Cabernet Sauvignon	81	$ 4.68
E & J Gallo Chardonnay	394	$ 4.76
Fetzer Cabernet Sauvignon	41	$ 7.47
Fetzer Sundial Chardonnay	53	$ 7.27
Glen Ellen Chardonnay	57	$ 5.76
Glen Ellen Merlot	46	$ 5.81
Mouton Cadet (red)	54	$ 8.48
Mouton Cadet (white)	56	$ 8.37
Sutter Home Cabernet Sauvignon	60	$ 5.38
Sutter Home Chardonnay	73	$ 5.54
Champagne	1,192	$15.45
Freixenet Cordon Negro Brut	431	$ 8.07
Korbel Brut	361	$10.80
Moet & Chandon Brut	156	$30.07
Moet & Chandon White Star	244	$26.04
All	6,480	$12.34

We began collecting data in June of 1995, shortly after learning that the U.S. Supreme Court had agreed to hear the *44 Liquormart* case in its next term. We knew that a decision would arrive sometime between the fall of 1995 and summer of 1996, but we did not

[9] Information on top-selling national brands is from the *Massachusetts Beverage Price Journal* (formerly, the *Massachusetts Beverage Journal*) and the *Rhode Island Beverage Journal*.

[10] When asked, one store manager said, "I don't allow that kind of thing in my store." Even when the owner was not present, store employees were generally reluctant to grant us permission to gather price data.

[11] As the numbers of observations in Table 1 indicate, the short-list products always include: Jack Daniels (1 liter), Budweiser 12-pack (cans), Samuel Adams 6-pack (bottles), E & J Gallo Chardonnay, Kahlúa (1 liter), and Freixenet Cordon Negro Brut and Korbel Brut sparkling beverages (all 0.75 liter).

know how the Supreme Court would rule.[12] When the advertising ban was found unconstitutional in May 1996, we were positioned to produce a unique data set on retail prices from both before and after the Court's ruling. However, unless prices were expected to remain constant in the absence of a change in the law, we could not measure the effect of the change in the law using only data on Rhode Island retail prices. Rather, we needed some other controls that might show how retail prices would have evolved in the absence of a change in the law.

We obtained three additional controls for Rhode Island retail prices. First, we obtained retail price data for Massachusetts, where liquor price advertising was already legal. These prices were collected in the same manner as those in Rhode Island. We selected Massachusetts, both because it is adjacent to Rhode Island and because the Providence metropolitan area is essentially contiguous with that of Boston. Hence, we expected factors apart from the possible law change—and therefore retail prices—to evolve similarly in both places.[13] Second, we collected information on wholesale liquor prices in Rhode Island; these data are published each month in the *Rhode Island Beverage Journal.*[14] Since wholesalers in Rhode Island enjoy statewide exclusive territories for nearly every product in our sample, we were not confronted with multiple wholesale prices for each product.[15] Finally, we also collected monthly wholesale prices in Massachusetts, from the *Massachusetts Beverage Business.* However, because multiple wholesalers may offer any particular product in Massachusetts, we use the average of the listed wholesale prices as our measure of a product's wholesale price.[16]

An important caveat must be made regarding the wholesale price data. We observe only posted prices, not actual exchange prices. Published wholesale prices do not reflect quantity discounts and therefore may be inaccurate in their levels. However, if the Rhode Island markup (retail price − wholesale price) is stable during the period prior to the change in law, then we can use Rhode Island wholesale prices as a control for retail prices. If, on the other hand, the markup varies over time but is otherwise similar in the two states, then we can use the markup in Massachusetts as a control for the markup in Rhode Island.

Our retail price data were collected on 540 store visits in the two states. We visited 58 different stores in Rhode Island (one-quarter of the 232 liquor stores in the state)[17] and 57 stores in Massachusetts. Our store visits took place at approximately quarterly intervals (see Table 2). The Supreme Court decided *44 Liquormart* on May 13, 1996 by a 9–0 vote for the plaintiff, immediately lifting Rhode Island's ban on price advertising; several stores began advertising that same month. In June of 1996 we visited most of the stores in both states, and we continued our quarterly visits through the following June. Although time and budget constraints prevented us from collecting a balanced panel, we did make multiple visits to every store.

Our sample includes stores in three areas of Rhode Island and Massachusetts:

(1) *Southern Rhode Island.* All stores in Warwick, Cranston, North Kingstown, East Greenwich, West Warwick, and Exeter, as well as stores adjacent to these towns in Johnston, South Kingstown, and Coventry.
(2) *Northwest Boston Suburbs.* Stores in the northwest-of-Boston towns of Bedford, Billerica, Burlington, Everett, Lexington,

[12] We spoke to several retailers who were members of the Rhode Island Liquor Store Association; they did not expect to lose the case.

[13] Of course, wholesale and retail liquor sales are regulated (taxed) at the state level and this regulation (taxation) is different in Rhode Island and Massachusetts. However, with the exception of the possible change in Rhode Island advertising, there is no reason to expect differences across state regulation (taxation) to affect the time pattern of prices in Massachusetts relative to Rhode Island (no other state regulations or taxes changed during the period of our study).

[14] This is a common practice for the industry in this region; similar price journals are published in Connecticut, Massachusetts, and New York. State laws in Connecticut and Massachusetts require wholesalers to post the prices of alcoholic beverages each month.

[15] The exceptions were Kahlúa, Heineken, Amstel Light, and Narragansett beer; in each of these cases we used the average posted wholesale price in Rhode Island.

[16] There is very little price variation across Massachusetts wholesalers. For example, in June 1995 all wholesalers charged the same price on 29 of 33 sample products.

[17] The source for the total number of liquor stores in Rhode Island is the GTE Superpages (http://www.superpages.net).

TABLE 2—TIMING OF PRICE SURVEYS AND ADVERTISING

Dates	Number of stores visited		Number of stores advertising in Rhode Island		Number of newspaper advertisements in Rhode Island	
	Rhode Island	Massachusetts	Sample	All	Sample	All
June 1995	22	18	0	0	0	0
September 1995	30	39	0	0	0	0
February 1996	15	11	0	0	0	0
June 1996	49	39	3	10	4	15
September 1996	21	41	1	3	1	3
December 1996	52	46	5	15	27	45
March 1997	52	27	6	17	16	25
June 1997	26	44	0	13	4	17

Note: Sample refers to all stores in the Rhode Island sample, not just those visited on a particular date.

Malden, Reading, Stoneham, Winchester, and Woburn.

(3) *Rhode Island/Massachusetts Border*. All stores in the town of East Providence, Rhode Island, and four stores in adjacent Seekonk, Massachusetts.[18]

While we do not directly observe quantities sold, we do observe a relevant proxy, sales of Rhode Island lottery tickets. The Rhode Island Lottery Commission provided us with lottery ticket sales, by agent, for five separate time periods surrounding the period of our study, one entirely before the law change and three entirely after (see Table 8). While lottery ticket sales may not be proportional to liquor sales across stores, we propose to proxy a store's change in liquor sales with its change in lottery revenue.

B. *Sample Characteristics*

Table 1 shows the 33 products included in the sample, the number of observations for each product and their average prices. Products in the sample range in price between an average of $3.16 for a 6-pack of Narragansett beer and $30.07 for a 0.75 liter bottle of Moet & Chandon Brut champagne. Because of this variation across products, we analyze the natural logarithm of prices and we include product dummies in all of our regressions. For similar reasons, we define the markup to be the natural logarithm of the retail price less that of the wholesale price (the percentage markup ranged from 8 percent on champagnes in the sample to 15–20 percent on beers). In all, we collected 2,844 retail price (and markup) observations in Rhode Island and 3,636 in Massachusetts.

C. *Advertising After the Ban*

After the ban on advertising was lifted in Rhode Island, only some of the retailers in our sample chose to advertise. We collected systematic data on two forms of price advertising: signs displayed at the stores themselves (e.g., window displays) and print advertisements in newspapers. Both of these forms of advertising were illegal in Rhode Island prior to May 1996.[19] Information on window advertising was obtained during our store visits. By the end of our data collection in June of 1997, 32 of the 58 sample stores in Rhode Island had employed some form of window advertising, compared to all but one of the sample stores in Massachusetts. The data on print advertisements were collected from the area's only major newspaper, the *Providence Journal-Bulletin*.[20] We moni-

[18] It is important to note that, with the exception of the four Massachusetts stores near the border, the remaining Massachusetts stores are too far from Rhode Island to be affected by Rhode Island market conditions.

[19] Retailers in Rhode Island were always allowed to display price information inside their stores, provided these displays were not visible from outside the store.

[20] We also monitored several town-specific weekly publications, but found no advertisements placed by liquor stores for the months in which we collected price data.

tored all regional editions of the *Providence Journal-Bulletin* for liquor store ads during the months of data collection from the time that the advertising ban was lifted until June of 1997. We collected information on newspaper price advertising by all liquor stores, not only for advertisements placed by the stores in our sample. That allows us to measure the association between rivals' newspaper advertisements and own prices, as well as that between own advertisements and own prices. In most of the following analysis, we distinguish only between newspaper advertisers and nonadvertisers.[21] Unless otherwise noted, all references to advertisements concern newspaper advertisements.

Of the 58 stores in the Rhode Island sample, only nine ran advertisements in the newspaper in the year following the change in law, but most advertising stores ran multiple advertisements during the year. Table 2 shows the number of stores in Rhode Island running newspaper advertisements and the number of ads run. The information is presented for the month of each survey wave, for stores in the sample and for all stores advertising in the newspaper.[22]

III. The Effect of Price Advertising on Prices

A. *Do Low-Price Stores Advertise?*

Before turning to the effect of advertising on prices, it is interesting to ask whether the Rhode Island stores that ultimately choose to advertise already had lower prices under the ban. This is an important question because advertising can convey valuable information to consumers even if stores' prices do not change. Because we have information on stores both before and after the advent of advertising in Rhode Island, our data allow us to answer this question. In effect, we ask whether stores use advertising to communicate that they have low prices. We test for this by regressing (log) prices in Rhode Island prior to the change in the law on product dummies, time dummies, and two mutually exclusive dummies indicating whether and how a store chooses eventually to advertise. The first dummy variable is one for prices at stores that eventually employ window, but not newspaper, advertising. The other dummy is one for prices at stores that eventually advertise in the newspaper. Those Rhode Island stores that eventually choose to advertise prices in their windows (24 of 58 stores) had significantly lower prices (5.61 percent lower, $t = 9.92$) prior to May of 1996, than did nonadvertising stores in Rhode Island. Stores that eventually advertise in the newspaper had prices which were 7.71 percent lower than prices at nonadvertising stores prior to June 1996 ($t = -9.83$). The fact that stores that eventually choose to advertise had lower initial prices is consistent with the notion that advertising provides a valuable signal to consumers.[23] If advertising diverts customers from high- to low-price stores, then the mean and variance of prices *paid* can decline, even if no store changes the prices that it *charges.*

B. *Measuring the Effect of Price Advertising on Prices Charged*

We now turn to the main question of the paper, whether advertising affects prices that stores charge. We first ask whether there are aggregate effects on prices of alcoholic beverages. Because the sample is unbalanced in both stores and products, we must control for products and stores to isolated time effects. We allow for state-specific product effects because stores face different wholesale prices and possibly different demand conditions in the two states. We therefore estimate price and markup regressions with store effects, state-specific product fixed effects, and state-specific time effects:

[21] We found no difference between the pricing behaviors of nonadvertisers and window-only advertisers, so window-only advertisers are grouped with nonadvertisers in the analysis in the text.

[22] Some nonsample Massachusetts stores located near the Rhode Island border also place advertisements in the Rhode Island newspaper.

[23] Of course, this alone does not demonstrate the value of advertising as a signal. In fact, the information signaled by advertising may be redundant if other signals exist. For example, in our store visits, we quickly noticed that large stores had lower prices. As an informal test of this, we recorded subjective evaluations of store size; these size ratings are closely associated with both initial price levels and whether stores choose to advertise. Even when price advertising was prohibited, stores could conceivably have achieved coordination through advertising their size, as in Kyle Bagwell and Garey Ramey (1994a, b), but we did not observe this sort of advertising.

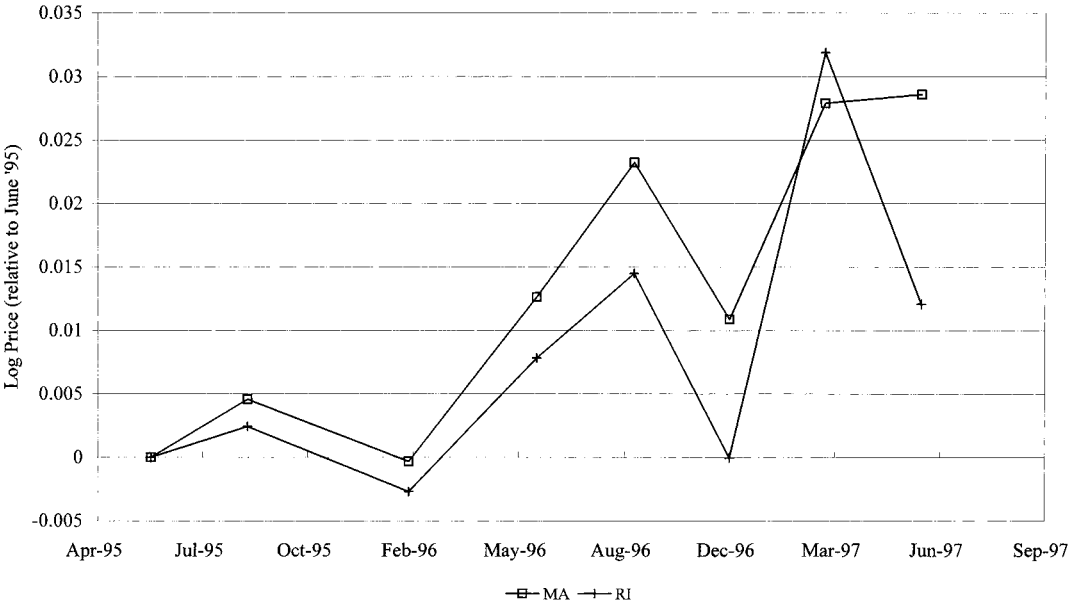

FIGURE 1. TIME EFFECTS IN RHODE ISLAND AND MASSACHUSETTS (LOG PRICE)
STORE AND STATE-PRODUCT FIXED EFFECTS

$$p_{sdt} = \theta_s + \gamma_d + \gamma'_d\delta^{RI} + \alpha_t + \alpha'_t\delta^{RI} + \epsilon_{sdt},$$

where p_{sdt} is either the log price or the percentage markup [measured as log(retail price/wholesale price)] on product d at store s at time t; θ_s is a store effect; γ_d is a product effect; γ'_d is the deviation between the Massachusetts and Rhode Island effect for product d; α_t is a time effect; δ^{RI} is an indicator that is 1 for prices at Rhode Island stores; α'_t is the difference between the time t effect in Rhode Island and Massachusetts; and ϵ_{sdt} is an idiosyncratic error. The time periods run from 1 (June 1995) to 8 (June 1997), and time periods 4 through 8 fall after the change in the law. With a spanning set of store dummies, we set $\alpha_1 = \alpha'_1 \equiv 0$.

Figure 1 presents the Massachusetts and Rhode Island time effects from the log price regression. While more formal tests follow, a number of things are clear from Figure 1. First, prices are not stable over time. Prices rise by 2 to 3 percent in the two states over the two-year period, although almost all of this increase occurs in both states after the change in Rhode Island law. This immediately suggests that the change in Rhode Island price will provide a poor measure of the effect of the law. Even though Rhode Island prices are stable prior to the change in the law, the subsequent price changes in both states undermine the assumption of stable prices in the absence of the change in the law. Second, prices in the two states do appear to move together. This suggests that Massachusetts prices provide a reasonable control for Rhode Island prices. Third, there is no clear effect of the lifting of the ad ban on Rhode Island prices. While Rhode Island prices rise relative to their own history, in four of five postlaw-change periods, Rhode Island prices have risen less far than Massachusetts prices, suggesting a negative effect of price advertising on prices.

Figure 2 shows the pattern of markups by time analogous to the log prices in Figure 1. While the Rhode Island markup is lower after the ban is lifted than before, the Massachusetts markup declines as well. This suggests that the change in the Rhode Island markup provides a misleading measure of the effect of price advertising. Because Massachusetts and Rhode Island markups move together, however, the Massachusetts markup appears to be a suitable control for the Rhode Island markup. We move now to more formal measurement approaches.

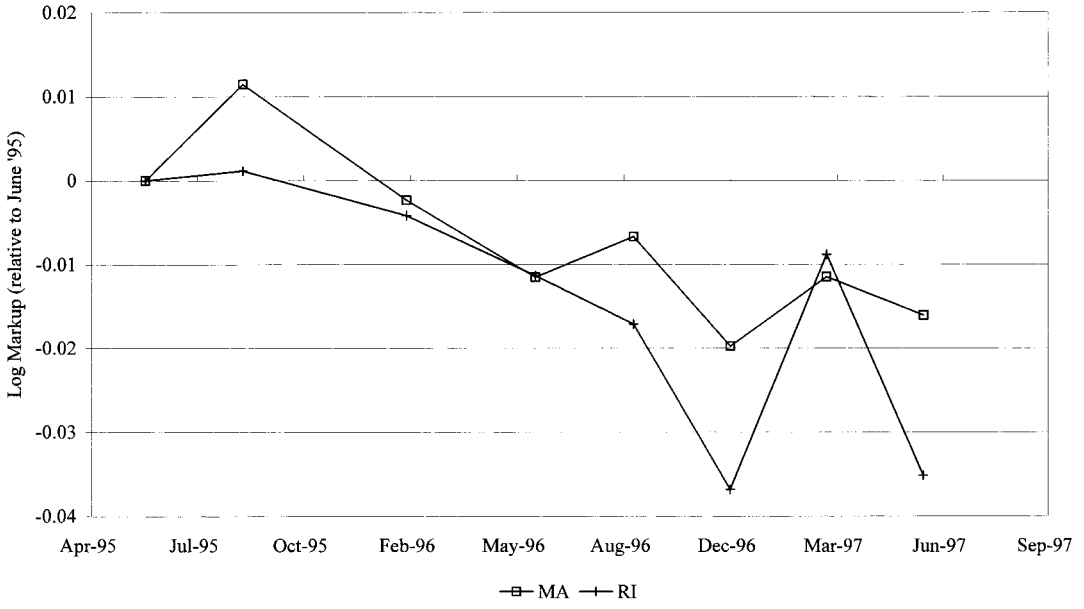

FIGURE 2. TIME EFFECTS IN RHODE ISLAND AND MASSACHUSETTS (MARKUP)
STORE AND STATE-PRODUCT FIXED EFFECTS

Given the evidence in Figures 1 and 2, we propose to measure the aggregate effect on prices using a difference in difference approach, identifying the effect as the deviation between Rhode Island and Massachusetts time patterns in prices or markups following the change in the law. Because we have data on prices and markups in multiple periods prior to the change in the law, we can test the control by asking whether Rhode Island prices or markups follow the time patterns of their Massachusetts analogues before the law changes, or whether $\alpha_2' = \alpha_3' = 0$. We estimate the overall effect by constraining $\alpha_4' = \alpha_5' = \alpha_6' = \alpha_7' = \alpha_8'$. In addition to estimates with store and state-product fixed effects, we also perform estimates allowing the pattern of prices across products to vary across stores by including store-product fixed effects.

C. *Testing the Controls*

Table 3 reports *F*-tests for the null hypotheses that log prices and markups in Massachusetts track those in Rhode Island prior to the change in the law. The first two columns are based on regressions including store and state-product effects. The last two columns are based on regressions with store-product effects. We can not reject any of these control approaches under any of the three specifications of store and product effects.[24]

D. *Overall Effects of Advertising on Prices*

Table 4 reports estimates of the overall effect of advertising using two different specifications for product and store effects. The first two columns report estimates that include store and product effects. The last two columns report estimates including store-product effects. Estimates vary between −0.39 percent and −0.80 percent, and none are significantly different than zero.

These results stand in contrast to what has been previously inferred from cross-sectional comparisons of prices. While the literature has found that jurisdictions permitting advertising

[24] We also attempted to use the Consumer Price Index for malt beverages, imported and domestic vodka, and wine in the Northeast as controls for Rhode Island prices. However, we rejected the constancy of the ratio of Rhode Island prices to average Northeast alcoholic CPI indices prior to the change in the Rhode Island law.

TABLE 3—TEST OF CONTROLS

Log price in Massachusetts and Rhode Island	Markup in Massachusetts and Rhode Island	Log price in Massachusetts and Rhode Island	Markup in Massachusetts and Rhode Island
0.65	0.47	0.45	0.77
(0.52)	(0.63)	(0.64)	(0.46)
State-product and store fixed effects		Store-product fixed effects	
$F_{(2,6319)}$		$F_{(2,4047)}$	

Notes: These are test statistics of the hypotheses that, prior to the change in the law, Massachusetts and Rhode Island prices and markups move together. Regressions in columns 1 and 2 include separate product effects for each state, as well as store fixed effects. Regressions in columns 3 and 4 include store-product effects All regressions include 6,480 observations. Coefficients are in percentages. Probability values appear in parentheses.

TABLE 4—OVERALL EFFECT OF ADVERTISING ON PRICES

Log price in Massachusetts and Rhode Island	Markup in Massachusetts and Rhode Island	Log price in Massachusetts and Rhode Island	Markup in Massachusetts and Rhode Island
−0.51	−0.73	−0.39	−0.80
(−1.15)	(−1.58)	(−1.02)	(−1.94)
State-product and store fixed effects		Store-product fixed effects	

Notes: Coefficients are in percentages. *T*-statistics are in parentheses. Regressions in columns 1 and 2 include separate product effects for each state, time effects, and store fixed effects. Regressions in columns 3 and 4 include time effects and store-product effects. All regressions are based on 6,480 observations.

have prices substantially below jurisdictions allowing advertising, we find no significant effect.[25] A few caveats are in order, however. First, as we have mentioned above, our data concern prices charged. Prices paid may decline—if customers shift toward low-price stores—even if prices charged remain constant. Second, our sample is not necessarily representative of products sold.

We estimate this overall effect of advertising on prices by grouping all stores and products together. However, if advertising and nonadvertising stores behave differently, then the aggregate effect may obscure some more complex behavior. Consequently, in the subsequent tables, we decompose the advertising effect by whether products are advertised and by whether stores advertise.

[25] For example, Benham (1972) finds that consumers pay 20 to 50 percent less for eyeglasses in states allowing price advertising than in those forbidding it.

E. *Estimating the Separate Effects of Price Advertising on Prices*

We have information on products advertised and whether particular stores advertise or not. Consequently, we are able to decompose the overall effect of advertising on prices into three separate effects corresponding to three mutually exclusive sets of price observations:

(1) prices of products at stores that do not advertise in the newspaper. We term this the "nonadvertising store effect";
(2) not-currently advertised prices of products at stores that currently advertise other products. We term this the "advertising store effect"; and
(3) currently advertised prices of products at stores that currently advertise them. We term this the "advertised product effect."

The last of the three is the effect that Glazer (1981) measures with longitudinal data on

TABLE 5—EFFECT OF ADVERTISING ON PRICES, BY STORE TYPE

	State-product and store fixed effects		Store-product fixed effects	
	Log price in Massachusetts and Rhode Island	Markup in Massachusetts and Rhode Island	Log price in Massachusetts and Rhode Island	Markup in Massachusetts and Rhode Island
Nonadvertising Rhode Island store [1,328]	−0.15 (−0.38)	−0.56 (−1.37)	−0.26 (−0.58)	−0.48 (−1.03)
Nonadvertised product at an advertising Rhode Island store [124]	−0.19 (−0.23)	−0.41 (−0.48)	−0.13 (−0.14)	−0.28 (−0.29)
Own-advertised product at an advertising Rhode Island store [22]	−21.43 (−11.83)	−22.14 (−11.41)	−24.16 (−13.14)	−24.84 (−12.94)
H_0: Same coefficient for all nonadvertised products (Probability value)	0.00 (0.86)	0.00 (0.96)	0.02 (0.88)	0.05 (0.83)

Notes: Coefficients are in percentages. *T*-statistics are in parentheses. Number of price observations by category in brackets reported in heading column. Regressions in columns 1 and 2 include separate product effects for each state, time effects, and store fixed effects. Regressions in columns 3 and 4 include time effects and store-product effects. All regressions are based on 6,480 observations.

prices of commonly advertised produce and meat products at grocery stores during and after a newspaper strike. If retailers advertise low prices on selected "loss leaders" solely to attract consumers to the store, then the advertised product effect may be very different from the overall effect of advertising on prices.[26]

Table 5 reports three separate effects of advertising on prices for the three mutually exclusive sets of prices. The results are striking. First, under each measurement approach, stores running ads reduce the advertised products' prices by about 20 percent. This "advertised product effect" is similar in magnitude to that found by Glazer (1981), but we find no consistent evidence that this effect of price advertising propagates across products or stores. Prices of products in the other two categories, by contrast, remain constant relative to prices in Massachusetts.[27] Indeed, under each measurement approach, one cannot reject the hypothesis that all effects, save the "advertised product effect," are identical.[28]

F. *Own and Rival Advertising*

One question we can address is how firms price when rivals advertise, which we term the "rival advertised price effect" to distinguish it from the own "advertised price effect." The question is whether the "own store" charges lower prices on a product (e.g., Korbel Brut), when a rival advertises its price on that same product. Because stores face customers with different mixes of price elasticities of demand, different stores may change their prices differently in the presence of rival price ads. Consequently, we decompose the effect of a rival advertising the price of a particular product according to whether the own store is an advertising store as well as whether it is advertising its Korbel Brut price. We accomplish this decomposition by interacting a dummy variable indicating the presence of rival advertising on a product with dummies for each of the three mutually exclusive groups of prices defined above.

[26] For example, Rajiv Lal and Carmen Matutes (1994) show that loss-leader pricing can lead to an increase in the prices of nonsale items (see also Bagwell and Ramey, 1994a, b).

[27] Prices in these two categories are also statistically indistinguishable from a fourth category, prices at stores that advertise in the window but not in the newspaper.

[28] To see that the results in Table 5 are consistent with the small overall effects in Table 4, note that advertised products make up a small fraction of the sample.

TABLE 6—EFFECT OF ADVERTISING ON PRICES, BY STORE TYPE AND THE PRESENCE OF RIVAL ADVERTISING

	State-product and store fixed effects				Store-product fixed effects			
Definition of rival store:	Any store advertising in Rhode Island newspaper	Any store advertising in Rhode Island newspaper	Only stores within five miles	Only stores within two miles	Any store advertising in Rhode Island newspaper	Any store advertising in Rhode Island newspaper	Only stores within five miles	Only stores within two miles
Nonadvertising store in Rhode Island [$N = 1{,}328$]	−0.24 (−0.53)	−0.37 (−0.80)	−0.39 (−0.88)	−0.32 (−0.71)	−0.15 (−0.37)	−0.23 (−0.57)	−0.26 (−0.66)	−0.24 (−0.62)
Nonadvertised product at an advertising store [$N = 124$]	−0.11 (−0.12)	0.63 (0.63)	0.49 (0.51)	0.64 (0.68)	−0.18 (−0.23)	−0.003 (−0.004)	0.24 (0.28)	0.38 (0.46)
Own-advertised product at an advertising store [$N = 22$]	−24.14 (−13.05)	−16.42 (−6.38)	−16.50 (−6.42)	−16.69 (−7.76)	−21.43 (−11.69)	−13.77 (−5.11)	−13.73 (−5.10)	−10.51 (−4.66)
Rival advertised product [$N = 355$]	−0.08 (−0.14)				−0.001 (−0.003)			
Rival advertised product × nonadvertising Rhode Island store		0.56 (0.95) [$N = 312$]	1.15 (1.79) [205]	1.23 (1.17) [62]		0.32 (0.62)	0.73 (1.20)	1.09 (1.03)
Nonadvertised product at an advertising store in Rhode Island		−2.74 (−1.81) [$N = 31$]	−3.31 (−1.81) [22]	−5.66 (−2.49) [13]		−0.51 (−0.33)	−2.14 (−1.21)	−5.55 (−2.54)
Own-advertised product at Rhode Island advertising store		−13.79 (−4.20) [$N = 12$]	−13.76 (−4.19) [12]	−23.10 (−6.57) [7]		−12.41 (−3.83)	−12.75 (−3.93)	−28.38 (−8.15)

Notes: Coefficients are in percentages. *T*-statistics are in parentheses. Number of price observations by category in brackets reported in heading column. Regressions in columns 1–4 include separate product effects for each state, time effects, and store fixed effects. Regressions in columns 5–8 include time effects and store-product effects. All regressions are based on 6,480 observations.

Prior to the change in the Rhode Island law, we asked store owners how they expected the possible change in the law to affect their businesses. Most said they would not advertise in the paper. Asked how he would respond to possible advertising by a large nearby store (that ultimately advertised heavily), the owner of a small store that did not ultimately advertise colorfully responded, "If he lowers his price, I'll lower mine. I ain't gonna roll over and play dead, for nobody."[29] Here we attempt to measure the relationship between own pricing and rival advertising more systematically.

In Table 6, we report results only for the differences in differences in log price measurement approach. We observe similar patterns of results with markups as the dependent variable. The specification described in the first column of Table 6 is similar to that of Table 5, but for the addition of one variable, the "rival advertised product." This dummy variable is one whenever a product is advertised in the newspaper (by any other store). The estimates in Table 6 show that own prices of a product are not systematically different when rivals advertise the product. Recall that the own-advertised product effect is −20 percent, suggesting that prices of rivals' advertised products are also 20 percent below their customary levels.

In the second column of Table 6, we interact rival advertising with the three mutually exclusive categories of prices: prices at nonadvertising stores, nonadvertised prices at newspaper-advertising stores, and advertised prices at the

[29] Interview with anonymous Rhode Island liquor store owner, June 25, 1995.

stores that advertise them. Our goal is to see whether prices in these three categories vary differently when rivals advertise. The results show different own-price changes when rivals run price ads, depending on own-store advertising status. An own-advertised product is priced 13.79 percent lower when it is also advertised by a rival. (Note that the effect of own advertising of the product, over 20 percent in Table 5, falls to −16.42 percent in Table 6 because of the correlation between own and rival advertising). When a rival runs a price ad, a newspaper-advertising store not currently advertising the product charges 2.74 percent less (although this difference is only marginally significant). Nonadvertising stores' prices are not significantly different in the presence of rival advertising.

If these rival advertised product effects reflect responses to rival behavior, then they should be more pronounced when we restrict the definition of rival to include only stores in the immediate vicinity. In the third and fourth columns, we define rival stores as all those within five or two miles, respectively. The pattern of responses documented above becomes more pronounced for narrower definitions of rivals. Prices of products advertised by both a store and rivals within 2 miles are 23 percent lower than products advertised only by that store (this estimate is significant despite the small cell size of seven price observations). The "play dead" result is also more pronounced: nonadvertising stores raise prices on products advertised by rivals by 1 percent, although this result is not significant. The strengthening of the result pattern with more narrow definitions of rivalry supports the interpretation of these effects as responses to rival behavior.[30]

The important result in Table 6 is that different stores price differently in the presence of rival advertising. This is not consistent with the predictions of Stigler (1961), in which all stores would be compelled to reduce their prices to meet the competition, reducing the mean and variance of prices. Indeed, because nonadvertising stores, which charge higher prices, do not reduce their prices, while lower-price stores do reduce their prices, the variance of prices appears to increase. However, the results are consistent with models such as Salop and Stiglitz (1977). When different stores face demand curves with different elasticities, they will optimally charge different prices.

[30] An alternative explanation that we tested and rejected is that our rival-advertised price effects reflect large stores' stocking up and discounting products in anticipation of impending wholesale price increases. We tested this hypothesis by regressing log wholesale prices for the eight sample time periods on 33 product fixed effects and a dummy indicating whether some retailer is currently advertising the product in the newspaper. The coefficient on the ad variable is insignificant.

G. *Do Advertisers Sell More?*

Like previous studies of advertising prohibitions, we have thus far focused on the effects of advertising on posted prices. However, unlike previous studies, we can not infer that advertising leads to lower prices for consumers, since we do not observe a uniform decrease in posted prices. Nevertheless, there are two reasons to believe that consumers may indeed pay lower prices. First, consumers may substitute across products and time toward (deeply discounted) advertised products. Second, since advertising is a signal of lower average prices, more consumers may frequent lower-priced advertising stores.

We do not have information on quantities sold, by product or store, so we can not answer the question of whether consumers pay lower prices. However, we do have some indirect information on sales volume, by store, in the form of Rhode Island lottery sales. Virtually all Rhode Island liquor stores are also Rhode Island lottery outlets, and we were able to get lottery sales data, by store, for various time periods before and after the change in the law. We do not require the level of lottery sales to be a good proxy for quantities sold; we only require the change in lottery sales to be associated with the change in quantities sold. Further, we expect the change in lottery sales to somewhat understate changes in sales. To the extent that lottery buyers are loyal to certain stores, they will be relatively price insensitive in their alcohol purchases compared to the average customer.

We have lottery sales data for five time periods:

(1) Entire year 1995;
(2) Early 1996 (January 1, 1996 to September 30, 1996);

TABLE 7—PERCENT OF RHODE ISLAND LOTTERY SALES AT ADVERTISING AND NONADVERTISING STORES IN THE SAMPLE

	Number of stores	Entire year 1995	Early 1996 (1/1–9/30)	Late 1996 (10/1–12/31)	Early 1997 (1/1–4/22)	Mid-1997 (4/23–9/1)
Advertising stores	9	16.38	16.44	17.14	17.35	18.40
Nonadvertising stores	42	83.62	83.56	82.86	82.65	81.60

Notes: "Advertising stores" refers to stores ever employing newspaper price ads in effect during months of price data collection (through June 1997). "Nonadvertising stores" are stores that do not employ newspaper advertising, although they may post prices in their windows.

(3) Late 1996 (October 1, 1996 to December 31, 1996);
(4) Early 1997 (January 1, 1997 to April 22, 1997); and
(5) Mid-1997 (April 23, 1997 to September 1, 1997).

The first period, entire year 1995, is prior to the change in the law. The second period, unfortunately, spans the pre- and postperiod. Roughly two-thirds of the period occurs before the change in law and the remainder after. The latter three periods are all after the prohibition on price advertising was lifted. Table 7 reports the fraction of Rhode Island lottery tickets sold, among tickets sold by liquor stores in our sample, by whether they ever employ newspaper price ads after the law change.

The pattern of sales by stores that run newspaper advertisements suggests that sales volume increased at stores that advertise. While the nine sample stores that eventually advertise prices in the newspaper sell 16.38 percent of the lottery tickets in the sample in 1995, they sell 18.40 percent in mid-1997. The increase in share occurs almost exclusively after the law change. Between late 1996 and mid-1997, lottery ticket volumes at advertising stores increase by 7.4 percent.

We find this evidence of increased quantities sold at advertising stores even though most prices at advertising stores do not fall (relative to prices at nonadvertising stores). Nevertheless, stores which ever advertise in the newspaper did have lower initial prices than nonadvertising stores, so increased sales at price-advertising stores may arise because price advertising allows stores to communicate their low average prices. This is the mechanism that Bagwell and Ramey (1994a, b) use to explain a theoretical effect of price advertising on prices. However, stores that ever employ window advertising (but not newspaper advertising) also had lower initial prices, but these stores did not realize an increase in lottery sales after the change in the law.

TABLE 8—PRICE DISPERSION IN RHODE ISLAND AND MASSACHUSETTS BEFORE AND AFTER ADVERTISING

	Rhode Island	Massachusetts
	A. Standard deviation of store effects	
Preadvertising	\$0.620	\$0.689
Postadvertising	\$0.735	\$0.783
	B. Standard error of regression of prices on product and time dummies	
Preadvertising	\$1.018	\$1.248
Postadvertising	\$1.283	\$1.320

Notes: Panel A standard deviations are calculated as the standard deviations of store fixed effects from regressions of prices on store, product, and time dummies. Four separate regressions are run for Massachusetts and Rhode Island, before and after the change in the law. The standard errors in Panel B are based on four separate regressions of prices on product and time dummies.

H. *Effects on Variance of Prices*

As noted above, Stigler (1961) predicts that advertising should lead to a reduction in price dispersion across stores; this claim has found some support in cross-sectional studies cited above. Below we test the effect of advertising on the dispersion of prices. In a world of one product, it would be straightforward to test this claim by comparing the variance in prices across stores before and after the advent of advertising. However, our task is somewhat more complicated by the fact that we observe multiple products.

We measure interstore price variance in two ways. First, we calculate the interstore

variation in store fixed effects. Store fixed effects are calculated from separate pre- and postlaw-change regressions of the price level on product dummies, store dummies, and time dummies; we report these standard deviations for each state in Table 8. The standard deviation of the estimated store effects in Rhode Island rises from $0.620 before the law changed to $0.735 afterwards (an increase of over 11 percent). This is not consistent with the claim that advertising reduces price dispersion, but we do not know if the variance in prices would have increased in the absence of the change in law. Therefore, we compare these results to the same in Massachusetts. The standard deviation of store fixed effects in Massachusetts also rises, from $0.689 to $0.783 (both increases are statistically significant). Both the absolute and relative increases in the standard deviation of store effects is greater in Rhode Island than in Massachusetts ($0.069 vs. $0.048 and 11.1 percent vs. 6.5 percent), so it is clear even without formal statistical tests that price dispersion does not decline with the advent of advertising.

Our second test compares regression standard errors from regressions of price levels on product dummies and time dummies. This "unexplained variation" in prices reflects not only interstore price variation but also within-store variation. We run four separate regressions: one for the time period before advertising in each state, and one for the postadvertising period in each state. The results are also reported in Table 8. The standard errors of these regressions increase in both states, but more so in Rhode Island ($0.230 vs. $0.037 and 22.6 percent vs. 2.9 percent). Again, there is no evidence of a reduction in price dispersion.

It is possible that the increased Rhode Island dispersion arises because of the difference between advertised and nonadvertised prices. To test this, we ran regressions of Rhode Island postlaw-change prices on time dummies, product dummies, and indicators for whether the product's price is advertised (a) anywhere and (b) here. The residual variation declines only slightly with the inclusion of these advertising dummies and remains far above its Rhode Island preadvertising level.

IV. Conclusion

Price advertising has traditionally been expected to increase customers' demand elasticities, causing all stores to reduce their prices toward competitive levels and thereby reducing the mean and variance of prices. This has been the consistent finding of an empirical literature based almost exclusively on cross-sectional comparisons of prices in jurisdictions allowing—and those forbidding—price advertising. A more recent theoretical literature posits that consumers face different costs of obtaining information, so that price advertising may differentially inform potential customers at different stores. In the postadvertising equilibrium, stores may face different demand curves and may therefore price differently.

Using unique longitudinal data on liquor products, we find that Rhode Island prices decline insignificantly, relative to Massachusetts prices, after Rhode Island's ban on liquor price advertising is lifted. While the prices of advertised products fall by over 20 percent at the stores that advertise them, other prices do not change on average under the advertising regime. We find that stores' responses to rival price ads vary by their own advertising status. Newspaper-advertising stores tend to reduce their prices of rival-advertised products, while nonadvertising stores do not. When a product is advertised by a rival, a store advertising the same product sets its price substantially lower than if the store alone advertised the product's price.

Our results are interesting in two ways. First, using longitudinal data on an exogenous policy change, we find no significant overall effect of the price-advertising regime on prices charged in the first year that price advertising is allowed. This result stands in sharp contrast with existing results based on cross-sectional studies. Second, our results on stores' heterogeneous responses to rival stores' ads suggest that price advertising affects different stores differently.

Two important caveats are in order. First, our data describe prices charged, not average prices paid. While stores do not change the prices they charge, we present suggestive evidence, based on lottery ticket sales, that the lower-priced newspaper-advertising stores attract more business after they begin to advertise. Second, although we have data on prices for a full year

after the change in the law, the long-run effects may require more time. The long-run impact of the lifting of the ad ban may eventually entail failure and exit of small, high-priced stores. Similarly, customers may become more informed over time, leading to the effects envisaged by Stigler (1961). We believe that additional studies using panel data and broad coverage of products would be useful.

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